सत्यमेव जयते

Report of the Comptroller and Auditor General of India on Implementation of Phase-III Delhi Mass Rapid Transit System by DMRC

भारतीय लेखापरीक्षा और लेखा विभाग ✦ INDIAN AUDIT AND ACCOUNTS DEPARTMENT

सत्यमेव जयते

लोकहितार्थ सत्यनिष्ठा
Dedicated to Truth in Public Interest

Union Government
Ministry of Housing and Urban Affairs
No. 11 of 2021
(Performance Audit)

DELHI METRO

METRO NETWORK*
Phase I, II, III & NCR

Distance Covered

Phase I - 65.1 kms / 58 Stns.
Phase II - 124.9 kms / 87 Stns.
Phase III - 159.68 kms / 109 Stns.
Phase I + Phase II + Phase III = 349.68 kms / 254 Stns.

Other Metros in NCR

Rapid Metro - 12.00 kms / 11 Stns.
Aqua Line - 29.70 kms / 21 Stns.
Rapid Metro + Aqua Line = 41.70 kms / 32 Stns.

Total Network = 391.38 km, 286 Stations

Key to Lines

Operational	Length (KM)	Stations
Line 1 - Red Line Rithala to Shaheed Sthal (New Bus Adda)	34.69	29
Line 2 - Yellow Line Samaypur Badli to HUDA City Centre	49.31	37
Line 3 - Blue Line Dwarka Sec 21 to Noida Electronic City	56.61	49
Line 4 - Blue Line Yamuna Bank to Vaishali	08.74	8
Line 5 - Green Line Kirti Nagar / Inderlok to Brig. Hoshiar Singh (Bahadurgarh)	29.64	24
Line 6 - Violet Line Kashmere Gate to Raja Nahar Singh (Ballabhgarh)	46.63	34
Line 7 - Pink Line Majlis Park to Mayur Vihar Pocket 1	39.72	23
Line 7 - Pink Line Trilokpuri - Sanjay Lake to Shiv Vihar	17.86	15
Line 8 - Magenta Line Botanical Garden to Janakpuri West	37.46	25
Orange Line (Airport Express) New Delhi to Dwarka Sec 21	22.70	6
Line 9 - Grey Line Dwarka to Najafgarh	4.29	3
Rapid Metro	12.00	11
Aqua Line - Noida-Greater Noida	29.70	21
Total	**391.38**	**285**

Under Construction	Length (KM)	Stations
Line 7 - Pink Line Mayur Vihar Pocket 1 to Trilokpuri - Sanjay Lake	0.85	0
Line 9 - Grey Line Najafgarh to Dhansa Stand	1.18	1
Total	**2.03**	**1**

Key to Symbols

- Airport
- ISBT
- Metro Museum
- Interchange Station
- Indian Railway
- Hospital

As on 04.10.2019

Report of the
Comptroller and Auditor General of India
on
Implementation of Phase-III
Delhi Mass Rapid Transit System by DMRC

Union Government
Ministry of Housing and Urban Affairs
No. 11 of 2021
(Performance Audit)

Laid on the table of Lok Sabha and Rajya Sabha on …….

Index

PREFACE

The Performance Audit Report on 'Implementation of Phase-III Delhi Mass Rapid Transit System' by DMRC has been prepared under the provisions of Section 19-A of the Comptroller and Auditor General's (Duties, Powers and Conditions of Service) Act, 1971 for submission to the Governments. The Audit has been carried out in line with the Regulations on Audit and Accounts, 2007 (revised in August 2020) and Performance Audit Guidelines, 2014 of the Comptroller and Auditor General of India.

The Audit covered the period from 2011-12 to 2019-20. This report examines planning, implementation, monitoring and operations & maintenance of corridors and outcome of the activities of Phase III project for the period April 2011 to March 2020.

Audit wishes to acknowledge the assistance provided by the Technical Consultant (IIT Delhi) and co-operation extended by the officers and staff of DMRC, Ministry of Housing and Urban Affairs and Government of National Capital Territory of Delhi for this Performance Audit.

Executive Summary

Delhi Metro Rail Corporation Limited (DMRC) is a joint venture with equal equity (50:50) contribution from Government of India (GoI) and Government of National Capital Territory of Delhi (GNCTD). Delhi Mass Rapid Transit System Project Phase-I covering 65 km was conceptualised (September 1996) and completed (November 2006) by DMRC. This was followed by Phase-II (124.93 km during 2006-2011), Phase-III (160.75 km during 2011-2019) and Phase-IV covering 103.93 km which is under implementation and scheduled to be completed by December 2024. The Performance Audit of Phase-I was taken up in March 2007 and completed in July 2008. Compliance Audit of Airport Metro Express Line was taken up under Phase-II and included in Report No 13 of 2013. Performance Audit of Delhi Mass Rapid Transit System Phase-III was taken up to assess implementation of the project in terms of economy, efficiency, and effectiveness due to public interest in the project, growing transport requirement of Delhi, substantial cost involved, and delay in completion of the project.

The objectives of the Performance Audit were to examine whether (i) effective planning was done to ensure economic viability and selection of the most appropriate technologies; (ii) implementation in terms of project execution and contract management was done with due care, economy, and in a timely and transparent manner; and (iii) an adequate mechanism was in existence to monitor the project to ensure timely completion and conformity of works executed with laid down specifications, and (iv) the operation and maintenance were efficient, and the planned benefits were achieved after commercial operation of Phase-III.

The Performance Audit covered the 13 corridors[1] and outcome of the activities of Phase-III project for the period since inception (April 2011) to March 2020. A total of 93 (four more contracts added during audit) out of 259 contracts valued above ₹5 crore relating to civil, rolling stock, track, electrical, signalling & telecom, property development and operation & maintenance were covered during the audit. The coverage in terms of number of contracts was 36 *per cent*. In terms of monetary value, the audit coverage was ₹25,616 crore out of sanctioned cost of ₹48,565.12 crore which amounts to 53 *per cent*. The Indian Institute of Technology, Delhi (IIT Delhi) provided technical consultancy during review of the technical aspects of the Phase-III project.

A summary of the main audit findings is given below:

Policy, Planning and Selection of Technology

- National Urban Transport Policy 2006, stipulated that GoI contribution shall not exceed 20 *per cent* of the capital cost of the project (including equity, subordinate debt and grant etc.) excluding the cost of land and Rehabilitation and Resettlement. The funding pattern of Dwarka-Najafgarh, Mundka-Bahadurgarh and Badarpur-Faridabad extensions envisaged GoI contribution of more than 20 *per cent* leading to additional contribution of ₹421.34 crore by GoI.

(Para 2.1.1)

[1] ***Jahangir Puri to Badli (Line–2 Extension), Mukundpur (Majlis Park) to Yamuna Vihar (Line-7) , Janak Puri West to Kalindi Kunj (Line–8), Badarpur-Faridabad Extension (Line-6), Maujpur to Shiv Vihar (Line-7 Extension), Kalindi Kunj-Botanical Garden (Line–8 Extension), Dwarka–Najafgarh, Mundka–Bahadurgarh, Escorts Mujesar (Faridabad)–Ballabhgarh, Najafgarh to Dhansa Bus Stand extension, Noida City Centre–Noida Sector -62, Central Secretariat-Kashmiri Gate and Dilshad Garden–New Bus Adda, Ghaziabad***

- There was no minimum Financial Internal Rate of Return criteria for approval of a metro corridor before 2013. This resulted in sanctioning of two corridors (Badarpur-Faridabad and Shiv Vihar extension) with negative Financial Internal Rate of Return. After Ministry of Housing and Urban Affairs instructions (August 2013), for minimum eight *per cent* Financial Internal Rate of Return, Detailed Project Report of (i) Dilshad Garden to Ghaziabad, New Bus Adda, (ii) Noida City Centre to Noida Sector-62, (iii) Kalindi Kunj to Botanical Garden, (iv) YMCA Chowk to Ballabhgarh corridors were revised (up to October/ December 2014) to make them viable and higher Financial Internal Rate of Return of 12.23 *per cent*, 8.63 *per cent*, 9.85 *per cent* and 11.01 *per cent* were computed as against the earlier 4.02 *per cent*, 2.03 *per cent*, 1.11 *per cent* and 4.50 *per cent*, respectively. Increased Fare Box Revenue ranging from 111 *per cent* to 175 *per cent* has been considered to attain the Financial Internal Rate of Return of eight *per cent* or more for sanctioning the projects.

(Para 2.1.2)

- DMRC did not have any protocol for scientifically estimating the cost of an upcoming project. They also did not have any approved policy for selection of type of corridor i.e., elevated, at grade or underground; policy for providing interchange between two stations and mode of interchange facility.

(Para 2.1.3)

- Gross infirmities and adoption of different assumptions in formulation of Detailed Project Report were noticed. Chapter on Comprehensive Mobility Plan highlighting developing an integrated plan was not included in the DPR. Guidelines/ instruction/ standard operating procedures were not formulated by DMRC for preparation of the Detailed Project Reports. No cost and benefit analysis was conducted for adopted Technologies.

(Para 2.1.4.1)

- Detailed Project Reports were inadequate and lacked specific information on the project. There was no information on tunnel details, cut and cover method, tunnelling methods, support system, lining, excavation methods etc. Detailed Project Reports also did not mention about any quick and cost-effective geophysical methods to get the strata condition depth wise along the alignment.

(Para 2.1.4.4)

- Memorandum of Understanding was not signed among GoI, GNCTD and DMRC although it was required as per condition of sanction letter of Phase-III Delhi Mass Rapid Transit System project to ensure effective implementation of the project and conditions of sanction.

(Para 2.2.1)

- Government of India sanction letter for Shiv Vihar extension required that a Memorandum of Understanding be signed between DMRC and Government of Uttar Pradesh, as some portion of this extension was passing through territory of Uttar Pradesh and required partial

funding by Government of Uttar Pradesh. DMRC utilised ₹63.27 crore from their own funds for construction of the Uttar Pradesh portion. Since the Memorandum of Understanding is not in place, Government of Uttar Pradesh has not released the funds, although construction work has been completed by DMRC and the corridor is operational.

(Para 2.2.2)

- As per the Detailed Project Report, Dwarka-Najafgarh metro corridor was not financially viable with assessed negative cash flow of ₹5,178 crore during the horizon period of 33 years. A requirement of 4.03 hectare of land at Najafgarh station for Property Development was, therefore, included in the Detailed Project Report to make the corridor viable. The metro corridor was completed in October 2019, but DMRC had not ensured availability of land for Property Development till December 2020 although Property Development from the land was the only way to make this corridor viable. This section was further extended to Dhansa Bus Stand.

{Para 2.2.3(i) and 2.2.3(iii)}

- Since the metro corridor of Mundka-Bahadurgarh was not financially viable, 4 hectare land with 'residential' land use for Property Development at Ghevra (Delhi) and 1.56 hectare in Haryana was envisaged in Detailed Project Report to make it viable. Metro corridor has been completed in June 2018, but as on December 2020, 4 hectare land in Delhi portion has not been acquired by DMRC for Property Development. Further, out of 1.56 hectare land for Property Development in Haryana portion, only 0.8 hectare space is available, which also remained unutilised as of March 2020.

(Para 2.2.3(ii))

- The Board of Directors of DMRC approved (February 2011) the Detailed Project Report of Phase-III with nine car operation on new standalone corridors of Phase-III i.e. Line-7 and Line-8. However, DMRC decided (27 May 2011) to change the plan of running nine cars to six cars on Line-7 and Line-8 due to reduction in the train's headway under Communication Based Train Control system. The decision of nine cars to six cars train operations was taken without any cost benefit analysis. This eliminated the possibility and scope for further increase in cars in a rake to cater to increase in ridership in future.

(Para 2.2.5)

- DMRC awarded RS-11 and RS-13 contracts at the same time but the clauses of Heating Ventilation and Air-Conditioning, Coefficient of Performance in the two contract agreements were different. This resulted in additional payment of ₹3.24 crore for lower Heating Ventilation and Air-Conditioning, Coefficient of Performance (i.e., 2.3) in RS-11 contract as compared to 2.5 in RS-13 contract.

(Para 2.3.1.2)

- After approval of Phase-III project by DMRC, GNCTD and GoI, DMRC decided to adopt Unattended Train Operation/ driverless technology on all new lines of Phase-III i.e. Line-7, Line-8 and Line-9 without preparedness and cost-benefit analysis.

(Para 2.3.1.3)

- Quality issues of rails and wheels of rolling stock were noticed. Comparison of hardness as specified in contracts and actuals were different. There was higher vibration and noise level in the trains and stations. Lubricant waste on the track, and maintenance issues were also noticed.

(Para 2.3.1.5)

- With the same specifications for train control and signalling system and common Pre-Qualification tender, DMRC awarded two separate tenders for Line-7 and Line-8. Due to deficiency in tender evaluation of not comparing the per km cost, DMRC incurred an avoidable expenditure of ₹23.97 crore.

(Para 2.4.1)

- Communication Based Train Control system had the deficiency of reduced reliability due to wireless connections of access points, excess values of mean time between hazardous events, mean time to repair and mean time between failures and vulnerability to interference and jamming in Communication Based Train Control system.

(Para 2.4.2(ii))

- The capacity and design of the Traction Transformer on Line-7 and Line-8 was planned for nine car and 90 seconds headway operation, however, DMRC decided to have six car operations on Line-7 and Line-8. DMRC procured Traction Transformer and Auxiliary Main Transformer of higher size and location of Receiving Substation was predefined rather than the optimal placement.

(Para 2.5)

- DMRC did not carry out any detailed study on installation of Platform Screen Doors during Phase III. Resultantly, DMRC did not consider full height Platform Screen Doors which would have ensured not only improved climate control within the station but also energy saving.

(Para 2.6.1)

With reference to Audit findings on Policy, Planning and Selection of Technology, Audit recommends that:

1. ***DMRC should ensure at the project planning stage itself that Detailed Project Reports are prepared with realistic assumptions for computation of Financial Internal Rate of Return to ensure economic viability of the corridor.***
2. ***DMRC may formulate a policy for selection of type of corridor, interchange between two stations, and mode of interchange facility, which would benefit future Mass Rapid Transit System projects in the country. Also, the policy document may clearly define the circumstances under which deviations from the stated policies are allowed.***
3. ***DMRC may consider preparing Guidelines/ Standard operating Procedures for formulation of the Detailed Project Reports for future metro rail projects/ expansion. The revised Detailed Project Reports may be approved by the Board of Directors before submission to Government of India and Government of National Capital Territory of Delhi.***

4. ***A Guideline/ criteria for selection of mode of transport for different scenarios like Light Metro, Bus Rapid Transit system based on viability and alternative analysis may be formulated.***

5. ***DMRC should ensure timely availability of land for Property Development which is of paramount importance to make the project financially viable.***

6. ***DMRC may consider optimising the sizing of Traction Transformers in Receiving Sub Stations instead of putting transformers of uniform capacity across all Receiving Substation on a Line.***

7. ***DMRC may consider full height Platform Screen Doors including evaluation of its effect on Heating, Ventilation and Air Conditioning requirements in the under-ground station design studies.***

Contract and Project Management

- DMRC prepared cost estimates of CC-26 R on the basis of awarded rates of civil contracts awarded in the year 2006 by adding @ 5 *per cent* p.a. escalation (i.e. 34 *per cent)* to obtain the estimated rate as on February 2012 instead of taking completed rates having actual escalation (i.e. 11.02 *per cent*). This has resulted in higher cost estimation by 23 *per cent*. There is no practice of preparing a justified cost estimate to know the reasonable cost to execute the given project.

