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Bangladesh

Paksey Bridge Construction Project (I) (II)
(L/A No. BD-P42, BD-P50)

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Field survey: March 2008

1. Project Profile and Japan's ODA Loan

Site Map

Paksey Bridge

1.1 Background

Bangladesh (pop. 141 million, 2004) is geographically divided by three of the world's largest rivers (Ganges/Padma River, Jamuna River, Meghna River). Ferries used to cross these large rivers bottleneck road traffic, and prevent balanced development of the country. In 1993 a bridge over the Meghna River on the road connecting the capital city of Dhaka and the international port city of Chittagong had already been completed through Japanese grant aid. Construction had also been planned for a multipurpose bridge (Jamuna Bridge) over the Jamuna River that divides Dhaka and the northwest region, to be co-financed by JBIC, the World Bank, and the Asian Development Bank. However, there were no concrete bridge plans for the Ganges River that divides the northwest and southwest regions or the Padma River (downstream of the Ganges River), which divides the east and southwest regions. Thus, road traffic to the southwest region, which encompasses Khulna, the third largest city in the country, as well as Mongla, the second largest international port, was forced to use these inefficient ferries.

In Paksey, the target area of this project, there is already a railway bridge (Hardinge Bridge) that was built during the British colonial period. However, the construction of a road bridge to this area would not only increase the efficiency of road transport between the northwest and southwest regions, but would also create a bypass to connect Dhaka, Khulna, and Mongla Port using the Jamuna Bridge until a bridge over the Padma River was built in the future. In addition, the national road that would pass over this road bridge would be a part of the Asian Highway Network, thus being an important international trunk line.

It was here in 1993 that Japan performed a preparatory study (Ministry of Construction) regarding a bridge in Paksey. After SAPROF confirmed the economic

relevance and examined the basic technology, a loan for engineering services (herein noted as E/S) was provided. In 1997 with a secondary yen loan, construction began on the four-lane, 1,786 meter Paksey Bridge (currently officially named the Ralon Shyah Bridge).

1.2 Objectives

The project aims to construct a bridge over the Ganges River, which flows in an east/west direction through Bangladesh, to develop a land route crossing the western side of the country and establish a safe and sufficient transport grid and thereby contribute to the development of the economy of the western side of the country using the port of Mongla, located in the southwest region, and to bolster the economic activities between the eastern and western areas.

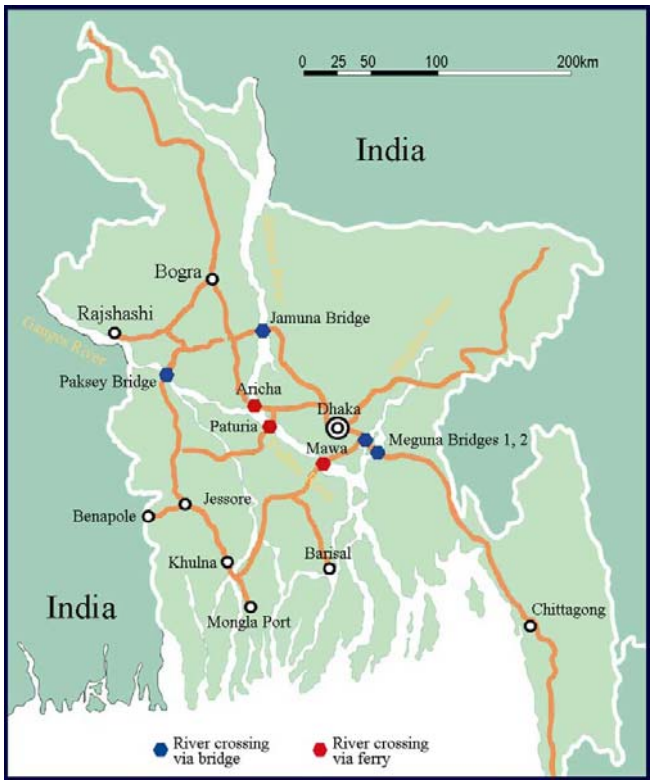


Fig 1 Arterial highway network of Bangladesh (current state)

1.3 Borrower / executing agency

Government of Bangladesh / Road Highway Department

1.4 Loan contract outline

Loan Amount / Disbursed Amount	1st phase: 8,707 million yen / 8,620 million yen 2nd phase: 9,209 million yen / 7,211 million yen
Exchange of Notes / Loan Agreement	1st phase: June 1997 / July 1997 2nd phase: March 2003 / March 2003
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	 1.0 % 30 year term (10-year) General untied
Final Disbursement Date	1st phase: September 2004, 2nd phase: May 2007
Main contractors (only those over 1 billion yen noted)	Major Bridge Engineering Bureau (China)
Consultant Services (only those over 100 million yen noted)	KS Consultants Ltd. (Bangladesh), Kuljian Corp. (U.S.A.), Parsons Brinckerhoff International, Inc. (U.S.A.), Sarm Associates Ltd. (Bangladesh), Worley International Ltd. (New Zealand) (JV)
Feasibility Study (F/S) etc.	1993 Preliminary survey (Ministry of Construction) 1993-94 SAPROF 1995-96 E/S

2. Evaluation Results (Rating: B)

2.1 Relevance (Rating: a)

2.1.1 Relevance at the time of appraisal

In Bangladesh's fifth 5-year plan (1997-2002), it was stated that "an appropriate and efficient transport system is a prerequisite for the promotion of economic development, and investment into the corresponding sectors will contribute to the integration and expansion of the domestic and international markets." Emphasis was placed on the transport sector.

The fifth 5-year plan is based on market integration and a "poles of development" approach, and five corridors for focused investment in the transport sector are presented. Within this, three corridors ("Dhaka ~ Chittagong", "Dhaka ~ Northwest Region", and "Khulna ~ Northwest Region") are emphasized. For these corridors, investments are to be made for road improvements, improvement of ferries, and the construction of necessary bridges to create roadways suitable for international traffic and traffic between the various regions. This project falls within the "Khulna ~ Northwest Region" corridor, which has been given a high level of emphasis, and has also been presented as a priority project in the aforementioned 5-year plan.

In the 5-year plan, the reason for the importance placed on the "Khulna ~ Northwest Region" corridor has not been specified, but the appraisal mission recognized the necessity of this project in that the creation of this corridor would bring "economic development of the western areas utilizing Mongla Port," and "revitalization of economic activity between the eastern and western areas." In other words, the necessity of this project is recognized based on the assumption of the following two points. (1) The envisioned development at Mongla Port is achieved[1] and (2) the traffic between the east and southwest regions that is bottlenecked when using ferries to cross the Padma River will use the alternate route through the Jamuna and Paksey Bridges.

In the "Khulna ~ Northwestern Region" corridor, the Ganges River was crossed using ferries operated by the RHD in Paksey. Including waiting time, the time required to cross the river had reached up to five hours for trucks, and two hours for buses and passenger vehicles. Furthermore, it was necessary to move the ferry ghat (wharf) when water levels in the river changed, causing ferry service to be stopped approximately 20 times per year, for nearly two days each time. As is evident, the length of time in crossing the river and the low level of reliability of ferry service were large obstacles for traffic in this corridor. Consequently, it was determined that building a bridge to replace the ferries was important for developing this corridor, and it was given a high level of necessity.

