Analyzing poverty-reducing effect of road improvement

Ministry of Land, Infrastructure and Transport
International Division for Infrastructure　Planning Chief Official　Takeshi　YOSHIDA
Infrastructure Development Institute　Director of 3rd Research Department　Satoshi　UEDA
? Infrastructure Development Institute　Senior Researcher　Yukihiko　YUDASAKA
Infrastructure Development Institute　Senior Researcher　Fujio　ITO

1. Introduction

Benefits of road improvement projects are often evaluated quantitatively through a cost-benefit analysis of direct benefits to road users, such as shorter travel time. Benefits thus quantified, however, constitute only a limited part of the benefits of road improvement. In evaluating road improvement in developing countries, it is important to quantitatively evaluate social benefits (a wide variety of benefits such as the creation of employment opportunities, increase in income, reduction in service prices, and improvement of the medical, educational and other demand and supply environment) for the residents of the areas that are considered to benefit significantly from the road improvement project under consideration. Few attempts have been made, however, at making a quantitative evaluation of the degree to which an infrastructure project eventually contributes to poverty mitigation.

Meghna River This report focuses on the role that road bridge projects in Bangladesh play in improving the living environment of local residents, particularly people belonging to the poor class, and in helping meet their basic human needs, and evaluates the benefits of road bridge projects as quantitatively as possible.

2. Analysis of benefits of road bridge projects

(1) Study projects and study area

The projects considered for the purposes of this study are ones for the construction of road bridges on a major arterial road in Bangladesh, which has been designated as Asian Highway Route 41. The Meghna Bridge (930 m long; in service since 1990) and the Meghna-Gumti Bridge (1310 m; in service since 1994) (Figure 1) were constructed under Japanese "grant aid" projects. The Meghna Bridge, located about 22 km to the east of Dhaka, the capital of Bangladesh, is on the same route as the Meghna-Gumti Bridge, which is located at a distance of 12.5 km from the Meghna Bridge.

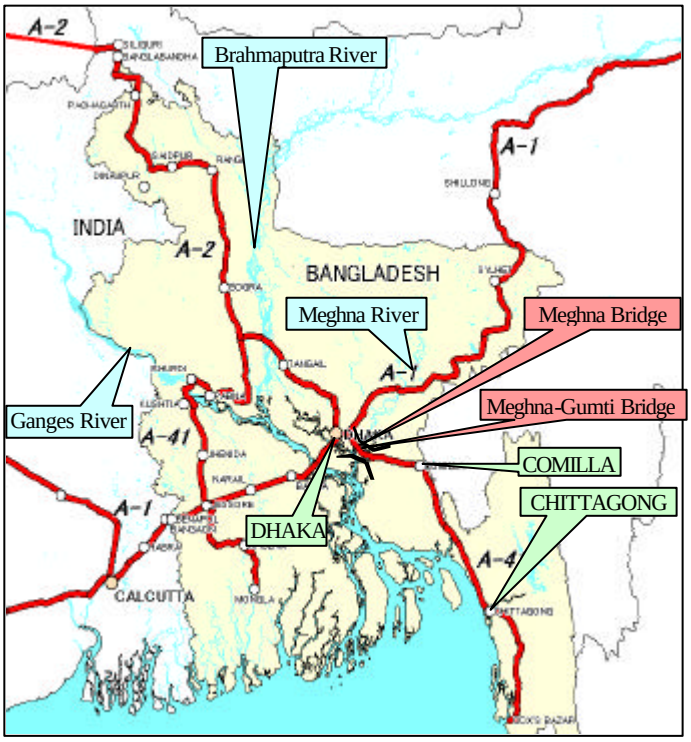


Figure 1　Location map of impact study site

(2) Scope of study

Before the bridges were constructed, ferryboats were the only means of crossing the river (movement of people, transportation of goods, etc.). Since the average waiting time was one hour, crossing the river used

to be an inefficient economic activity. Interview surveys were conducted in two stages: outline survey and detailed survey.

In the outline survey, local residents were interviewed about their opinions and feelings about the bridge projects, and information on their income, living conditions, etc., was collected. The information collected during the outline survey, however, did not reveal the influence of the bridges that had gone into service on the movement of people and goods, particularly the movement of goods.

In view of the results of the outline survey, the detailed survey focused mainly on changes in the quality of life of the people belonging to the poor class brought about by the construction of the bridges. Specifically, in the detailed survey, changes in income levels associated with the movement of products, in opportunities to receive health and medical services and welfare services and in newly created employment opportunities that have been brought about by the construction of the bridges were evaluated. Thus, the effects of the bridges on the quality of life of the poor class were evaluated quantitatively by analyzing collected data.

(3) Survey method

For each survey item, people who were thought to have been affected directly or indirectly by the construction of the bridges were selected (e.g., local residents, distribution industry workers, transportation-related industry workers), and these people were interviewed to collect basic data.

(4) Interview survey areas

Survey areas are areas that are thought to have been affected by the construction of the Meghna Bridge and the Meghna-Gumti Bridge on the Chittagong Highway, which connects Dhaka, the capital of Bangladesh, and Chittagong. The six survey areas selected are Dhaka (capital), Mugrapara, Gazaria, Daudkandi, and Chandina (Figure 1). An interview survey was also conducted in the Meghna Bridge area, which is divided by the river.

(5) Interview survey items

The outline survey items include the following: personal attributes (e.g., age, address, income, family structure), bridge usage (frequency, means of transportation (before-after comparison)), economic status (e.g., changes in sales, market and customers, particularly in agriculture and commerce), living conditions (e.g., changes in access to food, prices and income), education conditions, medical care conditions and employment conditions.

The detailed survey focused on factors affecting the distribution of products, namely, changes in income levels, medical services, and employment opportunities, with a view to determining their influence on the movement of goods. In order to evaluate various benefits, data showing changes in the income and spending of agricultural, fishery, transportation, commercial and other workers (learned individuals (e.g., teachers, public workers) in the survey areas, along with their breakdowns, were collected.