(Para 3.1.1 and 3.1.2)

- DMRC released special advance of ₹555.69 crore to 13 civil contractors beyond contractual provisions. There were two instances where outstanding advances availed by the contractor was more than balance work to be executed.

(Para 3.3)

- Social Impact Assessment study and Detailed Project Report of Phase-III was silent on relocation of Project Affected Persons of Trilokpuri. During the execution, DMRC frequently changed the relocation site thereby delaying the completion of Mayur Vihar Pocket-I to Trilokpuri section. This further led to delay in awarding of revenue contracts, cost escalation of the balance work, and under-utilisation of Rolling Stock and depot facilities.

(Para 3.5)

- DMRC envisaged at grade metro station at Majlis Park (earlier Mukundpur) without ensuring land availability from Delhi Police. Resultantly, DMRC had to construct elevated Majlis Park station after incurring extra expenditure of ₹72.73 crore without exploring the possibility of construction at grade station on the vacant PWD land available under the existing elevated alignment, which could have saved ₹39.01 crore to DMRC.

(Para 3.6)

- DMRC on the request of Delhi International Airport Limited extended passenger subway from Terminal 1C to Terminal 1D and to the new terminal building with its own fund.

DMRC did not recover ₹40 crore from Delhi International Airport Limited for this connectivity.

(Para 3.7)

- DMRC appointed General Consultant on nomination basis in violation of Detailed Project Report recommendations. Further, DMRC constructed Sadar Bazar cantonment and Shankar Vihar stations without the approval of GoI and GNCTD and the flawed design of Hauz Khas interchange station resulted in inconvenience to the commuters.

(Paras 3.2, 3.8 and 3.13)

- Environmental clearance was not obtained by DMRC for the Phase-III project even though it had constructed four car maintenance depots[2] each having built up area of more than 20,000 sqm. DMRC did not conduct water audit though it was required under the National Water Policy, 2012 and DMRC Water Policy. No details and records were maintained either by DMRC or by the contractors for water extracted, consumed or loss of water during Phase-III.

(Para 3.15)

- There were discrepancies in tree cutting estimation in Detailed Project Report and Environment Impact Assessment study, and estimation of cost of compensatory plantation. There was no monitoring of compensatory afforestation locations and disposal of wood as per permit letters. DMRC deposited an excess amount of ₹14.20 crore in advance with Forest Department, GNCTD as the number of trees cut was less than the permission granted.

(Para 3.16)

With reference to Audit findings on Contract and Project Management, Audit recommends that:

8. ***DMRC may ascertain cost estimates of projects on the basis of scientific method; establish a cell to study the cost aspects of various contracts and may consider formulating a schedule of rates like Delhi Schedule of Rates for metro projects.***
9. ***DMRC may formulate a policy on grant of special advances to the contractors.***
10. ***DMRC should ensure efficient planning and timely completion of rehabilitation and resettlement activities for smooth completion of project.***
11. ***DMRC may ensure adherence to relevant environmental requirements of obtaining environmental clearance, carry out water audit, maintain records for water consumption and prepare Water Management Plans for future projects.***

[2] ***Mukundpur (45,686 sqm), Kalindi Kunj (29,310 sqm), Vinod Nagar (32,104 sqm) and Badli (46,063 sqm)***

Project Monitoring

- DMRC failed to complete the corridors within stipulated time-period due to various impediments like delay in land acquisition, Rehabilitation and Resettlement activities, slow progress of work by contractors etc., resulting in foregoing of Fare Box and Non Fare Box Revenue. Besides, the Board Sub Committee on Project Management did not meet at regular intervals to monitor the progress of work and suggest measures to expedite the projects.

(Paras 4.1.2 and 4.1.3)

- Absence of a proper formwork[3] system of civil structure at Hauz Khas and other metro stations were noticed. Non-optimisation of quantities of construction materials, lack of uniform project Quality Management Plan were also noticed.

(Paras 4.2.1, 4.2.2, 4.2.3 and 4.2.4)

- DMRC had Building Management System for controlling and monitoring the building's mechanical and electrical equipment such as Heating Ventilation and Air Conditioning**,** lighting, power systems, fire systems, and security systems. But, in the absence of real time performance monitoring, Building Management System is of not much value. No record was maintained on the actual fresh air being introduced or the CO_2 levels maintained inside the coaches and the energy consumption of the air-conditioning unit.

(Paras 4.2.5 and 4.2.8)

- The method of duct designing was based on equal friction instead of better optimisation methods which can help in minimisation of space, material or operating cost savings. For Heating Ventilation and Air Conditioning load calculations, DMRC adopted outdated carrier method in comparison to the well-established state of the art hourly load calculation methods using software such as Hourly Analysis Programme, Trane etc.

(Para 4.2.7)

With reference to Audit findings on Project Monitoring, Audit recommends that:

12. DMRC may strengthen the monitoring mechanism by ensuring periodic review by the below Board level Sub Committee on Project Management and follow up thereon, to ensure timely completion of the projects.

13. DMRC may formulate a template for (i) Quality Management Plans and (ii) specifications for the system of formwork.

14. DMRC may ensure optimal utilisation of Building Management System for better monitoring of the ambient conditions at the metro stations to achieve anticipated energy savings, and to render maximum comfort to the commuters.

15. DMRC may adopt latest method of load calculations for Heating Ventilation and Air Conditioning for simulation and better estimations.

---

[3] ***Formwork is the term used for the process of creating a temporary mould into which concrete is poured and formed under civil construction***

16. DMRC may consider real time monitoring and data logging of parameters relating to Rolling Stock Heating, Ventilation and Air Conditioning.

Operation & Maintenance and Revenue Management

- As per sanction letters, and instructions of GoI and GNCTD, DMRC had to ascertain line-wise operation profit and loss, and in case of operational loss, if any, necessary claims are to be made with the respective State Governments. While DMRC did not maintain line wise operational loss/ profit statements till 2019-20, it decided (January 2021) to apportion operating loss from 2020-21. However, it remained silent on recovery of past years' operational loss, if any.

(Para 5.2.1)

- As against the projected ridership of 20.89 lakh in 2019-20 from initially sanctioned Phase-III four corridors, the actual ridership in 2019-20 was 4.38 lakh only, which is 79.02 *per cent*, less than projected ridership. Similarly, in case of National Capital Region/other extension, the actual ridership on these corridors were 15.12 *per cent* to 87.63 *per cent* lower than projected ridership. The total ridership of entire DMRC network (Phase-I, Phase-II and Phase-III) in the year 2019-20 was estimated as 53.47 lakh. Against this, the actual ridership of DMRC was 27.79 lakh (2019-20) i.e. 51.97 *per cent* of projected ridership.

(Para 5.2.2)

- DMRC utilises only 174 buses, out of 400 buses (43.5 *per cent*) for providing last mile connectivity to metro commuters. Due to shortage of buses, DMRC was operating buses on only 32 out of 73 approved routes (44 *per cent*). Since January 2021, even these 174 Midi feeder CNG Non-AC buses are not operating on the 32 routes and the operators have requested for termination of contracts.

(Para 5.2.3)

- While calculating operating ratio, which indicates operational efficiency, DMRC excluded the depreciation & amortisation expenses and interest cost as part of the operating expenses, thereby reducing the operating expenses. Thus, DMRC was suffering operational loss instead of earning operating profit. Even without considering the depreciation and interest expenses, there has been a consistent increase in the operating cost ratio, from 48.99 *per cent* in 2011-12 to 80.55 *per cent* in 2019-20, which indicates inefficient operational performance of DMRC.

(Para 5.2.4)

- DMRC did not keep the provision for additional land areas required for implementation of complete Multi Modal Integration. Non-implementation of all the components of Multi Modal Integration at metro stations resulted in denial of seamless interchange between various modes of transport to the daily commuters, non-availability of safe pedestrian crossing facilities near metro stations, absence of traffic calming measures, improved access and last mile connectivity, safety, improved short term parking and drop off facilities, Non- Motorised Vehicle lanes, bus shelters, public toilets etc.

(Para 5.2.5)

- As against consolidated targeted earning of ₹2,505 crore (from Phase-II & Phase-III) from Property Development as per sanction letters issued by GoI, DMRC could generate only ₹657.13 crore (26.23 *per cent*) from Property Development till 31 March 2020.

(Para 5.3.1)

- DMRC constructed Property Development area of 44,751 sqm on Badarpur-Faridabad-Ballabhgarh metro corridor at a cost of ₹151.49 crore, out of which 40,071 sqm area remained idle as DMRC has not been able to lease them out till date.

(Para 5.3.2)

- For Phase-III and extensions, revenue from Property Business during 2016-17 to 2019-20 was estimated at ₹1,917.25 crore. DMRC generated only ₹76.06 crore during 2016-17 to 2019-20 from Property Business.

(Para 5.4.1)

With reference to Audit findings on Operation & Maintenance and Revenue Management, Audit recommends that:

17. ***DMRC may prepare line-wise profit and loss account and claim operation losses, if any, from respective State governments.***
18. ***DMRC may also ensure last mile connectivity for augmentation of ridership through various modes including planned feeder bus services.***
19. ***DMRC may enhance its efforts to increase operating efficiency by reducing the operating ratio and also estimate more realistic ridership for future DPRs.***
20. ***DMRC may ensure implementation of a complete Multi Modal Integration (MMI) as per extant guidelines with integrated planning of land use and various modes of transport.***
21. ***A structured and approved Property Development and Property Business manual may be formulated for ensuring uniformity and consistent decision making. DMRC may also consider preparing a road map to accomplish targeted Non-Fare Box Revenue on the basis of combined experience of Phase-I, Phase-II & Phase-III.***
22. ***There should be a member/expert with marketing skill in Board for efficient dealing with Property Development and Property Business related activities.***

CHAPTER-1
INTRODUCTION

Chapter 1
Introduction

1.1 About DMRC

Delhi Metro Rail Corporation Limited (DMRC) was registered on 03 May 1995 under the Companies Act, 1956 for the implementation and subsequent operation of the metro rail in Delhi. DMRC is a joint venture between the Government of India (GoI) and the Government of National Capital Territory of Delhi (GNCTD) with 50:50 equity participation. DMRC is under the administrative control of Ministry of Housing and Urban Affairs (MoHUA), erstwhile Ministry of Urban Development (MoUD).

1.2 Organisation Set up

The Board of Directors of DMRC consists of 13 Directors as on 31 March 2020. The Chairman of DMRC is the nominee of the GoI while the Managing Director is the nominee of the GNCTD and the Chief Executive Officer of DMRC. The Managing Director is assisted by seven functional Directors viz. Director (Project and Planning), Director (Works), Director (Finance), Director (Operations), Director (Electrical), Director (Rolling Stock) and Director (Business Development). The Board of Directors of DMRC also has four GoI nominee non-executive Directors, besides four GNCTD nominee non-executive Directors, whose post was vacant.

1.3 Need for Mass Rapid Transit System for Delhi

In view of the intra-city traffic volume in Delhi and the urgent need for a full-fledged integrated multi modal mass rapid passenger system, Delhi Government entrusted the task of conducting a feasibility study for an 'Integrated Multi Modal Mass Rapid System' to RITES[1] in 1990-1991. Accordingly, Phase-I of Delhi Metro was conceptualised (September 1996) and completed (November 2006) with 65 km of length. This was followed by Phase-II (124.93 km during 2006-2011), Phase-III (160.75 km during 2011-2019) and Phase-IV covering 103.93 km, which is under progress. The last Performance Audit of DMRC was conducted during 2007-2008 on completion of Phase-I and Performance Audit Report No 17 of 2008 was placed before the Parliament of India and the Legislative Assembly of Delhi. Under Phase-II of Mass Rapid Transit System (MRTS) project, Audit of Airport Metro Express Line was conducted in 2012-13 and reported in CAG's Audit Report No 13 of 2013. As per the Detailed Project Report (DPR) (1995) of Phase-I, the ridership was estimated as 31.85 lakh which was subsequently reduced to 22.60 lakh in 2003. As against this, the actual ridership was 6.62 lakh in November 2007 which was 21 *per cent* of the original projection and 29 *per cent* of the revised estimates. Under Phase-II, the estimated ridership of Airport Line was 42,500 against which the actual ridership was 17,794 viz., 42 *per cent* of the estimated ridership. The total ridership of entire DMRC network (Phase-I, II and III) in the year 2019-20 was estimated as 53.47 lakh. Against this, the actual ridership of DMRC was 27.79 lakh (2019-20) only i.e., 51.97 *per cent* of

[1] ***RITES Limited erstwhile Rail India Technical & Economic Service***

projected ridership. In case of Phase-III specifically, as against the projected ridership of 18.56 lakh in 2016 (20.89 lakh in 2019-20) from initially sanctioned four corridors, the actual ridership in 2019-20 was only 4.38 lakh, which is 79.02 *per cent* lower than projected ridership as per DPR. Similarly, in case of NCR/ other extension, the actual ridership on these corridors was 15.12 *per cent* to 87.63 *per cent* lower than projected ridership as per DPRs as mentioned in table 1.1 below. In this Report, Audit reviewed the performance of Delhi MRTS Phase-III.

