Project Completion Report

Islamic Republic of Pakistan

The Project for Technical Assistance on
Implementation of Bridge Management System in NHA

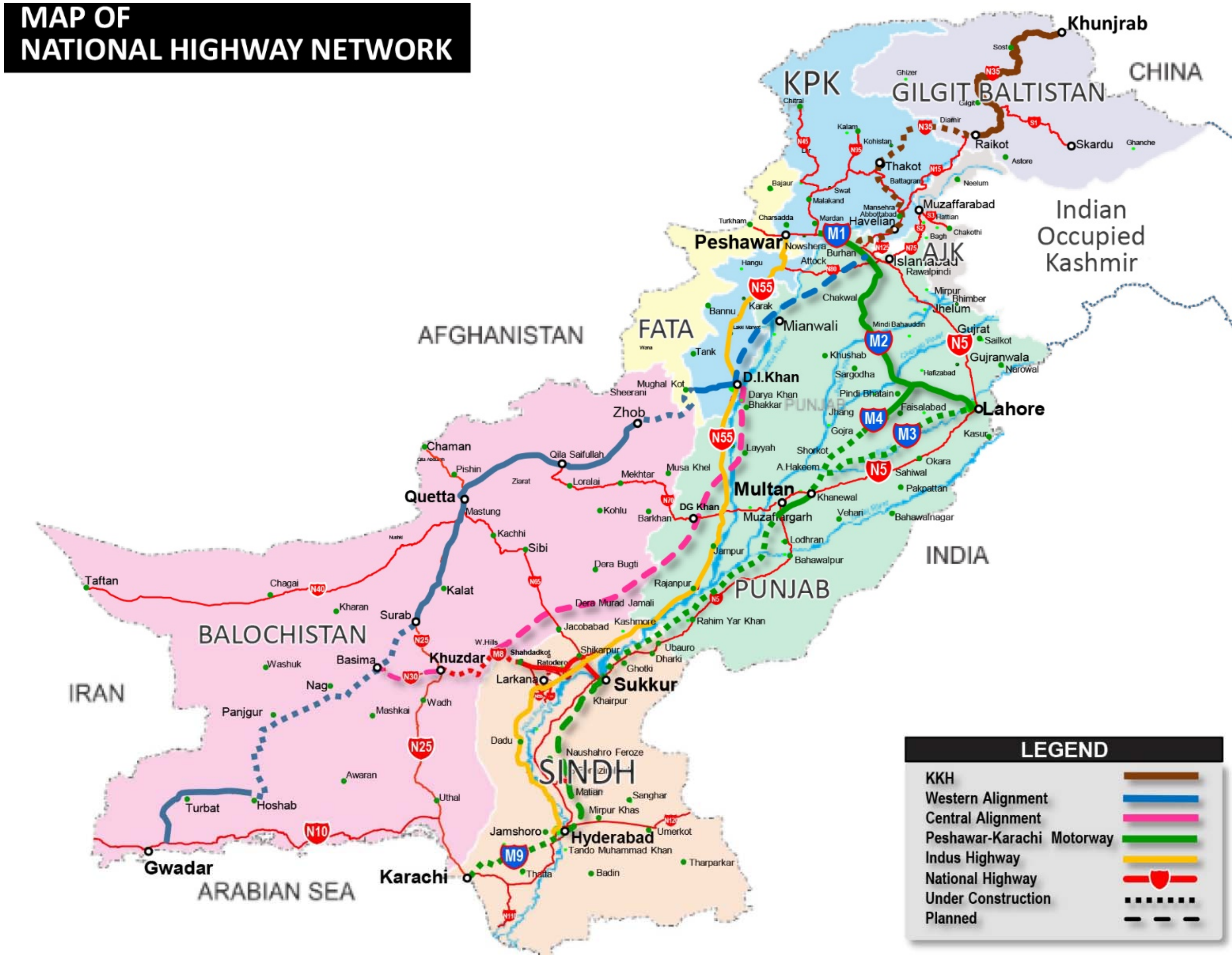
April 2019

Japan International Cooperation Agency JICA

Pacific Consultants Co., Ltd.

（Source: JICA）

Map of Pakistan（パキスタン地図）



S#		Road Description	Length (kms)
1		Northern Route	784
-		Khunjrab-Raikot	335
-		Raikot-Thakot	270
-		Thakot-Havelian	120
-		Havelian-Burhan	59
2		Western Alignment	2,461
-		Northern Route	784
-		Burhan-D.I.Khan	285
-		D.I.Khan-Zhob	205
-		Zhob-Quetta	331
-		Quetta-Surab	214
-		Surab-Hoshab	449
-		Hoshab-Gwadar	193
3		Central Ailgnment	2,545
-		Northern Route	784
-		Burhan-D.I.Khan (Partial Western Alignment)	288
-		D.I.Khan-Jampur	250
-		Jampur-Wangu Hills	363
-		Wangu Hills-Khuzdar	108
-		Khuzdar-Basima	110
-		Basima-Gwadar (Partial Western Alignment)	642
4		Peshawar-Karachi Motorway	1,512
-		Peshawar-Islamabad	155
-		Islamabad-Pindi Bhattian	235
-		Pindi Bhattian-Multan	298
-		Multan-Sukkur	392
-		Sukkur-Hyderabad	296
-		Hyderabad-Karachi	136
5	N-5	Karachi-Lahore-Peshawar-Torkham	1,819
6	N-5A	Khanewal - Bahawalpur (Lodhran)	109
7	N-10	Makran-Coastal; Liari-Ormara-Gwadar-Jiwani	653
8	N-15	Mansehra-Naran-Jalkhad-Chilas	240
9	N-25	Karachi-Kalat-Quetta-Chaman (Partial Western Alignment)	813
10	N-35	Hassanabdal-Thakot-Khunjrab (Partial Northern Route)	806
11	N-40	Lakpass-Dalbandin-Taftan	610
12	N-45	Nowshera-Dir-Chitral	309
13	N-55	Kotri-Larkana-D.G.Khan-D.I.Khan-Peshawar	1,264
14	N-65	Sukkur-Sibi-Quetta	385
15	N-70	Multan-D.G.Khan-Loralai-Qila Saifullah	447
16	N-75	Islamabad-Satra Mile-Lower Topa-Kohala	90
17	N-80	Tarnol-Fateh Jang-Jand-Khushal Garh-Kohat	146
18	N-90	Khwazakhela - Besham	64
19	N-95	Chakdara - Kalam	135
20	N-105	Larkana - Naudero - Lakhi	61
21	N-110	Gharo - Keti Bunder	90
22	N-120	Hyderabad - Mirpurkhas - Umarkot - Khokhrapar (Indian Border)	220
23	N-125	Taxila - Khanpur - Haripur	44
24	N-155	Larkana - Moenjo Daro Road up to Airport	28
25	N-255	Larkana - Nasirabad via Rasheed Wagan	34
26	N-305	Sakrand - Shaheed Benazirabad	35
27	N-455	Larkana - Kamber - Shahdadkot	50
28	N-655	Ratodero - Naudero Road incl. Internal Road of about 2 Km	18
29	S-1	KKH-Skardu Road (Strategic Road)	167
30	S-2	Kohala-Muzaffarabad	40
31	S-3	Muzaffarabad - Chakothi	55
32	M-3	Lahore-Abdul Hakeem	230
33	M-10	Karachi Northern Bypass	57

（Source: http://nha.gov.pk/en/maps/ より）

Map of National Highway Network（国道路線図）

Abbreviations

Organization

AD	Assistant Director
BMU	Bridge Management Unit
C/P	Counterpart
DD	Deputy Director
HRTC	Highway Research and Training Center
HQ	Headquarter
JCC	Joint Coordinating Committee
JICA	Japan International Cooperate Agency
JWG	Joint Working Group
MT	Master Trainer
MU	Maintenance Unit
NHA	National Highway Authority
RAMD	Road Asset Management Division
RO	Regional Office
TE	Trainee Engineer

Others

AMP	Annual Maintenance Plan
BIDB	Bridge Inspection Database
BMS	Bridge Management System
CPEC	China Pakistan Economic Corridor
CSR	Composite Schedule of Rates
FWD	Falling Weight Deflectometer
IRI	International Roughness Index
M/M, MM	Minutes of Meeting
M/M, MM	Man Month
MPD	Main Points Discussed
NDT	Non-Destructive Test
ODA	Official Development Assistance
OJT	On-the-Job Training
PDM	Project Design Matrix
PMS	Pavement Management System
PO	Plan of Operation
R/D	Record of Discussion
RAMS	Road Assets Management System
SOP	Standard Operating Procedure

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1. Basic Information of the Project

1.1 Country

Islamic Republic of Pakistan

1.2 Title of the Project

The Project for Technical Assistance on Implementation of Bridge Management System in NHA in the Islamic Republic of Pakistan

1.3 Duration of the Project

Planned: from July 12, 2016 to January 21, 2019 (31 months)

Actual: from July 12, 2016 to April 26, 2019 (34 months)

1.4 Background

The transportation sector in Pakistan accounted for 13.7% of GDP in 2011/12, and it is one of the most important sectors supporting economic activities. Within the transportation sector, road transport plays a big role, accounting for 92% of all passenger transport and 96% of freight transport, but low quality in transportation, such as long transportation times, cargo damage due to bad road conditions and high volume of traffic, is a problem. On the basis of the "Poverty Reduction Strategy Paper"[1], the Government of Pakistan is working on "Accelerating Economic Growth" and "Reducing Poverty", and the development of the transport infrastructure is positioned as an important element in supporting economic growth. In the said paper, measures and policies for securing adequate improvement and maintenance of roads are considered necessary, especially in response to the future increase in traffic demand. In "Pakistan Vision 2025"[2], "Improvement of infrastructure and strengthening regional connectivity" is set as one of the seven pillars that constitute the priority areas, and the transportation system is to be developed comprehensively in order to contribute to economic growth with comprehensive development of the transportation sector; targeted is the strategic implementation of the reduction of transportation costs, improvement of traffic safety, strengthening of connections between rural areas and markets/urban areas, extension of the road network, and expanded traffic capacity of economic corridor.

Pakistan has an existing road network of about 263,000km, accounting for 92% of domestic passenger traffic and 96% of freight traffic. Approximately 80% of road users in Pakistan rely on the national highways. The National Highway Authority (NHA) under the control of the Ministry of Communications (MOC) is responsible for the management, operation and maintenance of the national highway network totaling 12,131km, which is 4.6% of the overall road network of Pakistan, and includes about 5,000 bridges and 16,000 culverts[3].

[1] Accelerating Economic Growth and Reducing Poverty: The Road Ahead, Poverty Reduction Strategy Paper, Government of Pakistan, Ministry of Finance, December 2003

[2] Pakistan Vision 2025, One Nation – One Vision, Planning Commission, Ministry of Planning, Development & Reform, 29th May, 2014

[3] Inventory survey for all culverts, periodic inspection for culverts wider than 2.0m

To address road pavement maintenance, the Highway Development and Management Model 4 (HDM4) was introduced to NHA in 2003. In addition, a Road Asset Management System (RAMS) was developed as part of the World Bank's Highway Rehabilitation Project from February 2005 to March 2008. Road pavement maintenance has been implemented by NHA through the utilization of RAMS and HDM4.

Meanwhile, the Bridge Management System (BMS, a tool to gather bridge data for bridge maintenance management and repair planning) had been formulated as a component of RAMS. However, although the approximately 5,000 bridges and approximately 16,000 culverts on the national highway face the risks of premature deterioration and damage due to increased traffic volume, unchecked overloading, poor design and construction, etc., no maintenance plans have been formulated and periodic inspections have never been carried out.

As a result, repair works are carried out when damage is found, based on the concept of post-damage maintenance. However, by the time the damage is found, it is already difficult for repair works to be effective, so there are cases in which a bridge has to be replaced even though its design life has not been reached. Therefore, in order to keep bridges in good condition for a longer period of time, the bridge maintenance and management system urgently needs to be strengthened.

This being the situation, the Government of Pakistan requested Japan to provide technical cooperation in introducing preventive maintenance management using BMS. In response, the Japan International Cooperation Agency (JICA) conducted two surveys, in May and July of 2012, to confirm the necessity and the validity of the requests, reviewed the details of the requests, and studied and organized the necessary content of cooperation. After consultation, in July 2015, the JICA signed a record of discussions (R/D) on the framework of "the Bridge Maintenance and Management Project", and the Project has now been carried out.

1.5 Overall Goal and Project Purpose

(1) Initially Considered (PDM Version 1)

Overall Goal: Bridge maintenance status improved on the bridges on National Highways in Pakistan.

Project Purpose: Cost estimate necessary for bridge maintenance every fiscal year implemented on the basis of bridge inspection results of the bridges on National Highways in Pakistan.

(2) First Amendment (PDM Version 2 Amended)

Overall Goal: Bridge maintenance status improved on the bridges of National Highways in Pakistan.

Project Purpose: Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of entire NHA Network.

(3) Second Amendment (PDM Version 5 Amended[4])

Overall Goal: Bridge inspection and maintenance status improved on the bridges of

[4] The Project updated its PDM every time when it submitted a Monitoring Sheet to JICA. The latest PDM should be known as "Version3", not "Version 6", because the PDM has been revised twice since the commencement of the Project.

National Highways in the model area.

Project Purpose: Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.

The purpose of the Project is to implement the technical transfer for bridge and culvert inspection and selection of repair method through the development of manuals and formats required for bridge and culvert inspection and selection of repair method based on the current situation in Pakistan, and through the training of NHA staff. Further, BMS software and Bridge Inspection Database (BIDB) will be utilized in estimating the bridge maintenance costs for each fiscal year in order to improve the transportation infrastructure of Pakistan.

In order to achieve this goal, it is essential that the operation and maintenance cycle (see Figure 1-1) should be implemented efficiently through the building, improvement and strengthening of procedures. Located at the center of the cycle will be a Bridge Inspection Database consisting of the Inspection Scheme, Bridge Inspection, Evaluation & Judgment, Operation & Maintenance Plans, and Repair & Rehabilitation works. These items will be transferred through the technical transfer training.

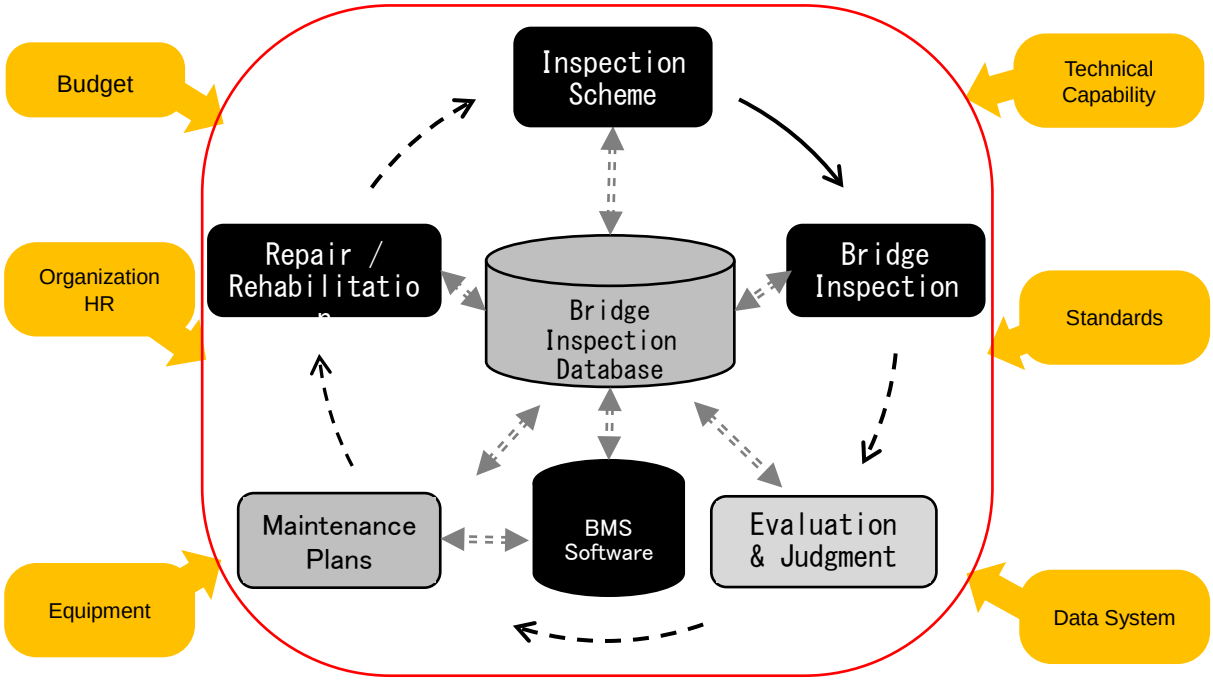


Figure 1-1 Ideal Bridge Operation & Maintenance System

1.6 Implementing Agency

(1) Sponsored by

Japan International Cooperation Agency (JICA)

(2) Related Ministry and Authority

(a) Counterpart (C/P)

NHA (National Highway Authority)

(b) Supervision Ministry

MOC (Ministry of Communications)

1.7 Project Outline

The Project Outline is set out as follows;

(1) Overall Goal

Overall Goal:	Bridge inspection & maintenance status improved on the bridges of National Highways in the model area.
Objective Verifiable Indicators:	1) The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan. 2) In the model area, more than [65] bridges are annually inspected and the bridge maintenance plan is annually revised.

(2) Project Purpose

Project Purpose:	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.
Objective Verifiable Indicators:	Bridge maintenance plan with breakdowns for the model area prepared by [November, 2018].

(3) Outputs

Output 1:	Manuals, Database and BMS developed for bridge inspection and bridge repair
Activity 1-1:	JICA Expert Team develops draft manuals for (1) bridge/culvert inspection, (2) bridge/culvert repair and (3) data input.
Activity 1-2:	JICA Expert Team develops draft bridge/culvert inspection formats.
Activity 1-3	JICA Expert Team develops Prototype Bridge Inspection Database & BMS.
Activity 1-4:	JICA Expert Team develops draft training materials for (1) bridge/culvert inspection and (2) bridge/ culvert repair.
Activity 1-5:	BMU reviews and finalizes the above manuals, inspection formats, prototype and training materials.
Output 2:	Bridge/culvert inspection in the model area is implemented after

BMS training.

Activity 2-1: JICA Expert Team provides on-the-job-training (OJT) which enables BMU to manage BMS training in NHA.

Activity 2-2: BMU implements BMS training (Inventory Survey Training and Bridge Inspection Training).

Activity 2-3: Inventory Survey and Bridge Inspection on-the-job-training (OJT) are implemented after BMS training.

Activity 2-4: JICA Expert Team reviews the inspection results and ability, and advises BMU to enhance their capacity.

Output 3: Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.

Activity 3-1: JICA Expert Team implements BIDB & BMS Software Training for BMU.

Activity 3-2: BMU analyzes Bridge Inspection Data of the model area included in database using BMS Software.

Activity 3-3: BMU prepares the annual bridge/culvert maintenance plan including budget estimation based on the analysis of registered data in Bridge Inspection Database.

(4) Target locations / sites

In/around Islamabad, Pakistan (for on-site training)

Targets are bridges/culverts on the national highways of NHA in the model area (jurisdictions of Rawalpindi and Wazirabad Maintenance Units)

(5) Work Flowchart

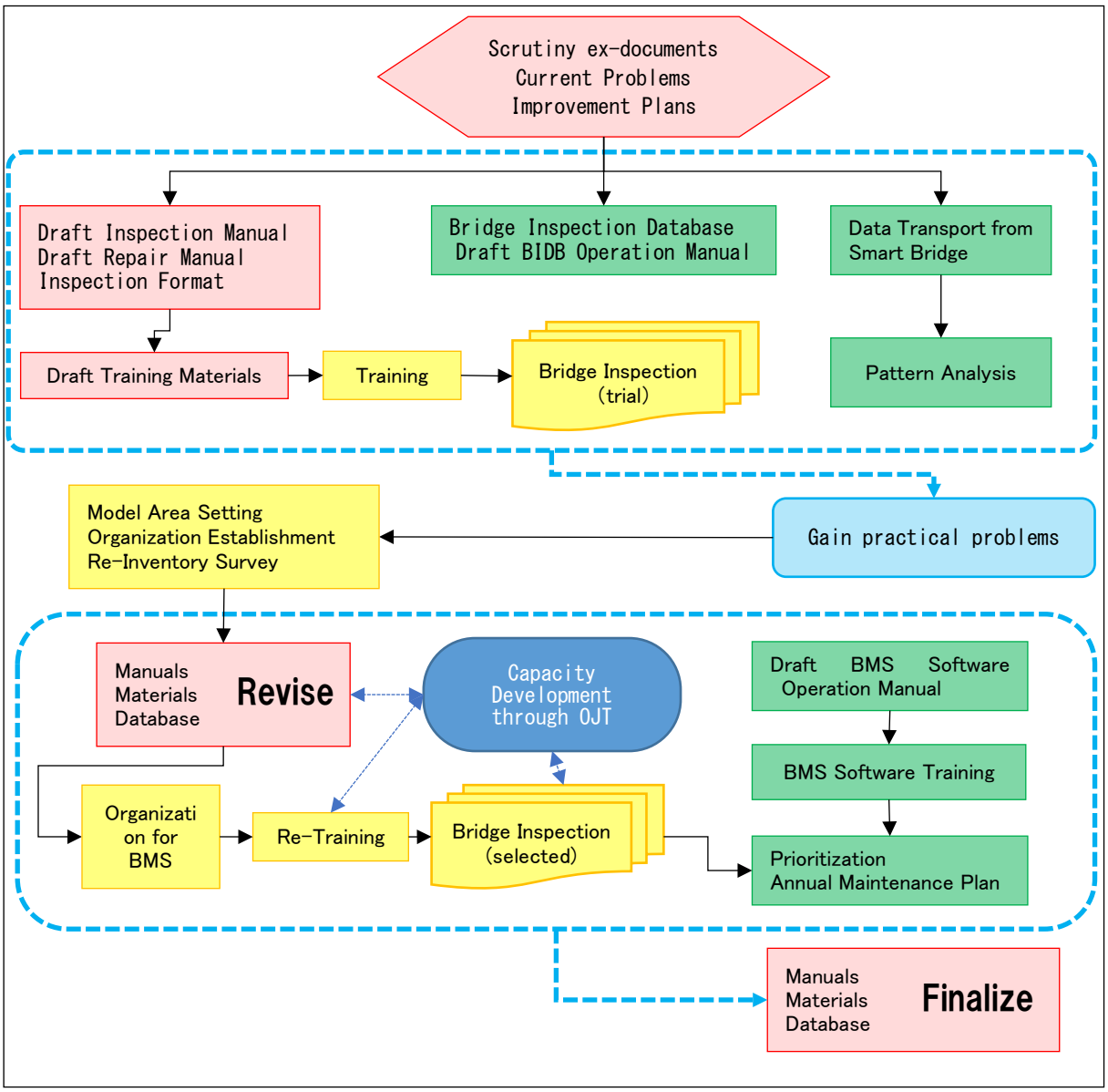


Figure 1-2 Work Flowchart

(6) Project Schedule

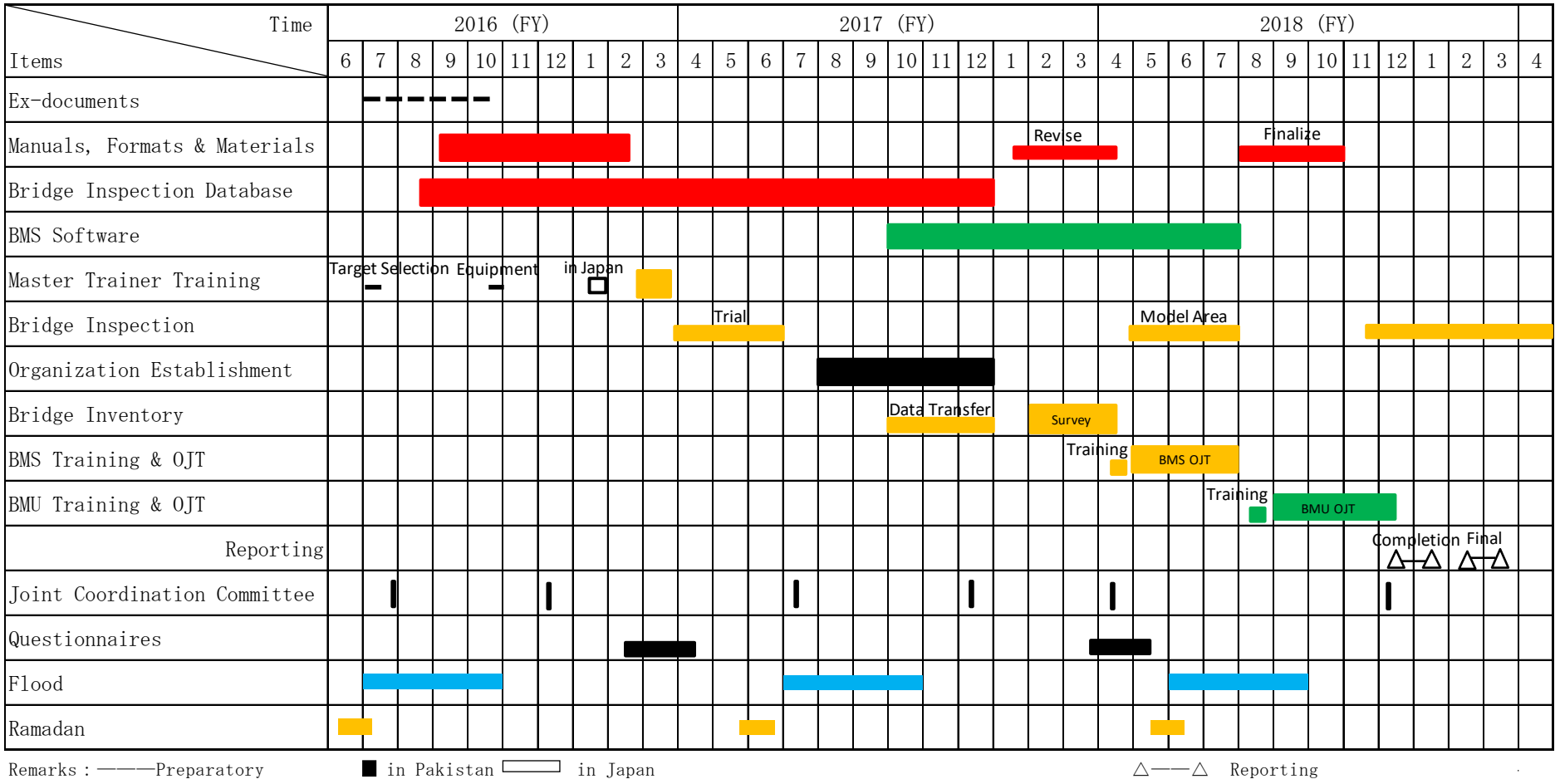


Figure 1-3 Project Schedule

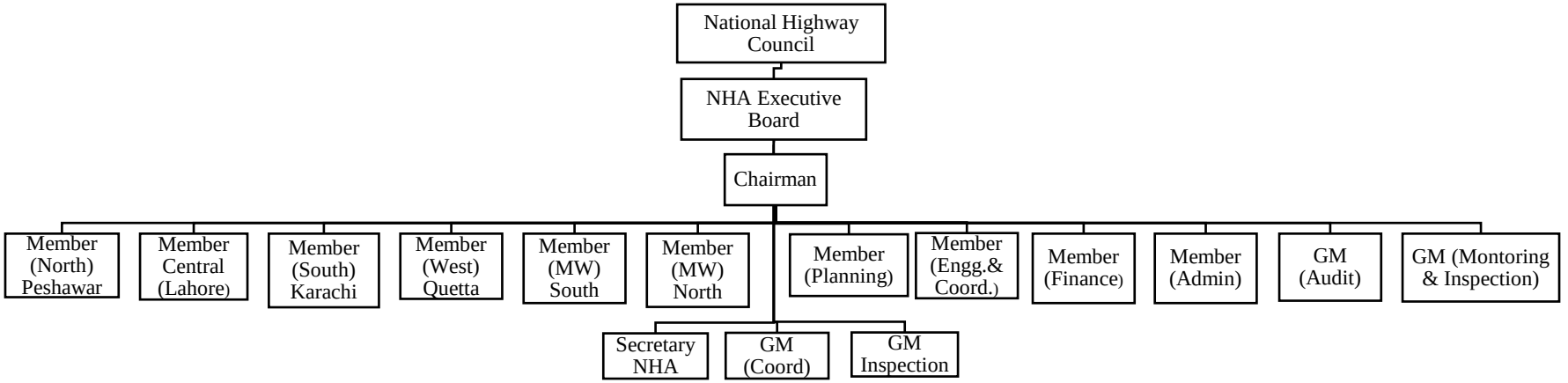
1.8 Project Structure

(1) JICA Expert Team

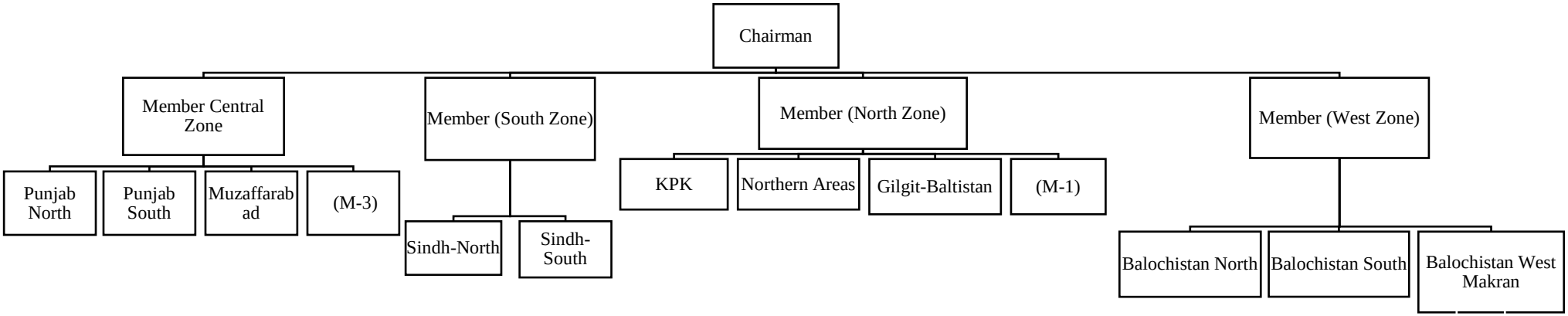
Expertise	Name	
Project Manager/Bridge Inspection	Yukio Igo	
Bridge Repair	Yoshiichi Fujimoto	
BMS (System Design)	Akio Mori	
BMS (System Design Assistance)	Shougo Abiru	
Capacity Development	Haruo Tomiyama	
Project Monitoring	Kenichi Tomi	
Project Monitoring(2)	Toshiko Shimada	
BMS (Specification Logic)	Fumiatsu Kamitani	
BMS (Specification Logic Assistance)	Ryo Nakai	

(2) Counterpart Organization

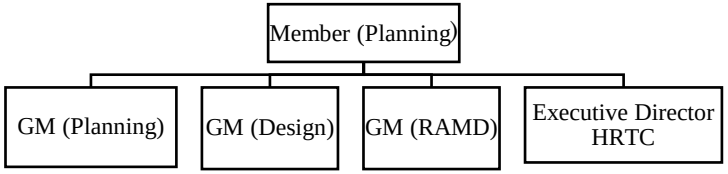
Organizational Structure of NHA (2018, September)



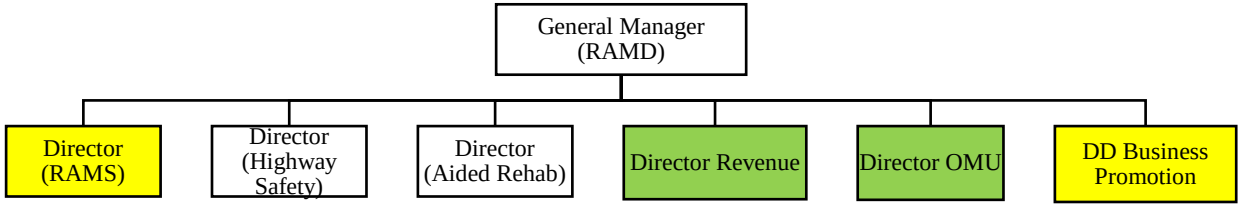
Organization under Members (Zones)



Organization under direct control of Member Planning



Organization for General Manager (RAMD[5])

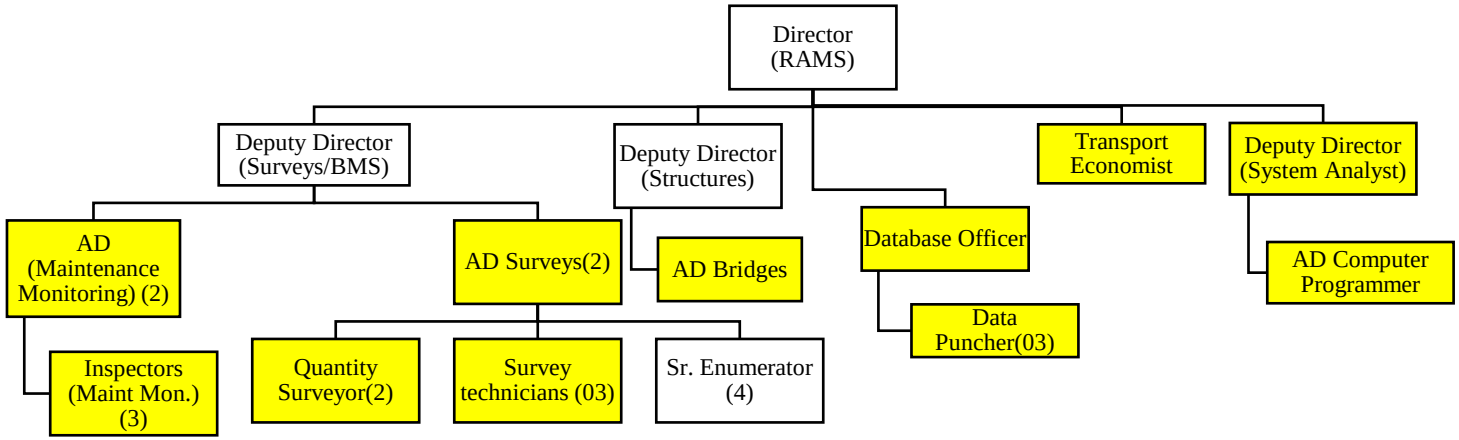


Shown as per approved organization structure in NHA code 2005. These posts have now been shifted to the Finance Wing.

Vacant positions

[5] RAMD: Road Asset Management Division, RAMS: Road Asset Management System

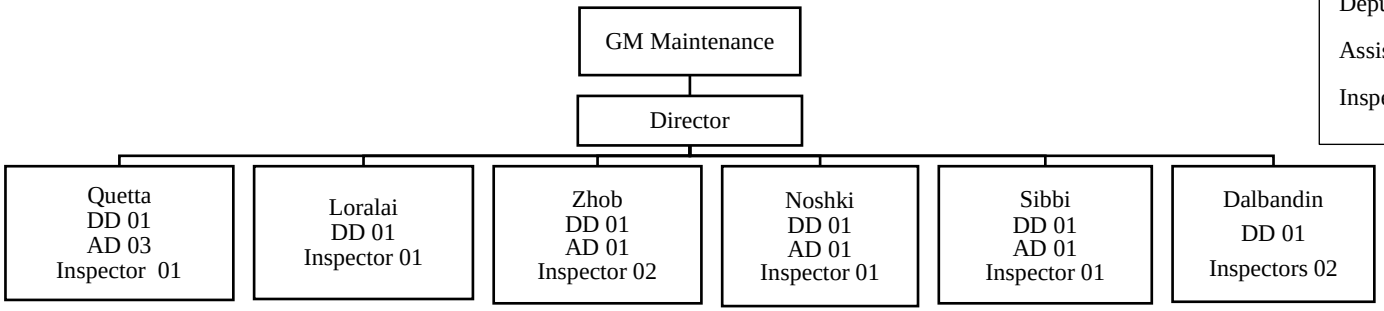
Organization under Director (Road Asset Management System)



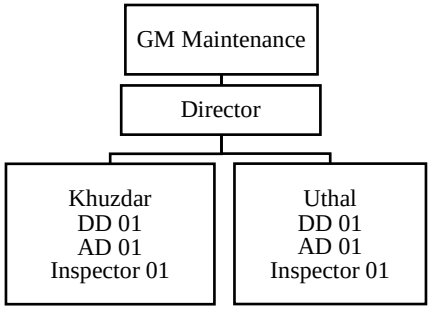
ORGANIZATION UNDER MEMBER (WEST ZONE)

General Manager 01
Director 01
Deputy Directors 06
Assistant Directors 06
Inspectors 08

Balochistan North

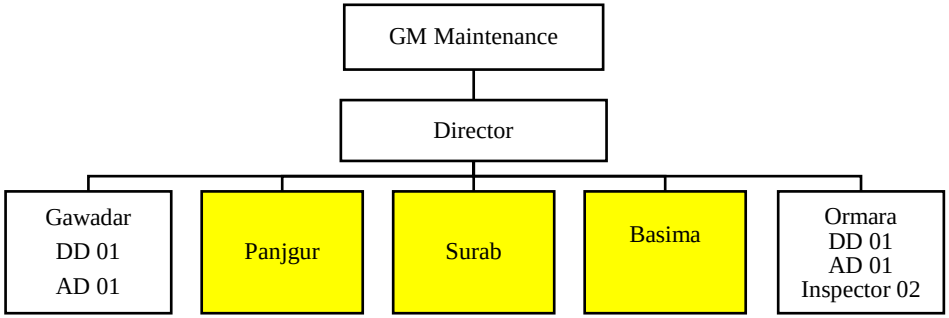


Balochistan South



General Manager 01
Director 01
Deputy Directors 02
Assistant Directors 02
Inspectors 02

Balochistan West Makran



General Manager 01

Director 01

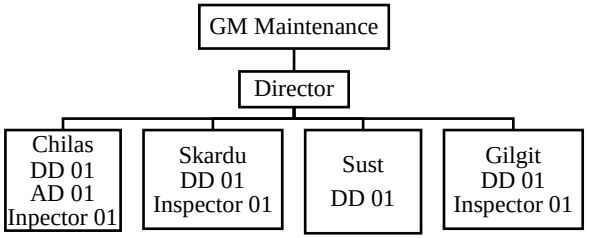
Deputy Directors 02

Assistant Directors 02

Inspectors 02

ORGANIZATION UNDER MEMBER (NORTH ZONE)

Gilgit Baltistan



General Manager 01

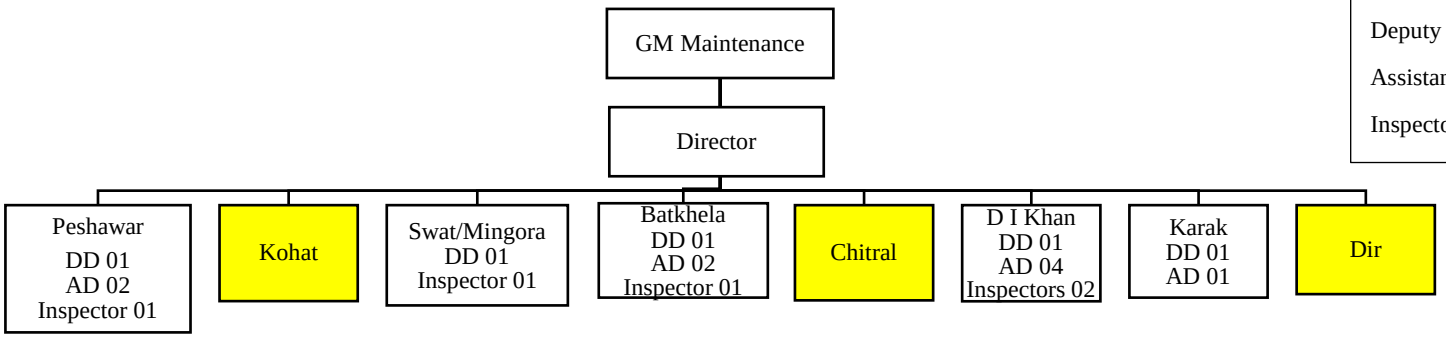
Director 01

Deputy Directors 04

Assistant Directors 01

Inspectors 03

Khyber Pakhtunkhwa



Member 01

General Manager 01

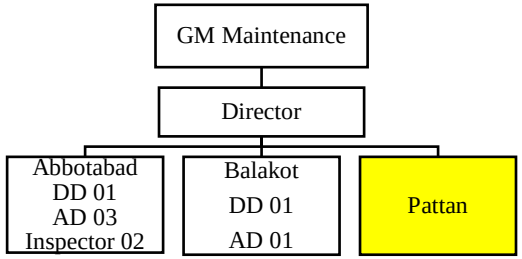
Director 01

Deputy Directors 05

Assistant Directors 09

Inspectors 05

Northern Areas



General Manager 01

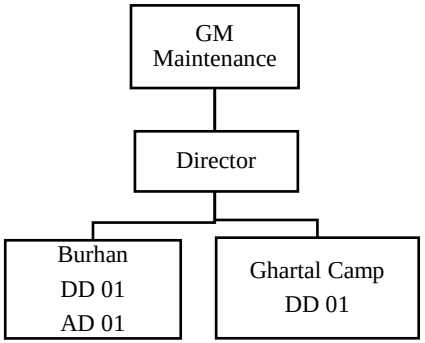
Director 01

Deputy Directors 02

Assistant Directors 04

Inspectors 02

ORGANIZATION UNDER MEMBER (MOTORWAYS NORTH)



General Manager 01

Director 01

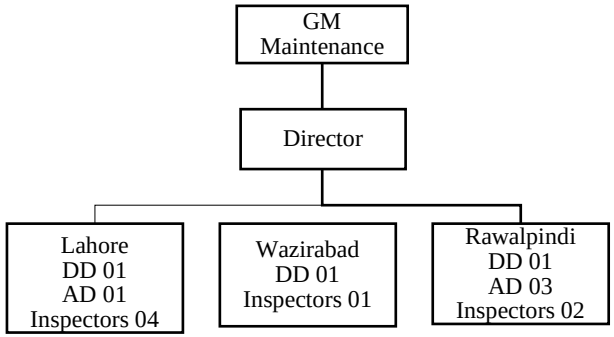
Deputy Director 02

Assistant Directors 01

Inspectors 0

ORGANIZATION UNDER MEMBER (CENTRAL ZONE)

Punjab North



General Manager 01

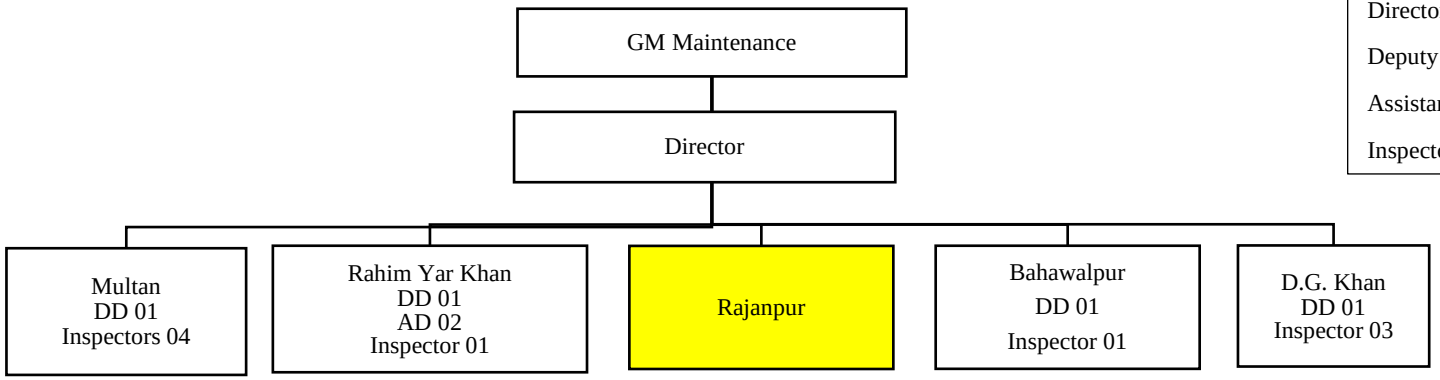
Director 01

Deputy Directors 03

Assistant Directors 04

Inspectors 07

Punjab South



General Manager 01

Director 01

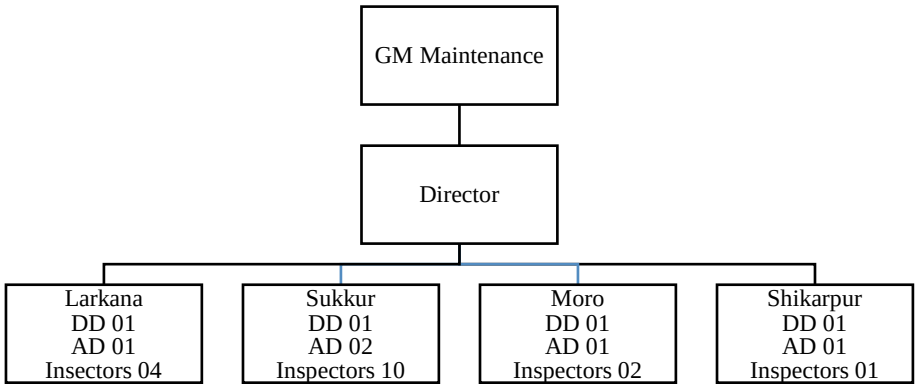
Deputy Directors 04

Assistant Directors 02

Inspectors 09

ORGANIZATION UNDER MEMBER (SOUTH ZONE)

Sindh North



General Managers 01

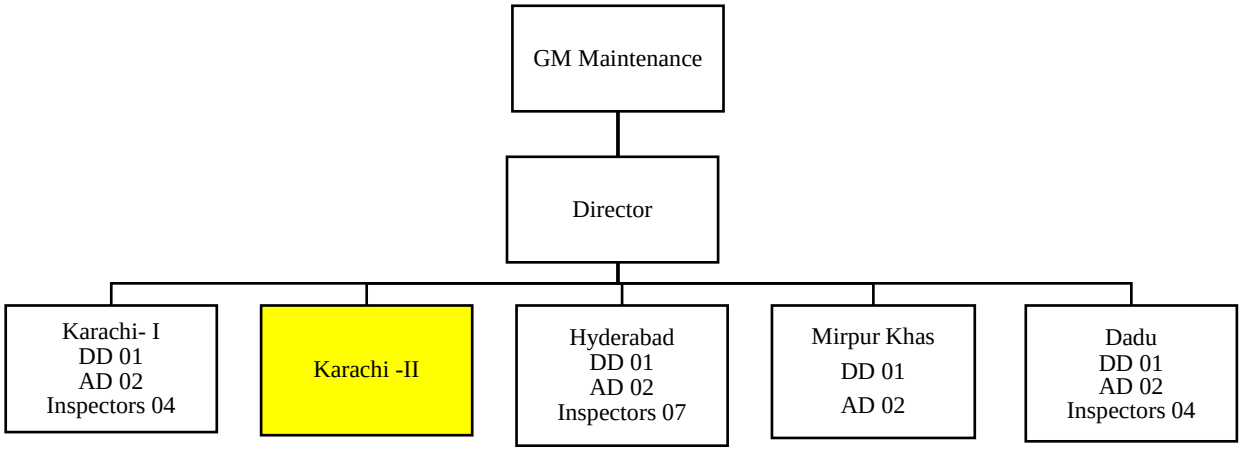
Director 01

Deputy Directors 04

Assistant Directors 05

Inspectors 17

Sindh South



General Managers 02

Directors 01

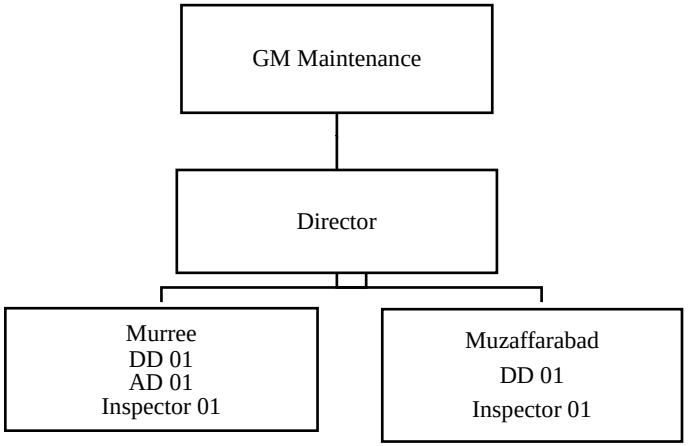
Deputy Directors 04

Assistant Directors 08

Inspectors 15

ORGANIZATION UNDER MEMBER (ENGG. COORD)

Muzaffarabad



Director 01

Deputy Directors 02

Assistant Directors 01

Inspectors 02

(3) JCC & JWG

A Joint Coordination Committee (JCC) was established as shown in Figure 1-4, in order to facilitate inter-organizational coordination. JCC meetings were held twice a year and whenever otherwise deemed necessary. The JCC approved the annual work plan, reviewed overall progress, conducted monitoring and evaluation of the Project, and exchanged opinions on major issues that arose during the implementation of the Project.

A Joint Working Group (JWG) was established within the JCC as shown in Figure 1-4, in order to facilitate working-level discussions. The JWG managed meetings to facilitate project progress, particularly in editing manuals and formats under mutual consensus.