To collect information on health and medical services, not only local residents but also local doctors were interviewed to collect detailed information on health and medical services. Changes in food and other prices were also surveyed in major markets.

(6) Questionnaire sheets and interview surveys

To collect information for the above-mentioned and other survey items, itemized questionnaires corresponding to the survey items were prepared. In November and December of 2000, an outline interview survey was conducted to get a general idea of changes in social and economic conditions brought about by the construction of a bridge. In the survey, data were collected from 215 people living in the bridge project area and from 110 people living in areas where there was no bridge. Late in 2001, a detailed survey was conducted with the aim of quantitative evaluation. In the survey, 516 agricultural, fishery and other workers, 207 health and medical service workers, 210 roadside business employees and 52 learned individuals and market workers in the survey areas were interviewed.

Photograph 1 Interviewing the principal of an elementary school

3. Interview survey results and data analysis results: summation

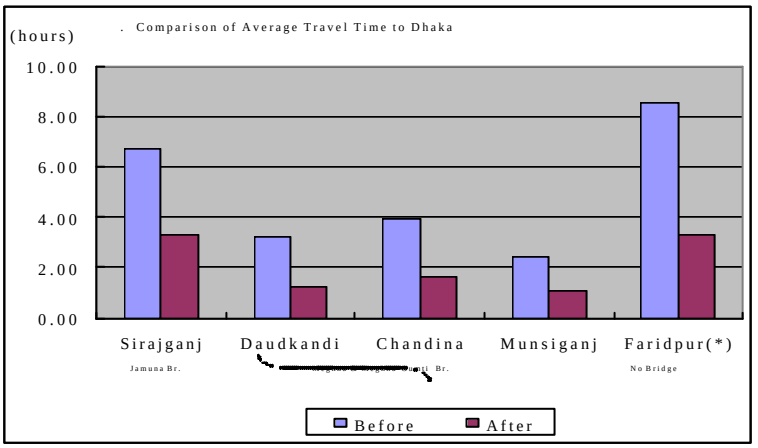
Analyses of data collected through the surveys (outline and detailed surveys) conducted over a period of two years revealed various benefits of the bridge construction. Focusing on main benefits to the poor class, this section summarizes the survey and analysis results.

A. Results of analysis of data obtained from outline survey

Benefit 1: Considerable reduction in travel time to Dhaka

Travel time between Dhaka and Chittagong

The interview survey results show that travel time to Dhaka from various places has been halved: on average, travel time has been reduced by about two hours. Before the bridges went into service, travel time including the average waiting time for ferryboats was two to four hours



The bridges have reduced travel time to one hour or so. **Figure 2 Comparison of travel time to Dhaka**

Benefit 2: Reduction in transportation charges due to travel time reduction

＜Transportation charges between Dhaka and Chittagong＞

Table1 Cost reduction made possible by transporting 5-ton goods

	Unit cost (TK/km･ton)	Distance between Chittagong and Dhaka (Km)	Weight of goods (Ton)	Transportation charge (1996prices) (TK)
1984	3.08	264	5	4065
1996	2.38	264	5	3141
Difference	0.70			924

If it is assumed for simplicity that all cargoes handled at the port of Chittagong (13,100,000 tons;

imports 11,460,000 tons, exports 1,630,000 tons) are transported to Dhaka, and that those cargoes are transported in five-ton trucks,13,100,000 tons / 5 ? 924 = TK2.4 billion that is, as much as 2.4 billion taka can be saved each year.

Benefit 3: Rise in land prices in adjacent areas

Table2 Changes in land principal districts（1988-1995）

Region	Land Value in Taka (millions) per Acre		
	Actual 1988	Inflation Related Only 1995	1995 (actual land prices)
Cox's Bazar	0.4*	0.470	0.70
Comilla	0.2	0.214	1.50
Kushtia (urban)	0.5	0.740	1.25
Kushtia (rural)	0.1	0.170	0.25

Table Land Value Changes

*: 1991 land price.

Source: Local government land sale offices.

In Comilla near the bridges, land prices increased by factor of 7.5 from 1988 to 1995. In Cox's Bazar, land prices increased by a factor of 1.75; and in the urban and rural parts of Kushtia, by a factor of 2.5. Thus, land price increases in these areas are considerably larger than in other areas.

Benefit 4: Very high employment-promoting effect during construction

Since the bridge construction itself was labor-intensive, it became ossible to expand local employment opportunities considerably. The construction of the Meghna Bridge and that of the Meghna-Gumti Bridge created employment opportunities for 634,000 and 562,000 people, respectively.

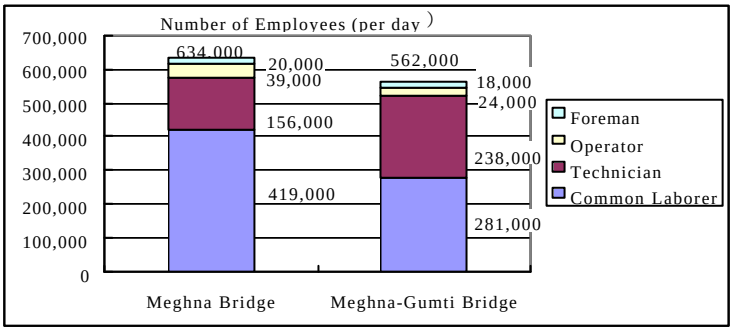


Figure 3 Number of workers involved in the construction of the bridges (Source: Pamphlet on the construction of the Japan-Bangladesh Friendshi Bridge)

The economic effect of the employment opportunities created by the construction of the two bridges equal to one year's worth of food assistance for employment promotion.

