Kingdom of Bhutan

FY2015 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Reconstruction of Bridges (Phase 3)"

External Evaluators: Yuko Kishino and Ryuji Kasahara, IC Net Limited

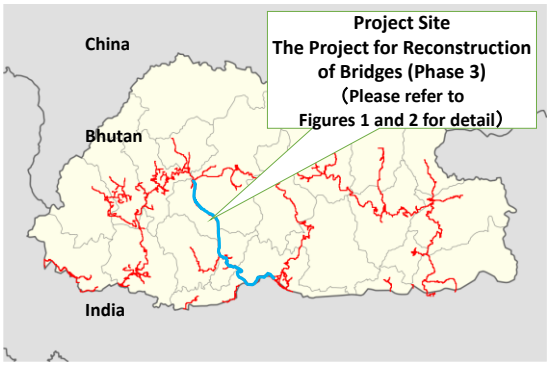
0. Summary

The project was implemented in order to secure stable transportation of people and goods, and contribute to the improvement of the local economy by reconstructing six temporary bridges (Lawakha Bridge, Basochu Bridge, Nyarachu Bridge, Burichu Bridge, Chanchey Bridge, and Loring Bridge) into permanent bridges. The bridges are located along National Road 5, one of the main roads running north and south in Bhutan.

The project has high relevance because it is in accordance with the road development plan and development needs of Bhutan at the time of both planning and the ex-post evaluation as well as with Japan's aid policy at the time of planning. Although the output as a whole was not changed and the project expense was kept within the budget, the project period was extended from the original plan. Therefore, the efficiency of the project is fair. Target values of travel distance for large-sized vehicle and maximum vehicle tonnage that can pass over the bridges have been set as indicators of output, and were achieved. Stable transportation of people and goods as well as improvement of the local economy have been confirmed by the results of interviews with the stakeholders and a survey of beneficiaries. Therefore, the project achieved high effectiveness and impact. Although the bridges that were reconstructed in the project have been maintained on a daily basis, they have some problems in terms of institution, technology, and finance for carrying out periodic and other necessary maintenance. Therefore, the sustainability of the project is fair.

In light of the above, this project is evaluated to be satisfactory.

1. Project Description



Project Locations[1]

The Roads Improved by the Project[2]

[1] Processed a blank map (http://creativecommons.org/licenses/by-sa/3.0) (as of March 15, 2016)The red lines indicate the

1.1 Background

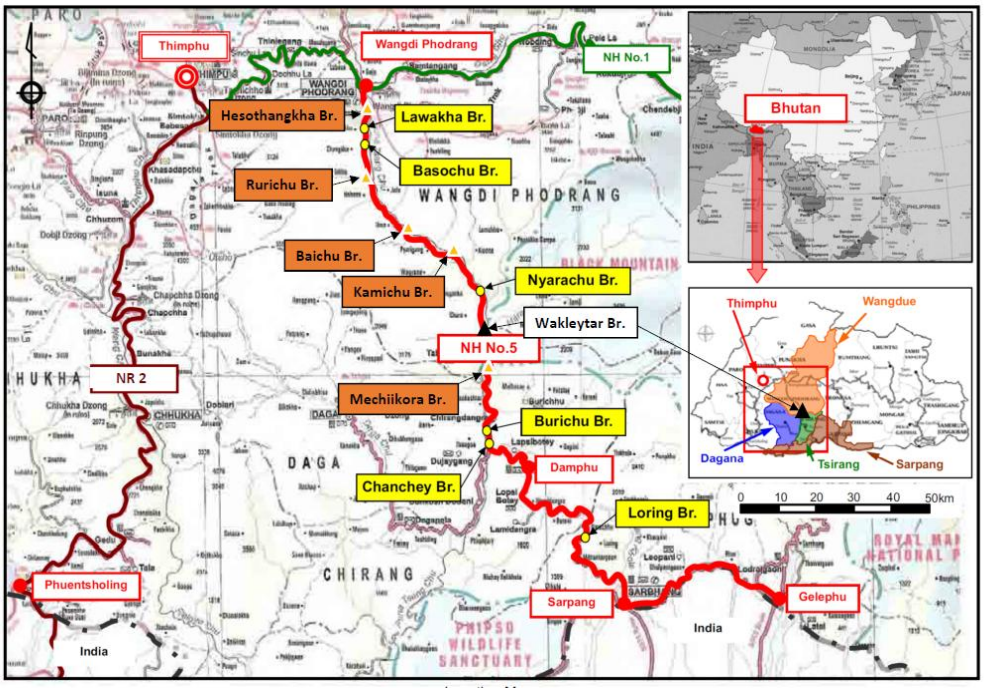
Most parts of Bhutan are in a mountainous area and road traffic is the only mode of transportation. Development of roads and bridges is always a prioritized issue of development in Bhutan. The Government of Bhutan has been developing an arterial road network that connects main cities across the country. However, many of the bridges along the arterial roads were temporary bridges constructed from 1970 to 1980.[3] They have been deteriorating and have reached the end of their life cycle. Under these circumstances, upon a request from the Government of Bhutan, the Government of Japan researched the relevance of reconstructing the bridges by conducting the "Study on National Highway Bridge Construction" (from 1997 to 1998) on the 22 bridges that are considered to have urgent needs of reconstructing. Subsequently, out of the 22 bridges researched, "The Project for Reconstruction of Bridges" (from 2001 to 2003) for the most prioritized five bridges and "The Project for Reconstruction of Bridges (Phase 2)" (from 2005 to 2007) for three other bridges were implemented and completed through grant aid. Following the two grant aid projects above, the project focused on the remaining eleven bridges out of the 22 bridges along National Road 5, and reconstructed six bridges with Japanese grant aid and five bridges with funds from Bhutan.[4] Figure 1 and Figure 2 show the locations of the bridges in the project as well as the road network of Bhutan.

arterial road network of Bhutan.

[2] Document provided by JICA (taken around March 2013.) The new Loring Bridge is at the front and the old Loring Bridge is at the back in the photograph. The old Loring Bridge was removed after the completion of the new Loring Bridge and does not exist anymore.

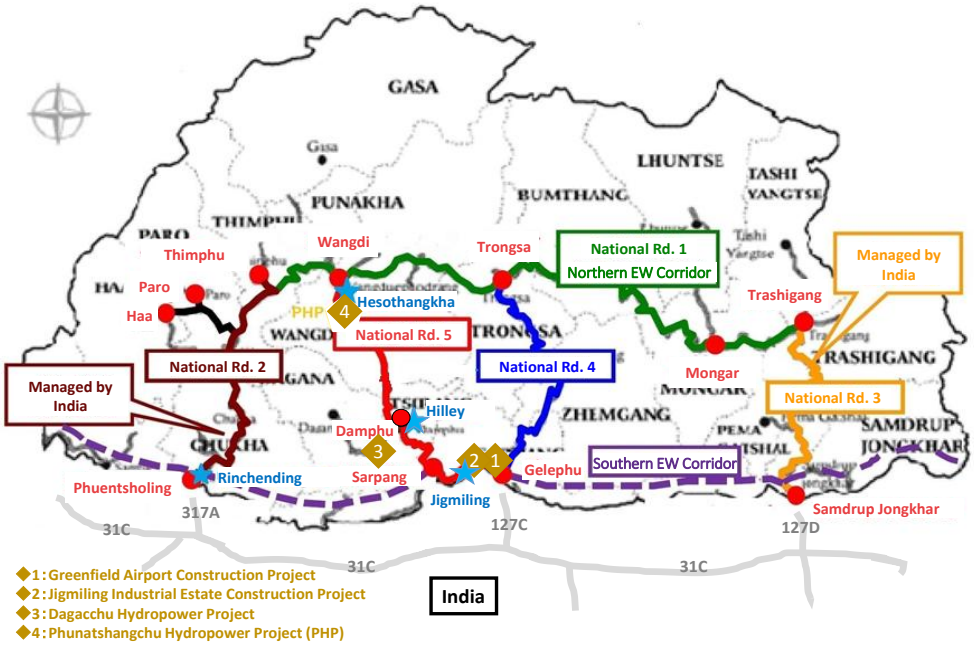
[3] For an image of a temporary bridge, please refer to Picture 1. The bridge is called Bailey Bridge by the local people.

