Ex-Post Project Evaluation 2016: Package IV-9 (India, Viet Nam)

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India

2015 Ex-Post Evaluation of Japanese ODA Loan Project

"Delhi Mass Rapid Transport System Project Phase 2 (I) - (V)"

External Evaluator: Yumiko Onishi, IC Net Limited

0. Summary

The Project aimed to reduce traffic congestion and pollution by constructing a mass rapid transport system in the National Capital Territory of Delhi (NCTD) that faced problems of economic loss and air pollution due to traffic congestion caused by rapid economic growth and urbanization since the 1990s. From the time of the appraisal to the ex-post evaluation, the urban transport sector continues to occupy an important position in development plans of the governments of India and the NCTD. The development need for a rapid transport system was seen at the times of both the ex-post evaluation and the appraisal. The Project is also in line with Japan's ODA policy, and thus, the relevance of the Project is high. Both the Project cost and Project period exceeded the plan. Therefore, the Project's efficiency is fair. Although some scopes have been added to the Project after its commencement, they were found to be appropriate. Most of the operational and effect indicators set at the time of the appraisal have achieved their targets. With regard to impact on such aspects as regional economic development and improving the urban environment, the Project made a certain degree of contribution. Thus, the effectiveness and impact of the Project are determined to be high. Delhi Metro Rail Corporation (DMRC), the Project's executing agency that has also been responsible for operation and maintenance (O&M), has the institutional structure to operate and maintain the Project as well as necessary technical skills. With regard to the financial status of DMRC, continuous efforts are required for improvement, but no serious issues are found. At the time of the ex-post evaluation, O&M are conducted properly and the sustainability of the Project is high.

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

1. Project Description

Project Location

Line 5 of Delhi Metro

1.1 Background

In India, the urban population increased from 217 million in 1991 to 285 million in 2001, and it was expected to grow further. While urbanization was proceeding rapidly, public transport infrastructure was not developed sufficiently. At the time of the appraisal for the Project, the population owning vehicles and two-wheelers was growing at a high rate of 12% per annum. Moreover, the ratio of population using public transport in urban areas decreased from 69% in 1991 to 55% in 2001, aggravating traffic congestion. Particularly in large cities such as Delhi and Bangalore, the congestion was worsening due to increasing demand on road transport. Health problems, arising out of air and noise pollutions from the vehicles along with economic loss, have become a serious issue. To reduce the traffic congestion and automobile-related pollution, it was necessary to develop a large-scale public transport system based on urban development plans.

1.2 Project Outline

The objective of the Project was to cope with the growing traffic demand in the Delhi metropolitan area, the capital city of India, by extending the mass rapid transport system totaling approximately 83 km in length, thereby contributing to the regional economic development and improvement of the urban environment through alleviation of traffic congestion and reduction of traffic pollution.

Loan Approved Amount/ Disbursed Amount	I.	14,900 million yen / 14,899 million yen	
	II.	13,583 million yen / 13,582 million yen	
	III.	72,100 million yen / 72,100 million yen	
	IV.	77,753 million yen / 76,543 million yen	
	V.	33,640 million yen / 30,312 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	I.	March 2006 / March 2006	
	II.	March 2007/ March 2007	
	III.	March 2008 / March 2008	
	IV.	March 2009 / March 2009	
	V.	March 2010 / March 2010	
Terms and Conditions	I/II	Interest Rate	1.3%
		Repayment Period	30 years
		(Grace Period)	(10 years)
		Conditions for Procurement:	General untied
	III/IV	Interest Rate	1.2% (Main portion), 0.01% (Consultancy)
		Repayment Period	30 years
		(Grace Period)	(10 years)
		Conditions for Procurement:	General untied
	V	Interest Rate	1.4% (Main portion) 0.01% (Consultancy)

	Repayment Period: 30 years (Grace Period): (10 years) Conditions for Procurement: General untied
Borrower / Executing Agency	The President of India/Delhi Metro Rail Corporation Limited
Final Disbursement Date	June 2015
Main Contractors (Over 10 billion yen. The list of contractors with more than 1 billion yen is attached at the end of the report.)	・ Dywidag-Systems International GmbH (Germany)/Ircon International Ltd. (India)/Larsen & Toubro Ltd. (India)/Shimizu Corporation (Japan)/Samsung C&T Corporation (South Korea) ・ Soma Enterprise Limited (India)/Continental Engineering Corporation (Taiwan) ・ Bombardier Transportation GmbH (Germany)/Bombardier Transportation India Ltd. (India) ・ ITD Cem (India)/Italian-Thai Development Public Company Limited (Thailand) ・ BEML Limited (India)/Mitsubishi Electric (Japan)/Mitsubishi Corporation (Japan)/Hyundai Rotem (South Korea)
Main Consultants (Over 100 million yen)	Rail India Technical and Economic Services Ltd (India)/Oriental Consultants Global Co. Ltd. [1] (Japan)/Japan Railway Technical Service (Japan)/Tonichi Engineering Consultants, Inc (Japan)/Oriental Consultants Co. Ltd. (Japan)/Parsons Brinckerhoff International, Inc. (USA) (JV)
Feasibility Studies, etc.	Executing agency prepared the feasibility study in 2005.
Related Projects	<u>Japanese ODA Loan</u> Delhi Mass Rapid Transport System Project Phase 1 (I)-(VI) (February 1997, March 2001, February 2002, March 2003, March 2004, March 2005) Delhi Mass Rapid Transport System Project Phase 3 (I) (II) (March 2012, March 2014) Bangalore Metro Rail Project (I)(II) (March 2006, June 2011) Chennai Metro Project (I)-(IV) (November 2008, March 2010, March 2013, March 2016) Kolkata East-West Metro Project (I) (II) March 2008, March 2010) Mumbai Metro Line III Project (September 2013) Ahmedabad Metro Project (March 2016) <u>Dispatch of Experts (JICA)</u> Rolling Stock Maintenance (2007-2008) Operational Safety (2007-2008)

[1] It was originally Oriental Consultants; however was split and became Oriental Consultants Global in 2014.

2. Outline of the Evaluation Study

2.1 External Evaluator

Yumiko Onishi, IC Net Limited

2.2 Duration of Evaluation Study

Duration of the Study: December 2015 – January 2017

Duration of the Field Study: March 7–21, 2016 and June 20–24, 2016

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

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to the Development Plan of India

At the time of the Project appraisal, to deal with traffic congestion due to increasing demand on road transport, economic loss and health hazards due to air and noise pollutions from vehicles in large cities like Delhi, the Government of India had given priority to development of the urban transport sector as described in the *Tenth Five Year Plan* (2002–2007). At that time, the *Master Plan for Delhi 2001* (MPD 2001) was approved in the Project target area of National Capital Territory of Delhi (NCTD), and a rapid transport system was planned. The *Master Plan for Delhi 2021* (MPD 2021), which was subsequently approved by the Government of India in February 2007, also emphasized the importance of a rapid transport system as the core means of transport in the NCTD.

The importance of a rapid transport system in India and Delhi remains the same at the time of the ex-post evaluation. The *Twelfth Five Year Plan* (2012–2017) regards public transport including metro projects as one of the pillars that make up India's cities in the future, and aims to increase the share of public transport to more than 50%. As can be seen, from the time of the appraisal to the ex-post evaluation, the Project is in line with the development plans of the Government of India and the Government of NCTD.

3.1.2 Relevance to the Development Needs of India

As mentioned earlier, at the time of the Project appraisal, Delhi faced the issue of chronic traffic congestion and other problems associated with it. The average vehicular speed was said to be 15 km/hour at that time, and the urban transport network's dependency on roads was reaching its limit, indicating strong development needs for the Project.

Delhi Metro has seen an annual average ridership increase of approximately 8%, and the Project seems to have contributed to reducing traffic congestion and air pollution to some extent (see "3.4 Impact" for details). At the same time, the population having four wheelers and two

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

[3] ③: High, ②:Fair, ①: Low

wheelers continues to increase even at the time of the ex-post evaluation, and the air pollution has become a serious issue. According to the World Health Organization (WHO), the level of PM 2.5 in Delhi in 2013 was 198 μg/m^3, about twenty times higher than the permissible limit (10 μg/m^3) set by the WHO. The Government of the NCTD implemented a vehicle restriction for 15 days in January and April 2016 and is considering regular enforcement of such restriction. Because of such restrictions, more people are expected to turn to public transport. Construction of the "Delhi Mass Rapid Transport System Project Phase 3" has also been underway since 2012. Development of public transport infrastructure is still needed in Delhi, and the Project is in line with the development needs at the time of the ex-post evaluation as well.

3.1.3 Relevance to Japan's ODA Policy

In the *Medium-Term Strategy for Overseas Economic Cooperation Operations* (2005) that was in effect at the time of the appraisal, development of economic infrastructure and resolving environmental problems were mentioned as important areas for India. In addition, the *Country Assistance Strategy for India* of 2005 also included urban transport as a core sector for assistance to India. It stated that assistance will be provided for urban transport infrastructure (including flyovers and bridges), particularly a mass rapid transport system, as they contribute to reducing traffic congestion and enhancing environmental protection by such means as reducing air pollution. In JICA's country analysis paper prepared in March 2012, the need for a large-scale public transport system based on urban development plans is pointed out to reduce traffic congestion and vehicle-related pollutions.

The Project has been highly relevant to the development plans and needs of India and Delhi as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

Civil works and procurement of rolling stocks

The Project is Phase 2 of the Mass Rapid Transport System Project in the NCTD. Originally, at the time of the appraisal in 2006, out of the 245 km network, it was to construct five lines comprising of six different sections (53.02 km long in total). Subsequently in 2008, the Central Secretariat – Qutub Minar section of Line 2 was extended to the Haryana State border and Line 6 was added to the Project's scope. As a result, a total length of 82.80 km has been constructed (see Attachment 1 for the metro network). Table 1 shows the outputs of the Project. The additional portion was included in the Project in view of the Commonwealth Games held in 2010. The network was to be used as public transport connecting the Games venues and major commercial areas in the city. Moreover, the construction of Line 6 was planned from the beginning. However, because the introduction of first ever standard gauge in the country was

being considered and its technical appraisal took time, Line 6 was included only after the Project started. With the changes in the network, the required number of rolling stocks has also increased from 312 to 734 coaches and the number of depots from one to four.

Table 1: Metro Line and Sections Covered by the Project

Line	Section	Type	Length (km)	
			Plan (2006)	Actual (2012)
1 (red)	Shahdara – Dilshad Garden	Elevated	3.09	3.09
2 (yellow)	Central Secretariat – Haryana State border (originally Qutub Minar)	Elevated	2.89	8.74
		Underground	7.98	11.76
	Vishwa Vidyalaya – Jahangirpuri	Elevated	5.42	5.20
		Underground	0.94	1.16
3 (blue)	Indraprastha – New Ashok Nagar	At grade	1.85	1.85
		Elevated	6.22	6.22
4 (blue)	Yamuna Bank – Anand Vihar	Elevated	6.16	6.16
5 (green)	Kirti Nagar – Mundka, Ashok Park – Inderlok	Elevated	18.47	18.46
6 (violet)	Central Secretariat – Badarpur	Elevated	—	14.06
		Underground	—	6.10
Total			53.02	82.80

Source: DMRC

The major changes to the Project output from the original plan are the extension of Line 2 and the inclusion of Line 6. In view of the Commonwealth Games, these lines were to be constructed from the beginning, and their inclusion into the Project is considered appropriate. With regard to the gauges, because Indian Railways uses broad gauges, all of Phase 1 and the plan for Phase 2 were in broad gauges. However, the introduction of standard gauge was debated from the time of Phase 1 appraisal. Compared to broad gauge, its project cost can be lower and other metro projects in the world are using standard gauge. Considering these points and that the use of standard gauge would enable the Project to leverage technical advancement, the change of gauge is considered appropriate.

Consulting Service

Consulting service for the Project included review of design, assisting in procurement procedures (civil works of the underground portion financed by the ODA Loan), supervision of works, quality control, safety management, implementing safety training program, assisting in trial run and review of operation and maintenance manuals. Initially, 1,922 man/months (M/M) was allocated for the consulting service. However, because the Delhi Metro Rail Corporation (DMRC) has developed internal human resources through the implementation of Phase 1, the dependence on external experts has decreased, and only 1,789 M/M was used. In Phase 1, the

consultants supervised the civil works, but DMRC personnel performed the same task in Phase 2, and the consultants have provided advisory services.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 2 compares the planned and actual total Project costs and the Japanese ODA Loan portion. Since the scale of the Project is large, ODA Loan was provided each year from FY 2006 to 2010 and the plan, including the project cost, was revised each time. Therefore, to compare the planned and actual project cost, the sum of cost from 2006 appraisal and cost of scopes additionally included in 2008 appraisal was used as the plan[4]. This has resulted in project cost to be above the plan as the total cost was 112% against the plan, and ODA Loan portion was 127%. The ODA Loan was mainly used for the civil works of the underground portion, electrical and telecommunication works, and procurement of rolling stocks. The main reasons for actual project cost exceeding the plan was rise in the price of rolling stocks and eventual increase in final number of rolling stocks procured. When compared to the plan made in 2006 appraisal, the output has increased; however, as already described in section 3.2.1, the addition of scope was appropriate and the resulting change in project cost is also appropriate.

Table 2: Planned and Actual Project Cost

	Planned	Actual	Achievement
Project Cost	338,782 million yen	379,866 million yen	112%
ODA Loan Portion	162,955 million yen	207,438 million yen	127%

Source: Prepared by the External Evaluator based on documents provided by JICA and DMRC

For financing the Project, other than Japanese ODA Loan, contributions from the Government of India, the governments of NCTD and Haryana State and DMRC were planned. The ODA Loan makes up 55% of the total Project cost, DMRC accounts for 6%, and the rest were provided by the central and state governments. The Project did not encounter problems such as delay in providing finance.

3.2.2.2 Project Period

The Project period was originally planned to be from March 2006, the time of the Loan Agreement, to November 2010, when all the corridors were to be in commercial operation, totaling 4 years and 9 months (57 months). Table 3 shows the dates of commercial operation

[4] The project cost in 2006 appraisal plan was JPY 188,377 million (out of which JPY 90,673 million was ODA Loan) and the project cost in 2008 appraisal plan for additional scope was JPY 150,405 million (out of which JPY 72,282 million was ODA Loan).

commencement for the sections constructed under the Project. The Project was completed in August 2011[5]. This makes the Project period 5 years and 6 months (65 months), which is 114% against the plan.

Table 3: Dates of Commercial Operation Commencement of Lines in the Project

Line	Date of Commercial Operation Commencement
1	June 2008
2	Central Secretariat – Haryana State border: June 2010 (partial), September 2010 (whole)
	Vishwa Vidyalaya – Jahangirpuri: February 2009
3	May 2009 (partial), November 2009 (whole)
4	January 2010
5	April 2010 (partial), August 2011(whole)
6	October 2010 (partial), January 2011 (whole)

Source: DMRC

In Delhi, the Commonwealth Games took place in October 2010 and the Project targeted to complete the corridors so as to serve as public transport system for the event. Although part of the related corridor for the Games was commissioned before the event, there was eight months delay for the Project as a whole, because the standard gauge was introduced for the first time in India and time was required for redesigning of tracks and stations. Most of the corridors under the Project have been completed by the original target of November 2010. The rest of the corridors were total of 8.13 km that comprises portions of Line 5 and 6.

In the Project, although the Project period was set considering the Commonwealth Games, the delay was caused mostly due to change in size of the gauge. Because the project period was planned with due consideration to using the standard gauge, the actual Project period is not necessarily relevant to the output.

3.2.1 Results of Calculations of Internal Rates of Return (Reference only)

Financial Internal Rate of Return (FIRR)

FIRR calculated in the 2010 appraisal was 3.04%. As assumptions for calculating FIRR, the cost included the project and operation and maintenance (O&M) costs while the benefit included revenues from fares, advertisement and property development. The project life was set for 30 years. For recalculation of FIRR at the time of the ex-post evaluation, basically the same parameters were used. However, at the time of the appraisal, the fare structure was assumed to remain the same for the course of the project life, which seemed inconceivable, and there was an indication of fare revision at the time of the ex-post evaluation. Therefore, recalculation was

[5] Consulting service was completed in June 2012.

made with the assumption that the fare will increase by 15% every four years from 2017. As a result, the recalculated FIRR is 3.84%[6].