By taking full advantage of the lessons learned from the construction of the first bridge, the number of common laborers was reduced and the number of skilled workers was increased. Another noteworthy fact from the viewpoint of productivity is that the amount of labor required to build the second bridge was less than that required to build the first bridge even though the second bridge was longer.

Benefit 5: Increases in local employment due to emergence of new factories and businesses

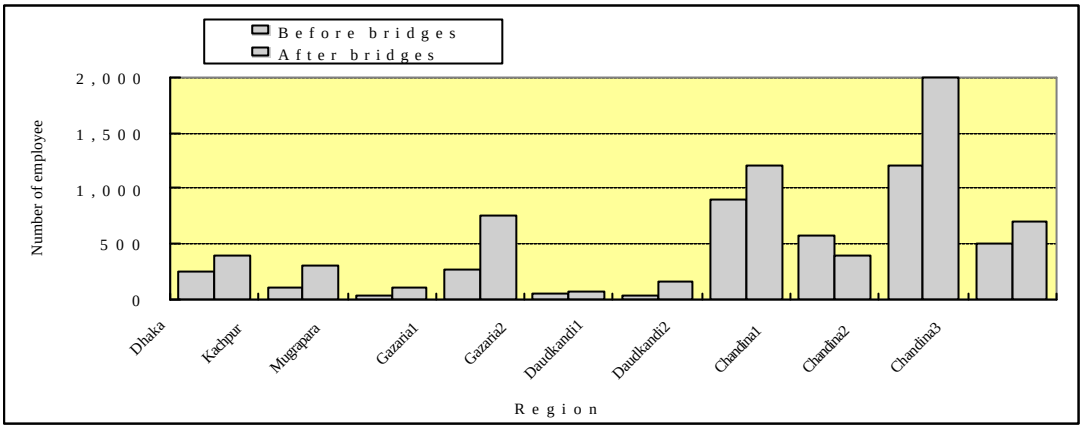


Figure 4: Employment status before and after bridge construction

It seems that improvements in the transportation environment have increased revenues of the roadside businesses and employment opportunities for local residents (Figure 4). The degree of employment improvement varies with the category of business and the size of businesses, but all businesses increased their employees after the bridges went into service. Among the companies surveyed, there was even a company whose 700 employees included 600 local residents (about 86%).

Benefit 6: Great contribution to movement of goods

« Comparison of volume of cargo handled: Chittagong port vs. Mongla port»

Changes in volume of cargo handled at major ports

As mentioned earlier, the Meghna Bridge and the Meghna-Gumti Bridge have shortened the travel time between Dhaka and Chittagong, greatly affecting the movement of goods in the area. Let us briefly review here to what extent the movement of goods has been affected by looking at the volumes of cargo handled at the port of Chittagong. Comparison of the volumes of cargo handled hat the Chittagong and Mongla ports reveals that the volume of cargo handled at the port of Chittagong increased significantly in 1990, when the Meghna Bridge went into service, and in 1994, when the Meghna-Gumti Bridge went into service.

The volume of cargo handled at the Mongla port, which is nearer to Dhaka than the Chittagong port is, also increased slightly but not as much as at the Chittagong port. A likely reason for this is that thanks to the construction of the Meghna and Meghna-Gumti bridges, the transportation time between Dhaka and Chittagong became shorter than the transportation time between Dhaka and Mongla, and, as a consequence, the volume of cargo handled at the Chittagong port increased.

This result indicates that the construction of the Meghna and Meghna-Gumti bridges has greatly helped improve the movement of goods.

Benefit 7: Local residents' opinions of the bridges

Table3 Public opinions about Meghna Bridge and Meghna-Gumti Bridge

Rating	Number of responses	(Persentage)
1.Very good	120	(55.8%)
2.Good	90	(41.9%)
3.Fair	3	(1.4%)
4.Bad	1	(0.5%)
5.Very bad	1	(0.5%)
Total	215	(100.0%)

Of the local residents surveyed, about 56 percent described the bridges as "very good"; 42 percent, "good." Thus, about 98 percent of the respondents had positive opinions of the two bridges.

Benefit 8: Increase in opportunities for exchanges (considerable increase in opportunities to cross the river)

About 45 percent of the local residents surveyed replied that they used at least one of the two bridges at least once a week; and more than 80 percent, at lease once a month. (In Faridpur, in which there is no bridge, there were no respondents who replied that they used at least one of the bridges everyday; slightly less than 20 percent reported a frequency of use of at least once a week, and a little more than 50 percent reported a frequency of use of at least once a month.)

Benefit 9: Major shift in mode of transportation

Table4 Changes in means of transportation used by agricultural producers to deliver produce

Means of Transportation	Before		After	
	Number.of responses	(Persentage)	Numb er.of responses	(Persentage)
1.Walking	47	(41.6%)	27	(18.5%)
2.Bicycle	0	(0.0%)	9	(6.2%)
3.Rickshaw	20	(17.7%)	40	(27.4%)
4.Auto-rickshaw	0	(0.0%)	8	(5.5%)
5.Truck	3	(2.7%)	7	(4.8%)
6.Pick-up	0	(0.0%)	2	(1.4%)
7.Bus	5	(4.4%)	12	(8.2%)
8.Van	2	(1.8%)	22	(15.1%)
9.Others	36	(31.9%)	18	(12.3%)
N/A	0	(0.0%)	1	(0.7%)
Total	113	(100.0%)	146	(100.0%)

The construction of the bridges and the improvement of the related road sections have resulted in a major shift in the mode of transportation, from walking to rickshaws, trucks and vans.

The percentage of walking fell from 42 percent to 19 percent, and the percentages of rickshaws and vans have jumped from 18 and 2 percent to 27 and 15 percent, respectively.

