Kingdom of Bhutan

FY2016 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Restoration and Improvement of Vital Infrastructure for Cyclone Disaster"

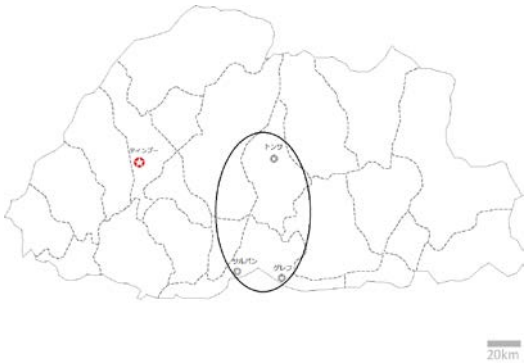
External Evaluator: Miyuki Sato, Japan Economic Research Institute Inc.

0. Summary

This project was implemented for local residents in order to improve the accessibility of a cyclone-affected area and to safeguard its accessibility from future cyclone attacks by replacing 5 bridges in the mid-interior region of Bhutan (Dolkhola Bridge, Jigmeling Bridge, Reotala (Mandechhu) Bridge, Kela Bridge and Jangbi Bridge) which had been destroyed by a cyclone, thereby contributing to the stable transport of people and goods and the improvement of the living situations of the local residents in the area. This project was consistent with the development plan and needs of Bhutan at the time of both planning and ex-post evaluation and also with the Japanese ODA policy at the time of planning. Since there was no problem with the project implementation plan or its approach, it can be confirmed that the relevance of this project is high. Also, the project was implemented mostly as planned and the project cost was within the plan. However, the project period exceeded that of the plan and thus the efficiency of the project is fair. The effectiveness and impact of the project are high because all of the 5 bridges have accomplished of "secure accessibility in case of disaster" and the stability and safety of the transportation flow at both the Dolkhola and Jigmeling bridges have been improved by the completion of concrete construction allowing the traffic volume of large vehicles, such as trucks and buses, to thusly increase. At Reotala Bridge, Kela Bridge and Jangbi Bridge, given that the bridges have become available for residents to pass over by car and the efficiency of transport and reduction of access time to the destination were realized, the effectiveness and impact are judged to be high. As for sustainability, there is no problem with the bridge's management performed by the Department of Roads, Ministry of Works and Human Settlement (hereinafter referred to as "DOR") in institutional, technical, and financial aspects; however, there needs to be consideration given to improving all institutional, technical, and financial aspects of operation and maintenance, including the current monitoring and maintenance status of bridges managed by Trongsa District; thus, the expected sustainability of project effect is moderate.

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

1. Project Description



Project Location(s) (Encircled part: targeted construction area of the bridges)

Reotala (Mangdechhu) Bridge[1] constructed in the mountain

1.1 Background

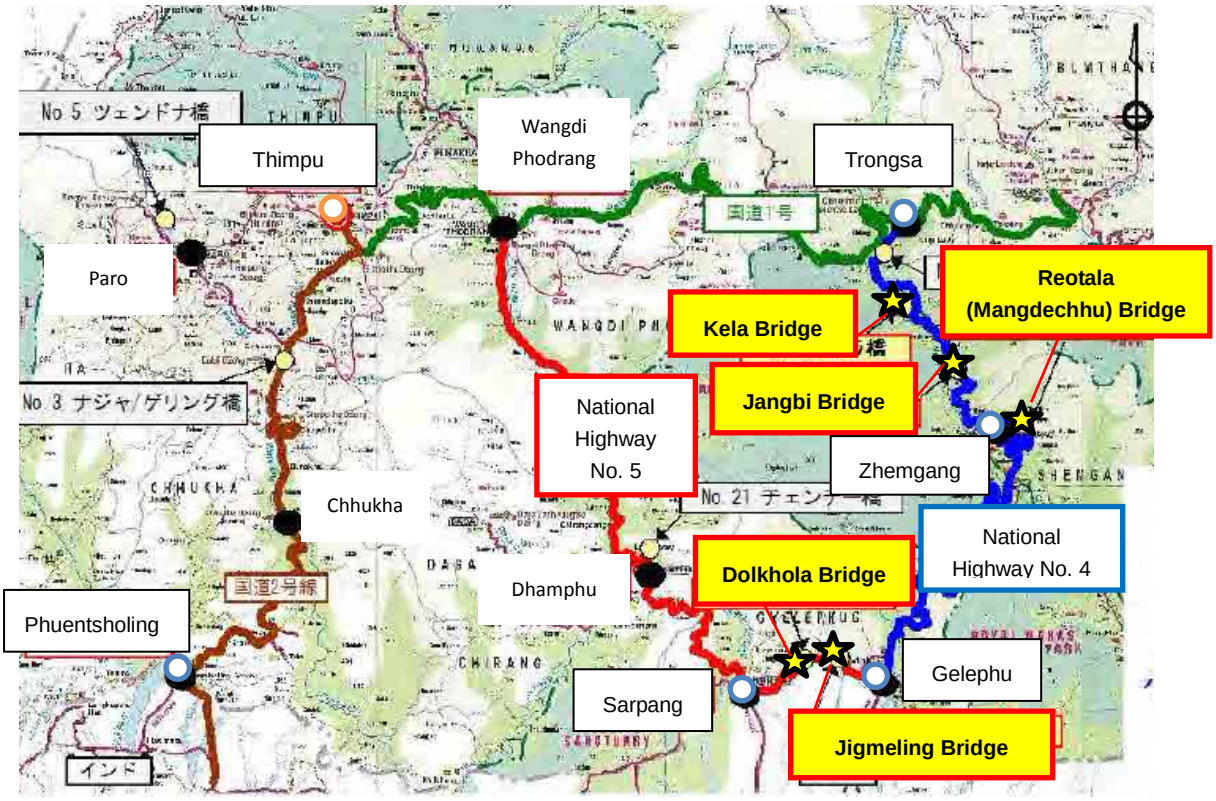
Roads and bridges are the primary means of transportation in Bhutan as most of its land is rugged and mountainous. Due to topographic constraints as mountainous area, there were only a few main roads, most of whose maintenance is not adequate. Thus it was necessary to build up efficient and safe road networks and bridges for economic and social development in Bhutan.. Cyclone Aila, which hit South Asia at the end of May 2009, brought the highest death toll (320 people) in the world during the first half of the year: more than 100,000 refugees and 100,000 destroyed houses in India, Bangladesh, and Bhutan. The cyclone which also hit Bhutan destroyed roads, bridges, schools, and healthcare facilities in many areas. The repair of those bridges and roads had not been carried out sufficiently even 2 years after the disaster, and residents in the cyclone-affected area were limited in their access to facilities necessary in daily life, such as hospitals, schools, markets etc.

1.2 Project Outline

The objective of this project was to improve and safeguard the accessibility from future cyclone attacks by restoring 5 bridges which were destroyed by a cyclone (Dolkhola Bridge, Jigmeling Bridge, Reotala Bridge, Kela Bridge and Jangbi Bridge) in the middle region of Bhutan, thereby contributing to the stable transport of people and goods and the improvement of the lives of the residents in the area.