Economic Internal Rate of Return (EIRR)

For calculating EIRR, the following assumptions were made: the cost involved the project and O&M cost excluding the taxes; the economic benefit included savings from the vehicle operating cost, the road and metro passenger travel time, the operating cost of buses and other transport systems from reduced traffic, and reduction in accidents and pollutions. EIRR at the 2006 appraisal was 22.70% but the figure does not include the addition to the Project scope. EIRR in 2010, including the final scope, was 13.72%. The recalculated EIRR at the time of the ex-post evaluation is 25.61%[7].

Both the Project cost and the Project period exceeded the plan. Therefore, the efficiency of the Project is fair.

3.3 Effectiveness[8] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

Effectiveness was evaluated with weight on basic operational and effect indicators for the railway projects set at the time of appraisal, namely operating rate, running distance, number of running trains per day, volume of transportation and income from the passengers. Table 4 shows the planned and actual figures of operational and effect indicators for the Project. For the Project, the target year is two years after the completion of the project, and therefore, for comparison, figures from two years after the project completion, which was 2013, were used.

[6] FIRR is improved as a result of recalculation; however, fare increases are set only to meet the rising operation and maintenance cost and price increase above the initial estimation and therefore, fare increases are not the factor for the higher FIRR

[7] EIRR is much higher than the one at the time of the appraisal because the saving from travel time at the time of the ex-post evaluation was found to be several times the one in 2010. At the time of the ex-post evaluation, the assumptions employed for the saving from travel time were that there is an economic benefit of INR 0.75/minute and that there is 12.67 minutes of saving for every 8 km of travel. Nevertheless, the difference in EIRR figures may have been the result of methods of calculation because the assumptions used for the appraisal could not be confirmed. On the other hand, if the 2006 appraisal figure is taken for comparison, it is fair to say that the Project has brought more economic benefit than expected.

[8] Sub-rating for Effectiveness is to be made with consideration of Impact.

Table 4: Planned and Actual Operational and Effect Indicators

	Target	Actual		
	2012	2011	2013	2015
	2 years after completion	Completion year	2 years after completion	4 years after completion
Operating rate (%/year)	94	94	94	94
Running distance (thousand km/day)	144.50	183.69	202.92	236.01
Line 1	5.93	6.22	6.24	7.66
Line 2 (Central Secretariat – Haryana State border)	40.09	101.95	115.37	129.51
Line 2 (Vishwa Vidyalaya – Jahangirpuri)	20.30	15.97	18.38	19.11
Line 3	12.64	12.62	13.79	17.20
Line 4	5.62	9.84	10.49	13.21
Line 5	26.62	11.35	10.78	10.67
Line 6	33.30	25.74	27.87	38.65
No. of running trains per day in 2 directions (X = peak hour frequency)	4,048	3,991	4,531	4,463
Line 1	480 (X=2.5)	462 (3.83)	498 (3.70)	521 (3.25)
Line 2 (Central Secretariat – Green Park)	456 (X=2.75)	668 (2.67)	657 (2.63)	667 (2.67)
Line 2 (Green Park – Haryana State border)	228 (X=5.5)	460 (2.67)	439 (2.63)	422 (2.67)
Line 2 (Vishwa Vidyalaya – Jahangirpuri)	456 (X=2.75)	451 (4.0)	451 (3.95)	424 (4.0)
Line 3(Indraprastha – Yamuna Bank)	456 (X=2.75)	668 (2.67)	651 (2.67)	688 (2.5)
Line 3 (Yamuma Bank – New Ashok Nagar)	228 (X=5.5)	331 (5.33)	328 (5.33)	345 (5.2)
Line 4	228 (X=5.5)	334 (5.33)	323 (5.33)	343 (5.2)
Line 5 (Ashok Park – Mundka)	416 (X=3)	402 (4.2)	381 (4.63)	389 (4.3)
Line 5 (Kirti Nagar – Ashok Park)	208 (X=6)	202 (8.4)	191 (9.27)	201 (8.57)
Line 5 (Inderlok – Ashok Park)	208 (X=6)	200 (8.4)	190 (9.27)	188 (9.27)
Line 6	416 (X=3)	327 (5.0)	354 (3.73)	491 (3.3)
Volume of transportation (million people km/day)	18.29	21.56	28.78	35.89
Income from passengers (INR million/day)	23.07	21.56	33.83	42.25

Source: DMRC

The operating rate has achieved its target. Running distance as a whole is 202,920 km/day against the target of 144,500 km/day and the number of running trains is 4,531 trains/day and

exceeded the target. Line 2 between Central Secretariat and Haryana State Border and Line 4 in particular have a large number of passengers because they cater to east Delhi that has many residential areas and connect Gurgaon and central Delhi. This has resulted in greatly exceeding the originally projected demand. By contrast, Line 5 has a limited number of passengers, and its daily running distance remains 40% of the target while frequency during the peak hours is also around 9 minutes. The volume of transportation and the income from passengers have also exceeded the targets.

For reference, ridership for the Project should be also explained. The ridership target for the Project inclusive of Phase 1 corridor two years after the Project completion was estimated at 2,980,000 people a day. However, the ridership in 2013 was 1,930,000 and the one in 2015 was 2,360,000. One of the reasons for ridership not reaching the target is the limited availability of the feeder bus services[9]. In addition, some buses operated by Delhi Transport Corporation (DTC) run parallel to the metro and the competition has kept the ridership of the metro from increasing.

All the basic operational and effect indicators set in the planning stage have achieved their targets. Except for the issue of ridership which was used for the evaluation as reference, the Project is evaluated to have brought originally expected effects.

3.3.2 Qualitative Effects

The expected qualitative effects of the Project were improved access to public transport, safety and security of metro operation, and improved services. In the ex-post evaluation, a beneficiary survey was conducted targeting mainly the Delhi Metro passengers. Through the survey, the qualitative effects and impact of the Projects were studied. Questionnaire interviews with 124 passengers were conducted at the Kailash Colony Station (Line 6) and the Noida Sector 16 Station (Line 4), both of which were selected randomly from the 79 stations constructed under the Project. In addition, interviews were conducted with residents (26 households) and business establishments (6 establishments) along the metro corridor. For the survey on residents, in addition to the two locations where the survey was conducted for the metro passengers, Punjabi Bagh Station and New Ashok Nagar Station were selected. Attachment 2 explains the sampling method and the results of the beneficiary survey in detail[10].

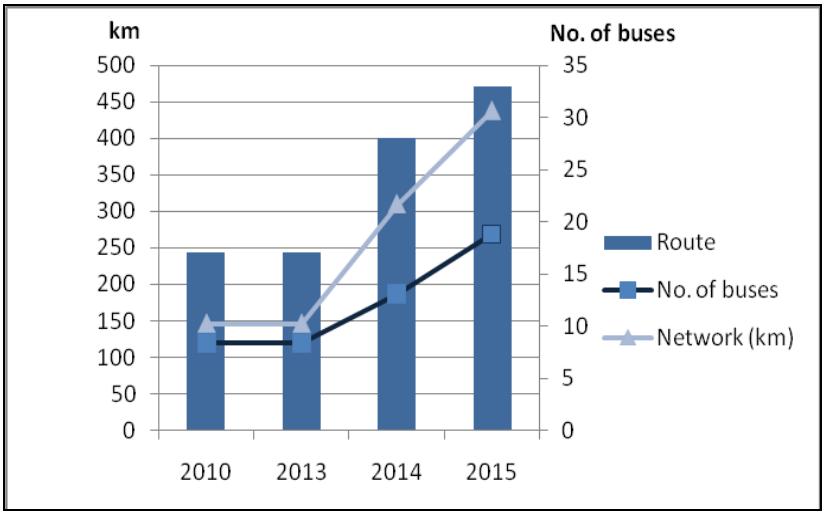
[9] Service of transporting passengers who are away from a metro station in order to promote the use of the metro.

[10] As a supplementary means to grasp the effect of the Project, questionnaire surveys were conducted targeting a) metro passengers (124 people), b) residents along the metro corridor (26 households) and c) business establishments along the metro corridor (6 establishments). A passenger survey was conducted during the peak hours on weekdays, and off-peak hours on weekdays and a holiday (Sunday). Three enumerators were assigned at the exit gate and sampled passengers every five minutes. The characteristics of passengers vary depending on the locality and the station. The survey does not necessarily reflect the whole picture of passengers because only a limited number of samples was taken. Moreover, best effort was made to sample the respondents to minimize selection bias; however, self-selection bias was unavoidable because some of the passengers declined to take part in the survey as they were in a hurry particularly during the peak hours (out of the 286 passengers who were approached for the survey, 124 took part in the survey). Hence, the off-peak hours on weekdays had the highest rate of responses. Gender-wise number of

Improved access to public transport

In the beneficiary survey, 69% (86 respondents) of the passengers replied that they use the metro on a daily basis. Ninety percent (111 respondents) said that, by using the metro, their travel time has reduced, indicating that the metro has become an important mode of transport for the people of Delhi.

On the operation of feeder buses, which aims to provide better access for passengers to their nearest station, DMRC started with 17 routes in 2010. The feeder bus network started expanding in 2014 and there are now 33 routes enabling passengers to use the service at 53 out of the 138 stations (excluding the Airport Express Line) constructed under Phase 1 and Phase 2 of the Project. Figure 1 below shows the changes in the feeder bus services.



Source: DMRC

Figure 1: Changes in Feeder Bus Services

Feeder buses have the service coverage of 5–8 km radius from the metro station. The rationalization of the route and the establishment of a new route are decided on the basis of the population density and socioeconomic condition (such as occupation and income) of the area. The operation of feeder buses is to be expanded to 69 routes as the metro network expands with the implementation of Phase 3 of the Project. There are buses operated within the city by DTC; however, they do not exclusively operate as feeder for the metro. According to DMRC, 140,000 people use the feeder buses every day, but only 40,000 of them are passengers of the metro, indicating that the feeder buses are not necessarily used as a means to connect a metro station

respondents were as follows: male 100 (81%) and female 24 (19%). According to DMRC, females normally make up about 25% of total passengers.

and the final destination. With regard to the connectivity between the metro and the feeder buses, according to the beneficiary survey, 17% (21 respondents) of the passengers said "well connected" and 12% (15 respondents) "not well connected" while 71% (88 respondents) do not use the feeder bus[11].

Safety and security of the metro operation

For security of the metro, the Central Industrial Security Force (CISF), a paramilitary force, is deployed at the entrance for frisking passengers and X-ray screening of their luggage. The safety inside the station is centrally monitored at the control room located in each station. The trains are equipped with surveillance cameras to monitor their interior at all times. In major stations, security personnel are deployed at the platforms to prevent accidents when the train arrives. Moreover, in the stations with many users and new stations, screen doors at the platform are being installed. In operational manuals on safety and disaster management, detailed procedures and instructions are spelled out in case of bad weather and coordination with the National Disaster Response Force.

Based on the site visits and interviews, it seems that necessary security measures are in place for the operation of the metro. At the same time, some passengers were seen standing beyond the warning blocks while waiting for the train, and large crowds were formed during the peak hours because of the security check. In a few stations, long queues waiting for the security check were continuing outside the station premises. DMRC has introduced additional metal detectors and X-ray machines in some of the stations and requested the CISF to deploy more personnel to deal with peak hour crowds. Nevertheless, considering that the ridership is expected to increase, it is necessary to address overcrowding and security check during the peak hours. In the beneficiary survey, complaints regarding overcrowding due to security checks and breakdown, slow response and poor performance of the automated fare collection (AFC) gates were heard.

Improved services

For riding the metro, ticketing is done by either a token or a prepaid smart card, and all entry and exit gates are automated. Moreover, there has been a tie-up with the debit card of a local bank named ICICI Bank since 2015, and the smart card can be recharged through Paytm, an e-commerce system. At the time of the ex-post evaluation, the smart card can be used in all lines of Delhi Metro including Airport Express Line and feeder buses as well as Gurgaon Rapid Metro located outside Delhi (but not possible for use in metros of other cities).

[11] If the originating and destination points are within the walking distance from a metro station, there is less need to use the feeder bus. Also, Noida Sector 16, which is one of the beneficiary survey locations, is outside Delhi and does not have feeder buses operated by DMRC. Therefore, the share of respondents who use the feeder buses was low.

There is a 24-hour customer helpline and any complaints and suggestions filed are referred to the concerned officer while they are also uploaded to the customer management system. Each station has a complaint-lodging book. When a complaint is filed, one of the station personnel must address it, and the action taken by the station personnel must be recorded. DMRC conducts a customer satisfaction survey every year on eight parameters such as access, comfort, and quality of service. In a 2014 customer satisfaction survey by Community of Metros (CoMET), an international metro benchmarking forum, which compared 18 metros around the world, DMRC was ranked second.

In the beneficiary survey of the ex-post evaluation, the passengers were asked about services provided by DMRC personnel. Out of the 124 respondents, 95 (77%) said that they found them to be "courteous/helpful." As for the fare structure of the metro, 87% felt "just right[12]" while 65% also felt the frequency of the train was "just right." At the same time, to handle the increasing ridership, some opined that the frequency of trains and the number of coaches should be increased during the peak hours[13]. Other than these, in the customer satisfaction survey of DMRC, the satisfaction with the environment outside the station was low. Specifically, the passengers pointed out issues such as cleanliness outside the station, parking space, access to the final destination from the metro, and sidewalks, all of which require coordination with other civic agencies. As described in the section on "3.4 Impacts," coordination with other civic agencies has been also pointed out from the perspective of improving access for differently-abled people[14].

3.4 Impacts

3.4.1 Intended Impacts

The expected impacts of the Project were "the regional economic development and improvement of the urban environment through alleviation of traffic congestion and reduction of traffic pollution." At the time of the appraisal, specific impacts were not spelled out. Thus, "improvement of urban environment" and "regional economic development" were further broken down as follows:

Improvement of urban environment	Regional economic development
a. Reducing traffic congestion b. Saving travel time c. Reducing road accidents d. Reducing energy consumption e. Reducing air pollution f. Reducing noise pollution	g. Increase in property value along the metro corridor h. Increased business activities along the metro corridor

[12] Because all the respondents are metro users, it is likely that they feel the fare structure is appropriate.
[13] At the time of the ex-post evaluation, trains are operated in four, six or eight coaches depending on the line. For the lines that have a large ridership especially during the peak hours, eight coaches are used.
[14] Apart from these, DMRC is taking initiative on public relations and effective use of public space. It took unique initiatives such as accepting study tours, having exhibition space in the station, and setting up a metro museum in 2008 at Patel Chowk Station.

a. Reducing traffic congestion

According to an estimate of the Central Road Research Institute (CRRI), the Project has reduced traffic volume equivalent to 419,000 cars in FY 2015[15]. However, the number of registered vehicles in Delhi is still on the rise even after the opening of metro and there has not been visible change in easing the traffic. Similarly, in a study on traffic volume conducted by the CRRI on Phase 1 corridors in 2007 and 2009, a significant increase has been observed on the roads parallel to the metro. In the beneficiary survey, the residents were asked about traffic volume around the main intersections nearby comparing before and after the opening of the metro. Thirty-five percent responded that there is "no change" while those answered "slightly increased" and "significantly increased" were 27% each, indicating that nearly 90% of the respondents do not recognize reduction in traffic volume due to the metro[16]. In addition, there are place around the metro station where cycle rickshaws waiting for customers are encroaching to the road triggering traffic congestion.

b. Saving travel time

According to a CRRI estimate, saving on travel time is about 30 minutes per trip. In the beneficiary survey, metro passengers were asked to compare the travel time for the same sector using the metro and other means. Ninety percent of the respondents answered that the travel time was reduced by using the metro.

c. Reducing road accidents

Table 5 shows the number of registered vehicles in Delhi and changes in the number of traffic accidents. The occurrence of traffic accidents per 10,000 vehicles is also calculated based on these data. Compared to 2006 when the operational network of the metro was limited, the occurrence of accidents has decreased to half (from 19 to 10 incidents) after 2010. According to the CRRI's estimate on "number of traffic accidents prevented," calculated based on years of traffic accidents, average vehicular kilometer and traffic volumes reduced by the Project, in recent years about 100 fatal accidents and 800 injury accidents were prevented annually.