Benefit 10: Improvement of medical environment

Nearly 70 percent of the respondents replied that they changed hospitals/infirmaries after the bridges went into service. The reasons for changing hospitals/infirmaries include the need for better facilities and doctors, which expanded the range of medical service options. Thus, the construction of the bridges has improved the local medical situation and has made it easy to go to advanced medical treatment facilities in Dhaka, thus improving the medical environment for local residents. Before the bridges went into service, there were no respondents who replied that the local medical situation was good. After the bridges went into service, about 57 percent of the local residents surveyed replied that the local medical situation had improved.

Benefit 11: Considerable increase in frequency of visiting Dhaka

Before the bridges were constructed, the average frequency of visiting Dhaka, the national capital, was only 25 to 40 times a year. After the bridges went into service, it rose sharply to 40 to 75 times a year. Many people visit Dhaka for business or pleasure, and there are also substantial benefits associated with work and daily life.

Benefit 12: Higher income than in bridgeless areas

Table5 Household income (average) by region

Region	Income(average)
Faridpur(without bridge; control)	8,853 TK
Munsiganj	10,309 TK
Chandina	10,068 TK
Daudkandi	12,750 TK

The bridges have also brought benefits in terms of income. Monthly income of households in the areas served by the bridges turned out to be higher than in Faridpur, a bridgeless community, by as much as 2000 to 3000 taka, indicating a high income level of the areas served by the bridges.

B. Results of analysis of data obtained from detailed survey

The detailed survey focused on changes in the quality of life of the poor class caused by the construction of the bridges. In the detailed survey, quantitative evaluation was made by analyzing collected data.

Benefit 13: Benefits due to changes in income levels of local residents

Data on the income levels, before and after the bridge construction, of people of different trades (learned individuals such as teachers and public workers; and workers in agriculture, fishery, transportation and commerce) in different areas collected through interview surveys are analyzed to evaluate the effectiveness of the bridges in mitigating poverty in the survey areas and the economic benefits (calculated on a trial basis) to the local communities.

(1) Calculation of deflators **Table 6 Deflators used**

To compare income and expenditure levels before and after the bridges went into service, deflators were used to convert all monetary amounts to present prices.

Year	Wholesale price index/deflator
◆Dhaka Division	
(1)1989-90	1,267
(2)1998-99	1,863
Dflator (1)/(2)*100]	68.01
◆Chittagong Division	
(1)1989-90	1,279
(2)1998-99	1,840
Deflator (1)/(2)*100]	69.51
◆Bangladesh	
(1)1989-90	1,225
(2)1998-99	1,760
Deflator (1)/(2)*100]	69.60

Deflators were defined using wholesale price indices before and after the bridges went into service. The periods before and after the bridges went into service considered here are 1989/90 and 1998/99, respectively. For example, if the pre-bridge income of Dhaka residents is 68.01 taka, the equivalent present price is 100 taka. Wholesale price indices are summed by region. Deflators to be used are also calculated by region..

(2) Definition of the poor class

For the purpose of mitigating the poverty of the poor class, the term "poor class" was defined.

As poverty line criteria needed for poverty measurement, results obtained by the cost-of-basic-needs (CBN) method used in Poverty Profile: People's Republic of Bangladesh (February 2001, Japan Bank for International Cooperation) are used.

The poverty lines calculated by the CBN method are shown in Table 7. JBIC's poverty lines cover all regions (by division; Bangladesh has five divisions) of Bangladesh and has urban and rural categories; all of the six cities covered in the present study are included in either Dhaka Division or Chittagong Division. Four interview survey areas, namely, Dhaka, Kachpur, Mugrapara and Gazaria belong to Dhaka Division, and Daudkandi and Chandina belong to Chittagong Division. Since the interview surveys were conducted mainly in rural areas, all areas are assumed to be rural.

If the values shown in Table 7 are to be applied to the present study, the following conditions need to be satisfied:

Table 7 Poverty lines for survey areas in Bangladesh (calculated by the CBN method; unit: take/month)

Divison	Area	1995/96 (*1)	
		ZL(※2)	ZU(※2)
Dhaka	Urbun	584	931
	Rural	523	661
Chittagong	Urbun	564	704
	Rural	548	638

(*1) Source: Poverty Profile
(*2) ZL: lower poverty line
ZU: upper poverty line
(*3) The figures are for single household members

1) The 1995/96 prices must be converted to present prices by using a deflator.

2) Since the actual number of members of each household is not known, the average number of household members is used to determine the household poverty line.

To determine the deflator, the rate of increase in consumer prices since 1995 was calculated and the value thus obtained was used (rate of increase: 23.5%). According to the 1999 Statistical Yearbook of Bangladesh (Bangladesh Bureau of Statistics), the average number of household members in Bangladesh is 5.6; therefore, this value

was used for the present study. By using these values, the poverty line corresponding to the household income at the time of the interview surveys were calculated. The results are shown in Table 8.

Table 8 Household income and poverty lines usable for comparison (calculated by the CBN method; unit: take/month)

Divison	Area	ZL(※2)	ZU(※2)
Dhaka	Urban	4,038	6,440
	Rural	3,618	4,570
Chittagong	Urban	3,903	4,866
	Rural	3,791	4,413

(*1) The data were compiled from Poverty Profile

(*2) ZL: lower poverty line
ZU: upper poverty line

The income and expenditure data collected through the interview surveys cannot be applied as they are because they are labor income data.

For the purposes of the this study, the difference between income and expenditure (income - expenditure) was regarded as household income, and the data thus obtained were compared with Table 8. Then, households with an income (income - expenditure) level below that level were categorized as poor (ZL: lower poverty line, ZU: upper poverty line). As mentioned above, the rural poverty line was applied.

(3) Poverty mitigation by region

By using the methods described above, the poverty rates for 516 interview survey respondents (households) before and after the bridges went into service were calculated. Table 9 and Figure 5 show the pre- and post-bridge poverty rates by region. Table 10 and Figure 6 show pre- and post-bridge poverty rates.