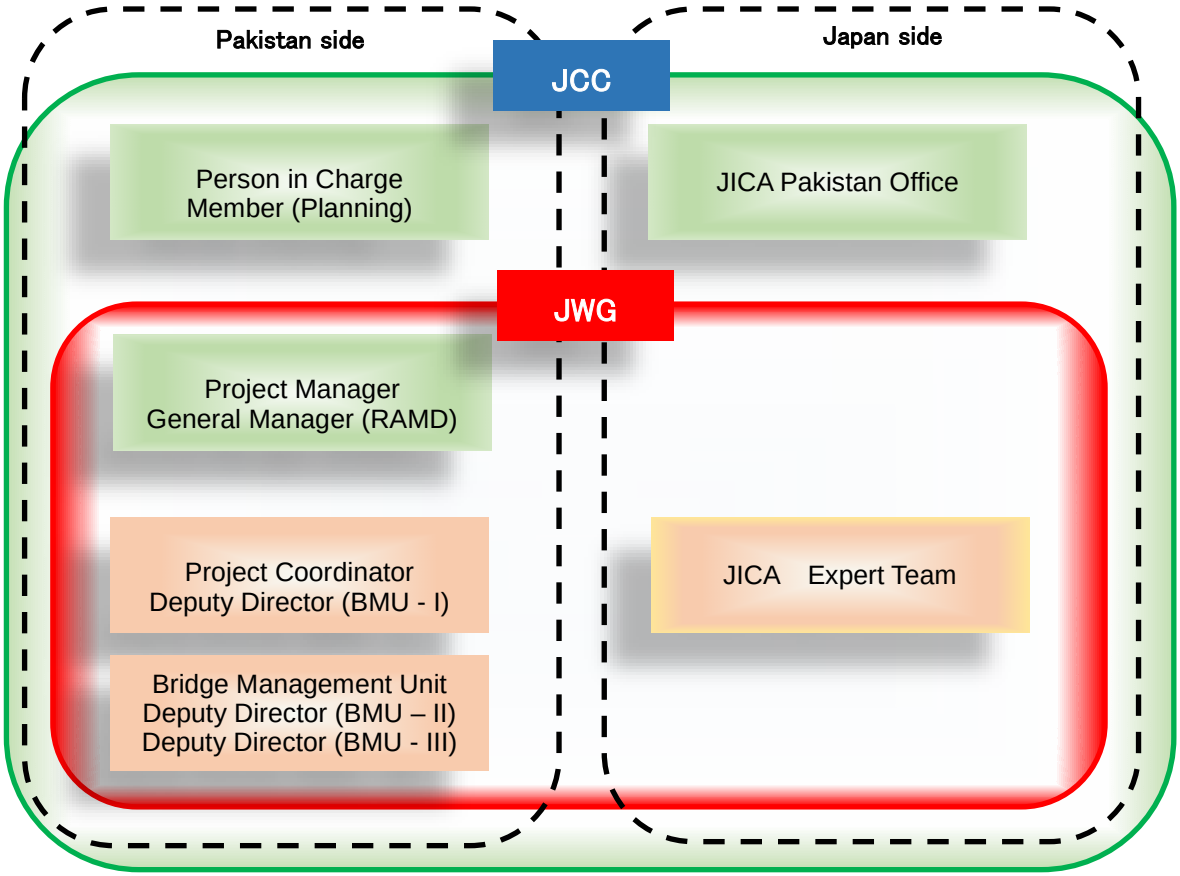


Figure 1-4 Joint Coordination Committee

2. Results of the Project

2.1 Inputs to the Project

2.1.1 Inputs by the Japanese side (Planned and Actual)

(1) Investment from the Japan side

Approximately 240 million Japanese Yen

Table 2-1 Comparison of Expenses

Item	Initial Plan (JPY)	Expected (JPY)	Remarks
Program Cost	8,055,000	5,000,000	In Pakistan
Report Printing	189,000	189,000	
Equipment	15,451,000	100,000	NDT to be prepared by NHA
Public Relation	3,000,000	50,000	
Subcontract in Japan	―	12,000,000	Software Programming
Training in Japan	819,000	698,000	
Total	27,514,000	18,037,000	

(2) JICA Expert Team

Approximately 54 M/M

Table 2-2 Inputs by JICA Expert Team

Expert	Name	Plan (M/M)		Actual (M/M)[6]	
		Pakistan	Japan	Pakistan	Japan
Project Manager/Bridge Inspection	Yukio Igo	10.77	1.85	12.53	3.35
Bridge Repair	Yoshiichi Fujimoto	5.07	1.85	4.27	1.85
BMS (System Design)	Akio Mori	2.87	3.00	3.27	4.30
BMS 2	******	0.00	2.50	―	―
BMS 3	******	0.00	2.50	―	―
BMS (System Design Assistance)	Syougo Abiru	―	―	0.00	1.50
Capacity Development	Haruo Tomiyama	10.60	1.00	10.67	1.50
Project Monitoring	Kenichi Tomi	3.33	0.00	3.33	0.00
Project Monitoring (2) (Terminal Evaluation)	Toshiko Shimada	―	―	0.50	0.50
BMS (Specification Logic)	Fumiatsu Kamitani	―	―	0.60	2.55
BMS (Specification Logic Assistance)	Ryo Nakai	―	―	1.63	1.50

[6] The results as of January, 2019 and expectation up to April, 2019

Total	32.64	12.70	36.80	17.05

Table 2-3 Inputs by JICA Expert Team at its own expenses

Expert	Name	Actual (M/M)	
		Pakistan	Japan
Project Coordination	Kotoko Yoneda	1.73	―
Capacity Development Assistance	Nagata (Yonezawa) Kayo	0.60	―

(3) Local Staff

(a) Local Administrator

Initially 10.5M/M

Actually Approximately 33.0M/M

Table 2-4 Inputs by Local Administrator

Personnel	Name	Duration
Local Administrator	Ms. Momina Rauf	September 1st, 2016 to March 31st, 2019

(b) Local Engineer

Initially 10.5 M/M for technical documentation

10.5 M/M for technical interview

Actually A contract was made for peer review and editing of technical documents under the condition of payment according to progress, i.e. in advance (10.56%), interim (70.51%) and on completion (19.23%). However, it became impossible to contact the local engineer after his submission of the edited version just before the first Master Trainer Training session.

Table 2-5 Inputs by Local Engineer

Personnel	Name	Duration
Local Engineer	Dr. Qaiser uz Zaman Khan	December 20th, 2016 to February 26th, 2017

(4) Training in Japan

(a) Trainees

Table 2-6 List of Trainees

No.	Name	Title	Affiliation
1	Mr. Aftab Ullah Babar	DD (Structure)	NHA, HQ

2	Mr. Muhammad Asif Azam	DD (Survey/BMS)	NHA, HQ

(b) Itinerary

Table 2-7 Schedule of Training in Japan

Date	Location	Contents		Lecturer
2017/1/16 (Mon)	PCKK, Tokyo	Lecture	Bridge and Maintenance in Japan, BMS in japan, Transportation Infrastructures and Projects Fields	PCKK[7]
2017/1/17 (Tue)	NEXCO Research Institute	Lecture	Technologies in Japan Highway Bridges, Bridge Maintenance in Japan Highway	NEXCO-RI
2017/1/18 (Wed)	Shingetsu Bridge	Visit	Bridge Repair Site Visit	Nippon Liner
2017/1/19 (Thu)	Japan Bridge Engineering Center	Lecture	License System of Road Bridge Inspectors	J-BEC
	Taiheiyo Consultant	Visit	Concrete Test Facilities and Equipment	Taiheiyo Consultant
2017/1/20 (Fri)	Nagoya University	Visit	N2U-BRIDGE (Concrete Inspection Training Facility)	N2U-BRIDGE
2017/1/23 (Mon)	PCKK, Osaka	Lecture	BMS for Municipality	PCKK
	Yao City	Visit	Exchange opinions with Municipality	Yao City
2017/1/24 (Tue)	PCKK, Osaka	Lecture	Procedures & Methods of Bridge Inspection	PCKK
	Toami Viaduct	Visit	Check concordance on site, RC radar, Shmidt Hammer, etc.	Himeji Office of Rivers and National Highways
2017/1/25 (Wed)	PCKK, Osaka	Lecture	Seismic Upgrading Design	PCKK
	Kyoto City	Visit	Bridges in Kyoto (incl. Nijyo Br. under rehabilitation works)	Kyoto City
2017/1/26 (Thu)	HANSHIN Expressway	Lecture	Bridge Management in Urban Highways	Hanshin Expressway
		Visit	Deteriorations in Urban Highway and Damages by Earthquake	
2017/1/27 (Fri)	Terada Viaduct	Visit	Bridge Repair Works Site Visit	Kyoto Office of National Highways

(5) Equipment Provided

Through discussions between the C/P and the JICA Expert Team, the provided equipment shown in Table 2-8 was delivered.

Table 2-8 Equipment Provided

Equipment	Purpose	Quantity		Handover date
		Planned	Actual	

[7] Abbreviation of Pacific Consultants Co., Ltd.

Carbonation Test (Phenolphthalein)	Carbonation	36 sets	18 bottles	June 28, 2018
Crack Scale	Crack width	36	100	February 1, 2017
Test Hammer	Lamination, honey comb	36	100	February 1, 2017
Helmet	Safety	―	100	February 24, 2017
Reinforcement detector (magnetic type)	Concrete cover	2	0	
Half cell (chloride ion penetration tester)	Corrosion	2	0	
Ultrasonic tester for concrete crack	Lamination, honey comb	2	0	
Shimidt Hammer	Concrete strength	13	0	
Client PCs	Terminal PC	13	0	
Server for clients	Data saving NAS-HDD	1	0	
MS Excel	Data input	13	0	
MS Access	Data processing	13	0	

2.1.2 Inputs by the Pakistani side

(1) Counterpart

Table 2-9 Inputs by the Counterpart

Personnel	Title	Name
Person in Charge	Member (Planning)	Mr. Raja Nowsherwan (～2017.10)
		Mr. Asim Amin (2017.10～2018.10)
	Member (Engg. & Coord.)	Mr. Arbab Ali Dhakan (2018.10～)
Project Manager	General Manager (RAMD)	Mr. Ikramus Saqlain Haider
Project Coordinator	Deputy Director (BMU-I)	Mr. Muhammad Asif Azam
Counterpart Personnel	Deputy Director (BMU-II)	Mr. Ghulam Murtaza Simair (2018.1～)
	Deputy Director (BMU-III)	Mr. Sohaib Mansoor (2018.1～)
IT Engineer	Assistant Director	Mr. Ashfaq Ahmed (2018.7～2018.10) Mr. M Nur-Ul-Eain (2018.10～)

(2) Project Room

The project room and facilities have been provided by the counterpart throughout the Project.

(3) Project Expenses

Table 2-10 Expenses borne by C/P

Item	Approximate Expense（PKR）
Salary for Trainee Engineers	3,381,890
Travel Allowance and Daily Allowance	3,118,550
Transportation and Drivers	2,300,000
Furniture for Project Room and Equipment[8]	350,000
Total	9,150,440

2.2 Activities (Planned and Actual)

2.2.1 Output 1: Manuals, Database and BMS developed for bridge inspection and bridge repair

2.2.1.1 Activity 1-1: JICA Expert Team develops draft manuals for (1) bridge/culvert inspection, (2) bridge/culvert repair and (3) data input.

(1) Bridge/Culvert Inspection Manual

The basic policy was to develop simple manuals in line with the current situation in Pakistan, with reference to bridge inspection manuals and guidelines from Japanese and the US where bridge maintenance/management is comprehensively recognized and implemented. In accordance with the C/P's requests, culverts were added to the scope of BMS in addition to bridges. As there are many brick and stone structures in Pakistan, these were also included in the manuals.

In order to calculate the approximate cost of repair work and to formulate the annual maintenance plan with appropriate prioritization, it was judged that detailed bridge/culvert inspection was to some extent indispensable. The JICA Expert Team decided that the Pakistan version bridge/culvert inspection manual would be simplified based on the Japanese "Periodic Bridge Inspection Guidelines". For example, 26 types of damage in Japan were simplified into 17 types for Pakistan. With respect to the classified evaluation system, the components (A, B, C1, C2, E1, E2, S1, S2, M) used in Japan were simplified in Pakistan into (A, B, Cd, Cs, Es, Ep, Sd, Sf, M) more easily understandable to inexperienced NHA staff.

As no systematic and organized bridge maintenance/management had been done so far in Pakistan, basic information such as the NHA road network and structures was explained in "1 A glance at NHA, its road network and structures". This Bridge/Culvert Inspection Manual was not limited to periodic inspection, but also included routine inspection, special inspection,

[8] Measuring tape, torch, GPS, cones for traffic management etc. (refer to Figure 2-14 Equipment Check List)

initial inspection, detail investigation, and inspection after maintenance/repair/renewal. The contents are shown in Figure 2-1.

Figure 2-1 Contents of Bridge/Culvert Inspection Manual

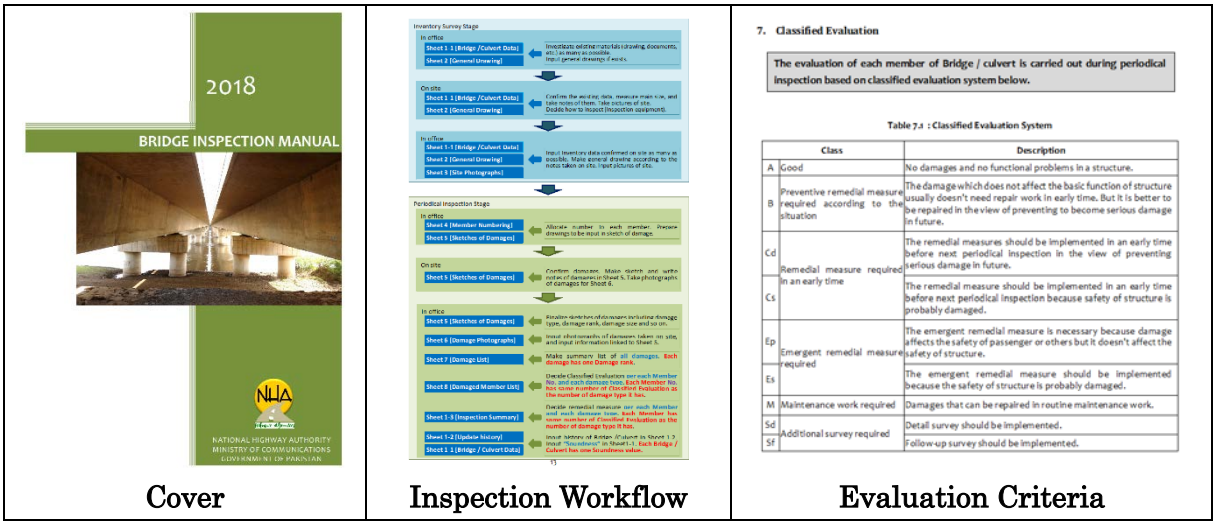


Figure 2-2 Bridge/Culvert Inspection Manual

(2) Bridge/Culvert Repair Manual

Collection of information on bridge/culvert repair/rehabilitation works in Pakistan revealed that repair/rehabilitation works had seldom been implemented because no qualified engineers

could be responsible for evaluation and design of bridge repair/rehabilitation, so that bridges/culverts were usually reconstructed fully or partially in line with their original design. Because more than 95% of NHA bridges were made of concrete, the main focus was on repair methods for concrete. Because no well-organized standards and guidelines for how to select a bridge repair method were in place, the repair methods widely adopted in Japan were introduced in the manual, taking into consideration the current situation in Pakistan. The main focus was on repair methods often adopted in Pakistan, such as crack injection and sectional repair, while other methods not often adopted, such as external cable, FRP, and cathodic protection were introduced for reference. The repair methods were explained using figures, photographs, flowcharts, etc. to help visual understanding. Strengthening and stabilization methods were also included for future reference, even though it was considered difficult for them to be adopted in Pakistan at the present time.

The contents are shown in Figure 2-3.

Figure 2-3 Contents of Bridge/Culvert Repair Manual

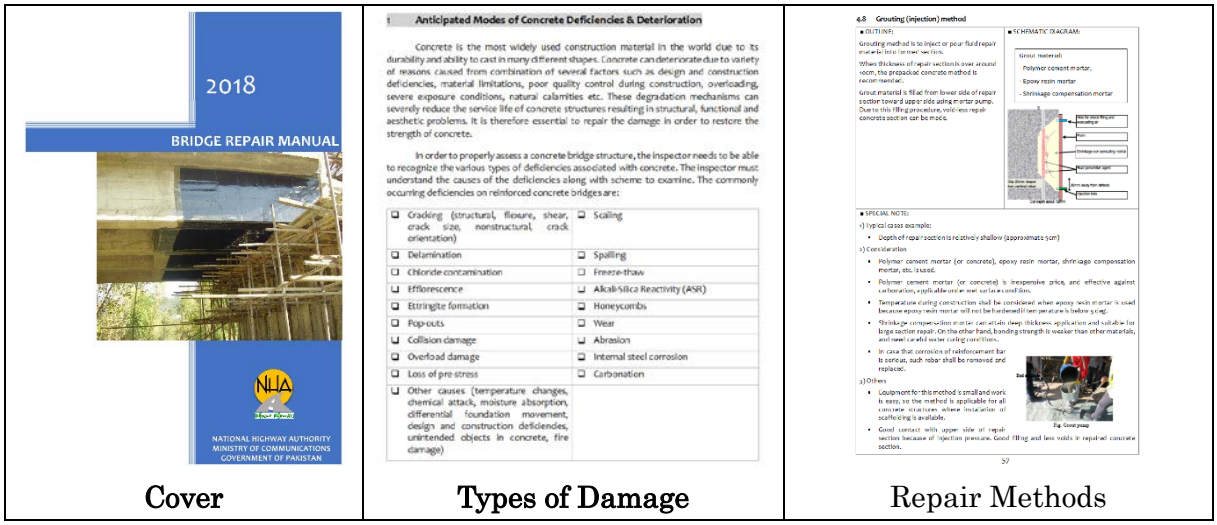


Figure 2-4 Bridge/Culvert Repair Manual

(3) Bridge Inspection Database (BIDB) Operation Manual

The BIDB was drawn up with creative screen configurations and on-screen supplements to enable it to be operated intuitively even without a manual.

However, important issues such as the sequence of input / confirmation, data transfer to the

BMS software, operating environment, installation procedures and detailed operation methods were described in the manual so that newcomers could understand operations and the system. A FAQ (Frequently Asked Questions) was also provided at the end of the manual so that NHA could improve it over the course of future operations.

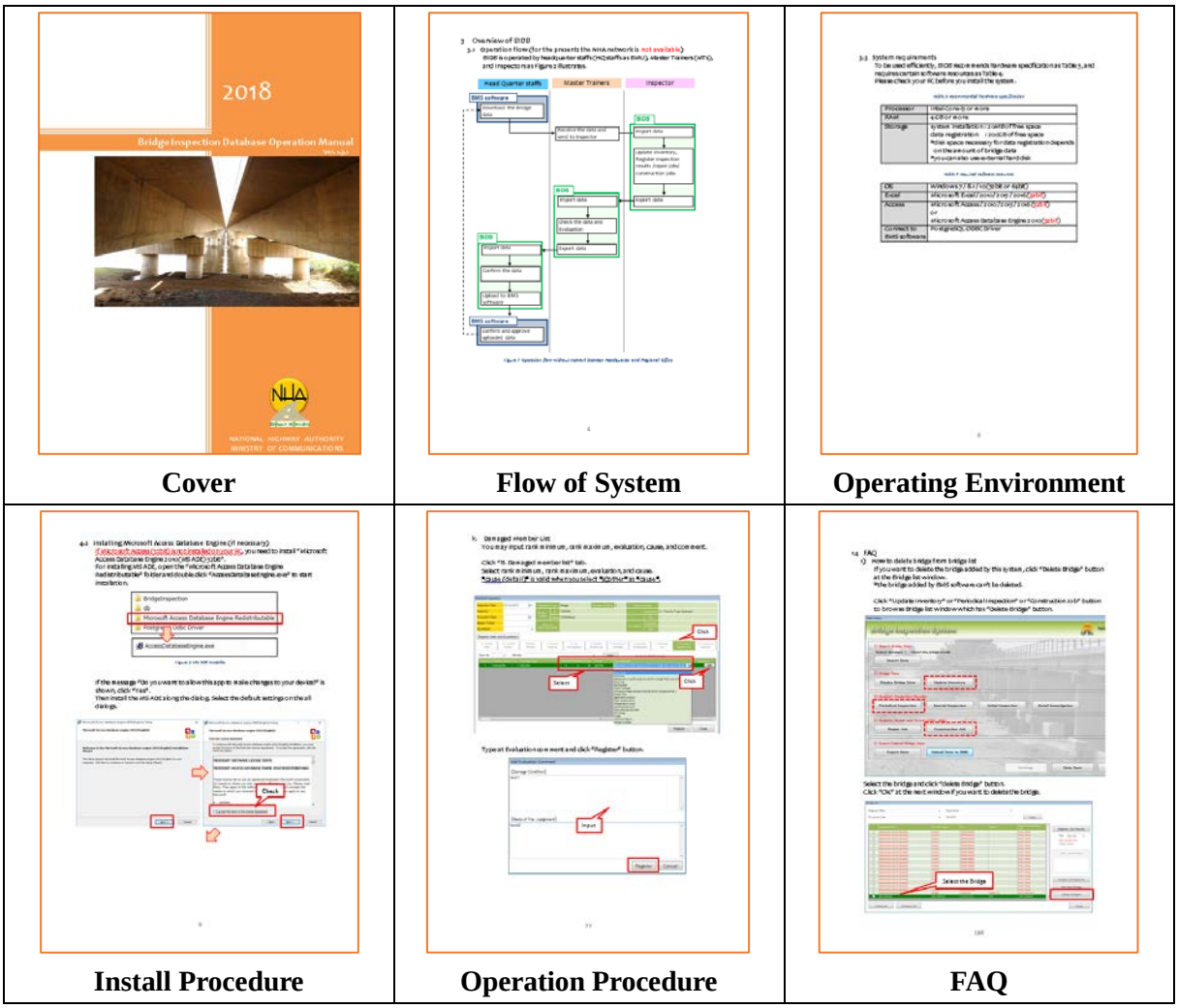


Figure 2-5 BIDB Operation Manual

(4) Bridge Management System (BMS) Software Operation Manual

The inventory data, inspection data and repair data entered into the BIDB are centrally controlled and collected in the BMS software for priority calculation and preparation of the Annual Maintenance Plan (AMP).

This manual was prepared mainly for the BMU who work with the BMS software at NHA headquarters. Important issues such as the sequence for registration / management, operating environment and detailed operating methods were described in the manual.

Since operations and settings related to priority calculation were particularly important functions in the BMS software, concepts of prioritization were clearly described and those operations were described in particular detail.

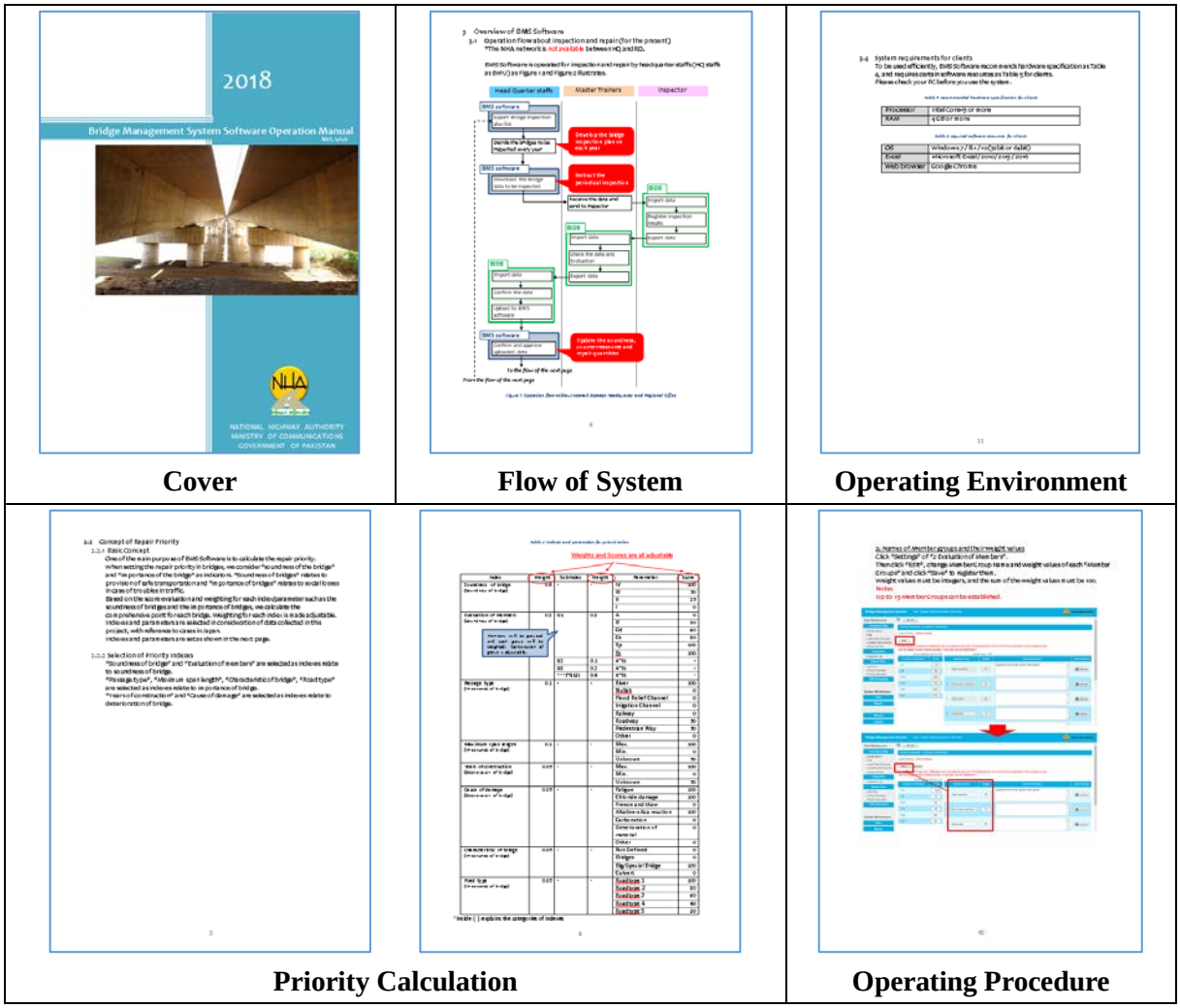
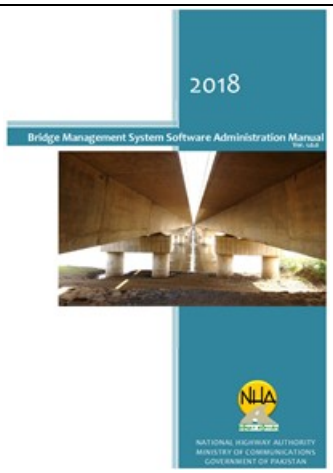


Figure 2-6 BMS Software Operation Manual

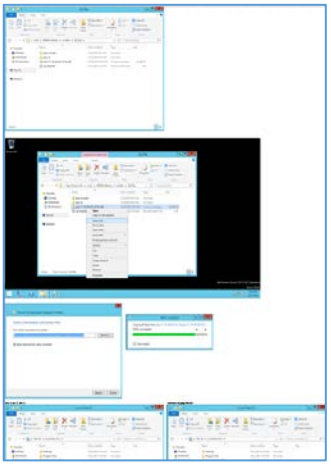
(5) Bridge Management System (BMS) Software Administration Manual

Operation of the BMS software requires not only the operation of the software but also subsequent maintenance and monitoring to ensure continuous and stable system operation. Therefore, in addition to the BMS software operation manual, a BMS Software Administration Manual was prepared setting out procedures for the continuous and stable operation of the BMS software.



Cover

System Structure



Install Procedure

Figure 2-7 BMS Software Administration Manual

2.2.1.2 Activity 1-2: JICA Expert Team develops draft bridge/culvert inspection formats.

The formats for bridge/culvert inspection were summarized and consolidated, and unnecessary items were restricted to prevent mistakes in input.

The bridge/culvert inspection formats currently used by the NHA were modified to meet the criteria of the new BMS, with reference to experience and implementation record in Japan.

The Inspection Report Sheet consisted of 8 types of sheets. Sheets 1 to 3 were identical to the Bridge Inventory Data.

Table 2-11 Inspection Report Sheet

Sheet	Title	Remarks
1-1	Bridge/Culvert Data	Common with Bridge Inventory
1-2	Update History	
1-3	Inspection Summary	
2	General Drawings	
3	Site Photographs	
4	Member Numbering	
5	Sketches of Damages	
6	Damage Photographs	
7	Damage List	
8	Damage Member List	

2.2.1.3 Activity 1-3 JICA Expert Team develops Prototype Bridge Inspection Database & BMS.

(1) Status Survey

In order to design the bridge inspection database and new BMS software, the JICA Expert Team interviewed NHA regarding the existing BMS software and system environment, such as networks and PC terminals.

(a) Existing BMS Software

The existing BMS software (Smart Bridge and Smart Index) was provided to the NHA as part of the World Bank project, and the initial data was collected and registered in that project. The JICA Expert Team interviewed NHA regarding the operational status and environment of the current BMS.

The following problems were found through the interviews.

i) Operational Problems

- The existing BMS server (computer) was not connected to the network and was usually powered down. It could not be used by anyone other than the person in charge.
- Only one BMS member of staff in NHA knew the specifications, functions, operations, etc. of the existing BMS software.
- Data in the existing BMS software had not been updated since the system was installed between 2006 and 2008. (It was impossible to update because the data set in the BMS software was different from the current inspection format.)
- It was difficult to prioritize the repair works because the inspection results were categorized into only 3 levels, without evaluation.
- There was no evaluation of the soundness of the entire bridge, but only the record of a Request Job based on inspection.

ii) System Problems

- Some functions (especially GIS) were not working properly.
- The existing BMS software was installed as a package software developed by Ramboll Company, Denmark. Copyright prevents third-party modification of the program. Neither the source code nor any specifications were provided.
- The system could not be updated because the license fee for the existing BMS software had not been paid.
- Support for software versions such as the OS used in the system had expired, and serious security issues were anticipated.

(b) Network status in NHA

The JICA Expert Team interviewed the IT section in NHA in order to understand the BMS software environment. The intranet inside NHA headquarters was in service, but intranets between the headquarters and Regional Offices and between the headquarters and some Maintenance Units were in service for the procurement section only.

NHA was considering an optical fiber network for the future, but it was not decided when it would be adopted.

(2) Requests for BMS software

The JICA Expert Team interviewed the person in charge of BMS in NHA with respect to the situation of NHA and BMS knowledge learned through Training in Japan, and the NHA's requests regarding BMS were summarized as follows.

(a) The past bridge inspection records should be registered and collected.
[Problem] Only the latest record could be recorded at the present time.

(b) There needs to be an easy means of calculating repair priority.
[Problem] The existing BMS software couldn't calculate repair priority because the bridge inspection records were old and incomplete.

(c) Registration and reference of bridge inspection data should be available through a network linking the headquarters, Regional Offices, and Maintenance Units in the future.
[Problem] The BMS software was not connected to the network; furthermore no network linking the headquarters, Regional Offices and Maintenance Units was available.

(d) The drawings such as general drawings and element drawings need to be prepared to enable easy control and registration of bridge inspection records.
[Problem] Many of the as-built drawings of NHA bridges had not been stored.

(e) An application software with higher data input operability is preferred to Excel and Access that have some data input restrictions.
[The BMS demonstrations given in Japan might have influenced opinion.]

(3) Basic Policy for the System

(a) New BMS software

i) The new BMS software must be established to register and collect the inspection results in a form compatible with the new inspection format, and the necessary data (mainly Inventory Data) in the existing BMS software should be transferred to the new BMS software.

ii) The new BMS software can be centralized to collect all the bridge data.

iii) The new BMS software has the new function of repair priority calculation.

iv) From the viewpoint of future flexibility, the system configuration should consist mainly of open-source software in order to transfer the copyrights for future program modification to the NHA so as to reduce license fees[9].

v) Taking future network connections into consideration, the system should be based on the Web method and configured to enable data reference from Regional Offices and Maintenance Units, with data received from the bridge inspection database via the network.

vi) Taking future network connections into consideration, data registration in the BMS software should be available via the network.

(b) Bridge inspection database (BIDB)

i) In addition to the bridge inspection results, the system shall support the input of a historical data series related to bridges, including basic information and repair records.

ii) The system should focus on operability in the registration of drawings and photographs

iii) BIDB should be a Windows desktop application using Windows standard .NET Framework,

[9] The costs for such as anti-virus software may occur.

taking into account operability, standardization and future flexibility.

iv) Since the network cannot be used to link the headquarters, Regional Offices and Maintenance Units, data exchange by files should also be available.

v) Taking future network connections into consideration, data registration in the BMS software should be available via the network.

(4) Definitions in Bridge Management

(a) Personnel for BMS

The personnel for bridge management in the NHA was determined as follows;

Table 2-12 Personnel for BMS

Personnel	Description
HQ Staff	HQ staff belongs to the headquarters, draw up periodic inspection plans and repair plans, manages and operates BMS.
Master Trainer (MT)	A Master Trainer belongs mainly to a Regional Office (RO), receives instructions from HQ Staff, implements and manages Inspection Jobs, implements and supervises Repair/Construction Jobs, and evaluates and instructs the inspection results submitted by the Inspector.
Inspector	An Inspector belongs mainly to a Maintenance Unit (MU), receives instructions from the MT, implements Inspection Jobs, and confirms the results of Repair / Construction Jobs.
HQ Special Team	The HQ Special Team belongs to the headquarters and carries out expert detailed investigation using equipment such as non-destructive inspection equipment.
RO Contract Section	A RO Contact Section belonging to a RO, receives the repair plan formulated by HQ Staff, and outsources the construction works to a Constructor.
Consultant	A Consultant is hired when needed for a Periodic Inspection.
Constructor	A Constructor contracts for new construction, replacement, widening, repair, etc., of bridges

(b) Workflow

The Routine Inspection and Maintenance Job were excluded from registration in BIDB because these were to be implemented on a regular basis, and registering the information seemed to be a hassle.

Table 2-13 Major Jobs in BMS

Major Job		Description	BIDB	BMS
Inventory Survey		Basic information (Inventory Data) of each bridge (implemented at the beginning of data accumulation)	○	―
Inspection Job	Periodic Inspection	Visual inspection, once every 5 years	○	―
	Routine Inspection	Simple visual inspection implemented twice a year for each bridge (mainly viewing from a distance)	―	―
	Special Inspection	Visual inspection after the occurrence of a disaster such as earthquake or flood, or a	○	―

		particular event or accident.		
	Initial Inspection	Visual inspection after new construction, renewal, major repair etc., to identify construction defects as a part of the completion inspection.	○	―
	Detail Investigation	Detailed survey implemented using non-destructive test equipment to reevaluate members / parts ranked "Sd" or "Sf" in the Periodic Inspection and to identify the causes.	○	―
Repair / Construction Job	Repair Job	General repair work	○	―
	Maintenance Job	Mainly minor maintenance work such as cleaning of the drainage basin.	―	―
	Construction Job	Major construction works such as new construction, renewal, widening.	○	―
Planning	Inspection Planning	Periodic inspection planning based on the timing of previous inspection, soundness, classified evaluation, etc.	―	○
	Construction and Repair Planning	Repair planning based on soundness, classified evaluation, and repair priority.	―	○

Table 2-14 Classified Evaluation System

Class		Description
A	Good	No damages and no functional problems in a structure.
B	Preventive remedial measure required according to the situation	The damage which does not affect the basic function of structure usually doesn't need repair work in early time. But it is better to be repaired in the view of preventing to become serious damage in future.
Cd	Remedial measure required in an early time	The remedial measures should be implemented in an early time before next periodic inspection in the view of preventing serious damage in future.
Cs		The remedial measure should be implemented in an early time before next periodic inspection because safety of structure is probably damaged.
Ep	Emergent remedial measure required	The emergent remedial measure is necessary because damage affects the safety of passenger or others but it doesn't affect the safety of structure.
Es		The emergent remedial measure should be implemented because the safety of structure is probably damaged.
M	Maintenance work	Damages that can be repaired in routine maintenance work.
Sd	Additional survey required	Detail survey should be implemented.
Sf		Follow-up survey should be implemented.

(5) General System Structure

(a) System Structure

The BIDB and BMS software created a bridge management system workflow consisting of

inspection, planning and repair through the mutual transfer of data.

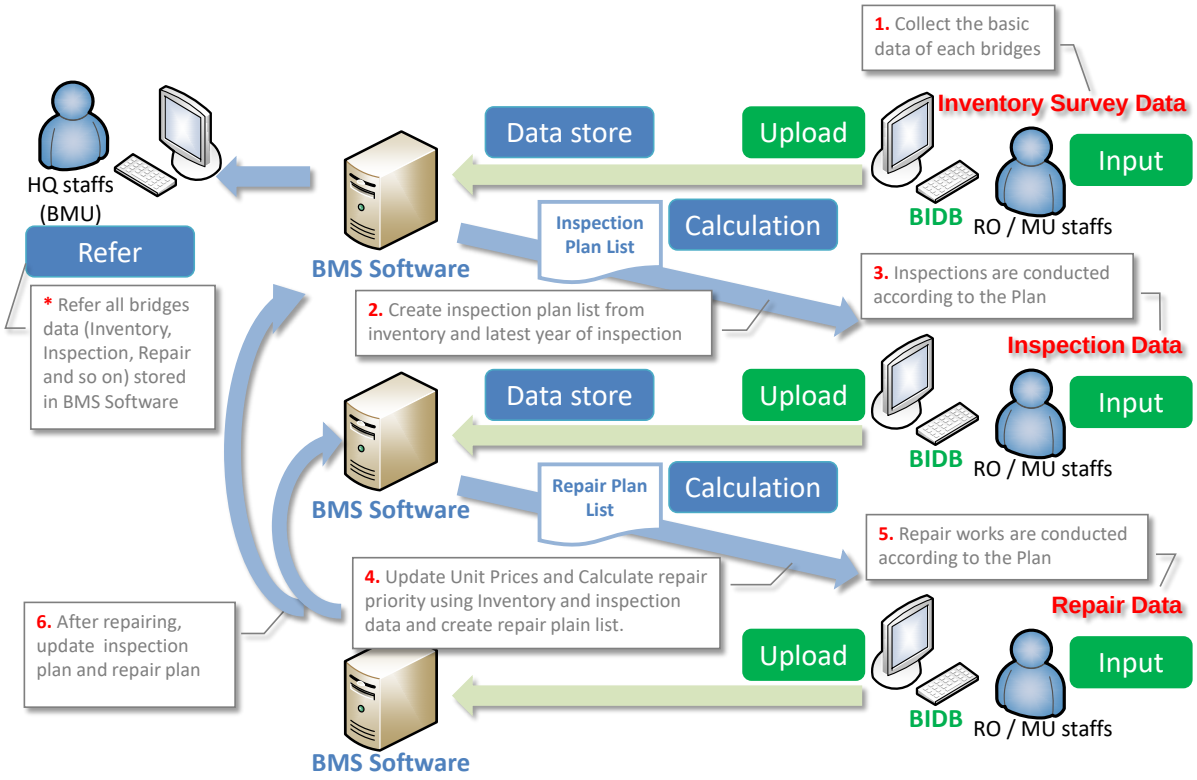


Figure 2-8 Relationship between BIDB and BMS Software

In view of the fact that there is no intranet linking the headquarters, Regional Offices and Maintenance Units in the NHA, the system shown in Figure 2-9 was adopted as a temporary measure.

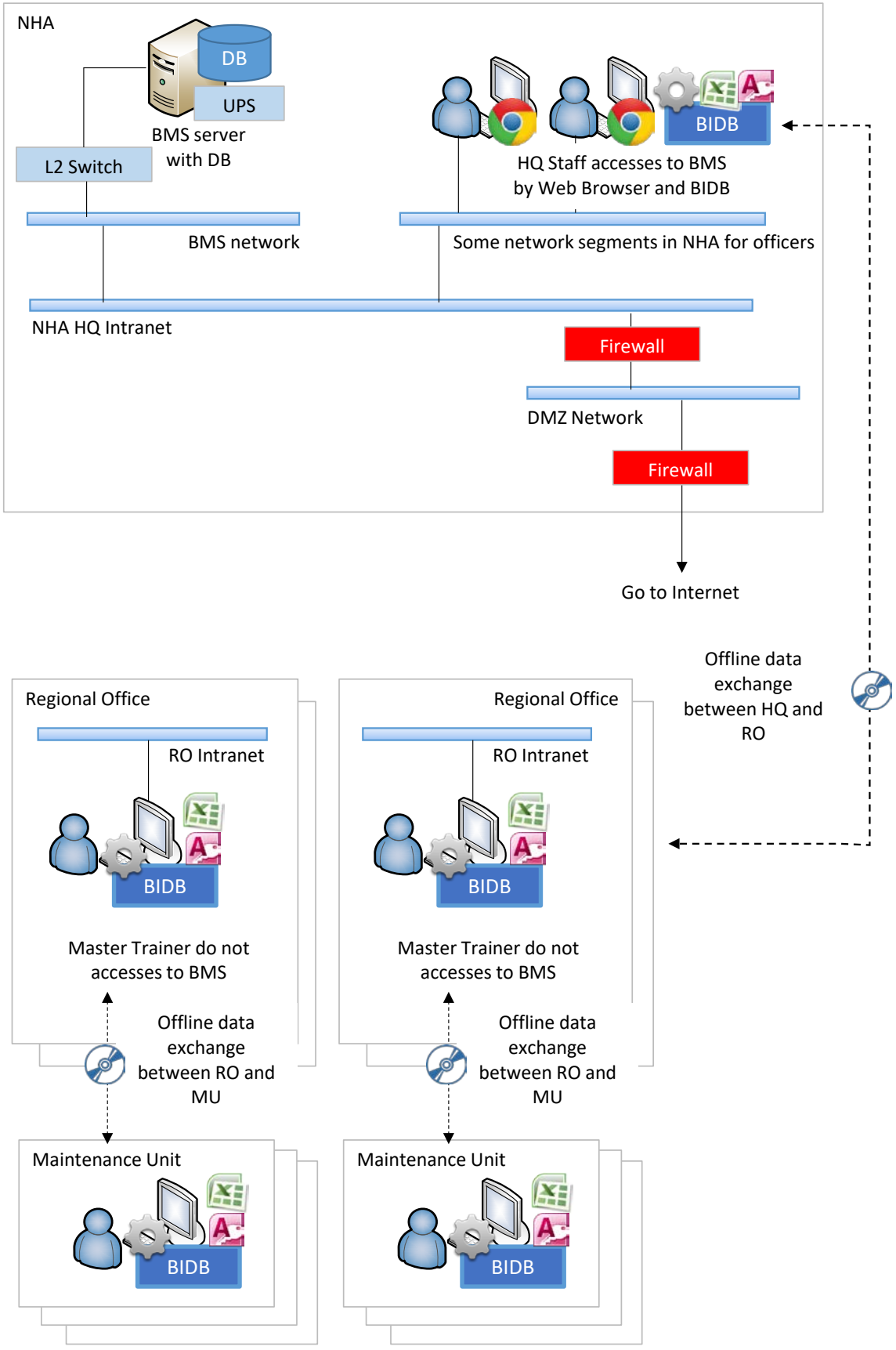


Figure 2-9 System Structure (current)

(b) User Types and Roles

In consultation with the NHA, the types of users and the roles of each user in the BIDB and BMS software were determined as follows.

Table 2-15 User Types and Roles in BIDB

User Type	Description
HQ Staff [System administrator]	·Confirmation of basic bridge information submitted, inspection, repair data if necessary ·Registration of inspection results and repair results in BMS
HQ Staff [Others]	·Confirmation of basic bridge information submitted, inspection, repair data if necessary ·Registration of inspection results and repair results in BMS
Master Trainer（MT）	·Confirmation and review of inspections and repair data submitted by the Inspector ·Output of inspection and repair data for submission to HQ Staff ·Registration of inspection and repair results in BMS (prospect)
Inspector	·Review of basic bridge information ·Input of inspection results and repair results ·Output of inspection and repair data for submission to MT

Table 2-16 User Types and Roles in BMS Software

User Type	Description
HQ Staff [System administrator]	·Search and reference of the latest bridge data ·Approval of inspection results and repair results registered in BMS ·Deletion of demolished bridge data ·Deletion of bridge data registered incorrectly ·Estimation of repair costs based on repair priority ·Preparation of inspection plan list and repair plan list
HQ Staff [Others]	·Search and reference of the latest bridge data ·Bridge data output for inspection and repair by MT and Inspectors
Master Trainer	·Search and reference of the latest bridge data (only that for which he/she is responsible) ·Bridge data output for inspection and repair by Inspector (prospect)
Inspector	·None (Not available)

(6) Bridge Inspection Database (BIDB)

(a) System Specification

i) Authorization

Table 2-17 Authorization and Restrictions

Functions \ Authorization	HQ Staffs [System administrator]	HQ Staff [Others]	Master Trainer	Inspector
Bridge Inspection Database				
Search and refer data (read only)	**Yes (all bridges)**	**Yes (all bridges)**	**Yes (only that for which they are responsible)**	**Yes (only that for which they are responsible)**
Register inventory data				
Register inspection and evaluation data				
Register construction and				

repair data				

ii) Specifications

Meanwhile supporting the input of inspection formats described in the previous section, the function specifications for data confirmation from ROs and MOs, data exchange between BIDBs and data synchronization with the BMS software, were discussed and determined.

In the specification review, we created prototypes, heard opinions from candidates for the position of MTs, examined operational issues based on trial operations and required items from the BMU, and gave consideration to them in the function specifications.