[15] CRRI. *Quantification of Benefits for Delhi Metro Phase I* (August 2009).
[16] Other responses include two respondents (8%) "slightly reduced" and one respondent (4%) "significantly reduced."

Table 5: Changes in Number of Registered Vehicles and Traffic Accidents in Delhi

	2006	2010	2012	2014
Registered vehicle (10,000)	523	693	777	883
Traffic accidents	9,699	7,220	6,937	8,623
Occurrence of accidents per 10,000 vehicles	19	10	9	10

Source: Prepared by the External Evaluator based on materials provided by DMRC

d. Reducing energy consumption

Based on the traffic volume reduced by the Project, the CRRI has estimated the amount of energy reduction per annum. The result shows that in 2007, 2011 and 2015, the amount reduced was 24,691 tons, 106,439 tons and 299,000 tons respectively. Comparing the figures from 2007 and 2015, because of the expansion of the metro network, the amount of energy reduced became tenfold in the eight-year period.

e. Reducing air pollution

Because the number of vehicles in Delhi continues to increase, the problem of air pollution has only worsened and there has been no visible improvement. A study was conducted to see how much of air pollution was controlled by the Project[17]. It observed the levels of NO_2, CO, and PM 2.5 from 2004 to 2006 at two locations in the city, namely ITO and Siri Fort. The study found that the Project reduced CO by 34%.

To reduce air pollution from electricity needed for metro operation and save energy, DMRC has installed a regenerative braking system on trains. The system supplies the kinetic energy generated from applying the brakes back to overhead electricity lines and reuse the energy. This initiative was registered as the first Clean Development Mechanism project in the railway sector and 220,591 CER[18] was traded between 2007 and 2012.

f. Reducing noise pollution

It is conceivable that, when the metro becomes operational, the traffic volume along the corridor would decrease, and the noise pollution in the area would also be reduced. According to DMRC's monitoring on the noise level along Line 6, 1.2 to 5.5 decibels of noise was reduced after the metro became operational.

By contrast, according to the study by the Council of Scientific and Industrial Research on

[17] Deepti Goel and Sonam Gupta (2015). *The Effect of Metro Expansion on Air Pollution in Delhi*. Police Research Working Paper 7448.
[18] Certified emission reduction

the noise level of elevated corridor of Phase 1 of the Project, an increase of 1.7 to 1.8 decibels was observed after the metro became operational within the 10-m radius from the corridor.

In the beneficiary survey, two out of the 26 respondents who were residents along the metro corridor said that the noise arising from the congestion near the metro station is of a concern. It indicates that the Project has not necessarily contributed to reducing the noise level depending on the area.

g. Increase in property value along the metro corridor

According to a study on property value along the Phase 1 corridor comparing before the metro construction (before 1996) and after the metro became operational (2001 to 2006) , the value within the 500-m radius from the corridor has increased on annual average by 11.3% (residential) to 18.1% (commercial). The property value has steadily increased after the metro became operational instead of during the construction period. In addition, a real estate website that compared property value between 2005 and 2008 also reported that there was an 18 to 40% increase per annum in north and western Delhi where the metro started operating.

In the beneficiary survey covering the residents along the metro corridor, 70% (18 respondents) said that the property value has increased after the opening of metro and they feel the change is boosted by the metro. The business establishments (6 establishments) along the metro corridor gave similar responses.

h. Increased business activities along the metro corridor

In the beneficiary survey, six business establishments that had been in operation near the metro corridor since the time before the metro opening were interviewed to see changes in business activities. Two respondents each replied that business activities "increased significantly," "increased slightly," and "no change." Four respondents with who felt increase in business activities cited as a reason the increase in the number of customers. A bank and a coaching center (tuition center) that were interviewed felt that more customers come from distant places using the metro than before.

As can been seen so far, with regard to improving the urban environment, it is difficult to specify the degree of impact because there are factors other than the Project particularly in relation to reducing traffic congestion, air pollution and noise level. However, it does not undermine the impact made by the Project. Actually, while traffic congestion in Delhi is not resolved, the impact from saving in travel time using the metro has been considerable as suggested by the CRRI study and the beneficiary survey. Moreover, reducing the number of traffic accidents and energy consumption has a significant effect on not only the urban environment but also on the economy in general. With regard to impact on the local economy, the Project is contributing to revitalization along the metro corridor while DMRC has its own initiative to provide commercial space within the metro station. Furthermore, considering that

many street vendors and new businesses popped up around the metro stations close to residential and office areas, although specific economic impact has not been measured, the Project has contributed to development of the local economy.

3.4.2 Other Impacts

3.4.2.1 Impacts on the Natural Environment

The Project was classified as Category A of the JICA guidelines on environmental and social considerations (April 2002) because it falls under the rail sector and was considered to have sensitive characteristics. During the Project implementation, the contractors conducted the environmental monitoring while DMRC monitored regularly the air and water qualities, noise and vibration after the Project completion. It was decided during the appraisal in 2006 to take necessary measures for reducing the noise, and noise barriers such as soundproof pads, sound insulating walls, and silent generators were arranged. Mitigation measures such as watering the site and frequent cleaning of the streets were implemented because a few areas complained about dust from the construction site.

With regard to the natural environment, the negative impact was considered minimal because the Project site is located in urban areas and most of the planned corridors pass through the existing road. The Project implemented thoroughly the practice of planting 10 trees in place of one that required felling for the construction.

Arrangements for environmental monitoring are in place both during the Project implementation and after its completion. During the implementation, there was a system to accept complaints from local residents, and if there were complaints on such matters as noise, measures were taken to minimize the negative effect.

3.4.2.2 Land Acquisition and Resettlement

At the time of the 2006 appraisal, the size of land acquisition required for the Project was estimated to be 99.05 ha and the number of structures that required resettlement was 986. Land acquisition and resettlement were planned to be completed by April and July 2007, respectively. However, owing to change in the Project scope and the route, the land acquisition ultimately became 204.16 ha and 971 structures were resettled; the process was completed in December 2009. Table 6 shows the comparison of the planned and actual land acquisition and resettlement.

Table 6: Planned and Actual Land Acquisition and Resettlement

	Plan (2006)	Actual
Land acquisition (ha)	99.05	204.16
No. of structures resettled	986	971*

Source: DMRC

*At the time of project completion, the number of structures (households) resettled was 1,364. However, the Delhi High Court subsequently ruled that 393 slum structures in Sarita Vihar were illegal and were not entitled for compensation. Therefore, these households were excluded from the resettlement.

Land acquisition was carried out in line with Land Acquisition Act while resettlement was carried out in line with Relocation and Rehabilitation Policy in Respect of Project Affected Persons of All Categories Due to Implementation of Delhi MRTS Project passed in 2006. DMRC submitted the amount required for resettlement and compensation to the Delhi government, and the processes were carried out by the land acquisition officer of the government. Residential structures in the relocation sites were taken care of by the Delhi Development Authority. For commercial establishments that required relocation along Line 5, DMRC constructed a commercial complex and provided the space for 104 units near Nangloi Station at a cost. The Slum Department of Delhi government took responsibility for relocating illegal settlements.

As was originally planned, the living conditions of slum residents after resettlement were monitored quarterly by an NGO from 2007 to 2008. Subsequently, a follow-up survey was conducted in 2010 noting that there are roads, water supply and basic social infrastructure (a school and a clinic) near the relocation site.

The NGO surveyed the average monthly income at the relocation sites of Savda Ghevra and Holambi Kalan soon after the relocation (2007) and after three years (2010). It was found that, in Savda Ghevra, the income increased from INR 3,600 to 5,270, and INR 4,480 to 6,273 in Holambi Kalan, indicating some improvement in livelihood compared to the time right after the relocation[19]. During the site visit of the ex-post evaluation, the resident representative of Savda Ghevra was interviewed. He stated that, compared to just after the relocation in 2008, the road network connecting to the city center improved but there were not enough bus services. He also said that because of the distance from the city center, it was difficult for the residents to find employment and commute. Particularly, 25% of the resettled residents have since left the relocation site citing the difficulty to commute among other reasons. By contrast, there are

[19] Even if the inflation rate (annual average of 10.9%, the World Bank) is taken into account, it is fair to say that there has been a slight improvement in the income level.

reliable services like water supply and electricity compared to before the relocation.

3.4.2.3 Unintended Positive/Negative Impact

Prevention of HIV/AIDS

A high risk of HIV infection was a concern because many migrant workers who were without families were involved in the construction for the Project. As part of DMRC's corporate social responsibilities, activities for preventing HIV were to be implemented in cooperation with a NGO. Referring to the same initiative taken under Phase 1 of the Project, activities like awareness raising, peer education and distribution of condoms were implemented.

Consideration for Elderly and Differently-Abled

In accordance with the Indian law, the Project constructed stations (elevators, toilet, announcement and tactile path) and trains (space for wheelchair) considering the use by the elderly and differently-abled people. Particularly, the Project strived to implement universal designs with the help of an organization that is an advocate for the physically challenged. At the time of the ex-post evaluation, each metro station is equipped with a wheelchair and elevators that cater for the use of a wheelchair. In the station building, there are wheelchair-accessible toilets and some of the parking lots have designated space for the differently-abled. The first and last coaches of the train have space for a wheelchair and there are priority seats for the elderly and differently-abled. Each station has a tactile path as well.

However, in an interview with Samarthyam, an NGO for the differently-abled, the following issues were pointed out for further improvement.

- Install a tactile path leading to the ticket vending machines.
- Remove the security booth placed on top of the tactile path in the station.
- For people with visual impairment, install audio announcement in vending machines.
- Improve information access (display of locations of elevators in the station map on the website)
- Introduce non-step buses in some of the feeder buses.
- Improve the access around the metro stations. Work with other civic agencies to resolve the issue such as paving the sidewalks and distance to pedestrian crossings.

Safe Mobility for Women

Although the opportunity for women to go out safely was not an impact clearly considered at the time of the appraisal, the metro has brought about a means of transport in which women can travel safer than before. It may have also improved the local security around the metro station as a secondary impact. To verify the hypothesis, 150 metro passengers and residents (116

men and 34 women) were asked about changes in the local security situation and the safe mobility for women. The results showed that 85% of the respondents felt the security around the metro station improved because of the opening of the metro.

Furthermore, the respondents were asked about changes in timing of women going out after the opening of the metro (male respondents were asked to report the cases of female family members). It was found that women tend to go out more in the evening and late hours than before. As can be seen, the Project has contributed to providing more opportunity for women to go out safely.

<Column: The metro helps women's empowerment>

In India, public space like bus and train stations is where women are likely to face harassment. The metro is no exception. However, the Delhi Metro has women-only coaches in all trains and is equipped with surveillance cameras in the trains and stations. When inquired about women-only coaches in the beneficiary survey, 86% of the passengers (107 respondents) consider them "helpful." Nine percent (11 respondents) felt "not very helpful" and 2% (2 respondents) said "not helpful at all." The remaining 3% (4 respondents) who did not know the availability of women-only coach were men. Moreover, female security personnel are deployed at the stations and trained CISF female personnel in plainclothes are on patrol to keep the train travel safe. In addition to the women-only coach, because of the opening of the metro stations, it can be said the women have better opportunity to go out with peace of mind. For instance, because metro stations are operational until late at night, the areas around the station where it used to be dark have become better lit and it is now possible for a woman to walk alone. It is supported by the results of the beneficiary survey that shows improved local security and increased frequency of women going out in the evening and night. Furthermore, in interviews with female passengers, some noted that they depended on male family members and private vehicles earlier because they felt uncomfortable going on auto rickshaw, but now they are able to go out alone.

The Project has largely achieved its objectives. Therefore, the effectiveness and impact of the Project are high.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

DMRC is the executing and O&M agency of the Project. DMRC was established in May 1995 under the Indian Companies Act of 1956 to implement the Delhi Mass Rapid Transit System Project with equal capital from the governments of India and the NCTD. DMRC was

given authority to implement the Project under the Metro Railways (Construction of Works) Act of 1978 and to operate and maintain the system under the Metro Railways (O&M) Act of 2002.

At the time of the ex-post evaluation, DMRC has 8,628 employees. Out of them, 2,173 were recruited for the operation of Phase 3. Each station has about 10 personnel from DMRC including a station manager (in charge of 2 to 3 stations), 2 to 4 station controllers and several customer care agents depending on the footfall at the station. In addition, housekeeping and security personnel are provided by external agencies. In each depot, about 200 personnel are working on maintenance of coaches.

At the time of the ex-post evaluation, problems such as shortage of staff were not seen, and the roles and responsibilities of O&M staff are clearly stated in operation manuals and rules. Various initiatives are taken to maintain and boost the personnel's morale. For instance, personnel are awarded for their outstanding performance while staff housing and loans are provided and there are regular meetings with human resource officers. Under the corporate vision of "commuting experience in Delhi Metro to be customer's delight," DMRC conducts regular seminars and training for behavioral change of staff aiming to provide services that exceed the expectations of the customers. Therefore, institutional arrangements for O&M are established.

In Delhi, there is a Unified Traffic and Transportation Infrastructure (Planning & Engineering) Center (UTTIPEC) which is mandated to plan and coordinate with various transport-related member agencies. Apart from DMRC, DTC, municipalities, and the Public Works Department are UTTIPEC members. Through UTTIPEC, any matters that require coordination with other mode of transport are discussed.

3.5.2 Technical Aspects of Operation and Maintenance

From the time of the appraisal in 2006, DMRC has a number of engineers who have come from the Indian Railways, and thus there were no issues with regard to the basic technical standards. Moreover, because DMRC has experience of O&M of the lines in Phase 1 that are fully operational, it was considered that there is no issue with its capacity. O&M manuals are prepared by system suppliers and used by the DMRC personnel, and updated when necessary.

DMRC recognizes that continuous upgrading of technical skills is required for improving O&M-related skills and strives for that purpose. It has its own ISO 9001-2008 certified training institute attached to the Shastri Park Depot and staff training takes place at the institute. The institute, established in 2002, is the first metro training institute in India and equipped with demonstration facilities such as train simulator and signaling system as well as hostel facility. Those taking up the job of train drivers are required to undergo 30 weeks of training and practice 5 hours at the simulator for each type of rolling stock[20].

[20] DMRC currently operates three types of rolling stock.

Table 7 shows the training courses planned and conducted at the institute in the last three years. The institute also offers courses for foreign trainees. There have been trainees from Bangladesh, Nepal and Indonesia. For other metros in the country, training courses on management, electrical and telecommunication and rolling stock maintenance have been offered. Annually, about 8,000 people take courses at the institute.

Table 7: Training Courses Conducted at the Institute

Unit: Courses

	2013	2014	2015
Induction training	33	34	37
Refresher training	98	71	84
Customized training	3	6	6

Source: DMRC

Taking advantage of the experience of implementing and operating Delhi Metro, DMRC now uses its knowledge and technical skills to provide services such as consulting and implementation of metros in other cities. As can be seen, DMRC not only maintains and improves the technical skills of its own employees but is technically contributing to other metro projects. Thus, it is fair to say that its technical standards are high.

3.5.3 Financial Aspects of Operation and Maintenance

Given that the corridors under Phase 1 were commissioned from 2004 onwards, DMRC was financially sound at the time of the appraisal in 2006. In FY 2008, the net profit marked a surplus, but it has been in deficit since 2009. Apart from the fare box revenue, the sources of O&M finance for DMRC includes earnings from lease operations (advertisement and property development) and feeder buses.

Table 8: Revenue and Net Profit for the Last Five Years

Unit: INR million

	2010	**2011**	**2012**	**2013**	**2014**
Total revenue	16,079	22,478	26,875	31,978	35,623
Fare box revenue	7,466	10,163	12,230	13,648	15,057
Other revenue	8,614	12,315	14,645	18,329	20,565
Operating profit	7,505	9,334	10,278	10,621	12,399
Net profit (after tax)	(4,139)	(1,851)	(909)	(998)	(1,048)

Source: DMRC Annual Reports

As seen in the above financial indicators, the total revenue has been steadily increasing. The debt equity ratio has also improved from 1.43 in 2006 to 1.15 in 2014. Operating profit has been in good condition since the commissioning of the metro and while net profit is in deficit, from the point of view of cash flow, it would not pose a financial problem for DMRC to perform O&M.