[1] With the construction of Paksey Bridge, SAPROF believed it was possible that a portion of the freight imported at Chittagong and headed for the northwest region would move to Mongla Port, and an increase in the volume of freight handled at Mongla Port was anticipated. The volume of freight handled at the time of appraisal was approximately 2.7 million tons (1996). In an ADB-funded survey, it was predicted that if the port was improved and the Rupsa Bridge was constructed, the amount of freight handled would increase to 6 million tons by 2010. This, along with the risk of overdependence on Chittagong Port for imports and exports, as well as Mongla Port's important location for sub-regional economic grouping of eastern India, Nepal, Bhutan, etc., are reasons that the necessity was recognized for the "economic development of the western areas utilizing Mongla Port" at the time of appraisal. Additionally, in the Rupsa Bridge F/S conducted by JICA in 1999, the volume of freight handled was estimated at 5.81 million tons for 2015.

2.1.2 Relevance at the time of ex-post evaluation

Currently, the transport sector, together with the energy sector, is still an important issue in the infrastructure field. In the transport sector, new policies are being employed with the aim of offering low-cost services to users according to their needs. This is being done by improving efficiency through the coordination of roads, railways and inland water transport, as well as the entry of the private sector, and adjusting the expense of users.[2] Following these policies, the Ministry of Planning linked together the entire country with multiple transport corridors. In order to improve access to domestic and foreign markets, and while taking into account the coordination of these road corridors with railway and inland water transport, these policies encouraged investing more efficiently. Reflecting on the fact that the growth of Bangladesh's economy centered around the capital city of Dhaka, and the advancement of the road networks and ferry service connecting Dhaka and the southwest region, these corridors were developed in a radial pattern with Dhaka as the central point.[3] Paksey Bridge does not fall into any of these corridors. Bangladesh is divided into three large areas (eastern region, northwest region, and southwest region) by major rivers, and traffic volume between these areas using bridges and ferry services are as follows. From the eastern region to the northwest region (using Jamuna Bridge, etc.) the traffic volume has increased 5.7 times in 14 years, while the volume between the eastern region and southwest region (ferry service) has increased by 4.2 times. In contrast, the volume between the southwest and northwest regions (Paksey Bridge) has remained at a 2.8-fold increase, which shows that while the traffic pattern centering around Dhaka continues to

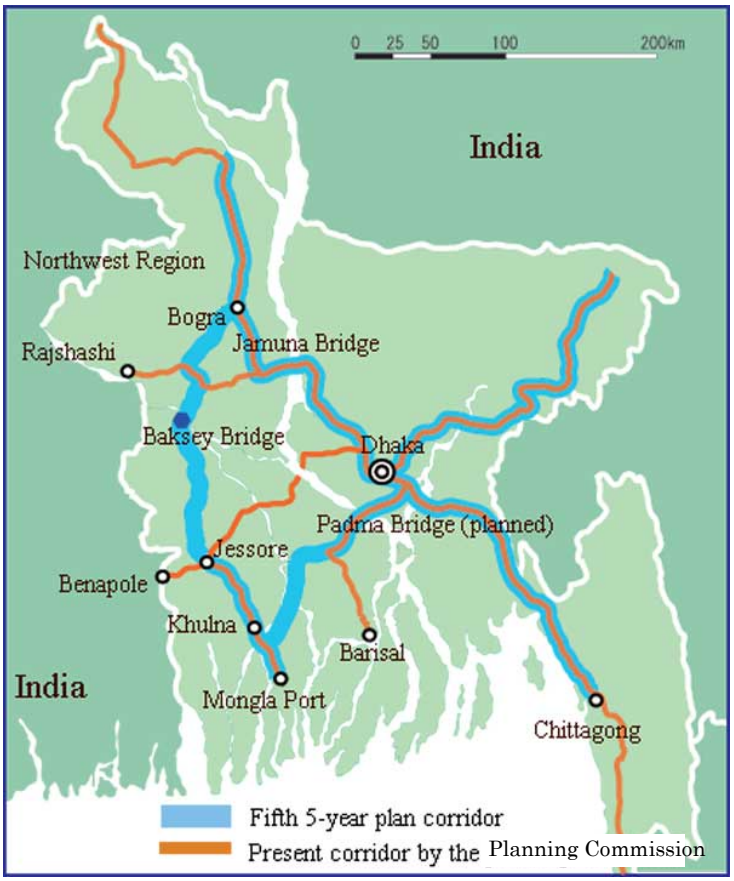


Fig 2. Major corridors of Bangladesh

[2] National Land Transportation Policy (NLTP), Integrated Multi-modal Transport Policy (IMTP). Reflecting on the excessive importance placed on using investments to build new roads in the past, these policies emphasize maintenance management as opposed to road construction. In addition, making suitable investments in railways and inland water transport are also emphasized as the policies aim to implement an integrated, efficient traffic system network. In response to this, donors including the World Bank and ADB began and continue to provide full support for the railway and inland water transport fields.

[3] According to hearings at the Ministry of Planning and the "Road Master Plan: Integrating Rail and IWT, 2007" created by the Ministry of Planning.

strengthen, the "Khulna ~ Northwest Region" corridor has a comparatively low level of importance (Chart 3).

With the extensive improvement ferry service, traffic between the east region and southwest region was circumvented to the Jamuna Bridge ~ Paksey Bridge route. It was thought that this was the reason that the bottleneck in traffic was improved compared to the time of appraisal.[4] Furthermore, with the planned construction of the Padma Bridge in 2014, the extensive improvement of this bottleneck will be possible. In the meantime, the investments envisioned for the port of Mongla at the time of appraisal were not made, the volume of handled freight decreased sharply, and compared to Chittagong Port, a large share was lost.[5] Consequently, compared to the time of appraisal, the two prerequisite conditions of recognizing the necessity of this project were substantially diminished.

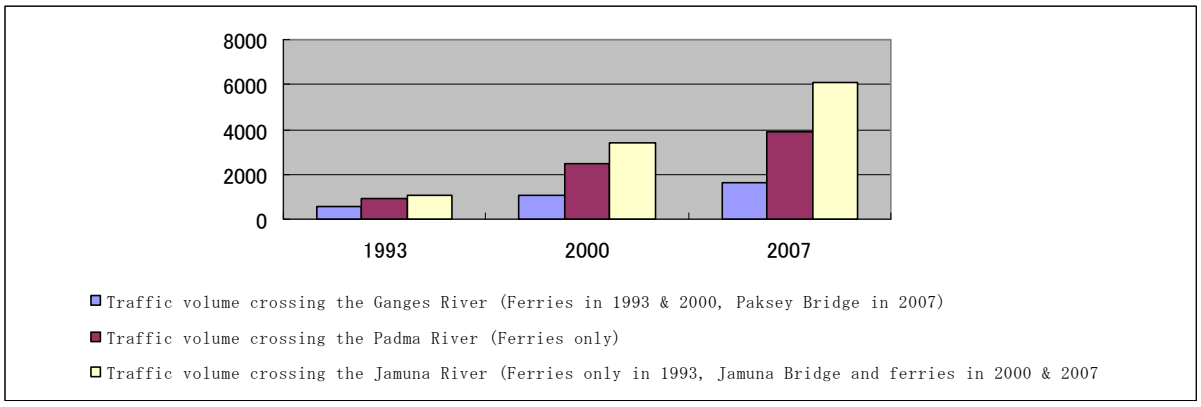


Fig 3 Trends in traffic volume crossing rivers for the Ganges River, Padma River, and Jamuna River (vehicles/day)
(Source: RHD, Jamuna Bridge Authority, Inland Water Transport Office Authority)

Although there is no doubt that sooner or later bridges will be necessary on the major highways, the examination of alternate plan in the series analyses begining with SAPROF is insufficient. Thus, the traffic volume predictions are based on