[4] Among the five bridges, the reconstruction of Hesothangkha Bridge was implemented as a part of the Phunatshangchu Hydropower Project aided by the Government of India.



Source: Edited the map in Basic Design Study Report on The Project for Reconstruction of Bridges (Phase 3), JICA (2008)
[Legend] Br.: Bridge, NR: National Road Note: The yellow boxes indicate the bridges constructed by Japan, and the brown boxes indicate the bridges constructed by Bhutan. The bridge marked by a white box (Wakleytar Bridge) was reconstructed under the "The Project for Reconstruction of Bridges (Phase 2)".

Figure 1: Location Map of the Bridges Reconstructed in "The Project for Reconstruction of Bridges (Phase 3)"



Source: Edited the Map of Data Collection Survey on Road Connectivity in the Kingdom of Bhutan, JICA (2014)
[Legend] EW corridor: East-West Corridor, Rd.: Road, Red marks ● indicate major cities, blue marks ★ indicate observation points for traffic counts survey, and the yellow marks ◆ indicate locations of development projects.
Note: Southern East-West Corridor, shown by the dotted line, is not completed yet.

Figure 2: Major Roads in Bhutan and Locations of the Project (National Road 5)

E/N Grant Limit or G/A Grant Amount / Actual Grant Amount		62 million yen / 61 million yen (Detailed Design) 2,494 million yen / 2,432 million yen (Actual Project)
Exchange of Notes Date (/Grant Agreement Date)		June 2009 (/ June 2009)
Implementing Agency		Department of Roads, Ministry of Works and Human Settlement
Project Completion Date		March 2013
Project practitioners	Main Contractor	Dai Nippon Construction
	Main Consultants	Joint venture of INGÉROSEC Corporation and CHODAI CO., LTD.
Basic Design		From March 2008 to December 2008
Detailed Design		From March 2009 to September 2009
Related Projects		Technical cooperation ● Senior Volunteers (Department of Roads, Job category: Construction; Subject of instruction: Bridge design from 2013 to 2015) Grant Aid Projects ● The Project for Improvement of Equipment for Road Construction and Maintenance (1987) ● The Project for Improvement of Equipment for Road Construction and Maintenance (Phase 2) (1995) ● The Project for Reconstruction of Bridges (From 2001 to 2003) ● The Project for Improvement of Machinery and Equipment for Road Construction (2003) ● The Project for Reconstruction of Bridges (Phase 2) (From 2005 to 2007) ● The Project for Restoration and Improvement of Vital Infrastructure for Cyclone Disasters (From 2011 to 2014)

1.2 Project Outline

The objectives of the project are to secure stable transportation of people and goods and to contribute to the improvement of the local economy by reconstructing six temporary bridges (Lawakha Bridge, Basochu Bridge, Nyarachu Bridge, Burichu Bridge, Chanchey Bridge, and Loring Bridge) into permanent ones at four Districts (Wangdi District, Dagana District, Tsirang District, and Sarpang District) along National Road 5, one of the main roads running north and south in Bhutan.

2. Outline of the Evaluation Study

2.1 External Evaluator

Yuko Kishino, IC Net Limited

Ryuji Kasahara, IC Net Limited

2.2 Duration of Evaluation Study

For this ex-post evaluation, the study was implemented as follows:

Duration of the Study: July 2015–September 2016

Duration of the Field Study: October 23–November 5, 2015 and February 1–6, 2016

3. Results of the Evaluation (Overall Rating: B[5])

3.1 Relevance (Rating: ③[6])

3.1.1 Relevance to the Development Plan of Bhutan

At the time of both planning and ex-post evaluation, the road development including bridges was a priority issue for Bhutan, a country that has no major means of transportation other than road. Bhutan has five main national roads, and the roads that link the capital Thimphu to India are National Road 2 and 5. National Road 5, with bridges having been improved under the project, is the only government-managed national road that links the capital city to India.[7] Furthermore, the Tenth Five Year Plan (2008‐2013), a national development plan at the time of planning, prioritized the construction of a road[8] that provides accesses to a hydropower generation site. National Road 5 is used for the transportation of materials to the hydropower generation site. Thus, the project can contribute to the objectives of the national development plan.

According to an interview with the Department of Roads, the development of National Road 5 has been systematically implemented as a part of the road network development in Bhutan together with maintenance projects of National Road 4 and rural roads by other donors' aid.[9] In other words, the project can be evaluated to show high relevance with the development policy of Bhutan because it constitutes an important part of a major road development plan.

3.1.2 Relevance to the Development Needs of Bhutan

At the time of both planning and ex-post evaluation, the project met the development needs of Bhutan, and it was a prioritized project for the Government of Bhutan.

At the time of planning, only vehicles of 18 tons or less could pass over the bridges on National Road 5, and National Road 2 was the only passable road for large-sized vehicle of the roads that connected the capital city with the southern area. Therefore, the project was also expected as the development of an alternative road to National Road 2 that connects Thimphu, the capital city of Bhutan, with India. At the time of ex-post evaluation, the roads that connect Thimphu with India are still National Road 2 and 5 only, and the importance of National Road 5 has not changed.

Neighboring development projects along National Road 5 (for example, ◆3 and ◆4 in Figure 2)[10] and those in the southern area (for example, ◆1 and ◆2 in Figure 2)[11] have high demand for

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[5] A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

[6] ③High; ② Fair; ① Low

[7] National Road 2 is operated and maintained by an Indian project .

[8] In Bhutan, hydropower generation is a major source of electricity in domestic consumption as well as an important means to acquire foreign currency by selling electricity to India. At the time of the Tenth Five Year Plan, the Electric Power Sector accounted for 25% of GNP and 40% of the national revenue. Development of hydropower generation plays a significant role in the economic growth of Bhutan.