The reasons for net profit being in deficit include lack of fare revision since 2009 and the increasing operational cost. The fare structure is to be revised in accordance with the Metro Railways (O&M) Act by the Fare Fixation Committee set up by the Ministry of Urban Development from time to time considering the inflation and fares of other transport modes. During the ex-post evaluation, the Fourth Fare Fixation Committee was constituted and fare revision may take place as early as within 2016 based on the recommendations of the committee. It has been more than 10 years since the opening of the Phase 1 corridor. Considering the necessity for maintenance of various systems and the increasing material costs, fare revision is essential.

To increase the revenue from fare box, DMRC has been trying to strengthen the revenue sources by increasing the number of coaches and taking up consulting services for metro projects in other cities. Since 2010, the second largest share of revenue after fare box is the income from external projects (32% share in FY 2014); however, income revenue from the consulting services and external projects cannot be expected in the long term. In recent years, DMRC has started new initiatives such as station naming rights and train wrapping[21]. However, some of such initiatives can be done only outside Delhi. Therefore, expanding these initiatives and regular revision of metro fare will be necessary in the future.

3.5.4 Current Status of Operation and Maintenance

In the Project, maintenance activities for rolling stock, tracks, buildings, telecommunication systems, AFC gates, and electrical facilities are carried out. Eight depots are in operation to maintain the coaches for corridors that are operational at the time of the ex-post evaluation (four of the eight were constructed by the Project). Regular maintenance is conducted based on the number of kilometers run by the train apart from daily inspection which is conducted prior to services according to the check sheet.

Depending on the kind of maintenance services to be done, different activities are carried out at various points in the depot. Rolling stocks are provided with a two-year warranty period. In the site survey, it appeared that the depots are maintained in order and clean. As can be seen, regular maintenance activities are carried out and a proper environment is established for the maintenance. As in the case of rolling stock, DMRC recommends domestic production of spare parts. Production centers have been established by private firms in the country, and procuring

[21] To wrap trains with advertisement films.

spare parts is not difficult. Moreover, having 90% of the spare parts produced domestically has contributed to cutting down the cost. The Project has been procuring the spare parts that will be required for 4 to 5 years after the Project completion as part of the Project cost, and transfers them to the O&M department, thereby ensuring that there will be no shortage of spare parts.

Regular inspection is conducted for station buildings as well. Monthly inspection is done according to a prescribed four-page checklist. The station manager checks the condition of equipment and manuals and reports it to the headquarters. Considering that Delhi tends to be dusty, the stations visited during the site inspection were comparatively clean. However, as was pointed out in the beneficiary survey, AFC gates seemed to have frequent breakdown. The problems with AFC gates appear to be triggered by rush use by passengers in addition to malfunction of software.

No major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system. Therefore, the sustainability of the Project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project aimed to reduce traffic congestion and pollution by constructing a mass rapid transport system in the NCTD that faced problems of economic loss and air pollution due to traffic congestion caused by rapid economic growth and urbanization since the 1990s. From the time of the appraisal to the ex-post evaluation, the urban transport sector continues to occupy an important position in development plans of the governments of India and the NCTD. The development need for a rapid transport system was seen at the times of both the ex-post evaluation and the appraisal. The Project is in line with Japan's ODA policy, and the relevance of the Project is high. Both the Project cost and Project period exceeded the plan. Therefore, the Project's efficiency is fair. The addition to the Project's scope after its commencement was found appropriate. Most of the operational and effect indicators set at the time of the appraisal have achieved their targets. With regard to impact on such aspects as regional economic development and improving the urban environment, the Project made a certain degree of contribution. Thus, the effectiveness and impact of the Project are determined to be high. DMRC has the institutional structure to operate and maintain the Project as well as necessary technical skills. With regard to the financial status of DMRC, continuous efforts are required to improve it, but no serious issues are found. At the time of the ex-post evaluation, O&M are done properly and the sustainability of the Project is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Fare revision

Since 2009, there has been no fare revision of Delhi Metro. The fare revision is decided by the Fare Fixation Committee constituted by the Ministry of Urban Development when deemed necessary in accordance with the Metro Railways (O&M) Act. As of June 2016, based on the request from DMRC in the past few years, the Fourth Fare Fixation Committee has been constituted and fare revision is being considered. With due regards to inflation and the increase in operational costs, regular fare revision is required in the future as well. To implement regular fare revision, it is desired for DMRC to approach the Government of India.

Further improvement for improving the access for the elderly and the differently-abled

The Project has incorporated the opinions on universal design by the associations advocating for the differently-abled from the planning stage. As a result, trains and station buildings that have given due consideration to the elderly and the differently-abled are highly appreciated. At the same time, there are areas that need improvement such as better information access for the differently-abled, putting a tactile path to the ticket vending machine, installing audio for the vending machine, and instructing DMRC and security personnel to avoid putting things on the tactile path. To improve access for users with diverse needs, further effort is desired through regular discussion with advocacy organizations and taking actions.

Coordination with civic and other transport agencies

As was pointed out by the beneficiary survey conducted during the ex-post evaluation and by the customer satisfaction survey of DMRC, improving access around the metro station is an issue. The issues hampering access of certain users include unpaved sidewalks, road congestion triggered by cycle rickshaws waiting for customers outside the station, and lack of pedestrian crossing on the road with a median. The jurisdiction of space outside the metro stations lies not with DMRC but with other agencies such as the Public Works Department and Municipal Corporation of Delhi. However, DMRC is desired to strive to improve the environment outside the metro stations for better access for their customers through discussions with other agencies. For better access for public transport, it is desirable to continue the coordination with other urban transport agencies such as DTC on matters including the enhancement of feeder bus services.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

Strengthening technical expertise of internal human resources beyond project implementation

DMRC has been trying to strengthen the technical expertise of its human resources from the implementation of Phase 1 with a view to implementing subsequent phases. Specifically, it was able to reduce the dependence on external experts in Phase 2 by deploying its personnel in consulting services and allowing them to have relevant technical experience from the beginning. Moreover, DMRC is passing on the technical expertise built up from the project implementation in its own personnel to new metros through its training institute. By taking up external projects to implement other metro projects, DMRC is contributing to disseminating its technology to other metros in and out of India as well. Systematic and effective use of technical expertise accumulated in the executing agency is a good practice. It would be desirable for new metro projects in other countries and projects employing new technology to consider taking up similar initiatives with a view to expanding their business in the future.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	Civil works 82.69 km Electrical, signaling, and telecommunication system Procurement of rolling stocks: 672 cars Construction of depots: 4 *Based on 2010 appraisal	82.80 km As planned 734 cars As planned
2. Project Period	March 2006 – November 2010 (57 months)	March 2006 – August 2011 (65 months)
3. Project Cost		
Amount Paid in Foreign Currency	80,567 million yen	95,578 million yen
Amount Paid in Local Currency	258,216 million yen (INR 97,704 million)	284,288 million yen (INR 141,437 million)
Total	338,782 million yen	379,866 million yen
Japanese ODA Loan Portion	162,955 million yen	207,438 million yen
Exchange Rate	INR 1 = 2.49 yen (As of July 2005, original scope), 2.85 yen (As of October 2007, additional scope) *Based on 2008 appraisal	INR 1 = 2.01 yen (Average between March 2006 and March 2015)

Main Contractors (above 1 billion yen)

- Larsen & Toubro Ltd. (India)
- Dywidag-Systems International GmbH (Germany)/Ircon International Ltd. (India)/Larsen & Toubro Ltd. (India)/ Shimizu Corporation (Japan) Samsung Corporation (South Korea)
- Soma Enterprise Limited (India)/Continental Engineering Corporation (Taiwan)
- Ircon International Ltd. (India)
- Alstom Transport SA (France)/Alstom India Ltd. (India)/Sumitomo Corporation (Japan)
- ABB India Limited (India)
- Patil Vossloh Rail System Pvt. Ltd. (India)
- VAE GmbH (Austria)
- Iljin Electric Company Ltd. Seoul (South Korea)
- Kalindee Rail Nirman (Engineers) Limited (India)
- Bombardier Transportation GmbH (Germany)/Bombardier Transportation India Ltd. (India)
- Kone Elevator India Private Limited (India)
- Senbo Engineering Ltd. (India)
- Suzhou Jiangnan Jiajie Elevator Group Company Ltd. (China)/Johnson Lifts Pvt. Ltd. (India)
- Thales Transportation Systems SA (France)
- Nippon Steel Corporation (Japan)/Mitsui & Co. (Japan)
- ITD Cem (India) Italian-Thai Development Public Company Limited (Thailand)
- Fibocm India Limited (India)/Ramco Systems Limited (India)
- Siemens AG Transportation Systems TS RA (Germany)/Siemens Ltd. (India)
- BEML Limited (India)/Mitsubishi Electric (Japan)/Mitsubishi Corporation (Japan)/Rotem Company (South Korea)
- Bombardier Transportation India Ltd. (India)/Bombardier Transportation Sweden AB (Sweden)
- Thales Transportation Systems SA (France)/Thales Portugal SA (Portugal)
- Larsen & Toubro Ltd. (India)/Furrer+Fray AG Ltd. (Switzerland)
- Kalindee Rail Nirman (Engineers) Limited (India)/Samsung SDS Co. Ltd. (South Korea)
- Samsung C&T India Pvt. Ltd. (India)/ Samsung C&T Corporation (South Korea)
- Blue Star Ltd. (India)
- Indu Projects Ltd. (India)/Laing O'Rourke PLC (U.K.)
- ETA Engineering Pvt Ltd. (India)/ Emirates Trading Agency (U.A.E)

Attachment 1: Metro Network of the Project

Outline of the Beneficiary Survey

As a supplementary means to grasp the effect of the Project, questionnaire surveys were conducted targeting the following people who are presumable beneficiaries of the Project: a) metro passengers, b) residents along the metro corridor, and c) business establishments along the metro corridor.

For the survey on metro passengers, a minimum sample size of 100 (valid responses) was taken with the standard error of 10% and the confidence interval of 95%[22]. The survey asked 124 passengers about mainly the convenience of the metro, satisfaction on its services, and safe mobility for women (including male respondents).

For residents along the metro corridor, 25 households were interviewed on the status of noise and vibration during the metro construction, changes in property value along the corridor, the status of local development after the opening of the metro, and changes in traffic congestion.

Six business establishments were interviewed along the metro corridor on changes in business activities and clientele after the opening of the metro.

Survey Locations and Sampling Methods

It would be prudent to include in the survey targets the corridors constructed under Phase 1 and 2 of the Project because the effect of the Project extends to the entire metro network. In addition to the extension of the Phase 1 corridor, namely Line 1 to 4, the new corridors Line 5 and 6 were commissioned under Phase 2. The survey on metro passengers was conducted at two locations because passengers' characteristics vary depending on the corridor and the locality where the station is located. The survey locations were randomly selected from the list of stations opened under Phase 2. Accordingly, Noida Sector 16 Station of Line 4 and Kailash Colony Station of Line 6 were selected. The survey was conducted during the peak hours on working days, off-peak hours on working days, and on a holiday (Sunday) as it is assumed that the characteristics of passengers vary depending on the time of the day. Three enumerators were assigned and the surveys were carried out on March 14–15 at Noida Sector 16 Station, March 16–17 at Kailash Colony Station, and March 20 at both stations. For sampling, the enumerators were positioned at the exit gate and selected the passengers who came through the gate every five minutes.

With regard to residents and business establishments along the metro corridors, basically the same two locations were used. However, because many residents declined to take part in the survey, two additional locations (four locations in total) were selected. The additional locations were Punjabi Bagh Station and New Ashok Nagar Station.

Regarding residents, houses and apartment buildings within the 500-m radius from the selected station were sampled, beginning with those who were closest to the station. In the survey plan, every third house was to be sampled; and in the case of apartment buildings, five flats were sampled by dividing the total number of the flats.

With respect to business establishments, six were interviewed to substantiate the impact of the Project as a reference, particularly the changes in business activities caused by the Project. Interviews were sought from those closest to the metro station: three at Noida Sector 16 Station, two at Kailash Colony Station, and one at New Ashok Nagar Station. To be interviewed, establishments needed to have been operating at the same location since the time prior to the Project implementation. The business types of the six establishments interviewed are as follows: courier service, bank, coaching center (tuition center), restaurant, automobile parts shop, and construction material shop.

Limitations of the Beneficiary Survey

The characteristics of metro passengers differ depending on the locality and the location of the station in Delhi. The beneficiary survey does not necessary reflect the whole picture of the

[22] This survey was not meant to make judgement based on rejecting null hypothesis by hypothesis testing.

passengers because only a limited number of samples were taken. In addition, best effort was made to sample the respondents in such a way as to minimize selection bias. However, it was impossible to avoid self-selection bias because some of the passengers declined to take part in the survey as they were in a hurry particularly during the rush hours (out of the 286 passengers approached for the survey, 124 took part in the survey). Thus, off-peak hours on weekdays had the highest number of responses.

Similarly, sampling methods were established for surveying residents and business establishments. Nevertheless, some residents declined to take part in the survey, and some security guards of the residential area prohibited the enumerator from entering the area. Therefore, sampling was done wherever possible starting with the buildings nearest to the metro station. It was made sure that the respondents had been living in the survey location since the time of the Project implementation.

Results

1. Metro passengers: The following are the profile and responses of the respondents.

<Profile of respondents>

Number of respondents by survey location

Location	No.	%
Kailash Colony	60	48%
Noida Sector 16	64	52%
Total	124	100%

Survey timing

Timing	No.	%
Peak hours on working days	44	35%
Off-peak hours on working days	60	48%
Holiday	20	16%
Total	124	100%

Gender

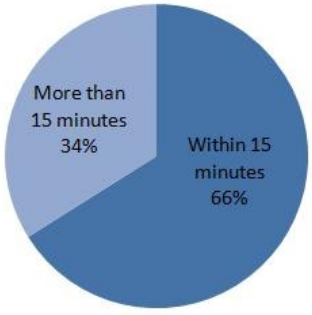
Gender	No.	%
Male	100	81%
Female	24	19%
Total	124	100%

Age

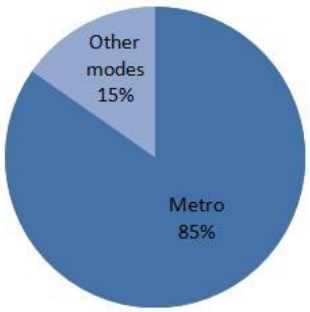
Age	No.	%
20s	71	57%
30s	34	27%
40s	13	10%
50s	3	2%
60 and above	3	2%
Total	124	100%

<Access to public transport>

Walking time from home to the nearest metro station

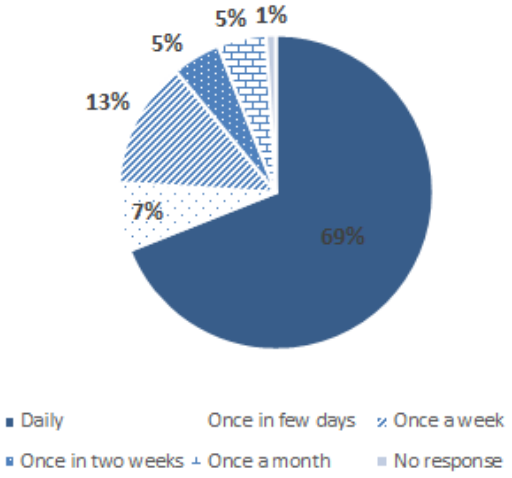


Main means of transport



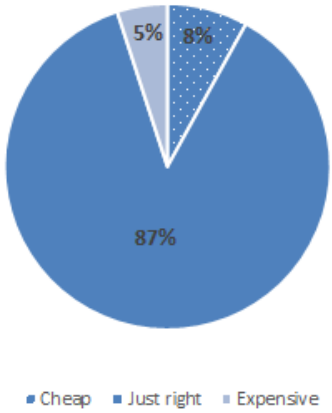
Attachment 2: Summary of the Beneficiary Survey