[4] The ferry service used to cross the Padma River between Aricha and Daulatdia was significantly improved. With the construction of the Jamuna Bridge, the traffic volume between Aricha and Nagarbari decreased, and the ferry used there was transferred to that route, and four new ferries were added for an increase in the total number of ferries. Approximately 5 km downstream from Aricha in Paturia, a new ghat was constructed, reducing river crossing time from 100 minutes to 30 minutes. The number of river crossings was also increased to one ferry per day. Currently, the average river crossing time, including waiting time, is 55 minutes for trucks, and 35 minutes for buses and passenger vehicles. The ferry service in Mawa, located further downstream, has also increased the number of ferries operating, and the road from the ghat to Khulna was improved with assistance from ADB. This increased usage of the road, and it is now used as a major route between Khulna and Dhaka. Because of this, the volume of traffic going through Jamuna Bridge and Paksey Brigde as an alternate route that was predicted at the time of appraisal has remained at about one-third of the predicted figure. (Full explanation in the "Effectiveness" section)

[5] The volume of freight handled at Mongla Port decreased from 3.2 million tons in fiscal 1998 to 980,000 tons in 2006, which means that only 15% of the 6.5 million ton freight handling capacity is being used. Meanwhile, at Chittagong Port, the volume of freight handled has increased nearly three-fold in the past ten years to 27.07 million tons in 2006. Currently, Chittagong Port handles 27 times more freight than Mongla Port. The 20% share that Mongla Port held in 1996 declined to 3% in 2006. Mongla Port is a river port, and regular dredging is necessary. However, due to the cost, dredging is not done adequately, and water depth continues to decrease. Compared to Chittagong Port, which can be used by large ships, Mongla Port has completely lost its competitive edge. This also appears to be having an effect on the economic stagnation of the Khulna area hinterland. While the government has begun a survey towards the construction of a new deep-water port near Chittagong Port, there is no plan for any significant investment in Mongla Port. Thus, the future recovery of the volume of freight handled at Mongla Port is not foreseen.

incomplete prerequisites, and the level of precision is low.[6] As a result of the actual traffic volume until this point, it can be judged that the predicted traffic volume and economic efficiency (EIRR) was overestimated, yet it is enough to justify the project from the economic efficiency aspect.[7]

Furthermore, the "Khulna ~ Northwest Region" corridor was envisioned as having the role of a major international highway. However, to achieve this, the improvement of the country's relationship with India is a prerequisite, and one which is presently uncertain.[8]

To summarize the above, while the fundamental necessity for this project is high, the predictions for traffic demand and economic efficiency were overestimated at the time of appraisal. At the time of evaluation, with the establishment of the ferry crossing the Padma River and the low standing of Mongla Port in the background, the importance of the project as a wide-area trunk line was lower than what was envisioned at the time of appraisal. However, since it is projected that the traffic demand is enough to justify investment, it was determined that the necessity for this project had not been lost.

Hardinge Railway Bridge and Paksey Bridge

2.2 Efficiency (Rating: b)

2.2.1 Output

For this project, a bridge with a total length of 1,786 m with two lanes on each side was constructed mostly as planned. Based on the current state of the facility, as well as the opinion of the RHD, the quality of construction was sufficiently high. According to consulting services, the quality of construction management was also high, and contributed to ensuring the quality of construction. Major changes in the planning and design since the time of appraisal, as well as from SAPROF, are as follows.

- SAPROF proposed one lane on each side plus a lane for slow moving vehicles (total width 14.5 m), but using the upward revision of the predicted traffic volume by E/S, it was expanded to two lanes on each side (total width 18.3 m).

[6] The study of the proposal for ferry improvement in Paksey done by SAPROF was no more than qualitative, and an alternate proposal for the improvement of ferry service for traffic between the east and southwest regions (the targeted alternate route) was not examined sufficiently. By moving the location of the ghat at Aricha downstream, the time it takes to cross the river was shortened. With this efficient operation of the ferry, a large improvement in service was achieved. However, SAPROF only examined an alternate proposal in which the number of ferries was increased, but the ghat was not moved. Refer to footnote 17 for details regarding the conditions for predicting traffic volume.

[7] Ref. section 2.3.3 Economic Analysis

[8] At the time of appraisal, the possibility of the north/south corridor passing through Paksey Bridge being used for the transport of transit freight when landlocked countries like Nepal and Bhutan used Mongla Port for importing and exporting was indicated. The transport of transit freight using this corridor was actually begun when an international agreement was made and freight was able to pass through India from Nepal to Mongla Port in 1997. However, India subsequently denied the passage of freight, and transport was stopped in 1998, with only 60,000 tons of freight ever being transported. Additionally, a portion of this corridor was a candidate to be a branch of the Asian Highway Network as a main line linking international ports, but due to the incongruent interests of Bangladesh and India regarding route selection in the network, the currently recognized route will mainly benefit India. Because of this, Bangladesh is refusing to sign the international agreement on the creation of the Asian Highway Network.

- As a result of examining specifics of the hydraulic model and field survey, 359 m were added to the western revetment to link it to the irrigation facilities located downstream for a total of 809 m, and the eastern revetment was lengthened to 470 m. In addition, 1,321 m of the revetment located upstream of the railway bridge (built at the time of the Hardinge Railway Bridge construction) was repaired. [9]
- Preliminary design of the bridge pier substructure piles was performed by E/S, but the depth was reviewed during the implementation stage and increased to 90 m.
- One toll booth and administrative building was planned by E/S, but another one was added on the opposite side during the implementation stage.

View of Paksey Bridge from the north side toll booth

Bridge portion of two lanes on each side

Based on actual traffic volume and future estimations of traffic volume, it seems as if it was not necessary to expand the number of lanes and width originally proposed by SAPROF, and that it was possible that the one lane on each side would have been sufficient. Additionally, when considering the traffic volume and efficiency of bridge operations and management, one toll booth and administrative building was also sufficient.

In addition, as there are no running lights on the bridge pier, boats and ships have had collision and overturning accidents. This has been indicated as a weak point in the design. Furthermore, because of the bridge's steep gradient, light vehicles carrying heavy freight are sometimes not able to proceed on their own power. Therefore, measures to limit load capacities, etc. are seen as necessary.

2.2.2 Period

This project was planned to be completed in the 55 months from April 1997 to October 2001. However, the actual time required was 79 months from July 1997 to February 2004 (144% of the plan). The bridge was opened in May 2004, 31 months later than planned. The main reason for the delay in completion was that the procurement of construction for the body of the bridge was nearly two years late

[9] Upstream of Hardinge Bridge, there is large bend in the Ganges River, and to stabilize the river channel downstream, a revetment was constructed as a part of the original railway bridge project. However, since there was severe damage to the revetment, repairs were made with this project.

due to failure in bidding.[10] Although there was no delay in the construction period for the body of the bridge, the period for revetment construction was increased by 12 months from the original plan. This was due to the time required for coordination between government authorities causing a large delay in securing the land needed for operations in the construction of the revetment on the west side. Also, increased water levels during the rainy season forced repair work and interruptions in construction.

2.2.3 Project Cost

The total project cost was 19.5 billion yen, staying at 93% of the plan. Due to changes in the plan including the extension of revetments and piles, as well as the addition of a toll booth and administrative building, the volume of construction was increased, but this margin was compensated for by keeping down prices with competitive bidding and with fluctuating currency exchange rates.

Table 1 Project cost plan vs. actual cost comparison (unit: million yen)

	Plan			Actual		
	Domestic currency	Foreign currency	Total	Domestic currency	Foreign currency	Total
Consultant	448	478	926	199	473	672
Bridge, revetment	5,564	7,358	12,922	4,290	9,332	13,321
Attached road	568	1,041	1,609	1,649		1,649
Land	377	0	377	294		294
Tax	3,649	0	3,649	3,518		3,518
General management cost	17	0	17	13		13
Contingency fund	586	819	1,405	0	0	0
Total	11,111	9,797	20,908	9,662	9,805	19,467

Notes: Currency exchange rate at the time of plan: 1Taka = 2.9 Yen (February 1997)
Currency exchange rate at the time of ex-post evaluation: 1Taka = 2.27 Yen (effective rate during implementation period)
Bridge, revetment, and attached road figures including price escalation.