Table 2-18 Specifications for BIDB

（○: Additional Function、●: Partially Modified Function）

Classification	Function	Description	Remarks
Login / Logout	Login	Log in to BIDB according to user authority.	
	Logout	Log out from BIDB.	
Data Import	Select File	Select the Export data files output from the BMS software or BIDB.	
	Import List	Display the bridge list included in the Export data files to be imported, and import only the selected bridge data.	
Display Bridge Data	Bridge Filtering	Refine search to display bridge data.	●
	Bridge List	Display a list of the bridges picked out by the search.	●
	Display Bridge Data	Display the latest Inventory and Inspection Summary screens for the selected bridge.	
	Bridge Data	Display the latest registered bridge specification data.	●
	Update History	Display the registered historical data of the latest repair, inspection etc.	
	Member Settings	Display the registered latest member components.	
	General Drawings	Display the image of the latest registered general views, side views, plan views, and sectional views.	
	Site Photographs	Display the latest site photos and general pictures.	
	Member Numbering	Display the latest registered member numbering diagram.	
	Inspection Summary	Display the latest registered inspection outline (damage rank of members, damage factors, need for Detail Survey, repair methods, repair quantity, comments, etc.	
	Output Inventory Report	Output the above input contents as an Inspection Sheet formatted in Excel.	
Update Inventory	Bridge Filtering	Refine search of the updated bridges in Inventory.	●

Classification	Function	Description	Remarks
	Bridge List	Display a list of bridges picked out by the search.	●
	Add New Bridge	Add a new bridge if unregistered.	
	Delete Bridge	Delete bridges only if newly added to BIDB, and not uploaded to the BMS software.	○
	Register Job Results	Display the new registration screen of the Inventory history for the selected bridge. New registration is disabled if there is unloaded updated data on a bridge.	●
	Register Bridge Data	Enter and update bridge specification data.	●
	Register Update History	Register the content of this history. Display historical data of past repairs, inspections etc.	
	Register Member Settings	Set up and update component members in structures.	
	Register General Drawings	Register images of general views, side views, plan views, and sectional views. The side view, plan view, and sectional view images can be created based on the schematic drawings.	
	Register Site Photographs	Register the site photos and their descriptions.	
	Register Member Numbering	Register the member numbering diagram. A simply configured member numbering diagram can be created automatically based on the Member Settings.	
	Edit Job Results	Edit the registered data for each Inventory update history Reflect the latest data limited to the latest history of each bridge.	●
	Output Job Report	Output the input content as an Inspection Sheet formatted in Excel.	
Periodic Inspection	Bridge Filtering	Refine search to target bridges in Periodic Inspection.	●
	Bridge List	Display a list of bridges picked out by the search.	●
	Add New Bridge	Add an unregistered bridge as a new bridge.	
	Delete Bridge	Delete bridges only if newly added to BIDB and not uploaded to the BMS software.	○
	Register Inspection Results	Display the new registration screen for Periodic Inspection of the selected bridge. If there is unloaded updated data on a bridge, new registration is disabled.	●
	Register Bridge Data	Enter and update bridge specification data.	●

Classification	Function	Description	Remarks
	Register Update History	Register the contents of this history. Display historical data of past repairs, inspections etc.	
	Register Member Settings	Set up and update member components.	
	Register General Drawings	Register images of general views, side views, plan views, and sectional views The side view, plan view, and sectional view images can be created based on the schematic drawings.	
	Register Site Photographs	Register site photos and their descriptions.	
	Register Member Numbering	Register the member numbering diagram. A simply configured member numbering diagram can be created automatically based on the Member Settings.	
	Register Sketches of Damages	Register sketches of damages.	
	Register Damage Photographs	Register the damage photographs including span, member, damage type, damage rank, and photo outlines Registered damage pictures can be displayed using photo display software.	●
	Register Damage List	Select the span, member, damage type and damage rank, and register quantity and remarks The member is automatically imported into the Damage List if a damage photograph is registered.	
	Register Damaged Member List	Register the evaluation rank, damage factor and comments based on the contents registered in the Damage List.	
	Register Inspection Summary	Aggregate inspection results based on the contents registered in the Damaged Member List, register the need for a Detail Inspection, repair method, repair quantity and comments.	
	Edit Inspection Results	Edit the registered data for each history of Periodic Inspection. Reflect only the latest history of each bridge, using the latest data.	●
	Output Inspection Report	Output the input content as an Inspection Sheet formatted in Excel.	
Special Inspection	Bridge Filtering	Refine search to target bridges for Special Inspection.	●

Classification	Function	Description	Remarks
	Bridge List	Display a list of bridges picked out by the search.	●
	Register Inspection Results	Display the Special Inspection registration screen for the selected bridges. New registration is disabled if there is unloaded updated data on a bridge.	●
	Register Bridge Data	Enter and update bridge specification data.	●
	Register Update History	Register the content of the history. Display historical data of past repairs, inspections etc.	
	Register Member Settings	Set up and update member components.	
	Register General Drawings	【Optional】 Register images of general views, side views , plan views, and sectional views The side view, plan view, and sectional view images can be created based on the schematic drawings.	
	Register Site Photographs	【Optional】 Register the inspection site photos and their descriptions.	
	Register Member Numbering	【Optional】 Register the member numbering diagram. A simply configured member numbering system can be created automatically based on the Member Settings.	
	Register Sketches of Damages	Register sketches of damage.	
	Register Damage Photographs	Register the damage photographs including span, member, damage type, damage rank, photo remarks. Registered damage pictures can be displayed using photo display software.	●
	Register Damage List	Select the span, member, damage type and damage rank, and register quantity and remarks. The member is automatically imported into the Damage List if a damage photograph is registered.	
	Register Damaged Member List	Register the evaluation rank, damage factor and comments based on the contents registered in the Damage List.	
	Register Inspection Summary	Aggregate inspection results based on the contents registered in the Damaged Member List, register the need for a Detail Inspection,	

Classification	Function	Description	Remarks
		repair method, repair quantity and comments.	
	Edit Inspection Results	Edit the registered data for each history of Periodic Inspection. Include only the latest history of each bridge, using the latest data.	●
	Output Inspection Report	Output the input content as an Inspection Sheet formatted in Excel.	
Initial Inspection	Bridge Filtering	Refine search to target bridges for Initial Inspection.	●
	Bridge List	Display a list of bridges picked out by the search.	●
	Register Inspection Results	Display the Initial Inspection registration screen for the selected bridges. New registration is disabled if there is unloaded updated data on a bridge.	●
	Register Bridge Data	Enter and update bridge specification data	●
	Register Update History	Register the content of the history Display historical data of past repairs, inspections etc.	
	Register Member Settings	Set up and update member components.	
	Register General Drawings	Register images of general views, side views , plan views, and sectional views The side view, plan view, and sectional view images can be created based on the schematic drawings.	
	Register Site Photographs	Register the inspection site photos and their descriptions.	
	Register Member Numbering	Register the member numbering diagram. A simple configured member numbering system can be created automatically based on the Member Settings.	
	Register Sketches of Damages	Register sketches of damages.	
	Register Damage Photographs	Register the damage photographs including span, member, damage type, damage rank, photo remarks. Registered damage pictures registered can be displayed using photo display software.	●
	Register Damage List	Select the span, member, damage type and damage rank, and register quantity and remarks. The member is automatically imported into the Damage List if a damage photograph is	

Classification	Function	Description	Remarks
		registered.	
	Register Damaged Member List	Register the evaluation rank, damage factor and comments based on the contents registered in the Damage List.	
	Register Inspection Summary	Aggregate inspection results based on the contents registered in the Damaged Member List, register the need for a Detail Inspection, repair method, repair quantity and comments.	
	Edit Inspection Results	Edit the registered data for each history of Initial Inspection. Reflect only the latest history of each bridge, using the latest data.	●
	Output Inspection Report	Output the input content as an Inspection Sheet formatted in Excel.	
Detail Investigation	Bridge Filtering	Refine search to target bridges for Detail Investigation.	●
	Bridge List	Display a list of bridges picked out by the search.	●
	Register Inspection Results	Display the Initial Inspection registration screen for the selected bridges. New registration is disabled if there is unloaded updated data on a bridge.	●
	Register Bridge Data	Enter and update bridge specification data.	●
	Register Update History	Register the content of the history Display historical data of past repairs, inspections, etc.	
	Register Inspection Summary	Display the latest registered Damaged Member List and update the evaluation rank, repair construction method and repair quantity based on the results of the Detail Investigation.	
	Register Attached Files	Register files such as the detail investigation results report.	
	Edit Inspection Results	Edit the registered data for each history of Detail Investigation, Include only the latest history for each bridge, using the latest data.	●
	Output Inspection Report	Output the input content as an Inspection Sheet formatted in Excel.	
Repair Job	Bridge Filtering	Refine search to target bridges for Repair Inspection.	●
	Bridge List	Display a list of bridges picked out by the search.	●
	Register Job Results	Display the Repair Inspection registration	●

Classification	Function	Description	Remarks
		screen for the selected bridges. New registration is disabled if there is unloaded updated data on a bridge.	
	Register Bridge Data	Enter and update bridge specification data.	●
	Register Update History	Register the contents of the history Display historical data of past repairs, inspections etc.	
	Register Inspection Summary	Display the latest registered Damaged Member List and update the evaluation rank, repair construction method and repair quantity based on the results of the Repair Job.	
	Register Attached Files	Register files such as the construction reports.	
	Edit Job Results	Edit the registered data for each history of Repair Job. Include only the latest history for each bridge using the latest data.	●
	Output Inspection Report	Output the input content as an Inspection Sheet formatted in Excel.	
Construction Job	Bridge Filtering	Refine search to target bridges for Construction Job.	●
	Bridge List	Display a list of bridges picked out by the search.	●
	Add New Bridge	Add an unregistered bridge as a new bridge.	
	Delete Bridge	Delete bridges only if newly added to BIDB and not uploaded to the BMS software.	○
	Register Job Results	Display the registration screen for Construction Job for the selected bridges. New registration is disabled if there is unloaded updated data on a bridge.	●
	Register Bridge Data	Enter and update bridge specification data.	●
	Register Update History	Register the content of this history. Display historical data of past repairs, inspections etc.	
	Register Member Settings	Set up and update component members in structures.	
	Register General Drawings	Register images of general views, side views, plan views, and sectional views. The side view, plan view, and sectional view images can be created based on the schematic drawings.	
	Register Site Photographs	Register the site photos and their descriptions.	
	Register Member	Register the member numbering diagram.	

Classification	Function	Description	Remarks
	Numbering	A simply configured member numbering diagram can be created automatically based on the Member Settings.	
	Register Attached Files	Register files such as construction reports.	
	Edit Job Results	Edit the registered data for each history of Construction Job. Include only the latest history of each bridge using the latest data.	●
	Output Inspection Report	Output the input content as an Inspection Sheet formatted in Excel.	
Data Export	Bridge Filtering	Refine search to output bridges.	
	Bridge List	Display a list of bridges picked out by the search.	
	Data Export	Export selected bridge data such as bridge specifications, inspection data and repair data which were input and updated in the bridge inspection database as data to transfer to other bridge inspection databases.	
Upload to BMS	Bridge Filtering	Refine search to target bridges to be uploaded to BMS.	○
	Bridge List	Display a list of bridges picked out by the search. Display only those bridges that were updated after approval of the BMS software before searching.	
	Data Upload	Upload the data of the selected bridges to the BMS software.	
Data Synchronization	Data Sync	Synchronize with the server system.	
	Settings	Set up a connection for data synchronization with the BMS software.	
DB Update	Master Code Update	Get the user information and the master code information from the user information and master code information update file (.accdb) downloaded from the BMS software in the certain folder.	
	DB Configuration Update	Add the updated DB configuration from the DB configuration update file arranged in a predetermined folder to the DB.	

(b) System Structures

The BIDB was structured based on the above specifications. These specifications were summarized for handing over to the NHA.

(7) BMS Software

(a) Logic for Priority Calculation

The JICA Expert Team held discussions and meetings to exchange opinions with the NHA in order to set up the calculation logic for prioritization.

Table 2-19 Discussion regarding Priority Logic

Meeting	Description
1st Meeting (2017/1/16)	・ Introduction of examples of the setting of repair priority for bridges in Japan (quantitative method, qualitative method) ・ NHA's request was confirmed to be for the quantitative method.
2nd Meeting (2017/7/6 ～2017/7/25)	・ Presentation of sample of priority calculation (score evaluation) using virtual bridge data (index, weight & score setting / calculation methods, etc.) ・ Discussion on setting of the draft index including the inspection system and DB.
3rd Meeting (2017/12/4 ～2017/12/16)	・ Presentation / explanation of index / weight & score / calculation logic (draft) using prototype tool (Excel) for priority calculation applying the tentative bridge inspection results by NHA. ・ Discussion and confirmation of index composition for prioritization, DB-related matters, calculation logic.

i) Overview

Bridge repair priority was set taking in to account "soundness of bridge" and "importance of bridge".

- Soundness of bridges: Index of safe transportation service
- Importance of bridges: Index of social loss due to traffic problems

ii) Index

The index used to set the repair priority order adopted sub-items subdivided on the basis of the following major items. In addition, small items were aligned with the master data in the BMS software.

Table 2-20 Index and Parameters

INDEX	No.	PARAMETER (boxes for score setting)
1.Soundness of bridge	1	I
	2	II
	3	III
	4	IV
2.Evaluation of members	1	A
	2	B
	3	Cd
	4	Cs
	5	Ep
	6	Es
3.Passage type	1	River
	2	Nullah
	3	Flood Relief Channel
	4	Irrigation Channel
	5	Railway
	6	Roadway
	7	Pedestrian Way
	8	Other
4.Maximum span length	1	Max.
	2	Min.
	3	Unknown
5.Years of construction	1	Max.
	2	Min.
	3	Unknown
6.Cause of damage	1	Fatigue
	2	Chloride damage
	3	Freeze and thaw
	4	Alkaline-silica reaction
	5	Carbonation
	6	Deterioration of material
	7	Other
7.Characteristic of bridge	1	Not Defined
	2	Bridges
	3	Big/Special Bridge
	4	Culvert
	5	Small Culvert
8.Road type	1	Roadtype 1
	2	Roadtype 2
	3	Roadtype 3
	4	Roadtype 4
	5	Roadtype 5

Table 2-21 Discussion of Priority Items

Index	Setting Concepts
1.Soundness of bridge	[Soundness of Bridge] ・Rating classification of each bridge. ・Index for evaluating soundness of the bridge as a whole. ・Bridges with a low level of soundness are prioritized in the evaluation.
2.Evaluation of members	[Soundness of Bridge] ・Rating classification of each member. ・Index for evaluating soundness as a part of the bridge. ・Consideration in evaluation of importance and soundness of parts.
3.Passage type	[Importance of Bridge] ・Crossing condition of the bridge.

	・Consideration in evaluation of the importance of intersecting object.
4.Maximum span length	[Importance of Bridge] ・Application of the maximum / minimum span length of each bridge *NHA evaluates the importance of bridges by their span length.
5.Years of construction	[Importance of Bridge] ・Application of the year of construction of the bridge.
6.Cause of damage	[Soundness of Bridge] ・Application of deterioration factors. ・ Consideration of influence and progression of deterioration factor.
7.Characteristic of bridge	[Importance of Bridge] ・Rated as bridge, culvert, or long/special bridge.
8.Road type	[Importance of Bridge] ・Evaluation of road types.

(b) System Specification

i) Authorization

Because the BMS software has important functions in data control, it is necessary to restrict the functions available to various types of users. The following authorization settings and function restrictions were put in place.

Table 2-22 Authorization and Restrictions

<table>
<tr><th>User Authorization
Major Function</th><th>HQ Staff [System administrator]</th><th>HQ Staff [Others]</th><th>Master Trainer</th><th>Inspector</th></tr>
<tr><td colspan="5">Server System</td></tr>
<tr><td>Search and refer data (read only)</td><td>Yes (all bridges)</td><td>Yes (all bridges)</td><td>Yes (only that for which they are responsible)</td><td>No (so far)</td></tr>
<tr><td>Export latest data to import bridge inspection DB</td><td rowspan="9">Yes</td><td>Yes</td><td>Yes</td><td rowspan="9">No</td></tr>
<tr><td>Approve uploaded data</td><td rowspan="8">No</td><td rowspan="8">No</td></tr>
<tr><td>Abolish bridge</td></tr>
<tr><td>Create inspection plan list</td></tr>
<tr><td>Update unit price</td></tr>
<tr><td>Calculate priority and create repair plan list</td></tr>
<tr><td>Add or delete the BMS user</td></tr>
<tr><td>Edit masters</td></tr>
<tr><td>Add or delete the documents such as manuals</td></tr>
</table>

ii) Specifications

Based on the results of the review and conclusions reached to this point, the JICA Expert Team examined and organized the functional specifications of the BMS software related to centralized management of bridge data, calculation of priorities, etc. The JICA Expert Team also examined and organized the functional specifications related to data synchronization with the BIDB, user authorization control, etc.

The JICA Expert Team created a system image at the design stage in order to discuss specifications with the NHA, built prototypes, exchanged opinions with the BMU, also discussed operational issues based on trial operation and requests from the BMU, and carefully reviewed and reflected the discussions in the function specifications.

Table 2-23 Specifications for BMS Software

（〇 Additional Function、●: Partially Modified Function）

Classification	Function	Description	Remarks
Login / Logout	Login	Log in to the BMS software according to user authority.	
	Logout	Log out from the BMS software.	
Inventory Data			
Bridge Search	Bridge Name Search	Search by partial bridge name and list the relevant bridges.	
	Hierarchical Search	Search bridge data by hierarchy of RO, MU, route, structure type and bridge name, and list the relevant bridges Furthermore, bridge length is added to the search variables.	
	Export Excel List	Export the contents of the search result list in Excel.	
	Bridge Detail	Display bridge Inventory data, pictures, history data, latest evaluation results (Inspection Summary), and related files. Display the relevant Inspection Sheet and attached file from the history data.	
	Add Documents	Register relevant files for each bridge.	
	Export Excel Sheet	Export the latest Inventory data for each bridge in Inspection Sheet format.	
	Print	Display the print dialog of the display screen.	
	Map	Call up the map function and display the area around the specified bridge.	
Map	Map	Display bridge data on a GIS map. Use the open street map for the GIS map and display the bridges color-coded according to soundness. Show / hide bridges by switching structure types and/or rating ranks.	
	Display Summary	Pop up Inventory summary of selected bridges.	

Classification	Function	Description	Remarks
		Call up the details screen.	
Latest Data Download	Bridge Filtering	Refine search for bridge to be downloaded.	
	Download	Export the latest Inventory data, history data, etc. of the selected bridge The exported data is imported into the bridge inspection database	
Data Upload	Data Upload	Upload the Inventory (input and updated in the bridge inspection database), inspection and repair data to the server system, and save as temporary data. Without providing GUI for this function, receive and capture data uploaded from the bridge inspection database via the network.	
Updated Data Approval	Bridge Filtering	Search bridges uploaded from BIDB.	
	Display Map	Display the bridge location on a map according to the uploaded bridge data.	○
	Display Updated data	Compare and display the data before and after updating of the uploaded bridge.	
	Data Approval	Approve the Inventory, inspection and repair data uploaded from BIDB and stored temporarily as actual data, and update the bridge data as actual data.	
	Data Disapproval	Disapprove the Inventory, inspection and repair data uploaded from BIDB and saved temporarily, and delete it.	
Bridge Discontinuation	Bridge Name Search	Search by partial name bridge to be discontinued and deleted, and list the relevant bridges.	
	Discontinue Bridge	Treat non-operational bridges as discontinued. Data of discontinued bridges is kept on the BMS software and can be redisplayed by searching.	
	Recover Discontinued Bridge	Recover the discontinued bridges as operational.	
	Delete Bridge Data	Completely delete the BMS software bridge data registered in error.	
Inspection			
Inspection List	Inspection List Generation	Generate and display an Inspection Plan List based on registered bridge specification data, inspection data, repair data, etc.	
	Export Inspection Plan List	Export the generated Inspection Plan List in Excel format.	
Repair Plan			

Classification	Function	Description	Remarks
Repair Plan	Unit Price	Edit unit price for repair works. Add repair work.	
	Priority Parameters	Set parameters for calculation of repair priority.	
	Priority Calculation	Calculate repair priority and approximate repair costs based on the registered bridge specification data, inspection data, repair data, etc., generate and display a Repair Plan List.	
	Export Repair Plan List	Export the generated Repair Plan List in Excel format.	
CSV Download			
CSV Download	CSV Download	Download the specified character and numerical data registered in the BMS software in CSV list format.	
System Maintenance			
System Maintenance	User Maintenance	Add, edit, or delete the login users to the BMS software.	
	Master Maintenance	Add, edit, or delete the options (Master) data used in the BMS software and bridge inspection database.	
	Manual Maintenance	Register, replace, or delete files such as manuals related to the BMS software.	
Data Synchronization	Data Sync	Distribute data from the bridge system in accordance with requests. Without GUI function, distribute the latest data via the network in response to a request from the bridge inspection database.	

(c) System Structures

The BMS software was built based on the above specification arrangement. The JICA Expert Team also summarized the specifications of the software structures so that the software can be handed over to the NHA.

2.2.1.4 Activity 1-4: JICA Expert Team develops draft training materials for (1) bridge/culvert inspection and (2) bridge/ culvert repair.

Training for NHA staff consisted of (1) Master Trainer Training, (2) Feedback Training after actual bridge inspection, (3) Inventory Survey Training, (4) Bridge Inspection Training (BMS Training), (5) BMS Software Training, and (6) Structural Mechanics Lecture (six times in total), and training materials were created in each case. However, since the training materials prepared in (1) were updated in the manual revision during the training under (3) and (4), the older versions were excluded from those handed over to NHA.

These training materials were created using a lot of animation, and explanations were shown after trainees answered the questions for themselves.

Thus they can be utilized for self-study by NHA staff in local areas and can be used as e-learning training materials in the future.

Table 2-24 Training Materials

No.	Contents	Classification		e-learning	Handover to NHA
		I:Inspection R:Repair B:BMS	B:Basic A:Advanced		
(1)Master Trainer Training					
1	Bridge Engineering (1)	I	B	○	×
2	Bridge Engineering (2)	I	A	○	○
3	Summary of Inspection Manual	I	B	○	×
4	Basics of Evaluation	I	B	○	×
5	Damage Rank of Concrete	I	B	○	×
6	Damage Rank of Others	I	A	○	×
7	Evaluation of concrete damage	I	B	○	×
8	Evaluation of others damage	I	A	○	×
9	Inspection Sheet (1)～(3)	I	B	○	×
10	Repair of Concrete Structures	R	B	○	×
11	Repair and Strengthening of Steel Structures	R	A	○	×
12	In-depth Inspection of Structures	R	A	○	×
13	Inspection Sheet (Shahia Bridge)	I	B	○	○
14	Inspection Sheet (Wah Garden Bridge)	I	B	○	○
15	Daily Test (Day 1 – 3)	I / R	B	○	×
16	Examination	I / R	B	×	×
(2) Feedback Training after actual bridge inspection					
17	Extra Training for filling out Inspection Report Sheets	I	B	○	○
18	Example of Inspection Report Sheets with comments	I	B	×	○
(3) Inventory Survey Training (BMS Training)					
19	Inventory Survey Training	I	B	○	○
20	Supplementary material for Inventory Survey	I	B	○	○
(4) Bridge Inspection Training (BMS Training)					
21	Bridge Engineering	I	B / A	○	○
22	Bridge/Culvert Inspection Manual	I	B	○	○
23	Bridge Inspection (1)～(3)	I	B / A	○	○
24	Repair of Concrete structure	R	B	○	○
25	Repair for others	R	A	○	○
26	How to fill out Inspection Sheet	I	B	○	○
27	Data Input by BIDB	I / B	B	○	○
28	Daily Test (Day 1 – 2)	I / R	B	○	○
29	Examination	I / R	B	×	○
(5) BMS Software Training					
30	BMS Software Training	B	A	○	○
(6) Structural Mechanics Lecture					
31	Structural Mechanics	I / R	A	○	○

2.2.1.5 Activity 1-5: BMU reviews and finalizes the above manuals, inspection formats, prototype and training materials.

The BMU has been revising the manuals, inspection formats, prototypes and training materials through discussions with the JICA Expert Team, Trainee Engineers and members of the JWG.

(1) Feedback through Master Trainer Training

Reflecting the opinions of participants in the Master Trainer Training, the following revisions were made;

[Bridge/Culvert Inspection Manual]

・Change of the overall configuration (addition of bridge maintenance and management flow, criteria for damage rank and classified evaluation in the main contents, contents of appendix, etc.);

・Addition of Inspection other than Periodic Inspection;

・Renaming of Classified Evaluations.
(A, B, C1, C2, E1, E2, S1, S2, M-> A, B, Cd, Cs, Es, Ep, Sd, Sf, M)

[Bridge/Culvert Repair Manual]

・Standardization of repair work countermeasures.

[Bridge/Culvert Inspection Format]

・Revision of the header part, simplifying and consolidating sheet names and terms.

[Training Materials]

・Reflecting revised manuals.

・

(2) Localization by BMU

[Bridge/Culvert Inspection manual]

・The BMU prepared an overview for each chapter of the road network and structures managed by NHA.

・Photographs from Japan were used to illustrate instances of damage in Appendix 4, but the The BMU will update to local photographs in the future as more cases are handled in Pakistan.

[Bridge/Culvert Repair Manual]

・The BMU prepared a CSR[10] to estimate the budget for approximate repair costs in the BMS Software. The CSR should continue to be revised on a regular basis.

[Training Materials]

・All the original training material electric data have been handed over to the BMU, and the BMU will in the future revise them in accordance with the actual situation in the field and the skill level of the trainees.

[10] CSR: Composite Schedule of Rates

(3) Feedback on BMS Training

[Bridge/Culvert Inspection Manual]

・The JICA Expert Team have created a handbook that picks up from the Bridge/Culvert Inspection Manual the items necessary for on-site works so that on-site inspection works can be made more efficient and mistakes in data entry can be avoided as much as possible.

[BIDB Operation Manual]

・Some parts of the BIDB Operation Manual were revised to reflect the opinions and requests gathered during the data entry training following BMS on-site training.

[BIDB Input System Prototype]

・Reflecting the opinions and requests received during the data entry training following BMS on-site training, improvements were made to Inventory Survey and Bridge Inspections, additional functions , interface modification, etc., for easier operation.

[BMS Software Prototype]

・Reflecting the opinions and requests received during the BMS Software Training, improvements have been made in registration, approval, and synchronization procedures of Inventory Survey and Bridge Inspection results.

(4) Comments and Opinions

・Comments and opinion relating to the three types of manual (Bridge/Culvert Inspection Manual, Bridge/Culvert Repair Manual, BIDB Operation Manual) and the Bridge/Culvert Inspection Format were delivered within and outside the NHA (academia and industry). The BMU sorted the opinions received and revised the manuals.

(5) Finalization

Reflecting the comments and opinions received from within and outside the NHA, the BMU has finalized the three manuals together with the SOP[11] compiled separately and sent to the NHA Executive Board Meeting for approval in October 2018.

2.2.2 Output 2: Bridge/culvert inspection in the model area is implemented after BMS training.

Though it was initially considered that the BMS of the NHA would be implemented nationwide through Master Trainers, the training target changed from Master Trainers to the Bridge Management Unit (BMU) as the scope changed from nationwide to the model area. The BMU consisted of three (3) civil engineers selected from excellent candidates in the Master Trainer Training and one (1) IT engineer.

2.2.2.1 Activity 2-1: JICA Expert Team provides on-the-job-training (OJT) which enables BMU

[11] SOP: Standard Operating Procedure

to manage BMS training in NHA.

(1) Master Trainer Training

(a) Candidates

Because of the need to educate the NHA staff widely regarding the BMS and situations in which most NHA staff had insufficient knowledge and experience in bridge maintenance, the C/P requested the JICA Expert Team to train 65 Master Trainer candidates and to select Master Trainers based on the results of the training.

As a result, the JICA Expert Team implemented one (1) week training three (3) times for 65 Master Trainer candidates at the Highway Research and Training Center (HRTC) from February to March 2017, as shown in Table 2-25. Each Master Trainer candidate was obligated to submit ten (10) bridge inspection reports as training outcomes of the technical transfer OJT in bridge inspection / evaluation, selection of bridge repair method and the bridge inspection database.

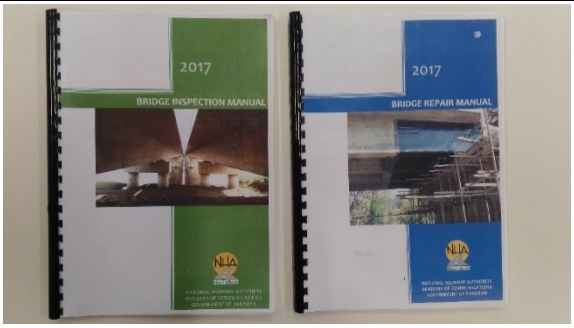
Table 2-25 Master Trainer Training

No.	Duration	Days	Attendees
1	2017/2/27～2017/3/3	5	16
2	2017/3/6～2017/3/10	5	20
3	2017/3/13～2017/3/17	5	29
Total		15	65

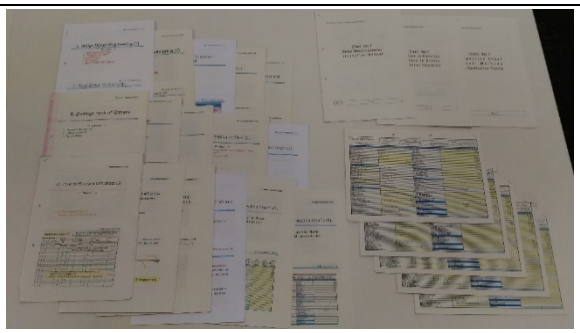
(b) Materials

· Bridge Inspection Manual (1st edition, 2017)
· Bridge Repair Manual (1st edition, 2017)
· Master Trainer Training materials
· Office supplies (bags, files, notebooks, 3-color ballpoint pens)

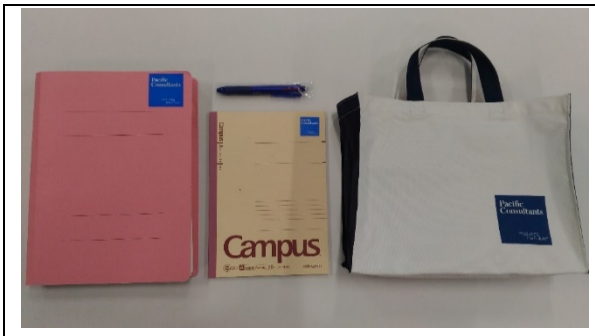
* The training materials were not distributed in digital format. (As requested by the C/P side.)



Manuals (1st Edition)



Materials for MT Training



Office Supplies

Figure 2-10 Goods distributed for the Training

(c) Target Bridges

The target bridges for on-site training were selected taking into consideration different types of damage, vertical access by ladder only, and parking space for all the trainees.

The target bridges selected were Shahiya Bridge and Wah Garden Bridge.

(d) Syllabus

The Master Trainer Training consisted of two and half (2.5) days in-house training and two and half (2.5) days on-site training. A quiz to confirm understanding was held just after the final lecture on each in-house training day so that each candidate was able to personally check his/her understanding.

Based on the results of the interview, since university courses included no lectures on bridge engineering (structural mechanics), lectures on the basics of bridge engineering were given at the beginning of the training. After that, lectures were given on bridge inspection, bridge repair, and the bridge inspection sheet.

Table 2-26 Syllabus (Day 1)

Date	Theme	Time	Activity	Details	Resource Person
Day 1 (Mon)	Bridge Design & Construction Inspection Manual, Evaluation	10:00 10:20	Presentation	Introduction of BMS, Background of the Project	Muhammad Asif Azam
		10:20 10:30	Presentation	Summary of training program and schedule	Yukio IGO
		10:30 11:00	Break	Questionnaires	
		11:00 11:50	Bridge Design Engineering (1) (Lecture)	Bridge Components & Types Basics about Deck Slab, Substructure Structural Mechanics	Haruo Tomiyama
		11:50 12:00	Break	-	
		12:00 13:00	Bridge Design Engineering (2) (Lecture)	Bridge Types (advanced), Deck Slab (advanced), Basics about Bearing support & Expansion Joint	Haruo Tomiyama
		13:00 14:00	Break	Lunch & Prayer	
		14:00 14:50	Inspection manual (1) (Lecture)	Summary of Bridge Inspection Manual [terminologies, required items & procedure for general inspection	Yoshiichi Fujimoto
		14:50 15:00	Break	-	
		15:00 15:50	Inspection manual (2) (Lecture)	Bridge Inspection Manual / Basics of Evaluation [Soundness diagnosis for damages]	Yoshiichi Fujimoto
		15:50 16:00	Break	-	
		16:00 16:30	Test	Quiz for Bridge Design & Inspection	
		16:30 17:00	Review	Review of Today's Lectures	

Table 2-27 Syllabus (Day 2)

Date	Theme	Time	Activity	Details	Resource Person
Day 2 (Tue)	Damage Evaluation & Bridge Inspection Sheet	9:30 10:30	Damages in Concrete (1) (Lecture)	Damage Evaluation [Cracks, Spalling, Exposed R-bars, Floating, Leakage, Efflorescence etc.]	Yoshiichi Fujimoto
		10:30 11:00	Damages in others (2) (Lecture)	Damage Evaluation of Joint, Bearing, pavement etc.	Yoshiichi Fujimoto
		11:00 11:30	Break		
		11:30 12:30	Soundness Diagnosis (concrete) (Lecture)	Evaluation for Soundness Diagnosis, Damage evaluation in concrete	Yoshiichi Fujimoto
		12:30 13:00	Soundness Diagnosis (others) (Lecture)	Evaluation for Soundness Diagnosis, Damage evaluation in joint, bearing, pavement, etc.	Yoshiichi Fujimoto
		13:00 14:00	Break	Lunch & Prayer	
		14:00 14:50	Inspection Sheet (1) (Lecture)	How to fill inspection sheet (1)	Haruo Tomiyama
		14:50 15:50	Inspection Sheet (2) (Lecture)	How to fill inspection sheet (2)	Haruo Tomiyama
		15:50 16:00	Break	-	
		16:00 16:30	Test	Quiz for Damages	
		16:30 17:00	Review	Review of Today's Lectures	

Table 2-28 Syllabus (Day 3)

Date	Theme	Time	Activity	Details	Resource Person
Day 3 (Wed)	Inspection Sheet, Countermeasures	9:30 10:30	Inspection Sheet (3) (Lecture)	How to fill inspection sheet (3)	Haruo Tomiyama
		10:30 11:00	Break	-	
		11:00 11:45	Repair Methods (1) (Lecture)	Countermeasure for concrete [crack repair, section repair, partial renewal, surface protection, anti-corrosion works, sealing etc.]	Yukio IGO
		11:45 12:30	Repair Methods (2) (Lecture)	Countermeasure for steel and other material [scour protection, repair of bearing & expansion joints etc]	Yukio IGO
		12:30 13:00	Non Destructive Testing (Lecture)	Test for concrete and steel [crack scale, test hammer, rebound hammer, GPR etc.]	Yukio IGO
		13:00 14:00	Break	Lunch & Prayer	
		14:00 14:30	Test	Quiz for Repairs	
		14:30 15:00	Review	Review of Today's Lectures	
		15:00 15:30	Move	HRTC → Indus River Bridge on M-1	
		15:30 17:00	Site Inspection	Bridge inspection and evaluation	

Table 2-29 Syllabus (Day 4)

Date	Theme	Time	Activity	Details	Resource Person
Day 4 (Thu)	Site Inspection	9:00 10:00	Move	HRTC → Shahia Bridge	
		10:00 11:00	Site Inspection	Bridge inspection (1)	
		11:00 11:10	Break	-	
		11:10 12:10	Site Inspection	Bridge Inspection (2)	
		12:10 12:40	Move	Shahia Bridge → HRTC	
		12:40 14:10	Break	Lunch & Prayer	
		14:10 15:10	Evaluation	Evaluation of Site Inspection	
	Review & Discussion	15:10 16:00	Review	Review of Inspection Results	
	Examination	16:00 17:00	Examination	Qualifying examination of MT Trainer	

Table 2-30 Syllabus (Day 5)

Date	Theme	Time	Activity	Details	Resource Person
Day 5 (Fri)	Site Inspection	9:00	Move	HRTC → Wah Garden Bridge on N-5	
		9:30			
		9:30	Site Inspection	Under Bridge inspection (1)	
		10:30			
		10:30	Break	-	
		10:40			
		10:40	Site Inspection	Under Bridge Inspection (2)	
		11:40			
		11:40	Break	-	
		11:50			
		11:50	Site Inspection	Bridge Inspection on Surface	
		12:30			
		12:30	Move	Wah Garden Bridge → HRTC	
		13:00			
		13:00	Break	Lunch & Prayer Questionnaires	
		14:10			
	Review & Discussion	14:10	Evaluation	Evaluation of Site Inspection	
		15:00			
		15:00	Break	-	
		15:10			
		15:10	Review	Review of Inspection Results	
		16:00			
	Conclusion and Certificate Distribution	16:00	Presentation	The Future of NHA	Aftab Ullah Babar
		16:20			
		16:20	Concluding Remarks	Review of Training Program	Yukio IGO
		16:30			
		16:30	Certificate Distribution	Master Trainer's Training Certification	TBD
		16:40			
		16:40	Closing Remarks	End of Training	TBD
		17:00			

(e) Master Trainer Training

In-house Training

On-site Training (Indus River Bridge)

On-site Training (Shahiya Bridge)

Examination

On-site Training (Wah Garden Bridge)

Certification Delivery

Figure 2-11 Master Trainer Training

(f) Candidate Evaluation

The JICA Expert Team evaluated the candidates on the basis of the examination held at the end of the Master Trainer Training and the bridge inspection sheet submitted by each candidate during bridge inspection OJT.

Of the 65 candidates only 17 submitted bridge inspection sheets, and of the 55 sets submitted, none met the required level of competence.

(g) Feedback Training (2017.7.25)

On the basis of the bridge inspection reports submitted by the Master Trainer candidates, the JICA Expert Team summarized easily-mistaken points as feedback training. Although the content of this feedback training was very practical and meaningful, only four (4) candidates attended. The JICA Expert Team distributed the training materials to all seventeen (17) candidates who had submitted bridge inspection reports.

1. Explanation of purpose of training
2. Criteria for evaluation of bridge inspection sheets, and score standards
3. Common mistakes to be avoided
4. Review of bridge inspection schedules for 17 bridges submitted by 17 trainees
5. Bridge inspection manual to be revised

Figure 2-12 Overview of Feedback Training

(2) BMS Organization

The Bridge Management System in the model area was implemented by the BMU and the Trainee Engineers.

(a) Shortage of human resources

The main work of the Maintenance Unit staff was to supervise daily inspections, periodic inspections, safety facilities, and small-scale repair works, and these tasks were carried out with a small staff (about one third of the quota). The current status of bridge inspection was limited to patrolling of the bridge road surface (guardrails, expansion joints, pavement, etc.), with hardly any inspection from beneath the bridge being carried out. The biggest cause of this was labor problems (union problem) inherent in the NHA, where there had been no new recruitment since the end of 2011, leading to lack of staff and in particular a lack of young staff.

Furthermore, in conjunction with the lower concern for and regard given to bridge maintenance, it seemed that human resources were preferentially assigned to new construction projects such as CPEC[12]. In terms of both quality and quantity, the allocation of personnel for bridge maintenance was insufficient.

In addition, there were also human resource shortages at Headquarters and Regional Offices (about 1/2 of the quota), and vacant positions and the doubling-up of positions were often seen.

(b) Shortage of bridge maintenance engineers

Though there were bridge design engineers in Pakistan and in the NHA, there were very few

[12] China-Pakistan Economic Corridor, part of the China-Pakistan Economic Corridor as known as "One Belt One Road"

engineers who were good at bridge maintenance.

It was heard that there were no lectures on bridge engineering (structural mechanics) at university in Pakistan, except at the graduate level. As a result basic knowledge on bridge structure appeared to be insufficient among the engineers. Furthermore, engineers were able to gain little experience of bridge repair and reinforcement in Pakistan, so there were few engineers who were good at bridge maintenance and management.

(c) Proposal of BMS Organization

The JICA Expert Team explained the situation regarding BMS in Japan, the legal system and the qualification system, proposed the need for an organizational structure for bridge maintenance, and indicated the number of bridge inspectors needed. The JICA Expert Team presented this summary to the Chairman of the NHA and obtained his understanding and cooperation.

In addition to preparing and maintaining the various manuals and training materials so that the BMU (Bridge Management Unit) established in the headquarters can extend BMS Training nationwide, the JICA Expert Team proposed to enhance BMU capability through OJT in which the BMU would take charge of BMS Training and practical instruction for Trainee Engineers.

(d) Organization Establishment

The BMU (the central entity in BMS) consisting of 4 personnel, i.e. BMS personnel (from the beginning of the Project), repair personnel (from early January 2018), inspection personnel (from mid-January 2018), and IT personnel (from July 2018), plus 12 Trainee Engineers (from late February 2018) in charge of the bridge inventory survey and bridge inspection in the model area were appointed to NHA headquarters for the short term.

The BMU took responsibility for BMS in NHA, and implemented BMS Training for Regional Office and Maintenance Unit staff and bridge inspectors. Since the Project Coordinator had been assigned to other assignments, he could not allocate sufficient time for the Project, which hindered the progress of the Project; but the BMU was able to compensate for his absence and normalize the progress of the Project.

Because NHA was not able at the time to hire new officers, 12 Trainee Engineers (10 in practice) were hired on a one-year contract basis instead of permanent bridge inspectors, and they took charge of the bridge inventory survey, the bridge inspection and data entry, and enabled the Project to make sufficient progress.

BMS in the model area was implemented mainly by the BMU and the Trainee Engineers.

(e) Bridge Management Unit (BMU)

In order for the BMU to play a central role in the BMS of NHA, the JICA Expert Team managed to build up a BMU (Bridge Management Unit) consisting of 3 civil engineers and 1 IT engineer.

At the time the BMU established, in addition to Mr. Muhammad Asif Azam who had been the Project Coordinator since the beginning of the Project, two members from the C/P side were selected taking into consideration the results of the 1st Master Trainer Training. The IT Engineer was selected later.

Table 2-31 List of BMU Members

Category	Position	Name
Civil Engineers	Deputy Director (BMU)-I	Mr. Muhammad Asif Azam
	Deputy Director (BMU)-II	Mr. Ghulam Murtaza Simair
	Deputy Director (BMU)-III	Mr. Sohaib Mansoor
IT Engineer	Assistant Director(BMU)-IT	Mr. Ashfaq Ahmed Mr. M Nur-Ul-Eain

(f) Trainee Engineers

Given the situations whereby the NHA had not been able to recruit new staff due to internal legal issues for almost ten years, the NHA decided to hire as one-year contract employees 12 Trainee Engineers, who had been working as Inspectors in other projects in the NHA. The Trainee Engineers numbered eight (8) because two (2) of them quit after the interview and two (2) of them were hired to other ministry positions in August, 2018. It was decided that 4 additional Trainee Engineers would join the BMS as one-year contract employees following interviews held in January 2019.

(3) OJT for BMU

The JICA Expert Team carried out technical transfer to the BMU through OJT to enable the BMU to implement BMS in NHA.

(a) Revision of Manuals

Two of the new members of the BMU tackled localization and were able to complete the revision work before the start of BMS Training.

(b) Revision of Materials

The content was explained to and discussed with the two new members who were actually in charge of the lectures, and their opinions were incorporated so that it was possible to complete revision work of the manuals before the BMS Training started.

(c) Inventory Survey Planning

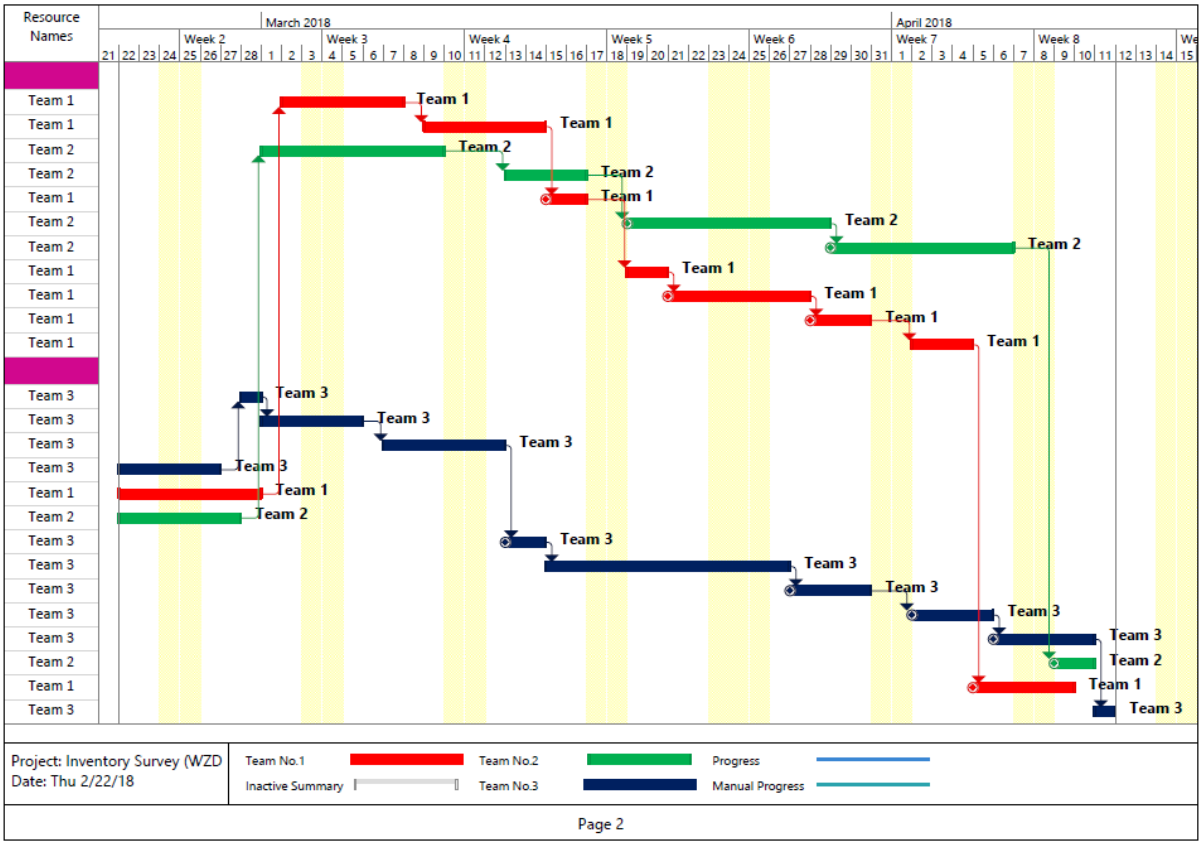
i) General Planning

ID	Task Mode	Task Name	Bridges	Culverts	Duration	Start	Finish	Predecessors
1		**WAZIRABAD MAINTENANCE UNIT**	**151**	**85**				
2		WZD-1: Narang Mandi More - Kala Shah Kaku (N5/M2 Interchange)	14	0	4 days	Fri 3/2/18	Wed 3/7/18	18FS+1 day
3		WZD-2: Kala Shah Kaku (N5/M2 Interchange) - Muridke	12	7	4 days	Fri 3/9/18	Wed 3/14/18	2FS+1 day
4		WZD-3: Muridke - Sadhoke	23	15	7 days	Thu 3/1/18	Fri 3/9/18	19FS+1 day
5		WZD-4: Sadhoke - Chand Da Qila	12	11	4 days	Tue 3/13/18	Fri 3/16/18	4FS+1 day
6		WZD-5: Gujranwala Bypass	4	13	2 days	Thu 3/15/18	Fri 3/16/18	3
7		WZD-6: Gujranwala Bypass (End) - Wazirabad Bypass (Start)	22	10	7 days	Mon 3/19/18	Wed 3/28/18	5
8		WZD-7: Wazirabad Bypass (Start) - Gujrat Bypass (End)	21	16	7 days	Thu 3/29/18	Fri 4/6/18	7
9		WZD-8: Gujrat Bypass (End) - Lala musa	6	7	2 days	Mon 3/19/18	Tue 3/20/18	6
10		WZD-9: Lala musa - Kharian	14	4	4 days	Wed 3/21/18	Tue 3/27/18	9
11		WZD-10: Kharian - Dina	11	2	3 days	Wed 3/28/18	Fri 3/30/18	10
12		WZD-11: Dina - Missa Kassowal	12	0	3 days	Mon 4/2/18	Wed 4/4/18	11
13		**RAWALPINDI MAINTENANCE UNIT**	**104**	**176**				
14		RWD-1: Missa Kassowal - Gujar Khan	3	0	1 day	Wed 2/28/18	Wed 2/28/18	17FS+1 day
15		RWD-2: Gujar Khan - Rawat	6	11	3 days	Thu 3/1/18	Mon 3/5/18	14
16		RWD-3: Rawat - Rawalpindi (GPO)	13	6	4 days	Wed 3/7/18	Mon 3/12/18	15FS+1 day
17		RWD-4: Rawalpindi (GPO) - Tarnol	10	4	3 days	Thu 2/22/18	Mon 2/26/18	
18		RWD-5: Tarnol - Taxila	10	21	5 days	Thu 2/22/18	Wed 2/28/18	
19		RWD-6: Taxila - Hassanabdal	7	23	4 days	Thu 2/22/18	Tue 2/27/18	
20		RWD-7: Hassanabdal - Burhan (N5/M1 Interchange)	5	8	2 days	Tue 3/13/18	Wed 3/14/18	16
21		RWD-8: Burhan (N5/M1 Interchange) - Kamra (Attock Road)	18	20	7 days	Thu 3/15/18	Mon 3/26/18	20
22		RWD-9: Kamra (Attock Road) - Haji Shah (Attock Road)	15	2	4 days	Tue 3/27/18	Fri 3/30/18	21
23		RWD-10: Haji Shah (Attock Road) - Khairabad (Indus Bridge)	10	12	4 days	Mon 4/2/18	Thu 4/5/18	22
24		RWD-11: Tarnol - Fatehjang	3	18	3 days	Fri 4/6/18	Tue 4/10/18	23
25		RWD-12: Fatehjang - Khunda More	0	20	2 days	Mon 4/9/18	Tue 4/10/18	8
26		RWD-13: Khunda More - Jand	3	22	3 days	Thu 4/5/18	Mon 4/9/18	12
27		RWD-14: Jand - Khushalgarh	1	9	1 day	Wed 4/11/18	Wed 4/11/18	24

Project: Inventory Survey (WZD
Date: Thu 2/22/18

Team No.1 Team No.2 Progress
Inactive Summary Team No.3 Manual Progress

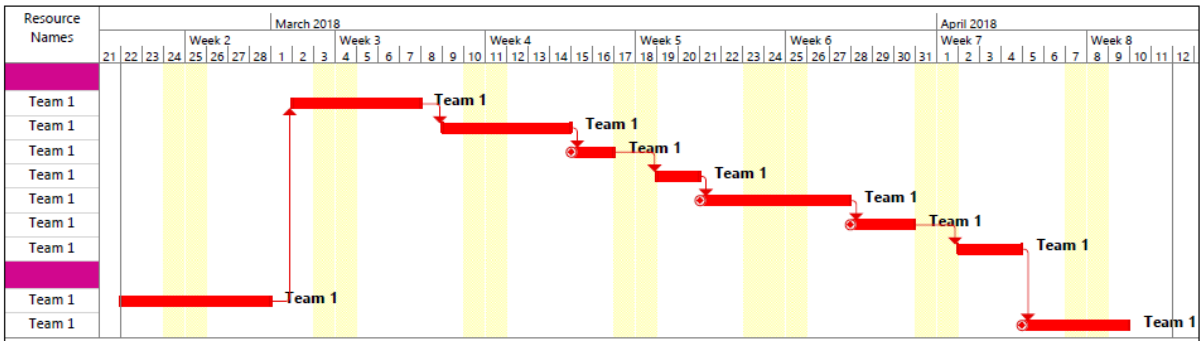
Page 1



Page 2

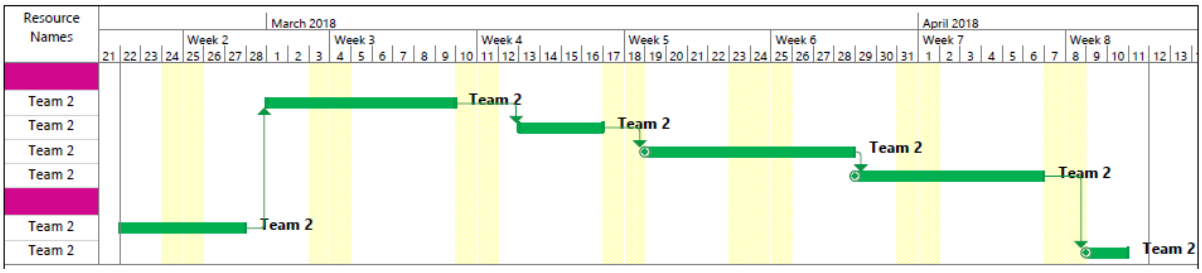
ii) Planning for Team 1

ID	Task Mode	Task Name	Bridges	Culverts	Duration	Start	Finish	Predecessors
1		**WAZIRABAD MAINTENANCE UNIT**	**151**	**85**				
2		WZD-1: Narang Mandi More - Kala Shah Kaku (N5/M2 Interchange)	14	0	4 days	Fri 3/2/18	Wed 3/7/18	18FS+1 day
3		WZD-2: Kala Shah Kaku (N5/M2 Interchange) - Muridke	12	7	4 days	Fri 3/9/18	Wed 3/14/18	2FS+1 day
6		WZD-5: Gujranwala Bypass	4	13	2 days	Thu 3/15/18	Fri 3/16/18	3
9		WZD-8: Gujrat Bypass (End) - Lala musa	6	7	2 days	Mon 3/19/18	Tue 3/20/18	6
10		WZD-9: Lala musa - Kharian	14	4	4 days	Wed 3/21/18	Tue 3/27/18	9
11		WZD-10: Kharian - Dina	11	2	3 days	Wed 3/28/18	Fri 3/30/18	10
12		WZD-11: Dina - Missa Kassowal	12	0	3 days	Mon 4/2/18	Wed 4/4/18	11
13		**RAWALPINDI MAINTENANCE UNIT**	**104**	**176**				
18		RWD-5: Tarnol - Taxila	10	21	5 days	Thu 2/22/18	Wed 2/28/18	
26		RWD-13: Khunda More - Jand	3	22	3 days	Thu 4/5/18	Mon 4/9/18	12



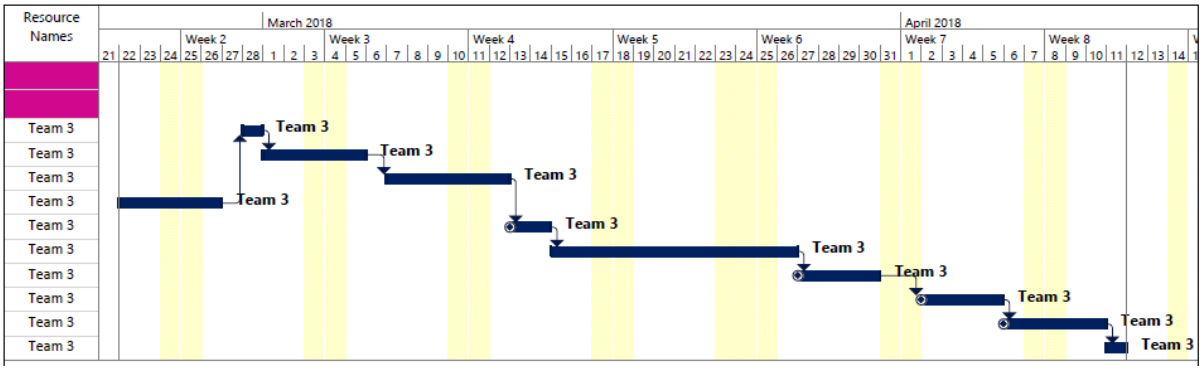
iii) Planning for Team 2

ID	Task Mode	Task Name	Bridges	Culverts	Duration	Start	Finish	Predecessors
1		**WAZIRABAD MAINTENANCE UNIT**	**151**	**85**				
4		WZD-3: Muridke - Sadhoke	23	15	7 days	Thu 3/1/18	Fri 3/9/18	19FS+1 day
5		WZD-4: Sadhoke - Chand Da Qila	12	11	4 days	Tue 3/13/18	Fri 3/16/18	4FS+1 day
7		WZD-6: Gujranwala Bypass (End) - Wazirabad Bypass (Start)	22	10	7 days	Mon 3/19/18	Wed 3/28/18	5
8		WZD-7: Wazirabad Bypass (Start) - Gujrat Bypass (End)	21	16	7 days	Thu 3/29/18	Fri 4/6/18	7
13		**RAWALPINDI MAINTENANCE UNIT**	**104**	**176**				
19		RWD-6: Taxila - Hassanabdal	7	23	4 days	Thu 2/22/18	Tue 2/27/18	
25		RWD-12: Fatehjang - Khunda More	0	20	2 days	Mon 4/9/18	Tue 4/10/18	8



iv) Planning for Team 3

ID	Task Mode	Task Name	Bridges	Culverts	Duration	Start	Finish	Predecessors
1		**WAZIRABAD MAINTENANCE UNIT**	**151**	**85**				
13		**RAWALPINDI MAINTENANCE UNIT**	**104**	**176**				
14		RWD-1: Missa Kassowal - Gujar Khan	3	0	1 day	Wed 2/28/18	Wed 2/28/18	17FS+1 day
15		RWD-2: Gujar Khan - Rawat	6	11	3 days	Thu 3/1/18	Mon 3/5/18	14
16		RWD-3: Rawat - Rawalpindi (GPO)	13	6	4 days	Wed 3/7/18	Mon 3/12/18	15FS+1 day
17		RWD-4: Rawalpindi (GPO) - Tarnol	10	4	3 days	Thu 2/22/18	Mon 2/26/18	
20		RWD-7: Hassanabdal - Burhan (N5/M1 Interchange)	5	8	2 days	Tue 3/13/18	Wed 3/14/18	16
21		RWD-8: Burhan (N5/M1 Interchange) - Kamra (Attock Road)	18	20	7 days	Thu 3/15/18	Mon 3/26/18	20
22		RWD-9: Kamra (Attock Road) - Haji Shah (Attock Road)	15	2	4 days	Tue 3/27/18	Fri 3/30/18	21
23		RWD-10: Haji Shah (Attock Road) - Khairabad (Indus Bridge)	10	12	4 days	Mon 4/2/18	Thu 4/5/18	22
24		RWD-11: Tarnol - Fatehjang	3	18	3 days	Fri 4/6/18	Tue 4/10/18	23
27		RWD-14: Jand - Khushalgarh	1	9	1 day	Wed 4/11/18	Wed 4/11/18	24



v) Teaming

The JICA Expert Team recommended that each team should have at least two (2) members for the sake of safety, with three (3) being better for recording efficiency. The BMU made up the teams in accordance with this recommendation.