Table 9 Poverty rates of interviewees before and after bridge construction

	Total	Before bridge construction		After bridge construction		Change	
		No. of poor households	Poverty rate	No. of poor households	Poverty rate	No. of poor households	Poverty rate
Dhaka	60	19	31.7	10	16.7	-9	-150
Kachour	61	36	59.0	25	41.0	-11	-180
Mugrapara	58	37	63.8	42	724	+5	+8.6
Gazaria	108	55	50.9	42	38.9	-13	-120
Daudkandi	116	85	73.3	87	75.0	+2	+1.7
Chandina	113	77	68.1	62	54.9	-15	-132
Overall	516	309	59.9	268	51.9	-41	-8.0

Figure5 Poverty rates of interviewees before and after bridge construction

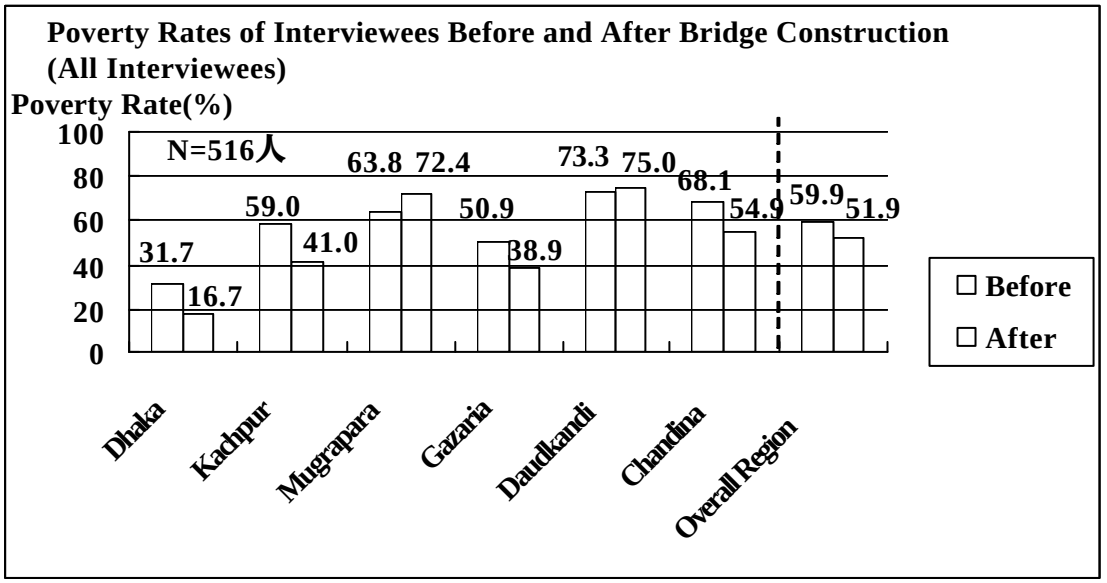
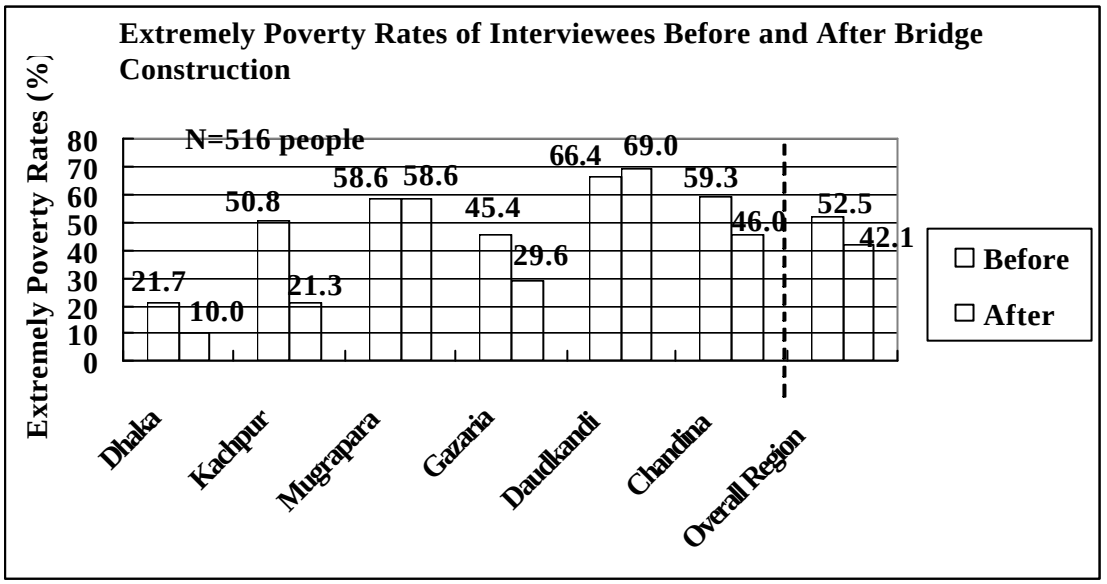


Table 10 Extreme poverty rates of interviewees before and after bridge construction

	Total	Before bridge construction		After bridge construction		Change	
		No. of poor households	Poverty rate	No. of poor households	Poverty rate	No. of poor households	Poverty rate
Dhaka	60	13	21.7	6	10.0	-7	-11.7
Kachour	61	31	50.8	13	21.3	-18	-29.5
Mugrapara	58	34	58.6	34	58.6	+0	+0.0
Gazaria	108	49	45.4	32	29.6	-17	-15.8
Daudkandi	116	77	66.4	80	69.0	+3	+26
Chandina	113	67	59.3	52	46.0	-15	-13.3
Overall	516	271	52.5	217	421.0	-54	-10.4

Figure 6 Extreme poverty rates of interviewees before and after bridge construction



According to Tables 9and 10 and Figures 5 and 6, the poverty rates of the interview survey areas before and after the bridges went into service were 59.9 and 42.1 percent, respectively, indicating a decrease of 8.0 percent. The extremely poverty rates of the same areas were 52.5 and 42.1 percent, indicating a decrease of 10.4 percent.