Frequency of using the metro

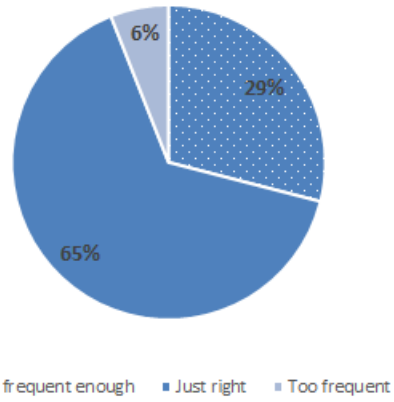


<Satisfaction on the metro service>

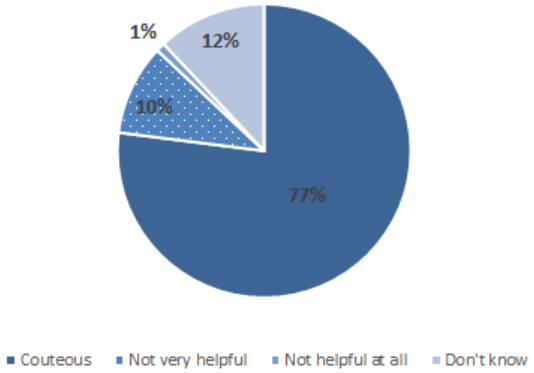
Fare structure



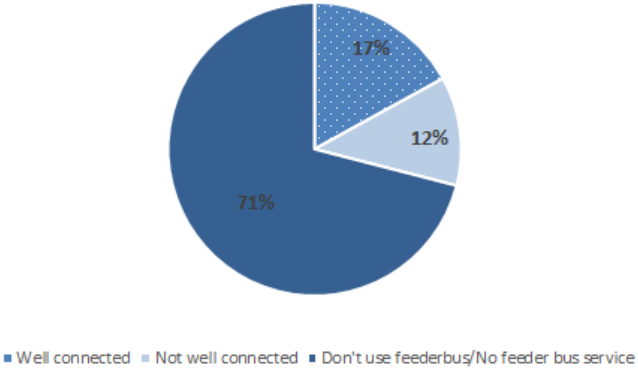
Frequency of train



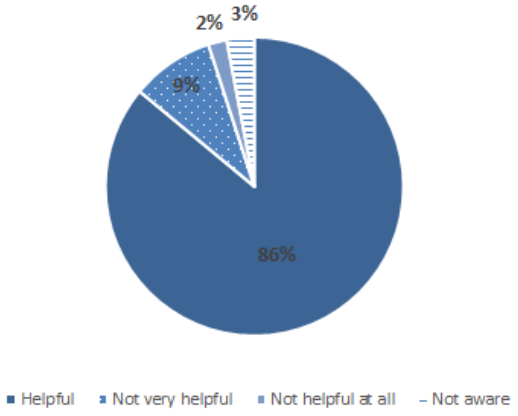
Service provided by station staff



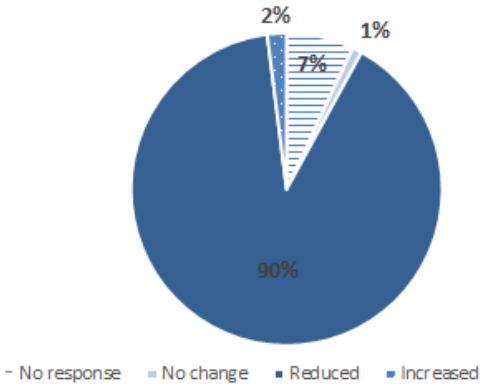
Connectivity with feeder bus



Women-only coach



Changes in transit time



<Safe mobility for women>

Gender wise responses are shown below. They include those from the passengers and residents as the same questions were asked to both groups (150 respondents in total). Male respondents were asked about the situation of female family members.

Change in women's outing after opening of the metro

	Female	%	Male	%	Total	%
Increased	34	100%	109	94%	143	95%
Reduced	0	0%	2	2%	2	1%
No change	0	0%	5	4%	5	3%
Total	34	100%	116	100%	150	100%

Change in the security situation around the metro station

	Female	%	Male	%	Total	%
Improved	30	88%	97	84%	127	85%
No change	4	12%	18	16%	22	14%
No response	0	0%	1	1%	1	1%
Total	34	100%	116	100%	150	100%

Changing time of women going out after opening of the metro

	Female	%	Male	%	Total	%
More outing in evening/night	30	88%	92	79%	122	81%
More outing in daytime	2	6%	16	14%	18	12%
No change	1	3%	1	1%	2	1%
More outing in daytime and evening/night	1	3%	7	6%	8	5%
Total	34	100%	116	100%	150	100%

2. Residents along the metro corridor: 26 people were interviewed at four locations.

<Profile of respondents>

Number of respondents in survey locations

	Person	%
Noida Sector 16	11	42%
New Ashok Nagar	8	31%
Punjabi Bagh	3	12%
Kailash Colony	4	15%
Total	26	100%

Gender

	Person	%
Male	16	62%
Female	10	38%
Total	26	100%

Age

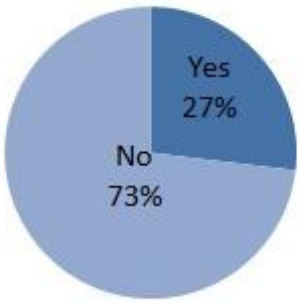
	Person	%
20s	5	19%
30s	4	15%
40s	4	15%
50s	5	19%
60 or above	8	31%
Total	26	100%

Frequency of using the metro

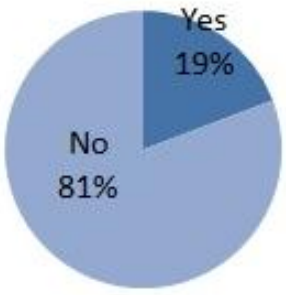
	Person	%
Daily	4	15%
Once every few days	4	15%
Once a week	5	19%
Once every two weeks	2	8%
Once a month	6	23%
Rarely	5	19%
Total	26	100%

<Noise and vibration during the Project implementation>

Whether the noise and vibration have bothered the respondent



Whether there were other concerns during the construction[23]

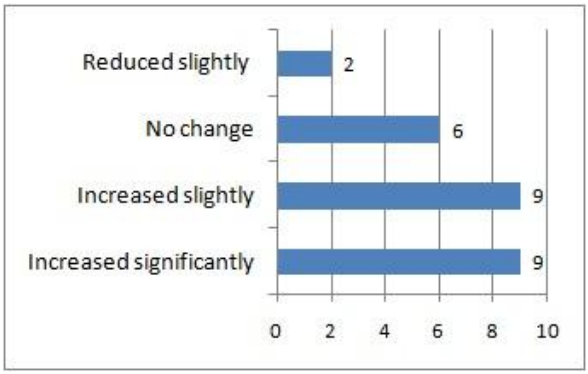


[23] For those answered "Yes" to the question, the specific concerns mentioned were traffic congestion around the construction sites.

<Situation of property price and development along the corridor>

Changes in property price and rent before and after the metro

Unit: Person



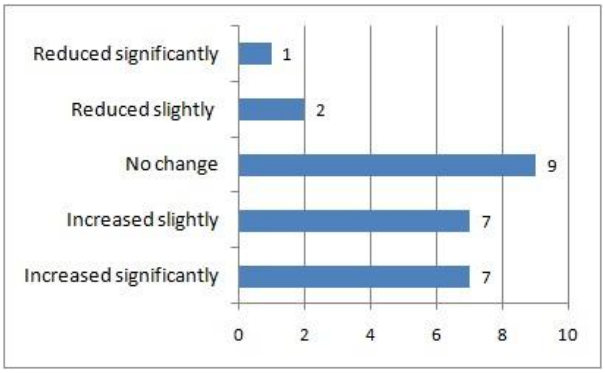
(If the price increased) whether the price rise was triggered by the opening of the metro

	Person	%
Yes	18	100%
No	0	0%
Total	18	100%

<Situation along the corridor after the opening of the metro>

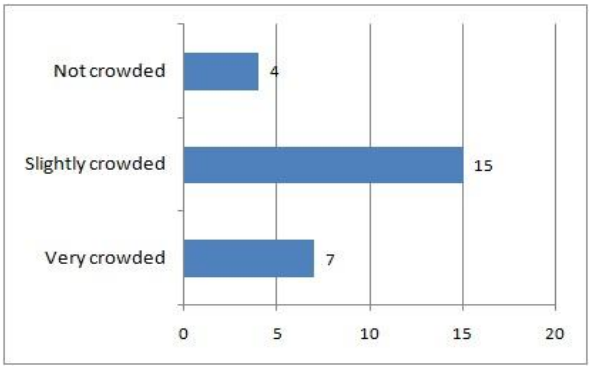
Traffic volume at the intersection

Unit: Person



Congestion around the metro station

Unit: Person



3. As for the survey of business establishments, interviews were conducted to understand the changes in business turnover before and after the Project because the sample size was limited. Below are a few excerpts from the interviews.

- After the opening of the metro, bank, coaching center and IT businesses increased in the area. (Noida Sector 16)
- The metro made commuting more convenient for the employees and reduced their commuting time. (Noida Sector 16)
- More customers from distant places come using the metro who otherwise did not come before. (Bank and coaching center)
- Our clientele is mostly upper-class to begin with. We have seen little change since the opening of the metro because wealthy people do not use the metro often. (Restaurant)
- More people come and go after the opening of the metro. At the same time, the number of criminal incidents seems to have increased. (Noida Sector 16)
- The congestion around the metro station particularly during the rush hours is really bad.

Socialist Republic of Viet Nam

FY2015 Ex-Post Evaluation of Japanese ODA Loan Project
"Third National Highway No. 1 Bridge Rehabilitation Project (I) (II)"

External Evaluator: Mitsunori Numaguchi, IC Net Limited

0. Summary

National Highway No. 1 had not functioned well in the section between Can Tho and Ca Mau, owing to damages from the Viet Nam War and subsequent inadequate maintenance. People had been forced to depend on inland water transportation for the greater part of logistics in the Mekong Delta Region. This project aimed to enhance the efficiency of road transportation by repairing and replacing bridges along the highway and thereby contributing to the economic growth of this region and help strengthen international competitiveness. Road development has been given higher priority in the development policy of the Vietnamese government from the time of the appraisal up to the time of the ex-post evaluation. Development needs have remained high even at the time of the ex-post evaluation. The relevance of this project, which was confirmed to be in conformity with Japan's ODA policy at the time of the appraisal, is high. However, the efficiency of this project is low because the project cost was higher than planned and the project period was significantly longer than planned. The scope of work was changed from 17 bridges to 16 bridges because Tra Kha Bridge, one of the bridges covered by this project, was transferred to the World Bank project. This change in scope was proper in both substance and process. The operation and effect indicators set at the time of the appraisal have mostly achieved the targets and other positive impacts have also appeared to a certain extent. Therefore, the effectiveness and impact of this project are high. Road maintenance agencies, including the Directorate for Roads of Viet Nam, are well established and have sufficient experience and skills. The budget for road maintenance is secured at the level required at the time of the appraisal and an additional budget can be appropriated whenever required. Accordingly, there is no financial problem and the sustainability of this project is high at the time of the ex-post evaluation.

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

1. Project Description

The Project Area
(from Can Tho City to Ca Mau Province)

A View of Cai RangBridge

1.1 Background

The transportation system of Viet Nam consists of roads with the total length of over 210,000km, railways extending about 2,650km, inland water transportation mainly via the Red River and Mekong River, coastal and ocean transportation via seven large ports, including the ports of Saigon and Hai Phong, and aviation. Looking at the prospect of each transport mode in 2001 at the time of planning, in the case of cargo transportation (in terms of weight), road transportation accounted for 63.9% of the total, inland water transportation accounted for 21.9%, coastal marine transportation 9.8% and railway transportation 4.4%, respectively. In the case of passenger transportation, roads accounted for 89.8%, railways accounted for 0.6%, waterways 8.9% and aviation 0.5%, respectively. In both cases, the rate of dependence on roads was the highest.

Thus, domestic transportation in Viet Nam is mostly served by road transportation in volume in the cases of both cargo and passenger transportation. Although the importance of roads in the transportation sector is clear, they did not sufficiently perform their functions owing to damages from the Viet Nam War to major highways, including National Highway No. 1 connecting the north to the south. Moreover, subsequent maintenance was inadequate, which caused the scraping of concrete and the cracking and warping of the bridge body for lack of enough strength to support the weight of passing vehicles.

The means of logistics in the Mekong Delta Region can be largely divided into two categories: (1) Inland water transportation via rivers and waterways, and (2) Road transportation via national and provincial roads. This region largely depends on inland water transportation established in the period of French reign for logistics, which accounts for about 70% of the total

transportation in this region. It was the only region that had the share of inland water transportation higher than road transportation in the whole of Viet Nam.

The establishment of a road network was left behind, whereas inland water transportation was established relatively well. This situation was an obstacle not only to the movement of people but also to large cargo transportation. In addition, bridge construction and improvement were also remarkably delayed, especially southward from Can Tho City, where people were forced to cross the river by ferry.

1.2 Project Outline

The objective of the project is to improve the efficiency of road transportation in the Mekong Delta region by repairing and rebuilding bridges along the National Highway No. 1 (Can Tho to Ca Mau) (176km) in southern Viet Nam, thereby contributing to the economic growth of this region and help strengthen international competitiveness.

Loan Approved Amount/ Disbursed Amount	5,013 million yen/4,937 million yen(Phase I) 1,038 million yen/553 million yen (Phase II)	
Exchange of Notes Date/ Loan Agreement Signing Date	March, 2003/March, 2003(Phase I) March, 2010/March, 2010 (Phase II)	
Terms and Conditions	Interest Rate	1.8%(Phase I) 1.2%(Phase II)
	Repayment Period	30 years
	(Grace Period)	(10 years)
	Conditions for Procurement	General untied
Borrower/ Executing Agencies	The Government of the Socialist Republic of Viet Nam/ Ministry of Transport	
Final Disbursement Date	September, 2012(Phase I) (Extended from July, 2009 as the initially planned date) July, 2013 (Phase II)	
Main Contactors	China State Construction Engineering Corporation (People's Republic of China)/ DatPhunong Joint-Stock Company(Viet Nam)/ Transportation Import Export and Construction Joint-Stock Co(Viet Nam)/ ChauThoi Concrete Joint-Stock Company No.620 (Viet Nam)	
Main Consultants	Japan Bridge & Structure Institutes, Inc. (Japan) /Chodai Co., Ltd. (Japan)/Oriental Consultants Co., Ltd. (Japan)	

Feasibility Studies, etc.	Feasibility Study ・APECO(Asia Pacific Engineering Consultants)(Executing Body: Vietnamese Government) (roads portion), 1997 ・Ministry of Transport Viet Nam (bridges portion), 2002
Related Projects	[ODA Loan] (Project Name, LA month/year) • National Highway No. 1 Bridge Rehabilitation Project (January 1994/March 1996) • Second National Highway No. 1 Bridge Rehabilitation Project (March 1996/March 2000) • Binh Bridge Construction Project (March 2000) • Red River Bridge Construction Project (March 2000/March 2002/March 2004) • Cuu Long (Can Tho) Bridge Construction Project (March 2001) • Bai Chay Bridge Construction Project (July 2001) • Transport Sector Loan for National Road Network Improvement Project(March 2004/March 2009) • Nhat Tan Bridge Construction Project (March 2006) [World Bank] (Project Name, Implementation Period) • National Highway No. 1 Improvement Project (from December 2000 to June 2011) [Asian Development Bank] (Project Name, Implementation Period) • Kunming to Hai Phong Logistics Promotion Project (from April 2003 to April 2008) • Noi Bai to Lao Cai Road Improvement Project (from October 2006 to December 2015)

2. Outline of the Evaluation Study

2.1 External Evaluator

Mitsunori Numaguchi (IC Net Limited)

2.2 Duration of Evaluation Study

Prior to this ex-post evaluation, the study has been carried out as follows:

Duration of the Study Period: December, 2015 – January, 2017

Duration of the Field Study: March 14, 2016 – March 29, 2016 and July 3, 2016- July 15, 2016

3. Results of the Evaluation (Overall Rating: B[1])

3.1 Relevance (Rating:③[2])

3.1.1 Relevance to the Development Plan of Viet Nam

The road development policy in the *Ten-year Socio-Economic Development Strategy (2001–2010)* formulated by the Vietnamese government at the time of the appraisal attached importance to the improvement of National Highway No. 1, the construction of Ho Chi Minh Highway, the provision of roads to the industrial development district of each region, the improvement of major bridges, and road rehabilitation and new road construction for better access to countries in the Greater Mekong Sub-region. In the *National Transport Development Master Plan (for 2010 as a target year)* included in the *Strategic Study on Transportation and Traffic Development in Viet Nam* as a mid-term development plan in the transportation sector (prepared by JICA in July 2000 for 2020 as a target year), a ten-year plan was formulated for the purpose of developing the transportation sector, conserving the environment and promoting integration with its neighboring countries and globalization. In the master plan, the required amount of investment was estimated at about $10.5 billion for the Vietnamese government to implement the ten-year plan. In terms of amount, investment in roads accounted for 65% of the total, followed by railways (13.2%), port and marine transportation (11.5%), aviation (6.6%) and inland water transportation (3.6%). In the ten-year plan as part of the master plan, this project was on the list of promising projects in the Mekong Delta Region and regarded as one of the projects to which the highest priority should be given and which should be launched by 2005.