[9] Second Rural Access Project (World Bank), Rural Road Project between Gelephu and Trongsa (Asian Development Bank)

[10] Mainly Phunatshangchu Hydropower, Dagachhu Hydropower, and the development project of rural village roads in Tsirang District and Dagana District

transportation of materials and heavy equipment by large-sized vehicle. Therefore, the project, which improved the load-bearing capacity of the bridges along National Road 5, met the demand. However, according to the interview with the Department of Roads and a constructor, despite an increase in transportation of materials via National Road 2 and National Road 5 from India to the southern area, the main transportation route to import materials for development projects is a direct route via Gelephu to the southern area. Thus, use of the bridges reconstructed in the project is limited.[12]

Before the reconstruction, narrow widths of the bridges caused restriction of two-way traffic, leading to traffic accidents. To improve traffic ability and safety, demand was high for widening the bridges at the time of planning. Since the reconstruction, the bridges have sufficient width to allow small vehicles to pass safely in two-way traffic.

3.1.3 Relevance to Japan's ODA Policy

The rolling plan toward Bhutan (final version on March 2008) at the time of the Basic Design (2008) stated that "the road network was the only means of transportation in Bhutan, where no railroads or domestic flights were available, and it was in very poor condition and drastically insufficient." It also declared continuous implementation of reconstruction of the bridges. Therefore, it can be evaluated that the project was relevant to Japan's ODA Policy at the time of planning.

3.1.4 Relevance to Appropriateness of Project Planning and Approach

As a direct effect of the project, Basic Design cited that the travel distance of large-sized vehicle (of 18 tons or over) between the capital city (Thimphu) and the local city (Gelephu) would shorten through switching the route from National Road 2 via India to National Road 1 and 5.

Therefore, here it will be confirmed whether the following items are appropriate for making the effect mentioned above visible: 1) choice of the six bridges to be reconstructed in the project, and 2) setting the load-bearing capacity to 40 tons.

(1) Appropriateness of choosing the six bridges to be reconstructed

There are also some bridges with a load-bearing capacity of 18 tons or less along National Road 5, which are located outside the section improved by the project (Sarpang-Gelephu). Thus, completion of the project alone does not mean that reconstruction of all bridges between Thimphu and Gelephu, as stated in the Basic Design Report, has been completed and large-sized vehicle can pass over all bridges along National Road 5.

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[11] Jigmiling Industrial Estate Construction Project and Greenfield Airport Construction Project

[12] For details on the change in the traffic volume, please refer to "3.3 Effectiveness 3.3.1 (2) Annual average daily volume of traffic."

Actually, two bridges between Sarpang and Gelephu, namely Dolkhola Bridge and Jigmiling Bridge, were reconstructed in "The Project for Restoration and Improvement of Vital Infrastructure for Cyclone Disasters" (2011–2014), a grant aid project implemented after the project,[13] and this strengthened the load-bearing capacity of the two bridges to 70R (100 tons)[14], which enabled large-sized vehicle to pass over all bridges along National Road 5.

Regarding these circumstances, an interview revealed the recognition by the Department of Roads that "load-bearing capacity of the two bridges did not hinder transport of materials by large-sized vehicle at the time of Basic Design of the project because the low water level of the river during the dry season allows large-sized vehicle to cross the river directly without the two bridges." In addition, the consultant of construction management stated that "conducting consultation including the bridges between Sarpang and Gelephu could also have been considered. However, in consideration of the budget limit, consultation on the project made progress by providing other cooperation to the bridges between Sarpang and Gelephu."

Based on the above, it has been found that reconstruction of the bridges between Sarpang and Gelephu had not been a major point of the project from the beginning of the project planning and people who were involved in the project did not recognize the bridges between Sarpang and Gelephu as a big obstacle to the traffic of large-sized vehicle at the time of the Basic Design. In other words, among the bridges on National Road 5, it was the targeted bridges of the project that hindered large-sized vehicle from passing through. Therefore, it can be said that the project appropriately dealt with the issue.

(2) Appropriateness of load-bearing capacity

A load-bearing capacity of 40 tons was set as the standard for reconstruction by Japan in the project after consultation between the Department of Roads and the JICA study team at the time of the Basic Design.

Although the Department of Roads requested a load-bearing capacity of 70R (100 tons) at the consultation, the two parties have reached an agreement on a load-bearing capacity of 40 tons for the following two reasons:

1) The load-bearing capacity of Wakleytar Bridge, already reconstructed under "The Project for Reconstruction of Bridges, (Phase 2)", is 40 tons. Therefore, the whole of National Road 5 would lack consistency in the load-bearing capacity if a load-capacity of 70R (100 tons) was set for the project.

2) One vehicle of 70R (100 tons) can pass over the bridges with a load-bearing capacity of 40 tons, which is the standard proposed by JICA, if the vehicle passes slowly with the utmost caution.

[13] The ceremony for the completion of the bridges was held in March 2013.
[14] Road Design Standard of India (Indian Road Congress: IRC). A bridge designed with 70R will have a load-bearing capacity of up to 100 tons (vehicle with wheels.)

However, there is inconsistency in design because the bridges funded by Bhutan have been designed with load-bearing capacity of 70R (100 tons) in accordance with the standard for a bridge on national roads. The Department of Roads recognized that there was substantially no problem because the bridges funded by Bhutan followed the national standard, and the bridges funded by Japan had the capability to endure vehicles of 70R (100 tons).

As seen above, this project has been highly relevant to Bhutan's development plan and development needs, as well as Japan's ODA policy through the appropriateness of project plan and approach. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

Table 1 and Table 2 show a comparison between the plans and results in project output. There were no changes in output that would affect the project objectives, which are actualization of large-size vehicle traffic and shortening of travel distance between Thimphu and Gelephu.

As the cutting of the mountain slope posed a risk of falling rocks at Loring Bridge, two construction works for slope protection and one additional construction work to prevent the bridge from being damaged by falling rocks were carried out. These construction works can be seen as a plan to reinforce the project impact, which is to secure the stable transportation of people and goods, rather than as a change of output.

As seen above, outputs were implemented mostly as planned.

Table 1: Plans and Results in the Project Output (Six Bridges Funded by Japan)

		Plan	Result	Any change
1. Lawakha Bridge	Load-bearing capacity	40 tons (IRC Class A)	40 tons (IRC Class A)	As planned
	Length	45.0 m	45.0 m	As planned
	Width	6.0 m (two-lane)	6.0 m (two-lane)	As planned
2. Basochu Bridge	Load-bearing capacity	40 tons (IRC Class A)	40 tons (IRC Class A)	As planned
	Length	40.0 m	40.0 m	As planned
	Width	6.0 m (two-lane)	6.0 m (two-lane)	As planned
3. Nyarachu Bridge	Load-bearing capacity	40 tons (IRC Class A)	40 tons (IRC Class A)	As planned
	Length	40.0 m	40.0 m	As planned
	Width	6.0 m (two-lane)	6.0 m (two-lane)	As planned
4. Burichu Bridge	Load-bearing capacity	40 tons (IRC Class A)	40 tons (IRC Class A)	As planned
	Length	50.0 m	50.0 m	As planned
	Width	6.0 m (two-lane)	6.0 m (two-lane)	As planned
5. Chanchey Bridge	Load-bearing capacity	40 tons (IRC Class A)	40 tons (IRC Class A)	As planned
	Length	45.0 m	45.0 m	As planned
	Width	6.0 m (two-lane)	6.0 m (two-lane)	As planned
6. Loring Bridge	Load-bearing capacity	40 tons (IRC Class A)	40 tons (IRC Class A)	As planned
	Length	70.0 m	70.0 m	As planned
	Width	6.0 m (two-lane)	6.0 m (two-lane)	As planned