Table 1.1

Details showing projected, actual ridership and shortfall in 2019-2020

(A) Initial Phase-III corridors

Sl. No.	Name of the corridor	Projected daily ridership as per DPR	Actual daily ridership	Percentage shortfall
1.	Jahangir Puri-Badli (Line-2 extension/ Red line)	52,081	27,600	47.01
2.	Mukundpur (Majlis Park)-Maujpur (Line-7/ Pink line)	11,44,467	1,76,876	84.55
3.	Janak Puri West-Kalindi Kunj (Line-8/ Magenta line)	6,50,188	1,71,262	73.66
4.	Central Secretariat-Kashmiri Gate (Line-6 Extension/ Violet line)	2,42,688	62,578	74.21
	Total	**20,89,424**	**4,38,316**	**79.02**

(B) NCR/ other extensions

Sl. No.	Name of corridor/ section	Projected daily ridership as per DPR	Actual daily ridership	Percentage shortfall
1.	Badarpur-Faridabad (Line-6 Extension/Violet line)	2,98,080	60,648	82.10
2.	Faridabad-Ballabhgarh (Line-6 Extension/ Violet line)	40,793		
3.	Mundka-Bahadurgarh (Line-5 Extension/Green line)	1,27,776	22,968	82.02
4.	Dwarka-Najafgarh (Line-9 Extension/ Grey line)	97,070	12,012	87.63
5.	Dilshad Garden-New Bus Adda (Ghaziabad) (Line-1 Extension/ Red line)	1,72,679	43,617	74.74
6.	Maujpur-Shiv Vihar (Line-7 Extension/ Pink line)	18,724	6,168	67.06
7.	Noida City Centre-Noida Electronic City (Line-3 Extension/ Blue line)	93,312	67,978	27.15
8.	Kalindi Kunj-Botanical Garden (Line-8 Extension/ Magenta line)	51,917	44,068	15.12

1.4 Phase-III of Mass Rapid Transit System

Phase-III of Delhi Metro was conceptualised to provide the required level of metro coverage for the size and spread of population of Delhi. The plan was to generate additional induced ridership on the existing Phase-I[2] and Phase-II[3] corridors through Phase-III corridors and also to maximise the coverage provided by the metro network as a whole. The main objective of the recommended corridors for Phase-III was to give a metro network to the commuters with smooth connectivity by providing more interchange stations for switching from one corridor to another. As per the sanction (26 September 2011) of the GoI, the initial four corridors[4] of Phase-III were approved for a length of 103.05 km (sanctioned cost ₹35,242 crore which was further extended to 160.76 km with sanctioned cost of ₹48,565.12 crore) after sanctioning of nine more sections/ corridors by the GoI. Against this, DMRC constructed 160.75 km (107.27 elevated and 53.48 km underground section) metro lines during Phase-III as detailed below:

Table 1.2
Corridors of Phase-III of Delhi MRTS project

Sl. No.	Corridor	Date of sanction	Length as per sanction letter (in km)	Sanctioned cost (₹ in crore) Including DVAT	Actual expenditure as on 31.03.2020 (₹ in crore)
1	Central Secretariat to Kashmiri Gate (Line-6 Extension)*	26.09.2011	9.37	36,702@	38,836.90
2	Jahangir Puri to Badli (Line-2 Extension)*		4.49		
3	Mukundpur (Majlis Park) to Maujpur (Line-7)*		55.69		
4	Janak Puri West to Kalindi Kunj (Line-8)*		33.49		
5	Badarpur-Faridabad Extension (Line-6)	13.09.2011	13.88	2,494	
6.	Maujpur to Shiv Vihar (Line-7 Extension)	11.09.2012	2.72	302.78#	
7	Kalindi Kunj-Botanical Garden (Line-8 Extension)	20.12.2017	3.96	997	
8	Dwarka-Najafgarh (Line-9)	11.09.2012	5.5	1,099.61	1,053.32
9	Mundka-Bahadurgarh	11.09.2012	11.18	2,076.52	1,778.36
10	Escorts Mujesar (Faridabad)-Ballabhgarh	27.03.2017	3.21	580.00	444.60
11	Najafgarh to Dhansa Bus Stand Extension	09.05.2017	1.18	565.00	472.01

[2] ***Phase-I comprising of three corridors (Line-1, Line-2 and Line-3) having 65 km length***
[3] ***Phase-II (125 km) comprising of three new corridors (Line-5, Line-6, Airport Line) and seven extensions of existing lines***
[4] ***Comprising of two new corridors i.e., Line-7 and Line-8 and two extensions of existing lines i.e., Line-2 extension and Line-6 extension***

Sl. No.	Corridor	Date of sanction	Length as per sanction letter (in km)	Sanctioned cost (₹ in crore) Including DVAT	Actual expenditure as on 31.03.2020 (₹ in crore)
12	Noida City Centre-Noida Sector 62	15.06.2018	6.68	1,967.00	1,489.66
13	Dilshad Garden-New Bus Adda, Ghaziabad	14.02.2019	9.41	1,781.21	1,394.03
Total			**160.76**	**48,565.12**	**45,468.89**

Initially sanctioned Phase-III corridors having length of 103.05 km
@ It includes ₹1,460 crore towards State taxes as per sanction letter 26 September 2011 issued by GoI
 # It includes ₹21 crore towards State taxes as per sanction letter 11 September 2012 issued by GoI

1.5 Agency wise funds sanctioned for Phase-III (including NCR extension)

The details of total funds sanctioned of ₹48,565.12 crore and details of total expenditure incurred of ₹45,468.89 crore for Phase-III are depicted below:

Table 1.3
Funds allocated and expenditure incurred of Phase-III as on 31 March 2020

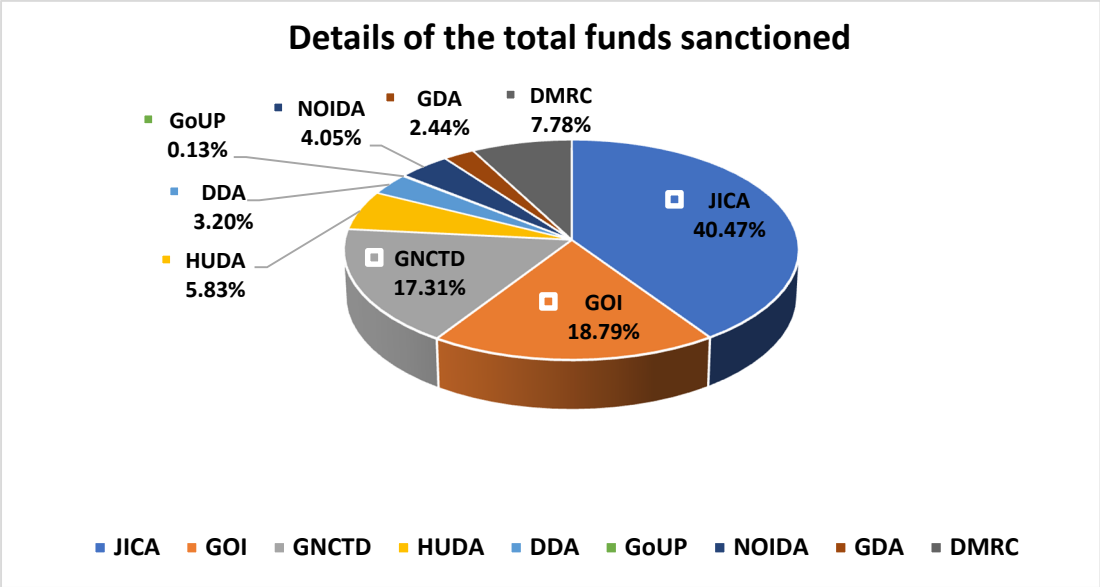
(₹ in crore)

Sl. No.	Source of fund	Total funds sanctioned*	Total funds received	Expenditure incurred
1	JICA[5] loan (through GoI)	19,656.00	19,556.32	18,593.82
2	GoI	9,123.57	9,123.57	8,883.68
3	GNCTD	8,407.38	8,407.38	8,830.39
4	Haryana Urban Development Authority (HUDA)	2,830.16	2,830.16	2,704.76
5	Delhi Development Authority (DDA)	1,554.00	1,554.00	1,554.00
6	Government of Uttar Pradesh (GoUP)	63.27	0.00	63.27
7	NOIDA	1,966.40	1,741.80	1,719.92
8	Ghaziabad Development Authority (GDA)	1,184.34	1,033.36	1,122.05
9	DMRC	3,780.00	544.51	1,997.00^
Total		**48,565.12**	**44,791.10**	**45,468.89**

(*) Share of sanctioned cost as approved by GoI
(^) The excess expenditure against the funds received till 31 March 2020 has been met out of the temporary funds from operation and maintenance etc.

[5] *Japan International Cooperation Agency*

Chart 1.1



1.6 Audit objectives

Performance Audit on implementation of Phase-III of Delhi Metro was conducted between November 2018 to March 2020. The objectives of Audit were to verify whether:

(i) Effective planning was done to ensure economic viability and selection of the most appropriate technologies;

(ii) Implementation in terms of project execution and contract management was done with due care, economy, and in a timely and transparent manner;

(iii) An adequate mechanism was in existence to monitor the project, to ensure timely completion and conformity of works executed with laid down specifications; and

(iv) Operation and maintenance of this phase was efficient, and the planned benefits were achieved after commercial operation of Phase-III.

1.7 Scope of Audit

The Performance Audit covered planning, implementation, monitoring and operations and maintenance of completed corridors and outcome of the activities of Phase-III projects for the period since its commencement from April 2011 to March 2020.

1.8 Audit criteria

The criteria to assess the performance of DMRC were derived from the following sources:

i. Agenda and Minutes of meetings of the Board of Directors and other sub committees;

ii. Schedule of Powers;

iii. Detailed Project Reports;
iv. Applicable General Financial Rules;
v. Guidelines issued by the Central Vigilance Commission;
vi. Directions and guidelines issued by the Administrative Ministry;
vii. Policies, standards, directives and guidelines of the DMRC;
viii. Annual Reports of the DMRC, and of the Administrative Ministry;
ix. General Conditions of Contracts and Special Conditions of Contracts;
x. National Urban Transport Policy, 2006; and
xi. Annual Sankalp Reports issued by DMRC.

1.9 Audit methodology

Audit methodology included review and examination of the agenda and minutes of the meetings of the Board, Empowered Committee[6] and Empowered Group of Ministers and below Board level Sub-committees. Questionnaire, audit enquiries and audit requisitions were also issued to DMRC for clarification, information, and records. Other methods adopted include interaction with DMRC officials, physical inspection of project sites, and photographic evidence collection.

Indian Institute of Technology, Delhi (IIT Delhi) was appointed as Technical Consultant on 26 September 2019 to review the technical aspects of civil works, signalling and telecom, rolling stock, heating, ventilation and air conditioning and electrical works executed by DMRC during implementation of Phase-III. Their observations and suggestions have been suitably incorporated in this report.

1.10 Sample selection

A total of 93 contracts were selected using stratified random sampling methodology. The details of the selected contracts are given in **Annexure-I**. The Audit coverage in terms of number of contracts was 36 *per cent*[7] and was 53 *per cent*[8] in terms of monetary value of the Phase-III project. Besides, four more related contracts[9] were also selected and audited. The contracts CS[10]-03 and CC[11]-11 were related to the selected contract. However, for better understanding two more contracts, CC-86 R and CC-95 were audited during the Performance Audit.

---

6 ***Empowered Committee is headed by Cabinet Secretary, the other members are Secretary, MoHUA, Secretary, Ministry of Finance, Secretary, Ministry of Road Transport and Highways (MoRTH), Secretary, Ministry of Environment, Forest and Climate Change (MoEF and CC), Member Secretary, Planning Commission, Member, Railway Board, Chief Secretary, GNCTD and Managing Director, DMRC***

7 ***93 contracts out of 259 contracts above ₹5 crore***

8 ***₹25,616 crore out of ₹48,565.12 crore***

9 ***CS-03, CC-11, CC-86 R and CC-95***

10 ***CS represents contract related to signaling work of phase-III***

11 ***CC represents contract related to civil construction of phase-III***

1.11 Audit process

The draft Audit Report was issued to DMRC in two stages, one with Financial and general observations (15 May 2020) and another with technical observations (23 July 2020); responses to which were received from DMRC in July 2020 and August 2020, respectively. Responses of DMRC to the draft report have been duly considered and relevant portions incorporated in this report as appropriate.

The Entry Conference before commencement of Performance Audit with DMRC was held on 12 November 2018. An Exit Conference with DMRC was held on 27/ 28 July 2020 to discuss the financial and general observations. This was followed by an Exit Conference on 18 September 2020 to discuss the technical observations. The draft Audit Report was issued to the Ministry/ GNCTD with a copy to DMRC on 2 November 2020 followed by an Exit Conference with Secretary, MoHUA on 11 January 2021 wherein it was suggested by Secretary, MoHUA that one more opportunity may be provided to DMRC to provide responses to some audit observations which the Ministry considered to be technically justified. Accordingly, a follow up Exit Conference was held with DMRC on 18 January 2021. The views expressed during the Exit Conferences along with MoHUA's reply (01 January 2021) and GNCTD's reply (29 January 2021) have also been duly considered while finalising the report.

1.12 Structure of the Report

Chapter 1 of the Report gives the background information of DMRC, the need for MRTS project, audit objectives, scope of audit, audit criteria, audit methodology, sample selection etc. Audit findings have been broadly categorised into four chapters aligning with four audit objectives.

Chapter 2 on Policy, Planning & Selection of Technology contains audit findings on the first audit objective and brings out inefficiencies in planning, which adversely affected economic viability and selection of appropriate technology. The audit findings include non-compliance of funding pattern prescribed in the National Urban Transport Policy, inconsistencies in computation of Financial Internal Rate of Return and traffic estimation to make the corridors viable, infirmities in formulation of DPRs including preparation of DPRs in contravention of Working Group on Urban Transport recommendations, non-approval of revised DPRs by the Board of Directors, execution of unviable corridors, violation of General Financial Rules, introduction of Unattended Train Operation without cost benefit analysis, deficiencies in Rolling Stock and rails, deficiencies in Communication Based Train Control system, and installation of transformer of higher capacity.

In Chapter 3 on Contract and Project Management, audit findings on the second audit objective are addressed which indicate deficiencies in project execution and contract management. Deficiencies include appointment of General Consultant on nomination basis, grant of special advance beyond the contractual provisions, delay in execution of Trilok Puri section affecting smooth connectivity on Line-7, flawed design of Hauz

Khas metro station, construction of two metro stations without the approval of GoI and GNCTD, and non-compliance to environmental requirements.

Chapter 4 on Project Monitoring addresses the third audit objective and highlights inadequacies in the mechanism for project monitoring. Audit findings under this chapter includes significant delay in completion of various corridors of Phase-III of MRTS, poor quality of civil structure, lack of uniform project Quality Management Plan, absence of real time monitoring, capacity control, and energy saving strategies, lack of real time monitoring of heating ventilation & air conditioning and absence of automatic monitoring of the health of rails.

Chapter 5 on Operation & Maintenance and Revenue Management contains audit findings on the fourth audit objective and highlights deficiencies in operation and maintenance leading to shortfall in achievement of planned benefits after commercial operation. These include DMRC's failure to accomplish the projected ridership with only 21 *per cent* of the total projected ridership of initial Phase-III corridors being actually achieved in 2019-20, non-compilation of line-wise operational profit/ loss, sub-optimal performance of DMRC in providing last mile connectivity services, inefficient operational performance of DMRC with increasing operating ratio, and non-implementation of all components of Multi Modal Integration.

The overall conclusion of the Report based on the major audit findings on the four audit objectives is brought out in Chapter 6. Audit recommendations on the key audit findings have also been included for each audit objective.

1.13 Acknowledgement

The assistance provided by the Technical Consultant (IIT Delhi) and cooperation extended by DMRC, MoHUA, GNCTD during the conduct of this audit is appreciated and acknowledged.

CHAPTER-2
POLICY, PLANNING AND SELECTION OF TECHNOLOGY


DELHI
METRO
दिल्ली
मेट्रो

Chapter-2
Policy, Planning and Selection of Technology

2.1 Policy Framework

Policy is a deliberate system of principles to guide decisions and achieve rational outcomes. A policy is a statement of intent and is implemented as a procedure or protocol. Policies can assist in both subjective and objective decision making. Policies usually assist senior management with decisions that must be based on the relative merits of a number of factors and as a result are often hard to test objectively.

Government of India approved (April 2006), the National Urban Transport Policy which *inter-alia,* seeks to promote integrated land use and transport planning, greater use of public transport, non-motorised modes of travel, and use of cleaner technologies. It offers Central Government's financial support for investments in public transport; infrastructure for greater use of non-motorised modes; construction of parking facilities, including demonstrative pilot projects. Accordingly, a common set of guidelines for preparation as well as appraisal of DPR for Mass Transit proposals was circulated (November 2006) to Heads of Metro Corporations across the country by the Ministry of Urban Development (MoUD).

