

Japanese ODA Loan**Ex-Ante Evaluation (for Japanese ODA Loan)**

South Asia Division 1, South Asia Department
Japan International Cooperation Agency

1. Basic Information

Country: India

Project: Patna Metro Rail Construction Project (I)

Loan Agreement: March 29, 2023

2. Background and Necessity of the Project

- (1) Current State and Issues of the Railway Sector/Area and the Priority of the Project in India

In recent years, India has undergone rapid urbanization, with approximately 473 million people (as of 2021), accounting for around 30 percent of the total population, residing in cities. By 2030, it is projected that there will be 40 cities with populations exceeding 2 million people, according to the United Nations (2018). As urbanization continues to escalate, the number of registered vehicles has also skyrocketed, rising from around 55 million in 2001 to 230 million in 2016, as reported by the Ministry of Statistics and Works Implementation in India. Consequently, major cities like Delhi are experiencing significant economic losses amounting to approximately INR 14.7 trillion per year due to traffic congestion alone, as estimated by the Boston Consulting Group (2018). Furthermore, the spread of air pollution, including PM2.5 particles, and the resulting health hazards have become increasingly severe. In 2017, illness and other factors related to air pollution led to labor income losses of approximately INR 2.5 trillion, with a staggering 1.7 million deaths recorded in 2019, according to the World Bank (2021). These alarming statistics underline the urgent need to improve urban environments.

To address these challenges, the Government of India has developed a metro rail policy, which was last updated in 2017. This policy aims to promote the development of public transportation systems such as metros, railways, and buses. The objectives are not only to meet the transportation demands and reducing traffic congestion resulting from recent economic growth but also prioritizing safety and energy efficiency. Prime Minister Modi, in 2019, announced a plan to invest INR 100 trillion in infrastructure over the next five years. Moreover, the Government of India, as highlighted in the 2021 Budget Speech and other

official announcements, intends to focus on developing metro systems in not just the eight major cities (Tier-1 cities) but also in regional core cities (Tier-2 cities) with populations ranging from 1 to 4 million. This includes 32 additional cities, alongside the already defined major cities such as Delhi. The government is actively pursuing less climate intensive measures to support economic growth, in line with its commitment under the Paris Agreement's Nationally Determined Contribution (NDC) (2022), which aims to reduce greenhouse gas emissions per unit of GDP to 45% of 2005 levels by 2030.

Bihar, with a population of approximately 100 million according to the 2011 census, has experienced remarkable growth in recent years. It boasts an average GDP growth rate of 8.2% per year, surpassing the national average of 6.7% per year. Additionally, Bihar has sustained an average population growth rate of 1.09% per year, slightly higher than the national average of 1.04% per year, during the five-year period from 2015 to 2019, as reported by the Ministry of Statistics and Project Implementation in India. Patna, the state capital and a Tier-2 city, currently has an estimated population of approximately 2.6 million, and it is projected to reach 5 million by 2050, according to Ontario Tech University (2021). Notably, Patna's population density is extraordinarily high, with 15,000 persons per square kilometer based on the 2011 census, a figure comparable to that of Delhi and nearly double the density of other leading Tier-2 cities like Lucknow, Kochi, and Jaipur. Furthermore, Patna faces severe air pollution issues, surpassing even Delhi and ranking as the fifth most polluted city globally in terms of PM_{2.5} concentration. In 2018, the PM_{2.5} level in Patna was approximately 140 µg/m³, which is nearly ten times the annual average standard set by the World Health Organization (WHO) at 15 µg/m³. The rapid population growth and urbanisation in Tier-2 cities have contributed to the worsening of urban problems, including air pollution, as identified by the WHO in 2018. According to the Comprehensive Clean Air Action Plan for the City of Patna (2019) drafted by the Bihar Government, the transport sector accounts for 19% of PM_{2.5} emissions, ranking as the third-largest contributor behind industry (28%) and household demand (22%). Without improvements in public transportation, it is projected that PM_{2.5} emissions from the transport sector will increase by approximately 88% by 2030.

Considering these circumstances, the Government of Bihar has recognized the development of a metro system as a crucial aspect of urban development in its "Patna Master Plan 2031" (2016) and "Urban Transport Plan" (2018). The "Patna

Metro Construction Project" aims to play a pivotal role in Patna with the construction of Metro Lines 1 and 2. The primary objective of this project is to meet the growing demand for transportation while promoting urban development centered around public transport.