From the above, it can be evaluated that despite the increase in scope of the project (river control facilities, etc.), and the 2.5 year delay in opening (144% of plan) due to the long delay in procurement of bridge construction, a high-quality bridge was created. From this, it is determined that the efficiency level for project implementation is moderate.

[10] Since the company that was ranked first in initial bidding withdrew, contract negotiations with the companies that ranked second and third were attempted, but both ended in a breakdown of contract negotiations. Rebidding was held, limited to the two companies that were ranked first and second in negotiations, but only one company placed a bid, resulting in failure. The procurement source was decided at the third bidding.

Toll booth on the north side and administrative building (The same building are also located on the south side.)

2.3 Effectiveness (Rating: b)

2.3.1 Achieving effective and safe river crossings

With the construction of Paksey Bridge, the river crossing time was shortened by about 4~5 minutes. Long waiting times caused by moving ferry ghats during times of low-water levels were eliminated, and the efficiency and reliability of river crossing traffic was vastly improved according to plan.[11]

Before this project, there were accidents with the ferries, but there have been no accidents resulting in personal injury or death on the bridge. Therefore, this project has contributed to the improvement of the safety of river crossing traffic.[12]

2.3.2 Traffic volume

Since 2005, the actual traffic volume has been 2,000~2,500 vehicles per day, which is two-thirds the volume of the plan at the time of appraisal. One-third of the traffic volume is occupied mainly by light vehicles (two- and three-wheeled vehicles and motorcycles modified by adding carrying space for cargo/passengers) traveling short distances. The actual traffic volume for four- or more wheeled vehicles is less than half of the figure of the plan at the time of appraisal.[13] In 2007, 43% of the total traffic volume was light vehicles, 13% was passenger vehicles, vans, pickup trucks, etc., and 54% was trucks and buses (41% trucks, 13% buses).[14]

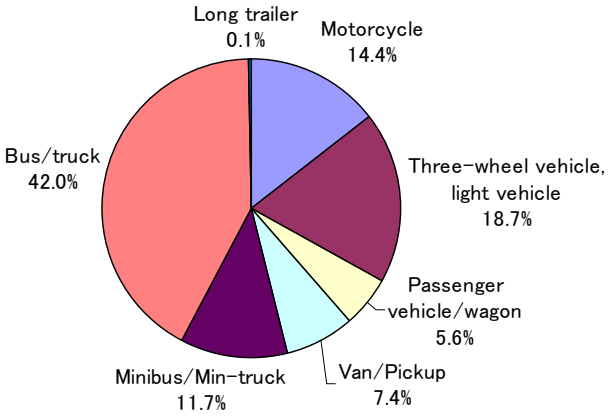
[11] Ref. 2.1.1. for information regarding river crossing time before the project.
[12] In the 18 months following opening, there were 46 traffic accidents resulting in 10 deaths on the 16 km of attached road. However, as no safety problems were found in the shape of the road or its ancillary facilities, it cannot be said that this project caused an increase in the number of accidents.
[13] While considering that this project was implemented with the objective of improving the wide-area transport network of Bangladesh, analyses on effectiveness and impact were performed focusing mainly on the traffic volume of four- or more wheeled vehicles.
[14] The traffic volume of Paksey Bridge is recorded at the toll booths, but since the toll categories based on vehicle size do not make a distinction between buses and trucks, the breakdown of buses and trucks was not available from this data. Therefore, the breakdown of buses and trucks was estimated through data gathered in a traffic survey implemented separately.

Table 2 Average annual river crossing traffic volume (vehicles/day)

	Plan at time of appraisal[15]		Actual (plan ratio)	
	Vehicles with 4 or more wheels	Total	Vehicles with 4 or more wheels	Total
2005	2,869	3,105	1,280 (45%)	1,945 (63%)
2006	3,084	3,338	1,481 (48%)	2,292 (69%)
2007	3,316	3,589	1,599 (48%)	2,445 (68%)

Source: Values for the plan were calculated using appraisal documents. Actual values are from toll booth data from the RHD.

Fig 4 Composition of vehicle types for Paksey Bridge traffic (2007)



[15] The values for the "plan at the time of appraisal" were taken from the first stage of appraisal. The traffic volume estimation methods used to find planned values from the second stage of appraisal were incongruous with the estimation methods used by SAPROF, E/S, and those used in the first stage of appraisal. Additionally, an overestimation was made by misinterpreting initial actual traffic volume data; therefore it is unsuitable for comparison to actual data.

Various types of vehicles passing over Paksey Bridge: bus (upper left), truck (upper right), 3-wheeled taxi (lower left), light vehicle modified from motorcycle (lower right)

Putting together information gathered from interviews with carrier companies and drivers with the traffic survey, the conceivable reasons for the traffic volume falling below the plan are as follows. (Ref. Fig 5)

a) Thirty percent (approx. 200 vehicles/day in 1993) of the river crossing traffic volume before the project was traffic that used Khulna/Mongla Port as a point of origin or destination. This was expected to increase at a rate of 8% per year, but it actually only increased 3% per year. Possible causes for this are the industrial stagnation of the southwest region including Khulna[16] and the stagnation of Mongla Port.
b) The traffic volume diverted from inland water transport to roads between Khulna/Mongla Port and the eastern region (2007 estimation: 375 vehicles/day) and the traffic (2007 estimation: 207 vehicles/day) between Benapole (point for border trade with India) and the eastern region (mainly the Dhaka area) were expected to use the alternate route through the Paksey

[16] Khulna is the third largest city in Bangladesh. Khulna, along with the belt zone that links it with the city of Jessore to the north, is an industrial and commercial center for the jute industry, among others. However, the largest jute factory, the Adamjee Jute Mills, a government-owned company, was closed in 2002. Since then, seven of the eight government-owned jute factories in Khulna and Jessore have been closed, and other state-owned companies including printing factories, textile plants, and hardboard factories have closed one after another. Thus, industry has stagnated since entering the 2000s. In the background of the multiple state-owned factory closings, there have beenmanagement issues, intensifying international competition, as well as a serious power shortage in the region. According to the Federation of Bangladesh Chambers of Commerce & Industry, the electrical power shortage and a lack of a natural gas supply in the southwest region are the two largest issues in the development of industry.

and Jamuna Bridges instead of the more time-consuming Padma River ferry. However, almost all of the traffic used the ferry.

c) The traffic using the Padma River ferry between the east and southwest regions that diverted to the route using the Jamuna and Paksey Bridges fell below expectations. (2007 estimation was 416 vehicles/day, but the actual number was 340 vehicles/day.)

d) The traffic volume using the alternate route through the Paksey and Jamuna Bridges (b + c from above) stopped at one-third of the expected volume. (2007 estimation was 998 vehicles/day, but the actual number was 340 vehicles/day.) The main reasons for this were the overestimation of diverted traffic based on shortened time requirements alone, and the reduction of the alternate route's merits with sharply rising fuel prices and the improvement of ferry service. [17]