Table 2-32 Teams for Inventory Survey

Survey Team	Maintenance Unit	Trainee Engineers	Contact Numbers
Team No.1	LAHORE	Safwan Naeem	03318727566
		Ashar Tariq	03347721894
		Shawez Hassan	03005093900
		Imran	03127232007
Team No.2	WAZIRABAD	Shahzeb Farooq	03235053321
		Jawad Naeem	03455058505
		Shahzeb Salim	03311160026
		Akhunzada	
Team No.3	RAWALPINDI	Abdur Rehman	03415179869
		Ubaid	03325579996
		Hussain Ahmed Abbas	03353688147

vi) Schedule for data input

As only one (1) desktop computer[13] had been prepared for the Project during the Inventory

[13] One (1) desktop computer (old-fashioned) was initially allocated, and three two (2) more desktop

Survey, the data entry schedule was also planned for most efficient usage of the computer.

INVENTORY DATA ENTRY AT BMU OFFICE - NHA H/Q

TEAMS	FULL DAYS (For Group)	PART TIME (Only one TE)
Team No.1	1-Mar-2018	15-Mar-2018
	8-Mar-2018	21-Mar-2018
	10-Apr-2018	28-Mar-2018
		5-Apr-2018
Team No.2	28-Feb-2018	19-Mar-2018
	12-Mar-2018	29-Mar-2018
	11-Apr-2018	9-Apr-2018
Team No.3	27-Feb-2018	13-Mar-2018
	6-Mar-2018	27-Mar-2018
	12-Apr-2018	2-Apr-2018
		6-Apr-2018

Figure 2-13 Schedule for Data Input

vii) Equipment Checklist

The BMU prepared the equipment check list for the Inventory Survey in accordance with the JICA Expert Team's suggestion. Each team confirmed all items to be brought on-site.

computers (old-fashioned) were temporarily allocated. Finally three (3) laptop computers were allocated by the C/P to enable data input in the field and to cope with power outages.

A Project for Technical Assistance on Implementation of Bridge Management System in NHA

EQUIPMENT CHECKLIST

Bridges/Culverts Inventory Survey in Punjab North

Sr. No	Equipment	Quantiry (Nos)
1	Safety Halmets	4
2	Reflective Waists	4
3	Measuing Tape	1
4	Tourch	1
5	Slate for Numbering	1
6	GPS	1
7	Cones for Traffic Management	4
8	Field Data Books	2

Handed Over by

Signature: _____
Name: _____
Date: _____

Taken Over by

Signature: _____
Name: _____
Date: _____

Note:

(a) Proper handling of the survey data record and equipments is the sole responsibility of all the Team members

(b) Inventory Survey data is sole property of NHA and it should not be shared with anyone outside BMU.

(c) The Equipments shall be handedover to the BMU in good conditionas and when the Inventory Survey is completed.

Figure 2-14 Equipment Check List

(4) Preparation for BMS Training

The BMU and the JICA Expert Team collaborated in preparing for the BMS Training. The check list was prepared not only for this BMS Training but also for the future BMS Training to be managed independently by the BMU. A BMS Training syllabus was also drawn up through collaboration between the BMU and the JICA Expert Team.

Table 2-33 Check List for BMS Training

Item	Rsponsible person	Due date	Checked date	Notes
Official confirmation of holding date				Apr 16 (Mon) ～ Apr 20(Fri), can not change
Request Letter to Member (Planning)	Mr. Igo	22 February	22 February	
Approval by stakeholder	BMU(S&M)	09 March		
Reservation of venue				
Selection of venue	BMU(S&M)	09 March	05 March	HRTC
Reservation of venue	BMU(S&M)	09 March		
Preparation of lunch and tea break	BMU(S&M)	30 March		
Preparation of transportation	BMU(S&M)	30 March		
Preparation of Personal Computer	BMU(S&M)	30 March		
Invitation of participants				
List up of participants	BMU(S&M)	09 March		
Notification to participants	BMU(S&M)	16 March		
Confirmation of participants	BMU(S&M)	30 March		
Training curriculum				
Timetable of training	BMU(S&M)&Tomiyama	09 March	06 March	draft
Selection of Bridge to inspect in training	BMU(S&M)	09 March	06 March	Wah Garden Bridge [PC & RC]
Selection of Culvert to inspect in training	BMU(S&M)	09 March		
Selection of lecturer for each subject	BMU(S&M)	09 March		
Selection of representative brdges and culverts	BMU(S&M)	30 March		
Bridge/Culvert inspection planning	BMU(S&M)	30 March		
Training Materials				
General	BMU(S&M)&Tomiyama	20 March		
Bridge Engineering	BMU(S&M)&Tomiyama	20 March		
Bridge Inspection	BMU(S&M)&Tomiyama	20 March		
Repair Method	BMU(S&M)&Igo	30 March		
Data Input	BMU(S&M)&Mori	10 April		
Printing materials		13 April		
Manual				
Brdge Inspection Manual	BMU(S&M)&Tomiyama	12 March		
Bridge Repair Manual	BMU(S&M)&Igo	30 March		
Bridge Inspection Database Operation Manual	BMU(S&M)&Mori	10 April		
Printing Manuals		06 April		

(5) Preparation for Bridge Inspection

Prior to the selection of the bridge / culvert to be inspected in the model area, NHA's existing data (data from the previous BMS software, "Smart Bridge") was used to analyze the pattern of bridges / culverts managed by NHA. On the basis of the results of this analysis, the following conclusion was reached.

- In selecting a representative bridge / culvert, consideration should be given to structure type, crossing condition, main material (superstructure / abutment / pier), choice of long / special bridge (bridge length / span length / steel bridge / long span / high pier).
- Punjab North RO satisfied almost all of the above categories as the model area.
- Focusing on structure type as the first priority, covers almost all the other categories.
- The choice of 36 bridges (including Slab Bridges and Slab Girder Bridges, which were the most common types in Pakistan, 10 of each type), will cover other categories and almost all patterns.
- 5 types of culvert can cover almost all patterns.

On the basis of the result of the above analysis, 36 bridges + 5 culverts were selected preferentially for the Periodic Inspection in the model area.

During pattern analysis, it became clear that the existing data included a lot of erroneous input, such as mistakes in the types of structures, ambiguous divisions into long / special bridges, and it became clear that the implementation of another nationwide Inventory Survey in Pakistan was indispensable for the future BMS in the NHA.

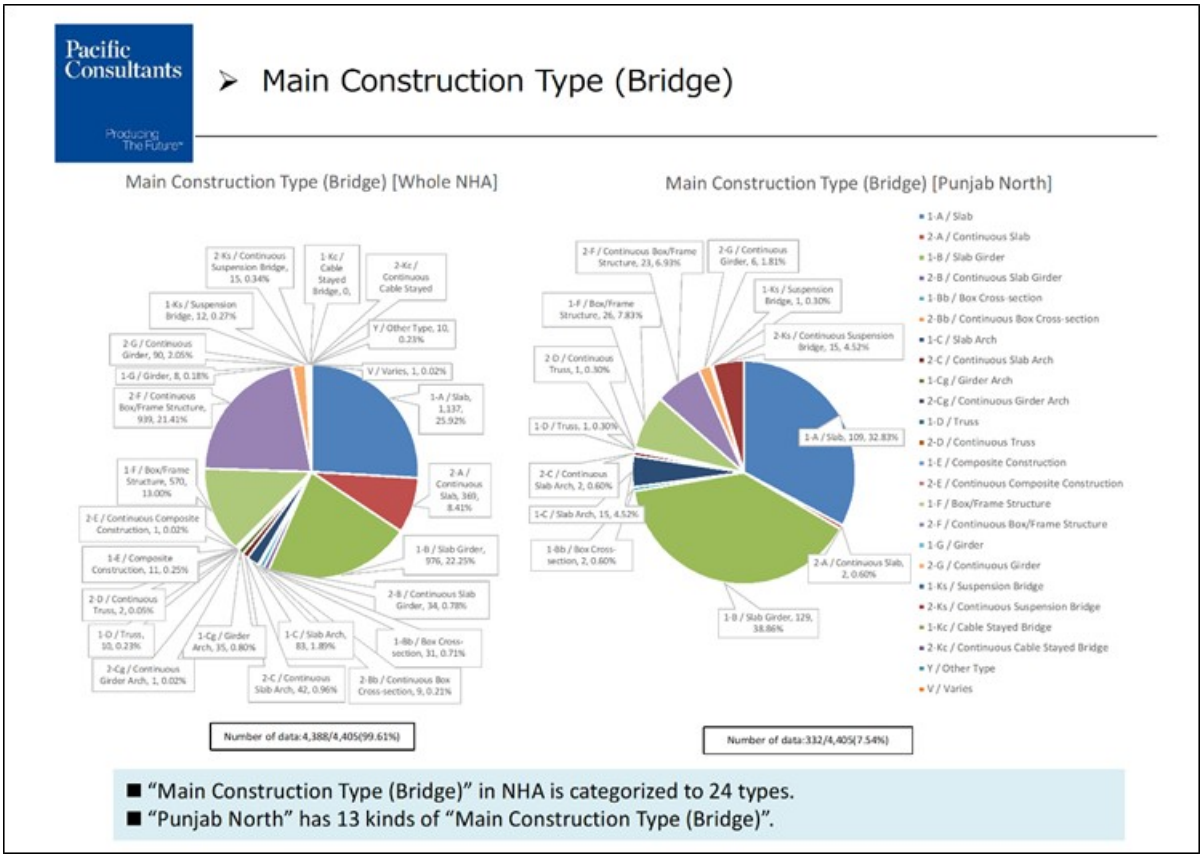


Figure 2-15 Structure Type (Bridge)

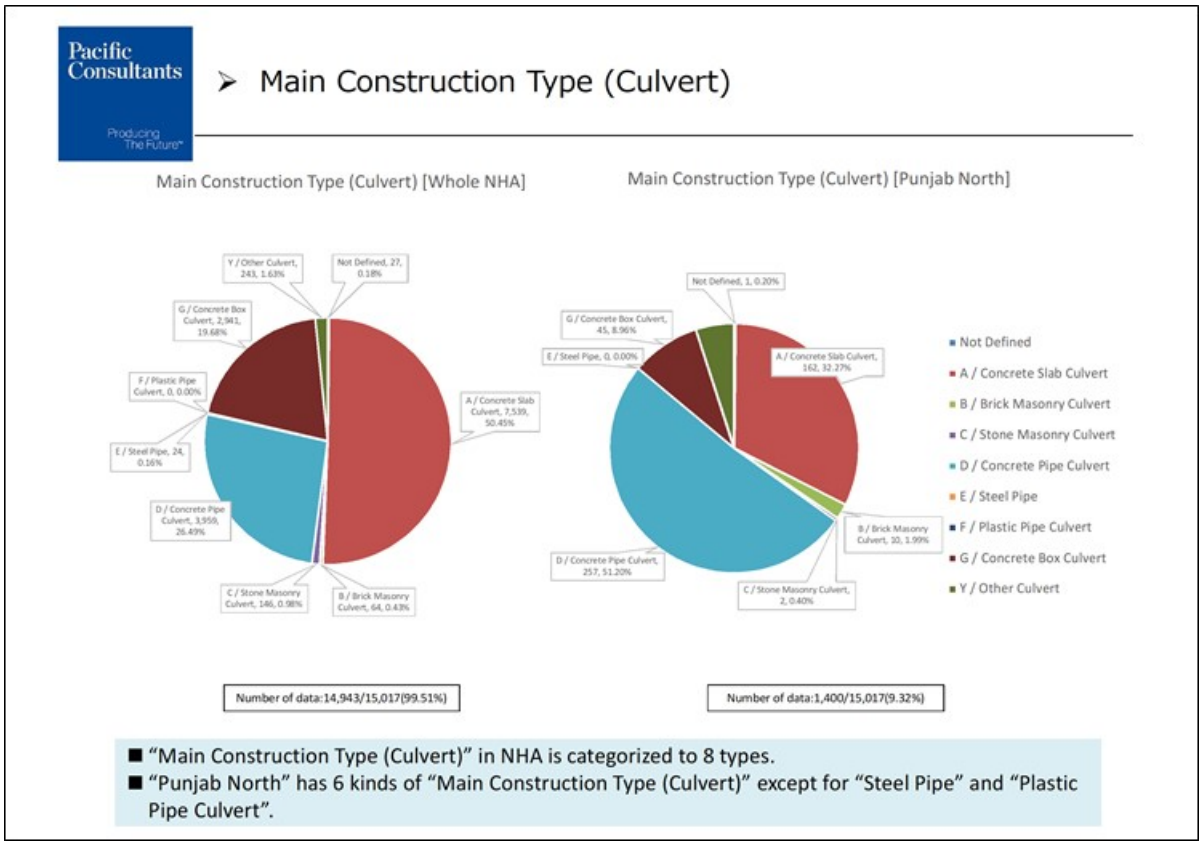


Figure 2-16 Structure Type (Culvert)

The BMU selected 36 bridges + 5 culverts to be inspected on a priority basis in the model area with the guidance and support of the JICA Expert Team.

In addition, the BMU formulated the inspection plan taking into consideration the location of the selected bridge / culvert, bridge length, number of spans, etc. The JICA Expert Team verified and supported their work.

Sq. No.	Bridge ID	Number of spans	Main Construction type		Passage type		Main material type					
							Superstructure		Abutment		Pier	
1	P-N5S-1546.7 BRIDGE	12	1-B / Slab Girder		F / Roadway		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
2	P-N5N-1547.2 BRIDGE	1	1-A / Slab		F / Roadway		A / Reinforced Concrete		D / Reinforced Concrete		X / None	
3	P-N5N-1593.2 BRIDGE	10	1-B / Slab Girder		E / Railway		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
4	P-N5S-1611.02 BRIDGE	5	1-A / Slab		B / Nullah		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
5	P-N5S-1620.7 BRIDGE	3	1-C / Slab Arch		B / Nullah		V / Varies		A / Stone Masonry		A / Stone Masonry	
6	P-N5S-1623.3 BRIDGE	1	1-C / Slab Arch		G / Pedestrian Way		D / Brick Masonry		B / Brick Masonry		B / Brick Masonry	
7	P-N80-107.1 BRIDGE	3	1-B / Slab Girder		E / Railway		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
8	P-N5-1569+500	2	1-A / Slab		B / Nullah		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
9	P-N5N-1561+400	1	2-C / Continuous Slab Arch		B / Nullah		A / Reinforced Concrete		B / Brick Masonry		X / None	
10	P-N5-1287+500	2	2-F / Continuous Box/Frame Structure		F / Roadway		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
11	P-N5N-1321+00	4	1-B / Slab Girder		D / Irrigation Channel		Ap / Prestressed Concrete		D / Reinforced Concrete		Y / Other	
12	P-N5N-1322+700	1	1-A / Slab		D / Irrigation Channel		A / Reinforced Concrete		B / Brick Masonry		X / None	
13	P-N5S-1322+708	1	1-A / Slab		D / Irrigation Channel		A / Reinforced Concrete		B / Brick Masonry		X / None	
14	P-N5N-1329+900	1	1-A / Slab		D / Irrigation Channel		A / Reinforced Concrete		B / Brick Masonry		X / None	
15	P-N5S-1394+116	3	2-A / Continuous Slab		D / Irrigation Channel		A / Reinforced Concrete		D / Reinforced Concrete		B / Brick Masonry	
16	P-N5N-1401+700	1	1-A / Slab		D / Irrigation Channel		A / Reinforced Concrete		D / Reinforced Concrete		X / None	
17	P-N5S-1403+220	4	2-A / Continuous Slab		D / Irrigation Channel		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
18	P-N5N-1419+600	2	2-F / Continuous Box/Frame Structure		B / Nullah		A / Reinforced Concrete		D / Reinforced Concrete		B / Brick Masonry	
19	P-N5S-1419+600	1	1-A / Slab		B / Nullah		A / Reinforced Concrete		B / Brick Masonry		X / None	
20	P-N5N-1430+10	23	1-B / Slab Girder		A / River		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
21	P-N5N-1469+500	3	2-F / Continuous Box/Frame Structure		B / Nullah		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
22	P-N5S-1469+500	3	2-C / Continuous Slab Arch		B / Nullah		D / Brick Masonry		B / Brick Masonry		B / Brick Masonry	
23	P-N5-1467+900	10	1-B / Slab Girder		Y / Other		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
24	P-N5N-1464+100	8	1-B / Slab Girder		C / Flood Relief Channel		Ap / Prestressed Concrete		B / Brick Masonry		D / Reinforced Concrete	
25	P-N5S-1450+567	5	1-B / Slab Girder		B / Nullah		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
26	P-N80-79+500	4	2-B / Continuous Slab Girder		B / Nullah		A / Reinforced Concrete		A / Stone Masonry		A / Stone Masonry	
27	PN5S 1296	3	1-B / Slab Girder		B / Nullah		A / Reinforced Concrete		V / Varies		V / Varies	
28	PN5N 1310+500	15	1-A / Slab		B / Nullah		A / Reinforced Concrete		B / Brick Masonry		B / Brick Masonry	
29	PN5N 1323	11	1-B / Slab Girder		F / Roadway		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
30	PN5S 1351	3	1-A / Slab		B / Nullah		A / Reinforced Concrete		B / Brick Masonry		B / Brick Masonry	
31	PN5N 1362	3	1-B / Slab Girder		E / Railway		A / Reinforced Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
32	PN5N 1368+300	16	1-B / Slab Girder		A / River		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
33	PN5S 1368+300	16	1-B / Slab Girder		A / River		Ap / Prestressed Concrete		D / Reinforced Concrete		D / Reinforced Concrete	
34	PN5N 1583	1	1-B / Slab Girder		B / Nullah		Ap / Prestressed Concrete		B / Brick Masonry		E / Columns	
35	P-N5S-1606.95 BRIDGE	4	V / Varies		B / Nullah		D / Brick Masonry		B / Brick Masonry		V / Varies	
36	P-N5S-1608.5 BRIDGE	8	1-C / Slab Arch		B / Nullah		D / Brick Masonry		Y / Other		A / Stone Masonry	
			1-A / Slab	10/18	A / River	3/11	A / Reinforced Concrete	21/106	A / Stone Masonry	2/26	A / Stone Masonry	3/6
			2-A / Continuous Slab	2/36	B / Nullah	16/121	Ap / Prestressed Concrete	10/78	B / Brick Masonry	12/56	B / Brick Masonry	6/35
			1-B / Slab Girder	14/117	C / Flood Relief Channel	1/3	B / Steel	0/0	C / Mass Concrete	0/0	C / Mass Concrete	0/0
			2-B / Continuous Slab Girder	1/7	D / Irrigation Channel	7/25	C / Stone Masonry	0/0	D / Reinforced Concrete	20/104	D / Reinforced Concrete	16/107
			1-Bb / Box Cross-section	0/0	E / Railway	3/17	D / Brick Masonry	4/10	E / Columns	0/0	E / Columns	1/1
			2-Bb / Continuous Box Cross-section	0/0	F / Roadway	4/14	E / Steel Girder Concrete SE	0/0	X / None	0/0	X / None	7/39
			1-C / Slab Arch	3/9	G / Pedestrian Way	1/4	K / Steel Cables	0/0	Y / Other	1/2	Y / Other	1/1
			2-C / Continuous Slab Arch	2/2	X / None	0/0	Y / Other	0/0	V / Varies	1/5	V / Varies	2/2
			1-Cg / Girder Arch	0/0	Y / Other	1/1	V / Varies	1/1				
			2-Cg / Continuous Girder Arch	0/0	V / Several	0/0						
			1-D / Truss	0/0								
			2-D / Continuous Truss	0/0								
			1-E / Composite Construction	0/0								
			2-E / Continuous Composite Construction	0/0								
			1-F / Box/Frame Structure	0/0								
			2-F / Continuous Box/Frame Structure	3/4								
			1-G / Girder	0/0								
			2-G / Continuous Girder	0/0								
			1-Ks / Suspension Bridge	0/0								
			2-Ks / Continuous Suspension Bridge	0/0								
			1-Kc / Cable Stayed Bridge	0/0								
			2-Kc / Continuous Cable Stayed Bridge	0/0								
			Y / Other Type	0/0								
			V / Varies	1/1								
			Total	36/194	Total	36/196	Total	36/195	Total	36/193	Total	36/191

Figure 2-17 Selection of the 36 Representative Bridges

Bridge ID	Bridge Name	Location	Spans	Passage type	Maintenance Unit	Teams	Days
P-N5N-1401+700	P-N5N-1401+700 (Lalamusa)	Lalamusa	1	D / Irrigation Channel	Wazirabad	Team 01	8
P-N5S-1403+220	P-N5S-1403+220 (Kharian)	kharian	4	D / Irrigation Channel			
P-N5N-1419+600	P-N5N-1419+600 (Kharian)	kharian	2	B / Nullah			
P-N5S-1419+600	P-N5S-1419+600 (Kharian)	kharian	1	B / Nullah			
P-N5N-1469+500	P-N5N-1469+500 (Missa Kassowal)	Missa Kassowal	3	B / Nullah			
P-N5S-1469+500	P-N5N-1469+500 (Missa Kassowal)	Missa Kassowal	3	B / Nullah			
P-N5-1467+900	P-N5-1467+900 (Missa Kassowal)	Missa Kassowal	10	Y / Other			
P-N5N-1593.2 BRIDGE	Punjab Floor Mill Bridge	Burhan	10	E / Railway	Rawalpindi		11
P-N5S-1620.7 BRIDGE	Del Foji Pump Bridge	Haji Shah	3	B / Nullah			
P-N5S-1623.3 BRIDGE	Masjid Faridia Bridge	Haji Shah	1	G / Pedestrian Way			
P-N80-107.1 BRIDGE	P-N80-107.1 BRIDGE	Jand	3	E / Railway			
P-N80-79+500	P-N80-79+500 (Jund)	Jund	4	B / Nullah			
PN5N 1583	Hassanabdal	Hassanabdal	1	B / Nullah			
PN5S 1581	Wah Garden Bridge	Hassanabdal	6	B / Nullah			
P-N5S-1606.95 BRIDGE	Saadat CNG Bridge	Burhan	4	B / Nullah			
P-N5N-1321+00	P-N5N-1321+00 (Gujranwala Bypass)	Gujranwala	4	D / Irrigation Channel	Wazirabad	Team 02	15
P-N5N-1322+700	P-N5N-1322+700 (Gujranwala Bypass)	Gujranwala	1	D / Irrigation Channel			
P-N5S-1322+708	P-N5S-1322+708 (Gujranwala Bypass)	Gujranwala	1	D / Irrigation Channel			
P-N5N-1329+900	P-N5N-1329+900 (Gujranwala Bypass)	Gujranwala	1	D / Irrigation Channel			
P-N5S-1394+116	P-N5N-1394+116 (Sadiqabad)	Gujrat Bypass	3	D / Irrigation Channel			
PN5S 1296	Al-Hayat CNG	Rajpura Village	3	B / Nullah			
PN5N 1310+500	Unique Dhaba BBQ	Kamokee City	15	B / Nullah			
PN5N 1323	Khiyali Flyover	Khiyali Flyover	11	F / Roadway			
PN5S 1351	Attock Fueling Station	Ojlan Kalan	3	B / Nullah			
PN5N 1362	1362 Km stone post	Wazirabad Bypass Road	3	E / Railway			
P-N5S-1611.02 BRIDGE	P-N5S-1611.02 BRIDGE	Kamra	5	B / Nullah	Rawalpindi		4
P-N5S-1608.5 BRIDGE	Wah College of Account Bridge	Kamra	8	B / Nullah			
P-N5-1287+500	P-N5N-1287+500 (Muridke)	Muridke	2	F / Roadway	Wazirabad	Team 03	14
P-N5N-1464+100	P-N5N-1464+100 (Missa Kassowal)	Missa Kassowal	8	C / Flood Relief Channel			
PN5N 1368+300	Chenab River	Gujrat	16	A / River			
PN5S 1368+300	Chenab River	Gujrat	16	A / River			
PN5N 1581	Wah Garden Bridge	Hassanabdal	12	B / Nullah	Rawalpindi		5
P-N5N-1547.2 BRIDGE	Perwadhi Mor UnderPass	Perwadhi Mor	1	F / Roadway			
P-N5-1569+500	P-N5-1569+500 (Taxila Bus Stand)	Taxila	2	B / Nullah			
P-N5N-1561+400	P-N5N-1561+400 (B17 Islamabad)	Sangani	1	B / Nullah			

Figure 2-18 Bridge Inspection Implementation Plan

2.2.2.2 Activity 2-2: BMU implements BMS training (Inventory Survey Training and Bridge Inspection Training).

The BMS Training consisted of Inventory Survey Training and Bridge Inspection Training. As none of the Trainee Engineers had sufficient knowledge and experience in bridge maintenance and repair, Inventory Survey Training was carried out first and the Bridge Inspection Training was done subsequently after the Inventory Survey results had been input and registered.

(1) Inventory Survey Training

Inventory Survey Training was carried out for Trainee Engineers and for the Maintenance Unit staff of Rawalpindi and Wazirabad who would support the Trainee Engineers in the Inventory Survey. It was initially planned to hold this training in December 2017, but recruitment procedures for the Trainee Engineers were delayed by about two (2) months. The training was eventually held on February 1st and 2nd, 2018.

Day 1 was for in-house training, and Day 2 was for on-site training. The lectures were carried

out in collaboration between the BMU and the JICA Expert Team.

On-site training was held at Wah Garden Bridge on Day 2 in order for the trainees to learn the inventory survey method, procedures etc., using training materials that verify the actual situation.

(a) Agenda

AGENDA

Inventory Survey Training on January 29th, 2018

0. Introduction
Time: 10:00 -10:10
Opening Remarks by Muhammad Asif Azam (BMU, Project Coordinator)

1. What is BMS?(1-4)
Time 10:10-10:30
By Mr. Muhammad Asif Azam (BMU, Project Coordinator)

2. Bridge inspection Report Sheet(4-12)
Time: 10:30-11:00
By Mr. Haruo Tomiyama (JICA Expert)

Question-and-answer session
Time: 11:00-11:30

3. What is Inventory Survey(12-36)
Time: 11:30-12:30
By Mr. Sohaib Mansoor and Mr. Ghulam Murtaza Simair (BMU)

Question-and-answer session
Time: 12:30-13:00

Lunch Time
Time: 13:00-14:00

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4. Patterning of bridge and Culverts in NHA(36-49)
Time: 14:00-14:30
By Mr. Haruo Tomiyama (JICA Expert)

5. How to input Inventory Data(49-64)
Time: 14:30-16:30
By Mr. Sohaib Mansoor and Mr. Ghulam Murtaza Simair (BMU)

Question-and-answer session
Time: 16:30-17:00

Figure 2-19 Agenda for Inventory Survey Training

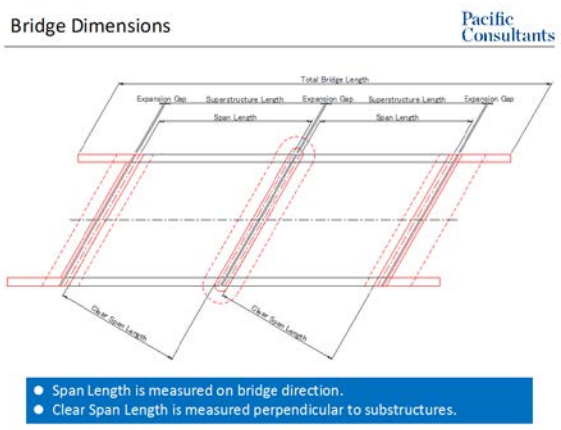
(b) Attendees

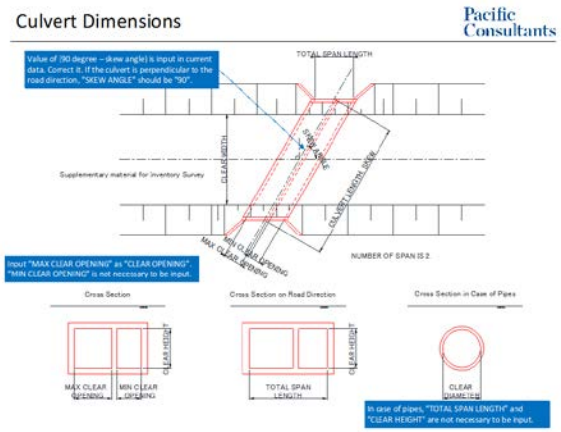
Table 2-34 Attendee List of Inventory Survey Training

Sr. No	Name	Designation
1	Asim Amin	Member (Planning)
2	M. Asif Azam	DD (BMU)
3	Sohaib Mansoor	DD (BMU)
4	Ghulam Murtaza Simair	DD (BMU)
5	Haruo Tomiyama	JICA Expert Team
6	Momina Rauf	JICA Expert Team
7	M. Ali Atif	Trainee Engineer
8	Imran Shabbir	Trainee Engineer
9	Shahzeb Saleem	Trainee Engineer
10	M. Shahwaiz	Trainee Engineer
11	M. Safwan Naeem	Trainee Engineer
12	Javed Ali	DD Maintenance (Wazirabad)
13	Hussain Ahmed Abbas	Trainee Engineer
14	M. Ismail	Inspector (MU Wazirabad)
15	Mazhar Rafique	Inspector (MU Wazirabad)
16	Naeem Shahzad	Inspector (MU Wazirabad)
17	Obaid Shahid Mir	Trainee Engineer
18	Ashar Tariq	Trainee Engineer
19	Shahzaib Farooq	Trainee Engineer
20	Abdul Rahman	Trainee Engineer
21	Jawwad Naeem Bhatti	Trainee Engineer
22	M. Arshad Abbas Malik	DD Maintenance (Rwp)
23	M. Naeem	AD Maintenance (Rwp)
24	M Saeed	Sub Engineer

(c) Supplementary Training

Supplementary training was led by the BMU on February 7th, 2018 in order to clarify the definitions of span distance, horizontal clearance and crossing angle in the case of a skewed bridge/culvert.





Lectures by BMU

Supplemental Training

Figure 2-20 Supplementary Training

(2) Bridge Inspection Training

After completion of the Inventory Survey in the model area, Bridge Inspection Training was carried out just before the start of the Bridge Inspection of the selected structures (36 bridges + 5 culverts).

The trainees were Trainee Engineers, three (3) Maintenance Unit staff from the Punjab North Regional Office who would support the Trainee Engineers in carrying out the Inventory Survey in the model area and Maintenance Unit staff from Punjab South Regional Office, which was expected to be the next model area on the way expansion from the model area to nationwide.

Following requests from the BMU to make the training more practical, it was decided that the training would consist of two (2) days for in-house training and three (3) days for on-site training; input of data to the Bridge Inspection Database (BIDB) was done during the latter part, and each team made a presentation to practice working on their own initiative.

As the purpose of the training was to enable the BMU to lead similar training by themselves in a sustainable manner, the JICA Expert Team took the role of supporting the BMU by

transferring experience / know-how to the BMU.

(a) Syllabus

The BMU and the JICA Expert Team jointly drew up the five-day syllabus for the Bridge Inspection Training.

Table 2-35 Syllabus (Day 1)

Date & Time		Theme	Activity	Details	Lecturer
Day 1 16 Apr	10:00 10:20	Bridge Engineering & Inspection	Presentation	Introduction of BMS, Background of the Project	Mr. Yukio Igo
	10:20 10:30		Presentation	Summary of training program and schedule	Mr. Yukio Igo
	10:30 11:30		1. Basics of Bridge Engineering	Road Bridge Component, Types of Bridges, Substructure, Basics of Structural Mechanics, Bearing Support, Expansion joint	Ms. Momina Rauf
	11:30 12:00		Break	Tea break	
	12:00 13:00		2. Bridge Inspection Manual	Summary of Inspection Manual, Types of inspection procedure,Method of Inspection	Mr. Haruo Tomiyama
	13:00 14:00		Break	Lunch & Prayer	
	14:00 15:00		3. Bridge Inspection (1)	Type of Damage, Damage Rank,Classified Evaluation, Typical causes of dameges, Soundness Diagnosis	Mr. Sohaib Mansoor
	15:00 15:50		4. Bridge Inspection (2)	Damages of Steel Members, Damage of Concrete Members	Mr. Sohaib Mansoor
	15:50 16:00		Break	Tea break	
	16:00 16:30		Test	Quiz for Bridge Engineering & Inspection	Mr.Haruo Tomiyama
	16:30 17:00		Review	Discussion on todays lectures	Mr.Haruo Tomiyama

Table 2-36 Syllabus (Day 2)

Date & Time		Theme	Activity	Details	Lecturer
Day 2 17 Apr	9:30 10:30	Repai Methods & Inspection Sheet	5. Bridge Inspection (3)	Other damages	Mr.Haruo Tomiyama
	10:30 11:00		Break	Tea break	
	11:00 12:00		6. Repair & Strengthening of Concrete Structures	Types of Repair Works, Repair method selection for damages in concrete,Strengthning Techniques, Replacing components	Mr. Ghulam Murtaza Simair
	12:00 13:00		7. Repair & Strengthening of Others & Steel Structures	Repair of foundation, Repair of Bearing, Repair of Steel structure, Detailed Investigation of concrete structures	Mr. Ghulam Murtaza Simair
	13:00 14:00		Lunch	Lunch & Prayer	
	14:00 15:30		8. How to fill out Inspection Sheet	How to fill inspection sheet with BIDB input system [Member Numbering, Sketch, Photograghy]	Mr. Ghulam Murtaza Simair
	15:30 16:00		Break	Tea break	
	16:00 16:30		Test	Quiz for Reoairs and Inspection Sheet	Mr.Haruo Tomiyama
	16:30 16:50		Review	Review of Today	Mr.Haruo Tomiyama
	16:50 17:00		Preparation for Inspection	Distribution of Inspection Sheet 4 & 5 [Homework : Member numbering]	

Table 2-37 Syllabus (Day 3)

Date & Time		Theme	Activity	Details	Lecturer
Day 3 18 Apr	8:30 9:30	Site Inspection (1)	Move	NHA → Wah Garden Bridge	
	9:30 12:30		Site Inspection	Bridge inspection (1) [Wah Garden] PC Slab Girder [1 span for each team]	
	12:30 13:00		Move	Wah Garden Bridge → HRTC	
	13:00 14:00		Break	Lunch & Prayer	
	14:00 15:30		Evaluation & Input	Evaluation of Site Inspection BIDB input	Mr. Akio Mori Mr. Sohaib Mansoor Mr. Ghulam Murtaza Simair
	15:30 16:00		Break	Tea break	
	16:00 16:30		Review	Review of Inspection Results	Mr.Haruo Tomiyama
	16:30 17:00		Preparation for Inspection	Input Sheet 4 & 5 & printing out	

Table 2-38 Syllabus (Day 4)

Date & Time		Theme	Activity	Details	Lecturer
Day 3 18 Apr	8:30 9:30	Site Inspection (1)	Move	NHA → Wah Garden Bridge	
	9:30 12:30		Site Inspection	Bridge inspection (1) [Wah Garden] PC Slab Girder [1 span for each team]	
	12:30 13:00		Move	Wah Garden Bridge → HRTC	
	13:00 14:00		Break	Lunch & Prayer	
	14:00 15:30		Evaluation & Input	Evaluation of Site Inspection BIDB input	Mr. Akio Mori Mr. Sohaib Mansoor Mr. Ghulam Murtaza Simair
	15:30 16:00		Break	Tea break	
	16:00 16:30		Review	Review of Inspection Results	Mr.Haruo Tomiyama
	16:30 17:00		Preparation for Inspection	Input Sheet 4 & 5 & printing out	

Table 2-39 Syllabus (Day 5)

Date & Time		Theme	Activity	Details	Lecturer
Day 5 20 Apr	8:30 9:30	Site Inspection (3)	Move	NHA → Culvert	
	9:30 11:30		Site Inspection	Bridge Inspection (2) [ ] [all teams together]	
	11:30 12:00		Move	Culvert → HRTC	
	12:00 13:00		Evaluation	Evaluation of Site Inspection	Mr. Akio Mori Mr. Sohaib Mansoor Mr. Ghulam Murtaza Simair
	13:00 14:00		Lunch	Lunch & Prayer	
	14:00 14:30		Review	Review of Inspection Results	Mr.Haruo Tomiyama
	14:30 15:30		Examination	Confirmation of understanding level	Mr.Haruo Tomiyama
	15:30 16:00		Closing	Bridge/Culvert inspection planning [Representative 36 bridges & 5 culverts]	Mr. Sohaib Mansoor

(b) In-House Training

The in-house training was carried out in the Auditorium at NHA-HQ on Day 1 (April 16th,

2018) and at HRTC[14] on Days 2 to 5 (April 17th to 20th, 2018)

The participants were 8 Trainee Engineers and 9 staff from the Regional Office and Maintenance Units. Most of the Training was carried out by the BMU. A series of enthusiastic activities led by the BMU including Q & A, was put into practice throughout the training.

Training at HRTC

Lectures by BMU

Figure 2-21 In-house Training

(c) On-Site Training

The on-site inspection training took place over 3 days (from April 18th to 20th, 2018) as follows;

Day 3 at Wah Garden Bridge (south bound, PC girder section)

Day 4 at Wah Garden Bridge (north bound, RC girder section)

Day 5 at Culvert near the toll gate (upstream: RC box, downstream: arch brick box)

<Outline of training>

The participants were ten (10) Trainee Engineers and nine (9) members of staff from the Regional Office and Maintenance Units. They were separated to three (3) teams and underwent practical inspection training in the morning and data input using BIDB software, presentation, discussion and review in the afternoon on Day 3 and 4. On Day 5, they were separated into two (2) teams and which each underwent practical inspection training regarding the RC culvert and arch brick culvert.

A bamboo ladder (7m in length) was used for the training. As the length of bamboo ladder cannot be adjusted, the JICA Expert Team requested the Regional Office and Maintenance Units to provide expandable aluminum ladders for the sake of safety.

[14] Highway Research and Training Center, located in Burhan, Punjab

	
On-site Training	**Practical Training**
	
Data Input Training	**Practical Training**
	
Data Input	**Presentation by Trainee Engineers**

Figure 2-22 On-site Training

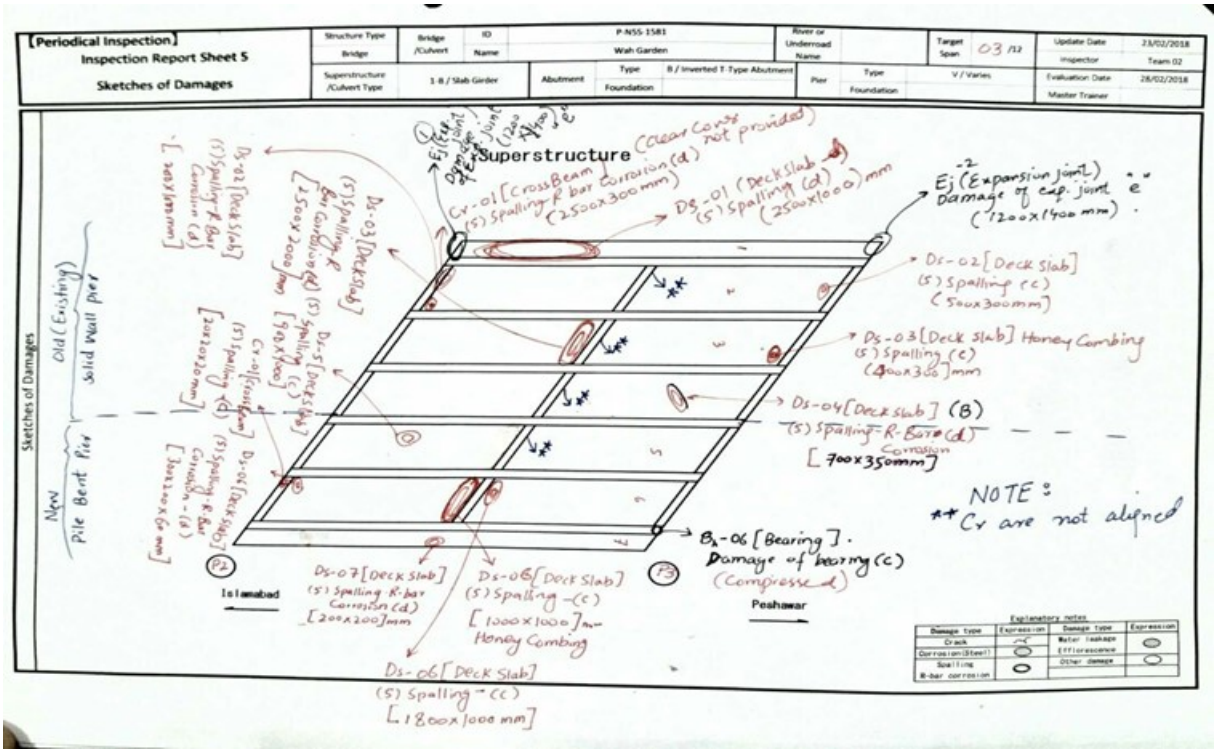


Figure 2-23 Bridge Inspection Sheet (Team 1)

(3) Structural Mechanics Lectures

An Inventory Survey under the jurisdiction of Lahore MU was planned following the bridge inspection and data entry for the 36 bridges + 5 culverts, but as there was no transport arranged, the Trainee Engineers were subjected to some idling time.

Since there apparently were no lectures on bridge engineering (structural mechanics) at the university in Pakistan, in order to deepen understanding of the important structural matters required for bridge inspection, the JICA Expert Team provided structural mechanics lectures focusing on the basic knowledge necessary for bridge inspection. The attendees were the BMU and eight Trainee Engineers.

The lecture was divided into five (5) sections, each with the following content, and took about ten (10) hours in total, each section lasting about two (2) hours.

Section 1 (Sep 12th, am): Flow of structure design, calculation of reaction force, and exercises

Section 2 (Sep 13th, pm): Calculation of sectional force, and exercises

Section 3 (Sep 14th, pm): Calculation of the primary and secondary moments of area, exercises

Section 4 (Sep 17th, am): Calculation of stress, crack generation location and reinforcement section in RC structure, and exercises

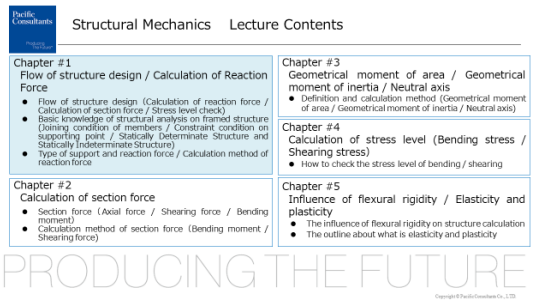
Section 5 (Sep 17th, pm): Influence of flexural rigidity, elasticity and plasticity

Photograph 2-1 Lecturing

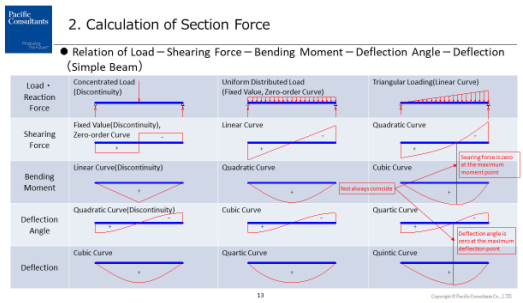
Photograph 2-2 Lectures

Figure 2-24 Lectures for Structural Mechanics

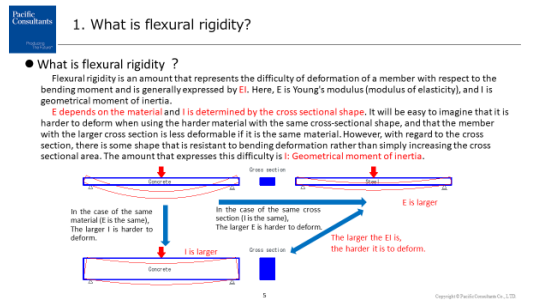
The lecture materials prepared for this training were subject to transfer to the NHA so that the BMU can continue to carry out similar training in the future. In addition, in order to allow local NHA staff to study by themselves, the materials were configured for use in e-learning.