Source: Basic Design Report; materials provided by JICA

Table 2: Plans and Results in the Project Output (Five Bridges Funded by Bhutan)

		Plan	Result	Any change
1. Hesothangkha Bridge	Load-bearing capacity	70 R (100 tons)	70 R (100 tons)	As planned
	Length	31.0 m	31.0 m	As planned
	Width	7.0 m (two-lane)	7.0 m (two-lane)	As planned
2. Rurichu Bridge	Load-bearing capacity	70 R (100 tons)	70 R (100 tons)	As planned
	Length	30.0 m	30.0 m	As planned
	Width	7.0 m (two-lane)	7.0 m (two-lane)	As planned
3. Baichu Bridge	Load-bearing capacity	70 R (100 tons)	70 R (100 tons)	As planned
	Length	16.0 m	16.0 m	As planned
	Width	7.0 m (two-lane)	7.0 m (two-lane)	As planned
4. Kamichu Bridge	Load-bearing capacity	70 R (100 tons)	70 R (100 tons)	As planned
	Length	21.0 m	21.0 m	As planned
	Width	7.0 m (two-lane)	7.0 m (two-lane)	As planned
5. Mechiikora Bridge	Load-bearing capacity	70 R (100 tons)	70 R (100 tons)	As planned
	Length	21.0 m	21.0 m	As planned
	Width	7.0 m (two-lane)	7.0 m (two-lane)	As planned

Source: Materials from the implementing agency

Photograph 1 and Photograph 2 show a comparison of before and after the construction work of Burichu Bridge.

Photograph 1: Before Construction Work[15]

Photograph 2: After Construction Work[16]

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total cost of the project[17] amounted to 2,493 million yen, 97% of the budget of 2,556 million yen at the time of planning. Table 3 shows a summary of planned cost, actual cost, and percentage against the planned cost borne by Japan and Bhutan. The cost borne by Japan was lower than planned, totaling 98% of the planned cost. According to an interview with the Department of Roads, the unit costs of the materials used for bridges funded by Japan were higher than those used for other bridges. In contrast, the Department of Roads recognized that using high-priced materials lowered maintenance cost. Therefore, it is fair to say that the investment (cost) from Japan is appropriate.

[15] Materials provided by JICA (Burichu Bridge, a condition before construction work)
[16] Materials provided by JICA (Burichu Bridge, a condition after construction work)
[17] Including the cost of the detailed design and the cost borne by Bhutan

The cost borne by Bhutan was higher than planned, totaling 154% of the planned cost when calculating in the local currency. The main reason for this is that the cost for the reconstruction of five bridges implemented by Bhutan was higher than planned. It was 94% of the planned cost when calculated in yen currency owing to a strong yen. In addition, construction insurance covered the cost for countermeasure construction against falling rocks, so that the project cost itself has not been affected. Thus, it can be said that the project cost stayed within the planned amount.

Table 3: Project Cost (Unit: million yen)

		Planned Cost	Actual Cost	% against the planned cost
A	**Cost borne by Japan (million yen)**	2,556(1)	2,493(2)	98%
B	**Cost borne by Bhutan (1,000 Nu)**	39,747(3)	61,243(4)	154%
C	**Cost borne by Bhutan (million yen)(5) (6)**	114	107	94%
D	**Total cost (A+C=D)**	2,670	2,600	97%

Source: Materials provided by JICA and the implementing agency

Note 1: G/A Grant Amount (including Detailed Design); Note 2: Including the Detailed Design; Note 3: Planned value at the time of Basic Design; Note 4: From material of the 1st Field Study; Note 5: Planned value: Basic Design (At the time of adding: May 2008, exchange rate: 1US$ = ¥107.97, 1Nu. = ¥2.87 (average value from November 1, 2007 to April 30, 2008) Actual value: the 1st Field Study (average value from June 19, 2009 to March 21, 2013, exchange rate: 1Nu.*= ¥1.74)* Using India currency, calculate with 1BTN = 1IDR because exchange data of IMF does not have information about Bhutan's currency; Note 6: Hesothangkha Bridge was reconstructed as a part of a hydropower development project aided by India. Therefore, the Department of Roads was not involved in the reconstruction of the bridge.

3.2.2.2 Project Period

The actual period of the project was 48.3 months, slightly longer than the planned period of 45 months, 107% of the planned time.[18] Table 4 shows a summary of the planned period, actual period and percentage against the planned period. Because the planned period for construction funded by Bhutan is not available, it is impossible to compare the planned period with the actual period. However, it is known that all construction of the bridges funded by Bhutan was completed before the construction funded by Japan had been completed. Thus, the project period for construction funded by Bhutan did not give a negative impact on the project results.

[18] When not including detailed design and looking at only the construction period, it was 109% of the planned period including countermeasure construction against falling rocks of Loring Bridge, and 103% not including countermeasure construction against falling rocks. From these results above, the actual period was slightly longer than the planned period.

Table 4: Project Period

	Plan (month)	Actual Result (month)	% against the planned period
Project Period (Detailed design + main construction) (1)	45.0	48.3	107%
Reference data: main construction period			
Period when cost was borne by Japan (not including countermeasure construction against falling rocks)(2)	37.5	38.5	103%
Period when cost was borne by Japan (including countermeasure construction against falling rocks)(3)	37.5	41.0	109%
Period when cost was borne by Bhutan(4)	–	31.5	Unknown

Source: Materials provided by JICA and the implementing agency
Note 1: Whole project (detailed design and main construction)
Plan: March 13, 2009 (concluding G/A) up to 45 months
Actual result: March 13, 2009 (concluding G/A) to March 21, 2013 (completion date) (including countermeasure construction against falling rocks), 48.3 months
Note 2: Main construction only (when not including countermeasure construction against falling rocks)
Plan: October 26, 2009 (date of starting construction) up to 37.5 months
Actual result: October 26, 2009 (date of starting construction) to January 10, 2013, 38.5 months (completion date of Loring Bridge)
Note 3: Main construction only (when including countermeasure construction against falling rocks)
Plan: October 26, 2009 (date of starting construction) up to 37.5 months
Actual result: October 26, 2009 (date of starting construction) to March 21, 2013, 41.0 months (completion date)
Note 4: April 22, 2010 (starting construction of Baichu Bridge and Kamichu Bridge) to December 3, 2012 (completion of Hesothangkha Bridge)

Consequently, although the project cost remained within the plan, the project period exceeded the plan. Therefore, the efficiency of the project is fair.

3.3 Effectiveness[19] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

The effectiveness of the project was evaluated by reference to the two output indicators written in the Ex-Ante Project Evaluation (made at the time of basic design). The indicators are as follows: Indicator 1: maximum number of tons of trafficable vehicles; and Indicator 2: travel distance (large-size vehicles).[20] Also, as reference information, the travel time (Effect Indicator) and the annual average daily volume of traffic (Operation Indicator) were adopted. Table 5 shows the baseline, the target and the results.