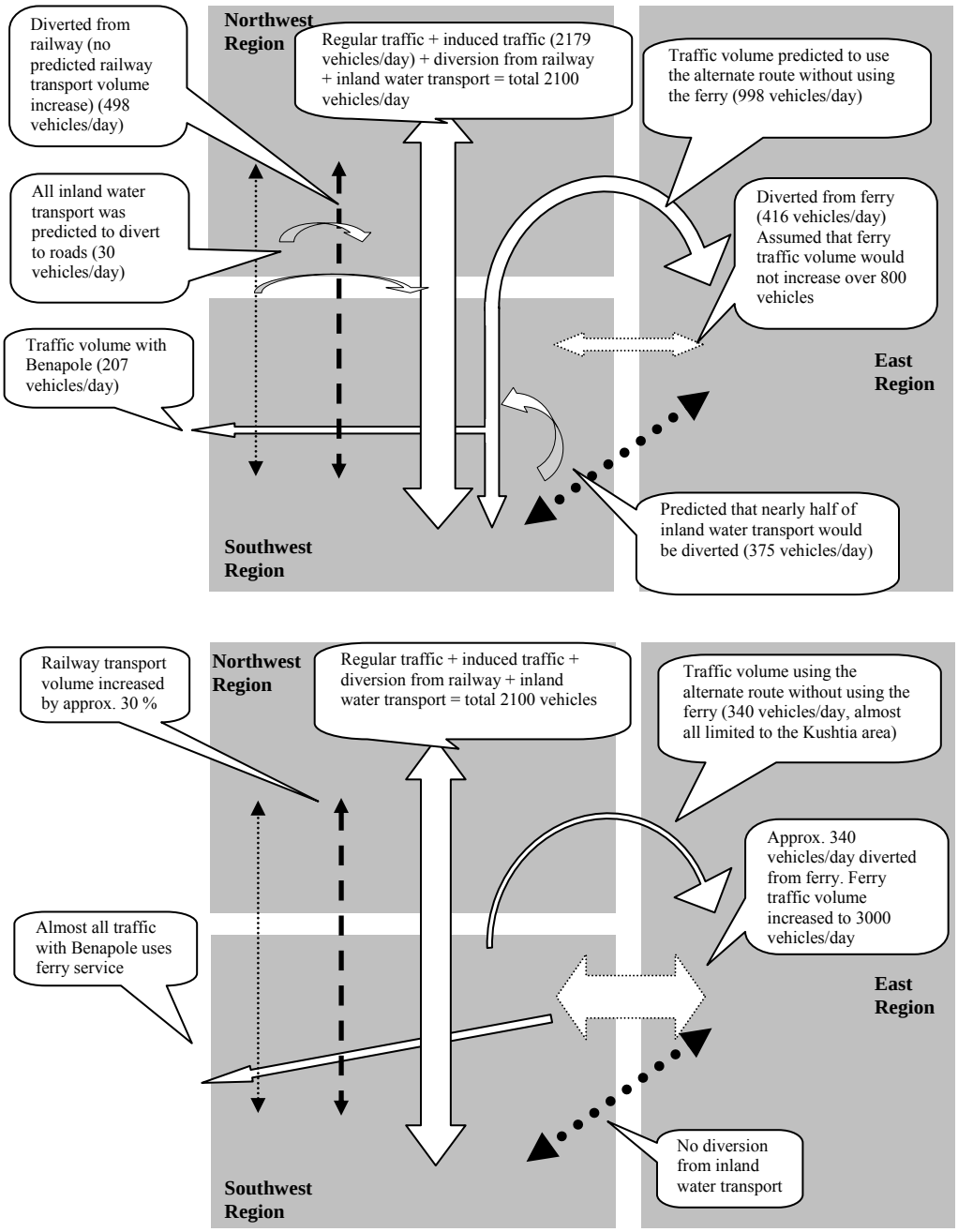
e) Traffic volume observed has decreased due to growth in the size of vehicles (increase in load capacity/number of passengers).

[17] For each expected point of origin and destination for traffic volume between the east and southwest regions, SAPROF calculated the times required for river crossing in the case that a bridge existed and in one in which it did not exist. These calculations considered the river crossing times using ferries in Paksey and Aricha in 1993, as well as river crossing times using the Jamuna and Paksey Bridges. Traffic volume was then predicted on the hypothesis that all traffic would choose the route with the shortest required time. As a result, it was predicted that the traffic volume using the alternate route in 2007 would reach 1330 vehicles per day.

However, even though the required time was shortened, the distance travelled became longer. Consequently, since the cost of running a vehicle, including fuel costs, was increased, diversion in traffic to the alternate route was not necessarily seen, depending on the route. For predicting traffic volume, instead of deciding the route based on a comparison of required time alone, a more appropriate prediction would have been made by comparing the total cost (vehicle operating cost + time cost) by vehicle classification and determining characteristics enabling the easy diversion to bridge routes. For example, buses would place more importance on shortening required travel time. In addition, in interviews with truck drivers, it was found that even if they have to wait 2-3 days for a ferry, they will use the ferry terminal as a rest stop. They also show a trend to habitually use the same ferry route, which shows that attention must be paid to route preference characteristics.

According to E/S, this point was overlooked in the review as well. However, in a new review done by the RHD in the first stage of appraisal, the problem was recognized and the diverted traffic volume was adjusted lower. The hypothesis in the RHD's review states that "Within the diverted traffic volume estimated using SAPROF's method, traffic currently using ferries (approx. 1000 vehicles) will continue to use ferries in the future, while the portion of traffic that exceeds that amount will choose the Jamuna Bridge ~ Paksey Bridge alternate route." This did not take into the consideration the possibility of the improvement of ferry service crossing the Padma River. With this, the estimated diverted traffic volume was corrected to approximately 750 vehicles for 2007, but the actual ferry traffic volume increased three-fold, while the alternate route traffic volume was less than half of the expected amount at 340 vehicles per day (ref. footnote 4). Furthermore, the actual price of fuel increased by 2.6 times in the 12 years from 1995.

Fig 5 Estimations (top) at the time of appraisal (1993) and actual figures (bottom) at the time of evaluation (2007) of the 2007 traffic volume using the Paksey Bridge



2.3.3 Economic analysis

At the time of appraisal, the economic internal rate of return (EIRR) calculated with the following prerequisites was 19.1%. In this evaluation, it was recalculated at 12.1 %[18] with the same prerequisites. The main reason that the value was lower than that of appraisal was that the traffic volume was lower than planned.

Table 3 Prerequisite conditions in economic analysis

Cost:	Bridge construction costs, maintenance management cost
Benefit:	Reduction of required river crossing time for passengers/freight, reduction of vehicle operating costs, reduction of waiting time caused by moving ferry ghats, savings in maintenance management and investment costs necessary for ferry facilities if this project did not exist.
Project life:	30 years

Synthesizing the above, through bridge construction, this project achieved an efficient and safe crossing of the Ganges River according to plan. However, traffic volume of four- or more wheeled vehicles was low, with only half the planned amount, and with the EIRR dropping to approximately 12%, it cannot be said that the effectiveness of the project was very high.

2.4 Impact

2.4.1 Impact on the wide-area socio-economic development

In the appraisal, it was stated that "In order to develop the western regions, it is first necessary to establish a land route originating at Mongla Port in the southwest region, passing through the major urban city of Khulna in the western region to link to the northwest region." As a high-ranking objective, it offered this: "With the completion of Jamuna Bridge…a road network foundation will be established between Dhaka, Chittagong and Khulna, helping the economic development of the western region using Mongla Port and revitalizing economic activity between the eastern and western regions." A wide-area socio-economic impact was expected. Specifically, the alternate route using the Paksey Bridge and Jamuna Bridge was expected to: (1) link Dhaka and Mongla Port with a land route, (2) revitalize distribution in the eastern and southwestern regions, (3) be used as an import route from Benapole on the border with India, and (4) favorably affect agriculture and industry in the northwest region through the improved distribution efficiency between the southwest and northwest regions. Each of these was envisioned with Paksey Bridge being a wide-area trunk line, and also as being used as part of an alternate route linking the eastern and southwest regions with Khulna and Mongla Port as a prerequisite condition.