As per sanction letters issued by GoI for Phase-III MRTS Project, equity was to be contributed 50:50 by GoI and GNCTD for corridors within Delhi. For acquisition of land in Delhi and bearing of central taxes, subordinate debt was provided by GoI and GNCTD. Besides, 4.5 *per cent* of project cost was to be funded by earning revenue from property development and about 40 *per cent* of project cost was to be financed through principal loan from the Japan International Cooperation Agency (JICA) at concessional rates by GoI and the same has been transferred to DMRC as Pass Through Assistance[12].

For corridors outside Delhi in the NCR, the entire project cost (except Rolling Stock, which are to be procured by DMRC through its internal accruals) is funded by the respective State Government and the GoI in 80:20 ratio. In the NCR, land is provided free of cost while for bearing of state taxes, subordinate debt is provided by the respective State Governments. Further, there is no funding from loan in NCR extension projects.

Audit reviewed the approval of the initial Phase-III projects having four corridors and nine extension corridor to assess whether effective planning was in place and observed deficiencies as brought out in the following paras.

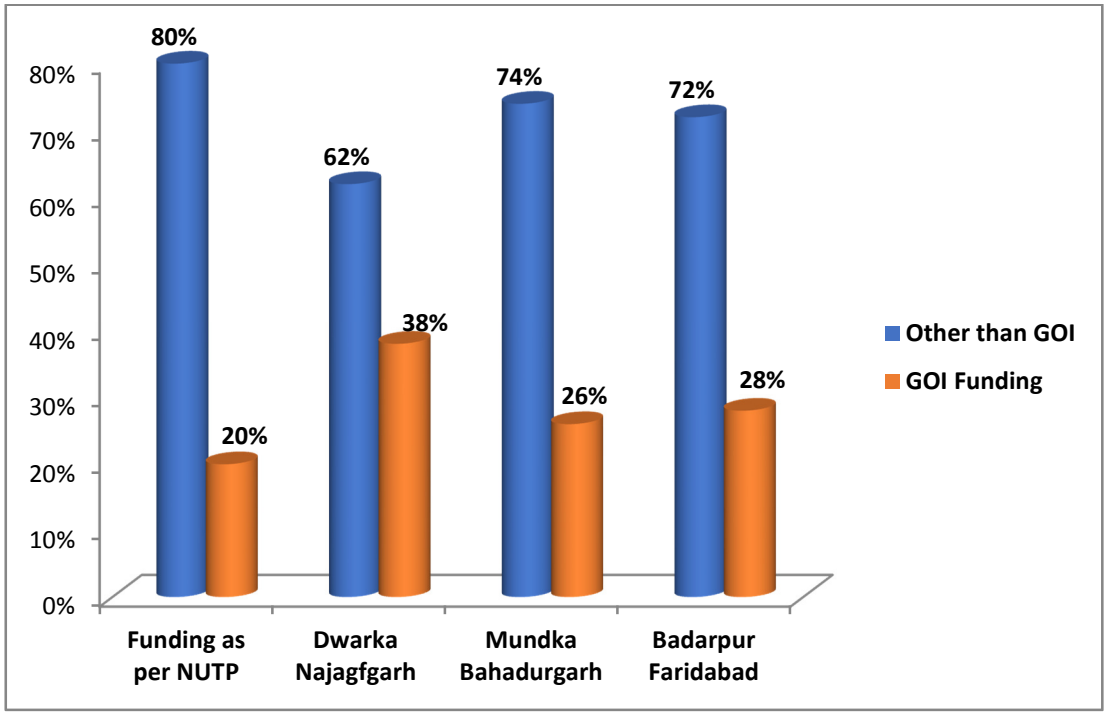
[12] ***Pass Through Assistance is a mechanism through which the GoI obtains loan from JICA in Japanese Yen (JPY) and passes it to DMRC in rupee terms.***

2.1.1 Funding pattern in the DPRs of Phase-III were not in accordance with provisions of National Urban Transport Policy 2006

National Urban Transport Policy stipulated that in the metro rail projects being set up through the mechanism of Special Purpose Vehicle, the Central Government would offer financial support either in the form of equity or one time Viability Gap Funding (VGF) subject to a ceiling of 20 *per cent* of the capital cost of the project (including equity, subordinate debt and grant etc.,) excluding the cost of land and Rehabilitation and Resettlement. DMRC formulated DPRs for Phase-III corridors and extension of metro to NCR towns. The sanction orders issued by the GoI revealed that funding pattern projected in the DPRs of Dwarka-Najafgarh, Mundka-Bahadurgarh and Badarpur-Faridabad corridors were 18 *per cent*, 6 *per cent* and 8 *per cent* in excess over the prescribed ceiling of 20 *per cent* of the project cost. This resulted in excess contribution by GoI amounting to ₹165.92 crore, ₹98.82 crore and ₹156.6 crore for Dwarka-Najafgarh, Mundka-Bahadurgarh and Badarpur-Faridabad corridors, respectively.

Thus, DMRC's funding plan in the DPR was in contravention of National Urban Transport Policy, 2006.

Chart 2.1
Funding pattern in deviation of National Urban Transport Policy



The Ministry/ DMRC in the Exit Conference (11 January 2021) has agreed to implement the funding pattern as per National Urban Transport Policy 2006.

2.1.2 Inconsistency in Financial Internal Rate of Return criteria for approval of corridors

In August 2013, the MoUD instructed that Financial Internal Rate of Return[13] of investment in MRTS projects should preferably be eight *per cent* or more for consideration by the GoI. Prior to this circular (August 2013), there was no minimum criteria of Financial Internal Rate of Return for approval. Accordingly, the MoUD instructed for modification of all DPRs prepared after August 2013 to comply with the criteria of eight *per cent* of Financial Internal Rate of Return.

In compliance, DPRs of (i) Dilshad Garden to Ghaziabad, New Bus Adda, (ii) Noida City Centre to Noida Sec-62, (iii) Kalindi Kunj to Botanical Garden, (iv) YMCA Chowk to Ballabhgarh corridors were revised (up to October/ December[14] 2014) and higher Financial Internal Rate of Returns of 12.23 *per cent*, 8.63 *per cent*, 9.85 *per cent* and 11.01 *per cent* were computed as against the earlier Financial Internal Rate of Return of 4.02 *per cent*, 2.03 *per cent*, 1.11 *per cent* and 4.50 *per cent*, respectively.

In this regard, Audit observed that:

(i) Financial Internal Rate of Return of all the corridors/ sections sanctioned before August 2013 were in the range of 0.08 *per cent* to 6.06 *per cent* except Shiv Vihar and Badarpur-Faridabad extensions which had negative return of ₹755 crore and ₹798 crore, respectively, over the horizon period of 30 years.

(ii) In pre-revised DPRs[15], 15 fare slabs from ₹10 to ₹44 (with a difference of ₹1 to ₹3) were considered while in the revised DPRs, 7 fare slabs from ₹10 to ₹60 (in multiples of ₹10) were considered. For instance, in the pre revised DPRs, fare slabs of ₹19 to ₹24 for the distance of 6 km to 12 km were considered, whereas, in the revised DPRs for the same distance, fare of ₹30 was considered. Consequently, Fare Box Revenue[16] has increased from ₹9,443 crore to ₹19,928 crore (111 *per cent* increase), ₹5,327 crore to ₹12,624 crore (137 *per cent* increase) and ₹2,573 crore to ₹7,066 crore (175 *per cent* increase) in Dilshad Garden to Ghaziabad, Noida City Centre to Noida Sector-62, and Kalindi Kunj to Botanical Garden, respectively. In case of pre revised DPR (January 2013) of Faridabad to Ballabhgarh section, 15 fare slabs in range of ₹11 to ₹40 with escalation factor @ 7.5 per cent for every two year was considered. However, while revising the DPR (December 2014), 15 fare slabs in range of ₹14 to ₹52 with escalation factor @ 15 per cent for every two year was considered resulting in increase in Fare Box Revenue from ₹2,578 crore to ₹6,559 crore (154 *per cent* increase).

(iii) DMRC prepared (December 2014) the feasibility report of Najafgarh-Dhansa Bus Stand but did not revise the Financial Internal Rate of Return of 3.4 *per cent* which was lower than benchmark of eight *per cent* and still recommended it as a viable

---

[13] ***An indicator to measure the financial return on investment of an income generation project and is used to make the investment decision***

[14] ***YMCA Chowk (Faridabad) to Ballabhgarh***

[15] ***Dilshad Garden to Ghaziabad, Noida City Centre to Noida Sector-62, and Kalindi Kunj to Botanical Garden***

[16] ***Fare Box Revenue is the revenue collected from passengers through sale of tokens and smart cards***

corridor. Financial Internal Rate of Return was calculated after considering 15 *per cent* escalation after every two years on fare slab as recommended by Third Fare Fixation Committee. The Fourth Fare Fixation Committee in its Report (September 2016) had suggested to DMRC that if no Return on Investment is to be considered, the repayment of loan is to be taken into account for considering the viability of the project. Audit also noticed that the effective rate of interest (after considering foreign exchange fluctuation risk) of JICA loan was 5.20 *per cent*. Hence, considering lower Financial Internal Rate of Return of 3.4 *per cent* than effective rate of interest of 5.20 *per cent* was unjustifiable.

(iv) Resultantly, Financial Internal Rate of Return of five corridors[17] sanctioned from August 2013 to February 2019 were in the range of 8.63 *per cent* to 12.23 *per cent* except Najafgarh-Dhansa Bus Stand (3.4 *per cent*) as detailed in **Annexure-II**.

Thus, out of the 13 corridors proposed for Phase-III, DMRC recommended two financially unviable corridors[18] with negative Financial Internal Rate of Return and one corridor i.e., Najafgarh-Dhansa Bus Stand extension was approved with Financial Internal Rate of Return less than the benchmark of eight *per cent.* In four corridors[19] Financial Internal Rate of Return was enhanced considering inflated Fare Box Revenue to meet out the benchmark of eight *per cent*.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that:

- The Group of Ministers had directed (August 2011) for the Shiv Vihar extension. Accordingly, the proposal was prepared and submitted to the Government despite low ridership.
- The fare slabs with 15 slabs recommended by the Third Fare Fixation Committee were mostly in odd figures and created a lot of problems in tendering change to the passengers at the stations. Accordingly, the new fare structure with seven slabs was included in the revised DPRs.
- GoI realised that achieving the Financial Internal Rate of Return of eight *per cent* is normally difficult and subsequently dispensed with the requirement of Financial Internal Rate of Return and switched over to Economic Internal Rate of Return[20] in the Metro Policy, 2017. DMRC agreed with Audit that lending interest rate including exchange fluctuation should have been quoted for such comparison. However, in this case, loan amount was only 38.32 *per cent* with the balance as equity and subordinate debt. Therefore, the Financial Internal Rate of Return of 3.4 *per cent* on the project cost established its viability even up to the interest rate of 8.87 *per cent* on the loan component.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as approving of DPRs with negative and low Financial Internal Rate of Return would lead to operational loss

---

[17] ***Corridors mentioned at Sl. no. 9 to 13 in Annexure-II***

[18] ***Maujpur-Shiv Vihar and Badarpur-Faridabad***

[19] ***Dilshad Garden to Ghaziabad, Noida City Centre to Noida Sector-62, Kalindi Kunj to Botanical Garden and Faridabad to Ballabhgarh***

[20] ***Economic Internal Rate of Return is the discount rate at which discounted net benefits (Revenue-Cost) equals to zero. It quantifies the financial and non-financial benefits from the investments.***

for DMRC and extra burden on the Government exchequer/ taxpayer's money. The rate of return should be compared with weighted average cost of capital i.e., borrowed fund and equity. DMRC should have prepared DPR with realistic and objective assumptions for computation of Financial Internal Rate of Return based on the fare existing at the time of preparation of DPR with prevailing escalation. Reply of DMRC regarding inclusion of new fare structure with seven slabs in the revised DPRs (October 2014) is not tenable as in case of revised DPR for YMCA Chowk to Ballabhgarh (December 2014), DMRC continued to consider 15 slabs. Besides, Audit also noticed that currently 70 *per cent* (approximately) of commuters use smart cards, where the need for tendering of change is largely minimised.

2.1.3 Non-formulation of various policies by DMRC

Policies are standing plans that provide guidelines for decision making. It establishes the boundaries or limits within which decisions are to be made. Various policies/ procedures/ practices adopted by DMRC in preparation of cost estimates, taking decisions on selection and modification of routes, distance between inter change stations etc., have been reviewed by Audit along with the Technical Consultant (IIT Delhi) and the following is observed:

(i) There is no protocol in DMRC for estimating the cost of an upcoming project in a scientific manner. Rather, DMRC uses the concept of derivation of cost estimate based on 'similar project'. Also, the coefficients in the Price Variation Clause formulas are applied uniformly across all types of projects irrespective of whether they are at grade, underground, or elevated.

DMRC while accepting the observation stated that in the Phase-IV contracts, estimates are being prepared by enhancing the Last Accepted Rates based on Price Variation Clause formulas available in the contracts.

(ii) There is no approved policy on the selection of type of corridor i.e., elevated, at grade or underground.

DMRC responded that type of alignment is decided based on the Right of Way of the road, traffic on the road and other factors like Archaeological Survey of India monuments in the area, localities wherein the corridor passes through etc.

DMRC needs to formulate a policy document on the selection of type of corridor and should also clearly indicate the circumstances under which deviations are allowed.

(iii) There is no approved policy of permissible ground water lowering[21] while constructing underground structures in the absence of which decisions are going to be subjective and may not always result in optimal solution.

---

[21] ***Permissible ground water: Normally underground construction below groundwater table will face certain problems. To facilitate the construction, DMRC allows to do the lowering of water table by dewatering systems at a locality based on assessment. This temporary lowering is known as "permissible ground water lowering". But lowering should not disturb the ecosystem and habitat of the area.***

DMRC did not provide specific reply to the point.

(iv) There is no approved policy for providing interchange between two stations and mode of interchange facility. For instance, Dhaula Kuan-Durga Bai Deshmukh South Campus interchange (1.2 km length) was constructed with additional expenditure of ₹73.17 crore over DPR provision of ₹5.25 crore which indicates poor planning and absence of an approved policy in this regard.

DMRC replied that as per the DPR, Dhaula Kuan station was planned at an isolated location with no habitation nearby. Therefore, the station was shifted towards a location with many colleges and residential areas, which resulted in increase in the length of interchange. However, it was not clear under which premise/ assumption the station was planned in a forest area in the DPR in the first place.