Thus, if a time a little before 1994, in which the Meghna and Meghna-Gumti bridges were completed to connect Dhaka with the Comilla area and with the Chittagong area, is regarded as the pre-bridge time, these decreases in poverty rates and extreme poverty rates occurred in about six years.

The poverty rate and extreme poverty rate data in the poverty profile (Table 6) shows that the poverty rate in the rural areas in Bangladesh during the 12 years from 1983/84 to 1995/96 has decreased by only 2.9 percent (from 59.6% to 56.7%). Similarly, the extreme poverty rate data show that the decrease in extreme poverty rate has been only 2.8 percent (from 42.6% to 39.8 percent).

Table 11 （Reference）Changes in Poverty Rate and Extreme Poverty Rates in Bangladesh（1983/84～1995/96）

Changes in Poverty Rate

(ZU: percentage of population below upper poverty line; defined by the World Bank)(Calculated by CBN Method)

Poor Class (Upper:%)	1983/84	1985/86	1988/89	1991/92	1995/96
National	58.5	51.7	57.1	58.8	43.1
Rural	59.6	53.1	59.2	61.2	56.7
Urban	50.2	42.9	43.9	44.9	35.0

Source : Poverty Profile: People's Republic of Bangladesh (Feb 2001.JBIC)

Changes in Extreme Poverty Rate

(ZL: Percentage of population below lower poverty line; defined by the World Bank)

Poor Class (Upper:%)	1983/84	1985/86	1988/89	1991/92	1995/96
National	40.9	33.8	41.3	42.7	35.6
Rural	42.6	36.0	44.3	46.0	39.8
Urban	28.0	19.9	22.0	23.3	14.3

Judging from these results, it is likely that the Meghna and Meghna-Gumti bridges greatly helped mitigate poverty. The fact that the rate of decrease of the extreme poverty rate is higher than that of the poverty rate is thought to indicate that the bridges have helped increase the income of people belonging to the low-income bracket.

(4) Economic benefits to local communities

Economic benefits to the communities of Gazaria, Daudkandi and Chandina, which were chosen because they were likely to be affected greatly by the Meghna and Meghna-Gumti bridges, were studied. Data on pre-bridge and post-bridge labor income and expenditure obtained from the interview survey results for the three areas were used to calculate overall changes in income and expenditure and evaluate the influence of the bridges on local economy.

(a) Calculation procedure

The average income increase and average expenditure increase data for different regions and different trades were used to calculate bridge-induced changes in income and expenditure in the three regions (Gazaria, Daudkandi, Chandina) by multiplying by working population by industry.

The calculation steps are as follows:

1) Extract and sort out data on working population by industry

Extract and sort out data on working population by industry for the Gazaria, Daudkandi and Chandina areas from statistical data.

2) Extract and sort out data on income changes by industry (due to bridge construction) from interview survey results

Extract and sort out data on income changes due to the bridge construction (pre-bridge income minus post-bridge income) in different industries from the interview survey results.

3) Total income changes (due to bridge construction) by region

Total income changes due to the bridge construction by industry by multiplying the value obtained at Step 1 by the value obtained at Step 2. Take the value thus obtained as the amount of income change in each region due to the bridge construction (i.e., calculate the total by multiplying the value obtained at Step 1 by the value obtained at Step 2).

4) Extract and sort out data on expenditure changes by industry (due to bridge construction) from interview

survey data

Extract and sort out data on expenditure changes (pre-bridge expenditure minus post-bridge expenditure) due to the bridge construction by industry from interview survey results.

5) Total expenditure changes (due to the bridge construction) by region

Total expenditure changes due to the bridge construction by industry by multiplying the value obtained at Step 1 by the value obtained in Step 4. Take the value thus obtained as the amount of expenditure change in each region due to the bridge construction (i.e., calculate the total by multiplying the value obtained in Step 1 by the value obtained in Step 4).

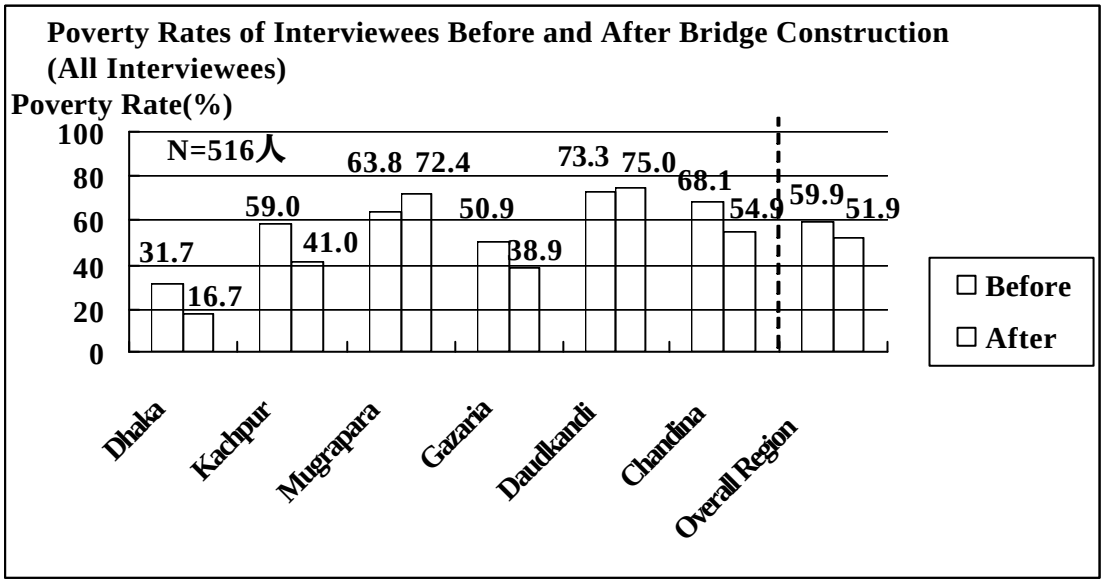
(b) Calculation results

Table 7 and Figure 4 show the overall changes in income and expenditure (averages) due to the bridge construction in the Gazaria, Daudkandi and Chandina areas in all industries surveyed (N=516 respondents), calculated by following the steps described above.