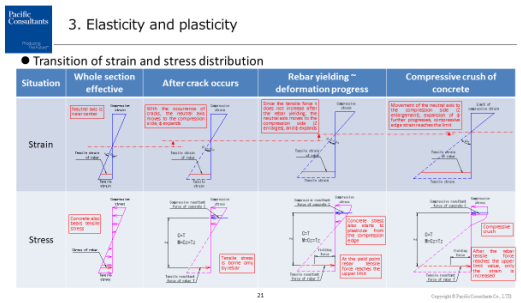
Contents of Lectures



Cross-section force in a simple beam



Bending Stiffness



Strain & stress in RC

Figure 2-25 Training Materials for Structural Mechanics

2.2.2.3 Activity 2-3: Inventory Survey and Bridge Inspection on-the-job-training (OJT) are implemented after BMS training.

(1) Inventory Survey

Although the Inventory Survey was scheduled to start immediately following training, due to delays in the arrangement of transportation for the Trainee Engineers, the survey actually started on February 23, 2018.

The numbers of surveyed bridges/culverts investigated by each team were reported to the

BMU and the JICA Expert Team each day, and progress was in line with the planned schedule. Once the Inventory Survey began, it was completed at more or less the pace planned.

	Team 1			Team 2			Team 3		
	Bridge	Culvert	Score	Bridge	Culvert	Score	Bridge	Culvert	Score
23-Feb	4	2	1.20	3	6	1.35	6	0	1.50
26-Feb	2	6	1.10	1	3	0.55	2	5	1.00
27-Feb	5	0	1.25	1	3	0.55	Data Entry		
28-Feb	0	5	0.50	Data Entry			4	0	1.00
1-Mar	Data Entry			0	0	0.00	nil/vehicle out of order		
2-Mar	0	0	0.00	2	6	1.10	2	5	1.00
5-Mar	8	0	2.00	3	0	0.75	0	2	0.20
6-Mar	6	0	1.50	2	3	0.80	Data Entry		
7-Mar	1	0	0.25	4	1	1.10	5	3	1.55
8-Mar	Data Entry			2	1	0.6	6	1	1.60
9-Mar	0	0	0.00	12	10	4.00	0	3	0.30
12-Mar	6	0	1.50	Data Entry			4	2	1.2
13-Mar	1	6	0.85		1	2.00	2	4	0.9
14-Mar	6	1	1.60	2	6	1.10	3	2	0.95
15-Mar	Seminar				7	0.70	Seminar		
16-Mar	Data Entry			3	5	1.25	1	7	0.95
19-Mar	6	0	1.50	Data Entry			3	6	1.35
20-Mar			0.00			0.00	3	3	1.05
21-Mar	4	0	1.00	3	1	0.85	2	3	0.8
22-Mar	7	0	1.75	3	5	1.25	re-counted structure nos		
23-Mar	Hoilday				8	0.80	Hoilday		
26-Mar	6	0	1.50	0	8	0.80	nil/vehicle out of order		
27-Mar	7	0	1.75	4	5	1.50	2	4	0.9
28-Mar	8	0	2.00	0	6	0.60	4	2	1.2
29-Mar	4	6	1.60	Data Entry			2	0	0.5
30-Mar	6	0	1.50	2	0	0.50	4	2	
2-Apr	7	0	1.75	1	4	0.65	0	9	
3-Apr	5	0	1.25	1	4	0.65	Data entry		
4-Apr	4	0	1.00	2	0	0.50	1	6	
5-Apr	4	0	1.00	2	5	1.00	2	3	
6-Apr	2	10	1.5	4	0	1.00			
9-Apr	1	12	1.45	0	9	0.9	1	9	
10-Apr				0	6	0.6			
Total	**110**	**48**	**1.20**	**57**	**113**	**0.95**	**59**	**81**	**1.00**
	158			**170**			**140**		

Figure 2-26 Progress of Inventory Survey

Inventory Survey

Inventory Survey

Data Input to BIDB

Data Input to BIDB

Figure 2-27 Inventory Survey

Following the completion of the Inventory Survey, a report meeting was held on April 13, 2018, in which each team in turn gave a presentation including a summary of the survey results, notes on safety and requests for equipment for future surveys. Discussions were also held on the handling of formats for special bridge types and irregular span arrangements.

Presentation

Discussion

Figure 2-28 Report Meeting

(2) Bridge Inspection

Periodic inspection of the typical 36 bridges + 5 culverts in the model area began from May

3, 2018 following the Bridge Inspection Training.

Prior to the periodic inspection, a handbook was prepared and delivered to the BMU and the Trainee Engineers, in which the important issues relating to bridge inspection and notifications regarding data input to the BIDB were summarized for on-site reference.

Figure 2-29 Bridge Inspection Handbook

Progress in the bridge inspection was summarized and organized in a table with a comparison between the planned and actual schedule of each team. During the period of Ramadan[15] and the time of the General Election[16] when the JICA Expert Team was absent, WhatsAPP was used to keep up to date with activities of the BMU and the Trainee Engineers and to give advice as necessary.

[15] From 15th May to 14th June in 2018.
[16] The General Election was held on 25th July 2018.

Date	Team 01(Plan)			Team 1(Implemented)		
	Bridge	Span No.	Maintenance Unit	Bridge	Span No.	Maintainence Unit
03/05/2018	PN5S 1581	1,2,3	Rawalpindi	PN5S 1581	1,2,3,4	Rawalpindi
04/05/2018	PN5S 1581	4,5,6	Rawalpindi	PN5S 1581	5,6,7,8	Rawalpindi
05/05/2018	Holiday			Holiday		
06/05/2018						
07/05/2018	Data Entry at HQ			Data Entry(No PC available)		
08/05/2018	Data Entry at HQ			Data Entry of Span 1,2 P-N5S-1581		
09/05/2018	P-N5N-1401+700	1	Wazirabad	P-N5N-1401+700	1	Wazirabad
	P-N5S-1403+220	1,2	Wazirabad	P-N5N-1420+200	1,2	Wazirabad
10/05/2018	P-N5S-1403+220	3,4	Wazirabad	P-N5N-1421+400	1,2	Wazirabad
	P-N5N-1419+600	1	Wazirabad	P-N5N-1419+600	1	Wazirabad
11/05/2018	P-N5N-1419+600	2	Wazirabad	P-N5N-1419+600	2	Wazirabad
	P-N5-1467+900	1,2	Wazirabad	P-N5-1467+900	1,2	Wazirabad
12/05/2018	Holiday					
13/05/2018						
14/05/2018	P-N5-1467+900	3,4,5	Wazirabad	P-N5-1467+900	3,4,5	Wazirabad
15/05/2018	P-N5-1467+900	6,7,8	Wazirabad	P-N5-1467+900	6,7,8	Wazirabad
16/05/2018	P-N5-1467+900	9,10	Wazirabad	P-N5-1467+900	9,10	Wazirabad
	P-N5N-1469+500	1	Wazirabad	P-N5N-1469+500	1	Wazirabad
17/05/2018	P-N5N-1469+500	2,3	Wazirabad	P-N5N-1469+500	2,3	Wazirabad
	P-N5S-1469+500	1	Wazirabad	P-N5S-1469+500	1	Wazirabad
18/05/2018	P-N5S-1469+500	2,3	Wazirabad	P-N5S-1469+500	2,3	Wazirabad
19/05/2018	Holiday			Holiday		
20/05/2018						
21/05/2018	PN5N 1583	1	Rawalpindi	P-N5N-1592+200	1,2,3	Rawalpindi
	P-N5N-1593+200	1,2	Rawalpindi			
22/05/2018	P-N5N-1593+200	3,4,5	Rawalpindi	P-N5N-1592+200	4,5,6	Rawalpindi
23/05/2018	P-N5N-1593+200	6,7,8	Rawalpindi	P-N5N-1592+200	7,8,9	Rawalpindi
24/05/2018	P-N5N-1593+200	9,10	Rawalpindi	P-N5N-1592+200	10	Rawalpindi
	P-N5S-1606+950	1	Rawalpindi	P-N5S-1620+700	1,2	Rawalpindi
25/05/2018	P-N5S-1606+950	2,3,4	Rawalpindi	P-N80-66+300	1,2,3	Rawalpindi
26/05/2018	Holiday			Holiday		
27/05/2018						
28/05/2018	P-N5S-1620+700	1,2,3	Rawalpindi	P-N80-107+100	1,2,3	Rawalpindi
29/05/2018	P-N5S-1623+300	1	Rawalpindi	P-N5S-1620+700	3	
	P-N80-79+500	1,2	Rawalpindi	P-N5S-1581	9	
30/05/2018	P-N80-79+500	3,4	Rawalpindi	P-N5S-1581	10,11	Rawalpindi
	P-N80-107+100	1	Rawalpindi			
31/05/2018	P-N80-107+100	2,3	Rawalpindi	P-N5S-1581	12	Rawalpindi
01/06/2018	Pedestrian Bridge	1	Rawalpindi	P-N5-1573+500	1	Rawalpindi

Figure 2-30 Progress of Bridge Inspection

At the beginning of the Bridge Inspection, the JICA Expert Team went with Trainee Engineers to the sites, and accompanied them at the time of data input to give instruction regarding bridge inspection reports, degree of damage, and classified evaluation.

JICA Expert Team on site

JICA Expert Team on site

Data Input OJT

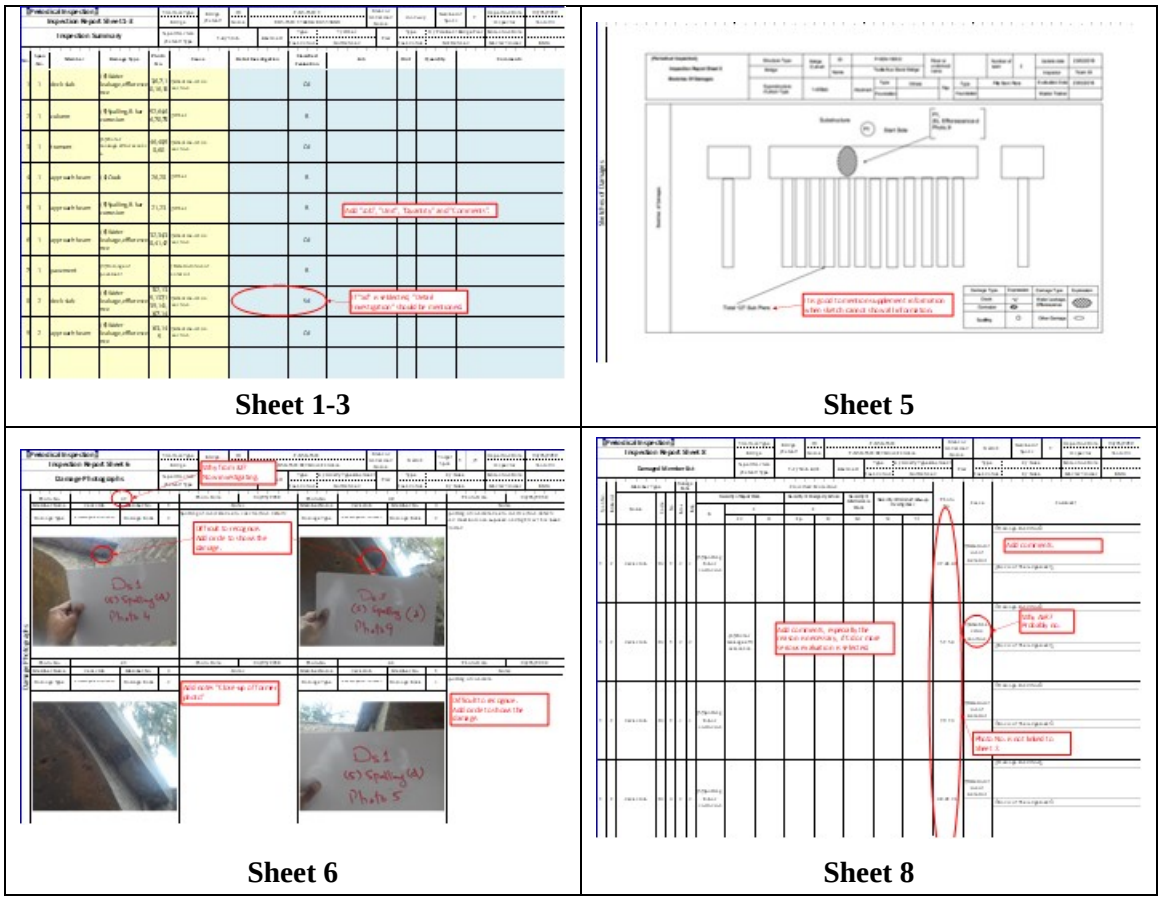
Data Input OJT

Figure 2-31 Bridge Inspection

2.2.2.4 Activity 2-4: JICA Expert Team reviews the inspection results and ability, and advises BMU to enhance their capacity.

To enhance understanding by the BMU and Trainee Engineers, the JICA Expert Team continued to check the bridge inspection sheets and make comments on their corrections and improvements by e-mail even when out of the country.

With regard to the bridge inspection sheets for the typical 36 bridges + 5 culverts in the model area, it was confirmed in October 2018 that the trial operation and adjustment of the BIDB input system and BMS software were completed and that all the inspection data including the repair quantities had been corrected and registered.



Sheet 1-3 | **Sheet 5**

Sheet 6 | **Sheet 8**

Figure 2-32 Corrections of Bridge Inspection Sheet

2.2.3 Output 3: Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.

2.2.3.1 Activity 3-1: JICA Expert Team implements BIDB & BMS Software Training for BMU.

(1) Training Materials and Preparations

The BMS software training was to be implemented mainly in the form of hands-on[17] training in the actual operating environment. For that purpose, first of all in-house training, including an outline of the BMS software and the concepts of priorities / important issues, was carried out using the training materials, and dummy bridge inspection data for the hands-on training was prepared.

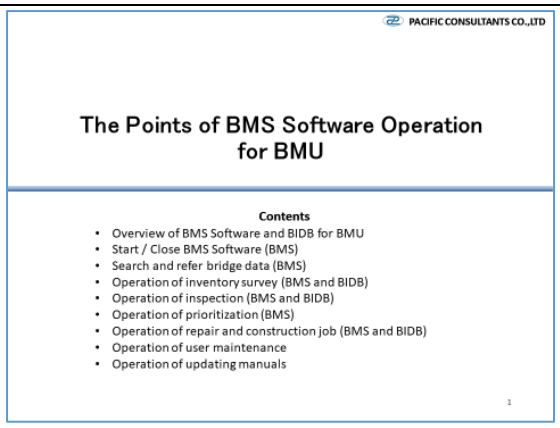
Preparations for a network connection and PC setup etc. at the training venue were made in advance as a part of the OJT.

[17] Involving or requiring personal operation of a keyboard

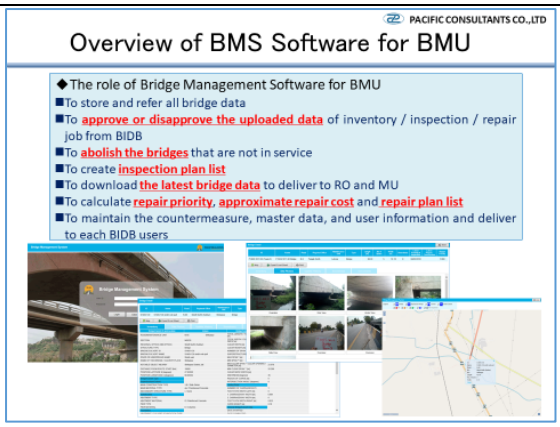
Network Connection Check

Preparation of PCs

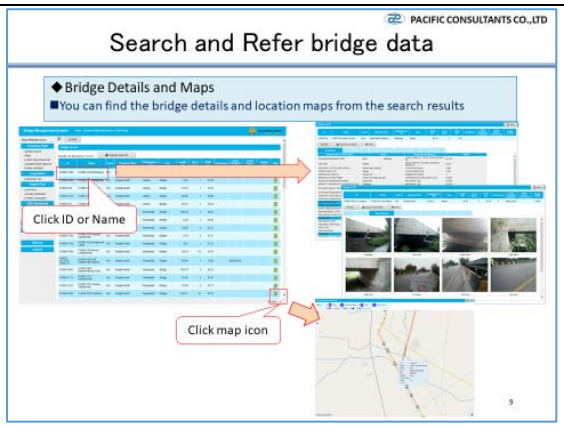
Figure 2-33 Preparations for BMS Software Training



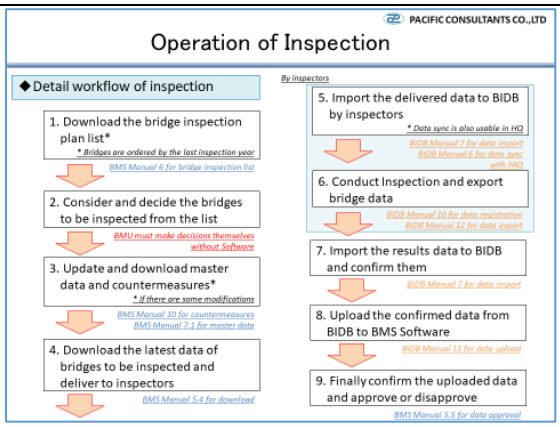
Cover Page



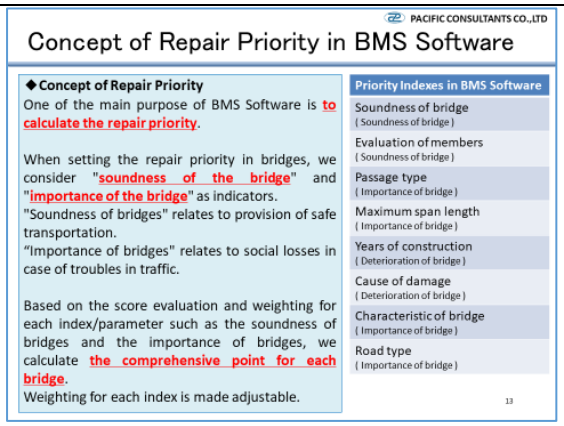
Overview of BMS Software



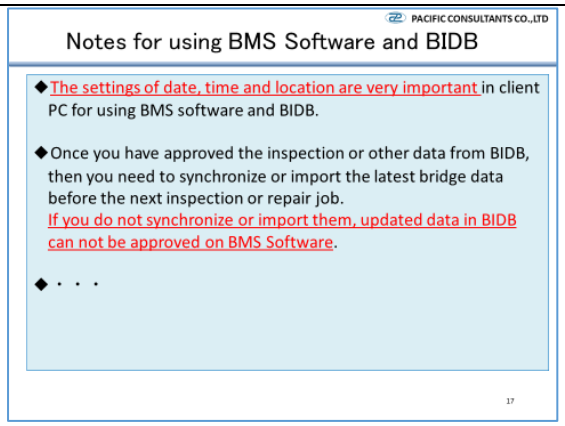
Functions



Operation Flow



Concepts of Prioritization



Important Issues

Figure 2-34 BMS Software Training Materials

(2) Training Schedule

The BMS software training covered two (2) days, the main training being held on August 9, 2018, and follow-up training to enhance understanding on August 10, 2018.

Table 2-40 BMS Software Schedule

Training	Date	Venue
BMS Software	2018/8/9	NHA（M/P Meeting Room）
Follow-up	2018/8/10	NHA（ Project Room）

(3) Attendees

The BMS software training focused mainly on operation of the BMS software for the BMU, but IT personnel also attended the training since the IT section of NHA would be involved in the future.

Table 2-41 BMS Software Training Attendee List

Sr. No	Name	Designation	8/9	8/10
1	Sohaib Mansoor	DD (BMU)	○	○
2	Ghulam Murtaza Simair	DD (BMU)	○	○
3	Sadaqat Ullah	AD (S/W)	○	－
4	Ashfaq Ahmed	AD (MIS Design)	○	－
5	Mian M Sarfaraz	AD (MIS P&CA)	○	－
6	Hafeez Akhtar	Database Officer (RAMD)	○	－
7	Yukio Igo	JICA Expert Team	○	○
8	Akio Mori	JICA Expert Team	○	○
9	Momina Rauf	JICA Expert Team	○	○

(4) BMS Software Training

In the BMS software training, enthusiastic discussions and exchanges of opinion were held through in-house and hands-on training involving the BMU, IT personnel and the JICA Expert Team. The IT personnel led the discussions on future operation of the system in the NHA.

In-house Training

In-house Training

Hands-on Training

Hands-on Training

Hands-on Training

Discussion and Opinion Exchange

Figure 2-35 BMS Software Training

2.2.3.2 Activity 3-2: BMU analyzes Bridge Inspection Data of the model area included in

database using BMS Software

(1) CSR prepared by BMU

When the bridge inspection data for the model area was being analyzed, the CSR for repair works was prepared by the BMU in order to estimate the cost of repair/upgrading works. With the cooperation of local consultants etc., the CSR was prepared.

(2) Analysis for Prioritization by BMU

The BMU analyzed and prioritized bridge inspection data for the model area included in the BIDB, using the BMS software. Calculation parameters for repair priorities obtained from the analysis, and the draft repair priority list, are as follows.

(a) Parameter settings

i) Weight settings

The weight settings prepared by the BMU are shown below, with the greater weight allocated to the top inspection results.

Table 2-42 Weight settings

Index	Weight
1 Soundness of Bridge	80
2 Evaluation of Members	10
3 Passage Type	2
4 Maximum Span Length	1
5 Years of Construction	1
6 Cause of Damage	2
7 Structure Type	2
8 Road Type	2

ii) Score settings

Table 2-43 Score settings for Soundness of Bridge

Soundness of Bridge	Score
1 I	25
2 II	50
3 III	75
4 IV	100

Table 2-44 Score settings for Evaluation of Members

Evaluation of Members	Score
1 A	0
2 B	30
3 Cd	60
4 Cs	80
5 Ep	100
6 Es	100

Member Group	Weight
1 Main element	30
2 Secondary element	10
3 Deck slab	20
4 Abutment	5
5 Pier	10
6 Bearing	5
7 Expansion joint	5
8 Guard fence	3
9 Pavement	3
10 Drainage	3
11 River training	3
12 Others	3
13 Not defined1	0
14 Not defined2	0
15 Not defined3	0

Table 2-45 Score settings for Passage Type

Passage Type	Score
1 Not Defined	0
2 A/River	100
3 B/Nullah	0
4 C/Flood Relief Channel	0
5 D/Irrigation Channel	0
6 E/Railway	0
7 F/Roadway	50
8 G/Pedestrian Way	50
9 X/None	0
10 Y/Other	0
11 V/Several	0

Table 2-46 Score settings for Maximum Span Length

Maximum Span Length	Length(m)	Score
1 Minimum Score Length	0	0
2 Maximum Score Length	100	100

Table 2-47 Score settings for Years of Construction

Years of Construction	Year	Score
1 Minimum Score Year	1950	0
2 Maximum Score Year	2000	100
3 Years of Construction is unknown	-	0

Table 2-48 Score settings for Cause of Damage

Cause of Damage	Score
1 a)Fatigue	100
2 b)Chloride damage	100
3 c)Freeze and thaw	0
4 d)Alkaline-silica reaction	100
5 e)Carbonation	0
6 f)Deterioration of material	0
7 g)Other	0

Table 2-49 Score settings for Structure Type

Structure Type	Score
1 Not Defined	0
2 Bridge	0
3 Big/Special Bridge	100
4 Culvert	0
5 Small Culvert	0

Table 2-50 Score settings for Road Type

Road Type Group	Score
1 CPEC	100
2 MOTERWAYS	80
3 EXPRESSWAYS	60
4 STRATEGIC ROUTES	40
5 NATIONAL HIGHWAY N-5&N-55	40
6 NATIONAL HIGHWAYS	10
7 Not Defined1	0
8 Not Defined2	0
9 Not Defined3	0
10 Not Defined4	0

(b) Prioritized repair plan formulated by BMU

Table 2-51 Prioritized repair plan formulated by BMU

Bridge Repair Plan List

Basic Data

ID	Name	Structure Type	Length [m]	No. of Spans	Width [m]	Soundness	Latest Inspectio	Repair Priority	Ep Rank	Es Rank	Total Cost [PKR]
PN5N-1368+300 (TEAM-03)	Chenab River Bridge	Bridge	718.00	16	10.30	IV	18/07/2018	89.860	Ep		760,901
PN5S-1368+300 (TEAM-03)	Chenab River Bridge	Bridge	718.00	16	10.30	IV	19/07/2018	89.530	Ep		6,979,783
P-N5-1573+500 (TEAM-01)	Pedestrian Bridge	Big/Special Bridge	25.00	2	2.00	IV	26/07/2018	88.025	Ep		1,676,556
P-N5S-1296 (TEAM02)	Rajpura Bridge	Bridge	38.80	3	13.29	IV	25/06/2018	87.287		Es	146,238
P-N5N-1581	Wah Garden Bridge	Bridge	97.00	6	15.50	IV	07/07/2018	87.050	Ep		2,423,310
P-N5N-1293+800 (TEAM-02)	Saime Nullah Pul	Bridge	69.40	6	15.50	IV	17/07/2018	86.008	Ep	Es	2,805,004
P-N5N-1323 (TEAM-02)	Khayali FlyOver Gujranwala	Bridge	629.00	11	10.60	IV	05/10/2018	85.690	Ep		2,645,065
PN5N-1362 (TEAM-02)	Gujrat	Bridge	48.00	3	9.80	IV	13/08/2018	83.578		Es	924,339
P-N5S-1606+950 (TEAM-03)	CNG Station Bridge	Bridge	20.30	4	10.88	IV	31/05/2018	83.232	Ep		356,624
PN5N-1464+100 (TEAM-03)	PN5N-1464+100 MISSA KASSOWAL	Bridge	226.37	8	8.20	III	07/07/2018	67.492		Es	3,944,606
P-N5S-1581 (TEAM-01)	Wah Garden Bridge	Bridge	98.00	12	15.60	III	04/05/2018	65.400			2,553,559
P-N5S-1608+500 (TEAM-02)	Wah College of Account Bridge	Bridge	57.40	8	10.10	III	28/06/2018	64.441			693,264
P-N5N-1310+500 (TEAM-02)	Unique Dhaba BBQ	Bridge	59.00	15	14.25	III	29/08/2018	62.336			100,760
P-N5N-1321 (TEAM-02)	Gujranwala	Bridge	99.00	4	8.65	III	20/07/2018	61.846			2,084,532
P-N5N-1592+200 (TEAM-01)	Punjab Floor Mill Bridge	Bridge	379.95	10	19.41	II	29/06/2018	47.471	Ep		15,729,960
P-N5S-1530+700 (TEAM-03)	Sawan Jor Bridge	Bridge	37.00	1	10.15	II	31/07/2018	44.474			518,020
P-N5S-1351 (TEAM-02)	Ojla Kalan	Bridge	14.00	3	12.80	II	15/08/2018	44.325			21,659
PN5N-1469+500 (TEAM-01)	Missa Kassowal	Bridge	30.10	3	9.50	II	09/05/2018	44.180			378,980
P-N5S-1611+020 (TEAM-03)	Kamra Bridge	Bridge	36.00	5	10.10	II	04/05/2018	44.013			358,202
P-N5S-1587+600 (TEAM-01)	Crystal Ice Factory Bridge	Bridge	14.50	1	11.00	II	22/08/2018	43.959			228,325
P-N5N-1561(TEAM-03)	B17 Main Entrance Bridge	Bridge	12.80	1	10.25	II	03/05/2018	43.774			106,914
PN5-1467+900 (TEAM-01)	Missa Kassowal	Bridge	211.00	10	19.40	II	19/07/2018	43.596			31,486,265
P-N5S-1623+300 (Team-03)	Faridia Masjid Bridge	Bridge	24.70	2	10.20	II	07/06/2018	43.112			569,896
P-N5S-1620+700 (TEAM-01)	Del Foji Petrol Pump Bridge	Bridge	36.60	3	10.20	II	02/08/2018	42.503			97,226
P-N5N-1552 (TEAM-03)	PSO Pump Bridge	Bridge	18.33	1	13.54	II	27/07/2018	42.330			620,854
PN5N-1420+200 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	II	26/06/2018	41.692			91,353
P-N5N-1587+600 (TEAM-01)	Crystal Ice Factory Bridge	Bridge	14.90	1	9.15	II	22/08/2018	41.548			334,193
P-N5N-1587+950C (TEAM-03)	NHA weigh Station Culvert	Small Culvert	1.20	1	15.60	II	27/07/2018	41.350			23,450
P-N5N-1401+700 (TEAM-01)	Lalamusa	Bridge	4.20	1	15.00	II	05/10/2018	41.329			32,818
PN5N-1421+400 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	II	26/06/2018	41.182			213,748
P-N5N-1587+850C (TEAM-03)	Wah Model Town Phase III Culvert	Small Culvert	1.20	1	16.15	II	27/07/2018	40.900			5,930
P-N5S-1552 (TEAM-02)	PSO Pump Bridge	Bridge	17.95	1	13.54	II	24/07/2018	40.478			613,880
PN80-66+300 (TEAM-01)	KHUND MORE	Bridge	80.00	3	10.00	I	18/07/2018	22.485			3,938,380
P-N5-1287+500 (TEAM-03)	Muridke Underpass	Bridge	20.57	2	28.00	I	06/06/2018	22.225			13,980
P-N5-1569+100 (TEAM-03)	Taxila Bus Stand	Bridge	98.00	2	21.60	I	07/05/2018	22.158			1,060,320
P-N5S-1576C (TEAM-03)	SkyLark School	Culvert	20.30	1	3.00	I	30/07/2018	21.840			126,660
P-N80-107+100 (TEAM-01)	Khushalgarh Bridge	Bridge	83.90	3	10.50	I	18/07/2018	21.289			1,228,324
PN5N-1419+600 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	I	26/06/2018	21.092			78,910
P-N5N-1625+500 (TEAM-01)	Chapper Sharif Bus Stop culvert	Culvert	6.05	2	32.50	I	22/08/2018	20.600			122,814
PN5S-1469+500 (TEAM-01)	Missa Kassowal	Bridge	36.01	3	9.50	I	02/08/2018	20.120			132,425
P-N5N-1623+800 (TEAM-01)	Haji Ramzan Shop Culvert	Culvert	4.50	1	12.30	I	27/07/2018	20.000			46,100

(3) Suggestions for Prioritization by JICA Expert Team

During the repair priority analysis by the BMU, the JICA Expert Team suggested a draft repair priority for the bridge inspection data for the model area based on cases and know-how from Japan.

The calculation parameters for repair priority obtained from the analysis and draft repair priority list are as follows.

(a) Parameter settings

i) Weight settings

The weight settings prepared by the JICA Expert Team are shown below, with weight distributed over the inspection results more evenly, with consideration given to the inventory data.

Table 2-52 Weight settings

Index	Weight
1 Soundness of Bridge	40
2 Evaluation of Members	20
3 Passage Type	10
4 Maximum Span Length	10
5 Years of Construction	5
6 Cause of Damage	5
7 Structure Type	5
8 Road Type	5

ii) Score settings

Table 2-53 Score settings for Soundness of Bridge

Soundness of Bridge	Score
1 I	25
2 II	50
3 III	75
4 IV	100

Table 2-54 Score settings for Evaluation of Members

Evaluation of Members	Score
1 A	0
2 B	30
3 Cd	60
4 Cs	80
5 Ep	100
6 Es	100

Member Group	Weight
1 Main element	30
2 Secondary element	10
3 Deck slab	20
4 Abutment	5
5 Pier	10
6 Bearing	5
7 Expansion joint	5
8 Guard fence	3
9 Pavement	3
10 Drainage	3
11 River training	3
12 Others	3
13 Not defined1	0
14 Not defined2	0
15 Not defined3	0

Table 2-55 Score settings for Passage Type

Passage Type	Score
1 Not Defined	0
2 A/River	100
3 B/Nullah	0
4 C/Flood Relief Channel	0
5 D/Irrigation Channel	0
6 E/Railway	0
7 F/Roadway	50
8 G/Pedestrian Way	50
9 X/None	0
10 Y/Other	0
11 V/Several	0

Table 2-56 Score settings for Maximum Span Length

Maximum Span Length	Length(m)	Score
1 Minimum Score Length	0	0
2 Maximum Score Length	100	100

Table 2-57 Score settings for Years of Construction

Years of Construction	Year	Score
1 Minimum Score Year	1950	0
2 Maximum Score Year	2000	100
3 Years of Construction is unknown	-	0

Table 2-58 Score settings for Cause of Damage

Cause of Damage	Score
1 a)Fatigue	100
2 b)Chloride damage	100
3 c)Freeze and thaw	0
4 d)Alkaline-silica reaction	100
5 e)Carbonation	0
6 f)Deterioration of material	0
7 g)Other	0

Table 2-59 Score settings for Structure Type

Structure Type	Score
1 Not Defined	0
2 Bridge	0
3 Big/Special Bridge	100
4 Culvert	0
5 Small Culvert	0

Table 2-60 Score settings for Road Type

Road Type Group	Score
1 CPEC	100
2 MOTERWAYS	80
3 EXPRESSWAYS	60
4 STRATEGIC ROUTES	40
5 NATIONAL HIGHWAY N-5&N-55	40
6 NATIONAL HIGHWAYS	10
7 Not Defined1	0
8 Not Defined2	0
9 Not Defined3	0
10 Not Defined4	0

(b) Prioritized repair plan formulated by JICA Expert

Table 2-61 Prioritized repair plan formulated by JICA Expert

Bridge Repair Plan List

Basic Data

ID	Name	Structure Type	Length [m]	No. of Spans	Width [m]	Soundness	Repair Priority	Ep Rank	Es Rank	Total Cost [PKR]
PN5N-1368+300 (TEAM-03)	Chenab River Bridge	Bridge	718.00	16	10.30	IV	70.240	Ep		760,901
PN5S-1368+300 (TEAM-03)	Chenab River Bridge	Bridge	718.00	16	10.30	IV	69.580	Ep		6,979,783
P-N5-1573+500 (TEAM-01)	Pedestrian Bridge	Big/Special Bridge	25.00	2	2.00	IV	61.050	Ep		1,676,556
P-N5N-1581	Wah Garden Bridge	Bridge	97.00	6	15.50	IV	56.702	Ep		2,423,310
P-N5N-1323 (TEAM-02)	Khayali FlyOver Gujranwala	Bridge	629.00	11	10.60	IV	56.700	Ep		2,645,065
P-N5S-1296 (TEAM02)	Rajpura Bridge	Bridge	38.80	3	13.29	IV	56.432		Es	146,238
P-N5N-1293+800 (TEAM-02)	Saime Nullah Pul	Bridge	69.40	6	15.50	IV	52.875	Ep	Es	2,805,004
PN5N-1362 (TEAM-02)	Gujrat	Bridge	48.00	3	9.80	IV	51.180		Es	924,339
PN5N-1464+100 (TEAM-03)	PN5N-1464+100 MISSAKASSOWAL	Bridge	226.37	8	8.20	III	47.995		Es	3,944,606
P-N5S-1606+950 (TEAM-03)	CNG Station Bridge	Bridge	20.30	4	10.88	IV	46.802	Ep		356,624
P-N5S-1581 (TEAM-01)	Wah Garden Bridge	Bridge	98.00	12	15.60	III	41.604			2,553,559
P-N5N-1592+200 (TEAM-01)	Punjab Floor Mill Bridge	Bridge	379.95	10	19.41	II	41.310	Ep		15,729,960
P-N5S-1608+500 (TEAM-02)	Wah College of Account Bridge	Bridge	57.40	8	10.10	III	40.370			693,264
P-N5N-1321 (TEAM-02)	Gujranwala	Bridge	99.00	4	8.65	III	35.660			2,084,532
P-N5N-1310+500 (TEAM-02)	Unique Dhaba BBQ	Bridge	59.00	15	14.25	III	34.962			100,760
P-N5S-1530+700 (TEAM-03)	Sawan Jor Bridge	Bridge	37.00	1	10.15	II	34.420			518,020
P-N5S-1351 (TEAM-02)	Ojla Kalan	Bridge	14.00	3	12.80	II	30.010			21,659
PN5N-1469+500 (TEAM-01)	Missa Kassowal	Bridge	30.10	3	9.50	II	30.000			378,980
P-N5S-1623+300 (Team-03)	Faridia Masjid Bridge	Bridge	24.70	2	10.20	II	29.800			569,896
P-N5S-1611+020 (TEAM-03)	Kamra Bridge	Bridge	36.00	5	10.10	II	29.530			358,202
P-N5N-1561(TEAM-03)	B17 Main Entrance Bridge	Bridge	12.80	1	10.25	II	29.300			106,914
P-N5S-1587+600 (TEAM-01)	Crystal Ice FactoryBridge	Bridge	14.50	1	11.00	II	28.870			228,325
PN5-1467+900 (TEAM-01)	Missa Kassowal	Bridge	211.00	10	19.40	II	28.837			31,486,265
P-N5N-1552 (TEAM-03)	PSO Pump Bridge	Bridge	18.33	1	13.54	II	27.100			620,854
P-N5S-1620+700 (TEAM-01)	Del Foji Petrol Pump Bridge	Bridge	36.60	3	10.20	II	25.830			97,226
P-N5N-1587+600 (TEAM-01)	Crystal Ice FactoryBridge	Bridge	14.90	1	9.15	II	23.960			334,193
PN5N-1420+200 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	II	23.715			91,353
P-N5N-1401+700 (TEAM-01)	Lalamusa	Bridge	4.20	1	15.00	II	22.970			32,818
03)	NHAweigh Station Culvert	Small Culvert	1.20	1	15.60	II	22.700			23,450
PN5N-1421+400 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	II	22.695			213,748
P-N5S-1552 (TEAM-02)	PSO Pump Bridge	Bridge	17.95	1	13.54	II	22.381			613,880
03)	Wah Model Town Phase III Culvert	Small Culvert	1.20	1	16.15	II	21.800			5,930
P-N5-1569+100 (TEAM-03)	Taxila Bus Stand	Bridge	98.00	2	21.60	I	18.180			1,060,320
P-N5-1287+500 (TEAM-03)	Muridke Underpass	Bridge	20.57	2	28.00	I	18.130			13,980
PN80-66+300 (TEAM-01)	KHUND MORE	Bridge	80.00	3	10.00	I	16.850			3,938,380
P-N5S-1576C (TEAM-03)	SkyLark School	Culvert	20.30	1	3.00	I	16.680			126,660
P-N80-107+100 (TEAM-01)	Khushalgarh Bridge	Bridge	83.90	3	10.50	I	14.490			1,228,324
PN5N-1419+600 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	I	12.515			78,910
P-N5N-1625+500 (TEAM-01)	Chapper Sharif Bus Stop culvert	Culvert	6.05	2	32.50	I	11.200			122,814
PN5S-1469+500 (TEAM-01)	Missa Kassowal	Bridge	36.01	3	9.50	I	11.200			132,425
P-N5N-1623+800 (TEAM-01)	Haji Ramzan Shop Culvert	Culvert	4.50	1	12.30	I	10.000			46,100

(4) Finalization of the draft repair priority list

The BMU and the JICA Expert Team collaborated in finalizing the draft repair priority list through mutual discussions.

The final repair priority calculation parameter and repair priority list are as follows.

(a) Parameter settings

i) Weight settings

The finalized settings are shown below, with a balanced weight distribution over the inspection results and the inventory data.

The weight for “Years of Construction” is set to zero because there is not sufficient data for it to be taken into account.

Table 2-62 Weight settings

Index	Weight
1 Soundness of Bridge	60
2 Evaluation of Members	20
3 Passage Type	5
4 Maximum Span Length	5
5 Years of Construction	0
6 Cause of Damage	5
7 Structure Type	4
8 Road Type	1

ii) Score settings

Table 2-63 Score settings for Soundness of Bridge

Soundness of Bridge	Score
1 I	25
2 II	50
3 III	75
4 IV	100

Table 2-64 Score settings for Evaluation of Members

Evaluation of Members	Score
1 A	0
2 B	30
3 Cd	60
4 Cs	80
5 Ep	100
6 Es	100

Member Group	Weight
1 Main element	30
2 Secondary element	10
3 Deck slab	20
4 Abutment	5
5 Pier	10
6 Bearing	5
7 Expansion joint	5
8 Guard fence	3
9 Pavement	3
10 Drainage	3
11 River training	3
12 Others	3
13 Not defined1	0
14 Not defined2	0
15 Not defined3	0

The score settings for “Passage Type” were decided in accordance with the BMU’s opinion on relative bridge importance.

Table 2-65 Score settings for Passage Type

Passage Type	Score
1 Not Defined	0
2 A/River	100
3 B/Nullah	25
4 C/Flood Relief Channel	25
5 D/Irrigation Channel	80
6 E/Railway	70
7 F/Roadway	70
8 G/Pedestrian Way	70
9 X/None	0
10 Y/Other	0
11 V/Several	0

Table 2-66 Score settings for Maximum Span Length

Maximum Span Length	Length(m)	Score
1 Minimum Score Length	0	0
2 Maximum Score Length	100	100

Table 2-67 Score settings for Years of Construction

Years of Construction	Year	Score
1 Minimum Score Year	1950	0
2 Maximum Score Year	2000	100
3 Years of Construction is unknown	-	0

Table 2-68 Score settings for Cause of Damage

Cause of Damage	Score
1 a)Fatigue	100
2 b)Chloride damage	100
3 c)Freeze and thaw	0
4 d)Alkaline-silica reaction	100
5 e)Carbonation	0
6 f)Deterioration of material	0
7 g)Other	0

Table 2-69 Score settings for Structure Type

Structure Type	Score
1 Not Defined	0
2 Bridge	0
3 Big/Special Bridge	100
4 Culvert	0
5 Small Culvert	0

N-5 and N-55 were chosen for scoring since they carry heavy traffic compared to other roads.

Table 2-70 Score settings for Road Type

Road Type Group	Score	Selected Road
1 Busy road	100	N-5, N-55
2 Not Defined	0	
3 Not Defined	0	
4 Not Defined	0	
5 Not Defined	0	
6 Not Defined	0	
7 Not Defined	0	
8 Not Defined	0	
9 Not Defined	0	
10 Not Defined	0	

(b) Prioritized repair plan (Final)

Table 2-71 Prioritized repair plan (Final)

Bridge Repair Plan List

Basic Data

ID	Name	Structure Type	Length [m]	No. of Spans	Width [m]	Soundness	Repair Priority	Ep Rank	Es Rank	Total Cost [PKR]
PN5N-1368+300 (TEAM-03)	Chenab River Bridge	Bridge	718.00	16	10.30	IV	84.040	Ep		760,901
PN5S-1368+300 (TEAM-03)	Chenab River Bridge	Bridge	718.00	16	10.30	IV	83.380	Ep		6,979,783
P-N5-1573+500 (TEAM-01)	Pedestrian Bridge	Big/Special Bridge	25.00	2	2.00	IV	78.925	Ep		1,676,556
P-N5S-1296 (TEAM02)	Rajpura Bridge	Bridge	38.80	3	13.29	IV	78.146		Es	146,238
P-N5N-1581	Wah Garden Bridge	Bridge	97.00	6	15.50	IV	77.951	Ep		2,423,310
P-N5N-1323 (TEAM-02)	Khayali FlyOver Gujranwala	Bridge	629.00	11	10.60	IV	74.750	Ep		2,645,065
P-N5N-1293+800 (TEAM-02)	Saime Nullah Pul	Bridge	69.40	6	15.50	IV	74.588	Ep	Es	2,805,004
PN5N-1362 (TEAM-02)	Gujrat	Bridge	48.00	3	9.80	IV	70.040		Es	924,339
P-N5S-1606+950 (TEAM-03)	CNG Station Bridge	Bridge	20.30	4	10.88	IV	68.841	Ep		356,624
PN5N-1464+100 (TEAM-03)	PN5N-1464+100 MISSA KASSOWAL	Bridge	226.37	8	8.20	III	63.988		Es	3,944,606
P-N5S-1581 (TEAM-01)	Wah Garden Bridge	Bridge	98.00	12	15.60	III	58.352			2,553,559
P-N5S-1608+500 (TEAM-02)	Wah College of Account Bridge	Bridge	57.40	8	10.10	III	57.315			693,264
P-N5N-1310+500 (TEAM-02)	Unique Dhaba BBQ	Bridge	59.00	15	14.25	III	52.031			100,760
P-N5N-1321 (TEAM-02)	Gujranwala	Bridge	99.00	4	8.65	III	51.680			2,084,532
P-N5N-1592+200 (TEAM-01)	Punjab Floor Mill Bridge	Bridge	379.95	10	19.41	II	48.955	Ep		15,729,960
P-N5S-1530+700 (TEAM-03)	Sawan Jor Bridge	Bridge	37.00	1	10.15	II	43.000			518,020
P-N5S-1587+600 (TEAM-01)	Crystal Ice Factory Bridge	Bridge	14.50	1	11.00	II	42.775			228,325
PN5-1467+900 (TEAM-01)	Missa Kassowal	Bridge	211.00	10	19.40	II	42.309			31,486,265
P-N5S-1351 (TEAM-02)	Ojla Kalan	Bridge	14.00	3	12.80	II	42.035			21,659
PN5N-1469+500 (TEAM-01)	Missa Kassowal	Bridge	30.10	3	9.50	II	41.850			378,980
P-N5S-1611+020 (TEAM-03)	Kamra Bridge	Bridge	36.00	5	10.10	II	41.465			358,202
P-N5N-1561(TEAM-03)	B17 Main Entrance Bridge	Bridge	12.80	1	10.25	II	41.080			106,914
P-N5S-1623+300 (Team-03)	Faridia Masjid Bridge	Bridge	24.70	2	10.20	II	38.940			569,896
P-N5N-1552 (TEAM-03)	PSO Pump Bridge	Bridge	18.33	1	13.54	II	38.450			620,854
P-N5N-1587+600 (TEAM-01)	Crystal Ice Factory Bridge	Bridge	14.90	1	9.15	II	37.920			334,193
P-N5N-1401+700 (TEAM-01)	Lalamusa	Bridge	4.20	1	15.00	II	37.775			32,818
P-N5S-1620+700 (TEAM-01)	Del Foji Petrol Pump Bridge	Bridge	36.60	3	10.20	II	37.565			97,226
PN5N-1421+400 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	II	34.738			213,748
PN5N-1420+200 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	II	34.508			91,353
P-N5S-1552 (TEAM-02)	PSO Pump Bridge	Bridge	17.95	1	13.54	II	33.741			613,880
03)	NHA weigh Station Culvert	Small Culvert	1.20	1	15.60	II	33.700			23,450
03)	Wah Model Town Phase III Culvert	Small Culvert	1.20	1	16.15	II	32.800			5,930
P-N5-1287+500 (TEAM-03)	Muridke Underpass	Bridge	20.57	2	28.00	I	22.205			13,980
P-N5-1569+100 (TEAM-03)	Taxila Bus Stand	Bridge	98.00	2	21.60	I	22.140			1,060,320
PN80-66+300 (TEAM-01)	KHUND MORE	Bridge	80.00	3	10.00	I	21.925			3,938,380
P-N80-107+100 (TEAM-01)	Khushalgarh Bridge	Bridge	83.90	3	10.50	I	21.795			1,228,324
P-N5S-1576C (TEAM-03)	SkyLark School	Culvert	20.30	1	3.00	I	21.180			126,660
PN5N-1419+600 (TEAM-01)	Kharian	Bridge	8.38	2	10.80	I	19.558			78,910
PN5S-1469+500 (TEAM-01)	Missa Kassowal	Bridge	36.01	3	9.50	I	17.850			132,425
P-N5N-1625+500 (TEAM-01)	Chapper Sharif Bus Stop culvert	Culvert	6.05	2	32.50	I	17.200			122,814
P-N5N-1623+800 (TEAM-01)	Haji Ramzan Shop Culvert	Culvert	4.50	1	12.30	I	16.000			46,100

2.2.3.3 Activity 3-3: BMU prepares the annual bridge/culvert maintenance plan including budget estimation based on the analysis of registered data in Bridge Inspection Database.

The BMU drew up the annual bridge/culvert maintenance plan including budget estimation for the forthcoming year based on the priority analysis of the data registered in the Bridge Inspection Database (BIDB).

At this point, 36 bridges and 5 culverts were targeted for maintenance and a budget could be prepared for them. However, after the target area has been expanded, there will be a limit on the budget allocated for maintenance work.

Here, we considered a scenario in which the budget allocation was ten (10) million PKR per year. Accordingly, annual maintenance plans were formulated to cover three (3) possible cases.