2.1.4 Formulation of Detailed Project Reports of Phase-III corridors

Audit reviewed the DPR of the initial Phase-III project of four corridors and DPRs for nine NCR/ other extensions executed during Phase-III, and observed the following deficiencies:

2.1.4.1 Gross infirmities and adoption of different assumptions in the formulation of DPRs

The MoUD issued (01 November 2006) guidelines[22] for preparation of DPR for Integrated Mass Transit System Development Plan. In this regard, Audit observed that:

(i) As per the guidelines, a Comprehensive Mobility Plan[23] is a prerequisite for planning metro rail in any city. A chapter on Comprehensive Mobility Plan highlighting developing an integrated plan was to be included in the DPRs. However, no chapter on Comprehensive Mobility Plan highlighting developing an integrated plan was included in the Phase-III DPR formulated by DMRC. Resultantly, integrated planning with respect to land use and transport, integration of various modes (fares, routes, and facilities) and institutional framework for coordination was not ensured by DMRC.

(ii) Cost and benefit analysis of the adopted technologies was not conducted and incorporated in the DPRs by DMRC during Phase-III of MRTS project, although this was a requirement under Para 4.3 'Alternative Analysis' of the above guidelines.

(iii) Delhi Metro Master Plan was prepared by DMRC for guidance in planning the expansion of the network and the DPR. However, this was not approved by the Board of Directors or Managing Director of DMRC.

---

[22] ***The guidelines inter-alia stipulates that based on the plan outline, projects are to be detailed out, conceptually designed, costs worked out, financial and economic feasibility examined and environmental and social impacts analysed and mitigation measures planned. This would include overall funding plan, including risk analysis.***

[23] ***"Comprehensive Mobility Plan" is a plan for improvement and promotion of public transport, non motorised vehicles and pedestrians. It also provides a recognised and effective platform for integrating land use and transport planning.***

(iv) Guidelines/ instructions/ Standard Operating Procedures were not formulated by DMRC for preparation of the DPRs.

(v) Detailed Project Reports were prepared on different assumptions **(Annexure III A & B)**. Replacement cost (after 20 years) of Signalling and Telecom equipment considered in the DPRs **(Annexure-III A)** ranged from 10 *per cent* to 50 *per cent*. Similarly, replacement cost of electrical equipment ranged from 10 *per cent* to 25 *per cent*. Besides, escalation factors of 5 *per cent* and 7.5 *per cent* were considered for calculating Operation & Maintenance cost. No justification was given for the different assumptions in various DPRs. While estimating Fare Box Revenue, DMRC did not consider 10 *per cent* discount on every journey made through contactless smart card, resulting into higher projection of Fare Box Revenue by 7 *per cent.*

(vi) The revised DPRs[24] were not approved by the Board of Directors. Since the original DPRs were approved by Board of Directors, it is imperative that revised DPRs are also got approved by Board of Directors.

Thus, DPRs prepared by DMRC were not in conformity with Guidelines (2006) of MoUD for preparation of DPR and in the absence of any internal guidelines/ Standard Operating Procedures of DMRC for preparation of DPRs, DPRs were prepared on different assumptions.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the corridors recommended for metro in the DPR were as suggested in the Comprehensive Transport and Traffic Study Report prepared by RITES. Hence, no chapter on Comprehensive Mobility Plan was incorporated in the DPRs. DMRC claimed that cost benefit analysis of the adopted technology and the implementation Plan of Phase-III corridors were incorporated in the Project Viability chapter in the DPR. It stated that Delhi Metro Master Plan is not an approved document by the Board of Directors or Managing Director, DMRC, but only a guideline for planning future metro network. It is further replied that the sanction of Phase-III including its various extensions to NCR was not done in one go. While original project of Phase-III of Delhi MRTS project was sanctioned on 26 September 2011, its extensions to NCR were sanctioned subsequently on different dates. The concerned State Government and not DMRC has to approve the DPR, and the discount of 10 *per cent* does not change the Fare Box Revenue significantly.

The reply of the Ministry/ GNCTD/ DMRC is not tenable because Comprehensive Mobility Plan chapter in DPR was meant for integrated planning and not for recommendation of corridors. While the Viability Chapter of DPR highlights the estimated cost of the project, revenue projections for computation of Financial Internal Rate of Return, Economic Internal Rate of Return etc., it does not have any information of cost benefit analysis of adopted technology[25]. Since Delhi Metro Master Plan is a guideline for planning future metro network, it has to be approved by the Managing

---

[24] ***i)Dilshad Garden to Ghaziabad, New Bus Adda, (ii) Noida City Centre to Noida Sec-62, (iii) Kalindi Kunj metro to Botanical Garden, (iv) YMCA Chowk to Ballabhgarh***

[25] ***Like Communication Based Train Control, Platform Screen Door, Unattended Train Operation etc.***

Director or Board for efficient and effective implementation. As all the DPRs mentioned in the **Annexure-III (A & B)** pertained to Phase-III of Delhi MRTS, uniform and consistent assumptions should have been followed in their preparation which should be based on some policy, guidelines, or Standard Operating Procedure.

2.1.4.2 Preparation of Detailed Project Reports in contravention of Working Group on Urban Transport guidelines

The Planning Commission had constituted (18 May 2011) a Working Group on Urban Transport under the Chairmanship of then Managing Director, DMRC to make recommendations on urban transport for the 12th Five Year Plan. Terms of reference include determination of broad norms for selecting the different mode of transport in Indian cities. The recommendations (September 2011) specified the eligibility guidelines for the choice of different mode of transport, which is as follows:

For Metro Rail:

(a) Peak Hour Peak Direction Traffic [26] in 2021 should be >= 15,000 for at least 5 km continuous length;

(b) Population as per 2011 census should be >=2 million

For Bus Rapid Transit System:

(a) Peak Hour Peak Direction Traffic in 2021 should between 4,000 to 20,000

(b) Population as per 2011 census should be > 1 million

Further, as per the RITES traffic study (October 2010), for Peak Hour Peak Direction Traffic up to 20,000 (in 2021), Bus Rapid Transit System and for Peak Hour Peak Direction Traffic up to 30,000 (2031), Light metro can be proposed.

In this regard, Audit observed that:

(i) In case of Dwarka-Najafgarh corridor, Peak Hour Peak Direction Traffic of 5,780 and 10,373 in the year 2021 was assessed by RITES (October 2010) and DPR (March 2009), respectively. Further, as per 2011 census, the population of Najafgarh was 13.65 lakh. However, the proposal for Bus Rapid Transit System/ Light metro was not explored before sending the DPR to the MoUD/ GNCTD for approval.

(ii) In case of Mundka-Bahadurgarh corridor, average Peak Hour Peak Direction Traffic of entire section during the year 2021 was estimated as 6,817. As per 2011 census, the population of Bahadurgarh was 1.78 lakh. However, the proposal of Light metro/ Bus Rapid Transit was not explored before sending the DPR to MoUD/ Government of Haryana for approval.

(iii) In case of Maujpur-Shiv Vihar extension, Peak Hour Peak Direction Traffic at Shiv Vihar and Gokulpuri was only 1,805 and 3,935, respectively, in the year 2021 and the population was 63,752 only[27]. Hence, this stretch did not qualify for any mode of

[26] ***means the number of passenger trip in one peak hour***
[27] ***As per RITES traffic study report October 2010 of Shiv Vihar***

transport according to the recommendations of the Working Group on Urban Transport guidelines.

(iv) Thus, DPR of above corridors prepared[28] and submitted (after September 2011) by DMRC to the Ministry did not meet the eligibility criteria for choice of different modes of transport, recommended by the Working Group on Urban Transport and RITES Traffic Study. Further, based on projected Peak Hour Peak Direction Traffic, other modes of transport like Light Metro/ Bus Rapid Transit were not explored. While the sanctioned cost of Dwarka-Najafgarh, Mundka-Bahadurgarh and Shiv Vihar extension were ₹1,070 crore, ₹1,991.61 crore and ₹437.85 crore, respectively, DMRC did not furnish line/ corridor wise actual expenditure. As per DPR of Phase-IV MRTS Project, capital expenditure for construction of 1 km Heavy Metro, Light metro and Bus Rapid Transit are ₹250 crore, ₹175 crore and ₹20 crore respectively. Similarly, annual operation & maintenance expenditure for operating Heavy Metro, Light Metro and Bus Rapid Transit will also be in descending order.

Thus, DPRs prepared by DMRC were in contravention of guidelines of Working Group on Urban Transport and RITES study regarding selection of mode of transport on the basis of Peak Hour Peak Direction Traffic and the population criteria. This has resulted in infusing high capital into the projects and consequent higher operation and maintenance cost.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the recommendations of the Working Group on Urban Transport are only for guidance and were applicable for selection of mode of urban transport for a city as a whole. The recommendations of a mode are to be made after considering techno-economic factor. Detailed Project Reports were prepared as per directives of the respective State Governments in-spite of low ridership and not in line with the recommendations of Working Group on Urban Transport. Light Metro is the same as Medium or Heavy Metro but with reduced train length i.e., four coaches or three coaches instead of eight/ six coaches. Bus Rapid Transit system can carry maximum Peak Hour Peak Direction Traffic of only up to 6,000 to 8,000 while for Mundka-Bahadurgarh, the projected Peak Hour Peak Direction Traffic was 9,883 in 2016 and 21,168 in 2026. DMRC also claimed that the Bus Rapid Transit could be sufficient for a few years but cannot be relied upon for seamless connectivity.

The reply of DMRC is not tenable as the Working Group on Urban Transport guidelines did not specify a single mode of urban transport for an entire city. Further, without conducting the techno-economic evaluation of other modes of transport like Light metro/ Bus Rapid Transit System, which have comparatively low cost, DMRC concluded that heavy metro was the most suitable option despite the low Peak Hour Peak Direction Traffic on these corridors. In case of Mundka-Bahadurgarh section, the projected Peak Hour Peak Direction Traffic of 21,168 in 2026 is only for 1 km stretch

[28] ***DPR prepared for Dwarka-Najafgarh in March 2009 and Mundka-Bahadurgarh in April 2012. The same were sent to Ministry for approval in October 2011 and April 2012, respectively***

and reduces to 1,673 at the last station. However, the actual Peak Hour Peak Direction Traffic of the entire section in December 2019 was only 2,558. There is also a huge difference between MRTS and Bus Rapid Transit System in terms of capital cost. The differences between Light Metro and Heavy Metro are not only in terms of reduced train length but also in terms of length of platform (185 meter/ 90 meter), width of car (3.2 meter/ 2.7 meter), and length of car (22 meter/ 18 meter) etc., which may cost almost half or less than the cost of elevated metro[29]. DMRC in its 86th Board meeting (December 2011) and Empowered Committee meeting (January 2012) had also stated that a heavy metro is not really justified for this level of traffic at Dwarka-Najafgarh. Yet, DMRC designed and constructed all civil structures for Heavy Metro.

2.1.4.3 Inconsistency in traffic estimation/ data in Detailed Project Report

(i) Dwarka-Najafgarh: As per the DPR, projected daily passenger ridership of Dwarka-Najafgarh corridor was estimated as 1,01,867 (2021), while table 9.3 of the same DPR mentioned it as 61,000 (2021). Projected ridership of 61,000 was considered in 2020-21 for calculation of Financial Internal Rate of Return. Thus, there was significant inconsistency in projected ridership in the DPR, which remained unreconciled before submission to MoUD for approval. The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that traffic estimation was done by one of the best available agencies, namely, Central Road Research Institute. Further, this estimation was moderated since the projected ridership of the earlier phase did not materialise.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as no details/ methodology of moderation was mentioned in the DPR of Dwarka-Najafgarh and the same moderation was not done in any of the DPRs prepared for Phase-III corridors. All the system planning like traction system, signalling system and rolling stock system were done on the basis of 1,01,867 ridership/ 10,373 Peak Hours Peak Direction Traffic. Incidentally, the actual ridership on the section from October-December 2019 was 12,012 only i.e., 12.37 *per cent* of the projected ridership of 97,070 in 2019-20.

(ii) Najafgarh-Dhansa Bus Stand: As per the MoUD guidelines (November 2006), DPR should contain travel characteristics based on primary survey data, and present travel patterns to forecast the future travel demand. But DMRC did not conduct any traffic survey for the Najafgarh-Dhansa Bus Stand section. Feasibility Report of Najafgarh-Dhansa Bus Stand was circulated (October 2016) to NITI Aayog (erstwhile Planning Commission) and other ministries for appraisal. NITI Aayog objected that the Peak Hour Peak Direction Traffic data are not provided in the Public Investment Board note, which was in-contravention of benchmark of Metro Policy 2013. DMRC responded (October 2016) to NITI Aayog that maximum Peak Hour Peak Direction Traffic anywhere on Line-3 is to be considered for this stretch as Najafgarh-Dhansa Bus Stand is the extension of Line-3 where maximum Peak Hour Peak Direction Traffic of 50,000 is being achieved by October 2016. DMRC did not intimate NITI Aayog that

[29] ***As per DPR of Kirti Nagar-Bamnoli (Dwarka) prepared in 2019***

as per RITES study, Peak Hour Peak Direction Traffic was assessed as 2,394 while it was stated as 10,373 (2021) in the Feasibility Report.

The Ministry/ GNCTD and DMRC accepted (January 2021) that traffic survey was not conducted for Najafgarh-Dhansa Bus Stand section as the catchment area remained the same. The reply of DMRC regarding Peak Hour Peak Direction Traffic is not acceptable as it vary from station to station and is estimated only after traffic study. Further, Najafgarh-Dhansa Bus Stand is not an extension of Line-3, but a standalone corridor i.e., Line-9.

2.1.4.4 Other observations on preparation of Detailed Project Report

Audit along with the Technical Consultant (IIT Delhi) observed that the DPR of initial Phase-III (February 2011) corridors did not have information or had minimal information on the following:

- tunnel details, cut and cover method, tunnelling methods, support system, lining, excavation methods etc;
- geological and geotechnical investigations methods mentioned in the DPR are general in nature and information about rock and rock mass properties which are essential for the foundations, tunnel design, ramps, support system were not found mentioned.
- excavation methodology including selection of suitable Earth Pressure Boring Machine, Tunnel Boring Machine or mixed type of system, would depend on the strata and their mechanical properties which were missing in the DPR; and
- quick and cost-effective geophysical methods to get the strata condition depth wise along the alignment were also not mentioned.

The Ministry/ GNCTD and DMRC agreed (January 2021 and July 2020) to the suggestions for further improvements in the DPRs as stated above.

2.1.4.5 Non-consideration of Planning Commission observations

The DPR (Mundka-Bahadurgarh) was circulated (November 2011) to Planning Commission and other ministries for appraisal. The Planning Commission raised (May 2012) various observations like (a) Reconsideration of metro on this corridor on the basis of low Peak Hour Peak Direction Traffic; (b) At least 4.5 *per cent* of the cost to be recovered under Property Development; (c) Inconsistency in per capita trip rates used for Delhi and Bahadurgarh region; and (d) Dropping of last metro station at City Park due to very low level of traffic etc. In response, DMRC stated that this extension corridor is proposed on Transit Oriented Development concept that wherever metro goes, development follows.

In this regard, Audit observed that except for a residential project constructed by DMRC at NSIC Okhla station on Line-8 no other instance of metro lines based on Transit Oriented Development was noticed.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that all observations of Planning Commission were complied with and incorporated in the revised DPR submitted to GoI in April 2012.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as all the above issues persist in the revised DPR submitted in April 2012. Further, DMRC accepted that the actual traffic on this corridor has not been achieved as development along the corridor has not taken place as was envisaged.