After the formulation of the above-mentioned transportation and traffic development strategy, the transportation and traffic infrastructure of Viet Nam had been steadily constructed and improved with the focus on the highway network. Nevertheless, the pace of economic growth exceeded that of infrastructure improvement and the volume of cargo transportation increased more than initially expected. Therefore, more provision and improvement of transportation infrastructure became an urgent challenge. Under these circumstances, the Vietnamese government formulated the *Five-year Socio-Economic Development Plan (2006-2010)* with emphasis on road rehabilitation and new road construction.

As the development policy of the Vietnamese government in the transportation sector at the time of the ex-post evaluation, the *Road Development Strategy (for 2020 as a target year)* formulated in 2013 stipulates that National Highway No. 1 in the southern region covered by this project should be widened to four lanes. Moreover, it stipulates the construction of an expressway which can lead to Ho Chi Minh City as an entrance to this region. In the *National Transport Development Master Plan (for 2020 as a target year)* formulated in 2010 under the

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[2] ③: High, ②: Fair, ①: Low

strategy, it is planned to advance improvement work on the whole stretch of National Highway No. 1 in the southwestern part of Viet Nam so that it will have two lanes on each side. Accordingly, this project is relevant to the development policy of the Vietnamese government from the time of the appraisal to the ex-post evaluation.

3.1.2 Relevance to the Development Needs of Viet Nam

As of the time of the appraisal, there were about 7,200 bridges throughout Viet Nam. About 40% of them were temporary ones and had some problems, including weight limitation due to obsolescence. There were also places where no bridges were available even on major national roads and people crossed the river by ferry in some cases.

Reflecting economic growth, traffic continued to increase rapidly on highways connecting urban areas such as Hanoi and Ho Chi Minh to local cities, such as Hai Phong and Can Tho. Traffic was expected to keep increasing as urban population and the number of vehicles increased as a result of income increases along with economic growth. The government had no choice but to cope with the increasing traffic by repairing and improving the existing roads and bridges because the improvement of railway, inland water and coastal marine transportation suitable for inter-city mass transportation (passenger and cargo) was delayed and the improvement of metropolitan public transportation was also left behind.

The Mekong Delta Region plays a role as a major production area of agriculture, forestry and fishery for the whole of Viet Nam. Promoting both agricultural development and rural industry was indispensable to sustainable economic development making good use of its regional characteristics. In turn, this required the expansion of the market, keeping products fresh, and the promotion of smooth logistics by improving the infrastructure of transportation.

Can Tho City plays a role as a central city of the Mekong Delta Region. The construction of Can Tho Bridge enabled the direct connection of Can Tho to Ho Chi Minh City, Viet Nam's largest economic city, via National Highway No. 1. Accordingly, it became a requirement for economic growth whether each area in the Mekong Delta could build an efficient transportation network with Can Tho. To do so, it was an urgent challenge to overcome dependence on the conventional type of small-scale logistics by small ship on the waterway and to make transportation cost efficient by establishing a road network and securing a means of smooth mass transportation by truck, etc.

At the time of the ex-post evaluation, pre- and post-project economic growth (GDP) in this region (from 2003 to 2013) is 15% to 25% per year. The share of the Mekong Delta Region including the project area in the whole Vietnamese economy is as significant as 16.5% (2007)[3].

As shown in Table 1, rice and cultivation of prawns are still major products in the Mekong Delta Region and showed a great increase in output after the start of this project. Looking at

[3]Source: JETRO Ho Chi Minh Office (Business Information 2013: The Suburbs of Ho Chi Minh, Viet Nam)

changes in the exports of all goods from the region in recent years, there was a substantial increase in value of goods and necessity for efficient mass transportation remained unchanged. There are hopes for a road network to facilitate more economic development in the future. For development, regional industry should be promoted by exporting major products. After the completion of this project, the export of all goods, including the major products, namely rice and prawns, achieved increases by value of goods. That is why people still expect more and quicker transportation in the section of National Highway No. 1 in the project area, including the bridges involved. As evidence for their expectation, the road-widening work is under way in accordance with the scheme "Build, Operate and Transfer" (BOT[4]) by own responsibility of Viet Nam side in Public Private Partnership on the roads covered by this project. Thus, there remain high development needs for improving National Highway No. 1 in this region.

Table 1: Changes in Rice and Prawn Output

Unit: thousand tons

	Rice			Cultivation of Prawn		
	2003 Start of Project	2013 One Year after Completion	Increase/ Decrease Rate (%)	2003 Start of Project	2013 One Year after Completion	Increase/ Decrease (%)
Total of Coverage Area	3,742	6,363	Increase of 70%	139	339	Increase of 143%

Source: Statistical Yearbook of General Statistics Office, 2014

3.1.3 Relevance to Japan's ODA Policy

At the time of the appraisal in 2003, support was provided mainly for improving infrastructure as the JICA's ODA policy. Transportation was one of the most important sectors of support, along with power sector under Country Assistance Strategy for Viet Nam. Japan offered ODA loan of about 202.5 billion yen (about 30% of the approved total) in total from 1993 to 2001 for roads and bridges in the transportation sector.

At the time of the appraisal of Phase II, *Japan's Country Assistance Policy for Socialist Republic of Viet Nam (July 2009)* and *JICA Country Assistance Strategy for Socialist Republic of Viet Nam (April 2009)* regarded the establishment of a highway network as one of the main features of their support in the "establishment of networks of urban development, transportation and communications" stated as critical issues in both the plan and the policy. This project to construct a specific section of National Highway No. 1 running through the country was positioned as a program for upgrading the highway network.

As mentioned above, at the time of the appraisal, it was recognized that the project was relevant to Japan's ODA policy.

[4]A sort of public-private joint venture. It means that roads and bridges will be constructed on private funds and operated by private companies for a period of time. Their ownership will be transferred to the government when the contract with the government expires.

3.1.4 Relevance to Appropriateness of Project Planning and Approach

At the time of the appraisal, this project was planned to cover 17 bridges, including Tra Kha Bridge, which was, however, a project targeted simultaneously by two organizations, namely JICA and the World Bank (WB). As a target of the WB, the project had already received a budget and had been started. That is why the WB came to support the project in consideration of the urgency and efficiency of the needs for rehabilitating Tra Kha Bridge. As a result, a budget which had already been secured by JICA for Tra Kha Bridgewas re-allocated to the rehabilitation of the remaining 16 bridges in this project. With regard to this transfer of project target, an agreement was made between the Vietnamese government and JICA on the exclusion of the transfer from this project in August 2004 after the consultation between the Ministry of Transport of Viet Nam and JICA by way of an official letter (document) in July 2004.

The transfer of Tra Kha Bridge to the WB project is appropriate because the support of JICA overlapped with that of the WB and necessary procedures were properly followed, including the consultation between the executing agencies of both projects within the Ministry of Transport of Viet Nam, the final request from the Vietnamese government, and the agreement with JICA on the transfer of Tra Kha Bridge to the WB project.

At the time of the ex-post evaluation, it was confirmed that a new national road was provided close to the project road and road-widening work was performed on the project road in accordance with the BOT scheme. In the coverage area of this project, a national road for direct connection between Quan Lo and Phung Hiep was provided in 2008 in order to facilitate logistics from Ca Mau Province to Ho Chi Minh City. A total of three BOT projects were planned and carried out in the coverage area of this project. Road-widening work is under way to make a total of four lanes with two lanes on each side on the whole stretch from Can Tho City to Ca Mau Province. Construction on all three BOT projects was launched from 2014 to 2015 and operation partially started in February 2016. With regard to these new national road construction and BOT projects, their planning and the necessity for them could be neither confirmed nor predicted at the beginning of this project. The plans for Phase I and II were appropriate because they took into consideration the circumstances of this project at the time of the appraisal.

In light of the above, the importance of National Highway No. 1 is still high in the Mekong Delta Region as this project area from the standpoint of the Vietnamese government policy. Development needs remain high because a parallel road was developed in a part of the section covered by this project and road-widening work in the BOT project is performed on the whole line in the section. Besides, as it is confirmed that this project is consistent with Japan's ODA policy, this project has been highly relevant to Viet Nam's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating:①)

3.2.1 Project Outputs

Bridge Rehabilitation Work

This project was initiated to secure smooth road transportation in the Mekong Delta Region and carry out the rehabilitation and replacement of 17 bridges in the section between Can Tho and Ca Mau (176km). Subsequently, Tra Kha Bridge was transferred to the WB because of overlapping with the WB project. The reason and process for the transfer of Tra Kha Bridge to the WB are described in 3.1.4 above. Finally, it was determined that this project would cover the rehabilitation and replacement of 16 bridges in the section between Can Tho and Ca Mau. At the time of the appraisal of Phase I, it was assumed that 17 bridges would be rehabilitated on the Japanese ODA loan. In fact, however, nine of those bridges which ranked high in priority were covered by the ODA loan, while seven bridges were constructed with Viet Nam's own funds. Table 2 shows the actual outputs of this project.

Table 2: Planned and Actual Outputs (Bridges)

	Plan (at the time of the appraisal of Phase I)	Actual	
	ODA loan (17 bridges)	ODA loan (9 bridges)	Viet Nam's Own Funds (7 bridges)
Can Tho City*	Dau Sou Bridge, Cai Rang Bridge, Nang Mao Bridge, Phung Hiep Bridge	Dau Sou Bridge, Cai Rang Bridge	—
Hau Giang Province*		Nang Mao Bridge	Phung Hiep Bridge
Soc Trang Province	Kinh Xang Bridge, Nhu Gia Bridge, Phu Loc Bridge, Khanh Hung Bridge	Kinh Xang Bridge, Nhu Gia Bridge, Phu Loc Bridge	Khanh Hung Bridge
Bac Lieu Province	Gia Rai Bridge, Noc Nang Bridge, Ho Phong Bridge, Xa Bao Bridge, Cai Day Bridge, Dan Xay Bridge, Xom Lung Bridge, Lan Tron Bridge, Tra Kha Bridge (**)	Gia Rai Bridge, Noc Nang Bridge Ho Phong Bridge	Xa Bao Bridge, Cai Day Bridge, Dan Xay Bridge, Xom Lung Bridge, Lan Tron Bridge

Source: Data from JICA

*Can Tho Province was divided into Can Tho City and Hau Giang Province in 2004.

**Tra Kha Bridge was excluded from the coverage of this project during the project period.

With regard to bridges, the scope of work was changed from the initially planned 17 bridges to 16 bridges. The reason for that change was confirmed by the field survey and interviews with the executing agency. It was done in order to avoid overlapping with the WB project, and procedures for the change were properly followed. Accordingly, the rehabilitation and replacement of 16 bridges were carried out according to plan.

Consulting Service

For consulting service on 16 bridges in this project, it was planned to hire International Consultant (85MM). Without any change to the plan made at the time of the appraisal of Phase I, the International Consultant performed its duties, including detail design review, tender assistance, construction supervision, training of engineers from the executing agency, training of managers, review of the resettlement plan, assistance in carrying out the plan, monitoring,

follow-up of the post-resettlement situation, support for environmental measures and formulation of traffic safety activities.

Approach Roads and Related Equipment

It was confirmed by the field survey and interviews with the executing agency that related equipment, including approach roads and traffic signs, were implemented as planned at the time of the appraisal of Phase II in 2010. Sites for replacing the bridges of Ho Phong and Nhu Gia have been changed from the time of the feasibility study (F/S) conducted by the Vietnamese government in 2002. At the time of the detail design, the specifications needed to be reconsidered. The executing agency changed the specifications by downgrading the specifications of approach road pavement without extreme decline of their performance. This change to the specifications of approach roads, being made under limited conditions, was proper because the problems of pavement scraping and warping are not found even at the time of the ex-post evaluation.

Thus, despite the change to the source of funding, outputs themselves were produced almost as planned with such minor changes as the exclusion of Tra Kha Bridge from the scope of work. Changing the specifications of approach roads was an appropriate measure for efficiency.

3.2.2 Project Inputs

3.2.2.1 Project Cost

In comparison of project cost between planned and actual values, the budget of 79 million yen for Tra Kha Bridge transferred to the WB was deducted from the amount in Phase I in order to determine the planned value. Although the total cost of this project was initially 6,652 million yen, the total after deducting the cost of Tra Kha Bridge was 6,573 million yen. The actual project cost became 10,701 million yen (excluding the portion of Tra Kha Bridge). Of the cost, the ODA loan covered a total of 5,490 million yen, while the Vietnamese government bore 5,217 million yen.

Table 3: Planned and Actual Project Cost

Unit: Million yen

Item	Plan At the time of the appraisal of (Phase I) 2002			Actual (as against plan) At the time of Ex-post Evaluation2016		
	Total	ODA Loan	Viet Nam's Own Funds	Total	ODA Loan	Viet Nam's Own Funds
Construction Works	3,706	3,706	0	7,143 (192%)	4,665 (125%)	2,483 (all increase)
Auditing Services for Procurement Procedure	0	0	0	0	0	0
Consulting Service	494	494	0	596 (120%)	596 (120%)	0
Price Escalation	141	141	0	0	0	0
Contingency	393	393	0	3(0%)	0	3 (all increase)
Interest During Construction	200	200	0	226 (113%)	226 (113%)	0
Commitment Charge	0	0	0	2 (all increase)	2 (all increase)	0
Land Acquisition Cost	795	0	795	2,653 (333%)	0	2,653 (333%)
Administration Cost	633	0	633	76(12%)	0	76(12%)
Tax (Value Added Tax &Tariff)	211	0	211	0	0	0
Total	6,573	4,934	1,639	10,701 (162%)	5,490 (111%)	5,217 (318%)

Source: The executing agency

Note: The exchange rate at planning was 1VND =0.00788 yen. Actual rates are the average rates (1VND =0.0057 yen) from 2003 to 2013 according to International Financial Statistics; Yearbook (IMF).

The total amount may not match because of the rounding down of numbers.

For this project, additional funds were required after the start of the project. That is due to an excessive rise in construction costs[5] (192%) caused by price escalation of materials during the project period and an increase (333%) in land acquisition costs following an increase in the number of affected households (for details, see Table 12). The extension of the project period also caused a slight increase in the cost for consulting service.

In response to the above-mentioned situation, the Vietnamese government decided to construct seven out of the 16 bridges covered by this project on its own funds. The investment by its own funds was a measure that the Vietnamese government took in order to prevent a delay that might be caused by financial difficulty.

The actual total cost of this project is significantly higher than planned (162%) and the portion covered by the ODA Loan is higher than planned (111%).

[5]On the assumption that the value at the time of signing the construction contract is 100, the indicators of rise factors of construction work as of August 2009 are as follows: 320.98 for labor costs, 168.52 for fuel costs, 173.80 for steel costs, 186.93 for cement, 271.56 for stone materials, 218.70 for sand, 175.31 for asphalt, and 168.23 for soil.

3.2.2.2 Project Period

At the time of the appraisal, the project period was planned to be from March 2003 (signing of Loan Agreement) to June 2007 (four years and four months, i.e., 52 months). Subsequently additional funds were extended, and it was planned at the time of the appraisal of Phase II that this project would be considered completed when the use of 16 bridges started (February 2011; 96 months). The starting year/month of using the bridges in this project is shown in Table 4. The actual completion of this project, which was in July 2011 (eight years and five months; 101 months), took 94% longer than the plan made at the time of the appraisal of Phase I.