Here, the results of the OD survey from this time and the results of the 1993 OD survey by SAPROF are compared by organizing the changes in traffic patterns after the completion of Paksey Bridge. Combining this with the details of the socio-

[18] For the calculations of benefits from the reduction of required time, at the time of appraisal it was assumed that after 2000, the value of time would grow at an annual rate of 5%, equivalent to the per capita GDP growth rate. In recalculating, the growth rate for the value of time would be half of the per capita GDP growth rate, in correspondence with research results for recent years in Bangladesh. Therefore, the figure was adjusted lower to 2.7% -- half the per capita GDP growth rate of 5.4% for 2000~2006. (Assuming a rate of 5%, as was done during appraisal, gives an EIRR of 13.8%.) Furthermore, in economic analyses of road and bridge projects in yen loan programs, time value is generally set as a constant. Recalculating with this assumption would give an EIRR of 10.5%.

economic impact that were reported locally, the way in which the estimations made in the appraisal were achieved were analyzed.[19]

For this traffic survey, in order to be able to compare results with the traffic survey implemented by SAPROF, an OD (Origin/Destination) survey was performed dividing the country into 19 zones and targeting four- or more wheeled motor vehicles on the Paksey Bridge. Those results are shown in condensed form in Table 4, Figure 6, and Figure 7.

Table 4 OD distribution (vehicles/day, 2007) for Paksey Bridge traffic volume (Vehicles with 4 or more wheels)

		Northwest region			Northwest region total	Dhaka, east region	Northwest, east region total
		Pabna, Rajshahi	Bogra	Other northwest regions			
Southwest region	Kushtia	337 (2.3x/ 6.1%)	48 (2.0x/ 5.1%)	29 (1.3x/ 1.9%)	414 (2.1x/ 5.4%)	482 (7.5x/ 15.5%)	896 (3.4x/ 9.1%)
	Jessore Faridpur	164 (4.0x/ 10.4%)	39 (3.2x/ 8.7%)	116 (5.0x/ 12.2%)	318 (4.2x/ 10.8%)	0 (NA)	318 (4.2x/ 10.8%)
	Khulna, other southwest regions	231 (2.5x/ 6.8%)	29 (0.8x/ -1.6%)	87 (1.0x/ 0.0%)	347 (1.6x/ 3.4%)	39 (3.9x/ 10.2%)	385 (1.7x/ 3.9%)
	Southwest region total	732 (2.6x/ 7.1%)	116 (1.7x/ 3.9%)	231 (1.7x/ 3.9%)	1,079 (2.2x/ 5.8%)	520 (7.0x/ 14.9%)	1,599 (2.8x/ 7.6%)
Distribution ratio (2007)		46%	7%	14%	67%	33%	100%

Note: For simplification, the 19 OD zones were combined into 7 zones, with neither point of origin or destination differentiated. Figures in parentheses are ratios compared to SAPROF's traffic volume survey (1993) and average annual increase ratios. NA means that there was no traffic at the time of the SAPROF survey, in which case calculation is impossible.

In Paksey, the traffic volume of vehicles with four or more wheels crossing the Ganges River from 1993 to 2007 increased by 2.8 times. This is an average annual increase of 7.6%. In this period, traffic volume of the nation-wide road network showed an average annual increase of 7~8%, but for the major corridors centering around Dhaka, the Jamuna Bridge had an annual rate of 13.3%, Bhairab Bridge (Dhaka ~ Chittagong corridor) had an annual rate of 15.2%, and the Padma River ferry (2 locations) had an annual rate of 10.8%, showing a further large increase in traffic volume. Consequently, the Paksey Bridge contributed to the promotion of transport and distribution as a part of the nation-wide road network, but that contribution was not as great as that of other major corridors.

[19] In the ex-post evaluation of this project, the following surveys were implemented with field studies.
- Traffic volume survey to confirm the precision of the traffic volume data offered by the Paksey Bridge toll booth (3 days)
- OD survey for motor vehicle traffic using the Paksey Bridge (questionnaire survey, 24 hours, approx. 200 samples)
- OD survey for motor vehicle traffic using the Paturia ferry (questionnaire survey, 24 hours, approx. 100 samples)
- Interviews with transport companies and the Dhaka, Bogra, Kushtia, and Khulna Chambers of Commerce
- Interviews with two NGOs that are active near both sides of the Paksey Bridge
- Hearings with the Mongla Port Authority and Ishurdi EPZ (north side of Paksey Bridge)
- Gathering and examination of relevant literature

Fig 6 OD zone divisions (Table 4)

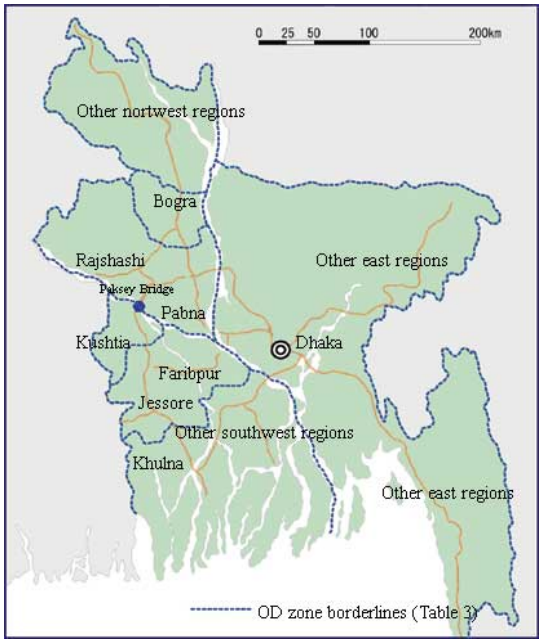
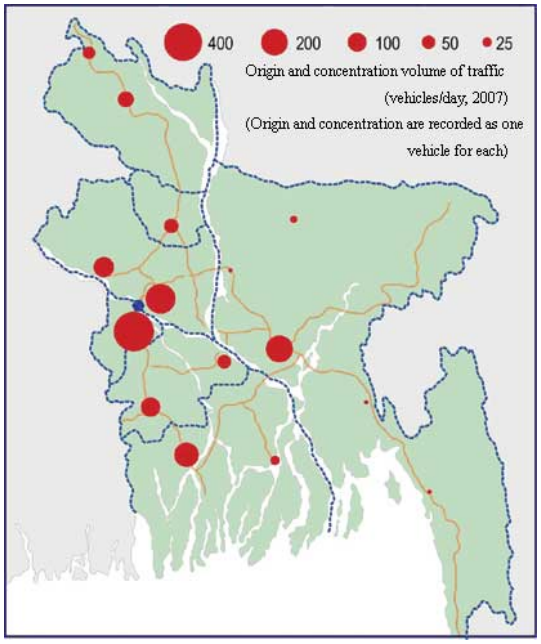


Fig 7 Distribution of origin and concentration volume of traffic (2007)



There was no large change in the ratio of passenger vehicles, buses and trucks, with the ratio at about 1 : 2 : 7. For passenger vehicle and bus traffic, 67% is bus traffic between Dhaka and Kushtia, and 28% is between districts neighboring the bridge. Long-distance traffic between the southwest region and northwest region is nearly all trucks.

Nearly half of the origin and concentration volume of traffic (distribution of OD points: Figure 7) is held by areas near the bridge including Kushtia, Pabna and Rajshahi, but traffic with an origin or destination point in Dhaka or Khulna accounts for one-fourth of the total volume.

According to the results of this survey, there was a large increase in the traffic volume for the following origin and destination points.