(2) Japan and JICA's Cooperation Policy Policy and Operations in the Urban Transport Sector

The Country Development Cooperation Policy for India (March 2016) identifies the prioritization of 'strengthening connectivity' as a priority area. This involves the development of transport infrastructure and other infrastructure to remove bottlenecks and enhance connectivity within major industrial cities, economic zones, and regions across India. The policy emphasizes the promotion of railway development, including high-speed rail and metros. It also recognizes the importance of 'strengthening industrial competitiveness' and supports the development of transportation networks in metropolitan areas, such as the project in question.

The JICA Country Analysis Paper for India (March 2018), highlights the need to eliminate infrastructure bottlenecks for economic growth. It emphasizes the project's role in promoting the development of transport hubs and networks, including trunk and urban railways, roads, and ports, to improve connectivity within major industrial cities, economic regions, and inter-regional connections in India. Furthermore, JICA's Global Agenda for Transportation emphasizes the importance of addressing environmental and climate change issues, promoting low-carbon and decarbonization strategies for Urban Public Transport, and improving maintenance and management technologies to enhance safety and this project is in line with these policies and analyses.

Regarding Japanese ODA Loan to India, a total of 79 projects amounting to JPY 3,359,200 million had been granted to the transport sector as of the end of December 2022. Of these, 50 projects totalling JPY 2,695,800 million have been allocated to the railway sector. This includes funding for metro projects in cities such as Delhi, Kolkata, Chennai, Bengaluru, Mumbai, and Ahmedabad.

(3) Other Donors' Activities

The World Bank has prioritized the improvement of connectivity and logistics in its Country Partnership Framework (2018-2022) and has offered various support to projects within the rail sector. This includes the Mumbai Urban Transport Project, which received acceptances in 2002 and 2010 totaling USD 972 million, as well as the Eastern Dedicated Freight Corridor Project, approved

in 2011, 2014, and 2015, with a total funding of USD 2,725 million.

The Asian Development Bank (ADB) has also been actively promoting the development of energy-efficient transportation modes as part of its Country Partnership Strategy(2018-2022). Within the rail sector, the ADB has provided support for several projects. This includes the Jaipur Metro, approved in 2014 for USD 176 million, and co-financing with the New Development Bank (NDB) for Mumbai Metro Lines 2A, 2B, and 7. The Mumbai Metro has received support from both the ADB (approved for USD 926 million) and the NDB (approved for USD 260 million).

It is important to note that no other donors have provided support for the Patna Metro project.

3. Project Description

(1) Project Description

1) Project Objective

The project aims to build Metro Lines 1 and 2 in Patna, the capital of Bihar, which will be operated in the city centre to meet the growing demand for transport, thereby contributing to the improvement of the urban environment, the development of the local economy and mitigation of climate change in the area through urban development centred on public transport.

2) Project Components

The sections covered by the project are as follows.

- Line 1 (new construction): between Danapur and Khemnichak station
Approx. 11 km underground, 7 km elevated/above ground, 6 underground stations, 8 elevated/above ground stations, total approx. 18 km, 14 stations
- Line 2 (new construction): between Patna station and New ISBT station
Approx. 8 km underground, 7 km elevated/aboveground, 7 underground stations, 5 elevated/aboveground stations, total approx. 15 km, 12 stations

Components eligible for Japanese ODA loan in the above sections are: the below a) civil works in the underground section of Line 1 b) - e) and i) in all sections of Lines 1 and 2, except for c), where the track laying in the rail yard and procurement of turnouts are not eligible for Japanese ODA Loan. Components not covered by Japanese ODA Loan are to be borne by the counterpart fund.

- (a) Civil works
- (b) Procurement of rolling stock (approx. 100 coaches)
- (c) Procurement and installation of rails and other equipment
- (d) Electricity and machinery
- (e) Signalling & train control system
- (f) Substation and distribution equipment works
- (g) Construction of Depot
- (h) Automatic Fare Collecton system (AFC)
- (i) Consulting services (support for preparation of bidding documents, bidding document reviews, bidding and procurement work assistance, construction supervision, support for work related to environmental and social considerations, operation and maintenance support (including human resource development and organisational capacity strengthening), financial management and non-fare revenue enhancement, regional development support, transportation planning support, awareness raising activities, etc.)