[1] The name “Mandechhu Bridge” means “a bridge which crosses over the Mangdechhu River”, a river in which is also crossed by the Kela Bridge and the Jangbi Bridge. For this reason, people having involved themselves in the project, such as DOR, call it the “Reotala Bridge” rather than the “Mangdechhu Bridge”. Therefore, this report denominates the “Mangdechhu Bridge” as “Reotala Bridge” from this point forward.

E/N Grant Limit or G/A Grant Amount / Actual Grant Amount	1,019 million yen / 999 million yen
Exchange of Notes Date /Grant Agreement Date	August 2011 / August 2011
Executing Agency	Department of Roads, Ministry of Works and Human Settlement
Project Completion	June 2014
Main Contractor(s)	Dai Nippon Construction
Main Consultant(s)	INGEROSEC Corporation
Basic Design	November 2010 – July 2011
Related Projects	<Technical Cooperation> ・"Transportation-Capacity Development for Transport Sector"(2006 – 2007) ・"Capacity Development in Construction and Maintenance of Bridges" (2016 – 2019) <Grant Aid Project> ・The Project for Improvement of Equipment for Road Construction and Maintenance (Phase 2) (1995) ・The Project for Improvement of Machinery and Equipment for Road Construction (2003) ・"The Project for Reconstruction of Bridges" (2001 - 2003) ・"The Project for Reconstruction of Bridges (Phase II)" (2005 - 2007) ・"The Project for Reconstruction of Bridges (Phase III)" (2009 - 2013) <Other International Organization and Donor Agencies> ・World Bank: Rural Access Project (1999), Bhutan Second Rural Access Project (2007)



Source: Information provided by JICA (Partially edited map)

Figure 1. Location Map of the Project (☆ mark in the figure indicates the bridge location)

2. Outline of the Evaluation Study

2.1 External Evaluator

Miyuki Sato, Japan Economic Research Institute Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: September 2016 – October 2017

Duration of the Field Study: January 16 – February 2, 2017 and April 16 – 26, 2017

3. Results of the Evaluation (Overall Rating: B[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Consistency with the Development Plan of Bhutan

At the time of planning, in the *Tenth Five-Year Plan 2008 – 2013*, which is the mid-term development plan of Bhutan for the stated years, states that a land-locked country with developing economy like Bhutan, the expansion of strategic infrastructure is a requisite for

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

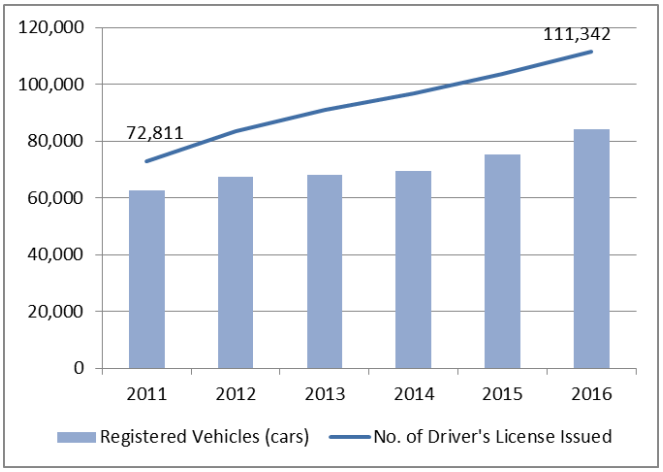
[3] ③: High, ②: Fair, ①: Low

broader economic and social transformation and national security and solidarity was to be enhanced through an expanded and improved road network. At the time of ex-post evaluation, the *Eleventh Five-Year Plan 2013 – 2018* mentioned the importance of upgrading road and bridge networks in order to improve the accessibility which brought results of promoting economic development and firmer security and replacement and new construction of the bridges were included in the plan. Improvement of bridges accompanied with expansion and improvement of roads were also an important policy for Bhutan, for which land routes were a major means of traffic and transportation.

Thus, both at the time of planning and ex-post evaluation, it can be confirmed that the development plan was aimed at the improvement of accessibility through infrastructure development, such as road expansion and improvement. Also, since both of the five-year development plans mentioned that improving accessibility of roads and bridges would facilitate economic development and strengthen national security, this project can be said to be consistent with Bhutan's policy direction.

3.1.2 Consistency with the Development Needs of Bhutan

At the time of planning, the accessibility of facilities which was necessary for the people's daily life in the target area, such as markets and hospitals, were limited due to the damage of roads and bridges by water disasters like cyclones, etc. Also, since Bhutan is land-locked, rugged, and mountainous, roads and bridges were implements of major transportation means; therefore, the need for improvement and construction of roads and bridges was high. At the time of ex-post evaluation, the needs for disaster management as well as road and bridge construction and improvement were continuously thought to be high. According to the Department of Hydro-Met Services (hereinafter referred to as "DHMS"), approximately 70% of the total annual rainfall coincides with the rainy season: from June to October. DOR pointed out that safe bridges devoid of any damage or blockage by swollen rivers and/or landslide disasters by heavy rain were even more important as a disaster management because landslides and floods by concentrated heavy rains frequently occur in Bhutan. Also, the numbers of driver's licenses issued and vehicles registered are increasing. According to the statistics from the Road Safety and Transport Authority, the numbers of issuances of driver's licenses and registration of vehicles in Bhutan between 2011 and 2016 had increased about 1.5 times over the period of 6 years. The needs for wider and multi-lane roads which could accommodate the increase in traffic were thought to be getting high. Therefore, as the construction of wider bridges was necessary for the broadening of the roads, it could be said that the needs for the development of such bridges were still high.



Source: Road Safety and Transport Authority

Figure 2. Number of Driver's License Issued and Vehicles Registered in Bhutan (2011 – 2016)

Since the needs for the improvement of roads and bridges, including those for disaster management and increasing traffic volume, were still high, this project can be said to have been consistent with the development needs for roads and bridges in Bhutan at the time of both planning and ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

At the time of planning, *Japanese Official Development Assistance White Paper 2011* showed a policy through which Japan would provide supports for transport network development, such as roads and bridges, in developing countries, which could accelerate the country's poverty reduction and economic development. For Bhutan, *Japan's ODA: Rolling Plan for the Kingdom of Bhutan* in FY2011 mentioned the provision of supports for the development of roads and bridges in order to secure efficient and stable transportation and to stimulate economic revitalization. Also, this plan paid attention to disaster management in Bhutan, as a "South-East Asia Regional Assistance" and Japan was planning to support the restoration of bridges damaged by cyclones through grant aid under the projects of disaster relief and grassroots grant aid.

Therefore, at the time of planning, this project was consistent with Japan's ODA policy.

In the light of above, this project has been highly relevant to Bhutan's development policy and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The project outputs between the plan and actual are shown in Tables 1 and 2; all bridges

were constructed according to the plan.

Dolkhola Bridge and Jigmeling Bridge were constructed by adopting the "Prestressed Concrete Bridge" (hereinafter referred to as "PC Bridge"), whose intensities were increased through compressing concrete. Although they were not included at the time of planning, the project had an additional work feature to include protection for bridge piers in order to prevent future damage from flowstones in the river.