- The traffic volume for the east region and Kushtia increased 7.5 times (average growth ratio 15.5%, 2007 traffic volume = 482 vehicles/day). Two-thirds of the volume was buses. In the east region, Dhaka was the point of origin or destination for 85%. Meanwhile, nearly all of the traffic between the east region and Jessore, Khulna/Mongla Port used the Paturia or Mawa ferries, with almost no diversion to the bridge.[20] With the project, the link for Kushtia with Dhaka was greatly deepened, but the same impact was not seen for areas further south of the area.[21]
- Traffic between the southwest areas of Jessore and Faridpur and the northwest region increased 4.2 times (average growth ratio 10.8%, 2007 traffic volume = 318 vehicles/day). Most of the volume was trucks. Jessore was the point of origin or destination for about 15% of the traffic with Benapole, where border trade takes place, and the northwest region.[22] In Faridpur, traffic increased greatly with the northwest region, excluding

[20] According to OD survey results from Paksey Bridge and Paturia
[21] The traffic with "Khulna/other southwest regions" and "eastern region" increased by 3.9 times, but the traffic volume itself was low at 39 vehicles/day. Therefore, this cannot be seen as having had an important impact.
[22] The traffic volume with Benapole and the east region has increased greatly (4.5x from 1993 to 2007, 1,011 vehicles/day in 2007), but the Paksey Bridge route is not used.

Bogra (7.1x, average growth ratio 15.0%, 2007 traffic volume = 106 vehicles/day). In both of these areas, links to the northwest region were deepened with this project, but traffic through the Padma River ferry was four times this amount, making links with the eastern areas greater.[23]

Meanwhile, in traffic that has its origin or destination in the furthest areas from the bridge in the southwest and northwest regions (excluding traffic with Jessore and Faridpur), ODs without much traffic volume growth were seen. For example, in "other northwest regions" ~ "Kushtia", "other northwest regions" ~ "Khulna/other southwest regions", and "Bogra" ~ "Khulna/other southwest regions" the traffic volume stopped at 0.8~1.3 times the volume compared to 1993. The growth in long-distance road traffic between the southwest region and northwest region passing through Paksey to cross the river was small compared to the traffic volume growth of the nation-wide road network. In these areas, the impact of Paksey Bridge is perceived to be small.

The traffic volume with the point of origin or destination at Khulna/Mongla Port was emphasized at the time of appraisal, but the real growth was less than the average (1.6x, 337 vehicles/day in 2007). It also declined from 37% to 21% of the total traffic volume of Paksey Bridge. This is thought to have been caused by the stagnation of industry in the Khulna district, the stagnation of Mongla Port, and the change in transport patterns centering around the economically growing Dhaka.[24]

Traffic between Bogra in the northwest region and the southwest region has also not shown much increase. One reason for this is thought to be that the impact of the Jamuna Bridge was greater on Bogra, strengthening its link with the Dhaka area.

After hearings with transport companies, chambers of commerce, NGOs, etc from each area, the following impacts have been reported in districts surrounding the bridge. Among these, various favorable impacts have been clearly recognized in Kushtia. However, in districts further south (Jessore, Khulna) and districts on the north side of the bridge (Bogra), significant impacts have not been reported. In Bogra, the opinion that "the impacts of Jamuna Bridge are dramatically large, but those for the Paksey Bridge are unclear" has been heard. In Khulna, there are no particular effects from the Paksey Bridge, and the many people had the opinion of "having great expectations for the realization of the Padma Bridge."

[23] In both areas of Jessore and Faridpur, the traffic volume with the east region via ferry reached a total of 1,272 vehicles/day

[24] In the past 15 years, the economy of Bangladesh has been pulled by the somewhat prominent growth of Dhaka. In the areas on the west side, growth in the southwest region is sluggish in comparison with the northwest region. According to the local chambers of commerce, 90% of the commerce activities of the western areas are linked with Dhaka, and the growth in demand for transport with Dhaka as a point of origin or destination is large. The annual average growth rate of the GDP in each region from 1990 to 2004 (dollar-based, nominal terms) is as follows: Dhaka (7.0%), northwest region (5.0%), southwest region (4.0%), east region (4.1%), south region (4.2%)

Table 5 Socio-economic impacts seen in areas surrounding the project

- Many one-day vacationers have begun to visit Paksey Bridge and Kushtia
- It has become easier for the residents of Kushtia to go to Dhaka. The number of buses has increased greatly, and the time required for travel has been shortened. It has become easier to go to good hospitals in Rajshahi. Socio-economic services are easier to obtain – for example, specialist doctors can come from Dhaka.
- The rice polishing facilities on the south side are of better quality, so the rice from the north side is now polished on the south side in the Kushtia area.
- Fresh fruits and vegetables from the north side are now easier to obtain on the south side. Production volume on the north side has increased, prices on the south side were lowered, and consumption increased. However, most of the products from increased vegetable production are shipped to the Dhaka area using the Jamuna Bridge.
- Fresh seafood from the south side is easier to obtain on the north side, and consumption on the north side has increased.
- Soon after the bridge was opened, an export processing zone was established in the area to the immediate north of the Paksey Bridge. However, of the eight EPZs nationwide, this has the lowest tenant rate, remaining at only 25%. Occupying companies export products to India using Chittagong Port or through Benapole, but are not using Mongla Port.

Regarding the wide-area social development impacts envisioned at the time of appraisal, the following can be assessed.

- "Land route linking Dhaka and Mongla Port": This project is almost never utilized as an alternate route to Mongla Port, thus there are no particular contributions perceived.
- "Distribution revitalization of the east and southwest regions": A clear impact can be confirmed in Krushtia, where traffic towards the Dhaka area has increased greatly, but there are no impacts that stand out in other regions.
- "Utilization as an import route from Benapole on the India border": Paksey Bridge is used as an import route to the northwest region, but most of the importation areas are in the east region, for which ferries are used as import routes. Consequently, the contributions from this project are limited.
- "Favorable effects on agriculture and industry in the northwest region with improved distribution efficiency between the southwest and northwest regions": In some districts, including Jessore and Faridpur, there has been a large increase in truck traffic between the north and south areas, and it is possible that this project made some contribution to this. However, it is thought that in the northwest region, the impact of the Jamuna Bridge is larger. Additionally, in both the southwest and northwest regions, the impacts of the Paksey Bridge on distribution in a north/south direction do not reach very far.

2.4.2 Impacts concerning resettlement and environment

For this project, approximately 143 hectares of land were acquired, and number of residents who were affected by losing all or a portion of their land or buildings was confirmed at 1,362 households. The RHD employed an NGO in 1999 to formulate an action plan concerning compensation and began with procedures. Of the affected residents, 2,544 were certified as being qualified to receive compensation for land and buildings, and by the end of August 2007, 2,248 people had received this compensation. There were also 741 people certified as being indirectly affected who also received compensation. There were no particular social problems related to the process or result of the compensation. However, a portion of residents living on the west bank who cannot clearly prove land ownership were not certified to receive compensation, and negotiations are still currently continuing. Additionally, although there was a budgetary allocation for moving and construction of the mosque on the ferry landing, the residents were not able to offer an appropriate area of land for it. Therefore, only a temporary mosque was able to be constructed.

For the environmental aspect during construction, the executing organization employed a consultant to monitor the environmental effects, but no particular problems were seen.

2.5 Sustainability (Rating: a)

2.5.1 Executing organization

2.5.1.1 Operation and management structure

The Paksey Bridge is operated and maintained by the Bridge Construction and Maintenance Division 1 of the Bridge Management Wing established by the RHS in 2006. Toll collection and inspection/repairs is outsourced, and a merged company from Bangladesh and Malaysia has provided the service. This company has placed its headquarters in Dhaka, and is accepting orders for the operations and maintenance of other bridges within Bangladesh. In the Paksey Bridge on-site office, there are 154 people employed, including 65 security staff members. The RHD receives monthly reports from the Dhaka headquarters of the commissioned company, and staff members visit the site for inspections, etc. once every 1-2 months.