Table 2-72 Case Study

Cases	Description
Case 1	Repair all deteriorated elements
Case 2	Repair only deteriorations on main elements
Case 3	Repair only elements with severe deterioration (Ep, Es and Cd)

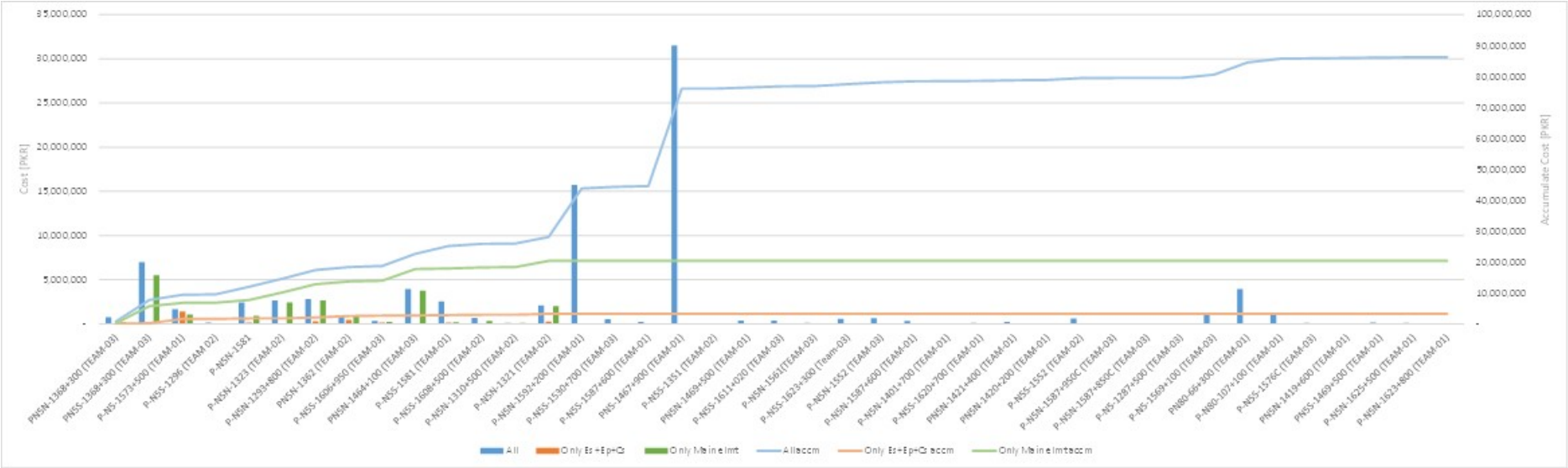


Figure 2-36 Repair costs for the three cases

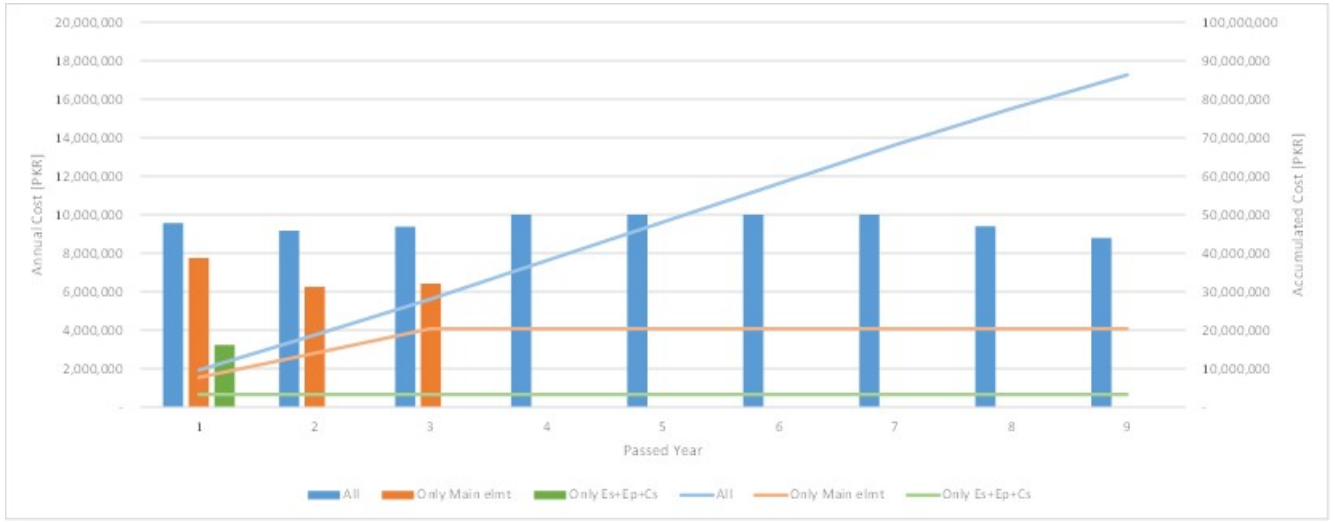


Figure 2-37 Repair costs for the three cases (Annual plan)

Case1:ALL										
RepairPriority	ID	1	2	3	4	5	6	7	8	9
84.04	PN5N-1368+300 (TEAM-03)	760,901								
83.38	PN5S-1368+300 (TEAM-03)	6,979,783								
78.925	P-N5-1573+500 (TEAM-01)	1,676,556								
78.146	P-N5S-1296 (TEAM 02)	146,238								
77.951	P-N5N-1581		2,423,310							
74.75	P-N5N-1323 (TEAM-02)		2,645,065							
74.588	P-N5N-1293+800 (TEAM-02)		2,805,004							
70.04	PN5N-1362 (TEAM-02)		924,339							
68.841	P-N5S-1606+950 (TEAM-03)		356,624							
63.988	PN5N-1464+100 (TEAM-03)			3,944,606						
58.352	P-N5S-1581 (TEAM-01)			2,553,559						
57.315	P-N5S-1608+500 (TEAM-02)			693,264						
52.031	P-N5N-1310+500 (TEAM-02)			100,760						
51.68	P-N5N-1321 (TEAM-02)			2,084,532						
48.955	P-N5N-1592+200 (TEAM-01)				10,000,000	5,729,960				
43	P-N5S-1530+700 (TEAM-03)					518,020				
42.775	P-N5S-1587+600 (TEAM-01)					228,325				
42.309	PN5-1467+900 (TEAM-01)					3,523,695	10,000,000	10,000,000	7,962,570	
42.035	P-N5S-1351 (TEAM-02)								21,659	
41.85	PN5N-1469+500 (TEAM-01)								378,980	
41.465	P-N5S-1611+020 (TEAM-03)								358,202	
41.08	P-N5N-1561(TEAM-03)								106,914	
38.94	P-N5S-1623+300 (Team-03)								569,896	
38.45	P-N5N-1552 (TEAM-03)									620,854
37.92	P-N5N-1587+600 (TEAM-01)									334,193
37.775	P-N5N-1401+700 (TEAM-01)									32,818
37.565	P-N5S-1620+700 (TEAM-01)									97,226
34.738	PN5N-1421+400 (TEAM-01)									213,748
34.508	PN5N-1420+200 (TEAM-01)									91,353
33.741	P-N5S-1552 (TEAM-02)									613,880
33.7	P-N5N-1587+950C (TEAM-03)									23,450
32.8	P-N5N-1587+850C (TEAM-03)									5,930
22.205	P-N5-1287+500 (TEAM-03)									13,980
22.14	P-N5-1569+100 (TEAM-03)									1,060,320
21.925	PN80-66+300 (TEAM-01)									3,938,380
21.795	P-N80-107+100 (TEAM-01)									1,228,324
21.18	P-N5S-1576C (TEAM-03)									126,660
19.558	PN5N-1419+600 (TEAM-01)									78,910
17.85	PN5S-1469+500 (TEAM-01)									132,425
17.2	P-N5N-1625+500 (TEAM-01)									122,814
16	P-N5N-1623+800 (TEAM-01)									46,100
	Annual Cost	9,563,478	9,154,342	9,376,720	10,000,000	10,000,000	10,000,000	10,000,000	9,398,223	8,781,363
	Accumulation Cost	9,563,478	18,717,820	28,094,540	38,094,540	48,094,540	58,094,540	68,094,540	77,492,763	86,274,126

Figure 2-38 Case 1 Analysis

Case2:Only MAIN ELEMENT										
RepairPriority	ID	1	2	3	4	5	6	7	8	9
84.04	PN5N-1368+300 (TEAM-03)	193,903								
83.38	PN5S-1368+300 (TEAM-03)	5,520,094								
78.925	P-N5-1573+500 (TEAM-01)	1,065,036								
78.146	P-N5S-1296 (TEAM 02)	80,769								
77.951	P-N5N-1581	882695								
74.75	P-N5N-1323 (TEAM-02)		2,439,855							
74.588	P-N5N-1293+800 (TEAM-02)		2,640,274							
70.04	PN5N-1362 (TEAM-02)		918,573							
68.841	P-N5S-1606+950 (TEAM-03)		239,067							
63.988	PN5N-1464+100 (TEAM-03)			3,778,275						
58.352	P-N5S-1581 (TEAM-01)			189,345						
57.315	P-N5S-1608+500 (TEAM-02)			331,841						
52.031	P-N5N-1310+500 (TEAM-02)			98,481						
51.68	P-N5N-1321 (TEAM-02)			2,003,948						
48.955	P-N5N-1592+200 (TEAM-01)									
43	P-N5S-1530+700 (TEAM-03)									
42.775	P-N5S-1587+600 (TEAM-01)									
42.309	PN5-1467+900 (TEAM-01)									
42.035	P-N5S-1351 (TEAM-02)									
41.85	PN5N-1469+500 (TEAM-01)									
41.465	P-N5S-1611+020 (TEAM-03)									
41.08	P-N5N-1561(TEAM-03)									
38.94	P-N5S-1623+300 (Team-03)									
38.45	P-N5N-1552 (TEAM-03)									
37.92	P-N5N-1587+600 (TEAM-01)									
37.775	P-N5N-1401+700 (TEAM-01)									
37.565	P-N5S-1620+700 (TEAM-01)									
34.738	PN5N-1421+400 (TEAM-01)									
34.508	PN5N-1420+200 (TEAM-01)									
33.741	P-N5S-1552 (TEAM-02)									
33.7	P-N5N-1587+950C (TEAM-03)									
32.8	P-N5N-1587+850C (TEAM-03)									
22.205	P-N5-1287+500 (TEAM-03)									
22.14	P-N5-1569+100 (TEAM-03)									
21.925	PN80-66+300 (TEAM-01)									
21.795	P-N80-107+100 (TEAM-01)									
21.18	P-N5S-1576C (TEAM-03)									
19.558	PN5N-1419+600 (TEAM-01)									
17.85	PN5S-1469+500 (TEAM-01)									
17.2	P-N5N-1625+500 (TEAM-01)									
16	P-N5N-1623+800 (TEAM-01)									
	Annual Cost	7,742,497	6,237,770	6,401,890	-	-	-	-	-	-
	Accumulation Cost	7,742,497	13,980,266	20,382,156	20,382,156	20,382,156	20,382,156	20,382,156	20,382,156	20,382,156

Figure 2-39 Case 2 Analysis

Case3:Only Es+Ep+Cs										
RepairPriority	ID	1	2	3	4	5	6	7	8	9
84.04	PN5N-1368+300 (TEAM-03)	52,950								
83.38	PN5S-1368+300 (TEAM-03)	167,705								
78.925	P-N5-1573+500 (TEAM-01)	1,391,040								
78.146	P-N5S-1296 (TEAM 02)	1,380								
77.951	P-N5N-1581	156456								
74.75	P-N5N-1323 (TEAM-02)	2095.92								
74.588	P-N5N-1293+800 (TEAM-02)	304673.42								
70.04	PN5N-1362 (TEAM-02)	447580								
68.841	P-N5S-1606+950 (TEAM-03)	145133.75								
63.988	PN5N-1464+100 (TEAM-03)	67154.6								
58.352	P-N5S-1581 (TEAM-01)	144231								
57.315	P-N5S-1608+500 (TEAM-02)	66995.6								
52.031	P-N5N-1310+500 (TEAM-02)	24390								
51.68	P-N5N-1321 (TEAM-02)	255760								
48.955	P-N5N-1592+200 (TEAM-01)									
43	P-N5S-1530+700 (TEAM-03)									
42.775	P-N5S-1587+600 (TEAM-01)									
42.309	PN5-1467+900 (TEAM-01)									
42.035	P-N5S-1351 (TEAM-02)									
41.85	PN5N-1469+500 (TEAM-01)									
41.465	P-N5S-1611+020 (TEAM-03)									
41.08	P-N5N-1561(TEAM-03)									
38.94	P-N5S-1623+300 (Team-03)									
38.45	P-N5N-1552 (TEAM-03)									
37.92	P-N5N-1587+600 (TEAM-01)									
37.775	P-N5N-1401+700 (TEAM-01)									
37.565	P-N5S-1620+700 (TEAM-01)									
34.738	PN5N-1421+400 (TEAM-01)									
34.508	PN5N-1420+200 (TEAM-01)									
33.741	P-N5S-1552 (TEAM-02)									
33.7	P-N5N-1587+950C (TEAM-03)									
32.8	P-N5N-1587+850C (TEAM-03)									
22.205	P-N5-1287+500 (TEAM-03)									
22.14	P-N5-1569+100 (TEAM-03)									
21.925	PN80-66+300 (TEAM-01)									
21.795	P-N80-107+100 (TEAM-01)									
21.18	P-N5S-1576C (TEAM-03)									
19.558	PN5N-1419+600 (TEAM-01)									
17.85	PN5S-1469+500 (TEAM-01)									
17.2	P-N5N-1625+500 (TEAM-01)									
16	P-N5N-1623+800 (TEAM-01)									
	Annual Cost	3,227,545	-	-	-	-	-	-	-	-
	Accumulation Cost	3,227,545	-	-	-	-	-	-	-	-

Figure 2-40 Case 3 Analysis

2.2.4 Training in Japan

The training in Japan was initially planned to follow the 1st Master Trainer Training, in order to improve the Master Trainers' capabilities. However, accordance with a strong request from the C/P side, the 1st Training in Japan was implemented prior to the 1st Master Trainer Training, in order to get an understanding of bridge maintenance and management in Japan so as to create an effective vision for the future in the NHA and Pakistan.

Two Deputy Directors from RAMD were selected and dispatched to Japan.

Duration: Monday, January 16, 2017 - Friday, January 27, 2017, 12 days

Trainees: Mr. Aftab Ullah Babar, Mr. Muhammad Asif Azam

JICA Training Manager: Ms. Kaoru Minase

In line with the request from the C/P side, for the 1st training in Japan, managing engineers at the headquarters, and for the 2nd training, inspectors in charge of bridge maintenance, would study the bridge maintenance in Japan. The JICA Expert Team planned to improve the efficiency of technology transfer throughout the organization through the implementation of more practical training centering on on-site visits, such as repair work.

However, after the 1st Master Trainer Training (February - March 2017), it became clear that there was a shortage of human resources in the NHA, in particular technicians/engineers in charge of practical maintenance work. Therefore, it was decided not to carry out the 2nd training in Japan as it was considered that improving their capacity in Pakistan was more important than giving them training in Japan.

(1) BMS in Japan

Topics	Bridge and Maintenance in Japan, BMS in Japan, Transportation Infrastructures and Projects Fields
Date & Time	January 16th, 2017 (Monday) 13:00 – 18:00
Venue	Pacific Consultants Co., Ltd. Headquarters (Jinboucho, Tokyo)
Attendees	Watanabe, Yoneda, Mori, Kamitani, Horii, Nakai, Ishihara, Suga, Igo, Fujimoto, Tomiyama (Pacific Consultants)
Contents	Bridge and Maintenance in Japan (by Nakai) BMS in Japan (by Mori) Opinion Exchange (by all) Transportation Infrastructures and Projects Fields (by Ishihara)

	
Exchange of Opinions	**Group Photo**

(2) BMS in Japan Highways

Topics	Technologies in Japan Highway Bridges, Bridge Maintenance in Japan Highway
Date & Time	January 17th, 2017 (Tuesday) 11:00 – 16:00
Venue	NEXCO Research Institute (Machida City, Tokyo)
Attendees	Mr. Hirose, Mr. Shirakawa (NEXCO RI) Igo (Pacific Consultants)
Contents	NEXCO Bridge Conditions and Remedial Technology (by Mr. Hirose) Overview of NEXCO's BMS (by Mr. Shirakawa) Diagnosing Soundness in Express Bridges (by Mr. Hirose) Facility Visit

	
Lecture	**Facility Visit**

(3) Bridge Repair Site Visit

Topics	Bridge Repair Site Visit
Date & Time	January 18th, 2017 (Wednesday) 14:00 – 16:00
Venue	Shingetu Bridge (Tukishima Station, Tokyo)
Attendees	Mr. Nagahata, Mr. Endou (Nippon Liner) Mr. Matsuoka, Mr. Takagi, Mr. Akanamie (MBS) Igo, Konuma, Kasahara (Pacific Consultants)
Contents	Site Visit of Bridge Parapet Repair

	
Site Visit	**Aerial Work Platform**

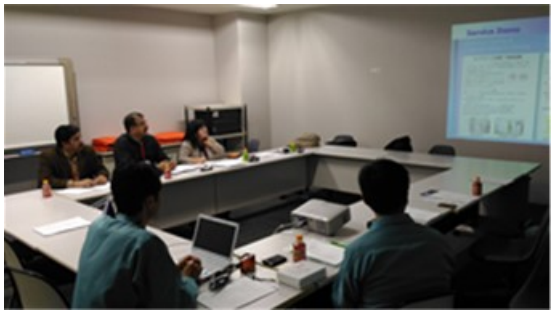
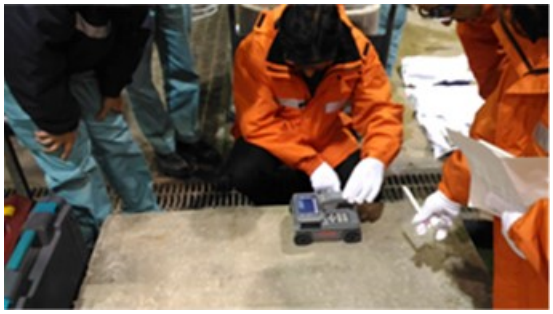
(4) License System

Topics	License System of Road Bridge Inspectors
Date & Time	January 19th, 2017 (Thursday) 9:30 – 11:30
Venue	Japan Bridge Engineering Center (Gokokuji Station, Tokyo)
Attendees	Mr. Yoshida (J-BEC) Igo, Yoneda (Pacific Consultants)
Contents	License System of Road Bridge Inspectors Questions and Answers

	
Lecture	**Q & A**

(5) Concrete Test Facilities and Equipment

Topics	Concrete Test Facilities and Equipment
Date & Time	January 19th, 2017 (Thursday) 14:30 – 17:00
Venue	Taiheiyo Consultant (Sakura City, Chiba)
Attendees	Mr. Kobayashi, Mr. Shirai, Ms. Tsukamoto, Mr. Tanaka (Taiheiyo Consultant) Igo (Pacific Consultants)
Contents	Facilities of Taiheiyo Cement Group Material Analysis Equipment (EPMA etc.) Non Destructive Test Equipment

	
Lecture	**NDT Operation**

(6) N2U-BRIDGE

Topics	N2U-BRIDGE (Concrete Inspection Training Facility)
Date & Time	January 20th, 2017 (Friday) 14:00 – 16:00
Venue	Nagoya University
Attendees	Mr. Imamura (N2U- BRIDGE) Igo, Tomiyama, Mutou (Pacific Consultants)
Contents	Visit the mock-up model for bridge inspection training

	
Explanation	**Facility**

(7) BMS for Municipality

Topics	BMS for Municipality
Date & Time	January 23rd, 2017 (Monday) 13:00 – 17:30
Venue	Yao City Hall (Osaka Prefecture)
Attendees	Mayor Tanaka, Mr. Matsui, Mr. Miyata, Mr. Nishio, Mr. Kaneko, Mr. Ooyama, Mr. Noguchi, Mr. Kako, Mr. Kuri (Yao City) Igo, Tomiyama, Tomi (Pacific Consultants)
Contents	BMS Operation and Bridge Inspection Site Visit in Municipality

	
Opinion Exchange	**Bridge Inspection Site**

(8) Bridge Inspection Site

Topics	Bridge Inspection Site
Date & Time	January 24th, 2017 (Tuesday) 14:00 – 16:00
Venue	Toami Viaduct
Attendees	Mr. Matsumoto (MILT) Igo, Tomiyama, Kyo, Mori (Pacific Consultants)
Contents	Check Concordance on site, RC Radar, Shmidt Hammer, etc.

	
Bridge Inspection	**NDT**

(9) Seismic Upgrading

Topics	Seismic Upgrading
Date & Time	January 25th, 2017 (Wednesday) 14:00 – 16:30
Venue	Bridges in Kyoto (incl. Nijyo Bridge under rehabilitation works)
Attendees	Mr. Iwakura, Mr. Mimura (Kansai Kasei) Igo, Tomiyama, Makata (Pacific Consultants)
Contents	Seismic Upgrading Work Site Visit

	
Site Visit	**Group Photo**

(10) Bridge Management in Urban Highways

Topics	Bridge Management in Urban Highways
Date & Time	January 26th, 2017 (Thursday) 10:00 – 16:00
Venue	Hanshin Expressway
Attendees	Ms. Kawakami, Mr. Tamagawa (Hanshin Expressway) Mr. Kuge (JICA) Igo, Tomiyama, Miyamoto, Kyoku (Pacific Consultants)
Contents	Bridge Management in Urban Highways Deteriorations in Urban Highway and Damages by Earthquake Disaster Museum Visit

	
Lecture	**Disaster Museum**

(11) Bridge Repair Work Site Visit

Topics	Bridge Repair Work Site Visit
Date & Time	January 27th, 2017 (Friday) 10:00 – 12:00
Venue	Terada Viaduct
Attendees	Mr. Konishi (MILT) Mr. Nakaya, Mr. Okabe, Mr. Kida (Sho Bond) Mr. Kuge (JICA) Igo, Tomiyama, Tomi, Nagata, Yaguchi (Pacific Consultants)
Contents	Bridge Repair Work Site Visit Repair Work Methods Repair Materials

Site Visit

Materials and Methods

2.2.5 Seminar

Seminar were originally considered for the purpose of not only the transfer of technology to NHA staff but also the dissemination and utilization of the results of the Project to those in the bridge maintenance field in Pakistan (repair/strengthening design companies, construction companies, material manufacturers, etc.). However, the number of participants in the Master Trainer Training was increased in accordance with the C/P's requests that NHA staff should be educated on bridge maintenance and management, and it was decided through discussion to focus on the Master Trainer Training, BMS Training, etc. rather than seminars.

Table 2-73 Seminar Plan (at the time of the Proposal)

Session	Expected Time of Year	Times
Basics of Bridge	2016, November	2
	2017, November	2
Bridge Maintenance Cycle	2016, November	2
	2017, November	2
Bridge Inspection / Evaluation	2017, May	2
	2017, September	1
	2018, June	2
Bridge Repair/Strengthening	2017, May	2
	2017, September	1
	2018, June	2
Bridge Management Database（BMS）	2016< November	1
	2017, May	1
	2017, December	1

	2018, June	2
	2018, September	2
Total		25

Table 2-74 Trainings Implemented

No.	Training Title	Duration	Days	Location	Participants
1	Training in Japan	2017/1/16~2017/1/27	12	Japan	2
2	Master Trainer Training 1	2017/2/27~2017/3/3	5	HRTC, site	16
3	Master Trainer Training 2	2017/3/6~2017/3/10	5	HRTC, site	20
4	Master Trainer Training 3	2017/3/13~2017/3/17	5	HRTC, site	29
5	Feedback Training	2017/7/25~2017/7/25	1	Auditorium	8
6	OJT for BMU	2018/1/16~2018/1/31	16	Project Room	3
7	BMS Training (Inventory Survey)	2018/2/1~2018/2/2	2	Auditorium, site	24
8	OJT for BMU	2018/2/5~2018/2/6	2	Project Room	3
9	Additional BMS Training	2018/2/7~2018/2/7	1	Auditorium	12
10	OJT for BMU	2018/2/8~2018/4/13	65	Project Room	3
11	BMS Training (Bridge Inspection)	2018/4/16~2018/4/20	5	HRTC, site	17
12	OJT for BMU	2018/4/23~2018/5/9	17	Project Room, site	3
13	OJT for BMU	2018/6/26~2018/8/8	44	Project Room	4
14	BMS Software Training	2018/8/9~2018/8/10	2	M/P Meeting Room	6
15	OJT for BMU	2018/8/28~2018/9/19	23	Project Room	4
16	Bridge Mechanics Study	2018/9/12~2018/9/17	4	M/P Meeting Room	10
17	OJT for BMU	2018/10/2~2018/10/17	16	Project Room	4
18	OJT for BMU	2018/10/30~2018/12/12	44	Project Room	4
	Total Training (man-days)		554		

	Total OJT (man-days)	808

Apart from the above, a seminar was held on December 10, 2018 to report on BMS and BMU activities.

An explanation was given of the Project content, progress; manuals for bridge / culvert inspection, repair, and data input to the bridge inspection database; BMS software; future plans; priorities; and budget allocation. Technology transfer and dissemination on bridge maintenance and management were implemented.

2.2.6 Public Relations

(1) Public Relations in Pakistan

For public relations regarding the Project in Pakistan, a draft brochure had been prepared by gathering opinions and reviews and had been referred to the JCC; but the Project Coordinator was not able to get the approval of the Chairman in NHA. As a result, the brochures have never been printed.

(2) Public Relations in Japan

The Training in Japan activities were featured on the website of Yao City.

橋梁維持管理に関する八尾市での取り組み研修会

［2017年2月21日］

パキスタン・イスラム共和国「橋梁維持管理に関する日本での取り組みに係る本邦研修」

パキスタンでは運輸インフラの整備が経済成長を支える上での重要な要素の一つとして取り組まれています。しかし、定期的な点検等が行われておらず、損傷が発見された時点では、既に補修による対応が困難な状況であり、新たな橋梁を建設せざるを得ないケースが生じていることから、橋梁維持管理計画の策定が喫緊の課題となっています。

そこで、JICAが実施する研修にてパキスタンより国の職員2名が来日され、国道事務所、高速道路会社、日本の民間コンクリート会社、国立大学等を視察されるなか、日本の地方自治体の橋梁維持管理の取り組み状況について学ぶことを目的に、今回、八尾市に訪問されることになりました。

意見交換会では、八尾市の橋梁維持管理の取り組み等について、活発な意見交換があり、特に限られた財源と人員のなかでの点検業務や修繕工事を行う上での組織体制、橋梁の維持管理計画についての質問等がありました。また、現地視察では、地方自治体の特徴である小規模橋梁の修繕方法について、興味深く質問されました。

日　時：平成29年1月23日（月） 13:00～17:15
場　所：八尾市役所本館6階601A会議室
内　容：意見交換及び現地視察
参加者：パキスタン職員
　　JICA研修監理員
　　コンサルタント会社
　　八尾市 都市整備部

●概要
1. 意見交換
　・八尾市の橋梁維持管理について
2. 現地視察
　・天神橋（長瀬川）　L=8.8m　※修繕後
　・電光橋（長瀬川）　L=7.5m　※修繕後
　・竜華38号橋（市内水路）　L=3.4m　※修繕前

●意見交換
　・計画策定から修繕工事まで、丁寧に取り組まれている。
　・橋梁台帳システムによる点検・修繕記録がしっかりできており、日本での良い事例を見ることができた。
　・日本での視察において、インフラ施設が壊れているのを見たことがなく、管理がしっかりとできている。

八尾市長への表敬の様子その1

八尾市長への表敬の様子その2

意見交換の様子その1

意見交換の様子その2

橋梁台帳システムの説明

現地視察（天神橋）その1

現地視察（天神橋）その2

現地視察（電光橋）その1

現地視察（電光橋）その2

2.2.7 Questionnaires

(1) Maintenance Staff

The JICA Expert Team requested the C/P to collect questionnaires from maintenance staff throughout Pakistan, but none of questionnaires had been collected until October 17, 2016 when ten (10) staff from the Regional Offices and Maintenance Units were invited to the small auditorium in NHA headquarters on in order to exchange opinions on bridge maintenance. At that time, a quiz on bridge maintenance was also held in order to check their knowledge of bridge maintenance and management.

The issues noted were as follows;

(a) Educational background

Most of the attendees had undergraduate degrees. According to the results of the questionnaire, their knowledge on bridge maintenance was insufficient. It was found that structural mechanics was usually studied during the master's course and that some post-graduate

engineers had a certain amount of knowledge on bridge engineering/structural mechanics.

(b) Experience in bridge maintenance

Bridge inspection had not been implemented since the nationwide implementation in 2008. As most of the repair/maintenance works by the NHA were countermeasures to issues found in daily patrols, most staff had insufficient experience in bridge inspection.

(c) English skills

As the English skills of more than 90% of the staff were declared to be “Good” or better, there would be no problem in English being used in the training.

(d) Regarding PCs

Only 40% of the attendees occasionally used a PC. However, it was considered that they had the capability to input data and to use Word, Excel etc. One of the reasons was presumed to be that possession of a personal computers was not so common.

The issues clarified for the Master Trainer Training were summarized as follows;

i) Training in English was considered to present no problem.
ii) Basic knowledge, such as bridge design, should be added to the training.
iii) Since it was anticipated that basic knowledge in bridge maintenance was insufficient, training should start from 101.
iv) Data input of the bridge inspection data was presumed to be no problem, but this would need to be confirmed in the training.

(2) Questionnaire at the 1st training in Japan

The results of the questionnaire given by the JICA to two (2) participants in the Training in Japan over the twelve (12) days from January 16th to 27th, 2017, generally confirmed that the training was effective. On this basis, the JICA Expert Team considered the strategy for future training.

(3) 1st Master Trainer Training

Participants were given questionnaires twice, at the beginning and at the end of the 1st Master Trainer Training, held from February 27th and March 17th, 2017.

Typical opinions are given below.

(a) The training period (1 week) was either too short or too long.
(b) Summary and Q & A should be handled by local staff.
(c) Lectures in Urdu by Pakistani instructors were desired.
(d) Utilization of videos (visual training materials).
(e) Arches and culverts should be included in the training.
(f) Training for Inspectors is necessary.
(g) Ultrasonic strength testing (sonic integrity, pile quality check test) should be included.
(h) Too many participants (trainees).
(i) Bridge design should also be included.
(j) Standardization for relevant countermeasures at NHA-HQ is important.
(k) Separate manuals for steel and concrete, and one manual for inspection and repair.
(l) No outcome can be realized unless the Master Trainer gets extra benefits.
(m) Maintenance Units in charge can be aware of damages by referring to the training materials.

(4) Regional Office

The visit to Punjab North Regional Office (Lahore) was held on April 9, 2018.
Typical opinions were as follows.

(a) Bridge repair works are procured by the Regional Office. The yearly repair/rehabilitation are need-based.
(b) Member (Central Zone) forwarded the engineer's report and estimate to the headquarters and then Regional/Zonal Office procured and supervised following the approval by Member (Planning), the Chairman, and the NHA Executive Board.
(c) Consultants are also hired for design review and supervision of periodic maintenance works.
(d) Repairs of severe damage to bridge/culvert are outsourced to a Structural Expert but procured in the Regional Office and supervised by the field staff.

(5) BMS training

The BMS Training (Bridge Inspection Training) was held from April 16th to April 20th, 2018. Participants were given questionnaires twice, at the beginning and at the end of the training.
Typical opinions were as follows;

(a) BMS Software and techniques are used worldwide for bridge management.
(b) Future implementation of damage rectification and cost evaluation of damage was not covered.
(c) More time should be given to the field survey, and the survey equipment should be improved.
(d) The participants should be provided with the software as the content is based on software.

3. Internal Terminal Evaluation

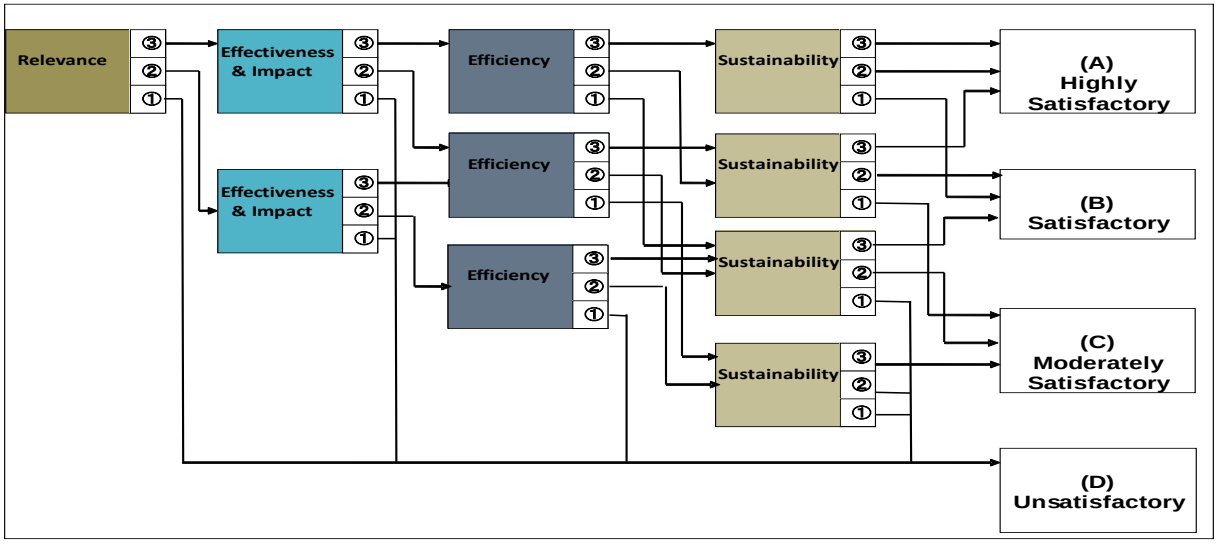
3.1 Objectives and methods

The Project will be terminated in April 2019. Thus, the NHA and the JICA Expert Team jointly conducted the Internal Terminal Evaluation for two weeks from January 14, 2019. The objectives of the Terminal Evaluation were as follows:

- Confirm the achievement of the Project as per the PDM;
- Assess the implementation process;
- Assess the Project based on the five evaluation criteria of relevance, efficiency and effectiveness, impact, and sustainability by referring to a rating flowchart of JICA's Ex-post Evaluation on a three-level scale; ①low, ②fair and ③high (See Table 3-1 and Figure 3-1);
- Make recommendations to be implemented by the end of the Project and after the termination of the Project; and
- Obtain lessons learned from the Project for better implementation of other projects.

Table 3-1 Five Evaluation Criteria

Relevance	Relevance refers to the validity of the Project Purpose and the Overall Goal in accordance with the policy direction of the Government of Pakistan and the NHA, and the Japanese Official Development Assistance as well as needs of beneficiaries and target groups.
Efficiency	Efficiency refers to the productivity of the implementation process, examining if the inputs of the Project were efficiently converted into the Output.
Effectiveness	Effectiveness refers to the extent to which the expected or desired outputs have been achieved as planned and examines if the outputs were produced by the Project.
Impact	Impact refers to direct and indirect, positive and negative impacts caused by implementing the Project, including the extent to which the Overall Goal has been attained.
Sustainability	Sustainability refers to the extent to which the NHA side can further sustain and strengthen the Project effects in the policy, organizational, institutional, financial and technical aspects.



Note: ①low, ②fair, ③high

Figure 3-1 Rating Flowchart of Ex-Post Evaluation

The Project formed the Internal Terminal Evaluation Task Team (hereinafter the "Task Team") comprising two members from the Director of Public and Private Partnership, NHA and the JICA Expert on Monitoring 2. The Task Team used the evaluation methods described below. The Terminal Evaluation consists of the following three parts: 1) Achievement and prospect of the Project; 2) Implementation process; and 3) Evaluation based on the five evaluation criteria (See Appendix 5.1 Evaluation Grid). Here are the detailed tasks in the evaluation.

- Reviewing PDM Version 1 to Version 6 (See 4.2 History of PDM Modification)
- Reviewing Project reports and other related documents including the official request form for the Project, M/M of the Detailed Planning Surveys,[18] R/D, monitoring sheets, MM of JCC meetings and others)
- Distributing and analyzing questionnaires for 8 stakeholders,[19] i.e., 3 C/Ps and 5 JICA Experts
- Interviewing 26 stakeholders such as NHA General Manager (GM) of the Road Asset Management Division (RAMD), 3 C/Ps of the BMU, IT engineer, JICA Advisor and Officer in charge of the Project of the JICA Headquarters, JICA Representative in charge and Senior Program Officer of the JICA Pakistan Office, GM (Maintenance) of the Punjab North Regional Office (RO), Deputy Director (DD) of the Lahore Maintenance Unit (MU), DD of the Wazirabad MU, ADs and Inspectors of the Rawalpindi MU, Executive Director of the Highway Research and Training Center (HRTC), 8 Trainee Engineers, and Chief Advisor of the JICA Expert Team
- Discussion in the Task Team
- Presentation of the evaluation results for the C/Ps, the JICA Expert Team and the JICA, and discussion among the stakeholders

[18] JICA conducted the Detailed Planning Surveys in May and July 2012. There is no description of the Ex-ante Evaluation for the Project in its report.
[19] The Task Team did not distribute the questionnaires for IT engineer who has newly jointed the Project since October 2018, and the JICA Experts whose assignment period in Pakistan was less than 1M/M.

3.2 Review of PDM

The Task Team reviewed PDM Version 1 of the attachment of R/D up to the latest one, i.e., PDM Version 6. The PDM has been revised twice.[20] Both the Project Purpose and a few Outputs were revised, and the numerical target value of Indicators were clearly set. However, PDM Version 6 has the following drawbacks.[21]

- Indicator 1 of the Project Purpose was described as "bridge maintenance plan with breakdowns for the model area prepared." The Project aimed to cover only 36 bridges and 5 culverts, not all the bridges and culverts, in the model area. This should have been clearly stated in Indicator 1.
- Output 2, i.e., "Bridge/culvert inspection in the model area is implemented after BMS training," reads as if it refers to a single activity. It should have been worded in such a way that it clearly refers to a series of activities.
- The Indicators of all the three Outputs are exactly the same as the Activities, which are means of achieving these Outputs.
- There is an overlap between a part of Output 3, i.e., "bridge maintenance plan is prepared," and the Project Purpose, i.e., "annual bridge maintenance plan is prepared." It is difficult to understand the difference between Output 3 and the Project Purpose because the same Indicators were set for both.
- "BMS is continuously in use by NHA for preparation of bridge maintenance plan" and "BMS organization is gradually established in NHA, who will implement BMS in a sustainable manner" are set as the Important Assumptions for achieving the Outputs. They do not constitute a proper logic of PDM for achieving the Overall Goal.

The Task Team evaluated the Project based on PDM Version 6 and comprehensively assessed the achievement of the Indicators above with shortcomings by comparing the original plan to the actual performance (See: Appendix 2. Project Design Matrix, 2.4 (6) Version 6 (3 December 2018)).

[20] The Project updated its PDM every time when it submitted a Monitoring Sheet to JICA. The latest PDM should be known as Version 3, not "Version 6," because the PDM has been revised twice since the commencement of the Project.

[21] According to the JICA stakeholders and the JICA Expert Team, the NHA did not agree the drastic change of the summary of the PDM during the second revision of PDM although JICA proposed to state "NHA's capacity to inspect bridge is enhanced" as the Project Purpose.

4. Achievement of the Project

4.1 Achievements Confirmed

4.1.1 Outputs and Indicators

The degree of the achievement on each output is described below.

Output 1:	**Manuals, Database and BMS developed for bridge inspection and bridge repair.**

The following are the indicators to assess the achievement of Output 1.

Indicator 1-1	**Draft manuals for 1 bridge inspection by December 2016, for 2 bridge repair by December 2016 and for 3 data input developed by December 2017.**

Indicator 1-1 has been already achieved. The JICA Expert Team developed the draft manuals for (1) bridge inspection in December 2016, (2) bridge repair in December 2016, and (3) data input manual (later renamed as the BIDB operation manual) in December 2017, respectively. In addition, the team drafted the BMS software operation manual in August 2018 and the BMS software administration manual in November 2018.

Indicator 1-2	**Draft bridge/culvert inspection formats developed by December 2016.**

Indicator 1-2 has been already achieved. The JICA Expert Team developed the draft bridge/culvert inspection formats in December 2016.

Indicator 1-3	**Prototype Database developed by July 2017, and prototype BMS by December 2017.**

Indicator 1-3 has been already achieved. The JICA Expert Team developed the network-based Bridge Inspection Database (BIDB) software in July 2017. The team also developed a prototype of the Excel-based BMS software in December 2017 and BMS software in August 2018. Development of this BMS software with the prioritization function was newly added as Activity 1-3 under Output 1 in PDM Version 2 after the commencement of the Project because the former BMS software (Smart Bridge) developed by the World Bank did not have such function.

Indicator 1-4	**2 types of draft training materials for 1 bridge/culvert inspection and 2 bridge repair developed by December 2016.**

Indicator 1-4 has been already achieved. The JICA Expert Team developed draft training materials for (1) bridge/culvert inspection and (2) bridge repair in February 2017.

Indicator 1-5	**Manuals, formats, Database & BMS, and training materials finalized by September 2018.**

Indicator 1-5 has been already achieved. By October 2018, the Bridge Management Unit (BMU) reviewed and finalized the manuals, the formats, BIDB and BMS, and the training materials.

Summary of Output 1

All the activities under Output 1 have made good progress. At the time of the Terminal Evaluation, all the five Indicators of Output 1 have been already achieved. **Thus, Output 1 has been achieved.**

Output 2:	**Bridge/culvert inspection in the model area is implemented after BMS training.**

The following are the indicators to assess the achievement of Output 2.

Indicator 2-1	**On-the-job-training (OJT) by JICA Expert Team which enables BMU to implement BMS in NHA by December 2018.**

Indicator 2-1 has been already achieved because the JICA Expert Team has provided a series of OJT activities such as revision of manuals and training materials, planning for the Inventory Survey to BMU staff members**. However, Indicator 2-1 is not relevant for directly assessing whether bridge/culver inspection in the model area is implemented.** OJT, which is one of the means for enhancing the capacity of the BMU to implement BMS, was undertaken as Activity 2-1.

Indicator 2-2	**Inventory Survey, Bridge Inspection and Data Input Training for NHA engineers.**

The Indicator 2-2 has been achieved because BMU implemented Inventory Survey Training in February 2018, and Bridge Inspection Training in April 2018 with the support of JICA Expert Team. Nevertheless, Indicator 2-2 is also not relevant for measuring the achievement of Output 2 directly. The training programs mentioned in Indicator 2-2 were carried out as Activity 2-2.

Indicator 2-3	**Bridge/culvert inspection, bridge repair and data input to Database completed in the model area including the representative 36 bridges and 5 culverts by October 2018.**

Indicator 2-3 has been already achieved. After the pattern analysis, the JICA Expert Team and the BMU selected 36 bridges and 5 culverts for periodic inspection with priority in the model area because these bridges and culverts can cover almost all other categories and patterns. Accordingly, the Project set the target value of Indicator 2-3. From February to April 2018, the BMU and the Trainee Engineers conducted the Inventory Survey of these bridges and culverts. After the training on bridge inspection, the BMU and the Trainee Engineers inspected them from May to July 2018. In September 2018, they input the results of inspection to BIDB. At the time of the Terminal Evaluation, the BMU has just completed the Inventory Survey for all 45 bridges and 100 culverts in the non-model area, i.e., the Lahore MU under the jurisdiction of the Punjab North RO. In addition, it has begun to inspect some of the accessible 31 bridges out of all 74 bridges in the Rawalpindi MU by mobilizing the Trainee Engineers.

Indicator 2-4	**The results of bridge repair method selection and data input to a bridge inspection database for model area evaluated to be accurate by BMU & JICA Expert Team by October 2018.**

Indicator 2-4 has been already achieved. In October 2018, the BMU and the Trainee Engineers reviewed and modified the inspection results and the data based on the advice of the JICA Expert Team. In November 2018, the JICA Expert Team confirmed the accuracy of all the data.

Summary of Output 2

Output 2 has been achieved because all Indicators have been achieved. It should be noted that Indicator 2-1 and Indicator 2-2 are not relevant for measuring the achievement of Output 2 directly. They were undertaken as Activity 2-1 and 2-2.

Output 3:	**Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.**

The following are the indicators to assess the achievement of Output 3:

Indicator 3-1	**BMS Software Training for BMU by December 2018.**

Indicator 3-1 has been already achieved. In August 2018, the JICA Expert Team carried out training on BIDB and BMS, and follow-up training for BMU. According to the C/Ps, these training programs helped them manage the bridge data of the model area.

Indicator 3-2	**Analysis of Bridge Inspection Data of the model area included in Bridge Inspection Database (BIDB) using BMS Software.**

Indicator 3-2 has been already achieved. The BMU, in cooperation with the local consultants, prepared Composite Schedule of Rates (CSR) to estimate the budget for approximate repair cost in BMS Software. Moreover, in October 2018, the BMU analyzed and prioritized the bridge inspection data of the model area in BIDB using the BMS software. Based on the experiences and practices in Japan, the JICA Expert Team proposed the draft repair priority of the bridge inspection data in the model area. Based on the results of the analysis above, the BMU finalized the repair priority list of the bridge inspection data of the model area.

Indicator 3-3	**Bridge maintenance plan as part of Annual Maintenance Plan, with repair methods and cost estimate for structures in model area including typical 36 bridges and 5 culverts is formulated.**

Indicator 3-3 has been achieved because the BMU formulated a bridge maintenance plan for 36 bridges and 5 culverts in the model area with the technical support of the JICA Expert Team. **It should be noted that this Indicator 3-3 is the same as Indicator 1 of the Project Purpose** (See 4.1.2 Project Purpose and Indicator). Output 3 should have been set as “bridge data in the model area are available for use in the BMU at the headquarters” because of an overlap between the latter part of Output 3, i.e.,

bridge maintenance plan is prepared, and the Project Purpose.

Summary of Output 3

There is an overlap between the latter part of Output 3 and the Project Purpose. Indicator 3-3 is the same as Indicator 1 of the Project Purpose. Output 3 should have been set as "bridge data in the model area are available for use in the BMU at the NHA headquarters." Indicator 3-1 and Indicator 3-2 have been achieved. **Thus, it is fair to say that Output 3 has been achieved.**

4.1.2 Project Purpose and Indicator

Project Purpose:	**Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.**

The status of each verifiable indicator is presented below.

Indicator	**Bridge maintenance plan with breakdowns for the model area prepared by November 2018.**

The Indicator above has been achieved. The Project has intended to prepare the bridge maintenance plan for 36 bridges and 5 culverts in the model area. This should have been clearly described in Indicator 1. In November 2018, the BMU prepared the draft bridge maintenance plan and calculated the budgetary request for the following three cases: 1) all the repairs are to take place in the cycle of five years; 2) most critical elements are to take place; and 3) repairs of Ep, Es, and Cs classified are to take place.

Summary of the Project Purpose

The Project has intended to prepare the bridge maintenance plan for 36 bridges and 5 culverts, not all the structures, in the model area. This should be clearly described in the Indicator. **Because the Indicator of the Project Purpose has been achieved and all three Outputs have been also achieved, the Project Purpose has been already achieved.**

4.2 History of PDM Modification

The major variations in PDM (Project Design Matrix) are shown in Table 4-1.

Table 4-1 Major Variations in PDM

Date	2016/7/14	2017/1/14	2018/8/9
PDM version	Version 1	Version 2 amended	Version 5 amended
Overall Goal	Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Bridge inspection & maintenance status improved on the bridges of National Highways in the model area.
Objectively Verifiable Indicators	Average bridge damage value, calculated by the existing BMS (Smart Bridge), decreased by XX% in [January, 2022] from the start of the Project.	Based on the bridge data, the number of bridge structures in the worst condition has decreased by one-third in [January, 2022] from the start of the Project.	1) The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan. 2) In the model area, more than [65] bridges are annually inspected and the bridge maintenance plan is annually revised.
Project Purpose	Cost estimate necessary for bridge maintenance every fiscal year implemented on the basis of bridge inspection results of the bridges on National Highways in Pakistan.	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of entire NHA Network.	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.
Objectively Verifiable Indicators	Bridge maintenance budget document with breakdowns prepared in [November, 2018].	Bridge maintenance budget document with breakdowns prepared by [September, 2018].	Bridge maintenance plan with breakdowns for the model area prepared by [November, 2018].
Output 1	Manuals and a database developed for bridge inspection and bridge repair method selection	Manuals, Database and BMS developed for bridge inspection and bridge repair method selection	Manuals, Database and BMS developed for bridge inspection and bridge repair.
Output 2	Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	Bridge/culvert inspection in the model area is implemented after BMS training.
Output 3	Data on all the bridges of National Highways in Pakistan input by MUs to the existing BMS (Smart Bridge) available to NHA's HQ and ROs.	Data on all the bridges of National Highways in Pakistan input by MUs to Database available to NHA's HQ and ROs.	Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.

4.3 Implementation Process of the Project

4.3.1 Framework for Project Management

(1) Overall management and progress of activities in the Project

As both the C/Ps and the JICA Expert Team acknowledged, the Project had not been smoothly implemented for the initial one and half years because of several factors including the following: 1) shortage of the C/Ps; 2) shortage of trained manpower in Maintenance Units and Regional Offices; 3) the original PDM that was less than feasible; and 4) much time needed for reaching mutual understanding between the C/Ps and the JICA Expert Team. After the establishment of the BMU and the change in target areas from the entire country to the model area, the Project improved its management and made much progress in its activities.