Table 1. Plan and Actual Output of the project for Dolkhola Bridge, and Jigmeling Bridge

	Plan (2011)	Actual (2014)
Bridge Structure	Prestressed Concrete Bridge (PC Bridge)	As planned
Length	70.0m	As planned
Width	7.0m (2 lanes)	As planned
Responsibilities of the Japanese Side	Construction of the bridges	As planned (Protection for bridge piers as an additional work feature)
Responsibilities of the Bhutanese Side	Removal of old bridges	As planned

Source: Information from JICA and the Executing Agency

(Before the construction: former Dolkhola Bridge)

(After the construction: Dolkhola Bridge)

(Before the construction: former Jigmeling Bridge)

(After the construction: Jigmeling Bridge)

(Photos provided by JICA)

Reotala Bridge, Kela Bridge and Jangbi Bridge were all constructed according to the plan shown in Table 2. These three old bridges were pedestrian suspension bridges but constructed as

motorable steel bridges through the project.

Table 2. Plan and Actual Output of Reotala Bridge, Kela Bridge and Jangbi Bridge

	Plan (2011)			Actual (2014)		
Bridge Name	Reotala Bridge	Kela Bridge	Jangbi Bridge	Reotala Bridge	Kela Bridge	Jangbi Bridge
Bridge Structure	Bailey suspension bridge	Bailey bridge[4]		As planned	As planned	
Length	103.7m	49.5328m		As planned	As planned	
Width	3.277m (1 lane)	3.277m (1 lane)		As planned	As planned	
Responsibilities of the Japanese Side	Substructure (Base part of the bridge: abutment, bridge pier, pile, etc.) and revetment works (for protection of abutment)			As planned		
Responsibilities of the Bhutanese Side	- Material procurement and construction of the superstructure (upper part from base: deck, etc.) - Removal of old bridges			- None of the three old bridges were removed yet - Other parts: as planned		

Source: Information provided by JICA and the Executing Agency

(Before the construction: Former Reotala Bridge)

*Circled part

(After the construction: Reotala Bridge)

(Before the construction: Former Kela Bridge)

(After the construction: Kela Bridge)

(Photos provided by JICA)

[4] Bailey Bridge is a motorable bridge whose parts were pre-assembled in a factory. It used to be for military use as a temporary passing bridge but in the viewpoint that it can be assembled by hand without special heavy machinery or tools, this type of bridge is sometimes constructed as a bridge for regular use, like through this project. “Bailey Suspension Bridge” is a wire-fixed bridge.

(Before the construction: Former Jangbi Bridge)

(After the construction: Jangbi Bridge)

(Photos provided by JICA)

On the other hand, the removal of old bridges, which was the responsibility of the Bhutanese side, had not yet been conducted and all three of the old bridges were confirmed to have been left standing even at the time of ex-post evaluation.

Among the three old bridges left intact, the former Jangbi Bridge was a suspension bridge with steel plates, and its condition was good enough and people sometimes passed through the bridge at the time of the site visit during the ex-post evaluation. For this reason, the former Jangbi Bridge is planned to be transferred to another place in the same gewog[5] and is to be removed from the present site when the new location is decided. The former Reotala Bridge is being discussed to be left as a back-up for the present Reotala Bridge and used for pedestrians in case of bridge blockages, damaged by rockfalls, and so forth, or difficulties when passing through with cars due to increased traffic of large vehicles. As for the removal of the former Kela Bridge, a consultant who was in charge of construction management for this project told that there was no specific opposition from the residents about the removal of the former Kela Bridge when the consultant explained the project to them before the construction of the new bridge. However, according to DOR, when DOR tried to remove the old bridge, the residents who had participated in the construction of the old bridge started raising an objection, thus, it has not yet been removed even now. The reason of their objection is rather sentimental; the residents wanted to keep the old bridge as it was because this was like a symbol of their effort. The possible danger of entering and passing over the old bridge by mistake is low because half of the bridge has fallen down from weathering, making it physically impossible to pass over, and its location is noticeably distant from the present farm road.

Although there are some bridges not yet removed at present, the possible threat to the safety of the residents seems low and there is thought to be no specific negative effect. As

[5] Geographic administrative unit in Bhutan: a gewog is a group of villages (chiwog) and a district is a collective unit of gewogs.

seen above, it is figured out that it does not seem to affect the efficiency.

The former Reotala Bridge (foreground) existing next to Reotala Bridge (background)

The still-existing former Kela Bridge

3.2.2 Project Inputs

3.2.2.1 Project Cost

The actual total project cost, which combines the Japanese side and the Bhutanese side, as shown in Table 3, was 1,131 million yen, which was within the plan. The total project cost ratio was 96% of planned value and both the Japanese and Bhutanese project costs were within the cost. If the three bridges had been removed as planned, the cost would have increased by about one million yen but the actual project cost would have still been lower than the planned cost.

Table 3. Total Project Cost

(Unit: million yen)

Item	Plan	Actual
Japanese side	1,019	999 *2
Bhutanese side	160 *1	132 *3
Total Project Cost (Japanese + Bhutanese)	1,179	1,131(96% of planned cost)

Source: Information provided by JICA and the Executing Agency

Note: Rounded down if the price was less than 1 million

*1 Price on the Ex-ante Evaluation sheet

*2 Including additional work (protection work) for the Dolkhola and Jigmeling bridges

*3 Calculated to the Japanese-yen equivalent from 80 million Ngultrum with an average exchange rate of 1.65 yen from 2011 – 2014 (IMF)

3.2.2.2 Project Period

The actual project period was 35 months, which was longer than the planned period of 25 months, and was 140% of the planned time. The cause of the gap was the delay of the commencement of the construction work of Reotala Bridge by the Bhutanese side.

For the reason of the delay of the commencement of the construction work, according to the explanation from DOR, the landslide disaster, caused by heavy rain, inflicted damages to some parts of the construction materials for the superstructure at their storage place,

which required re-procuring of the materials. To re-procure the materials, it was necessary to go through the government procurement process again, which took a long time to order the materials. Furthermore, DOR and Trongsa District had discussed for a long time which agency was supposed to pay the re-procurement cost[6]. As a result, the commencement of the construction was delayed by one year.

Table 4. Project Period

Plan	Actual	Comparison
25 months (August 2011 – August 2013)	35 months (August 2011 – June 2014)	140%

Note: Project completion is defined as the date of the opening of the bridges after the completion of the construction work by both the Japanese and Bhutanese sides. At the time of planning, construction work by the Bhutanese side would have been completed within 3 months of the completion of work by the Japanese side (planned in May 2013) after handing it over to the Bhutanese side.

The completion date of the construction work by the Japanese side was April 2013, a month earlier than the plan. According to DOR, the duration of the construction work by the Bhutanese side was virtually finished in 2 months, though the commencement of the work had been delayed. Therefore, it can be thought that the construction period was within 3 months as expected in the plan.

In light of the above, although the output and project cost were within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair.

Effectiveness[7] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

According to the operation indicator, the actual value of the bridge design loads and the number of lanes available cleared the target value (40t/24t, 2 lanes), as shown in Table 5. At the time of ex-post evaluation, the number of lanes and availability for a certain volume of vehicle traffic of each bridge were all confirmed as planned by the site visits. For Dolkhola Bridge and Jigmeling Bridge, both have a capacity of having vehicles up to 100t to pass over, but according to DOR, the actual maximum load capacity is recommended at 40t at present considering the capacity of other bridges nearby.