2.1.4.6 Excess estimation of ₹138.40 crore for acquisition of private land

Detailed Project Report Phase-III provides that private land for Mass Rapid Transit System project shall be acquired by the GNCTD and compensation shall be paid as per Land Acquisition Act, 1894. The average rate of private land was computed as ₹34,500 per square meter (sqm) based on awards issued for four cases (three industrial and one commercial) during 2009-10. In this regard, Audit observed that:

i. Corridor-wise location of required land including area, land use and ownership has been mentioned in the DPR and the Social Impact Assessment study. However, DMRC had estimated the land rates for entire corridors of Phase-III based on four locations of South Delhi instead of estimating the cost of land based on land usage like residential, industrial, commercial, agricultural etc.

ii. The cost of land acquired (December 2009) at Harkesh Nagar taken for estimation purpose, included cost of structures of ₹2.09 crore also. However, the cost of the structure was not excluded by DMRC while computing the land rate of ₹34,500 per sqm. After excluding the same, the average land rate comes to ₹31,365.69 per sqm. Thus, there was higher estimation of land cost of ₹11.12 crore due to adoption of higher land rate.

iii. Detailed Project Report of Dwarka-Najafgarh (March 2009) states that private land of 5.98 hectare required for alignment, station and Property Development from chainage 4,400 meter to 5,600 meter which is an agricultural land. As per GNCTD circular (24 January 2008), the agricultural land rate applicable was ₹53 lakh per acre. However, DMRC applied (March 2009/ April 2012), the rate of ₹8.09 crore/ ₹8.21 crore per acre[30] instead of ₹53 lakh per acre in the DPR of Dwarka-Najafgarh and Mundka-Bahdurgarh (Delhi portion), respectively. This resulted in over-estimation of land cost by ₹104.48 crore for Dwarka-Najafgarh corridor and ₹22.80 crore for Mundka-Bahadurgarh. In the subsequent land award (October 2012) of Urban Extension Road II near Mundka Industrial Area Station and land award (December 2013) of Greater Kailash land (Phase-III), agricultural land rate of ₹53 lakh per acre was considered.

Thus, DMRC did not prepare cost estimation for land in the DPRs after considering actual land usage and applicable land rates. This resulted in excess estimation and sanctioning of higher funds for the corridors.

---

[30] ***₹20 crore and ₹20.29 crore per hectare (equivalent to 2.47105 acre) as mentioned in DPR of Dwarka-Najafgarh and Mundka-Bahadurgarh corridor, respectively.***

The Ministry/ GNCTD and DMRC replied (July 2020 and January 2021) that the detailed survey of location and adjacent area is being determined after approval of the project as the exact/ detailed assessment of the land requirement from all the land categories is not possible during DPR stage. Private land at Dwarka-Najafgarh corridor acquired by DMRC was under residential use and it was not possible to procure the land by offering agriculture rate.

The Ministry/ GNCTD/ DMRC acknowledged that detailed assessment based on land usage is done after approval of the project. DMRC did not provide the supporting documents relating to land usage as 'Residential' as mentioned in the reply. The reply of DMRC is silent on the land acquisition award pronounced for land near Mundka Industrial Area station and Greater Kailash station, which were based on land usage (viz. agricultural). The reply was also silent on inclusion of structure cost for estimation of land. Thus, DMRC's preparation of cost estimation of private lands was flawed leading to excess estimation of ₹138.40 crore.

2.1.4.7 Excess estimation of ₹142.11 crore of Rehabilitation and Resettlement activities

Social Impact Assessment study of initial Phase-III corridors was conducted (June 2011) by RITES on behalf of DMRC after approval of DPR by the Board of Directors.

Audit observed that as per the Social Impact Assessment study, total cost of Rehabilitation and Resettlement activities on initial Phase-III corridors (four corridors) was ₹182.51 crore on the basis of land cost of ₹34,500 per sqm and construction cost as mentioned in the DPR. However, DMRC estimated ₹324.62 crore for Rehabilitation and Resettlement including hutments and road restoration, etc., on lump sum basis which was submitted to and approved by the MoUD on 26 September 2011. DMRC's estimation for Rehabilitation and Resettlement activities in the DPR was thus higher by ₹142.11 crore than that estimated in the Social Impact Assessment study. Despite vigorous pursuance, DMRC did not provide the details of amount paid for resettlement against the estimated amount.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that in the DPR, DMRC estimated ₹324.62 crore for Rehabilitation and Resettlement including hutments and road restoration etc., on lump-sum basis whereas in Social Impact Assessment report, cost of road restoration work, and cost of Government land was not included.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as Rehabilitation and Resettlement computed in DPR was not based on any scientific method, whereas Rehabilitation and Resettlement estimates in Social Impact Assessment were calculated after considering Government guidelines relating to eligibility for rehabilitation of project affected persons and average awarded rates of private land in the past. The cost of road restoration is part of civil work and cost of the Government land was already included in the land estimation in the DPR.

2.2 Planning Process adopted for Phase-III Projects

Planning is an organisational management activity for setting priorities, distributing resources, strengthening operations, and ensuring achievement of common goals. DMRC's planning work not only covers their core work of construction and operation of metro rail services, but also consultancy services to other metro organisations in India and neighbouring countries.

DMRC has a separate Planning Department whose core activities are coordination with various departments of DMRC, liasioning with MoHUA and GNCTD, attending to Parliament questions etc. The preparation of DPRs and other studies, which are essential for planning of MRTS projects are carried out by the Consultancy Division of DMRC. The core activities in Consultancy Division are carried out by the officers/ staff of DMRC, while activities like Traffic Survey, Topographical Survey, Environmental Impact Assessment and Social Impact Analysis and Geo technical investigations are outsourced. Based on the data obtained from the studies/ surveys, DMRC prepared DPR for Phase-III and the extensions of metro to various NCR towns. The basic parameters adopted for selection of project and formulation of DPR are Delhi's high population growth rate, high economic growth rate, and the excessive pressure on the city's existing transport system. The DPRs formulated by the Consultancy Division are approved by the Board of Directors and submitted to the MoHUA and GNCTD. Ministry of Housing and Urban Affairs then forwards the DPRs to Niti Aayog (erstwhile Planning Commission) and various Ministries[31] and departments for their views, comments and remarks which are then shared with DMRC for inclusion in the DPRs. Detailed Project Reports are also revised based on guidelines and further directions of the MoHUA and GNCTD. The Planning Department is headed by Director (Project and Planning) and Consultancy Division is headed by Director (Business Development).

DMRC initiated the work of preparation of Phase-III DPR in 2008. The initial DPR was submitted to the GNCTD and the GoI in March 2010. However, based on the traffic study report submitted (October 2010) by RITES and suggestions of GNCTD, revised DPR was sent (09/ 11 February 2011) to the MoHUA and the GNCTD for approval. The implementation of metro Phase-III was approved by Board of Directors in its 83th meeting (8 March 2011) and by GNCTD on 11 April 2011. The Empowered Committee and Empowered Group of Ministers (EGoM) approved the Phase-III of Delhi MRTS project on 26 April 2011 and 09 August 2011, respectively. The sanction of the President of India was accorded (26 September 2011) for implementation of Phase-III of Delhi MRTS project with four corridors[32] of 103.05 km length at an estimated completion cost of ₹35,242 crore over a period of five years. The same was further extended to 160.76 km (sanctioned cost of ₹48,565.12 crore) after sanctioning

[31] ***Ministry of Finance, Ministry of Railways, Ministry of Home Affairs and other concerned Ministries***

[32] ***comprising of two new corridors i.e., Line-7 and Line-8 and two extensions of existing lines i.e., Line-2 extension and Line-6 extension***

of nine more sections/ corridors by the GoI. The DPRs of the nine sections/ corridors were also prepared by DMRC.

In this regard, Audit observed the following about planning aspects in DMRC.

2.2.1 Non-signing of Memorandum of Understanding for implementation of Phase-III

As per sanction letters of Phase-I and Phase-II of Delhi MRTS projects, operational loss, if any, was to be borne equally by GoI and GNCTD. However, as per the sanction letter of Phase-III, the entire operational loss was to be borne by the GNCTD and a Memorandum of Understanding (MoU) was to be signed amongst the GoI, GNCTD and DMRC to ensure effective implementation of the project and conditions of sanction. The MoU was yet to be signed (February 2021).

2.2.2 Non recovery of ₹63.27 crore due to non-signing of Memorandum of Understanding with Government of Uttar Pradesh

The Ministry of Urban Development (MoUD) sanctioned (September 2012) the Maujpur-Shiv Vihar extension. As per Paragraph 2 (c) of sanction letter, a MoU shall be signed by DMRC with Government of Uttar Pradesh (GoUP) to ensure effective implementation of the project. DMRC forwarded (March 2013) the draft MoU for approval to GoUP. DMRC also apprised (November 2018) the Chief Secretary, GoUP that it had constructed the portion in Uttar Pradesh by diverting its own funds provided for Delhi State, and that these funds were immediately required for the work execution within Delhi. However, the Special Secretary, GoUP stated (January 2019) that there was no MoU between DMRC and the Ghaziabad Development Authority (GDA) in this regard, and hence there is no rationale for releasing the fund by the GDA for this corridor. Audit observed that after completion of construction work, the section has been opened (October 2018) for public, but the approval of MoU from GoUP and release of funds was still awaited. DMRC had utilised ₹63.27 crore for construction of corridor in the Uttar Pradesh portion which were earmarked for other corridors.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that DMRC has been pursuing with the GoUP/ GDA for release of funds of ₹63.27 crore and admitted that no amount has been received till date from GoUP**.**

2.2.3 Execution of unviable corridors

(i) Execution of Dwarka-Najafgarh corridor with net cash outflow of ₹5,178 crore

As per the DPR, Dwarka-Najafgarh metro corridor was not financially viable. To make the corridor viable, a provision of 4.03 hectare of land at Najafgarh station was included for Property Development. The same was to be made available by GNCTD to DMRC. Without income from Property Development during the horizon period of 33 years, DMRC assessed negative cash flow of ₹5,178 crore (i.e., total cash outflow/ total cost of ₹7,504 crore minus total revenue of ₹2,326 crore). However, after considering net Property Development revenue of ₹5,675 crore, Financial Internal Rate of Return was

estimated as 1.18 *per cent* over the horizon period with estimated net cash inflow of ₹125 crore. The corridor was approved (September 2012) by the MoUD at the cost of ₹1,070 crore and was to be completed by 2015 (actual completion in October 2019).

Audit observed that DMRC had assumed that 4.03 hectare land area would be made available by GNCTD, but no consent of the same was taken from the GNCTD. Further, no correspondence regarding acquisition of 4.03 hectare land was available. Normally, Non-Fare Box Revenue[33] of a Mass Rapid Transit System is in the range of 10 *per cent* of the Fare Box Revenue, but DMRC estimated Non-Fare Box Revenue of 126 *per cent* to 296 *per cent* of Fare Box Revenue from the period 2014 to 2046-47 to make this corridor viable.

Hence, DMRC had not ensured availability of land for Property Development till December 2020 despite the DPR highlighting this as the only way to make the corridor viable.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that when the DPR for the section was prepared in 2007-08, the estimated cost of 4.03 hectare private land was ₹80.60 crore. But when the project was approved in 2012, there was substantial development along the alignment raising the estimated cost to more than ₹1,000 crore making it impossible to acquire the identified plot. DMRC expressed their inability to acquire the identified land till date due to various impediments and the anticipated Non-Fare Box Revenue considered at the DPR stage could not materialise.

The Ministry/ GNCTD/ DMRC did not furnish specific reply to the Audit query on projection of unrealistic assumption of Non-Fare Box Revenue in DPR to make it viable. Thus, the fact remained that assessed revenue of ₹5,178 crore could not be realised in the absence of land required for envisaged Property Development.

(ii) Execution of unviable Mundka-Bahadurgarh corridor

As per the DPR, the proposed metro corridor of Mundka-Bahadurgarh was not financially viable. To make it viable, four hectare of land with 'residential' land use near Ghevra crossing (Delhi) was required for Property Development. As on March 2020, the said land had not been acquired for Property Development, although this was the determining parameter to make the project viable. Audit observed that the identified four hectare land was already planned for establishment of Public Health University and was under litigation since June 2008. However, DMRC did not carry out due diligence at the time of preparation of DPR to ensure availability of land at the approval stage. Rather, DMRC estimated upfront money of ₹168 crore from this four hectare land in the DPR. However, assessed revenue in Delhi portion could not be realised in the absence of envisaged Property Development area. As per the sanction letter (September 2012), it was also stipulated that in case the estimated Property Development revenue of ₹168 crore is not generated, the GoI and the GNCTD have to

[33] ***Non-Fare Box Revenue comprising of revenue from lease out of commercial space, advertisements, consultancy work etc.***

contribute the same as equity to DMRC. However, DMRC did not approach the GoI and the GNCTD for providing the additional equity in lieu of land for Property Development in Delhi portion.

Further, the DPR stated that Government of Haryana (GoH) will provide 1.56 hectare land for Property Development in Haryana portion. While as per the sanction letter, GoH was to provide 10 hectare of land for depot with some element of Property Development, GoH provided 12 hectare land for depot including Property Development. Audit observed that the depot has been constructed and only 0.8 hectare space was available for Property Development, which also remained unutilised as of March 2020. Thus, DMRC has not executed any Property Development activity even in the available 0.8 hectare of land after lapse of seven years from the sanctioning of the project though ₹549.27 crore (during horizon period of 30 years) was estimated from this 1.56 hectare land for estimating Financial Internal Rate of Return.

The Financial Internal Rate of Return was calculated after considering the Property Development income from 4 hectare land in Delhi portion and 1.56 hectare land in Haryana portion.

Thus, DMRC recommended two financially unviable corridors after considering revenue from Property Development without ensuring the availability of required land.

The Ministry and DMRC replied (January 2021 and July 2020) that the GNCTD has not provided four hectare land at Ghevra as proposed in the DPR. Necessary action to develop the remaining 0.8 hectare land (Haryana portion) has since been taken. The Ministry/ GNCTD while accepting (January 2021) the Audit observation for additional equity of ₹168 crore stated that the GNCTD does not have any land, and the required land is to be provided by the Delhi Development Authority (DDA). Accordingly, DDA has been requested to provide funds in lieu of the lands for Property Development. GNCTD endorsed the reply of DMRC.

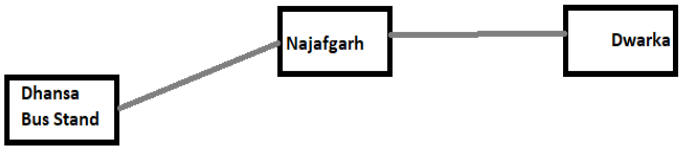
The reply of the Ministry/ GNCTD and DMRC is not acceptable as DMRC had not ensured availability of said land for Property Development which was of paramount importance to make the project viable.

(iii) Extension of unviable Najafgarh-Dwarka corridor upto Dhansa Bus Stand

DMRC prepared (December 2014) Feasibility Report for Najafgarh-Dhansa Bus Stand (1.18 km length) which was an extension of the Line-9 and had one underground station at Dhansa Bus Stand.