(1) Improvement of access by large-size vehicles

Indicator 1: The maximum number of tons of trafficable vehicles is reinforced to 40 tons as projected, accomplishing the goal at the time of the project completion and the ex-post evaluation. The load-bearing abilities of five bridges reconstructed by Bhutan were all reinforced

[19] Rating for judgement of effectiveness is made in consideration of Impact.
[20] In the Ex-Ante Project Evaluation (made at the time of the basic plan) the passage route of large-sized vehicles starting from the capital Thimphu to Gelephu is supposed to change from Thimphu → National Road 2 → via India → Gelephu to Thimphu → National Road 1 → National Road 5 → Gelephu.

to 70R (100 tons). This has made it possible for large-size vehicles to run safely and smoothly on all the twelve bridges along National Road 5 between Wangdi and Sarpang, including Wakleytar Bridge which was reconstructed under "The Project for Reconstruction of Bridges (Phase 2)".

Indicator 2: The target value of the travel distance (large-size vehicles) was achieved. As the definition of a large-sized vehicle was not made clear at the time of planning, it has been defined as "a vehicle of more than 18 tons and equal to or less than 40 tons" as a matter of convenience for the evaluation. On the basis of the definition, the target length for which the project would make it possible for large-size vehicles to run smoothly is not "about 260 km from the capital (Thimphu) to the southern city (Gelephu)" as shown in the Ex-Ante Project Evaluation, but it is actually 160 km, which does not include about 70 km along National Road 1 from the capital Thimphu to Wangdi and about 30 km from Sarpang to the southernmost town (Gelephu) along National Road 5 where bridge reconstruction was not carried out under the project[21]. As a result of the project, the 160 km became trafficable for large-size vehicles. In addition, according to the parties involved, the load-bearing capacity of the two bridges between Sarpang and Gelephu was strengthened by the "Project for Restoration and Improvement of Vital Infrastructure for Cyclone Disaster", a grant aid project of JICA implemented between 2011 and 2014, and completed after the project, and it was possible at the time of the ex-post evaluation for large-size vehicles that weigh between 18 and 40 tons to run smoothly on the nearly 260-km road between Thimphu and Gelephu.

Reference Indicator: An interview on travel time was conducted with taxi drivers and transport operators.[22] It was found that the travel time between the capital Thimphu and Sarpang[23] used to take nearly ten hours but had shortened by about an hour and a half and was eight and a half hours in the case of using National Road 5 at the time of the ex-post evaluation. However, it is necessary to note that the reduction has been caused not only by the project but also the national governmental projects and the road widening under the hydropower generation project supported by the Indian government.

[21] After the capacity of flyover at Semtokha located near to Thimphu was enhanced by Department of Roads in 2004, the loading capacity of National Road 1 was improved. However, as the bridge reconstruction of this section was included in the project (phase 3), the length 70km was excluded from the project indicator.

[22] A questionnaire survey was carried out for 30 taxi drivers at a taxi stand in Thimphu. Also interviews were conducted on four transport operators.

[23] In the hearing survey, information about travel time between Thimphu and Sarpang was collected.

Table 5: Effect Indicator

	Baseline 2008	**Target 2012**	**Result 2013**	**Result 2015**	
	Baseline Year	Expected Completion Year	Completion Year	After Completion	Target Achieve-ment
Indicator 1: Maximum number of tons of trafficable vehicles					
A. Support by Japan (6 bridges)	18 (minimum)	40	40	40	achieved
B. Operation by Bhutan (5 bridges)	8 (minimum)	Not set	100	100	achieved
Indicator 2: Travel distance (km)					
Thimphu ⇔ Gelephu	About 380(1)	About 260(2)	About 260(2)	About 260(2)	achieved
(Wangdi ⇔ Sarpang)		About 160(3)	About 160(3)	About 160(3)	
Reference Indicator: travel time (hours)					
A1. National Road 2	About 7	Not set	About 5.5	About 5.5	
A2. Via India	About 5	Not set	About 5	About 5	
B. National Road 1-Via National Road 5	About 9.75	Not set	About 8.25	About 8.25	shortened

Source: documents provided by JICA, documents provided by the Department of Roads, survey on parties involved
Note 1: Thimphu – National Road 2 – via India – Gelephu
Note 2: Thimphu – National Road 1 – National Road 5 – Gelephu
Note 3: Target zone of the project

(2) Annual average daily volume of traffic

As for the annual average daily volume of traffic, the target was not set in the Ex-Ante Project Evaluation (made at the time of the basic design) and no study was carried out on traffic demand forecast at the time of the basic design. At the time of the ex-post evaluation, the increase and decrease of vehicles before and after the project was confirmed using the number[24] of vehicles running on the roads measured twice a year by the Department of Roads.

The four observation points of the Department of Roads used for the ex-post evaluation were as follows: (1) Hesothangkha (the north end of the northern zone), which is a point along National Road 5 near Wangdi; (2) Hilley (the north end of the southern zone); (3) Jigmiling (southern area); and (4) Rinchending, which is a point along National Road 2 near Phuentsholing, near the Indian border (point ★ on the map in Figure 2).[25] Figure 3 shows the information before and after[26] the project of each point.

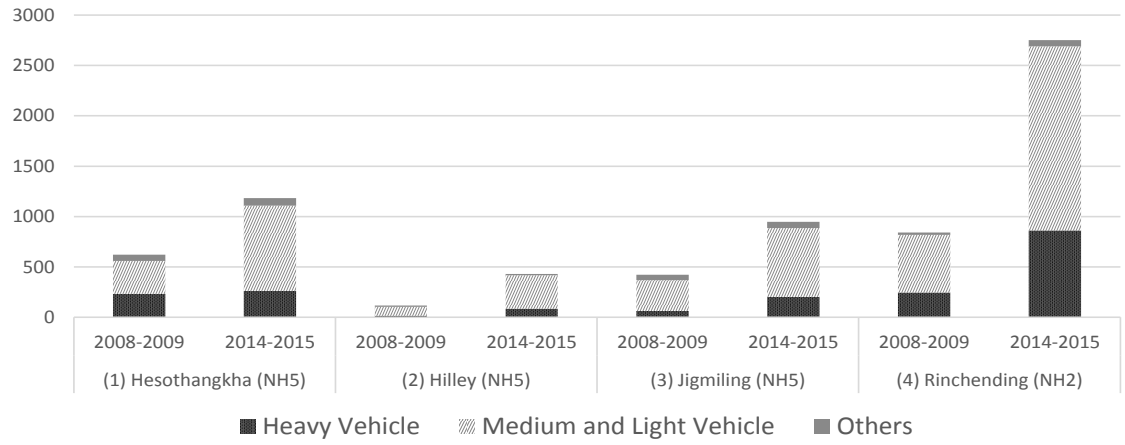
[24] The Department of Roads conducts a fixed-point observation of vehicles running on roads for two weeks around February and September every year. As the observation time is during 6 a.m. and 6 p.m., the number of vehicles running after 6 p.m. has not been counted.

[25] The observation points (1), (2) and (3) were chosen on the assumption that changes in the zones by reconstruction of the project could be observed, and the point (4) on the assumption that changes on National Road 2 could be observed.