[6] Trongsa District agreed to bear the cost at last.
[7] Sub-rating for Effectiveness is to be evaluated along with Impact.

Table 5. Operation Indicator

	Baseline	Target	Actual	
	2010	2016	2014	2017
	Planned Year	3 Years After Completion	Completion Year	3 Years After Completion
Dolkhola Bridge / Jigmeling Bridge				
Load Capacity	18t	40t	100t*	100t*
Lanes	1 lane	2 lanes	2 lanes	2 lanes
Reotala Bridge / Kela Bridge/ Jangbi Bridge				
Vehicle Traffic	Unavailable / pedestrian bridge	Available (24t)	Available (24t)	Available (24t)

Source: Documents provided by JICA and the Executing Agency
*Equivalent ton (t) against Indian standard unit "IRC Class 70R"

The effect indicator shown in Table 6 accomplished the shortening of the distance of the target value (260km) both at the time of project completion and 3 years after the completion. Since it was a result of the rehabilitation of the roads and bridges on the entire National Highway No. 5, the construction of the Dodlkhola and Jigmeling bridges alone are not thought to have had a big effect on making the distance shorter.

Table 6. Effect Indicator: Distance of Dzong (administration office) in each District

Index	Baseline	Target	Actual	
	2010	2016	2014	2017
	Planned Year	3 Years After Completion	Completion Year	3 Years after Completion
Travel distance between Gelephu and Thimphu (passing through the Dolkhola and Jigmeling bridges)	370km	260km	257km	257km

Source: Information provided by the Executing Agency

As reference indicators, the ex-post evaluator conducted surveys of (1) changes in access time to each bridge and (2) traffic volume near the bridges.

(1) Change of access time to each bridge

The access time to the destination by using each bridge is shown in Table 7 and 8. From both the interviews and beneficiary survey[8] conducted in the project areas, there

[8] The survey was conducted by visiting companies and houses which are located near the bridges and interviews with drivers who pass over the targeted bridge(s) in February 2017. The number of valid respondents: 100 (59 male, 41 female); age of respondents (below 20: 3, 20 – 29: 20, 30 – 39: 38, 40 – 49: 25, 50 – 59: 7, 60 and over: 7); place of residence or work: (Trongsa District: 54, Sarpang District: 39, Zhemgang District: 6, Other: 1); bridges for use: (Dolkhola Bridge: 40, Jigmeling Bridge: 40, Reotala Bridge: 20, Kela Bridge: 20, Jangbi Bridge: 20 *including multiple answers); questions: Bridge for use, purpose of using the bridge (destination), access time to destination

is no big difference of access time that can be seen between Gelephu and Sarpang via the Dolkhola and Jigmeling bridges compared to before and after the construction of the new bridges. According to local residents, the old bridges were already motorable, and since there was not much traffic at that time, it did not take time to pass over the bridge.

For the Reotala, Kela and Jangbi bridges, as shown in the interviews and beneficiary survey results, there was a big improvement of access time to Trongsa Town because people could get to the destination by car. Before the bridges were constructed, people couldn't pass over the bridges by car resulting in some cases in which people tried to go around getting to the destination without having to pass over the bridge. After the construction of the new bridges, people could go to the destination by passing over the bridge by car, and as a result, the travel time was reduced.

Table 7. Reference Indicator (1) Change of Access Time:
Change of Average Access Time of Each Bridge

Average Travel Time between Gelephu and Sarpang (Using the Dolkhola and Jigmeling Bridges)

Name of Bridges	Before Construction of New Bridges	After Construction of New Bridges
The Dolkhola and Jigmeling bridges	36 min. (by car)	30 min. (by car)

(Beneficiary Survey Results)

Average Travel Time from each gewog to Trongsa Town (Reotala, Kela and Jangbi bridges)

Name of Bridges	Before Construction of New Bridge	After Construction of New Bridge
Reotala Bridge	11.5 hours (on foot)	3.85 hours (by car)
Kela Bridge	11.45 hours (on foot)	2.75 hours (by car)
Jangbi Bridge	11.25 hours (on foot)	2.9 hours (by car)

(Beneficiary Survey Results)

(before and after the construction), bridge blockage after the construction, economic effect from the construction, etc. Incidentally, no differences between men and women were seen in the beneficiary survey results.

Table 8. Reference Indicator (2) Change of Access Time: Access Time to Nearby Destinations via the Bridges (Example)

Occupation	Route (Bridges to be used)	Travel Time	
		Before Construction of New Bridge	After Construction of New Bridge
Grocery Store Staff	Store – Supplier (in Gelephu) (Dolkhola and Jigmeling bridges)	30 - 40 min. (by car)	No change
Officer of National Park	Office – Office in National Park (Reotala Bridge)	5 - 6 hours (on foot)	2 hours (by car)
Farmer	Home – Farm (Cattle Shed) *Took cows (Kela Bridge)	1 day (on foot)	Half day (on foot)
Construction Worker	Home – Construction site (in Trondsa Town) (Kela Bridge)	1 day (on foot)	3 hours (by car)
Doctor	Jangbi Village – TrongTrongPhay BHU-1 (Jangbi Bridge)	3 hours (on foot)	30 min. (by car)

Source: Interviews conducted in Bhutan

*Before the construction of the new bridge, the farmer had to go around to the destination because she could not take her cows by passing over the bridge; but after the construction, she could use the bridge to get to the destination faster.

(2) Change of Traffic Volume around the Bridge

According to interviews with local residents, the traffic volume after construction increased compared to before construction of the new bridges. In fact, per traffic volume surveys between Gelephu and Sarpang, whose checkpoint was Jigmeling Bridge, conducted in 2011 and 2016 by DOR, Sarpang Regional Office, the traffic volume in 2011—before the construction of new bridge—was 130 vehicles per day on average (total of up-traveling and down-traveling[9]), and in 2016—after the construction—the traffic volume increased 10 times that of 2011 to 1,371 vehicles per day on average (total of up-traveling and down-traveling). The background for the increasing traffic volume can be thought of as follows: the traffic of buses and taxis increased after the construction of both bridges as a result of the increasing of companies, schools, and stores being located near the bridge; and car transport became more convenient through the process of replacing of bridges on National Highway No.5.

Reotala, Kela and Jangbi bridges were originally pedestrian bridges which were impossible for vehicles to pass over but after the construction of the new bridges, vehicles became possible to pass over the bridges. According to DOR, Trongsa Regional Office, the average traffic volume over Reotala Bridge is 20 – 30 vehicles per day.

[9] An average volume per day from the total number of up-traveling and down-traveling in February and September divided by the observation days.