The commissioned company collects tolls and conducts regular inspection and everyday repairs. The responsibilities of the RHD include repairing and renewing electrical machines and equipment over 100,000 taka, and restoring damages to civil engineering facilities made by natural disasters.

2.5.1.2 Operation and management system and technical capacity

The company entrusted with the operations and management of this project, mentioned above employs personnel experienced in the operation and management of the Jamuna Bridge, and is thought to have a high technical level. The senior engineers have acquired ISO certification for bridge management.

The RHD had an abundance of experience with toll collection, but no experience in implementing the maintenance management for such a long bridge. Therefore, their capacity for supervising the commissioned company on a technical level is not high. For all practical purposes, they are completely leaving maintenance management in the hands of the commissioned company. In the unlikely case that the company performed inappropriate management, it is possible that it would go

unnoticed. At the RHD, a resident bridge engineer from Japan has been placed as a JICA long-term expert, and he is working to transfer technology regarding bridge maintenance management. This expert is currently working mainly on Japan's past assistance projects (Meghna Bridge, etc.), however, he has not yet been directly involved with the Paksey Bridge.

2.5.1.3 Financial status

The financial resources for operations and maintenance management come from the RHD's road maintenance management budget. As outsourcing costs, 165 million taka (27.5 million taka annually, approximately 43 million yen) has been paid over six years. Maintenance management budget for items other than outsourcing costs is to be secured as necessary, but thus far, there has been no such necessity.

Toll fees collected at Paksey Bridge in fiscal 2006 totaled approximately 100 million taka, but all of it goes to the national treasury. Thus, the RHD cannot directly use this money. The Ministry of Communication set the toll fee base on a policy stating that it was to be "on the same level as the ferries." In order to secure financial resources for the maintenance management of roads, the government is working on the creation of a law to establish a road fund.

2.5.2 The current status of the facilities

Limited to visual observation, the condition of the facility is extremely good, with the exception of the multiple burned-out lights above the bridge. Thus far, damage caused by rain to the shoulder of the attached road was repaired, but repairs have not been necessary for the body of the bridge. The commissioned company created a manual for inspection and repairs, and inspection results and a record of repair work are being kept appropriately.

Upstream revetment with flood damage

In the consignment contract, there is a list of equipment that should be prepared by the commissioned company. In order to visually inspect the underside and sides of the bridge, normally a bridge inspection vehicle is included in this list. However, this is not clearly specified in the contract. The commissioned company has not provided such a vehicle, nor does the RHD own one. Because of this, the underside and sides of the bridge have not had a detailed inspection. However, since it has only been a short since Paksey Bridge was opened, the possibility of a problem occurring is low. Therefore, this is not necessarily considered an urgent issue for this project.

Furthermore, at the revetment upstream of the bridge that was restored in this project, large-scale damage has been confirmed. This damage is thought to have been caused by flooding before 2007. This revetment was constructed by the Bangladesh railway for the Hardinge Railway Bridge, which runs parallel to this project. After the project was started, the need for its repairs was confirmed, and it was added to the scope of the project. After completion, Bangladesh Railway was to

conduct maintenance management. Regarding plans for restoration of the revetment, a clear answer has not been received from Bangladesh Railway.

Synthesizing the above, there are no problems in either the abilities of the executing organization or the maintenance management system for this project, and it has been evaluated as having a high level of sustainability.

3. Conclusions, Lessons Learned and Recommendations

3.1 Conclusions

For this project, a high-quality bridge was constructed, and a safe and efficient river crossing for the Ganges River was achieved. However, its completion was two and a half years late. Traffic volume predictions were overestimated during the appraisal, and with the subsequent stagnation of Mongla Port and the Khulna area, as well as the improvement of the ferries crossing the Padma River, the volume of traffic did not reach expected levels. The current traffic volume is considerably lower than the appraisal plan, and it is possible that there was no need for two lanes on each side. However, it is probable that the economic efficiency to justify the investment will be attained. Thus far, the socio-economic impacts have been limited, but there are no problems in operations and maintenance management, and a high level of sustainability is foreseen.

As a conclusion, this project is evaluated to be generally satisfactory.[25]

3.2 Lessons learned

If the diverted traffic volume will greatly affect the economic relevance of the project, alternate proposals regarding targeted diverted (alternate) routes should be sufficiently considered. Additionally, it is necessary to understand the characteristics of the traffic, and accurately predict the volume of diverted traffic. The economic relevance should, of course, be verified at the beginning of the project. It is also necessary, however, to conduct a careful study when the plan is modified to expand the scale or standards of the project (for example, expansion of lane composition or bridge width).

3.3 Recommendations

- In order to be able to appropriately supervise bridge maintenance management by commissioned companies, it is necessary for the RHD to equip themselves with technical abilities through engineer training, etc.
- For the inspection of bridges several years after construction, it is necessary for the RHD to employ a bridge inspection vehicle to conduct a detailed inspection of the underside and sides of the bridges.
- It is necessary for Bangladesh Railway to conduct a survey and plan a restoration project regarding the damage to the revetment upstream of the Hardinge Railway Bridge, as control of the revetment was transferred to their organization.

[25] Based on each category of the evaluation results, and following the JBIC rating system, the overall evaluation for this project is "B" (satisfactory). However, the traffic volume for 4- or more wheeled vehicles is less than half of the appraisal plan, thus giving the possibility that two lanes on each side were not necessary. Since this cannot be overlooked, it was decided that the overall evaluation of "generally satisfactory" would be suitable.

Comparison of Original and Actual Scope

Category	Plan	Results
□ Outputs	(1) Construction of Paksey Bridge Total length: 1.786 m Road width: 7.5 m x 2 Total width: 18.3 m No. of spans: 17 (2) Construction of revetments West side: 450 m East side: 425 m (3) Construction of attached roads West side attached road: 5.84 km East side attached road: 9.77 km One toll booth (4) Construction of irrigation ditch bridge Total length: 61.8 m (5) Consulting services ・ Design review ・ P/Q and bidding assistance ・ Implementation supervision ・ Environmental management ・ Planning and implementing training ・ Fee establishment survey ・ Progress report creation	(1) Construction of Paksey Bridge According to plan except for the extension of piles (2) Construction of revetments West side: 809 m East side: 470 m Repair of upstream railway bridge revetment (3) Construction of attached roads Nearly according to plan One toll booth location added (4) Construction of irrigation ditch bridge According to plan (5) Consulting services Nearly according to plan
□ Period Consultant procurement Bridge revetment procurement Bridge revetment construction Attached road procurement Attached road construction Opening	April 1997 ~ October 2001 (55 months) Apr. 1997 ~ Dec. 1997 Jan. 1998 ~ Dec. 1998 Jan. 1999 ~ Oct. 2001 Jan. 1998 ~ Jun. 1999 Jun. 1999 ~ Mar. 2001 Oct. 2001	July 1997 ~ February 2004 (79 months) Jul. 1997 ~ May 1998 Dec. 1998 ~ Aug. 2000 Aug. 2000 ~ Feb. 2004 Oct. 1999 ~ Jun. 2001 May 2001 ~ Oct. 2003 May 2004
□ Project Costs Foreign currency Domestic currency Total Yen loan portion Exchange rate	 9.797 billion yen 11.111 billion yen (3.8 billion taka) 20.908 billion yen 16.865 billion yen 1 taka = 2.9 yen (as of Feb. 1997)	 9.805 billion yen 9.662 billion yen (4.256 billion taka) 19.467 billion yen 15.831 billion yen 1 taka = 2.27 yen (Yen loan portion is JBIC disbursed amount)