[26] "Before" shows the average of the four measured values from the basic design survey and the detail design survey in 2008 and 2009, and "after" shows the average of the four measured values in 2014 and 2015 in consideration of the project having been finished in 2013. However, information on the following points has not been included as it was not obtained, and these are missing values: (1) the survey results from the first observation in 2008 and the second in 2009 at the Hesothangkha point; (2) the survey results from the first and the second in 2015 at the Hilley point; (3) the

In comparison of the traffic volume between before and after the project at the observation points (1), (2), and (3) along National Road 5, the traffic volume has increased overall. Large-sized vehicles using the roads have also increased, though the rate of increase is not as high as that for private vehicles. The information of the observation point (4) indicates clearly that the traffic volume on National Road 2 increased at the same time; however, it is not clear whether some shifted to National Road 5 as an alternate road.

The comparison of the results from the observation points (1), (2), and (3) indicates that the traffic volume at point (2) is less than the one at point (1) in the north end of National Road 5, and the one at point (3) in the southern area. Thus, it is fair to say that the traffic volume in the middle point tends to be less than other areas along National Road 5.



Source: documents provided by the Department of Roads

Note: "Heavy Vehicle" means a motor vehicle exceeding 10 tons gross vehicle weight (which is not a bus) or a bus seating more than 25 adults (including the driver), "Medium Vehicle" means a motor vehicle (which is not a bus) exceeding 3 tons but not exceeding 10 tons gross vehicle weight or a bus seating between 13 and 24 passengers, "Light Vehicle" means a motor vehicle (which is not a two-wheeler) seating not more than 12 adults (including the driver) and not exceeding 3 tons gross vehicle weight.

Figure 3: Annual Average Daily Volume of Traffic before and after the Project

3.3.2 Qualitative Effects

Please refer to the section on Impact.

3.4 Impacts

3.4.1 Intended Impacts

In the project "realizing (1) improvement of running performance and safety and (2) improvement of regional economy" were expected to be achieved by reconstructing bridges along National Road 5. In the ex-post evaluation, the following were confirmed about the above two impacts by means of an interview and questionnaire survey for parties involved.

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survey results from the first observation in 2008 and the second in 2009, and the second in both 2014 and 2015 at the Jigmiling point; and (4) the survey results from the first and the second in 2015 at the Rinchending point.

(1) Improvement of running performance and safety

In the interview survey for drivers of hospital ambulances, taxies and buses and a construction company [27], the problems concerning the makeshift bridges before the project were pointed out as follows: "There was a risk of tire blowouts because of nails protruding from joint and fix boards over the bridges", "To convey heavy machinery, we had to unload it, and the truck and a machinery had to run separately over the bridges", "It took longer time to pass over the bridges because only one vehicle could go at a time owing to their narrow width and unsteadiness". These indicated less convenience caused by weight limitation and aging. On the other hand, after the project, comments such as "the risk of a blowout has disappeared", "It is now possible to pass over the bridges with heavy machinery on a truck", and "Two-way traffic is now possible in two lanes for small-size vehicles" were made, proving that the above problems had been solved by the reconstruction.

Photograph 3: Material Transportation (Burichu Bridge)

In the beneficiary survey explained in (2) below, to the questions about safety improvements made by the project, 90% of respondents answered "improved". This reflects the same results of the above interview survey and shows that the reconstruction of bridges by the project could have contributed to the stable transportation of people and materials. Photograph 3 shows a truck running on the reconstructed bridge.[28]

(2) Improvement of regional economy

The beneficiary survey with questionnaire was conducted on residents in Tsirang (partially Dagana) where National Road 5 passes through. The questions were about behavioral changes of the residents (whether they use the bridges, change of time taken in their behavior) and change of commodity quantity, etc. Sampling[29] was taken with the valid responses set at 100.[30]

As there are some limitations to acquiring information, it is difficult to distinguish the

[27] A questionnaire survey was conducted on 30 taxi drivers at a taxi stand in Thimphu. Also, an interview survey was conducted on ambulance drivers working for a municipal hospital in Dagana. A hearing survey was also conducted at Construction Development Corporation Limited (CDCL), which lends and maintains equipment.

[28] The photograph was taken at Burichu Bridge in October 2015.

[29] A sample size of 97 people is necessary if the ratio significance level is set at 95%, the margin of error is 10% and the population rate is 50%.

[30] The sample size actually collected was 131 people. (65 male, 66 female) (14 between 20 and 29 years old, 33 between 30 and 39, 42 between 40 and 49, 22 between 50 and 59, 19 over 60, 1 uncertain age) (40 households in rural areas and near the bridge, 41 households in rural areas and away from the bridge, 50 households in urban areas) It was possible to obtain information of the number of households at the level of an administrative village (Gewog), but not to obtain the population registry. Sampling was carried out by means of dividing the number of households by sample size by an intended administrative village, fixing an interval and visiting houses at the intervals. Incidentally, no differences between men and women were seen in the beneficiary survey results.

attribution of this project from other factors on "influences of bridge reconstruction on stimulation of the regional economy" only by the survey. Therefore, the analysis is limited to indicating only the possibility of "positive or negative influences of bridge reconstruction on activation of the regional economy", by comparing the behavior and recognition of the beneficiaries before and after the project.

(i) Behavioral change of the residents

The questions of the survey were about 1) travel to work, 2) supply of commercial goods / services, 3) travel to administrative institutions, 4) travel to educational institutions, 5) travel to hospitals, 6) travel to markets for shopping, etc.

The results of the survey about whether they used the reconstructed bridge by the project for the above purposes five years ago and at the time of the ex-post evaluation made it clear that there was almost no change. The bridge was mainly used for three purposes; 2) supply of commercial goods and services (about 50% of the survey respondents), 5) travel to hospitals (about 20%) and 6) travel to markets for shopping, etc. (about 30%).

In contrast, a certain tendency could be seen in changes in required time for each behavior of those who answered that they used the bridge. Respondents were asked to answer how many hours (or minutes) were necessary to travel each time before and after the bridge reconstruction. For example, as for the comparison of time for supply of commercial goods and services, about 80% of respondents of households in urban areas and about 60% in rural areas answered that travel time after the reconstruction was shorter than that before. As for travel to markets for shopping, etc., about 80% of the households in rural areas near the bridge and all the households in urban areas answered that travel time after the reconstruction was shorter than that before. These results mean that the project has contributed to reducing travel time of those who use the bridge. As they use it mainly for the behaviors related to economic activities such as 2) supply of commercial goods and services and 6) travel to markets for shopping, etc., it is fair to say that the project could have contributed to stimulating the market.

(ii) Change of commodities

The questions asked about changes in variety and quantity of daily commodities. Between 60 and 70 % of respondents answered that there were wider variety and larger quantity. Table 6 shows the response rates to each question. It is considered that these show the possibility that the bridge reconstruction by the project could have contributed to improving the quality and quantity of people's daily commodities.

Table 6: Change of Commodities (unit: %)

	Variety of daily commodities	Quantity of daily commodities
More	69	63
Same	28	16
Less	3	21
Total	100	100

From the results of the beneficiary survey above, the possibility was confirmed that the project could have had positive impacts to "improvement of running performance and safety" and "improvement of regional economy" at the time of the ex-post evaluation. Because the appearance of the impacts are involved with not only the bridge reconstruction but also other factors such as the economic situation of the whole nation, improvement of access and quality of roads, development of transport operators, and others, it is difficult to conclude that there were impacts only from the results of this beneficiary survey. However, when considering comprehensively the information from the above interviews mentioned in 3.4.1(1), it is reasonable to assume that the bridge reconstruction may have some contributions to contribute to "improvement of running performance and safety" and "improvement of regional economy." The reason why it was not confirmed whether the project had directly contributed to behavioral change of the residents was that the access itself to daily necessities and public services had been ensured using the old bridge even before reconstruction. The project is not new bridge construction but reconstruction, and the objective is to improve passing possibility of large-size vehicles. In other words, the project has contributed not to ensuring access but to the reduction of travel time and to the improvement of convenience and safety of access.