3.3.2 Qualitative Effects (Other Effects)

Improving Accessibility at time of Disaster

According to local residents and each DOR regional office, several bridges are washed away by rivers flooding by concentrated heavy rains in the monsoon season, from June to October, every year. Despite such an environment, it has been confirmed by the data recorded by DOR, Sarpang Regional Office, and beneficiary survey results at the time of ex-post evaluation that the bridges constructed through this project have never had a blockage except one time, which resulted from damage by rockfalls in October 2016[10]. The residents interviewed by the site survey told that they recognized each of these bridges as a "disaster-resistant bridge". Consequently, the objective of the project, which was to improve accessibility at the time of disaster, can be said to have been achieved.

BOX 1: "Disaster-Resistant Bridge"

According to local residents near the bridge and DOR, Sarpang Regional Office, the Sarpang District in which the Dolkhola and Jigmeling bridges are constructed have almost no river water during the dry season. However, in the rainy season, the water volume of the river rises to a high level immediately due to a heavy concentration of rain. It is said that there were many bridges that became impossible to pass over or were washed away.

According to DHMS, there was a concentration of heavy rain in late July 2016; many water levels of rivers rose higher than the warning level and many roads and bridges were washed away or became impossible to pass. In addition, when Sarpang Town flooded, many residents were evacuated from their homes. According to DOR, Sarpang Regional Office and local residents around the bridges, the Dolkhola and Jigmeling bridges also experienced increased river water levels of 2 to 3 meters higher than the normal water levels for that time, but neither of the bridges was blocked and there was no problem with the bridge condition to pass over after the heavy rain. The residents seem to recognize these bridges as "disaster-resistant bridge(s)" as the bridges have not had any damage or blockage although many of other bridges have suffered blockages.

A consultant who designed and managed the construction gave a comment that the design brought success because they designed the bridges higher than the estimated value of river water levels during flooding. It can be said that this is a good example in which "design defeated the disaster".

[10] The bridge was blocked to vehicle traffic for the time being due to the inclining of the bridge whose wire fastener (a part) had dropped off. However, according to DOR and construction workers at the bridge, the repair work was completed in a short term (about one month) and vehicles can currently pass over the bridge.

Jigmeling Bridge at a time of flooding of the river
(The foreground is a pier of the old bridge: Photo provided by a local resident)

3.4 Impacts

3.4.1 Intended Impacts

(1) Improvement of living situations of the residents

According to statistics from 2015 which were published by the National Statistics Bureau, the percentage of farmers per population in Sarpang District, in which Dolkhola Bridge and Jangbi Bridge are located, was about 30% in Sarpang District, which was on average with the national level, and was about 80% in Trongsa District, which greatly exceeded the national level; thus, the percentage of farmers as a total of both districts was high. Comparing the agriculture statistics of the two districts before (2011) and after (2015) construction of the new bridges, the percentage of cash income that farmers gained in 2015 increased from that in 2011, as shown in Table 9. Since these statistics cover entire areas in each district, a direct casual relation with this project cannot be proven. However, it is assumed that the replacement bridges made a certain contribution to the efficiency of the transportation of goods, including agricultural products, and to the improvement of the residents' living situations. Also, in the beneficiary survey, Table 10 shows that more than 90% of the respondents said that both the quality and quantity of daily commodities improved compared to those before the construction of the new bridges.

Table 9. Percentage of Farmers who had Cash Income

	2011	2015
Sarpang District	29%	39%
Trongsa District	33.7%	42%

Source: Agriculture Statistics 2011 and 2015
Note: Cash income means the income from business activity, including selling agricultural products.

Table 10. Changes of Quantity and Quality of Daily Commodities Before and After the Bridge Construction (total 5 bridges)

	Greatly improved	Improved a little	No change	Worsened
Quantity	88%	12%	0%	0%
Quality	70%	29%	1%	0%

Source: Beneficiary survey results

In addition to the results above, "3.3.1 (2) Change of Traffic Volume around the Bridge", as mentioned before, and the upcoming section "(2) Activation of Large Vehicle Traffic" state that after the construction of the new bridges, the number of companies and schools around the bridges increased, thus the traffic of people and goods became active. As a result, it became easier for the residents to obtain daily commodities.

Also, the newly constructed bridges allowed ambulances to take residents to medical facilities[11] in case of emergency, such as events of sudden illness or serious injury, and so forth. (Please see BOX 2.)

BOX 2: Situation on Emergency Transfer Before and After the New Bridge Construction

JICA provided ambulances to several medical facilities in Bhutan in 2012 and 2016[12]. In this context, ambulances at Gelephu General Hospital in Sarpang District, Tongtongphey BHU-1 in Trongsa District, and Yebilaptsa Hospital in Zhemgang District use the bridges constructed through this project. Targeted medical facilities and bridges for use are shown in the table below.

Table: Targeted Medical Facilities for Ambulance Provision Which Use the Targeted Bridges

Name of Medical Facility	Year of Provision	Bridge(s) for Use	Purpose of Use	Frequency of Using Bridge(s)
Gelephu General Hospital (Sarpang District)	2016	Dolkhola Bridge Jigmeling Bridge	Patient transport: Gelephu - Thimphu	306 times (actual result in 2016)
Yebilaptsa Hospital (Zhemgang District)	2012	Reotala Bridge	Patient transport: village - hospital	3 times/ month in average
Tongtongphey BHU-1 (Trongsa District)	2016	Kela Bridge Jangbi Bridge	Patient transport: village – BHU	Kela Bridge: 3 times Jangbi Bridge: 5 times (actual result from July 2016 – January 2017)

Source: Interviews with and information from people relevant to the project

In Gelephu General Hospital, a patient who needs advanced medical treatment, for example, brain surgery, is delivered to the National Referral Hospital in Thimphu by ambulance, passing over the Dolkhola and Jigmeling bridges. Ambulance drivers explained that the distance from Gelephu General Hospital to the National Referral Hospital in Thimphu is about 250km and it took about 8 to 14 hours, depending on the patient's condition. They also mentioned that

[11] There are medical facilities in Bhutan which are a "BHU" (Basic Health Unit) and a "hospital". A BHU is located in each gewog (group of villages) and there are two types: a BHU-1 is where doctors are working and a BHU-2 is where doctors visit periodically. If a BHU cannot treat the patient, the patient is supposed to be taken to the hospital in the city/town. Also, if there is a patient in critical need for care that the city hospital cannot treat, the hospital sends the patient to a "General Hospital" located in major cities such as Gelephu, etc. If there is a need to undergo advanced medical treatment, such as brain surgery, the patient is sent to the "National Referral Hospital" in Thimphu.

[12] The Project for Replacement of Ambulances Phase 1 and Phase 2

between Gelephu and Sarpang, which is about 30km (35 – 40 minutes), it became safer and more stable to transfer patients.

The Reotala, Kela, and Jangbi bridges used to be pedestrian suspension bridges over which vehicles were not able to pass. An emergency medical technician (a nurse who is in charge of coordinating ambulances and giving emergency medical treatment inside of the ambulance) told that at that time, ambulance crews walked to a village to pick up a patient, carried the patient on their back and walked back to where the ambulance was waiting on the roadway. It took 4 – 5 hours from a village to the nearest roadway, and it took another 25 – 30 minutes traveling along the roadway to the hospital. If the inclusion of the time from the hospital to the village for pick up is considered, it took more than half a day to deliver one patient. At present, since roads and bridges have been developed, it has become possible to pass over these bridges by car; hence, it takes about 35 – 40 minutes on average to get to a hospital from a village.