The MoUD sanctioned (09 May 2017) Najafgarh-Dhansa Bus Stand section with an estimated completion cost of ₹565 crore. Audit observed that Dwarka-Najafgarh corridor was viable only if the private land for Property Development (4.03 hectare) near Najafgarh station was made available to DMRC.

Figure 2.1



Since the land could not be acquired, further extension of this unviable Dwarka-Najafgarh corridor up to Dhansa Bus Stand without any Property Development will further increase net cash outflow as construction cost (two times) and O&M cost (10 times) of underground section is much higher than elevated section.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that due to time gap and substantial development, it was not possible to acquire the identified land. Further, while preparing the Feasibility Report for Dhansa Bus Stand extension, fare structure escalation of 7.5 *per cent per annum* and average lead of 16 km was considered for calculation of Financial Internal Rate of Return. This led to positive value of Financial Internal Rate of Return (3.4 *per cent*) even without Property Development land.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as without Property Development activities on four hectare land, the net cash flow of Dwarka-Najafgarh corridor was negative to the extent of ₹5,178 crore and extending this line to Dhansa Bus Stand will further add to negative cash flows. Also, for an extension of 1.18 km section, fare of average lead/ journey of 16 km had been considered for calculating Financial Internal Rate of Return, which was already considered in earlier extension (Dwarka-Najafgarh). This has resulted in estimation of higher Fare Box Revenue for 1.18 km of Najafgarh-Dhansa Bus Stand.

2.2.4 Non-approval and implementation of Corporate Plan of DMRC

In August 2009, DMRC proposed to revisit its original vision, mission etc., and to prepare a long-term Corporate Plan. Accordingly, consultancy work of revisiting the vision, mission etc., and preparation of a Corporate Plan was awarded (January 2010) to M/s Feedback Ventures with scheduled completion period of 100 calendar days. The consultant submitted its report in 2017-18 and was paid an amount of ₹0.32 crore by DMRC. Audit observed that the horizon period of the proposed Corporate Plan was 2011 to 2021. Thus, a significant period of nine years of the horizon period had already elapsed by the time the Corporate Plan was submitted. The delay was attributed to extension of time given by DMRC due to delay in completion of Phase-II of MRTS and subsequent discussions and presentations to DMRC. The Corporate Plan was approved neither by the Managing Director nor by the Board of DMRC. Thus, even after a lapse of 10 years, DMRC did not have a formal and approved Corporate Plan for guidance towards effective and efficient achievement of its targets and goals.

During Exit Conference (January 2021), the Ministry/ DMRC has agreed for submitting the Corporate Plan to Board of Directors for approval. As horizon period of the said Corporate Plan was upto 2021, a revised Corporate Plan for next horizon period may be prepared and approval of Board of Directors obtained before its implementation.

2.2.5 Change of planning from nine cars to six cars train platform after approval of Phase-III DPR

As per Phase-III DPR, the length of elevated stations was 210 meter and 280 meter to 320 meter in case of underground stations. The Managing Director, DMRC while

discussing (27 May 2011) the change of planning of running nine cars to six cars pointed out that savings in the cost of underground stations for Line-7 and Line-8 shall be the same as given in DPR for Central Secretariat-Kashmiri Gate[34], which was built for six cars trains. For elevated stations, savings was expected to be ₹2 crore for each station. The Managing Director, DMRC pointed out that Peak Hour Peak Direction Traffic of Phase-III as projected in the DPR can be carried by six car trains even up to 2031. Additional Peak Hour Peak Direction Traffic beyond 2031, if any, can be catered to by reducing the train's headway[35], which will be feasible under the Communication Based Train Control system. Accordingly, it was decided that Line-7 and Line-8 should have six car trains instead of nine cars as proposed in DPR. In this regard, Audit observed that:

(i) Due to the decision to change the planning for running nine cars to six cars train, the length of the platform size had to be reduced to 140 meter. Resultantly, the length of the tunnel (in underground) and viaduct (on elevated) also increased. As per the DPR, the cost of tunnelling per km and elevated viaduct was ₹144.31 crore and ₹29.87 crore, respectively. Due to change of decision from nine cars to six cars train operations, there was additional cost of ₹6.49 crore and ₹2.09 crore per station in case of underground and elevated stations, respectively. Thus, DMRC had to incur an additional expenditure of ₹211.53 crore[36]. While the total estimated savings by DMRC due to change of running nine cars to six cars train was ₹234.54 crore, the actual saving was ₹23.01 crore only for Lines-7 and Line-8.

(ii) The design life of the station building is 120 years. In Phase-I & Phase-II, the platforms were designed for eight car trains. Initially train operations were started with four car trains which was increased to eight cars to cater to the increased ridership. However, the reduction in size of platform to six car trains only (in Line-7 & Line-8) has eliminated the possibility and scope for further increase in cars in a rake to cater to the increase in ridership in the future.

(iii) DMRC also decided (27 May 2011) that the saving in civil cost of underground stations for Line-7 and Line-8 shall be the same as given in the DPR for Central Secretariat-Kashmiri Gate. DMRC adopted the estimated cost of underground station building of Line-6 (₹113.01 crore) for Line-8. However, it was observed that width of the Rolling Stock was different in the two lines: in Line-6, type 'A' Rolling Stock of 2.9 meter was used, while in Line-7 and Line-8, type 'B' Rolling Stock of 3.2 meter was proposed. Further, the operations on Line-6 and Line-8 were not similar. Thus, the specifications of both the corridors being different, the cost was not comparable.

(iv) The decision of running six cars train operations instead of nine cars was taken without any cost benefit analysis. Further, no reasons for the reduction were recorded at the time of approval. The decision was neither apprised to the Board of DMRC nor

---

[34] ***This was the only corridor having six cars train operations in initial Phase-III DPR***
[35] ***The distance between two metro trains in a transit system measured in time or distance***
[36] ***(₹6.49 crore x 21 underground station) + (₹2.09 crore x 36 elevated station) = ₹211.53 crore***

to the Administrative Ministry. Since the decision of changing of running nine cars to six cars was taken (May 2011) before the sanction letter (26 September 2011) issued by the MoHUA, the Phase-III DPR should have been revised accordingly.

Thus, DMRC changed the train operation from nine cars to six cars without detailed justification, after sanctioning of Phase-III projects. This has resulted in elimination of scope of further expansion to cater to the increased ridership in future.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the overall saving due to this change was ₹53.25 crore. The decision to reduce the platform station length from nine coaches to six coaches was taken after due deliberation as being advantageous on technical and financial grounds. For underground stations of Line-6, design for coach-width is 2.9 meter whereas for Line-7 and Line-8 the underground stations were designed for the coach width of 3.2 meter. Accordingly, cost of station has been considered in the DPR and no change in other cost like Viaduct/ Tunnel was considered. Since the DPR was submitted in February 2011, while decision was taken in May 2011, it was already in the advanced stage of approval. Hence, revision of DPR at that stage would have further delayed the approval process. As per Delegation of Powers, Managing Director DMRC has been authorised to take such decisions.

The reply of Ministry/ GNCTD and DMRC is not acceptable as low saving in the civil cost is not justified in view of the fact that six cars platform station box has eliminated the possibility and scope for further increase in cars in train composition in the future. Further, total estimated savings due to change of running nine cars to six cars train was ₹234.54 crore, with actual saving of ₹23.01 crore[37] only and not ₹53.25 crore. There was also inconsistency in the decision making, as in Phase-IV of Delhi MRTS from Aerocity to Tuglakabad corridor, nine cars operation was proposed in the DPR though the ridership was less than that of Line-7 and Line-8 of Phase-III. Additionally, as per the minutes of the 13th Board Meeting (January 1998), any substantive change in the scope of work from DPR should be put up to the Board for approval. However, in this case no such approval of the Board was obtained.

2.2.6 Blockage of funds of ₹106.24 crore due to construction of residential complex under Transit Oriented Development

A Transit Oriented Development is a project that mixes residential and commercial opportunities with the objective of optimising the use of land and maximising access to public transport.

Transportation Chapter-12 of Master Plan of Delhi, 2021 as part of review of Master Plan of Delhi-2021 was notified (14 July 2015) by the MoUD, GoI. This chapter envisages Transit Oriented Development policy and development control norms. Delhi Development Authority (DDA) have formulated and notified (November 2015) draft regulations for operationlisation of Transit Oriented Development policy. DMRC planned (August 2015) construction of a residential block at Okhla NSIC station under Transit Oriented Development policy. In this regard, Audit observed that: -

[37] *₹234.54 crore-₹211.53 crore*

(i) There was no approved and notified Transit Oriented Development regulations as the same were under review (from July 2015) of DDA and MoHUA. However, DMRC constructed the residential project under Transit Oriented Development and incurred a cost of ₹82.54 crore on structure and ₹23.7 crore on land cost. The residential complex has been completed (November 2018), but so far, no dwelling unit has been sold/ leased for generating Non-Fare Box Revenue.

(ii) DMRC has been requesting DDA since November 2018 to grant permission of higher floor area ratio of 1.4 as against the permitted 1.0 for residential block. But DDA has not granted any such permission. Audit noticed that Master Plan of Delhi does not provide for any relaxation in floor area ratio for metro stations. Further, due to non-availability of such permission/ approval from DDA, South Delhi Municipal Corporation (SDMC) has not granted statutory approvals for allotment of residential units. Delhi Fire Services provided (August 2016), no objection to DMRC for construction of the said building. However, fire safety certificate from Delhi Fire Services for the residential complex after its completion has not been obtained by DMRC.

(iii) The Ministry has not allowed construction of residential project by DMRC. Moreover, funds for the residential project were utilised from the Phase-III project. No approval of the Board or the Ministry was obtained for implementation of residential project under Transit Oriented Development.

(iv) Transit Oriented Development norms stipulated that 50 *per cent* dwelling units of size ranging between 32 sqm to 40 sqm and balance 50 *per cent* less than and equal to 65 sqm can be constructed. Total 108 dwelling unit areas ranging from 32 sqm to 50 sqm was approved by the Managing Director, DMRC. However, only 93 dwelling units areas ranging from 42 sqm to 110 sqm were actually constructed. Further, six economic weaker section flats were planned but not constructed by DMRC. In addition, 20 *per cent* of the area of the amalgamated plot was to be designed as green public open space. However, this has not been provided at the residential complex.

Thus, DMRC constructed residential project under Transit Oriented Development policy without approved regulations for the same. This has resulted in blockade of funds of ₹106.24 crore.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the proposal of development of Transit Oriented Development was in accordance with the mandate given to DMRC by MoUD (March 2009) to explore Property Development options, wherever feasible, as an accepted source of resource mobilisation towards capital cost as well as sustainable operations. Accordingly, a commercial cum residential complex was planned at Okhla NSIC as a mixed-use development. Since Transit Oriented Development regulation by the MoHUA was not notified, the proposal could not be submitted to the local authority. The project under consideration consists of 93 residential units of one and two bed-rooms units, commercial area and public spaces as per Transit Oriented Development norm as notified in July 2015 with 1.4 floor area norm excluding operational area and ground coverage of 30 *per cent* which is

within the Transit Oriented Development norms. The Okhla NSIC project qualifies as a Transit Oriented Development project as per both the policies except that Okhla does not fall under any of the Transit Oriented Development nodes as per the new policy. The number of residential units and their sizes cannot be predicted cent *per cent* before completion of the structure design. While developing the concept design, DMRC anticipated 108 residential units but while making the structural drawings, DMRC were able to construct only 93 residences of various sizes. If the project gets approved as per Transit Oriented Development necessary modification can be done to fulfil the size requirement of the guidelines.

The reply of the Ministry/ GNCTD/ DMRC is not tenable because the guidelines of MoUD does not encourage development of residential project under Property Development. The proposal for approval of connection of water, electricity and occupancy certificate etc., has not been issued by local authority due to non-notification of Transit Oriented Development regulations. DMRC in their reply has accepted that it had initially planned to construct 108 dwelling units but ultimately constructed 93 units only. Further, the residential project at NSIC Okhla does not fall under any of the Transit Oriented Development Nodes approved by DDA. The fact remains that construction of residential project without approved Transit Oriented Development Regulations, resulted in blockage of funds of ₹106.24 crore.

2.2.7 Non-adoption of General Financial Rules for sanction and administrative approval from the appropriate authority and for incurring expenditure

2.2.7.1 Execution of work of ₹2,912.21 crore without administrative approval and expenditure sanction

As per Rule 129 (1) of General Financial Rules (GFR), 2005, no works shall be commenced or liability incurred in connection with it until administrative approval has been obtained from the appropriate authority in each case and sanction to incur expenditure has been obtained from the competent authority. In this regard, Audit observed that the works were started by DMRC in violation of GFR as discussed below:

(i) The work on three corridors i.e., Kalindi Kunj-Botanical Garden, Noida City Centre to Noida Sector-62 and Dilshad Garden to New Bus Adda, Ghaziabad were commenced on the basis of signing of Memorandum of Agreement between DMRC and NOIDA/ Ghaziabad Development Authority, but without obtaining the sanction of the competent authority i.e., MoHUA.

(ii) The work on the Faridabad- Ballabhgarh corridor was commenced even without signing of Memorandum of Agreement between DMRC and Government of Haryana and without the sanction of the competent authority. The same was signed on 04 January 2019 i.e., after Revenue Operation Date on 19 November 2018.

(iii) In the case of Kalindi Kunj-Botanical Garden corridor (Line-8 extension), sanction of Cabinet was granted (20 December 2017) after completion of work and just five days before commissioning of corridor. In the case of Dilshad Garden-New Bus

Adda, sanction order was issued (14 February 2019) by GoI with stipulated scheduled completion date as 31 January 2019 (14 days before the issue of sanction order).

(iv) An expenditure of ₹1,081.85 crore, ₹537.68 crore, ₹1,081.72 crore and ₹210.96 crore for Noida City Centre to Noida Sector-62, Kalindi Kunj- Botanical Garden, Dilshad Garden to New Bus Adda, and Faridabad-Ballabhgarh corridors, respectively, was incurred even before sanction/ administrative approval from the competent authority in contravention of the GFR.

Thus, work of three corridors was started without approval of Administrative Ministry and in case of Ballabhgarh extension, DMRC neither signed the MoU with Government of Haryana nor got the project sanctioned from GoI before commencement of work.

DMRC replied (July 2020) that while ordering the work, it was for the State Government to ensure that relevant approvals have been obtained to undertake the work and to get the project sanctioned from GoI. DMRC started the work on getting part money in advance from the State Government. Any delay in getting the sanction by GoI is the responsibility of the Government of Uttar Pradesh (GoUP). However, GoUP had signed the MoU before the project was sanctioned by GoI. Therefore, there is no violation of GFR. The Ministry/ GNCTD replied (January 2021) that these corridors were taken up after signing of Agreement with the respective authorities and release of fund by them. Procuring administrative approval and expenditure sanction was the responsibility of the concerned authorities and the same were obtained before commissioning of the lines.