3.4.2 Other Impacts

(1) Impacts on the Natural Environment

Before starting the project, the Department of Roads applied the Checklist for Environmental Clearance, which corresponded to the Initial Environmental Examination of Bhutan and acquired an Environmental Clearance Certificate on December 19, 2007. According to an interview from Environment Section, Policy and Planning Division, Ministry of Works and Human Settlement, which issued the certificate, it had been supposed that the Environment Section execute environmental monitoring. However, there were no records, and whether regular monitoring was carried out could not be confirmed.

According to the Policy and Planning Division, because the expiry date of the Environmental Clearance Certificate of environmental appraisal was set at halfway during the project (December 31, 2010), another environmental appraisal was conducted at that point.[31] From

[31] In the second Environmental Clearance Certificate (issued on December 1, 2010, expired on December 31, 2012), there were no suspected large environmental impacts. As the completion date of the project was on March 21, 2013, it was necessary to conduct an environmental appraisal to ensure that another Environmental Clearance Certificate was

December 19, 2007, when the first certificate was issued, to December 1, 2010, when the second appraisal was conducted, it is considered that there was no large negative impact on the natural environment by the project. After December 2010, there was no report of environmental monitoring by the Policy and Planning Division, and it could not be confirmed in writing at the time of the ex-post evaluation. However, there was no report either about any large negative impacts on the natural environment, according to the Department of Roads.

(2) Land Acquisition and Resettlement

As far as the above Environmental Clearance Certificate can be confirmed, there were no land acquisitions or resettlements.

According to the above, this project has largely achieved its objectives. Therefore effectiveness and impact of the project are high.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

The organization of the head office of the Department of Roads at the time of the ex-post evaluation consisted of four departments: the Design Division, Road Division, Bridge Division and Maintenance Division. Daily maintenance of bridges such as cleaning and clearing earth and sand is carried out by regional offices of the Department of Roads. And adjustment of bridge maintenance by each regional office is supervised by the Construction and Maintenance Section under the Bridge Division. The Maintenance Department is in charge of restoration works after cyclone disasters. Figure 4 shows the outline of the organization chart and the institutional aspects of maintenance of the Department of Roads.

Of the bridges reconstructed by the project, Lawakha Bridge, Basochu Bridge, and Nyarachu Bridge are maintained by Lobesa Office and Burichu Bridge, Chanchey Bridge, and Loring Bridge are maintained by Sarpang Office on a daily basis. As mentioned in the next article 3.5.2 Technical Aspects of Operation and Maintenance, there are some civil engineering technicians in each regional office, where they can deal with simple maintenance on site.

Therefore, it can be said that the institutional aspects and personnel for each unit necessary for maintenance are in place. However, the result of the interview from the personnel of the Department of Roads has shown that some matters under their jurisdiction are not clear, and some information is scattered and lost owing to the influence of several organizational changes over the years.

In consideration of experiences during the former organizational system, which had executed daily maintenance and restoration works against natural disasters appropriately, they would be

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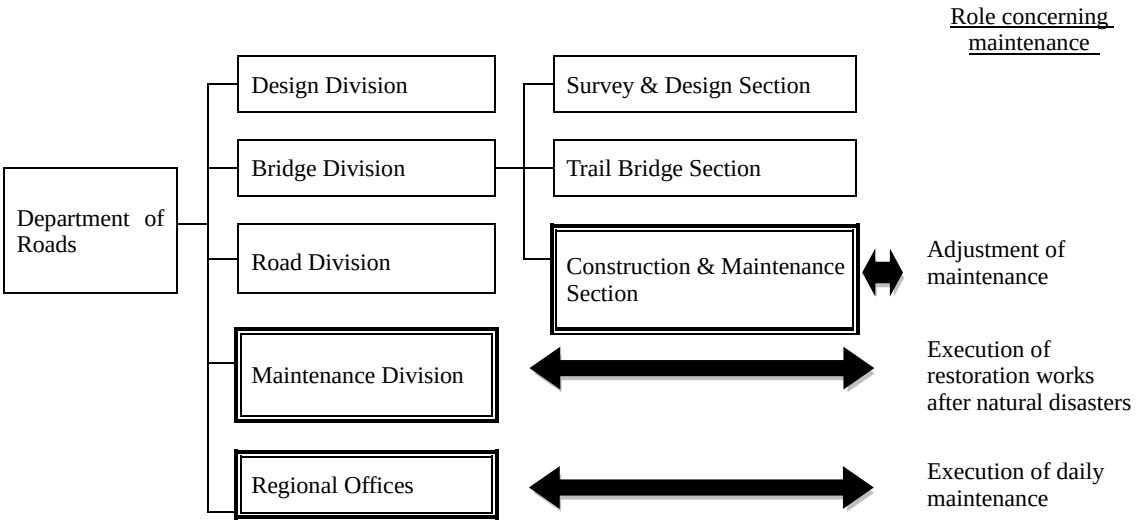
reissued by December 31, 2012. However, an appraisal and reissuance for this were not confirmed according to collected information from the Environmental Section and the Department of Roads.

able to do the same under the new system, if the personnel understood matters under their jurisdiction through training in the future and operations could get on the right track. Under the present circumstances, some problems have been observed in the institutional aspects of maintenance.



Source: documents provided by the implementing agency

Figure 4: Organization Chart and Roles of Bridge Maintenance

3.5.2 Technical Aspects of Operation and Maintenance

(1) Level of Technical Aspects of the Department of Roads

The number of the staff members in the Department of Roads was 506 at the time of the ex-post evaluation. Out of those, 243 staff members are engineers who have graduated from technical high school or university. Each section office under the regional offices manages daily maintenance of bridges as well as roads, and they assign engineer-level officers as managers of district offices. However, the number of engineers specialized in bridges (design, construction and maintenance, etc.) in the Department of Roads is limited and some regional offices have a situation where they do not know the necessary items of the bridge to be checked regularly. Although the Department of Roads intends to increase bridge experts in the future, it has no regular training system for its personnel and the Department of Roads needs to set up systems to improve its expertise of bridge maintenance.

(2) Maintenance Manual

The Maintenance Manual designed under the "Project for Reconstruction of Bridges (Phase 2)", and the Maintenance Manual for PC Bridge[32] under the project (Phase 3) were delivered to

[32] PC bridge means a bridge using prestressed concrete. PC is concrete given stress in advance. It is reportedly able to overcome the weakness of concrete that it is strong in pressure but weak in tension. (reference: Japan Prestressed Concrete Contractors Association http://www.pcken.or.jp/pubinfo/pcinfo/) (as of April 15, 2016)

those involved. However, interviews conducted at the head office of the Department of Roads and regional offices found that they had not been sufficiently used. Items to be checked for bridges were not arranged, and checklists were not made on the basis of those manuals. The Department of Roads explained that they were not used because of scattered information in the organization due to several organizational changes over the years. The Department of Roads intends to share guidelines within Department of Roads' officials again in the future.