(2) Implementation structure

The Project established a JCC chaired by the Member (Engg.&Coord.) who was appointed as Person in Charge of the Project in accordance with the R/D. The General Manager of the RAMD was appointed as the Project Manager. Concerning the main C/P, the Deputy Director who is responsible for BMS was appointed as the Project Coordinator. Other C/Ps had not been assigned by the time of the establishment of the BMU because of the labor issues in the NHA.[22] The Project has organized the JCC meetings twice a year. The C/P and most of the JICA Experts have noted that the JCC meetings have enabled the participants to share the progress of Project activities, discuss the issues and countermeasures, and approve the scope of the work, the revision of the PDM, the PO, and monitoring sheets. Some C/P opined that the JCC meetings would have more productive discussions from diverse perspectives if not only internal Project stakeholders but also relevant external stakeholders such as other divisions of the NHA and experts from universities and local consultants participated in them. Several JICA Experts noted that there was room for improvement in JCC meetings because they took the lead in preparing, presenting, and following up on the meeting agenda in most of the meetings except the 6th JCC meeting in December 2018 in which the C/Ps actively participated and made a presentation with a sense of ownership. Other Experts also pointed out another problem that it often took two months to confirm and sign the M/M of JCC.

(3) Monitoring

The Project has monitored the progress of activities by the following means: 1) JCC meetings; 2) development of monitoring sheets every six months; and 3) weekly meetings using a “To Do List” between the C/Ps and the JICA Expert Team after the establishment of the BMU. A few C/Ps stressed the effectiveness of the “To Do List” that enabled the C/Ps and the JICA Expert Team to know exactly what has been done, what has not been done, and who should do what by when.

[22]According to the decision of the government, the NHA has been banned from recruiting its permanent staff since the end of 2011.

(4) Communication among Project stakeholders

The C/Ps and the JICA Expert Team have closely communicated with one another after the establishment of the BMU. For the initial one and half years, they often found it difficult to adjust their schedule because the C/Ps including the Project Coordinator, the Project Manager, and the Person in Charge were too busy with their routine tasks and other development partners' projects such as the China-Pakistan Economic Corridor (CPEC) to work with the JICA Expert Team during the latter's limited assignment duration. All the JICA Experts who filled out the questionnaire noted that they have smoothly communicated with one another in their team because they worked together in the same firm in Japan. The results of interview and questionnaire conducted by the Task Team also revealed that the JICA Experts have closely coordinated and communicated with the JICA Headquarters and the JICA Pakistan Office so that they have been able to share the progress and issues of the Project with these JICA stakeholders.

(5) Ownership of the implementing agency

It took time for the C/Ps and the JICA Expert Team to reach a consensus on the scope of the Project as well as the roles and responsibilities of the C/Ps and the JICA Expert Team, because it was the first time for the RAMD to participate in a JICA Technical Cooperation project. In the beginning, the RAMD was not clear about the JICA Technical Cooperation scheme in which the C/Ps need to take the lead in implementing activities to improve their own capacity while JICA Experts are not subcontractors of a project but serve as a coach to provide advice and technical support. Since the establishment of the BMU, the RAMD has been more actively involved in Project activities with a sense of ownership.

4.3.2 Sharing of knowledge and expertise and technical transfer

According to the C/Ps, their overall capacity related to BMS has improved through the OJT from the JICA Expert Team, a series of training programs in the Project and the training in Japan. They enhanced the following capacities in particular: 1) bridge and culvert inspection including damage assessment and condition evaluation; 2) bridge repair techniques and methods; 3) use of BMS software in storing and assessing bridge-related data; 4) development of bridge maintenance plans with prioritization; and 5) management of BIDB. The C/P greatly appreciated both the expertise and the ways of technical transfer and knowledge sharing from the JICA Expert Team because they obtained practical knowledge and know-how related to BMS. Regarding bridge repair, all the C/Ps felt that the manual on the matter was inadequate for increasing their capacities. They noted that, although it was beyond the scope of the Project, they should have acquired more practical knowledge on implementing bridge repair from the JICA Expert Team. Most of the Trainee Engineers were also of the same opinion. As the Trainee Engineers have been fully involved in using BMS software during bridge inspection, they have desired more advice and more technical support regarding BMS software directly

from the JICA Expert Team. The IT engineer of the Computer Bureau who has been involved in the Project activities as a C/P since October 2018 indicated that the JICA Expert Team should have provided technical transfer and training opportunities of BMS software which was completed before his joining. The GM of the RAMD emphasized that the NHA/BMU would like technical support from the JICA if problems on BIDB and revision of BMS software that the NHA could not solve emerged.

As for the ways of technical transfer in the Project, most of the JICA Experts noted that they developed the manuals related to BMS, the training manuals and BMS software based on the experiences and practices in Japan while considering the local context. Simultaneously, they have put much more emphasis on discussions with the C/Ps from various aspects. For example, in the specification logic of BMS, the JICA Experts presented several options based on the Japanese experiences, and encouraged the C/Ps to consider which of them would be suitable for the BMU/NHA. Such OJT approach helped increase not only the C/Ps' technical capacity but also their level of ownership for BMS. Several JICA Experts stated that they provided their expertise and shared their knowledge and experiences of BMS so that the C/Ps would be able to conduct necessary activities on their own after the termination of the Project. The C/Ps took sustainability of the Project seriously, which may help establish the BMU. On the other hand, several JICA Experts pointed out the following areas in which they should have done better: 1) much time needed to get the C/Ps to understand the concept of the Project; 2) much time needed to have a good relationship of trust with the C/Ps and understand what the C/Ps really think; 3) much time needed to recognize that the original PDM was different from the status of the NHA and its BMS; and 5) much time needed to stimulate the change in attitudes of C/Ps toward bridge maintenance and management.

5. Results of Joint Review

5.1 Results of Review based on the DAC Five Criteria

The Project conducted the Internal Terminal Evaluation from January 14 to January 28, 2019. The Task Team was formed, comprising two members from the Director of Public and Private Partnership, NHA and the JICA Expert on Monitoring 2 who were not directly involved in the Project. This Task Team took the lead in assessing the Project based on the DAC five criteria and discussed the results of the review with the C/Ps and the JICA Expert Team. The results of review based on the DAC five criteria are described below:

5.2 Relevance: High

(1) Consistency with the policies of the Government of Pakistan and the Government of Japan

The Project is consistent with "Pakistan Vision 2015," which emphasizes modernized infrastructure and strengthening regional connectivity as one of its seven priority areas. Pakistan Vision 2015 seeks to establish an efficient and integrated transportation system and sets key related targets including the following: to ensure reduction in transportation costs, safety in mobility, effective connectivity between rural areas and markets/urban centers, inter-provincial high-speed connectivity, integrated road/rail networks between hubs, and high capacity transportation corridors connecting major regional trading partners.

The Project is also in line with Japan's Country Assistance Policy for the Islamic Republic of Pakistan (2018) and the Official Development Assistance Rolling Plan of Japan for the Islamic Republic of Pakistan (2017). According to the policy and the plan, "improvement of economic infrastructure" is one of the three priority areas for assistance. The Project is a program of industrial development and investment environment development. Thus, the Project is consistent with these Japanese aid policies. The know-how and experiences of BMS in Japan with a focus on preventive maintenance management was applied to the Project.

(2) Consistency with the needs of the NHA

Although the approximate 5,000 bridges and 16,000 culverts on the National Highway have the risks of premature deterioration and damage due to such factors as increased traffic volume, rampant overloading, and poor design and construction, maintenance plans have yet to be formulated and periodic inspection has never been carried out effectively. Thus, it was urgent for the NHA to strengthen bridge maintenance and management using BMS with a focus on preventive maintenance management. Therefore, the Project meets the needs of the NHA to improve its capacity to implement BMS appropriately.

(3) Appropriateness of project plan and approach

The Project Purpose in the original PDM was to enable the NHA to implement cost estimation for annual bridge maintenance based on inspection results of all the bridges on National

Highways in the entire country. For achieving this Project Purpose, the following three Outputs were set: 1) development of manuals and database for bridge inspection and repair methods selection, 2) involvement of engineers of the NHA headquarters, and all ROs and MUs as Master Trainers of BMS Training; and 3) use of the existing BMS (Smart Bridge). Many engineers had to be trained in a short period, and had to complete the inspection of 5,000 bridges and 16,000 culverts on National Highways in the entire country within the two and half years of the Project duration. However, the above Project Purpose, Output 2 and Output 3 had to be changed through the revisions of the PDM in January 2017 and August 2018. The main reasons are as follows: assigning only one C/P who is responsible for BMS at the NHA headquarters; shortage of trained manpower in ROs and MUs; and breakdown of the existing BMS. The reports of the JICA Detailed Planning Surveys in May and July 2012 imply that the Ex-Ante Evaluation was not carried out. It should have been undertaken during these Surveys to examine carefully the feasibility and validity of the scope of work including the Project Purpose and the approach.

The PDM was modified twice. Development of BMS software was added to Output 2. The Project Purpose and the target areas were also changed from the entire country to the model area, focusing on some of the bridges and culverts under the jurisdiction of the Rawalpindi MU and the Wazirabad MU in the Punjab North RO. The changed approaches of involvement of young and dedicated Trainee Engineers in carrying out inventory survey and bridge inspection in the model area on a pilot basis were considered as relevant because the bridge maintenance plan based on the analysis of bridge inspection results in the model area can introduce preventive maintenance management using BMS. In addition, the know-how and experiences of BMS in Japan have been reflected to this Project.

5.3 Effectiveness: High

(1) Degree of the achievement of the Project Purpose

The Project Purpose has been already achieved by the time of the Terminal Evaluation because Indicator 1 has been already achieved.

(2) Contribution of Outputs

It is fair to say that the achievement of all the three Outputs have contributed to the attainment of the Project Purpose although the description of Output 3 in the PDM partially overlapped with that of the Project Purpose.

The Project has newly developed BMS at the NHA headquarters. More specific effects include the following: 1) development of BMS and other related manuals; 2) development of training manuals concerning BMS; 3) development of BIDB and BMS software; 4) enhancement of the capacity of BMU staff and Trainee Engineers; and 5) development of the bridge maintenance plan of the model area focusing on 36 bridges and 5 culverts.

(3) Influence of Important Assumptions from the Outputs to the Project Purpose

The Important Assumptions were set twice as follows: NHA arranges adequate human resources for BMS implementation, and NHA allocates enough budget to maintain and repair prioritized implementation of activities. The first Important Assumption in particular has influenced the achievement of the Project Purpose to some extent. That is because the C/Ps including additional engineers have become more actively involved in the Project activities with a sense of ownership since the establishment of the BMU although the JICA Expert Team has mostly taken the lead in implementing them. Other factors except for the Important Assumptions will be indicated later (See "5.6 Contributing Factors for Generating Effects").

5.4 Efficiency: Fair

(1) Degree of the achievement of the Outputs

The three Outputs have been already achieved.

(2) Project Period

The duration of the Project was extended by three months to 34 months because of relative lack of progress of the Project in the initial one and half years, based on the discussions including the change in the Project Purpose between JICA and the NHA during the JICA Consultation Mission in April 2018. The both parties amended the R/D and approved it on October 16, 2018.

Table 5-1 Project Period

	Plan	Achievement
Project Period	July 12, 2016－January 21, 2019 (31 months)	July 12, 2016－April 26, 2019 (34 months)

(3) Efficiency of the Inputs from the Japanese side

The number of JICA Experts has increased from seven to nine mainly because BMS software needs to be newly developed. The total person-months were 58.85, which is a 19% increase from the Plan.

JICA allocated 27.67 million yen for the cost of operation in Pakistan, such as implementation of training and other activities, employment cost for one administrative staff member, and others including training in Japan, costs of equipment, subcontracting in Japan, and costs of report printing and public relations. Such actual costs borne by JICA exceeded the Plan by nearly 0.6%. Although the cost for the subcontracting for software programming in Japan was planned and borne by JICA, the costs of equipment items such as the non-destructive testing equipment and those of training in Japan were reduced because of the cancellation of provision of these inputs based on a series of discussions between the NHA and JICA (See "2.1.1 Input by the Japanese side").

Table 5-2 Inputs from the Japanese side

	Plan	Achievement*
Experts	7 people（4 6.34M/M）	9 people（5 3.85M/M）
Program budget**	27.51 million yen	27.67milion yen
Equipment	15.45 million yen	2.56 million yen
Training in Japan (Number of Trainee Received)	2 times	1time (2 participants)

Note: *It includes the achievement as for January 2019 and the expected achievement, i.e., the estimated budget from February to April 2019.
**It includes the cost of equipment, training in Japan, subcontracting for software programming in Japan and others.

(4) Efficiency of the Inputs from the Pakistani side

Six people including the Person in Charge and the Project Manager were assigned as C/Ps at the time of the Terminal Evaluation. Nine people in total have been so far involved in the Project as C/Ps, and three of them left the Project because of personnel transfer and retirement. Prior to the Project, the NHA planned to deploy two main C/Ps such as the Project Coordinator and the Assistant Coordinator of the RAMD, but it assigned only the Project Coordinator for the initial one and half years. Since the establishment of the BMU in January 2018, the number of main C/Ps has increased from one to four.

As planned, the NHA has borne around PKR 9.15 million for the Project to cover such items as the salary, travel allowance, and daily allowance of Trainee Engineers, transportation and drivers' travel allowance and daily allowance for bridge inspection, furniture for the JICA Expert Team's room, survey equipment, and others. These expenditures were allocated from the NHA's regular budget (See 2.1.2 Inputs by the Pakistani side).

Table 5-3 Inputs from the Pakistani side

	Plan	Achievement
Counterparts (C/Ps)	4 people （M ain C/Ps: 2 people）	6 people at present (Main C/Ps: 4 people) So far 9 people involved
Cost borne:	Only items to be covered by the NHA were stated	PKR 9.15milliion (Approximately 9.15 million yen) *
Facilities:	Office space with furniture, internet and telephone	Office space with furniture and internet

Note: *It includes the furniture for JICA Expert Team's room, salary, daily allowance, and travel allowance for Trainee Engineers, and others.

(5) Causal relationship

As described before, after the changes in the Project Purpose, Output 2 and Output 3, as well as the establishment of the BMU with the three C/Ps and one IT engineer, the activities were smoothly implemented and transformed to the respective Outputs.

(6) Influence of Important Assumptions from the Activities to the Outputs

Three Important Assumptions were set from the Activities to the Outputs, and one of them, i.e., “BMU is established in NHA headquarters,” has largely influenced the implementation of Project activities and the efficiency of the Project. Other two Important Assumptions such as “BMS is continuously in use by NHA for preparation of bridge maintenance plan” and “BMS organization is gradually established in NHA, who will implement BMS in a sustainable manner” should have been set as the higher-level Important Assumptions from the Project Purpose to the Overall Goal.

(7) Influence of Pre-Conditions

As the Pre-Conditions of the PDM, “Pakistan, especially Islamabad and Lahore, is continuously safe enough for the JICA Expert Team to implement the activities” was set. This pre-condition was met.

(8) Contributing and hindering factors that have influenced the efficiency of the Project

The following factors affected the efficiency of the Project in its initial one and half years: 1) shortage of C/Ps; 2) limited involvement of C/Ps in Project activities; 3) limited coordination and communication; 4) time-consuming process to reach a consensus; and 5) lack of trained manpower of BMS in ROs and MUs. As countermeasures for the above, the Project Purpose and the target area were changed together with the changes in the approach from training and mobilizing Master Trainers in the whole country to establishing the BMU at the headquarters and involving the Trainee Engineers in the model area. As described above, the duration of the Project was extended by three months.

The following factors considerably helped to increase the efficiency of the Project from January to December 2018: 1) establishment of the BMU; 2) deployment of C/P in the BMU; 3) change in the target area from the whole country to the model area; 4) employment and involvement of Trainee Engineers by the NHA in undertaking the inventory survey and bridge inspection; and 5) extension of the entire duration of the Project by three months.

5.5 Impact (Prospective): High

(1) Prospects for the achievement of the Overall Goal

The Overall Goal is likely to be achieved if the activities in the Short-, Medium- and Long-Term Plans are undertaken as planned.

(2) Influence of Important Assumptions from the Project Purpose to the Overall Goal

The following two Important Assumptions were set: “Availability of optimum maintenance budget” and “Continuous update of bridge data.” These Important Assumptions are likely to influence the achievement of the Overall Goal in the future.

(3) Ripple effects

The following positive signs towards the achievement of the Overall Goal have emerged: 1) establishment of the BMU based on the recommendation by the Project and the consultation by the JICA Headquarters and the JICA Pakistan Office; 2) approval of three manuals such as Manuals for Bridge Inspection, Bridge Repair and BIDB developed by the Project and Standard Operating Procedures (SOP) developed by the BMU from the NHA Executive Board; and 3) development of the Short-, Medium- and Long-Term Plans of BMS implementation by the BMU.

5.6 Sustainability (Prospect): Fair

(1) Policy aspect: High

Based on a recommendation of the JICA Expert Team, the NHA/BMU decided to implement bridge inspection once every five years, which is the same policy as the one in Japan. Moreover, the NHA/BMU firmly set a policy to take the lead in conducting an inventory survey and bridge inspection at the headquarters by mobilizing Trainee Engineers for a certain period and simultaneously outsourcing these activities to consultants based on their Short-, Medium- and Long-Term Plans.

The above policy is likely to be sustained because the BMU has already begun to undertake activities such as conducting an inventory survey and bridge inspection in the model area and a few non-model areas and drafting the terms of reference for consultants.

(2) Organizational aspect: Fair to High

The BMU was established with three engineers to keep implementing BMS, which is expected to play a key role in ensuring the sustainability of the Project. Furthermore, the NHA renewed the one-year contract of the existing eight Trainee Engineers up to February 2020 and finished interviewing four prospective Trainee Engineers. These initiatives of the NHA contributed to enhancing the sustainability in the organizational aspect and are likely to continue after the completion of the Project.

On the other hand, a few concerns remain. Insufficient trained manpower at the BMU/NHA is still a major issue. One IT engineer who has been partially involved in the Project as the C/P has yet to be deployed officially as a member of the BMU; he is still working in the Computer Bureau of the NHA headquarters. It is more convenient and effective for both the BMU and this IT engineer to work together for maintaining BMU software and managing its server. Furthermore, the BMU runs a risk of losing its trained Trainee Engineers. It may be difficult for some of them to keep working for the BMU because their contract is for one year without any insurance, and the title of “Trainee Engineer” undermines their morale. For example, they sometimes faced difficulties in obtaining necessary support for arranging vehicles from the administrative section of the headquarters and even MUs and ROs immediately, because other stakeholders tended to consider the Trainee Engineers as administrative staff members working for a short-term period and did not take their request

seriously. Two Trainee Engineers already left the BMU during the implementation of the Project because they found better and permanent job opportunities. The BMU/NHA decided to award local consultants a contract to conduct the inventory survey and bridge inspection in detail for all bridges and culverts of the entire country because it will take a long time for the BMU and the Trainee Engineers to conduct these tasks. However, an adequate number of trained human resources such as Trainee Engineers and the C/Ps at the BMU is essential for providing training for consultants, supervising their work, and ensuring the quality of data. Another issue is inadequate equipment and transportation for bridge inspection. As some of the C/Ps and the Trainee Engineers pointed out, they were unable to inspect the inaccessible bridges at present because of inadequate equipment and highlighted the necessity for procuring equipment such as non-destructive testing (NDT) equipment and an Under Bridge Inspection Truck (UBIT). To conduct full-fledged bridge inspection in the future, it will be necessary for the BMU/NHA to procure such equipment. At the time of the Terminal Evaluation, it was not clear how the BMU/NHA would address the issues described above. However, based on the government's decision, it was clear that the NHA is unlikely to be able to recruit new permanent staff for a while.

(3) Institutional aspect: Fair to High

The approval of the three manuals developed by the Project and SOP from the NHA Executive Board is a positive step for institutionalizing the effects of the Project. Development of the Short-, Medium- and Long-Term Plans of implementation of BMS and plans to integrate BMS Training into the training program of Highway Research Training Center (HRTC) are also good initiatives of the BMU.

The Project has contributed to establishing a basis for BMS. Under the Project, the practice for BMS was undertaken for 36 bridges and 5 culverts in the model area for just a year. In other words, it is still the initial stage of institutionalizing BMS in the NHA. Accordingly, it will take more time for the BMU to institutionalize and sustain BMS. As for bridge repair, the Project developed a manual, but has not implemented it because it is beyond the scope of the Project. The BMU may face a few challenges in acquiring necessary materials and introducing bridge repair methods at the stage of operation. At the time of the Terminal Evaluation, it was uncertain how the BMU will be able to address these issues.

(4) Financial aspect: Fair to High

In the financial aspect, the effects of the Project are likely to be sustained in three years after its end if all goes smoothly based on the Medium-Term Plan (December 2018–May 2022) that focuses on the implementation of an inventory survey and bridge inspection in the entire country, which will not require much budget.

During the Implementation of the Project, the bridge maintenance budget was 2% to 4% of the total maintenance budget of the NHA. The source of the bridge maintenance budget is the NHA's revenue such as road maintenance funds mainly collected from road tolls. The

inauguration of the new government in 2018, which focuses on review and reduction of unnecessary public works, is unlikely to affect the NHA's budget immediately. However, financial sustainability in the long run is uncertain because the BMU has yet to develop the Annual Bridge/Culvert Maintenance Plan for the entire country based on priority analysis of the data in BIDB and budget estimation.

(5) Technical aspect: Fair to High

While working in the BMU, all the C/Ps who acquired knowledge, skills and know-how related to BMS will keep applying what they learned from the Project. They have greatly enhanced their capacities and confidence so that they have already developed the Short-, Medium- and Long-Term Plans of BMS by themselves. At the time of the Terminal Evaluation, the BMU has completed the Inventory Survey for all 45 bridges and 100 culverts in the non-model area, i.e., the Lahore MU under the jurisdiction of the Punjab North RO. Furthermore, it has begun to inspect some of the accessible 31 bridges out of all 74 bridges in the Rawalpindi MU by mobilizing the Trainee Engineers.

The Trainee Engineers have strengthened their capacities so that they can take the lead in conducting the Inventory Survey and bridge inspection under the supervision of BMU. These Trainee Engineers are likely to put what they learned into practice on sites for a while. However, given their unstable status, there is a risk for the NHA/BMU to lose some of these trained Trainee Engineers. In addition, the BMU engineers may be transferred.

Both the C/Ps and the Trainee Engineers have found it necessary to enhance their capacity, particularly the practical knowledge and experiences of bridge repair and bridge design, which is not scope of the Project. The IT engineer was not confident about his knowledge and skills of BMS programming because he worked with the JICA Expert for a very short term and did not participate in any training in the Project. The BMU/NHA will need further support if technical problems of BIDB and BMS software that they cannot solve by themselves occur. There is room for improvement of capacity in these areas.

As pointed out by many stakeholders including the C/Ps, the director of the HRTC, and the general director and deputy directors of RO and MUs in the model area, the NHA has no in-service training program, and limited opportunities for technical training and sharing knowledge and expertise. To ensure the long-term sustainability of the Project in the technical aspect, the NHA needs a comprehensive strategy for human resource development and capacity development to train the existing manpower and improve the capacity on BMS.

5.7 Key Factors Affecting Implementation and Outcomes

(1) Contributing Factors Concerning Planning

At the time of the Consultation Mission in April 2018, the NHA and JICA agreed on the changes in the Project Purpose, the target area and the approach of the Project, considering the status of bridge inspection in Pakistan, the inadequate capacity of the NHA, and the relative lack of progress in the Project activities. Accordingly, the R/D was modified on

October 16, 2018. This decision has contributed to enhancing the efficiency and effectiveness of the Project.

(2) Contributing Factors Concerning the Implementation Process

The JICA Expert Team has had a series of discussions with high-level officials including the Chairman of the NHA and proposed that the NHA establish the BMU and assign additional C/Ps immediately. Both the JICA Headquarters and the JICA Pakistan Office have also encouraged the NHA through the "High-level Official Invitation Program" organized by the JICA Headquarters in November 2017 and other meetings to take the above into consideration seriously. These initiatives from the Japanese side have enabled the NHA to demonstrate a commitment to establish the BMU with the appointment of three C/Ps, employ the Trainee Engineers on a contractual basis, and approve the SOP. This has greatly enhanced the effective and efficient implementation of the Project since January 2018, and increased the effectiveness, efficiency, impacts and sustainability of the Project in the organizational and institutional aspects.

(3) Inhibiting Factors Concerning Planning

As described in "5.2 Relevance: High" the original PDM was not appropriate regarding its feasibility, which led to reducing the part of relevance, and the efficiency of the Project for the initial one and half years. The inadequate input from the Pakistani side, particularly the assignment of an inadequate number of C/Ps, has adversely affected the efficiency of the Project in the above period.

(4) Inhibiting Factors Concerning the Implementation Process

As indicated in "4.3.1(4) Communication among Project stakeholders and 4.3.1(5) Ownership of the implementing agency" the following factors affected the smooth implementation of the Project and reduced the efficiency of the Project to some extent: 1) less than active participation of the C/Ps and the high-level officers because of their being occupied with routine tasks and other development partners' programs such as CPEC; and 2) lack of awareness of the JICA technical cooperation scheme.

5.8 Evaluation on the results of the Project Risk Management

(1) Risk Management Results

The JICA Expert Team explained the C/Ps several times about the scheme of JICA 's technical cooperation project, and roles and responsibilities of the C/Ps and the Expert Team. Furthermore, they recommended that the NHA establish a unit for bridge management and assign additional C/Ps to this unit immediately. JICA Headquarters and the JICA Pakistan Office also convinced the high-rank officials of the NHA to consider the above proposal. Accordingly, the NHA established the BMU within its headquarters and assigned additional C/Ps in January 2018. In addition, the NHA employed 10 Trainee Engineers on a contractual

basis in February 2018.

As already described, JICA and the NHA agreed to scale down the scope of the Project based on the series of discussions at the time of the Consultation Mission in April 2018. They amended the R/D and approved it on October 16, 2018.

Overall, the countermeasures above have greatly contributed to the smooth implementation of the Project.

(2) Results of the use of lessons learnt

One of the lessons learnt from "the Research on Technical Cooperation on Maintenance of Roads and Bridges" conducted by JICA in February 2009 is that aiming to strengthen the necessary capacities of operation and maintenance with the feasible objectives is important and necessary based on the status of financial, organizational, institutional, technical capacities of implementing agencies, rather than aiming to establish an optimal entire maintenance cycle. Based on this lesson, the Project was designed and modified to establish the fundamental BMS, develop training manuals, and BIDB and BMS software, strengthen the capacity of BMU staff and Trainee Engineers, and develop the bridge maintenance plan of the model area focusing on 36 bridges and 5 culverts.

As described in 5.2(3) Appropriateness of project plan and approach, the original Project Purpose, aiming to complete the inspection of 5,000 bridges and 16,000 culverts on National Highways in the entire country within the two and half years, was not feasible because of lack of trained engineers and inspectors of NHA. The ex-ante evaluation seemed not be conducted during the Detailed Planning Surveys in 2012 because the report was not fully completed. The original Project Purpose inevitably had to be changed as the PDM Version 5 during the last year of the Project duration.

5.9 Lessons Learned from the Project

(1) In ensuring the sustainability of a project, it is effective for its stakeholders to discuss and take concrete measures towards institutionalization of project effects during the project period.

The JICA Expert Team, in cooperation with the JICA Headquarters and the JICA Pakistan Office, has proposed the establishment of the BMU within the NHA Headquarters in order to put BMS into practice. It is beyond the scope of the Project, but one of the Important Assumptions to be fulfilled to generate the effects of the Project and ensure its sustainability. One of the lessons learned from this Project is that it is effective for project stakeholders to discuss and take concreate measures towards institutionalization of project effects even during the project period.

(2) The scope of a project and its required arrangements from JICA and the recipient country such as dispatching a JICA Expert Team, assigning C/Ps, provision of

equipment and allocating budget should have been fully discussed and appropriately examined by ex-ante evaluation prior to the commencement of a project.

During the Detailed Planning Surveys, both the NHA and JICA seemed to recognize the challenges of lack of trained manpower at the NHA headquarters, ROs and MUs. However, it is questionable whether they discussed how to address these challenges in the Project, and to what extent the NHA was aware of the JICA technical cooperation scheme. The implementation could have been much smoother for the initial term if the Project, its approach and institutional arrangements were properly designed and examined by ex-ante evaluation. The scope of a project and its required arrangements should have been fully discussed and appropriately examined prior to the commencement of a project.

6. For the Achievement of Overall Goal after Project Completion

6.1 Prospects to achieve the Overall Goal

Overall Goal:	**Bridge inspection & maintenance status improved on the bridges of National Highways in the model area.**

Indicator 1)	**The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan.**

Based on the Medium-Term Plan (December 2018–May 2022) developed by the BMU, the BMU plans to complete the first cycle of bridge inspection by mobilizing the trainee engineers and awarding consultant firms within three years after the completion of the Project. It will take more time to procure and complete bridge repair works.

According to the C/Ps and the JICA Expert Team, some of the inspected bridges and culverts are likely to be integrated into the Annual Maintenance Plan with the budget request and be repaired during the above period. **If the activities identified in the Short- (**December 2018–February 2020**) and Medium-Term Plans are to be undertaken as planned, Indicator 1) is likely to be achieved.**

Indicator 2)	**In the model area, more than 65 bridges are annually inspected and the bridge maintenance plan is annually revised.**

According to the existing BMS supported by the World Bank, 325 bridges were identified under the jurisdiction of the Punjab North Regional Office including the model area. The NHA decided to inspect all bridges once every five years. Based on this policy, the Project has set “more than 65 bridges” as the annual target value of Indicator 2. Given that the BMU has already begun the bridge inspection as one of its regular activities in the model area, **Indicator 2) is likely to be achieved.**

Summary of the Overall Goal

The Overall Goal is likely to be achieved if the activities identified in the Short- and Medium- Term Plans are undertaken, and if the Important Assumptions described in the PDM are met. It should be noted that the BMU needs to follow and implement the policy of inspection once every five years.

6.2 Plan of Operation and Implementation Structure of the Pakistani side to achieve the Overall Goal

The NHA/BMU has already developed the Short- **(**December 2018–February 2020**),** Medium- (December 2018–May 2022) and Long-Term Plans. Based on the Short- and Medium-Term Plans, the BMU will conduct an inventory survey and bridge inspection by mobilizing Trainee Engineers for a certain period and simultaneously outsourcing these activities to consultants.

6.3 Recommendations for the Pakistani side

(1) Strengthening BMS by implementing, monitoring the activities in the Short-, Medium- and Long-Term Plans, and revising these plans whenever necessary

The Project has established BMS in the BMU/NHA, which is expected to be a basis for BMS. Thus, it is recommended that the BMU/NHA further strengthen BMS by implementing and monitoring the activities based on the Short-, Medium and Long-Term Plans. It is also necessary for the BMU to revise these Plans whenever necessary.

(2) Reporting and sharing the progress and issues of the activities above with JICA by submitting monitoring sheets on a quarterly basis

At the 8th JCC in December 2018, the NHA agreed to report on and share with JICA the progress and issues related to BMS. The NHA is expected to submit monitoring sheets to JICA on a quarterly basis.

(3) Taking countermeasures to retain the trained and dedicated Trainee Engineers in BMU

There is a risk for the NHA/BMU to lose the capable Trainee Engineers because of their unstable employment status. It is recommended that the NHA take countermeasures such as change in their designation of Trainee Engineers, provision of insurance, employment as contracted assistants for the BMU and others to retain them in the BMU.

(4) Promoting information dissemination of BMS and strengthening coordination to be further institutionalized in NHA HQs, MUs and ROs

The BMS developed by the Project and its effects have not been widely recognized even by the NHA stakeholders. The seminar organized by the BMU in December 2018 was considered a good initiative, in which the participants discussed the BMS and exchanged various opinions with one another. It is imperative for the NHA/BMU to promote the importance and necessity of the BMU and strengthen coordination for further institutionalizing the BMS among the NHA Headquarters, MUs, ROs and other stakeholders. As the first trial, it is recommended that the NHA/BMU conduct the sharing and feedback workshop for General Managers of Maintenance of ROs once the bridge inspection is completed in their jurisdiction.

(5) Allocating financial resources for bridge maintenance countermeasures in the Annual Maintenance Plan

The NHA/BMU is expected to incorporate the bridge maintenance plan with budget estimation into the Annual Maintenance Plan after the completion of bridge inspection in the entire country. It is recommended that the NHA/BMU allocate more financial resources for bridge maintenance countermeasures identified in the Annual Maintenance Plan.

6.4 Monitoring Plan from the end of the Project to Ex-post Evaluation

In accordance with the decision of the 8th JCC in December 2018, the NHA is expected to submit monitoring sheets to JICA on a quarterly basis to report on and share the progress and issues of BMS.

1. Results of the Project

1.1 Dispatched Experts（専門家渡航実績）

Expertise 専門	Name 氏名	Period from 渡航開始	Period to 渡航終了	Days 日	Total 計	Affiliation 所属
Project Manager/Bridge Inspection 総括／橋梁点検	Yukio Igo 以後　有希夫	2016/7/20	2016/8/4	16	382	Pacific Consultants Co. Ltd.
		2016/8/24	2016/9/8	16		
		2016/10/3	2016/10/20	18		
		2016/11/28	2016/12/22	25		
		2017/1/30	2017/2/10	12		
		2017/2/22	2017/3/23	30		
		2017/5/8	2017/5/25	18		
		2017/7/10	2017/8/24	46		
		2017/9/6	2017/9/16	11		
		2017/12/11	2017/12/21	11		
		2018/2/5	2018/3/1	25		
		2018/3/19	2018/4/26	39		
		2018/6/25	2018/8/16	53		
		2018/10/29	2018/12/13	46		
		2019/1/14	2019/1/29	16		
Bridge Repair 橋梁補修	Yoshiichi Fujimoto 藤本　吉一	2016/7/20	2016/8/4	16	103	Pacific Consultants Co. Ltd.
		2016/8/24	2016/9/8	16		
		2016/10/3	2016/10/20	18		
		2016/11/28	2016/12/22	25		
		2017/2/20	2017/3/19	28		
BMS (System Design) BMS（システム設計）	Akio Mori 森　暁雄	2016/8/29	2016/9/8	11	98	Pacific Consultants Co. Ltd.
		2017/5/15	2017/5/25	11		
		2017/7/10	2017/7/20	11		
		2017/12/6	2017/12/21	16		
		2018/4/9	2018/4/21	13		
		2018/7/30	2018/8/16	18		
		2018/10/29	2018/11/15	18		
Capacity Development 能力強化（技術移転計画）	Haruo Tomiyama 富山　春男	2016/8/22	2016/9/8	18	316	Pacific Consultants Co. Ltd.
		2016/10/3	2016/10/20	18		
		2016/11/28	2016/12/22	25		
		2017/2/20	2017/3/23	32		
		2017/5/8	2017/5/25	18		
		2017/7/3	2017/7/27	25		
		2017/11/20	2017/12/14	25		
		2018/1/15	2018/2/8	25		
		2018/2/28	2018/3/22	23		
		2018/4/9	2018/5/10	32		
		2018/8/27	2018/9/20	25		
		2018/10/1	2018/10/18	18		
		2018/11/12	2018/12/13	32		
Project Monitoring プロジェクトモニタリング	Kenichi Tomi 冨　健一	2016/7/20	2016/8/4	16	97	Pacific Consultants Co. Ltd.
		2016/11/30	2016/12/10	11		
		2017/7/10	2017/7/27	18		
		2017/12/11	2017/12/21	11		
		2018/4/4	2018/4/26	23		
		2018/11/21	2018/12/8	18		
Project Monitoring (2) プロジェクトモニタリング(2)	Toshiko Shimada 島田　俊子	2019/1/14	2019/1/29	16	16	Pacific Consultants Co. Ltd.
BMS (Specification Logic) BMS（仕様検討）	Fumiatsu Kamitani 上谷　史淳	2017/7/10	2017/7/27	18	18	Pacific Consultants Co. Ltd.
BMS (Specification Logic Assistance) BMS（仕様検討補助）	Ryo Nakai 中井　諒	2017/7/10	2017/7/27	18	49	Pacific Consultants Co. Ltd.
		2017/12/4	2017/12/16	13		
		2018/10/29	2018/11/15	18		

1.2 List of Counterparts

Personnel	Title	Name
Person in Charge	Member (Planning)	Mr. Raja Nowsherwan (～2017.10)
		Mr. Asim Amin (2017.10～2018.10)
	Member (Engg. & Cord.)	Mr. Arbab Ali Dhakan (2018.10～)
Project Manager	General Manager (RAMD)	Mr. Ikramus Saqlain Haider
Project Coordinator	Deputy Director (BMU-Ⅰ)	Mr. Muhammad Asif Azam
Counterpart Personnel	Deputy Director (BMU-Ⅱ)	Mr. Ghulam Murtaza Simair (2018.1～)
	Deputy Director (BMU-Ⅲ)	Mr. Sohaib Mansoor (2018.1～)
IT Engineer	Assistant Director	Mr. Ashfaq Ahmed (2018.7～2018.10) Mr. M Nur-Ul-Eain (2018.10～)

1.3 List of Training

No.	Training/OJT	From	To	Days	Location	Attendees	Remarks
1	Training in Japan	2017/1/16	2017/1/27	12	Japan	2	DD 02
2	Master Trainer's Training 1	2017/2/27	2017/3/3	5	HRTC, site	16	D, DD
3	Master Trainer's Training 2	2017/3/6	2017/3/10	5	HRTC, site	20	DD, AD
4	Master Trainer's Training 3	2017/3/13	2017/3/17	5	HRTC, site	29	AD, Inspectors
5	Feedback Training	2017/7/25	2017/7/25	1	Auditorium	8	
6	OJT for BMU	2018/1/16	2018/1/31	16	Project Room	3	
7	BMS Training (Inventory Survey)	2018/2/1	2018/2/2	2	Auditorium, site	24	Trainee Engineers
8	OJT for BMU	2018/2/5	2018/2/6	2	Project Room	3	
9	Supplemental BMS Training	2018/2/7	2018/2/7	1	Auditorium	12	
10	OJT for BMU	2018/2/8	2018/4/13	65	Project Room	3	
11	BMS Training (Bridge Inspection)	2018/4/16	2018/4/20	5	HRTC, site	17	
12	OJT for BMU	2018/4/23	2018/5/9	17	Project Room, site	3	
13	OJT for BMU	2018/6/26	2018/8/8	44	Project Room	4	
14	BMS Software Training	2018/8/9	2018/8/10	2	M/P Meeting Room	6	
15	OJT for BMU	2018/8/28	2018/9/19	23	Project Room	4	
16	Structural Mechanics Lecture & Exercise	2018/9/12	2018/9/17	4	M/P Meeting Room	10	
17	OJT for BMU	2018/10/2	2018/10/17	16	Project Room	4	
18	OJT for BMU	2018/10/30	2018/12/12	44	Project Room	4	

2. Project Design Matrix

2.1 Major variations in PDM（PDM 変更概要）

Major variations in PDM

Date	2016/7/14	2017/1/14	2018/8/9
PDM ver	Version 1	Version 2 amended	Version 5
Overall Goal	Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Bridge inspection & maintenance status improved on the bridges of National Highways in the model area.
Objectively Verifiable Indicators	Average bridge damage value, calculated by the existing BMS (Smart Bridge), decreased by XX% in [January, 2022] from the start of the Project.	Based on the bridge data, the number of bridge structures in the worst condition has decreased by one-third in [January, 2022] from the start of the Project.	1) The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan. 2) In the model area, more than [65] bridges are annually inspected and the bridge maintenance plan is annually revised.
Project Purpose	Cost estimate necessary for bridge maintenance every fiscal year implemented on the basis of bridge inspection results of the bridges on National Highways in Pakistan.	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of entire NHA Network.	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.
Objectively Verifiable Indicators	Bridge maintenance budget document with breakdowns prepared in [November, 2018].	Bridge maintenance budget document with breakdowns prepared by [September, 2018].	Bridge maintenance plan with breakdowns for the model area prepared by [November, 2018].
Output 1	Manuals and a database developed for bridge inspection and bridge repair method selection	Manuals, Database and BMS developed for bridge inspection and bridge repair method selection	Manuals, Database and BMS developed for bridge inspection and bridge repair.
Output 2	Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	Bridge/culvert inspection in the model area is implemented after BMS training.
Output 3	Data on all the bridges of National Highways in Pakistan input by MUs to the existing BMS (Smart Bridge) available to NHA's HQ and ROs.	Data on all the bridges of National Highways in Pakistan input by MUs to Database available to NHA's HQ and ROs.	Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.

2.2 PDM Amendment-1（第 1 回 PDM 変更）

MINUTES OF MEETINGS
BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY
AND
THE AUTHORITIES CONCERNED OF
THE ISLAMIC REPUBLIC OF PAKISTAN
FOR AMENDMENT OF THE RECORD OF DISCUSSIONS
ON
THE PROJECT FOR TECHNICAL ASSISTANCE ON IMPLEMENTATION OF BRIDGE MANAGEMENT SYSTEM
IN NHA

The Japan International Cooperation Agency (hereinafter referred to as "JICA") and National Highway Authority hereby agree that the Attached PDM on The Project for Technical Assistance on Implementation of Bridge Management System in NHA will be amended as follows;

Islamabad, 8th February, 2017

Mr. Yukio IGO
Project Manager / Bridge Inspection
The Project for Technical Assistance on Implementation of Bridge Management System in NHA
Pacific Consultants Co., Ltd.
Japan

Mr. Raja Nowsherwan
Member (Planning)
National Highway Authority
Islamic Republic of Pakistan

AMENDMENT POINTS

1. Project Purpose

Before	Amended Version
Cost estimate necessary for bridge maintenance every fiscal year implemented on the basis of bridge inspection results of the bridges on National Highways in Pakistan.	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of entire NHA Network.
Reason: Because bridge inspection data has not been carried out regularly since the ex-BMS (Smart Bridge) was developed, NHA's bridge maintenance plan including all the procedures must be prepared as priority.	

2. Output 1

Before	Amended Version
Manuals and a database developed for bridge inspection and bridge repair method selection	Manuals, Database and BMS developed for bridge inspection and bridge repair method selection
Reason: Because bridge inspection data has not been carried out regularly since the ex-BMS (Smart Bridge) was developed, BMS with the prioritization function is newly made in this project..	

3. Activity 1

Before	Amended Version
1-1 Develop 3 types of draft manuals (for (1) bridge inspection, (2) data input to a bridge inspection database, and (3) bridge repair method selection).	1-1 Develop 3 types of draft manuals i.e. (1) bridge/culvert inspection, (2) bridge repair method selection and (3) data input to Database.
1-2 Develop a draft bridge inspection format.	1-2 Develop draft bridge/culvert inspection formats.
1-3 Develop a manual for culvert inspection and a culvert inspection format.	—
1-4 Develop a draft bridge inspection database (in Excel/Access).	1-4 Develop prototype Database & BMS.
1-5 Develop 2 types of draft training materials for the master trainers of NHA's HQ and ROs (for (1) bridge inspection and (2) bridge repair method selection).	1-5Develop 2 types of draft training materials for training i.e. (1) bridge/culvert inspection and (2) bridge repair method selection.
1-6Review and finalize the above 3 types of manuals (Activity 1-1), a format (Activity 1-2), a data base (Activity 1-4) and 2 types of training materials (Activity 1-5).	1-6Review and finalize the above 3 types of manuals (Activity 1-1), inspection formats (Activity 1-2), prototypes (Activity 1-3) and 2 types of training materials (Activity 1-4).

Reason: Because (1) BMS with the prioritization function is newly made in addition to Bridge Inspection Database, and (2) the training is conducted for Master Trainer candidates in order to improve capability of NHA staff though all of them are not expected to achieve to deserve to be the certified Master Trainer, those expressions and wordings are modified.

4. Activity 2

Before	Amended Version
2-1 Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges in/around Islamabad (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database).	2-1 Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges (for (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database)
2-2 By master trainers (trained in Activity 2-1), implement 3 types of training for the staff of MUs (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database).	2-2 Implement 3 types of OJT for the field staff by Master Trainers (trained in Activity 2-1), (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) inspection data input to Database.
2-3 By the staff of MUs (trained in Activity 2-2), implement (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database for all the bridges.	2-3 Implement (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database for all the bridges/culverts, by field staff (trained in Activity 2-1 & 2-2).
Reason: Because (1) the training target is not only bridge but also culvert and (2) all the staff of MUs are not dedicated to bridge/culvert inspection, those expressions are revised.	

5. Output 3

Before	Amended Version
Data on all the bridges of National Highways in Pakistan input by MUs to the existing BMS (Smart Bridge) available to NHA's HQ and ROs.	Data on all the bridges of National Highways in Pakistan input by MUs to Database available to NHA's HQ and ROs.
Reason: Because MUs will input data to Bridge Inspection Database, not Smart Bridge (correction of improper usage).	

6. Activity 3

Before	Amended Version
3-1 Implement training for the staff of NHA's HQ of operation and management of the existing BMS (Smart Bridge).	3-1 Implement training for NHA HQ regarding management of BMS (software and database).
3-2 Transfer the data from a bridge inspection database input by the staff of MUs to the existing BMS (Smart Bridge).	3-2 Monitor bridge data input by NHA staff (Activity 2-3) to Database, and data transfer to BMS by HQ RAMD (Road Asset Management Division) staff.
3-3 Estimate the cost necessary for bridge maintenance in the fiscal year of 2019 based on the data transferred to the existing BMS (Smart Bridge) in Activity 3-2.	3-3 Prepare the annual bridge/culvert maintenance plan including estimated budget for 2019 based on the data transferred to BMS (Activity 3-2).
Reason: Because (1) BMS is newly made instead of the existing BMS (Smart Bridge), (2) to clarify the roles of NHA staff and HQ RAMD staff respectively, and (3) to define the task of maintenance plan not just limited only to budget estimation.	

Attached Documents:

Annex 1 : 2nd JCC Meeting Memorandum

Annex 2 : PDM (Version.2 amended)

Annex 3 : PO (Version.2 amended)

2.3 PDM Amendment-2（第２回 PDM 変更）

Annex1

The draft of the amendment of the Project Design Matrix (PDM)

(1)Overall Goal

Before	Amended Version
Overall Goal	
Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Bridge inspection & maintenance status improved on the bridges of National Highways in the model area.
Reason: The concept of the model area was confirmed in the meeting at JICA HQ on November 10th, 2017. Considering number of bridges of entire NHA network, repair of the nation-wide bridges before ex-post evaluation (3 years after the project completion) are too ambitious. Overall goal should be scaled down to a realistic scope and be referred to some kind of repair. The model area means jurisdiction of Rawalpindi MU and Wazirabad MU in Punjab North.	
Objectively Verifiable Indicators	
Based on the bridge data, the number of bridge structures in the worst condition has decreased by one-third in [January, 2022] from the start of the Project.	1) The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan. 2) In the model area, more than [65] bridges are annually inspected and the bridge maintenance plan is annually revised.
Reason: We defined improvement of maintenance status as sustainable revision of bridge maintenance plan and repair of identified bridges according to the plan.	
Means of Verification	
Output data of the BMS	Inspection and maintenance record in the BMS based on which bridge/culvert maintenance plan is prepared as part of Annual Maintenance Plan.
Reason: 1) Specify the types of the BMS outputs 2) “Bridge maintenance plan” is added from the viewpoint of BMS sustainability in NHA.	
Important Assumption	
· Copyright of software (source code) · Availability of optimum maintenance budget. · Continuous update of bridge data	
Reason: Added to achieve Overall Goal. Budget allocation, which is affected by policy priority and major disasters, is the most critical constraint for bridge improvement.	

(2)Project Purpose

Before	Amended Version
Project Purpose	
Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of entire NHA Network.	Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.
Reason: The concept of the model area was confirmed in the meeting at JICA HQ on November 10th, 2017. Considering number of bridges of entire NHA network, inspection of the nation-wide bridges during the project period is too ambitious to be the project purpose.	
Objectively Verifiable Indicators	
Bridge maintenance budget document with breakdowns prepared by [September, 2018].	Bridge maintenance plan with breakdowns for the model area prepared by [November, 2018].
Reason: The concept of the model area was confirmed in the meeting at JICA HQ on November 10th, 2017.	
Means of Verification	
Analysis of complete input data to BMS and bridge maintenance budget document (with anticipated budget requirement for forthcoming years)	Analysis of the model area input data to BMS and bridge maintenance plan (with anticipated budget requirement for forthcoming years)
Reason: The concept of the model area was confirmed in the meeting at JICA HQ on November 10th, 2017.	
Important Assumption	
NHA's road maintenance budget does not decrease from the start of the Project. Natural disasters with the risk of damages on bridges do not occur on National Highways in Pakistan.	Availability of optimum maintenance budget. Continuous update of bridge data.
Reason: Added to achieve Overall Goal	

(3)Outputs

1) Output1

Before	Amended Version
Output 1	
Manuals, Database and BMS developed for bridge inspection and bridge repair method selection	Manuals, Database and BMS developed for bridge inspection and bridge repair
Reason: Rename according to practice	
Objectively Verifiable Indicators	
1-1. Draft manuals for (1) bridge/culvert inspection, (2) bridge repair method selection by [December, 2016] and draft manual for (3) data input to Database & BMS developed by [December, 2017].	1-1.Draft manuals for (1) bridge inspection by [December, 2016], for (2) bridge repair by [December, 2016] and for (3) data input developed by [December, 2017]
1-4. 2 types of draft training materials for the master trainers for (1) bridge/culvert inspection and (2) bridge repair method selection developed by [December, 2016].	1-4. 2 types of draft training materials for (1) bridge/culvert inspection and (2) bridge repair developed by [December, 2016].
Reason: Rename according to practice	
Activities	
1-1. Develop 3 types of draft manuals i.e. (1) bridge/culvert inspection, (2) bridge repair method selection and (3) data input to Database. 1-2. Develop draft bridge/culvert inspection formats. 1-3. Develop prototype Database & BMS. 1-4. Develop 2 types of draft training materials for training i.e. (1) bridge/culvert inspection and (2) bridge repair method selection. 1-5. Review and finalize the above 3 types of manuals (Activity 1-1), inspection formats (Activity 1-2), prototypes (Activity 1-3) and 2 types of training materials (Activity 1-4).	1-1 JICA Expert Team develops draft manuals for (1) bridge/culvert inspection, (2) bridge/culvert repair and (3) data input. 1-2 JICA Expert Team develops draft bridge/culvert inspection formats. 1-3 JICA Expert Team develops Prototype Bridge Inspection Database & BMS. 1-4 JICA Expert Team develops draft training materials for (1) bridge/culvert inspection and (2) bridge/culvert repair. 1-5 BMU reviews and finalizes the above manuals, inspection formats, prototype and training materials.
Reason: Clarify the practitioner in charge. Rename according to practice.	