Table 4: Starting Year/Month of Using Bridges

Construction Work	Starting Year/Month of Use
Package 2a (3 bridges on ODA Loan)	April 2011
Package 2b (7 bridges on Vietnamese funds)	April 2011
Package 2c (6 bridges on ODA Loan)	April 2011 (4 bridges) July 2011 (2 bridges)

Source: The executing agency

This project took 101 months in total and 49 months longer than the plan for the following reasons:

- It took eight months longer than planned to evaluate the bidder because three companies that applied for consulting service and passed the pre-qualification set up a joint venture by forming themselves into one consortium after the start of this project.
- The detail design of approach roads to the bridges of Ho Phong and Nhu Gia was changed and it took more time to redesign.
- Upon the selection of a contractor, the bid price exceeded the planned price and the tender failed. It took much time to coordinate with the company that bade the lowest price on determining which bridge should be covered by the ODA Loan and which bridge should be covered by Vietnamese government funds. As a result, the detail design was delayed seven months and the selection of a contractor was delayed 13 months owing to the splitting of the work package.
- The land acquisition required for this project was expanded in scale. In the F/S conducted by the Vietnamese government in 2002, information was not sufficiently collected on the assumption that the detail design should be made after the start of this project and a report was prepared on the basis of limited and less reliable information. The extension of the project period is attributable to the less reliable F/S report. Regarding the expanded land acquisition and the subsequent delay, there was the distinction of mandate between the executing agency as a provider of funds for land acquisition and the Compensation Committee as a negotiator with the households subject to resettlement. The executing agency could take only a limited measure to avoid a delay although it made an internal adjustment for smooth land acquisition.

- The contractor had financial difficulty because the parent company was unable to give adequate financial assistance for escalation in the prices for materials and machines. It also took much time to negotiate the price of contract and resulted in a delay of up to 15 months in construction work.

To cope with the delayed work, the remaining work of a contractor that made less progress in construction due to their worsened financing was partially entrusted to another contractor. In addition, Project Management Unit No. 2 (PMU2) and the JICA Viet Nam Office reinforced monitoring in order to make up for the delay. JICA identified problems and considered countermeasures in the interim supervision survey (conducted in September 2009). As for the six bridges with delayed construction work, JICA and the executing agency adopted the domestic competitive tender system according to the JICA procurement guidelines. They also strived to make construction work more efficient by shortening the time for selecting contractors. Nevertheless, the actual project period was significantly longer than planned (194%).

3.2.3 Results of Calculations of Internal Rates of Return (Reference only)

Table 5 shows the economic internal rate of return (EIRR).

Table 5: Comparison of Economic Internal Rate of Return
(at the Time of the Appraisal and the time of Ex-Post Evaluation)

At the time of the appraisal		At the time of Ex-Post Evaluation	
EIRR:	12.8% (Data from JICA)	EIRR:	15.7%
Benefit:	Driving-cost-reducing effect	Benefit:	Driving-cost-reducing effect
	Driving-time-reducing effect		Driving-time-reducing effect
Cost:	Operating costs (tax exclusive)	Cost:	Operating costs (tax exclusive)
	Management & maintenance costs		Management & maintenance costs
Project life:	25 years	Project life:	25 years

EIRR became 15.7% as a result of recalculation at the time of the ex-post evaluation (2016), which is higher than 12.8% calculated at the time of the appraisal. This is because an increase in traffic at the time of the ex-post evaluation over the level expected at the time of planning enhanced the driving-cost-reducing effect. When the above-mentioned calculation was made, the WB project (for one bridge) was included in operating costs at the time of the appraisal but excluded from the costs at the time of the ex-post evaluation. This has no significant effect on the increase of EIRR.

In light of the above, both the project cost and project period significantly exceeded the plan. Therefore, efficiency of the project is low.

3.3 Effectiveness (Rating:③)

3.3.1Quantitative Effects (Operation and Effect Indicators)

The Annual Average Daily Traffic (AADT) (Passenger Car Unit, PCU) and reduction in the required time were used as indicators to measure quantitatively the operation and effect of this project. Setting 2002 as a base year of the time of the appraisal, the results of comparison between target at the time of appraisal one year after the completion of this project (2008) and actual values in 2013 one year after the completion of this project are shown in Table 6.

Target figures of AADT as of 2008 were calculated by taking the growth rate estimated through a similar survey in Viet Nam at the time of F/S into consideration. According to the result of the F/S, the growth rate of AADT for Viet Nam nationwide was estimated 1.2 to 1.8 times above GDP growth rate, and the growth rate of AADT of this project section was set as 1.5 times above GDP growth rate. As the GDP growth rate in Viet Nam in 1997 was 8.8%, the GDP growth rate in 2008 was set as 9%. The target figures of this project were set by considering the estimated growth rate, which was 13.5% (source: F/S report). With regard to AADT after the completion of this project, Can Tho showed a rapid increase above estimated growth rate (annual average growth rate from 2002 until 2013 was 19.09%) and other spots also achieved the targets. According to data from JICA, increases in traffic during the project period (from 2002 to 2009) were as gradual as 93% in Can Tho, 81% in Soc Trang, 109% in Bac Lieu and 82% in Ca Mau. Reductions in the travel time are 30 minutes, 45 minutes and 40 minutes in the sections between Can Tho and Soc Trang, Soc Trang and Bac Lieu, and Bac Lieu and Ca Mau, respectively as shown in Table 7. The traffic in Can Tho and Soc Trang one year after the completion of this project showed significant increases of 560% and 180% respectively, exceeding the targets, while the travel time in the section involved was reduced by only 66%. In Soc Trang and Bac Lieu, the traffic showed substantial increases of 180% and 140%, respectively exceeding the targets, while the travel time in the section involved was reduced by 81%.In Ca Mau, the traffic showed increases of 140% and over 100%, respectively, while the travel time in the section involved was significantly reduced by 160%. It was assumed that actual AADT in Can Tho exceeded much more than the target figure because GDP growth rate of Can Tho used as basis for the estimation increased far more than that of the national level or that of the project area as shown in Table 10.

Table 6: Planned and Actual Annual Average Daily Traffic

Annual Average Daily Traffic Unit (PCU/day)	Baseline	Target	Actual (Annual Average Growth Rate)	Actual
	2002	2008	2013	2014
	Year of Appraisal	1 Year after Completion	1 Year after Completion	2 Years after Completion
Can Tho	9,319	11,265	63,683（19.09%）	-
Soc Trang	6,250	11,321	20,596（11.45%）	22,903
Bac Lieu	6,238	13,053	18,575（10.43%）	21,112
Ca Mau	9,370	17,084	18,605（6.43%）	21,113

Source: PMU2

Table 7: Planned and Actual Reductions in the Travel Time

Reduction in Required Time (time) (Note 1)	Baseline	Target	Actual	Actual
	2002	2008	2013	2014
	Year of Appraisal	1 Year after Completion	1 Year after Completion	2 Years after Completion
Can Tho–Soc Trang	1h & 45min	1h (45min reduced)	1h & 15min (30min reduced)	1h & 15min (30min reduced)
Soc Trang – Bac Lieu	1h & 45min	50min (55min reduced)	1h (45min reduced)	1h (45min reduced)
Bac Lieu – Ca Mau	1h & 55min	1h &30min (25min reduced)	1h & 15m (40min reduced)	1h & 15min (40min reduced)

Source: Survey by interview (Note 2).
(Note 1) Despite the expression "reduction in the travel time," the actual baseline value is the travel time itself.
(Note 2) Relevant agencies, including the executing agency, did not conduct a survey on the required time and there are no official statistical data. Therefore, data were obtained from interviews with long-distance bus companies that have rendered service in the section covered by this project since before the start of this project.

3.3.2 Qualitative Effects (Other Effects)

It is fair to say that the qualitative effect of this project is the improvement of safety and convenience of National Highway No. 1. As a result of interviewing beneficiaries at the time of the ex-post evaluation in order to confirm the qualitative effect, the improvement of safety and convenience of the bridges involved to a certain extent was confirmed.

3.3.2.1 Outline of the Beneficiary Survey

A survey was carried out by interviewing beneficiaries in this project with a questionnaire[6].

(1) Bridge Users: The profile of respondents is as follows:

- Average Age: 42.61 years old

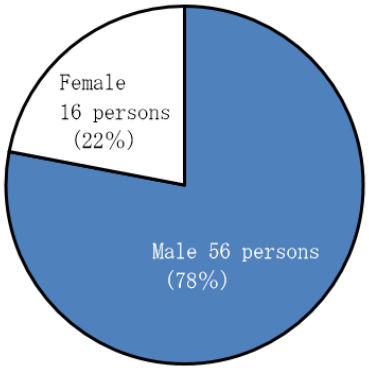


Figure 1 Gender of respondents

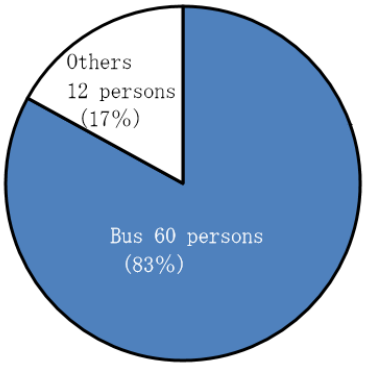


Figure 2 Means of transportation in use

Note: Total number of percentage may not be 100% due to rounding off.

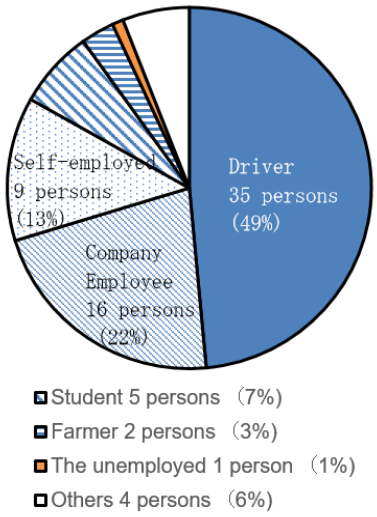


Figure 3 Occupation of respondents

(2) Residents along the Highway: The profile of respondents is as follows:

- Average Age: 48.25 years old

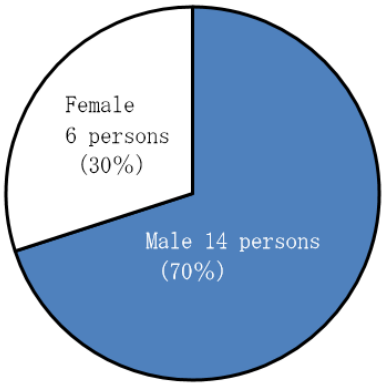


Figure 4 Gender of respondents

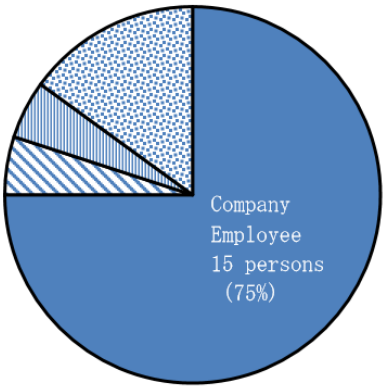


Figure 5 Occupation of respondents

[6]As a complementary means to grasp the project effects, a survey was conducted by interviewing (1) bridge users (72 people), (2) residents along the highway (20 people) and (3) companies along the highway (11 companies) using a questionnaire. When users were sampled, passengers getting on the long-distance buses from the long-distance bus terminals in Can Tho City and Ca Mau Province were interviewed by the interviewer getting on the bus together with them. Of all the bridges covered by this project, residents living near the seven bridges which are large-scale and in the neighborhoods with commercial facilities and tourist spots (the bridges of DauSou, CaiRang, Phung Hiep, PhuLoc, DanXay, Xom Lung andNoc Nang) were chosen for this survey. Companies along the highway introduced by the Vietnamese Ministry of Transport were chosen for this survey, including four companies that run transportation businesses (one each from the city and three provinces involved) and seven other business types (three from Can Tho City, two from Soc Trang Province and two from Bac Lieu Province).

(3) Companies along the highway: The profile of respondents is as follows:

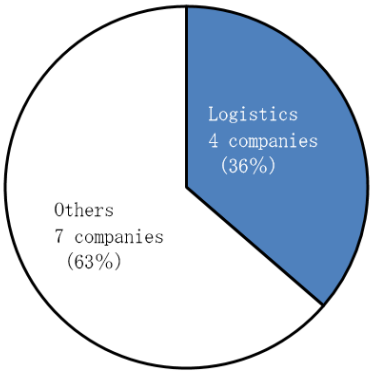


Figure 6 Business industry of responded companies

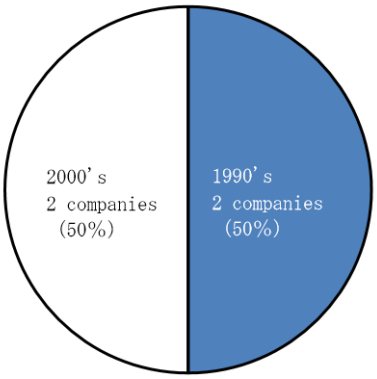


Figure 7 Year of establishment (Logistics company)

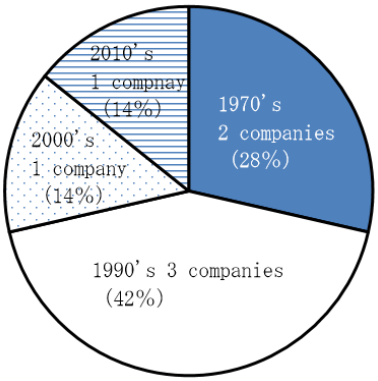


Figure 8 Year of establishment (Others)

Note: Total number of percentage may not be 100% due to rounding off.

3.3.2.2 Improvement of Safety

Table 8 shows the number of recent traffic accidents on National Highway No. 1. Since bridges were rehabilitated and the pavement of the road was improved thanks to this project, no car accident has occurred on the bridges involved in the period from 2014 up to now, as of the ex-post evaluation. According to the survey on project beneficiaries, 61% of bridge users (including long-distance bus users and the employees of companies along the highway who drive their cars on the road with the bridges involved) replied that traffic accidents decreased because the renewed bridges had better driving conditions.

Table 8: Number of Traffic Accidents in the Section Involved of National Highway No. 1

		2014	2015	January–June 2016
Can Tho–Soc Trang	Accidents	56	58	70
	Tolls	13	23	10
	Injuries	76	85	97
Soc Trang – Bac Lieu	Accidents	108	80	50
	Tolls	25	9	8
	Injuries	171	140	93
Bac Lieu – Ca Mau	Accidents	45	81	34
	Tolls	7	7	4
	Injuries	105	186	60

Source: Directorate for Roads of Viet Nam

However, pedestrians who forcibly tried to cross near the bridge got involved in car accidents because there was no pedestrian safety fence on the bridge at the time of project completion. In fact, residents along the highway (mainly pedestrians) who reported a decrease in traffic accidents on the survey accounted for no more than 20% (Table 9). Subsequently, however, it was confirmed by interviewing residents along the highway that the installation of a pedestrian safety fence by the provincial government led to a reduction in accidents.

Table 9: Results of the Beneficiary Survey on Changes in the Number of Traffic Accidents

Reply	Bridge Users		Residents	
	Respondents	%	Respondents	%
Accidents increased	21	29	10	50
Accidents decreased	44	61	4	20
I don't know	7	10	6	30
Total	72	100	20	100

3.3.2.3 Improvement of Convenience

All eleven companies along the highway that were interviewed in the beneficiary survey replied that they benefitted from this project, and six of them replied that the driving costs decreased. Moreover, two companies replied that they were able to use larger vehicles than before, transport a large volume of cargo at once and reduce the cost of transportation to final destinations such as Ho Chi Minh. Thus, it can be judged that this project has improved convenience.

At the time of the appraisal, this project, regarding logistics, aimed to shift the means of transportation from small inland water transportation to large land transportation. Thus, the beneficiary survey tried to grasp the actual situation. As a result of the survey, it was confirmed that progress was made in the shift of means from inland water to land transportation because the vast majority of respondents (82% of bridge users and 90% of companies along the highway) replied that the shift from small inland water transportation to large land transportation (changes in the cases of transportation and the volume of logistics) showed "a large increase" after the completion of this project.