According to the above, it is fair to say that the organization maintains basic knowledge about civil engineering, as about half of all the officers are engineers and they are assigned to the maintenance sites. Nevertheless, because it is necessary to use the existing manuals in the days ahead and nurture bridge experts, some problems have been seen in technical aspects of maintenance.

3.5.3 Financial Aspects of Operation and Maintenance

The budget for the day-to-day maintenance of roads and bridges conducted by regional offices of the Department of Roads is secured. The maintenance expenditure is allocated to each regional office based on the category and length of a road and the number of bridges. This maintenance expenditure is allotted for minor maintenance. Although this cost is divided between different budget sections for roads and bridges, reallocation is possible within these sections and to use the budget flexibly to some extent.

The budget for confirmation of disaster situations and restoration of roads and bridges damaged by monsoons conducted by the Maintenance Division of the Department of Roads is secured separately from the abovementioned maintenance expenses. However, the restoration expenses are lacking overall, and only half of the necessary budget is allocated according to an interview with the Maintenance Division of the Department of Roads. According to the chief engineer of the Maintenance Division, bridge restoration is a matter of a priority, and the budget for it after disasters are secured under the category of Restoration Costs for Bridges.

In relation to other restoration works, application must be made from the regional office to the Department of Roads, from the Department of Roads to the Ministry of Works and Human Settlement, and from the Ministry of Works and Human Settlement to the Ministry of Finance to secure budgets.

At the time of the ex-post evaluation, it was not confirmed that the Department of Roads had received a maintenance plan of bridge restoration works or secured the necessary budget for periodic maintenance (e.g., restoration works every five years) for each bridge in a planned manner.

Bhutan does not have a system for collecting special tax or usage fees for maintenance of roads and bridges. Nevertheless, when it is clear which entity uses roads or bridges, it occasionally bears the maintenance cost for the part used. For example, the Phunatshangchu Hydropower Project bore the damage restoration cost for a part of the road and the bridge along

National Road 5 that it was using. Therefore, a budget system for periodic maintenance has not been established, though budget for daily maintenance and restoration after disasters has been secured. It is necessary to establish such a system based on a maintenance plan. Thus, a few problems have been observed in financial sustainability.

3.5.4 Current Status of Operation and Maintenance

It was confirmed that checks and maintenance of road paving on bridges were carried out. For example, maintenance work is planned for road paving on Lawakha Bridge and Nyarachu Bridge because the roads started to be denuded by heavy traffic of vehicles carrying construction materials to the construction site near the bridges. During the on-site inspection, cleaning as daily maintenance work was confirmed on bridges as well as National Road 5. The cleaning is conducted by cleaning personnel (called National Work Force) staffed at certain locations.

According to interview with regional offices in charge of bridge maintenance, checks on bridge shoes,[33] which is one of the items necessary for bridge maintenance to be checked every year, has not been conducted. Offices explained that they could not do it because they did not know the necessary items to be checked and did not have any checklists. According to the Bridge Division and Maintenance Division of the Department of Roads, the Department of Roads tries to renew Bridge Lists (inventory) [34] regularly. To the extent that can be confirmed from the inventory, it seems that the items to be maintained for the bridges are not checked, though an on-site inspection was carried out for all the bridges upon renewal of the inventory. The latest inventory was made in FY 2013/2014, and the next is planned for FY2016/2017 according to the Department of Roads.

According to the above, some problems have been observed in institutional, technical and financial aspects of the operation and maintenance system. Therefore, the sustainability of the project effects is fair.

Paving Condition of a Road

[33] A bridge shoe is a member fixed between the upper and lower structure (abutment or pier) of a bridge. The basic functions are to (1) transfer the load transferred from the upper structure to the lower one without fail and (2) conform to expansion, contraction and revolution of upper structure due to live load or temperature change, etc. and absorb relative displacement of upper and lower structures. (reference: Handbook of Shoes of Roads and Bridges, Japan Road Association)

[34] Apparently, senior JICA volunteers deployed in the Department of Road advised them to create a format of the inventory.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project was implemented in order to secure stable transportation of people and goods, and contribute to the improvement of the local economy by reconstructing six temporary bridges (Lawakha Bridge, Basochu Bridge, Nyarachu Bridge, Burichu Bridge, Chanchey Bridge, and Loring Bridge) into permanent bridges. The bridges are along National Road 5, one of the main roads running north and south in Bhutan.

The project has high relevance because it is in accordance with the roads development plan and development needs of Bhutan at the time of both planning and the ex-post evaluation as well as with Japan's aid policy at the time of planning. Although the output as a whole was not changed and the project expense was kept within the budget, the project period was extended from the original plan. Therefore, the efficiency of the project is fair. Target values of travel distance for large-size vehicle and maximum vehicle tonnage that can pass over the bridges have been set as indicators of output, and were achieved. Stable transportation of people and goods as well as improvement of the local economy have been confirmed by the results of interviews with the stakeholders and a survey of beneficiaries. Therefore, the project achieved high effectiveness and impact. Although the bridges that were reconstructed in the project have been maintained on a daily basis, they have some problems in terms of institution, technology, and finance for carrying out periodic and other necessary maintenance. Therefore, the sustainability of the project is fair.

In light of the above, this project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agency

(1) Capacity Building of Personnel

The implementing agency is expected to set strategies and systems for capacity building of personnel. The interview in the ex-post evaluation has made it clear that the Department of Roads does not have long-term strategies and systems for organization reinforcement. In the short term, it seems practical to share knowledge and information of bridge maintenance by means of staff training and manuals. Meanwhile, when organizational reform takes hold, it is necessary to establish systems for regular training and prepare a framework based on a long-term perspective.

(2) Management of documents and data

It has been found that information such as manuals and data were scattered and lost in the process of organizational reforms, which the Department of Roads has implemented relatively frequently. From here on, establishing a system to manage information without being subject to excessive influence of organizational reforms is necessary. It is also necessary to examine how it

should manage information as an organization.

4.2.2 Recommendations to JICA

In light of the systems (institutional, technical, and financial) of the Department of Roads at the time of the ex-post evaluation, it is possible to execute daily maintenance of roads and bridges, but not periodic maintenance adequately. To secure the output, the impacts and sustainability of this project and the past bridge reconstruction projects, support for reinforcement of maintenance systems would be desirable.

4.3 Lesson Learned

Necessity of Following up the Recommendations

In the ex-post evaluation (2012) of the "Project for Reconstruction of Bridges (Phase 2)", prior to this project, it was recommended to the Department of Roads that guidelines, including items to be checked regularly and work procedure by reference to the Maintenance Manual developed in that project, be set in order to establish a system for periodic checking of bridges. Nevertheless, the ex-post evaluation of this project has made it clear that the Maintenance Manual has not been used adequately and a system for periodic checking has not been established, which means that the results of the ex-post evaluation have not been sufficiently acted on.

Action based on recommendations by the ex-post evaluations is usually entrusted to the implementing agency. However, especially in case of supporting the same implementing agency continuously, as with this project, it is desirable to devise ways to improve the sustainability of project effects, such as by strengthening the follow-up and monitoring recommendation contents and responses of the implementing agency by JICA overseas offices.

End