3) Project Beneficiaries (Target Group)

Metro users (approx. 0.71million) and all Patna citizens (approx. 2.6 million) who will benefit from reduced congestion due to Metro improvements

- (2) Estimated Project Cost
306,585 million Yen (Japanese ODA loan (for the tranche I): 98,612 million Yen)
- (3) Schedule
May 2023 to October 2029 (80 months in total). The commencement of operation for all the lines (October 2028) shall be the time of the Proect's completion.
- (4) Project Implementation Structure
 - 1) Borrower: President of India
 - 2) Guarantor: None
 - 3) Executing Agency: Patna Metro Rail Corporation Limited (PMRCL)
 - 4) Operation and Maintenance Agency: Same as above 3).
- (5) Collaboration and Sharing of Roles with Other Donors
 - 1) Japan's Activity: N/A
 - 2) Other Donors' Activity: N/A
- (6) Environmental and Social Consideration / Cross-Sectoral Issues / Gender

Category

1) Environmental and Social Consideration:

- ① Category: A
- ② Reason for Categorization: Because the project falls under the railway sector and sensitive characteristics listed in the JICA Guidelines for Environmental and Social Considerations (promulgated in April 2010).
- ③ Environmental Permit : An Environmental Impact Assessment (EIA) report for the project has been prepared and approved by PMRCL in July 2020, although it is not required under Indian domestic law.
- ④ Anti-Pollution Measures : Measures are being taken to ensure that air quality, water quality, waste, noise and vibration during construction meet national emission and environmental standards, including water spraying, wastewater treatment, overburden disposal and installation of sound insulation walls. Noise mitigation measures during service will include the installation of sound barriers and vibration mitigation measures will include the installation of elastic rubber under the track.
- ⑤ Natural Environment : The project area is adjacent to the Sanjay Gandhi Botanical Park ("SGB Park"), which is designated as a protected area by the Government of Bihar. The SGB Park is managed by the State Government as a botanical and zoological garden, and in implementing the project, interviews were conducted with relevant parties and experts, and measures were put together to minimise any additional impact of the project on flora and fauna, etc. In addition, the project site is located in the Key Biodiversity Area ("KBA"). However, as the project site is limited to the existing trunk road, it is assumed that the undesirable impacts on the natural environment will not be significant. Of among the approximately 1,400 trees in the project area, 103 trees that are subject to felling in accordance with the State's legislation will be replanted at a cost of three trees per tree, and all the remaining trees will be transplanted.
- ⑥ Social Environment : The project involves the acquisition of approximately 47.6 ha of land (of which approximately 35.7 ha is privately owned) and the involuntary resettlement of approximately 46 households and 227 people, and land acquisition is being carried out in accordance with the resettlement plan prepared in accordance with the country's law and the JICA Guidelines for Environmental and Social Considerations.

- ⑦ Other/Monitoring: Under the supervision of the PMRCL, monitoring will be carried out by contractors during construction and by external consultants commissioned by the PMRCL during service for air quality, water quality, waste, noise and vibration, and the presence of valuable species in the construction area. In addition, internal monitoring by PMRCL and external monitoring by third parties will be carried out for land acquisition, resettlement and livelihood restoration assistance. In addition, Bihar will set up a grievance office for the implementation of compensation and other measures for the relocated residents.

2) Cross-Sectoral Issues:

- ① Climate change: The impact on climate change mitigation (estimated GHG emission reductions) of the project is expected to be 72,000 tonnes/year CO₂ equivalent (estimated as of 2030), contributing to climate change action (mitigation measures). The Government of India has set a target of reducing greenhouse gas emissions per unit of GDP to 45% of 2005 levels by 2030, as part of its Nationally Determined Contribution (NDC) (2022) under the Paris Agreement, and the project is expected to contribute to this target.
- ② Disability considerations: Station and carriages (lifts, escalators, internal broadcasting, Braille blocks, wheelchair spaces, etc.) will be designed in accordance with Indian domestic laws and regulations, with consideration for use by the elderly, disabled and others.
- ③ Infectious disease control: The contract with the construction operator will include the implementation of AIDS control measures, such as prevention and awareness-raising activities for workers. In addition, as part of efforts to prevent the spread of new coronavirus infection, the implementing agencies have agreed on a list of measures (36 items in total) to be taken at the time of project formation and project implementation, and clarified the items of activities such as the maintenance of quarantine equipment and materials and the working environment, including the dissemination of a code of conduct, construction supervision and awareness raising. The implementing agencies will receive quarterly reports on the status of implementation of these measures, so that the impact of the virus can be closely monitored throughout the project implementation phase, and the implementing agencies can take flexible and appropriate measures.

3) Gender Category:

■ GI (S) (Gender Activity Integration project)

<Details of Activities/Reason for Categorization>

As a result of the gender analysis, issues relating to the safe and comfortable movement of women were identified. The project plans to introduce women-only carriages, provide priority seating for passengers requiring assistance, including women, and install separate toilets for men and women in station buildings, and this project has set the operational distance of women-only carriages as an indicator. In addition, when the project is implemented, it is planned to assign and appoint female staff to the implementing agencies and promote the employment of female workers at construction sites.