Thus, actual traffic exceeded the target to a remarkable extent in this project. The required travel time might have been reduced to a greater extent if traffic had been as planned for the section involved. In this respect, it seems reasonable that reductions in the travel time in the sections where actual traffic remarkably increased were limited to 66% and 81%, respectively. In addition, it can be judged that this project had brought sufficient effects when taking into consideration of its positive effects on the improvement of safety and convenience.

3.4 Impacts

3.4.1 Intended Impacts

The expected impact of this project is “promotion of economic growth and reinforcement of international competitiveness.” The realization of the impact on “promotion of economic growth” and “reinforcement of international competitiveness” is as follows:

3.4.1.1 Promotion of Economic Growth

The GDP of the project area showed a high increase of 14% to 23% on annual average for ten years from 2003 to 2013 as shown in Table 10. The project area exceeds the average of Viet Nam as a whole. Eleven companies along the highway which were interviewed in the beneficiary survey replied that the infrastructure of logistics, including warehouses and gas stations, improved after the start of this project. Also, shops opened along the highway, which enabled them to secure sites for selling the specialties of the project area to those who use National Highway No. 1. Thus, the implementation of this project seems to have had a certain effect on the economy of the project area.

Table 10: Changes in Pre- and Post-Project Economic Growth in the Project Area

Unit: billion VND

	2003	2013	CAGR (%)
Can Tho	9,408	77,811	23.52%
Hau Giang	NA (before separation)	21,233	NA
Soc Trang	7,419	40,162	18.40%
Bac Lieu	5,667	30,417	18.30%
Ca Mau	8,871	34,595	14.58%
Whole Project Area	31,365	204,218	20.60%
Whole Viet Nam	613,442	3,584,261	19.31%

Source: Statistical Yearbook of General Statistics Office, 2014

3.4.1.2 Reinforcement of International Competitiveness

In case rice and prawn productions are compared before and after this project in the project area on a provincial basis, they are generally increasing (See Table 1). Because of lack of information, it cannot be judged how much of the increased production was exported. According to Table 11, however, it is presumable that international competitiveness was reinforced by two factors: improvement in trade conditions following mass production and the decrease in driving costs. This is based on a substantial increase in the amount of all exported goods in the project area in 2014 compared with the previous year, although a temporary decrease is seen in 2015. It seems that this decrease is temporary because some sections of the project road were under construction under BOT projects in 2015. The operation of these sections started in February 2016 and the amount of exports in the project area is expected to increase.

Table 11: Changes in the Amount of Exports in the Project Area

Unit: million dollars

	2013	2014 (as against previous year)	2015 (as against previous year)
Can Tho	1,252	1,239 (-1.0%)	1,175 (-5.1%)
Hau Giang	181	336 (+85.6%)	379 (+12.7%)
Soc Trang	519	656 (+26.3%)	533 (-18.7%)
Bac Lieu	497	692 (+39.2%)	477 (-31.0%)
Ca Mau	1,103	1,370 (+24.2%)	968 (-29.3%)

Source: General Department of Viet Nam Customs

3.4.2 Other Impacts

3.4.2.1 Impacts on the Natural Environment

At the time of the appraisal of Phase I, this project was classified into Category B. This is because an adverse effect of this project on the environment was judged not to be serious because this project aimed to rehabilitate bridges and the project area of this project was an area where a remarkable environmental impact was not characteristically foreseeable in light of the *JBIC Guidelines for Environmental Consideration in Japan's ODA Loan* (formulated in October 1999). According to the *International Cooperation Bank Guidelines for Confirming Environmental and Social Consideration* (formulated in April 2002) as guidelines adopted to appraise Phase II, this project can be classified into the road sector and into Category A because it is characteristically influential. However, it was determined that the 1999 guidelines adopted to appraise Phase I should also be applied to Phase II because there was no significant change to the scope of work.

When Phase I was appraised, there was a concern about air pollution, noise and water contamination. Necessary countermeasures were required (F/S report) during the implementation of this project. When Phase II was appraised, consideration was given to meeting the environmental standards of Viet Nam by taking the required measures to dispose of waste and to prevent water contamination under the supervision of consultants during the construction and at the time of handing over of the bridges from the contractor to the implementing agency.

It was confirmed by interviewing the executing agency and checking the progress report that environmental monitoring was performed by the consultant in charge of supervision during the implementation of this project. The monitoring system was operated as follows: PMU that should supervise the implementation of this project on the whole gave guidance to the contractor through the person from the executing agency in charge of the project site, and the contractor carried out monitoring at the site and reported to PMU every month. Environmental mitigation measures were carried out by the contractor according to plan, including the prevention of water contamination by using the filtration system and the adjustment of working time and construction equipment as described below. Waste disposal and the prevention of water contamination and noise during the construction were properly monitored. Waste was hardly

emitted thanks to efforts to reuse it as far as possible. Water deterioration by drainage was confined by filtration to a tolerable extent, while efforts were made to minimize drainage. Noise and vibration were also confined to a tolerable extent because they were mitigated by suspending construction work after four o'clock in the evening until six o'clock in the early morning and by using centrifugal reinforced concrete posts.

Regarding impacts on the natural environment, proper monitoring was carried out during the implementation of this project, and no negative impact in particular was found.

3.4.2.2 Land Acquisition and Resettlement

When this project was appraised, land acquisition was required for 1,646 households and 175 households were required to be resettled as shown in Table 12. In the end, 1,989 households were subject to land acquisition and 277 households were resettled. According to the executing agency, the reason for the number of resettled households increased from 175 to 277 is that the number of households to be resettled at the time of planning was just a reference, and it increased when the detailed plan was formulated after the start of this project. As a result, the whole process was significantly delayed. At the time of the appraisal, it was planned that land acquisition and resettlement should have been completed by May 2005. In fact, the payment of compensation to residents affected by land acquisition was completed in December 2009 and the resettlement was completed in April 2011 after an adjustment was made for residents who lodged an objection against the resettlement.

Procedures for land acquisition and resettlement were followed in accordance with JICA's environmental and social consideration guidelines along with the master plan for resettlement of residents that was prepared by the executing agency under the domestic laws of Viet Nam. Residents subject to resettlement were entitled to file a complaint to the county compensation committee about the decision on resettlement by the Compensation Committee, such as the assessed price of land. Moreover, if they had objected to the response of the county compensation committee, they could have requested the provincial compensation committee to solve the dispute. According to interviews with the resettled residents, they actually lodged an objection, which was treated properly under the domestic laws and resolved finally in such a way as to satisfy them.

Table 12: Households Subject to Land Acquisition and Resettlement

Unit: household

	Land Acquisition Households (Plan)	Land Acquisition Households (Actual)	Resettled Households (Plan)	Resettled Households (Actual)
Can Tho	138	391	175	187
Hau Giang	233	323	0	90
Soc Trang	359	359	—	—
Bac Lieu	916	916	—	—
Total	1,646	1,989	175	277

Source: PMU2

As a result of the interviews with the resettled residents, negative effects of this project were not found because they were resettled to places near their former houses and the Compensation Committee carefully dealt with their complaints about compensation (e.g. a complaint about the certification of compensation coverage). Twenty residents who lived along the highway became subjects of the survey. Sixteen of them were subject to land acquisition and eight out of those 16 were resettled. Of residents along the highway, five people (25%) got new jobs after the start of this project and 15 people (75%) did not change their jobs.

As a result of comparison with the target of traffic (PCU/day) set at the time of the appraisal of Phase I, PCU/day as a quantitative indicator achieved the target. The saving of the travel time was also generally good. The target was achieved judging from the travel time almost being kept despite the increasing traffic.

With regard to the qualitative effect, the results of the beneficiary survey show that convenience has improved. In the period from 2014 to the ex-post evaluation, there were no traffic accidents (vehicles or pedestrians) on the bridges involved. On the other hand, a few accidents occurred involving pedestrians near the bridges. As a countermeasure for such accidents, a pedestrian safety fence that this project could not cover was installed on the budget of the provincial government. Therefore, the situation was indirectly improved by the effort of relevant agencies although it was not the direct effect of this project.

As for impacts on economic growth and international competitiveness, this project had a certain impact as exemplified by a substantial increase in GDP despite some fluctuations in the amount of exports. There is no negative effect on the natural environment. Resettlement and land acquisition were carried out in compliance with domestic laws.

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

3.5 Sustainability (Rating:③)

3.5.1 Institutional Aspects of Operation and Maintenance

At the time of the appraisal, it was assumed that Viet Nam Road Administration (VRA) and Regional Road Management Unit No. 7 (RRMU7) would take charge of maintenance of this project. After that, the Directorate for Roads of Viet Nam (DRVN) reorganized from VRA, and Regional Management Bureau No. 4 (RMB4) reorganized from RRMU7 assumed the operation and maintenance of this project.

DRVN under the Ministry of Transport analyzes the managerial situation based on the annual report from RMB with the whole country divided into four regions and makes a maintenance plan for the approval of the authorities (the inspection of road administration and proposals on the mechanism and policy for road administration work). DRVN supervises the activities of RMB by directly making contact with the road maintenance site and promotes proper maintenance.

RMB is an agency that is directly responsible for road inspection, operation and maintenance. This bureau rearranges and renews data on the situation of roads and files related documents on a regular basis.

The practice of road operation and maintenance is assumed by the branch of RMB (Sub-RMB), which actually entrusts the work to contractors. The bridges covered by this project are operated and maintained by RMB4 under the supervision of DRVN. Sub-RMB5 and Sub-RMB6, as branches of RMB4, administer the work. Moreover, contractors to which Sub-RMB5 and Sub-RMB6 entrust the work take charge of the operation and maintenance of each bridge.

The organization of RMB4 in charge of the maintenance of this project has 52 staff members in total, along with three vice-directors under the director. It is composed of five divisions (general affairs, safety, maintenance, planning and accounting) and one office (inspection). Nearly 30 staff members are positioned in both Sub-RMB5 and Sub-RMB6 under the direct control of this bureau.

Maintenance work is carried out by DRVN, RMB4, Sub-RMB5, Sub-RMB6 and contractors, each of which makes regular reports and contact and has consultations daily, weekly and monthly at each level. In addition, 17 members or one third of the staff of RMB4 are engaged in maintenance and inspection; and almost all the members of Sub-RMB5 and Sub-RMB6 are engaged in road inspection. Thus, there is no institutional problem.

3.5.2 Technical Aspects of Operation and Maintenance

The skills of the maintenance personnel of DRVN, RMB and Sub-RMB are kept at a proper level by positioning those who learned engineering in colleges as staff members. In RMB4, Sub-RMB5, Sub-RMB6 and the contractor, staff members do not receive training in

maintaining and improving their technical level but human resources are developed by OJT through the daily work. As there are manuals on operation and maintenance which DRVN prepared, the staff members of RMB, Sub-RMB and the contractor perform operation and maintenance according to the manuals.

The skills of operation and maintenance are generally adequate because the staff members of RMB, its branches and the contractor have skills required for their jobs; in addition, manuals are available.

3.5.3 Financial Aspects of Operation and Maintenance

In Viet Nam, the maintenance costs of roads (including bridges) are covered by the budget for road maintenance that the Ministry of Finance allocates to the Ministry of Transport after approval by the Ministry of Planning and Investment. Specifically, DRVN reports a plan for road maintenance throughout the country to the Ministry of Transport. In response to the report, the Ministry of Transport presents a draft budget for planning maintenance to the Ministry of Planning and Investment. After the budget is finally approved by the Ministry of Planning and Investment, the Ministry of Finance will appropriate it.

The budget is allocated through the Ministry of Finance to DRVN under the Ministry of Transport and RMB and Sub-RMB under DRVN, all of which take charge of operation and maintenance. According to the interview with RMB4 in charge of this project, a necessary and minimum budget is secured at the time of the ex-post evaluation. The F/S report made a recommendation that "0.25% of the total construction cost should be applied to the maintenance costs". The cost of maintenance calculated from actual values (a total construction cost of 7,143 million yen for a total length of 2,540 m) is 7,030 yen per meter. The budgets for maintenance in 2013 and 2014 are 1,480,000 VDN (7,408 yen) and 1,430,000 VDN (7,119 yen), respectively, which are adequate for maintenance by RMB4. These budgets include extraordinary ones allocated in case of an emergency which requires maintenance and construction work.

Although information has not been obtained with reference to a mid- and long-term situation of budgeting, there is no problem for the time being because the maintenance budget has been so far secured and allocated at the level required at the time of the appraisal.

3.5.4 Current Status of Operation and Maintenance

When the maintenance of all 17 bridges including Tra Kha Bridge was checked at the time of the field survey, minor damages were detected, including broken parts of the drain, slight cracks in the outside walls, and cracks in the paved edges of the approach roads. However, these are not so serious as to hinder the operation. Maintenance required for operating the bridges (regular inspection and urgent or serious defect repairs) has been carried out.

Those minor damages were found on a total of seven bridges (Dau Sou, Cai Rang, Khanh

Hung, Dan Xay, Lan Tron, Gia Rai and Noc Nang). Three bridges (Kinh Xang, Xa Bao and Cai Day) were under widening work as a BOT project.

With regard to operation and maintenance, although lack of maintenance on minor damages which were unlikely to hinder bridge operation was found, damage which might seriously hinder bridge operation was repaired according to the interview with RMB4 and the field survey by the external evaluator. In this respect, the maintenance required for bridge operation is being carried out adequately.

In light of the above, no major problems have been observed in the institutional, technical and financial aspects of the operation and maintenance system. Therefore sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

National Highway No. 1 had not functioned well in the section between Can Tho and Ca Mau, owing to damage s from the Viet Nam War and subsequent inadequate maintenance. People had been forced to depend on inland water transportation for the greater part of logistics in the Mekong Delta Region. This project aimed to enhance the efficiency of road transportation by repairing and replacing bridges along the highway and thereby contributing to the economic growth of this region and help strengthen international competitiveness. Road development has been given higher priority in the development policy of the Vietnamese government from the time of appraisal up to the time of the ex-post evaluation. Development needs have remained high even at the time of the ex-post evaluation. The relevance of this project, which was confirmed to be in conformity with Japan's ODA policy at the time of the appraisal, is high. However, the efficiency of this project is low because the project cost was higher than planed and the project period was significantly longer than planned. The scope of work was changed from 17 bridges to 16 bridges because Tra Kha Bridge, one of the bridges covered by this project, was transferred to the WB project. This change in scope was proper in both substance and process. The operation and effect indicators set at the time of the appraisal have mostly achieved the targets and other positive impacts have also appeared to a certain extent. Therefore, the effectiveness and impact of this project are high. Road maintenance agencies, including DRVN, are well established and have sufficient experience and skills. The budget for road maintenance is secured at the level required at the time of the appraisal and an additional budget can be appropriated whenever required. Accordingly, there is no financial problem and the sustainability of this project is high at the time of the ex-post evaluation.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Design Emphasizing Safety Management

When this project was designed, a certain consideration was given to safety management, but a pedestrian safety fence was not included in the initial design. Near the bridge under specific conditions (the existence of commercial facilities and schools and a wide road for large traffic), many pedestrians got involved in traffic accidents on the approach road shortly after the completion of this project. If the installation of a pedestrian safety fence had been included in the initial design, unnecessary accidents could have been avoided. Therefore, as for bridges under such specific conditions as proximity to schools, houses and commercial facilities and a wide road (two lanes on each side), if a rapid increase in traffic is predicted or if residents in the neighborhood are likely to cross the bridges daily in a similar project in the future, safety measures, including the installation of a pedestrian safety fence, should be taken in the project.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	17 bridges (16 bridges *1)	16 bridges *1 As planned
2. Project Period	March 2003 - June 2007 (52 months)	March 2003 - July 2011 (101 months)
3. Project Cost Amount Paid in Foreign Currency	3,220 million yen	1,077 million yen
Amount Paid in Local Currency	3,432 million yen (435 billion VDN)	9,622 million yen (1,688 billion VDN)
Total	6,652 million yen (6,573 million yen *2)	10,701 million yen
Japanese ODA Loan Portion	5,013 million yen (4,934 million yen *2)	5,490 million yen
Exchange Rate	1 VDN = 0.00788 yen (As of March 2003)	1 VDN = 0.0057 yen (Average between March 2003 to July 2013)

*1 Tra Kha Bridge was properly transferred to the WB.

*2 The budget of 79 million yen for Tra Kha Bridge at the time of appraisal in 2002 was deducted upon evaluation.