Compared to the Dolkhola and Jigmeling bridges, the number of transports of patients over the Reotala, Kela, and Jangbi bridges is less, but these bridges have contributed greatly to significantly reducing the transfer time and also to the patients, their family, and hospital staff in reducing their physical and mental burden through the construction of such motorable bridges.

An ambulance passing over Jangbi Bridge while transporting a patient

In light of the above, the construction of the new bridges has resulted in activating the traffic of people and goods, thus improving the quality and quantity of commodities. Also, the transportation for people and goods has become safer and faster by the construction of the new bridges. Also, it became possible for the medical facilities to offer emergency transport in a safer and quicker manner. Therefore, the living environment of residents improved after the construction of the new bridges.

(2) Activation of Large Vehicle Traffic (Dolkhola Bridge and Jigmeling Bridge)

As mentioned in 3.3.1 (2), the traffic volume in 2016 increased compared to that in 2011 - before the bridge construction. Along with this result, the traffic volume of large vehicles (more

than 10t of vehicle weight, such as buses and trucks) has also increased: 46 large vehicles per day in 2011 increased to 224 large vehicles per day in 2016. In addition, Jigmeling Industrial Estate near Jigmeling Bridge, which is under construction, is planned to be in operation from July 2017 and according to a newspaper report[13], food processing industries, forest-based industries, and so forth will settle in an area of approximately 756 acres (306km^2). In order to transfer goods and staff to the estate, the number of large vehicles passing over the Dolkhola and Jigmeling bridges, such as trucks and buses, is expected to increase further.

(3) Running Condition and Safety of the Bridges (Dolkhola Bridge and Jigmeling Bridge)

In the beneficiary survey, all drivers who passed over Dolkhola and Jigmeling bridges replied that the running condition after the construction of new bridges was more comfortable than that before the construction. Usually, when a traffic accident occurs on Dolkhola Bridge or Jigmeling Bridge, the police are supposed to report the accident to DOR, Sarpang Regional Office. According to DOR, Sarpang Regional Office, the number of reports of accidents from the police, from the construction of the new bridge until as of April 2017, was only one: an accident in which a car hit the railings of Jigmeling Bridge in November 2016. One of the reasons for the decrease in the number of traffic accidents is the improvement of the bridge's running condition and safety created through the expansion of roads and replacements of bridges. Therefore, the running condition and safety of both bridges improved compared to that from before according to the acquired data and beneficiary survey results.

(4) Efficiency of Equipment and Materials Transport (Dolkhola Bridge and Jigmeling Bridge)

According to the interviews with staff at companies located near the Dolkhola and Jigmeling bridges, they had had to disassemble parts to meet with the vehicle weight limitation of the bridge, but after the construction of new bridges, whose load capacity became 40t, there was no need to disassemble the parts for delivery. According to DOR, as for Southern East-West Highway connecting the eastern and western regions of Southern Bhutan, the section connecting Gelephu and the eastern city of Panbang and the section connecting Sarpang to the western city of Lhamoizingkha—both of which have yet to be constructed—will be targets of the development area under the *Twelfth Five-Year Plan (2018 - 2023)*. The contribution of both bridges can be expected in the future in terms of transportation measures for materials during the construction period and transport efficiency, connecting the eastern part and the western part after the construction. Therefore, it can be said that both bridges are contributing to the improvement of efficient transport of equipment and materials.

[13] Article from Business Bhutan, June 23, 2016

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

Both DOR, Trongsa Regional Office, and the Agriculture Department of Trongsa District, which manage bridges, explained that although the Reotala, Kela, and Jangbi bridges—among the 5 targeted bridges—were constructed close to a national park, none of the bridges had any problem in terms of their locations which might affect the natural environment. Also, according to DOR, they had secured a place for disposal of waste during the construction in order to prevent the waste from flowing out to the river and waterways. DOR explained that they had removed all of the waste from the waste site promptly and properly after the construction. Thus, there was no negative effect on the environment both during the construction and at the time of operation.

Therefore, it can be said that no negative impact occurred on the natural environment.

(2) Land Acquisition and Resettlement

Since all of the 5 bridges were constructed for the purpose of replacing old ones and there were no houses in the location, there were no land acquisitions or resettlements.

(3) Other Impacts

Poverty Reduction through Improvement of Accessibility

As for poverty reduction through improvement of accessibility, since there has been an active flow of people and goods due to the construction of the new bridges and there was job creation; it can be thought that there has been a certain level of positive effect for the reduction of the poverty status among residents. To sum up the interviews of local residents and the beneficiary survey results, job creation was effected, as the number of companies near the bridges increased and along with that, the number of residents passing over the bridges to go to their workplaces increased, all of which made it possible for them to acquire a means of earning money besides income from agriculture. From the beneficiary survey, 88% of respondents improved their economic situations after the construction of the new bridges.

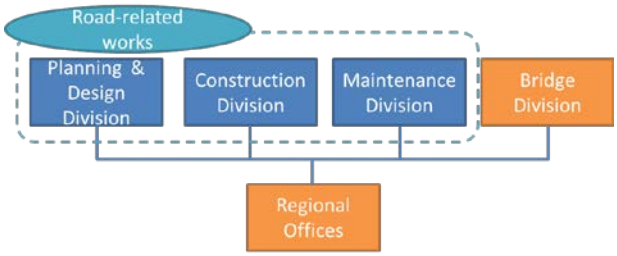
In light of the above, this project has largely achieved its objectives. Therefore effectiveness and impact of the project are high.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

An organization chart of DOR is shown in Figure 3. In Thimphu, the capital city, there are four divisions in DOR: Planning and Design Division, Construction Division and

Maintenance Division for road-related works and Bridge Division, which is to study, design, construct, and maintain the bridges as well as to provide regional officers technical instruction. There are also regional offices which are in charge of daily maintenance of roads and bridges nationwide under the instruction of these four divisions.



Source: Interview results with the Executing Agency

Figure 3. Organization Chart of DOR

The organizations in charge of these 5 targeted bridges in the project are classified by the type of road on which the bridge was constructed. The Dolkhola and Jigmeling bridges, which are on the national highway, and Reotala Bridge, which is on the GC road[14], are maintained by DOR. The Kela and Jangbi bridges, which are on farm roads, are maintained by Trongsa District.

Table 11. Organization-in-charge for Operation and Maintenance of Each Bridge

Target Bridge	Road	Organization-in-Charge	Detail
Dolkhola Bridge	NH	DOR Sarpang RO	- Cleaning of the bridge(s) and condition check done by the National Work Force (1 staff per bridge[15]) - Bridge inspection (cleaning condition and bridge condition check) done by site engineers (RO staff)
Jigmeling Bridge	NH	DOR Sarpang RO	
Reotala Bridge	GC Road	DOR Trongsa RO	
Kela Bridge	Farm Road	Trongsa District	- Cleaning of the bridge(s) done by local residents (multiple people) - Periodic inspection done by one gewog[16] engineer (a staff from Trongsa District)
Jangbi Bridge	Farm Road	Trongsa District	

NH = National Highway, RO = Regional Office
Source: Result from interviews

Dolkhola Bridge, Jigmeling Bridge, and Reotala Bridge are managed by regional offices of the DOR. The National Work Force (hereinafter referred to as "NWF") cleans each bridge

[14] GC road is an abbreviation of "Gewog Connectivity road" which connects to the administrative facility in gewog. In addition, in 2015, GC road has come under the management of DOR from District Administration.