(7) Other Important Issues : N/A

4. Targeted Outcomes

(1) Quantitative Effects

1) Outcomes (Operation and Effect Indicators)

Indicator		Baseline (Actual value in 2022)	Target (2030) [2 years after project completion]
Operating rate (%/year)	Line 1	-	92.2
	Line 2	-	92.2
Running distance (thousand km/day)	Line 1	-	19.1
	Line 2	-	13.5
Running distance of women-only cars (thousand km/day)	Line 1	-	5.7
	Line 2	-	4.5
Number of running trains (trains/day)	Line 1	-	166
	Line 2	-	166
Volume of Transportation (million passengers/km/day)	Line 1	-	3.5
	Line 2	-	1.7
Number of Passengers (thousand persons/day)	Line 1	-	534
	Line 2	-	267
Income from passengers (million INR/day)	Total	-	26.3

(2) Qualitative Effects

Mitigation of traffic congestion, air pollution and climate change burdens in Patna, improvement of economic efficiency by ensuring safe and punctual travel, promotion of planned urban development and promotion of economic development.

(3) Internal Rate of Return

Based on the assumptions listed below, the economic internal rate of return (EIRR) for the project is 9.61% and the financial internal rate of return (FIRR) is 2.53%.

【EIRR】

Cost: project costs, operation and maintenance costs, etc. (all excluding taxes)

Benefit : Effect on reduced journey times for metro and road transport users, reduced vehicle maintenance costs for metro and road transport users, reduced road transport infrastructure maintenance costs, reduced road transport accidents, reduced emissions of environmental pollutants from road transport.

Project Life : 40 years

【FIRR】

Cost : project cost, operation and maintenance costs, etc. (all including taxes)

Benefit : Fare Box Revenue, advertising income, station development, tenant income, etc.

Project Life : 40 years

5. External Factors and Risk Control

(1) Preconditions: N/A

(2) External Factors: N/A

6. Lessons Learned from Past Projects

The results of the ex-post evaluation of the Metro Manila Metropolitan Area Traffic Congestion Relief Project, Japanese ODA loan to the Republic of the Philippines (evaluation year: 2008), etc., indicate that the establishment of a financially independent project implementation system is important from the perspective of ensuring appropriate operation and maintenance management. In addition, the results of the ex-post evaluation of the Delhi Rapid Transit System Construction Project and its Phase 2 Project (evaluation years: 2010 and 2015, respectively), etc., have indicated that the technical strengthening of internal human resources with a view to implementing the continuation phase of the DMRC has been evaluated as a good practice. The reasons for this include the fact that internal human resources have improved their technical capacity by gaining experience through working with the Japanese ODA loan consultants

from an early stage, as well as contributing to the dissemination of metro technology in Japan and abroad by undertaking external projects such as training for other metro management bodies. In addition, it has been pointed out that under the Bangkok Mass Transit Network Development Project (Purple Line) (I) (II) (evaluation year 2018), a Japanese ODA loan to Thailand, the bus routes (feeder network) connecting metro stations and residential areas are underdeveloped, which is one of the factors hindering the promotion of Purple Line usage. This is one of the factors hindering the promotion of the Purple Line.

The project will support PMRCL's efforts to implement measures to strengthen its financial base and improve accessibility to stations for passengers through consulting services. In addition to strengthening internal human resources through a memorandum of cooperation with DMRC, which PMRCL has already concluded, the project will also transfer technology related to project supervision to PMRCL staff through the consulting services of the project.

7 . Evaluation Results

The project aims to meet the increasing demand for transport by constructing a metro in Patna, the capital city of Bihar State, which is in line with India's development challenges and policies as well as the cooperation policy and analysis of Japan and JICA. It is also in line with SDGs Goal 8 'Promote sustained, inclusive and sustainable economic growth and productive and rewarding jobs for all', Goal 9 'Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation', Goal 11 'Build inclusive, safe, resilient and sustainable cities and human settlements Building', and Goal 13 'Urgently address climate change and its impacts', there is a strong need to support the implementation of the project as it is also considered to contribute to Goal 13 'Urgently address climate change and its impacts'.

8 . Plan for Future Evaluation

- (1) Indicators to be Used
As indicated in Sections 4 (1)~(3).
- (2) Future Evaluation Schedule
Ex-post evaluation: two years after the project completion