Table12 Trial Calculation :Overall Changes in Income and Expenditurein Three Regions due to Bridge Construction

Region	Overall change in Income	Overall Change in Expenditure
Gazaria	102,507	57,624
Daudkandi	1,103,105	1,149,099
Chandina	159,397	70,919

Figure 7 Trial Calculation: Changes in Monthly Income/Expenditure (Total of Three Regions)



As can be seen from Table 7 and Figure 4, of the income changes in the three areas under consideration (Gazaria, Daudkandi, Chandina), those in the Daudkandi area near the Meghna-Gumti Bridge are by far greater than those in the other areas. This indicates that the bridges have greatly affected the lives of the residents of the Daudkandi area. Since the large increase in expenditure due to the bridge construction indicates an increase in the amount of money in circulation in the area, it can be said that there have been considerable indirect economic benefits and that impact on the economy of the area has been substantial.

(5) Examples of benefits

As an example, this section introduces a great benefit of the bridge construction (effect of bridge construction on work) to a truck driver in Gazaria (male, 50 years old) chosen from the interview survey respondents.

Figure 8 Case Study : Change of Situation : Truck Driver living in Gazaria

Item	Before bridge construction	Change	After bridge construction
Weight of goods transported /time	4 ton	+2 ton/trip ? ? ? ? ? ? ? >	6 ton
Income/time (TK/time)	800	+700TK/trip ? ? ? ? ? ? ? >	1,500
Frequency (time/month)	10	+5 trips/ month ? ? ? ? ? ? ? >	15
Monthly Income (TK/month)	8,000	+14,500TK/month ? ? ? ? ? ? ? >	22,500
Departure/Destination	Dhaka/Comilla	Transportation distance +152km ? ? ? ? ? ? ? >	Dhaka/Chittagong

After the bridges went into service, this truck driver changed his trucking destination (from Dhaka) from Comilla to Chittagong. A major factor contributing to this change should be a considerable reduction in travel time made possible by using the bridges instead of ferryboat service. As a result, income per transportation trip has nearly doubled from 800 taka to 1500 taka, and the frequency of transportation has increased by 50 percent from 10 trips per month to 15 trips per month. Since the amount of cargo transported per trip also has increased, monthly income has almost tripled from 8000 taka to 22500 taka. Thus, the truck driver has increased his income considerably by using the bridges.

The fact that the quantity of goods transported by truck drivers in a week has increased considerably indicates that the quantity of goods transported between the two major Bangladeshi cities, Dhaka and Chittagong, has increased accordingly. The bridges have helped increase the movement of goods, thereby stimulating the transportation market.

The switchover from ferryboating to trucking resulted in increases in transportation distance. The distance between Comilla and Chittagong of 152 km corresponds to about three hours of travel. The difference, however, between the time required for ferryboating and the time required for trucking via the bridges is roughly three hours. Therefore, although there is little difference in the time required between pre-bridge transportation and post-bridge transportation, the bridges have expanded the sphere of activity and have helped increase income considerably. This example clearly shows dramatic, far-reaching effects of the bridges.

Benefit 14: Cost-benefit analysis results

A cost-benefit analysis of the construction of the Meghna Bridge and the Meghna-Gumti Bridge was conducted strictly on a trial basis. The cost-benefit analysis was conducted following a benefit calculation procedure widely used in Japan, but only benefits from reduced travel time were calculated because unit pricing was difficult. In Japan, it is standard practice to calculate benefits according to Cost-Benefit Analysis Manual (June 1998, Road Bureau and City Bureau, Ministry of Construction). For the purposes of this study, the same manual was used to calculate time benefits.

(a) Cost-benefit analysis and its results

The analysis procedure and conditions are described below.

(1) Calculation of amount saved per hour

The amount saved per hour, which is needed to calculate benefits, is calculated.

1) As the first step, the average income of households in the survey area is calculated using the working-population-by-industry data for the Gazaria, Daudkandi and Chandina areas and the difference between the average income and the average expenditure in each industry. [2297 taka/month]

2) The value thus obtained is divided by 30 to calculate the income per day. The income per day, then, is divided by 8 (hours) to calculate the amount saved per hour, and the value thus obtained is taken as the amount saved per hour for the entire survey area. [9.6 taka/hour]

* The average income data obtained from the interview survey results indicated a larger value, but the smaller value was obtained because the income of unemployed people, job-seeking people and people who stay at home was assumed to be zero.

(2) Traffic volume calculation

The volume of traffic passing the Meghna Bridge and the Meghna-Gumti Bridge is determined, and the number of beneficiaries is determined.

1) From the RHD survey results, traffic volumes of different types of vehicles are determined. [1998 survey results: four-wheeled vehicles: 6522 vehic les/day (trucks: 2446 vehicles/day, buses: 1863 vehicles/day, cars: 2213 vehicles/day)]

2) The average numbers of occupants in different types of vehicles are determined from a report prepared at the time of construction planning (1984 survey) (because there are no data on the present conditions). [Average number of occupants: buses: 53.0 persons/vehicle, cars: 3.0 persons/vehicle, trucks and other two- and three-wheeled vehicles: 1.0 person/vehicle (conservative value)]

3) The number of persons passing the bridges per day is calculated by multiplying the traffic volume by the average number of occupants. [107,894 persons/day; Bangladesh Transport Sector Study Final Report Volume II (The World Bank, December 1994) predicted that about 30.7 million persons would pass the Dhaka-Chittagong Corridor in 2000. This translates to 84,100 persons/day. The value shown above (107,894 persons/day), therefore, is considered reasonable because it does not differ greatly from the Work Bank projection.]