[15] Normally, there is one NWF assigned for every 2km of road and if there is a bridge on the road, the bridge is included in the assigned area for daily maintenance. However, for the Dolkhola and Jigmeling bridges, which are on the national highway, there is one specific NWF for each bridge who is in charge of the bridge and access road connected to the bridge.

[16] "Gewog" is an administrative unit under the District. There are 5 gewogs in Trongsa District and one gewog which contains a group of villages (which are called "chiwogs").

and regional office staff (site engineers) check the condition of the bridges and roads, whose operation and maintenance (hereinafter referred to as "O&M") system is conducted for all of the bridges and roads in Bhutan.

In Trongsa District, the office which manages the Kela and Jangbi bridges, local residents near the bridge usually clean the bridge and farm road. In cases of repairing, the gewog sends a request to the district. A gewog engineer from the district administration is supposed to design the repair plan after a site visit and a technician from the administration is also supposed to visit the bridge for conducting repairs according to the repair plan.

It seems that both DOR and the Trongsa District Office have their respective organizational structures for O&M. However, the picture of Trongsa District Office does not fit the reality. Gewog engineers, who are district administration staff, are in charge of all types of infrastructure (roads, bridges, and water utilities) in each gewog, which is a group of villages, but there is only one engineer per gewog and some say that the work load of each engineer is too heavy to maintain bridges. Also, only one backup staff for all gewog engineers (5 staff members in total) is provided, which does not seem to be enough support in cases in which there are several absences of staff.

Therefore, some problems have been observed in the institutional aspects of operation and maintenance.

3.5.2 Technical Aspects of Operation and Maintenance

Table 12 shows the presence or absence of a maintenance manual for each bridge and the contents of the work outlined.

Table 12. O&M Manual and Contents of Work

Bridge Name	Managed by	Manual	Contents of Work
Dolkhola Bridge	DOR Sarpang Regional Office (RO)	Yes (Manual for PC bridge)	O&M works according to the manual
Jigmeling Bridge			
Reotala Bridge	DOR Trongsa RO	None	Cleaning of the bridge and checking if there are any damages on the bridge
Kela Bridge	Trongsa District (Actual work is done by gewog)	None	Cleaning of the bridge, grass cutting on the farm road, making and cleaning of drainages
Jangbi Bridge			

Source: Interview results from the DOR Sarpang Regional Office and Trongsa Regional Office, and gewog leaders

For the Dolkhola and Jigmeling bridges, there are manuals for PC bridge which consultants had created during the project period and DOR, Sarpang Regional Office makes use of the manual during periodic checks in which site engineers at the Office instruct operations to the NWF along with providing the manual. DOR, Trongsa Regional Office, which manages Reotala Bridge, mentioned that there was no manual for maintenance like

that of the Dolkhola and Jigmeling bridges, but there was no problem to do the maintenance without a manual so far because the daily routine done by the NWF is simple. Gewog leaders who manage the Kela and Janbi bridges responded that the contents of the work were simple and there was no specific technical problem so far, which was also mentioned by DOR, Trongsa Regional Office. On the other hand, gewog engineers at the district administration office who are in charge of periodic inspection told that they had not checked the bridge periodically and that they were not sure how to check the condition of the bridge specifically. Many of the 5 gewog engineers are less-experienced, as they have only one to three years of experience in engineering. And, there was almost no opportunity for gewog engineers to take technical group training for brushing up their skills. Technicians who are in charge of repair works told that no one had an opportunity to receive technical training for maintaining and repairing bridges. As for gewog engineers who have little support for technical improvement, there are some problems in the point of difficulty in comprehending the accurate bridge condition in the future and a lack of opportunities for capacity enhancement for technical improvement.

For a better O&M operation, JICA conducted a technical assistance project, "Project for Capacity Development in Construction and Management of Bridges" (hereinafter referred to as "CAMBRIDGE Project") at the time of ex-post evaluation, and the consultants of the project have been creating an O&M manual for bridges with DOR[17]. The manual is planned to be completed in 2018 and DOR will distribute it to DOR regional offices and to each district by 2019. In the future, DOR and districts are expected to maintain bridges by utilizing the manual.

As mentioned above, technical aspects of operation and maintenance can be said to have some problems because there is a lack of opportunity for engineers to obtain technical expertise and to take part in trainings.

3.5.3 Financial Aspects of Operation and Maintenance

For Dolkhola Bridge, Jigmeling Bridge, and Reotala Bridge, DOR provides a certain amount of budget every year in order to secure a financial source for sustainable O&M. As shown in Table 13, DOR distributes 26,000 Ngultrum per bridge per year as a maintenance budget. Table 14 shows examples of expenditures and annual expenditures which are usually within the budget. If the cost exceeds the budget, the regional office can request DOR head office in Thimphu (capital) to provide additional budget. Also, the actual cost in 2016 shows

[17] Targets are 273 bridges which are under DOR's management (concrete bridges, bailey bridges and steel bridges) and it is expected that the manuals and participations in workshops will be shared with districts which manage bridges separately from DOR because districts manage the same types of bridges that DOR does. The project period will be October 2016 – September 2019.

that DOR internally secures a “Monsoon budget” for emergency support in case of disaster. It can be said that there is a sufficient source of funding from the source for sustainable O&M.

Table 13. Annual Budget of DOR in 2016 (Dolkhola Bridge, Jigmeling Bridge and Reotala Bridge)

(Unit: Ngultrum/ Nu.)

Cycle	Target	Cost for Maintenance
1 year	Bridge[*1] and access road (per bridge)	26,000
Total of 3 bridges		78,000
(Equivalent Japanese yen = 127,000 yen)[*2]		

Source: Information provided by the Executing Agency

*1 Targeted bridge of this budget is a motorable bridge

*2 Exchange rate: 1 Nu. = ¥1.62 (IMF average rate in 2016)

Table 14. Examples of Expenditure of O&M Cost by DOR (Dolkhola Bridge, Jigmeling Bridge and Reotara Bridge: Actual)

Year	Fund Usage	Cost
2014	Street lights (Dolkhola Bridge and Jigmeling Bridge) 2 lights / each	Nu. 38,000 (Total of two bridges)
2014 - present	Electricity fee for street lights (Dolkhola Bridge and Jigmeling Bridges: every year after the settlement)	Nu. 12,000 / yr. (Total of two bridges)
2016	Repair of the bridge (Reotala Bridge)	Nu. 310,000*

Source: Information provided by the Executing Agency

*Normal budget + Monsoon budget that DOR secures as an annual budget

As for the Kela and Jangbi bridges, neither Trongsa District, which is responsible for managing, or the gewog, which is virtually doing O&M work, have a specific budget to cover O&M costs. This is because normal O&M operation is basically done by local residents without any payment. In cases which require repair at a cost, both the district and gewog are thinking of disbursing the necessary cost from a part of a development fund which is provided by the central government. However, the usage of the development fund, which is allocated to the district or gewog is decided through discussion at a gewog leaders meeting (for usage of the development fund for a gewog, the discussion is to be held at a leaders meeting of chiwogs, which are units of villages within a gewog), which cannot ensure that the source of the funding for O&M and repair of the bridge can be secured every year. Since it is thought that there will be a necessity for repair for dilapidation from aging and for the prevention of such dilapidation, it is desirable to keep a certain volume of budget for O&M cost every year from a long-term perspective. Therefore, a few problems have been observed in terms of financial sustainability.