2) Output2

Before	Amended Version
Output 2	
Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	Bridge/culvert inspection in the model area is implemented after BMS training.
Reason: Clarify the practitioner in charge. Simplify the expression.	
Objectively Verifiable Indicators	
2-1. 3 Master Trainers' training for (1) bridge/culvert inspection and (2) bridge repair method selection implemented by [March 2017], and (3) data input to Database implemented by [September, 2018]. 2-2. 3 types of training (for (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database) implemented by Master Trainers (trained in Activity 2-1) to all field staff by [November, 2017]. 2-3. Bridge/culvert inspection, bridge repair method selection, and data input to Database completed for all NHA bridges by [June, 2018]. 2-4. 90% or more results of bridge repair method selection and data input to a bridge inspection database by the staff of MUs evaluated to be accurate by NHA's HO & JICA Experts by [October, 2018]. 2-5. Certification of master trainers after training by JICA experts (scoring more than 80% in capacity test).	2-1 On-the-job-training (OJT) by JICA Expert Team which enables BMU to implement BMS in NHA by [December, 2018]. 2-2 Inventory Survey, Bridge Inspection and Data Input Training for NHA engineers. 2-3 Bridge/culvert inspection, bridge repair and data input to Database completed in the model area including the representative [36] bridges and [5] culverts by [October, 2018]. 2-4 The results of bridge repair method selection and data input to a bridge inspection database for model area evaluated to be accurate by BMU & JICA Expert Team by [October, 2018].
Reason: Clarify the practitioner in charge. 2-1: Training target from Master Trainer to Bridge Management Unit. 2-2: Definition of BMS Training 2-3: Definition of OJT 2-4: Non availability of adequate MU staff 2-5: Deleted because of no Certified Master Trainer	

Means of Verification	
2-3. Completed bridge inspection formats and input data to a bridge inspection database	2-3 Inspection data of the model area including the representative [36] bridges and [5] culverts in Bridge Inspection Database.
Reason: Focus on the model area. Registered data in Bridge Inspection Database instead of the formats and input data.	
Activities	
2-1. Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges (for (1) bridge /culvert inspection, (2) bridge repair method selection, and (3) data input to Database). 2-2. Implement 3 types of OJT for the field staff by Master Trainers (trained in Activity 2-1), (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) inspection data input to Database. 2-3. Implement (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database for all the bridges/culverts, by field staff (trained in Activity 2-1 & 2-2).	2-1 JICA Expert Team provides on-the-job-training (OJT) which enables BMU to manage BMS training in NHA. 2-2 BMU implements BMS training (Inventory Survey Training and Bridge Inspection Training). 2-3 Inventory Survey and Bridge Inspection on-the-job-training (OJT) are implemented after BMS training 2-4 JICA Expert Team reviews the inspection results and ability, and advises BMU to enhance their capacity.
Reason: Clarify the practitioner in charge. Simplify the expression. 2-4: Added in order to make capacity building in NHA more fruitful.	

3) Output3

Before	Amended Version
Output 3	
3. Data on all the bridges of National Highways in Pakistan input by MUs to Database available to NHA's HQ and ROs.	3. Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.
Reason: Clarify the practitioner in charge. Database will be available only in HQ for the time being.	
Objectively Verifiable Indicators	
3-1. Training for management of BMS implemented by [December, 2017]. 3-2. Data on all the bridges of National Highways in Pakistan input to Database by [October, 2018]. 3-3. Cost estimate necessary for bridge maintenance in the fiscal year of 2019 based on BMS.	3-1 BMS Software Training for BMU by [December, 2018]. 3-2 Analysis of Bridge Inspection Data of the model area included in Bridge Inspection Database (BIDB) using BMS Software. 3-3 Bridge maintenance plan as part of Annual Maintenance Plan, with repair methods and cost estimate for structures in model area including 36 bridges and 5 culverts is formulated.
Reason: Simplify and correct expression.	
Means of Verification	
3-1. Training records and report 3-2. Training records and report 3-3. Input data to Database	3-1 Record of BMS Training 3-2 Output data of BMS (Prioritization) 3-3 Bridge maintenance plan
Reason: Not input data, but output data of BMS analysis.	
Activities	
3-1. Implement training for NHA HQ regarding management of BMS (software and database). 3-2. Monitor bridge data input by NHA staff (Activity 2-3) to Database, and data transfer to BMS by HQ RAMD (Road Asset Management Department) staff. 3-3. Prepare the annual bridge/culvert maintenance plan including estimated budget for 2019 based on the data transferred to BMS (Activity 3-2).	3-1 JICA Expert Team implements BIDB & BMS Software Training for BMU. 3-2 BMU analyzes Bridge Inspection Data of the model area included in database using BMS Software. 3-3 BMU prepares the annual bridge/culvert maintenance plan including budget estimation based on the analysis of registered data in Bridge Inspection Database
Reason: Clarify the practitioner in charge.	

4) Important Assumption for Outputs

Before	Amended Version
Important Assumption	
BMS is continuously in use by NHA for preparation of bridge maintenance plan.	NHA arranges adequate human resources for BMS implementation. NHA allocates enough budget to maintain and repair prioritized bridges in the annual maintenance plan.
Reason: BMU is necessary in Activity 1-5 and to achieve project purpose. BMS staff necessary to achieve Project Purpose	

5) Important Assumption for Activities

Before	Amended Version
Important Assumption	
	BMS is continuously in use by NHA for preparation of bridge maintenance plan. BMU (Bridge Management Unit) is established in NHA headquarters. BMS organization is gradually established in NHA, who will implement BMS in a sustainable manner.
Reason: BMU is necessary in Activity 1-5 and to achieve project purpose. BMS staff necessary to achieve Project Purpose	

(4)Inputs

1) Inputs (Japanese side)

Before	Amended Version
2. Equipment	
(subject to changes) Non-destructive testing equipment such as · Crack Scale & Test Hammer · Concrete Compression Strength · Crack Depth · Rebar Arrangement · Rebar & Cover · Rebar Corrosion · Carbonation · Server (and Terminals) for Database & BMS (Numbers and specifications will be determined through mutual consultations between JICA and NHA during the implementation of the Project as necessary)	(subject to changes) Non-destructive testing equipment such as · Crack Scale & Test Hammer · Carbonation (Phenolphthalein) · Helmet
Reason: Bridge repair prioritization and budgetary estimation can go without Concrete Strength, Crack Depth and Rebar Detection/Corrosion.	

2) Inputs (Pakistani side)

Before	Amended Version
1. Personnel	
Administrative Personnel 1) Person in Charge: Member (Planning) 2) Project Manager: General Manager (RAMD) 3) Member Director (Design) Counterpart Personnel 1) Project Coordinator: Deputy Director (BMS) 2) Assistant Project Coordinator: Assistant Director (BMS)	Administrative Personnel 1) Person in Charge: Member (Planning) 2) Project Manager: General Manager (RAMD) 3) Project Coordinator: Deputy Director (BMU)-I Counterpart Personnel Deputy Director (BMU)-II Deputy Director (BMU)-III
Reason: Assistant Director (BMS) has never been assigned since the beginning of the Project. BMU is considered as the key persons in NHA BMS and should attend JCC.	

(5)Pre-Conditions

Pre-Conditions	Amended Version
Pre-Conditions	
· The participants for training by JICA experts (Activity 2-1) must have at least 15 years of remaining service period in NHA. · Pakistan, especially Islamabad and Lahore, is continuously safe enough for JICA Experts to implement the activities.	(delete) · Pakistan, especially Islamabad and Lahore, is continuously safe enough for JICA Expert Team to implement the activities.
Reason: Internal issues in NHA Unification of terms	

This amendment will become effective as of April, XX, 2018.

2.4 All versions of PDM

(1) Version 1 (29 July 2016)

Project Design Matrix

Project Title: The Project for Technical Assistance on Implementation of Bridge Management System in NHA Version 1

Implementing Agency: National Highway Authority Dated 29, July, 2016

Target Group:

Period of Project: July, 2016 – January, 2019 (30 months)

Project Site: in/around Islamabad, Pakistan **Model Site:**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Average bridge damage value, calculated by the existing BMS (Smart Bridge), decreased by XX% in [January, 2022] from the start of the	Output data of the existing BMS			
Project Purpose					
Cost estimate necessary for bridge maintenance every fiscal year implemented on the basis of bridge inspection results of the bridges on National Highways in Pakistan.	Bridge maintenance budget document with breakdowns prepared in [November, 2018].	Analysis on each of input data to the existing BMS (Smart Bridge) and bridge maintenance budget document (with breakdown)	· NHA's road maintenance budget does not decrease from the start of the Project. · Natural disasters with the risk of damages on bridges do not occur on National Highways in Pakistan		
Outputs					
1. 1. Manuals and a database developed for bridge inspection and bridge repair method selection.	1-1. 3 types of draft manuals (for (1) bridge inspection, (2) data input to a bridge inspection database, and (3) bridge repair method selection) developed by [November, 2016]	1-1. 3 types of draft manuals	· The existing BMS (Smart Bridge) is continuously in use by NHA for cost estimate of bridge maintenance.		
	1-2. A draft bridge inspection format developed by [November, 2016].	1-2. A draft bridge inspection format			
	1-3. A manual for culvert inspection and a culvert inspection format developed by [November, 2016].	1-3. A manual for culvert inspection and a culvert inspection format			
	1-4. A draft bridge inspection database developed by [November, 2016].	1-4. A draft bridge inspection database			
	1-5. 2 types of draft training materials for the master trainers of NHA's HQ and ROs (for (1) bridge inspection and (2) bridge repair method selection) developed by [November, 2016]	1-5. 2 types of draft training materials			
	1-6. Manuals (1-1 & 1-3), a bridge inspection format (1-2 & 1-3), a database (1-4) and training materials (1-5) finalized by [September, 2018].	1-6. 3 types of manuals, a bridge inspection format, a database and 2 types of training materials			

2. Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	2-1. 3 types of master trainers' training (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database) implemented by [October, 2017] 2-2. 3 types of training (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database) implemented by the master trainers (trained in Activity 2-1) at all the 36 MUs by [November, 2017] 2-3. Bridge inspection, bridge repair method selection, and data input to a bridge inspection database completed at all the 36 MUs by [June, 2018] 2-4. 90% or more results of bridge repair method selection and data input to a bridge inspection database by the staff of MUs evaluated to be accurate by NHA's HO & JICA Experts by [October, 2018] 2-5. 80% or more master trainers of NHA's HQ and ROs scored at the capacity test after the training 80% or higher than that before the training.	2-1. Training records and reports 2-2. Training records and reports 2-3. Completed bridge inspection formats and input data to a bridge inspection database 2-4. Input data to a bridge inspection database and its evaluation 2-5. Test records and reports			
3. 3. Data on all the bridges of National Highways in Pakistan input by MUs to the existing BMS (Smart Bridge) available to NHA's HQ and ROs.	3-1. Training for management of the existing BMS (Smart Bridge) implemented by [October, 2017]. 3-2. Data on all the bridges of National Highways in Pakistan input to the existing BMS (Smart Bridge) by [October, 2018] 3-3. Cost estimate necessary for bridge maintenance in the fiscal year of 2019 based on the data input to the existing BMS (Smart Bridge).	3-1. Training records and reports 3-2. Input data to the existing BMS (Smart Bridge) 3-3. Bridge maintenance budget document with breakdown			

Activities	Inputs		Pre-Conditions
	The Japanese Side	**The Pakistani Side**	
1-1. Develop 3 types of draft manuals (for (1) bridge inspection, (2) data input to a bridge inspection database, and (3) bridge repair method selection). 1-2. Develop a draft bridge inspection format. 1-3. Develop a manual for culvert inspection and a culvert inspection format. 1-4. Develop a draft bridge inspection database (in Excel/Access). 1-5. Develop 2 types of draft training materials for the master trainers of NHA's HQ and ROs (for (1) bridge inspection and (2) bridge repair method selection). 1-6. Review and finalize the above 3 types of manuals (Activity 1-1), a format (Activity 1-2), a data base (Activity 1-4) and 2 types of training materials (Activity 1-5). 2-1. Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges in/around Islamabad (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database). 2-2. By master trainers (trained in Activity 2-1), implement 3 types of training for the staff of MUs (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database). 2-3. By the staff of MUs (trained in Activity 2-2), implement (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database for all the bridges. 3-1. Implement training for the staff of NHA's HQ of operation and management of the existing BMS. 3-2. Transfer the data from a bridge inspection database input by the staff of MUs to the existing BMS (Smart	1. EXPERTS 1) Bridge Inspection Expert 2) Bridge Repair Expert 3) BMS Expert 4) Capacity Development Expert 5) Project Monitoring Expert 6) Local Coordinator (Pakistani) 2. EQUIPMENT Non-destructive testing equipment such as · Ground Penetrating Radar · Electrochemical Polarization Corrosion Measurement · Measurement by Sonic Testing · Schmidt Hammer · Carbonation Depth measurement Kit · Crack Scale · Test Hammer · Licensed Database with Server and Terminals (Input other than indicated here will be determined through mutual consultations between JICA and NHA during the implementation of the Project as necessary)	1. PERSONNEL Administrative Personnel 1) Project Director: Member (Operations) 2) Project Manager: Director (RAMS) Counterpart Personnel 1) Project Coordinator: Deputy Director (BMS) 2) Assistant Project Coordinator: Assistant Director (BMS) 2. OFFICE & FACILITIES · Office for JICA Experts in NHA's HQ Building with office furniture, internet and telephone. 3. ARRANGEMENT · Arrangements for master trainers' training and the training at all the 36 MUs. · Transportation for the field trips of JICA Experts in/around Islamabad. 4. BUDGET ALLOCATION Budget for travel expenses and allowances for the participants of master trainers' training and the training at al the 36 MUs.	· NHA staff, the participants in the training (Activity 2-1 and 2-2), do not retire from NHA. · Pakistan, especially Islamabad, is continuously safe enough for JICA Experts to implement the activities. **<Issues and countermesures>**

3-3. Estimate the cost necessary for bridge maintenance in the fiscal year of 2019 based on the data transferred to the existing BMS (Smart Bridge) in Activity 3-2			

(2) Version 2 (9 December 2016)

Project Design Matrix

Project Title: The Project for Technical Assistance on Implementation of Bridge Management System in NHA Version 2

Implementing Agency: National Highway Authority Dated 9, December, 2016

Target Group:

Period of Project: July, 2016 – January, 2019 (30 months)

Project Site: in/around Islamabad, Pakistan **Model Site:**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Average bridge damage value, calculated by the existing BMS (Smart Bridge), decreased by XX% in [January, 2022] from the start of the	Output data of the existing BMS			The existing BMS has not been used.
Project Purpose					
Cost estimate necessary for bridge maintenance every fiscal year implemented on the basis of bridge inspection results of the bridges on National Highways in Pakistan.	Bridge maintenance budget document with breakdowns prepared in [November, 2018].	Analysis on each of input data to the existing BMS (Smart Bridge) and bridge maintenance budget document (with breakdown)	· NHA's road maintenance budget does not decrease from the start of the Project. · Natural disasters with the risk of damages on bridges do not occur on National Highways in Pakistan		
Outputs					
1. Manuals and a database developed for bridge inspection and bridge repair method selection.	1-1. 3 types of draft manuals (for (1) bridge inspection, (2) data input to a bridge inspection database, and (3) bridge repair method selection) developed by [November, 2016]	1-1. 3 types of draft manuals	· The existing BMS (Smart Bridge) is continuously in use by NHA for cost estimate of bridge maintenance.	Bridge Inspection Database is separately scheduled from others.	Bridge inspection data has not been carried out regulary since the existing BMS (Smart Bridge) was
	1-2. A draft bridge inspection format developed by [November, 2016].	1-2. A draft bridge inspection format			
	1-3. A manual for culvert inspection and a culvert inspection format developed by [November, 2016].	1-3. A manual for culvert inspection and a culvert inspection format			
	1-4. A draft bridge inspection database developed by [November, 2016].	1-4. A draft bridge inspection database			
	1-5. 2 types of draft training materials for the master trainers of NHA's HQ and ROs (for (1) bridge inspection and (2) bridge repair method selection) developed by [November, 2016]	1-5. 2 types of draft training materials			
	1-6. Manuals (1-1 & 1-3), a bridge inspection format (1-2 & 1-3), a database (1-4) and training materials (1-5) finalized by [September, 2018].	1-6. 3 types of manuals, a bridge inspection format, a database and 2 types of training materials			

2. Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on all the bridges of National Highways in Pakistan.	2-1. 3 types of master trainers' training (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database) implemented by [October, 2017] 2-2. 3 types of training (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database) implemented by the master trainers (trained in Activity 2-1) at all the 36 MUs by [November, 2017] 2-3. Bridge inspection, bridge repair method selection, and data input to a bridge inspection database completed at all the 36 MUs by [June, 2018] 2-4. 90% or more results of bridge repair method selection and data input to a bridge inspection database by the staff of MUs evaluated to be accurate by NHA's HO & JICA Experts by [October, 2018] 2-5. 80% or more master trainers of NHA's HQ and ROs scored at the capacity test after the training 80% or higher than that before the training	2-1. Training records and reports 2-2. Training records and reports 2-3. Completed bridge inspection formats and input data to a bridge inspection database 2-4. Input data to a bridge inspection database and its evaluation 2-5. Test records and reports		The 1st Training in Japan is additionally scheduled from January 15th to 27th, 2017. The 1st MT training is postponed from November to March, 2017. The number of MT training participants will be increased because the training is conducted for candidates in order to improve capability of NHA staff though all of them are not expected to achieve to deserve to be the certified Master	Dispatching two senior engineers to Japan before MT training is strongly suggested.
3. Data on all the bridges of National Highways in Pakistan input by MUs to the existing BMS (Smart Bridge) available to NHA's HQ and ROs.	3-1. Training for management of the existing BMS (Smart Bridge) implemented by [October, 2017]. 3-2. Data on all the bridges of National Highways in Pakistan input to the existing BMS (Smart Bridge) by [October, 2018]. 3-3. Cost estimate necessary for bridge maintenance in the fiscal year of 2019 based on the data input to the existing BMS (Smart Bridge).	3-1. Training records and reports 3-2. Input data to the existing BMS (Smart Bridge) 3-3. Bridge maintenance budget document with breakdown		BMS with the prioritization funcrtion is newly made in addtion to Bridge Inspection Database.	BMS with the prioritization function is strongly required.

Activities	Inputs		Pre-Conditions
	The Japanese Side	**The Pakistani Side**	
1-1. Develop 3 types of draft manuals (for (1) bridge inspection, (2) data input to a bridge inspection database, and (3) bridge repair method selection). 1-2. Develop a draft bridge inspection format. 1-3. Develop a manual for culvert inspection and a culvert inspection format. 1-4. Develop a draft bridge inspection database (in Excel/Access). 1-5. Develop 2 types of draft training materials for the master trainers of NHA's HQ and ROs (for (1) bridge inspection and (2) bridge repair method selection). 1-6. Review and finalize the above 3 types of manuals (Activity 1-1), a format (Activity 1-2), a data base (Activity 1-4) and 2 types of training materials (Activity 1-5). 2-1. Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges in/around Islamabad (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database). 2-2. By master trainers (trained in Activity 2-1), implement 3 types of training for the staff of MUs (for (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database). 2-3. By the staff of MUs (trained in Activity 2-2), implement (1) bridge inspection, (2) bridge repair method selection, and (3) data input to a bridge inspection database for all the bridges. 3-1. Implement training for the staff of NHA's HQ of operation and management of the existing BMS. 3-2. Transfer the data from a bridge inspection database input by the staff of MUs to the existing BMS (Smart	1. EXPERTS 1) Bridge Inspection Expert 2) Bridge Repair Expert 3) BMS Expert 4) Capacity Development Expert 5) Project Monitoring Expert 6) Local Coordinator (Pakistani) 2. EQUIPMENT Non-destructive testing equipment such as · Ground Penetrating Radar · Electrochemical Polarization Corrosion Measurement · Measurement by Sonic Testing · Schmidt Hammer · Carbonation Depth measurement Kit · Crack Scale · Test Hammer · Licensed Database with Server and Terminals (Input other than indicated here will be determined through mutual consultations between JICA and NHA during the implementation of the Project as necessary)	1. PERSONNEL Administrative Personnel 1) Project Director: Member (Operations) 2) Project Manager: Director (RAMS) Counterpart Personnel 1) Project Coordinator: Deputy Director (BMS) 2) Assistant Project Coordinator: Assistant Director (BMS) 2. OFFICE & FACILITIES · Office for JICA Experts in NHA's HQ Building with office furniture, internet and telephone. 3. ARRANGEMENT · Arrangements for master trainers' training and the training at all the 36 MUs. · Transportation for the field trips of JICA Experts in/around Islamabad. 4. BUDGET ALLOCATION Budget for travel expenses and allowances for the participants of master trainers' training and the training at al the 36 MUs.	· NHA staff, the participants in the training (Activity 2-1 and 2-2), do not retire from NHA. · Pakistan, especially Islamabad, is continuously safe enough for JICA Experts to implement the activities. **<Issues and countermesures>** Crack Scale and Test Hammer shall be prpared for MT Training and OJT, while other non destructive test equipment and computers (Licensed Database with Server and Terminals) will be discussed after the 1st MT Training (April, 2017) Standard Operation Procedure (SOP) related to bridge maintenance is need to be built up.

3-3. Estimate the cost necessary for bridge maintenance in the fiscal year of 2019 based on the data transferred to the existing BMS (Smart Bridge) in Activity 3-2			

(3) Version 3 (12 July 2017)

Project Design Matrix

Project Title: The Project for Technical Assistance on Implementation of Bridge Management System in NHA Version 3

Implementing Agency: National Highway Authority Dated 12, July, 2017

Target Group:

Period of Project: July, 2016 – January, 2019 (30 months)

Project Site: in/around Islamabad, Pakistan **Model Site:**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Based on the bridge data, the number of bridge structures in the worst condition has decreased by one-third in [January, 2022] from the start of the Project.	Output data of the BMS	· Copyright of software (source code) · Availability of optimum maintenance budget. · Continuous update of bridge data		
Project Purpose					
Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of ***entire*** NHA Network.	Bridge maintenance budget document with breakdowns prepared by [September, 2018].	Analysis of ***complete*** input data to BMS and bridge maintenance budget document (with anticipated budget requirement for forthcoming years)	· NHA's road maintenance budget does not decrease from the start of the Project. · Natural disasters with the risk of damages on bridges do not occur on National Highways in Pakistan.		Set the "Model Area" to promote BMS.
Outputs					
1. Manuals, Database and BMS developed for bridge inspection and bridge repair method selection	1-1. Draft manuals for (1) bridge/culvert inspection, (2) bridge repair method selection by [December, 2016] and draft manual for (3) data input to Database & BMS developed by [December, 2017].	1-1. 3 types of draft manuals	· BMS is continuously in use by NHA for preparation of bridge maintenance plan.	(1) & (2) by Dec, 2016. (3) is in progress	
	1-2. Draft bridge/culvert inspection formats developed by [December, 2016].	1-2. Draft bridge/culvert inspection formats		Completed	
	1-3. Prototype Database developed by [July, 2017], and prototype BMS by [December, 2017].	1-3. Prototype Database & BMS		Still in progress	
	1-4. 2 types of draft training materials for the master trainers for (1) bridge/culvert inspection and (2) bridge repair method selection developed by [December, 2016].	1-4. 2 types of draft training materials		Completed	
	1-5. Manuals (1-1), formats (1-2), Database & BMS (1-3), and training materials (1-4) finalized by [September, 2018].	1-5. 3 types of manuals, bridge/culvert inspection formats, Database & BMS, and 2 types of training materials			

2. Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on ***all*** the bridges of National Highways in Pakistan.	2-1. 3 Master Trainers' training for (1) bridge/culvert inspection and (2) bridge repair method selection implemented by [March 2017], and (3) data input to Database implemented by [September, 2018].	2-1. Training records and reports		(1) & (2) by Mar, 2017. 1st MTT participants increased up to 65 because NHA desired to improve capability of NHA staff.	3-5 enginners selected for BMS in Model Area. Inspection of 100 br+200cb led by them. Experience in Model Area need to prevail nationalwidel
	2-2. 3 types of training (for (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database) ***implemented by Master Trainers (trained in Activity 2-1) to all field staff*** by [November, 2017].	2-2. Training records and reports		17 of 65 candidates submitted 58 brideg/culvert reports.	
	2-3. Bridge/culvert inspection, bridge repair method selection, and data input to Database completed for ***all*** NHA bridges by [June, 2018].	2-3. Completed bridge inspection formats and input data to a bridge inspection database		Current progress percentage is less than 0.28%	
	2-4. **90% or more** results of bridge repair method selection and data input to a bridge inspection database by the staff of MUs evaluated to be accurate by NHA's HO & JICA Experts by [October, 2018].	2-4. Input data to Database and its evaluation			
	2-5. ***Certification of master trainers after training by JICA experts (scoring more than 80% in capacity test)*** .	2-5. Test records and reports		Not enough candidates of the 1st MTT met with capacity test.	
3. Data on ***all*** the bridges of National Highways in Pakistan input by MUs to Database available to NHA's HQ and ROs.	3-1. Training for management of BMS implemented by [December, 2017].	3-1. Training records and reports		Not yet	Trainees may be limited in HQ.
	3-2. Data on ***all*** the bridges of National Highways in Pakistan input to Database by [October, 2018].	3-2. Input data to Database		Not yet	
	3-3. Cost estimate necessary for bridge maintenance in the fiscal year of 2019 based on BMS.	3-3. Bridge maintenance budget document with breakdown		Not yer	

Activities	Inputs		Pre-Conditions
	The Japanese Side	**The Pakistani Side**	
1-1. Develop 3 types of draft manuals i.e. (1) bridge/culvert inspection, (2) bridge repair method selection and (3) data input to Database. 1-2. Develop draft bridge/culvert inspection formats. 1-3. Develop prototype Database & BMS. 1-4. Develop 2 types of draft training materials for training i.e. (1) bridge/culvert inspection and (2) bridge repair method selection. 1-5. Review and finalize the above 3 types of manuals (Activity 1-1), inspection formats (Activity 1-2), prototypes (Activity 1-3) and 2 types of training materials (Activity 1-4). 2-1. Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges (for (1) bridge /culvert inspection, (2) bridge repair method selection, and (3) data input to Database) 2-2. ***Implement 3 types of OJT for the field staff by Master Trainers (trained in Activity 2-1), (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) inspection data input to Database*** 2-3. Implement (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database for ***all the bridges/culverts, by field staff (trained in Activity 2-1 & 2-2)*** . 3-1. Implement training for NHA HQ regarding management of BMS (software and database). 3-2. Monitor bridge data input by NHA staff (Activity 2-3) to Database, and ***data transfer to*** BMS by HQ RAMD (Road Asset Management Department) staff.	1. EXPERTS 1) Bridge Inspection Expert 2) Bridge Repair Expert 3) BMS Expert 4) Capacity Development Expert 5) Project Monitoring Expert 6) Local Coordinator (Pakistani) 2. EQUIPMENT (subject to changes) Non-destructive testing equipment such as · Crack Scale & Test Hammer · Concrete Compression Strength · Crack Depth · Rebar Arrangement · Rebar & Cover · Rebar Corrosion · Carbonation · Server (and Terminals) for Database & BMS (Numbers and specifications will be determined through mutual consultations between JICA and NHA during the implementation of the Project as necessary)	1. PERSONNEL Administrative Personnel 1) Person in Charge: Member (Planning) 2) Project Manager: General Manager (RAMD) 3) Member Director (Design) Counterpart Personnel 1) Project Coordinator: Deputy Director (BMS) 2) ***Assistant Project Coordinator: Assistant Director (BMS)*** 2. OFFICE & FACILITIES · Office for JICA Experts in NHA's HQ Building with office furniture, internet and telephone. 3. ARRANGEMENT · Training Arrangements · Transportation for the field trips of JICA Experts in/around Islamabad. 4. BUDGET ALLOCATION Budget for traveling and accommodation expenses of the training participants.	· The participants for training by JICA experts (Activity 2-1) must have at least 15 years of remaining service period in NHA. · Pakistan, especially Islamabad and Lahore, is continuously safe enough for JICA Experts to implement the activities. **<Issues and countermesures>** Crack Scale and Test Hammer shall be prpared for MT Training and OJT, while other non destructive test equipment and computers (Licensed Database with Server and Terminals) will be discussed after the 1st MT Training (April, 2017) Standard Operation Procedure (SOP) related to bridge maintenance is need to be built

3-3. Prepare the annual bridge/culvert maintenance plan including estimated budget for 2019 based on ***the data transferred to*** BMS (Activity 3-2).			

(4) Version 4 (13 December 2017)

Project Design Matrix

Project Title: The Project for Technical Assistance on Implementation of Bridge Management System in NHA Version 4

Implementing Agency: National Highway Authority Dated 13, December, 2017

Target Group:

Period of Project: July, 2016 – January, 2019 (30 months)

Project Site: in/around Islamabad, Pakistan **Model Site:**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Bridge maintenance status improved on the bridges of National Highways in Pakistan.	Based on the bridge data, the number of bridge structures in the worst condition has decreased by one-third in [January, 2022] from the start of the Project.	Output data of the BMS	· Copyright of software (source code) · Availability of optimum maintenance budget. · Continuous update of bridge data		
Project Purpose					
Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of ***entire*** NHA Network.	Bridge maintenance budget document with breakdowns prepared by [September, 2018].	Analysis of ***complete*** input data to BMS and bridge maintenance budget document (with anticipated budget requirement for forthcoming years)	· NHA's road maintenance budget does not decrease from the start of the Project. · Natural disasters with the risk of damages on bridges do not occur on National Highways in Pakistan.		Begin with Pujab North as the model area.
Outputs					
1. Manuals, Database and BMS developed for bridge inspection and bridge repair method selection	1-1. Draft manuals for (1) bridge/culvert inspection, (2) bridge repair method selection by [December, 2016] and draft manual for (3) data input to Database & BMS developed by [December, 2017].	1-1. 3 types of draft manuals	· BMS is continuously in use by NHA for preparation of bridge maintenance plan.	(1) & (2) completed (3) in Dec, 2017. Server is necessary.	
	1-2. Draft bridge/culvert inspection formats developed by [December, 2016].	1-2. Draft bridge/culvert inspection formats		Completed	
	1-3. Prototype Database developed by [July, 2017], and prototype BMS by [December, 2017].	1-3. Prototype Database & BMS		Database in July, 2017. BMS in December, 2017	
	1-4. 2 types of draft training materials for the master trainers for (1) bridge/culvert inspection and (2) bridge repair method selection developed by [December, 2016].	1-4. 2 types of draft training materials		Completed	
	1-5. Manuals (1-1), formats (1-2), Database & BMS (1-3), and training materials (1-4) finalized by [September, 2018].	1-5. 3 types of manuals, bridge/culvert inspection formats, Database & BMS, and 2 types of training materials		Currently drafted	

2. Trainers of bridge inspection and bridge repair method selection trained at NHA's HQ and ROs, and bridge inspection and bridge repair method selection of uniformed contents implemented on ***all*** the bridges of National Highways in Pakistan.	2-1. 3 Master Trainers' training for (1) bridge/culvert inspection and (2) bridge repair method selection implemented by [March 2017], and (3) data input to Database implemented by [September, 2018].	2-1. Training records and reports		(1) & (2) completed	Definition of Master Trainer / Certified Master Trainer / Bridge Management Unit (BMU) / Directors in RO.
	2-2. 3 types of training (for (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database) ***implemented by Master Trainers (trained in Activity 2-1) to all field staff*** by [November, 2017].	2-2. Training records and reports		Not yet	
	2-3. Bridge/culvert inspection, bridge repair method selection, and data input to Database completed for ***all*** NHA bridges by [June, 2018].	2-3. Completed bridge inspection formats and input data to a bridge inspection database		No progress in 6 months	
	2-4. **90% or more** results of bridge repair method selection and data input to a bridge inspection database by the staff of MUs evaluated to be accurate by NHA's HO & JICA Experts by [October, 2018].	2-4. Input data to Database and its evaluation		Still 0.28%	
	2-5. ***Certification of master trainers after training by JICA experts (scoring more than 80% in capacity test)*** .	2-5. Test records and reports		Not enough candidates of the 1st MTT met with capacity test (report submission).	
3. Data on ***all*** the bridges of National Highways in Pakistan input by MUs to Database available to NHA's HQ and ROs.	3-1. Training for management of BMS implemented by [December, 2017].	3-1. Training records and reports		Not yet	Trainees may be limited in HQ.
	3-2. Data on ***all*** the bridges of National Highways in Pakistan input to Database by [October, 2018].	3-2. Input data to Database		Not yet	
	3-3. Cost estimate necessary for bridge maintenance in the fiscal year of 2019 based on BMS.	3-3. Bridge maintenance budget document with breakdown		Not yer	

Activities	Inputs		Pre-Conditions
	The Japanese Side	**The Pakistani Side**	
1-1. Develop 3 types of draft manuals i.e. (1) bridge/culvert inspection, (2) bridge repair method selection and (3) data input to Database. 1-2. Develop draft bridge/culvert inspection formats. 1-3. Develop prototype Database & BMS. 1-4. Develop 2 types of draft training materials for training i.e. (1) bridge/culvert inspection and (2) bridge repair method selection. 1-5. Review and finalize the above 3 types of manuals (Activity 1-1), inspection formats (Activity 1-2), prototypes (Activity 1-3) and 2 types of training materials (Activity 1-4). 2-1. Implement 3 types of master trainer's training for the staff of NHA's HQ and ROs at the target bridges (for (1) bridge /culvert inspection, (2) bridge repair method selection, and (3) data input to Database) 2-2. ***Implement 3 types of OJT for the field staff by Master Trainers (trained in Activity 2-1), (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) inspection data input to*** 2-3. Implement (1) bridge/culvert inspection, (2) bridge repair method selection, and (3) data input to Database for ***all the bridges/culverts, by field staff (trained in Activity 2-1 &*** 3-1. Implement training for NHA HQ regarding management of BMS (software and database). 3-2. Monitor bridge data input by NHA staff (Activity 2-3) to Database, and ***data transfer to*** BMS by HQ RAMD (Road Asset Management Department) 3-3. Prepare the annual bridge/culvert maintenance plan including estimated budget for 2019 based on ***the data transferred to*** BMS (Activity 3-2).	1. EXPERTS 1) Bridge Inspection Expert 2) Bridge Repair Expert 3) BMS Expert 4) Capacity Development Expert 5) Project Monitoring Expert 6) Local Coordinator (Pakistani) 2. EQUIPMENT (subject to changes) Non-destructive testing equipment such as · Crack Scale & Test Hammer · Concrete Compression Strength · Crack Depth · Rebar Arrangement · Rebar & Cover · Rebar Corrosion · Carbonation · Server (and Terminals) for Database & BMS (Numbers and specifications will be determined through mutual consultations between JICA and NHA during the implementation of the Project as necessary)	1. PERSONNEL Administrative Personnel 1) Person in Charge: Member (Planning) 2) Project Manager: General Manager (RAMD) 3) Member Director (Design) Counterpart Personnel 1) Project Coordinator: Deputy Director (BMS) 2) ***Assistant Project Coordinator: Assistant Director (BMS)*** 2. OFFICE & FACILITIES · Office for JICA Experts in NHA's HQ Building with office furniture, internet and telephone. 3. ARRANGEMENT · Training Arrangements · Transportation for the field trips of JICA Experts in/around Islamabad. 4. BUDGET ALLOCATION Budget for traveling and accommodation expenses of the training participants.	· The participants for training by JICA experts (Activity 2-1) must have at least 15 years of remaining service period in NHA. · Pakistan, especially Islamabad and Lahore, is continuously safe enough for JICA Experts to implement the activities. **<Issues and countermesures>** Crack Scale and Test Hammer shall be prpared for MT Training and OJT, while other non destructive test equipment and computers (Licensed Database with Server and Terminals) will be discussed after the 1st MT Training (April, 2017) Standard Operation Procedure (SOP) related to bridge maintenance is need to be built

(5) Version 5 (11 April 2018)

Project Design Matrix

Project Title: The Project for Technical Assistance on Implementation of Bridge Management System in NHA Version 5

Implementing Agency: National Highway Authority Dated 11, April, 2018

Target Group:

Period of Project: July, 2016 – April, 2019 (34 months)

Project Site: in/around Islamabad, Pakistan **Model Site: Jurisdiction of Rawalpindi MU and Wazirabad MU in Punjab North**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Bridge maintenance status improved on the bridges of National Highways in the model area.	1) The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan. 2) In the model area, more than [65] bridges are annually inspected and the bridge maintenance plan is annually revised.	1) Inspection and maintenance record in the BMS 2) Bridge maintenance plan	· Copyright of software (source code) · Availability of optimum maintenance budget. · Continuous update of bridge data		The model area means jurisdiction of Rawalpindi MU and Wazirabad MU in Punjab North.
Project Purpose					
Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of the model area.	Bridge maintenance budget document with breakdowns for the model area prepared by [December, 2018].	Analysis of the model area input data to BMS and bridge maintenance budget document (with anticipated budget requirement for forthcoming years)	1)NHA gradually arranges adequate human resources for BMS implementation. 2)NHA allocates enough budget to maintain and repair prioritized bridges in the annual maintenance plan.		
Outputs					
1. Manuals, Database and BMS developed for bridge inspection and bridge repair	1-1 Draft manuals for (1) bridge inspection by [December, 2016], for (2) bridge repair by [December, 2016] and for (3) data input developed by [December, 2017]	1-1. 3 types of draft manuals	· BMS is continuously in use by NHA for preparation of bridge maintenance plan.	Completed	
	1-2. Draft bridge/culvert inspection formats developed by [December, 2016].	1-2. Draft bridge/culvert inspection formats	· BMU (Bridge Management Unit) is established in NHA headquarter.	Completed	
	1-3. Prototype Database developed by [July, 2017], and prototype BMS by [December, 2017].	1-3. Prototype Database & BMS		Completed	
	1-4. 2 types of draft training materials for (1) bridge/culvert inspection and (2) bridge repair developed by [December, 2016].	1-4. 2 types of draft training materials	· BMS organization is gradually established in NHA, who will implement BMS in a sustainalbe manner.	Completed	

	1-5. Manuals (1-1), formats (1-2), Database & BMS (1-3), and training materials (1-4) finalized by [September, 2018].	1-5. 3 types of manuals, bridge/culvert inspection formats, Database & BMS, and 2 types of training materials		Currently under revision	
2. Bridge/culvert inspection in the model area is implemented after BMS training.	2-1 On-the-job-training (OJT) by JICA Expert Team which enables BMU to implement BMS in NHA by [December, 2018].	2-1. Training records and reports		(1) & (2) completed	Definition of Master Trainer / Certified Master Trainer /
	2-2 Inventory Survey, Bridge Inspection and Data Input Training for NHA engineers.	2-2. Training records and reports		Inventory Survey Training was held on February 1. Bridge Inspection Training is scheduled between April 16 and 20.	
	2-3 Bridge/culvert inspection, bridge repair and data input to Database completed in the model area including the representative [36] bridges and [5] culverts by [October, 2018].	2-3 Inspection data of the model area including the representative [36] bridges and [5] culverts in Bridge Inspection Database.			
	2-4. The results of bridge repair method selection and data input to a bridge inspection database for model area evaluated to be accurate by BMU & JICA Expert Team by [October, 2018].	2-4. Input data to Database and its evaluation			
3. Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.	3-1 BMS Software Training for BMU by [December, 2018].	3-1. Record of BMS Training		Not yet	
	3-2 Analysis of Bridge Inspection Data of the model area using BMS Software.	3-2 Output data of BMS (Prioritization)		Not yet	
	3-3 Bridge maintenance plan with repair methods and cost estimate for structures in model area including typical 36 birdges and 5 culverts is formulated.	3-3. Bridge maintenance plan		Not yet	

Activities	Inputs		Pre-Conditions
	The Japanese Side	**The Pakistani Side**	
1-1. JICA Expert Team develops draft manuals for (1) bridge inspection, (2) bridge repair and (3) data input. 1-2. JICA Expert Team develops draft bridge/culvert inspection formats. 1-3. JICA Expert Team develops Prototype Bridge Inspection Database & BMS. 1-4. JICA Expert Team develops draft training materials for (1) bridge inspection and (2) bridge repair. 1-5. BMU reviews and finalizes the above manuals, inspection formats, prototype and training materials. 2-1 JICA Expert Team provides on-the-job-training (OJT) which enables BMU to manage BMS training in NHA. 2-2 BMU implements BMS training (Inventory Survey Training and Bridge Inspection Training) . 2-3 Inventory Survey and Bridge Inspection on-the-job-training (OJT) are implemented after BMS training. 2-4 The results of bridge repair method selection and data input to a bridge inspection database for model area evaluated to be accurate by BMU & JICA Expert Team by [October, 2018]. 3-1 JICA Expert Team implements BMS Software Training for BMU. 3-2 BMU analyzes Bridge Inspection Data of the model area using BMS Software. 3-3 BMU prepares the annual bridge/culvert maintenance plan including budget estimation based on the analysis of registered data in Bridge Inspection Database.	1. EXPERTS 1) Bridge Inspection Expert 2) Bridge Repair Expert 3) BMS Expert 4) Capacity Development Expert 5) Project Monitoring Expert 6) Local Coordinator (Pakistani) 2. EQUIPMENT (subject to changes) Non-destructive testing equipment such as · Crack Scale & Test Hammer · Carbonation	1. PERSONNEL Administrative Personnel 1) Person in Charge: Member (Planning) 2) Project Manager: General Manager (RAMD) 3) Project Coordinator: Deputy Director (BMU) - Ⅰ Counterpart Personnel Deputy Director (BMU) - Ⅱ Deputy Director (BMU) - Ⅲ 2. OFFICE & FACILITIES · Office for JICA Experts in NHA's HQ Building with office furniture, internet and telephone. 3. ARRANGEMENT · Training Arrangements · Transportation for the field trips of JICA Experts in/around Islamabad. 4. BUDGET ALLOCATION Budget for traveling and accommodation expenses of the training participants.	· Pakistan, especially Islamabad and Lahore, is continuously safe enough for JICA Expert Team to implement the activities. **<Issues and countermesures>** Standard Operation Procedure (SOP) related to bridge maintenance is need to be built up.

(6) Version 6 (3 December 2018)

Project Design Matrix

Project Title: The Project for Technical Assistance on Implementation of Bridge Management System in NHA Version 6

Implementing Agency: National Highway Authority Dated 3, December, 2018

Target Group:

Period of Project: July, 2016 – April, 2019 (34 months)

Project Site: in/around Islamabad, Pakistan **Model Area: Jurisdiction of Rawalpindi MU and Wazirabad MU in Punjab North**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Bridge **inspection &** maintenance status improved on the bridges of National Highways **in the model area.**	1) The bridges identified in the maintenance plan prepared under the Project are maintained and repaired according to the plan. 2) In the model area, more than [65] bridges are annually inspected and the bridge maintenance plan is annually revised.	Inspection and maintenance record in the BMS based on which bridge/culvert maintenance plan is prepared as part of Annual Maintenance Plan			The model area means jurisdiction of Rawalpindi MU and Wazirabad MU in Punjab North.
Project Purpose					
Annual bridge maintenance plan prepared on the basis of the latest bridge inspection data of **the model area.**	Bridge maintenance plan with breakdowns for the model area prepared by [November, 2018].	Analysis of **the model area** input data to BMS and bridge maintenance plan (with anticipated budget requirement for forthcoming years)	· Availability of optimum maintenance budget. · Continuous update of bridge data		
Outputs					
1. Manuals, Database and BMS developed for bridge inspection and bridge repair	1-1: Draft manuals for (1) bridge inspection by [December, 2016], for (2) bridge repair by [December, 2016] and for (3) data input developed by [December, 2017]	1-1: 3 types of draft manuals	· NHA arranges adequate human resources for BMS implementation. · NHA allocates enough budget to maintain and repair prioritized bridges in the annual maintenance plan.	Completed	
	1-2: Draft bridge/culvert inspection formats developed by [December, 2016].	1-2: Draft bridge/culvert inspection formats		Completed	
	1-3: Prototype Database developed by [July, 2017], and prototype BMS by [December, 2017].	1-3: Prototype Database & BMS		Completed	

	1-4: 2 types of draft training materials for (1) bridge/culvert inspection and (2) bridge repair developed by [December, 2016].	1-4: 2 types of draft training materials		Completed	
	1-5: Manuals (1-1), formats (1-2), Database & BMS (1-3), and training materials (1-4) finalized by [September, 2018].	1-5: 3 types of manuals, bridge/culvert inspection formats, Database & BMS, and 2 types of training materials		Completed and Forwarded to Executive Board Meeting in November 2018.	
2. Bridge/culvert inspection in the model area is implemented after BMS training.	2-1: On-the-job-training (OJT) by JICA Expert Team which enables BMU to implement BMS in NHA by [December, 2018].	2-1: Training records and reports		Completed in November	Definition of Master Trainer / Certified Master Trainer / Bridge Management Unit (BMU) / Directors in RO.
	2-2: Inventory Survey, Bridge Inspection and Data Input Training for NHA engineers.	2-2: Training records and reports		Complted in April	
	2-3: Bridge/culvert inspection, bridge repair and data input to Database completed in the model area including the representative [36] bridges and [5] culverts by [October, 2018].	2-3: Inspection data of the model area including the representative [36] bridges and [5] culverts in Bridge Inspection Database.		Completed in September	
	2-4: The results of bridge repair method selection and data input to a bridge inspection database for model area evaluated to be accurate by BMU & JICA Expert Team by [October, 2018].	2-4: Input data to Database and its evaluation		Completed in October	
3. Bridge data of the model area is available with BMU at NHA headquarters and bridge maintenance plan is prepared according to the data.	3-1: BMS Software Training for BMU by [December, 2018].	3-1: Record of BMS Training		Completed in August	
	3-2: Analysis of Bridge Inspection Data of the model area included in **Bridge Inspection Database (**BIDB) using BMS Software.	3-2: Output data of BMS (Prioritization)		Completed in November	
	3-3: Bridge maintenance plan as part of Annual Maintenance Plan, with repair methods and cost estimate for structures in model area including typical 36 bridges and 5 culverts is formulated.	3-3: Bridge maintenance plan		Completed in November	

Activities	Inputs		Important Assumption
	The Japanese Side	**The Pakistani Side**	
1-1: JICA Expert Team develops draft manuals for (1) bridge/culvert inspection, (2) bridge/culvert repair and (3) data input. 1-2: JICA Expert Team develops draft bridge/culvert inspection formats. 1-3: JICA Expert Team develops Prototype Bridge Inspection Database & BMS. 1-4: JICA Expert Team develops draft training materials for (1) bridge/culvert inspection and (2) bridge/culvert repair. 1-5: BMU reviews and finalizes the above manuals, inspection formats, prototype and training materials. 2-1: JICA Expert Team provides on-the-job-training (OJT) which enables BMU to manage BMS training in NHA. 2-2: BMU implements BMS training (Inventory Survey Training and Bridge Inspection Training) . 2-3: Inventory Survey and Bridge Inspection on-the-job-training (OJT) are implemented after BMS training. 2-4: JICA Expert Team reviews the inspection results and ability, and advises BMU to enhance their capacity. 3-1: JICA Expert Team implements BIDB & BMS Software Training for BMU. 3-2: BMU analyzes Bridge Inspection Data of the model area included in database using BMS Software. 3-3: BMU prepares the annual bridge/culvert maintenance plan including budget estimation based on the analysis of registered data in Bridge Inspection Database.	1. EXPERTS 1) Bridge Inspection Expert 2) Bridge Repair Expert 3) BMS Expert 4) Capacity Development Expert 5) Project Monitoring Expert 6) Terminal Evaluation 7) Local Coordinator (Pakistani) 2. EQUIPMENT · Crack Scale & Test Hammer · Carbonation (Phenolphthalein) · Helmet	1. PERSONNEL Administrative Personnel 1) Person in Charge: Member (Planning) 2) Project Manager: General Manager (RAMD) 3) Project Coordinator: Deputy Director (BMU) - Ⅰ Counterpart Personnel Deputy Director (BMU) - Ⅱ Deputy Director (BMU) - Ⅲ 2. OFFICE & FACILITIES · Office for JICA Experts in NHA's HQ Building with office furniture, internet and telephone. 3. ARRANGEMENT · Training Arrangements · Transportation for the field trips of JICA Experts in/around Islamabad. 4. BUDGET ALLOCATION Budget for traveling and accommodation expenses of the training participants.	· BMS is continuously in use by NHA for preparation of bridge maintenance plan. · BMU (Bridge Management Unit) is established in NHA headquarters. · BMS organization is gradually established in NHA, who will implement BMS in a sustainable manner. **Pre-Conditions** · Pakistan, especially Islamabad and Lahore, is continuously safe enough for JICA Expert Team to implement the activities. **<Issues and countermesures>**