4) The time required for crossing the river before and after the bridge construction is determined. [For both bridges, the time for crossing the river after the bridge construction was five minutes, compared with the pre-bridge travel time of 95 minutes. Consequently, travel time is reduced by 90 minutes, and if both bridges are used, travel time is reduced by a total of 180 minutes.]

5) From the above data, the total time saving per day made possible by the bridges in cases where the bridges are used is calculated (by multiply ing 180 minute time saving by the number of persons who use the bridges). [107,894 ? 3 (hours) = 323,682 person-hours/day]

* For the purpose of benefit calculation, it is assumed here that all vehicles between Katchpur and

Daudkandi in the traffic survey results pass both bridges. It is also assumed that none of the other vehicles does not pass the bridges. It is further assumed that the traffic volume in 2002 is the same as the 1998 traffic volume.

(3) Calculation of time saving per year

Benefits from time savings are calculated from the amount saved per hour ((1)) and the overall time savings calculated from traffic volumes ((2)).

1) The benefit (daily, annual) from time savings is calculated by multiplying the time saved by the amount saved per hour. [323,682 ? 9.6 = 3107 (thousand taka/day)]=58 (thousand dollars/day), 3107 ? 365 = 1,134,182 (thousand taka/year)=21 (million dollars/year)]

* Only the benefits from time savings are calculated from limited data. Benefits from fuel savings and benefits from accident reduction, which are usually treated as benefit items in Japan, are not calculated here. Other benefits from other improvements, such as environmental improvement and living environment improvement, are not calculated, either.

(4) Calculation of 30-year benefits

Benefits from the two bridges over a period of 30 years are totaled.

1) The total amount of benefit in 2002 is used in calculation as the amount of benefit per year.

2) Annual benefits (present value: 2002 value) are calculated using a discount rate of 5 percent. (Common practice in Japan is to use 4 percent. The five-percent discount rate was used in view of the rates of increase of consumer prices in recent years. The average annual rate of increase of prices in Bangladesh during the period between 1995 and 2000 was 5.7 percent.)

3) The amounts of annual benefits for different years are totaled. [459.40 (million dollars) - present value equivalent]

* Benefits and costs over a period of 30 years were considered (although a 40-year period is used in Japan for benefit-cost analysis). The Meghna Bridge and the Meghna-Gumti Bridge went into service in 1990 and 1994, respectively. For the purpose of benefit calculation, however, it was assumed that both bridges went into service in 1994, and benefits from the two bridges were calculated together.

(5) Calculation of costs (project cost, maintenance cost)

The project costs and maintenance costs for the Meghna Bridge and the Meghna-Gumti Bridge are determined, and the total cost (present value) over a period of 30 years is calculated.

1) The construction costs for the two bridges are determined. [Construction cost for Meghna Bridge: 45 million dollars, construction cost for Meghna-Gumti Bridge: 63 million dollars, total: 108 million dollars]

2) Because of the lack of maintenance cost data, estimated maintenance cost values (data for access roads and bridge structures) taken from a report prepared at the time of construction planning (1984 survey) for the two bridges were used for the two bridges. The cost values were based on 1984 prices, they were converted to present values, using an average discount rate of 5 percent.

3) After annual expenses are determined, the total for a period of 30 years is calculated. [169.46 (million dollars) - present value equivalent]

* As in (4) above, for the convenience of calculation, it was assumed that both bridges went into service in 1994, and the costs for the two bridges were calculated together.

(6) Cost-benefit analysis

A cost-benefit analysis is conducted, using the amounts of benefits and costs obtained in the preceding steps, to evaluate the economic efficiency of the two bridges.

1) The benefit/cost ratio is calculated (benefit/cost). [459.40/169.46=2.71]

2) Economic net present value (ENPV) is calculated (benefit - cost). [459.40 - 169.46=289.94 (million dollars)]

3) The economic internal rate of return (EIRR) is calculated from the amounts of benefit and cost (Table 5.2.6). [16.22%]

Although only benefits from time saving were calculated (on a trial basis), the calculated amount of benefits over a period of 30 years was 459.40 million dollars, and the cost for the same period was 169.4 million dollars (both benefit and cost are present values). From these amounts, a benefit/cost ratio (B/C) of 2.71, an economic net present value (ENPV: B - C) of 289.94 million dollars, and an economic internal rate of return (EIRR) of 16.22 percent were obtained. These results indicates that the Meghna Bridge and Meghna-Gumti Bridge projects are highly beneficial.

5. Conclusion

In this study, various data were analyzed to study the role that road bridge projects in a developing country play in reducing the number of poor people. Effort was made to use objective evaluation methods of project evaluation wherever possible, in order to find better ways to evaluate benefits quantitatively. As a result, it has been confirmed that the two bridges considered in the study are highly beneficial though some of the benefits of the bridge projects are thought to come from the combined effects of the bridge projects and other regional development projects.

The next challenges in the field of pre-project to post-project evaluation, research and development of evaluation methods, and the development of evaluation personnel. This study focused on road bridge projects, but in order to develop tools for providing judgment criteria necessary for efficient and effective planning and implementation of infrastructure projects in developing countries, it is important to develop different impact study methods suitable for application to different types of projects. It is believed that by developing impact study methods applicable to not only road projects but also river, electric power and other projects and by making effective use of those methods, effective infrastructure projects can be realized and accountability to the public can be fulfilled.

With the aim of poverty reduction, recent assistance to developing countries tends to lean toward basic human needs projects rather than road and other economic infrastructure projects. Some countries, however, need roads and bridges if basic human needs are to be met. We propose that PIARC make extensive effort to develop methods for evaluating such projects in order to gain the understanding of assistance organizations such as the World Bank about the benefits of infrastructure improvement.