3.5.4 Current Status of Operation and Maintenance

The condition of the Dolkhola and Jigmeling bridges are good. Items and the frequency of the O&M at the time of planning were all included in DOR’s daily and annual O&M operations and checkpoints at the time of ex-post evaluation. As shown in Table 15, the frequency of inspection was not according to the plan, that is to say, higher than as planned.

Also, as for daily O&M operations (shown on rows (1) – (3) and (5) – (6) in the table), one unit of the NWF is assigned to each bridge and conducts cleaning and inspection of the bridges and roads respectively.

Table 15. O&M work of the Dolkhola and Jigmeling Bridges

Item	Frequency (Plan)	Frequency (Actual)	In-charge
(1) Inspection/ cleaning of the drainage facilities	Annually	Daily	NWF
(2) Inspection/ cleaning of the expansion joints		Daily	NWF
(3) Inspection/ repair of the bridge surface		Daily	NWF
(4) Inspection/ cleaning of the bearings		Weekly	DOR Sarpang Regional Office (RO)
(5) Inspection/ repair of the access road pavement		Daily	NWF
(6) Inspection/ cleaning of the access road gutter		Daily	NWF
(7) Repair of the steel railing	Every 5 years	Weekly	DOR Sarpang RO
(8) Repair of the embankment		Annually	DOR Head office
(9) Re-painting of the road markings		Annually	DOR Sarpang RO

Source: Interview result from the Executing Agency

Reotala Bridge, Kela Bridge, and Jangbi Bridge are also in good condition. As for Reotala Bridge, the NWF cleans the bridge daily and site engineers from DOR, Trongsa Regional Office conduct weekly inspections. As for the Kela and Jangbi bridges, local residents near each bridge do the periodic cleaning at 3 times a year and a gewog engineer is supposed to carry out a periodic inspection twice a year (January and July) in order to check the condition of the bridges. For the Kela and Jangbi bridges, in order to deal with the change of bridge condition caused by dilapidation from aging, it may be necessary to think about increasing the frequency of O&M work and periodic inspection (monitoring). For the condition of each bridge, Trongsa District, which has the responsibility of O&M, mentioned that they have not actually done the bi-annual inspection. This is because gewog engineers did not recognize the necessity of the periodic inspection and they thought there was no problem with the bridges because they had never received any reports on problems from the gewog so far (in the normal process, a gewog is supposed to report to the district if there is any problem with the bridge). Although both bridges are in good condition at present, it may be necessary for the Kela and Jangbi bridges to have periodic inspections in order to minimize the repair especially if there is an occurrence of a problem.

As mentioned above, no major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system in DOR. However, some minor problems have been observed in Trongsa District: organizational structure has been established but the structure, including backup, is weak, which brings inadequate

comprehension of bridge condition; there has been a lack of opportunity to acquire O&M skills; there has been no certain budget for O&M, and so forth. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented for local residents in order to improve the accessibility of a cyclone-affected area and to safeguard its accessibility from future cyclone attacks by replacing 5 bridges in the mid-interior region of Bhutan (Dolkhola Bridge, Jigmeling Bridge, Reotala (Mandechhu) Bridge, Kela Bridge and Jangbi Bridge) which had been destroyed by a cyclone, thereby contributing to the stable transport of people and goods and the improvement of the living situations of the local residents in the area. This project was consistent with the development plan and needs of Bhutan at the time of both planning and ex-post evaluation and also with the Japanese ODA policy at the time of planning. Since there was no problem with the project implementation plan or its approach, it can be confirmed that the relevance of this project is high. Also, the project was implemented mostly as planned and the project cost was within the plan. However, the project period exceeded that of the plan and thus the efficiency of the project is fair. The effectiveness and impact of the project are high because all of the 5 bridges have accomplished of “secure accessibility in case of disaster” and the stability and safety of the transportation flow at both the Dolkhola and Jigmeling bridges have been improved by the completion of concrete construction allowing the traffic volume of large vehicles, such as trucks and buses, to thusly increase. At Reotala Bridge, Kela Bridge and Jangbi Bridge, given that the bridges have become available for residents to pass over by car and the efficiency of transport and reduction of access time to the destination were realized, the effectiveness and impact are judged to be high. As for sustainability, there is no problem with the bridge’s management performed by DOR in institutional, technical, and financial aspects; however, there needs to be consideration given to improving all institutional, technical, and financial aspects of operation and maintenance, including the current monitoring and maintenance status of bridges managed by Trongsa District; thus, the expected sustainability of project effect is moderate.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Establishment of an operation and maintenance system in Trongsa District

It is considered necessary for Trongsa District to design an operation and maintenance policy including future repairing and prevention of dilapidation due to aging by establishing

measures for routine work and periodic inspections regarding the O&M system for bridges in Trongsa District and by grasping the situation of the district administration on what gewog residents are doing for O&M and on how the bridge conditions are. At present, the organizational structure in the district is weak, as there is only one gewog engineer assigned in each gewog to be in charge of maintaining the entire infrastructure (roads, bridges, water facilities, etc.). Furthermore, the district does not understand what the residents are doing for O&M because the district has never done periodic monitoring. For institutional structure necessary for repairing and for financial support upon request from a gewog, it is necessary to establish a structure through which a gewog engineer and a district administration staff member visit a gewog regularly to see the condition of the bridge, and share how the residents in the gewog do the operation, as well as establish what the problems for the residents are. Also, when the bridge maintenance manual, which is under creation through the CAMBRIDGE Project, is distributed to Trongsa District, it would be desirable for DOR which is a co-producer of the manual to provide a trainer's training course and/or briefing session for district administration staff to have them explain to gewog residents about specific operations and checkpoints of O&M clearly.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

<u>Establishment of a common bridge O&M system and its implementation</u>

After the project completion, the O&M system has been split between DOR and Trongsa District according to which type of road the bridge is located on. As a result, there is a gap in both the organizational structure and financial condition of the O&M system between the bridges managed by DOR and those managed by the district. As for bridges managed by the district, staff members do not know the bridge condition in detail because they monitor neither the O&M operation, which residents do, nor the conditions of the bridges. Therefore, should a problem occur with the bridge in the future, the condition of the bridge may get worse due to delays (or negligence) in the repair work or due to insufficient repair done by the district. If the O&M operation of bridges is conducted by multiple institutions, it is preferable to set a focal point institution if at all possible, and establish a common O&M system through the initiative of the focal point institution. At the same time, it would be more effective that the focal point institution take the initiative on having trainings for persons in charge of the O&M operation and creating and distributing maintenance manuals.

End