The reply of DMRC is not acceptable as the work on these NCR extensions was commenced without the approval of the MoHUA and GNCTD. Commencement of work without approval of the competent authority is violation of GFR provisions. In 2012, at the time of drafting Memorandum of Agreement for Phase-III, MoUD instructed not to assign any other work to DMRC without prior consent of MoUD. However, the consent/ approval of the same from GoI was not taken before commencement of work. Being a Government organisation, DMRC has to abide by the procedure for construction of any metro corridor. Hence, it is also the responsibility of DMRC to ensure that all obligations have been fulfilled before commencement of any construction work.

2.2.7.2 Additional estimated expenditure of ₹3,246.80 crore relating to modification/ change in alignment of already sanctioned Phase-III corridors without approval of Cabinet

As per Rule 131 of GFR, 2005, any anticipated or actual savings from a sanctioned estimate for a definite project, shall not, without special authority, be applied to carry out additional work not contemplated in the original project.

Phase-III Delhi MRTS project was sanctioned and funded by the GoI and the GNCTD, and any modification/ deviation in sanctioned project/ corridor having financial implications require approval of sanctioning authority as per GFR provisions. Further, MoUD vide its letters dated 18 December 2012/ 31 October 2014, directed that any

deviation in Phase-III projects and extensions as against approved DPR would require Cabinet sanction with details/ justifications. In this regard, Audit observed that:

(i) Managing Director, DMRC modified (December 2011) the elevated alignment between Janak Puri (West) to Palam into underground section as a result of which the number of stations got reduced from four to three just after three months from sanctioning (September 2011) of the project by the GoI due to infirmities in the DPR. This change in alignment from elevated to underground led to additional cost of ₹601 crore which was to be met from the savings in the project. Besides, five other sections were also modified.

(ii) DMRC, in its midterm appraisal (2013) on Phase-III MRTS corridors had apprised the Board that there was marginal increase of ₹106 crore (0.26 *per cent*) over the sanctioned cost. It also apprised to the Board that there was an increase of 13.30 km length in the underground section and decrease of 11.214 km length in the elevated section. Based on estimated completion cost for the underground section and elevated section for Phase-III as per DMRC letter dated 08 April 2011, Audit calculated the additional estimated cost of these modification in alignment as ₹3,246.80 crore[38], which was 8.58 *per cent* (₹3,246.80 crore/ ₹37801.61 crore) of the sanctioned cost of initial phase-III corridors and Dwarka-Najafgarh. Moreover, for increase in completion cost vis-à-vis sanctioned cost, approval of the Cabinet was not sought.

(iii) Utilisation of saving from already sanctioned projects without the approval of the competent authority i.e., the Administrative Ministry (MoHUA) as per GFR was not prudent.

Thus, DMRC modified the alignments after sanctioning of the corridors by the GoI and approval was not obtained from GoI. Further, DMRC incurred expenditure of ₹3,246.80 crore after utilising the saving of already sanctioned Phase-III corridors in contravention of GFR provision.

DMRC replied (July 2020) that the cost of change in alignment from elevated to underground was to be met from the expected saving of Phase-III. Hence, the case was not sent to the MoUD. As per the preliminary expenditure details, the total expenditure for Phase-III is ₹42,734 crore (approx.) against the DPR provision of ₹39,796 crore. Further, out of ₹2,938 crore i.e., extra expenditure over and above the sanctioned cost, only ₹525 crore (1.47 *per cent*) was on account of actual construction of Civil, Electrical and Mechanical, Traction, Signalling and Telecom and Rolling Stock. The remaining expenditure was mainly on account of delay in handing over of land by various agencies and consequent extension of period of Phase-III. The completion cost as mentioned is the DPR cost and not the actual completion cost of Phase-III. Therefore, additional cost worked out by Audit was not correct, as it does not include savings obtained in contracts.

The Ministry/ GNCTD replied (January 2021) that Empowered Group of Ministers vide meeting held on 4 August 2000 directed that changes of design/ technical nature

[38] ***₹3,246.80 crore = {13.29 x ₹408 crore} – {11.214x ₹194 crore}***

vis-à-vis the DPR should be settled by DMRC Board unless these involve significant cost and time overruns or have major implications of such a nature as cannot be considered to be internal to the project. These changes are purely due to technical reasons internal to the project. The excess cost on this account was contemplated to be adjusted from the expected saving of Phase-III. Thus, the approval of these modifications was within the power of DMRC Board of Directors whose approval was taken by DMRC.

DMRC accepted that ₹2,938 crore was the extra expenditure incurred over and above the sanctioned cost. Hence, approval of both utilisation of funds from savings of sanctioned funds and incurring of additional expenditure should have been obtained from GoI. Further, break up (line wise and item wise) of expenditure of ₹42,734 crore against the DPR provision of ₹39,796 crore has not been provided to Audit despite requisition[39] and repeated reminders. The details of actual savings made in contracts has also not been furnished to Audit. The reply of the Ministry is not acceptable as modifications from elevated section to underground section involve significant cost overrun (i.e., 2 times) and time over run (i.e., 6 months to12 months). Further, MoUD letters issued in December 2012 and October 2014 also require approval of Cabinet for any deviation in Phase-III projects and extensions as against approved DPR.

2.3 Selection of Technology

A metro system requires a complex set of technological infrastructures and components to ensure its smooth operations. These components include Rolling Stock, Signalling system, Electrical, Track and Traction System etc. DMRC's planning and execution of various technologies in various lines of the metro system were examined by Audit along with the Technical Consultant (IIT Delhi) and the observations are as brought out in the following paragraphs.

2.3.1 Rolling Stock

During Phase-III, DMRC procured 924 metro cars at a cost of ₹7,862.71 crore through four contracts which include three contracts (RS-9, RS-11 and RS-13) for augmentation of Rolling Stock in existing Line-1 to Line-6 and a contract (RS-10) for newly constructed Lines-7, 8 and 9 as detailed below:

Table 2.1
Details of Rolling Stock contracts executed during Phase-III

Name of the contract	Procured for Line	Name of the contractor	Date of award of Contract	No. of cars procured	Awarded cost of one car (₹ in crore)
RS-9	5 & 6	M/s BEML & Hyundai Rotem consortium (BR Consortium)	01.07.2013	92+70= 162	8.22

[39] ***vide Audit Requisition no. 92 in December 2019***

Name of the contract	Procured for Line	Name of the contractor	Date of award of Contract	No. of cars procured	Awarded cost of one car (₹ in crore)
RS-10	7, 8 & 9	M/s Hyundai Rotem Company	01.04.2013	486+18= 504	8.62
RS-11	2, 3 & 4	M/s Bombardier Transportation India Private Ltd	12.06.2015	124+38= 162	9.25
RS-13	1, 2, 3 & 4	M/s BEML Ltd	21.05.2015	74+22=96	8.82
Total cars				**924**	

In this regard, Audit observed the following:

2.3.1.1 Inconsistency in variation clauses of Rolling Stock contracts

DMRC awarded four contracts[40] for procurement of Rolling Stock during the implementation of Phase-III. The variation clause in the contract agreements except RS-9 stipulates that the employer at his discretion may advise the contractor in writing about increase of the total quantity up to 30 *per cent* of the tendered quantity. However, the variation clause of RS-9 contract stipulates the variation quantity up to 60 cars (65 *per cent*) of the tendered quantity of 92 cars. The quantity was augmented up to 70 cars (76 *per cent* of tendered quantity) through a variation order.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that there is no stated guideline for quantity variation option to be followed in all contracts and the variation quantity is worked out based on anticipated requirement of additional quantity in the near future and included in the tender so that the additional quantity can be procured at the contracted terms without going through the process of fresh tendering.

It is suggested that as DMRC deals with significant number of contracts in metro projects, they should have a stated guideline for quantity variation in order to maintain consistency.

2.3.1.2 Avoidable expenditure of ₹3.24 crore due to non-incorporation of rate of Heating Ventilation and Air Conditioning Coefficient of Performance in RS-11 contract

Employer's Requirements Technical Specification (ERTS) of Heating Ventilation and Air-Conditioning under RS-11 contract stipulates that employer expects that energy efficient system comparable with the best available in the market shall be provided. However, in contract RS-13 under ERTS, it was mentioned that Coefficient of Performance[41] of Heating Ventilation and Air Conditioning shall not be less than 2.5 in summer and monsoon season under both outdoor and indoor conditions. DMRC initiated the tendering process of both RS-11 and RS-13 contracts in 2014. Hence, there

[40] ***RS-9, RS-10, RS-11 and RS-13***

[41] ***Coefficient of Performance indicate the ratio of heating or cooling provided by a unit relative to the amount of electrical input required to generate it. Higher Coefficient of Performance equate to higher efficiency, lower energy (power) consumption and thus lower operating cost***

was no reason for the clauses of Heating Ventilation and Air Conditioning Coefficient of Performance to be different in the two agreements.

Further, instead of approving the Heating Ventilation and Air Conditioning Coefficient of Performance of 2.5 (as in the case of RS-13 which was comparable with the best available) without any extra expenditure, DMRC granted variation of ₹3.24 crore (November 2017) to the contractor for Heating Ventilation and Air Conditioning Coefficient of Performance 2.3 in RS-11, which was a lower version than RS-13. Besides, the awarded cost[42] of RS-13 with Coefficient of Performance of 2.5 is less than RS-11. If RS-11 having Heating Ventilation and Air Conditioning with Coefficient of Performance 2.3 would have been purchased without variation and consistent clauses were incorporated in the tenders, DMRC could have saved up to ₹3.24 crore.

Thus, DMRC procured less efficient Heating Ventilation and Air Conditioning system in RS-11 contract after incurring additional expenditure of ₹3.24 crore.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that Notice Inviting Tender of RS-11 (augmentation of RS-2/ 5/ 7) and RS-13 were floated on 22 July 2014 and 22 August 2014, respectively. During the design evaluation phase (October 2015), it was noticed that Coefficient of Performance was as low as 1.7. DMRC informed M/s Bombardier Transportation (contractor) to improve Coefficient of Performance to the level of 2.5. The contractor informed (May 2016) that improved Heating Ventilation and Air Conditioning with Coefficient of Performance 2.3 is developed by the Original Equipment Manufacturer and mentioned that additional time and cost would be required for this additional work. Based on the mainline tests, total saving of energy per Heating Ventilation and Air Conditioning per hour works out to be 7.35 units. Considering energy cost of ₹6.03 per unit and 12 hours of operation daily, saving per day works out to be ₹532.36 per system. Considering the same, the variation cost will get paid back to DMRC through energy savings in approximately 175 days (approximately six summer months).

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as it is silent on the Audit observation regarding non-incorporation of the rate of Heating Ventilation and Air Conditioning Coefficient of Performance in RS-11 contract as mentioned in RS-13 contract although approval for procurement of RS-11 and RS-13 was taken at the same time in June 2014. In this regard, Audit observed that a highest possible value of Coefficient of Performance of Heating Ventilation and Air Conditioning (keeping up with industry state of art) may be specified in the contract instead of comparing to later variations, which might be difficult or have cost implications at a later stage. DMRC is justifying the variation amount paid on the basis of saving in energy. Further, incorporation of the clause for Coefficient of Performance 2.5 energy efficient Heating Ventilation and Air Conditioning, would have resulted in continuous saving of energy in the future years without any variation.

---

[42] ***Awarded cost of RS-11 Rolling Stock: ₹9.25 crore per car, RS-13 Rolling Stock: ₹8.83 crore per car***

2.3.1.3 Introduction of Unattended Train Operation technology without preparedness and cost-benefit analysis

DMRC issued (03 March 2012) Notice Inviting Tender (NIT) on International Competitive Bidding basis for 486 standard gauge cars (RS-10). Meanwhile, a detailed note was submitted (29 May 2012) to the Managing Director, DMRC by three Directors of DMRC stating that DPR of Phase-III corridors envisages train control and signalling system based on Communication Based Train Control which is an excellent opportunity for introduction of Unattended Train Operation[43] feature with marginal cost and attendant benefits. The note was approved (31 May 2012) by the Managing Director, DMRC. The benefits would include saving in manpower in depot and, to a certain extent, in the main Line too. In case of RS-10 contract, a clause related to minimum Guaranteed Energy Consumption during one round trip of Line-7 (factory test and actual Line) was included. In case of non-achievement of Guaranteed Energy Consumption, penalty was to be levied according to the penalty clause as mentioned in the contract.

In this regard, Audit observed that:

(i) During the preparation and approval stage of DPR of Phase-III (2008-11), proposal for introduction of new technology i.e., Unattended Train Operation along with proposed benefits/ merits were neither discussed nor appraised by DMRC at any stage before May 2012.

(ii) Although the mode of operation of Rolling Stock was modified, DMRC did not revise the estimated cost considering Unattended Train Operation mode and their features like additional Closed Circuit Television etc., in NIT.

(iii) Since DPR was prepared based on normal Rolling Stock, there was no provision for Platform Screen Doors in the DPR for Phase-III lines. Later, due to shifting at Unattended Train Operation mode, DMRC had to award the supply and installation of Platform Screen Doors contract for Line-7 and Line-8 at ₹312 crore.

(iv) At approval stage, DMRC stated that after introduction of Unattended Train Operation there would be cost reduction as number of Train Operators would be reduced. Yet, no cost benefit analysis was made by DMRC' and moreover in many countries Unattended Train Operation with staff/ driver was in operation for a long time. Thus, claim of DMRC regarding cost cut due to reduction/ rationalisation in number of Train Operators after the introduction of Unattended Train Operation is doubtful.

(v) Rolling Stock (RS-10) was operational since 25 December 2017 and due to lack of connectivity of Line-7, DMRC had not conducted Guaranteed Energy Consumption test online. Hence, any achievement of Guaranteed Energy Consumption value in real conditions by the contractor, and penalty, if any, in case of non-achievement of Guaranteed Energy Consumption could not be ascertained (31 March 2021).

---

[43] ***Unattended Train Operation is level of automation (GoA4), wherein the train shall be operated without train operator. Operation Control Centre will send a command to ATC system onboard to operate the train so as to align train doors with the Platform Screen Doors.***

Thus, DMRC introduced Unattended Train Operation technology without mentioning the same in DPR and also cost benefit analysis was not conducted at the approval stage.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that Communication Based Train Control technology had reached its maturity. Further, features required for operation in GoA3[44]/ GoA4[45] could be incorporated in the new Rolling Stock and Signalling and Train Control System at incremental additional cost but within the provisions available in the DPR of Phase-III, and that if these features were incorporated at a later date, the cost would be very high. As Unattended Train Operation with Communication Based Train Control was already a rapidly evolving and preferred technology for a number of metro systems, no major cost implications were envisaged and thus the estimate was not revised. The cost cut due to reduction of numbers of Train Operators can be ascertained only after introduction of Unattended Train Operation. DMRC agreed that initially, Platform Screen Doors were not considered. However, although not essential, under Indian conditions with Unattended Train Operation provision, Platform Screen Doors is expected to increase passenger safety against accidental falls and unauthorised entry to track. The demonstration on mainline is pending as the specified section from Mukundpur (Majlis Park) to Maujpur is still not ready due to pending construction work.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as introduction of new technology was neither discussed nor appraised by DMRC at any stage before May 2012. DMRC admitted that no cost estimation was made before introduction of Unattended Train Operation. Further, Audit has not been provided any component wise cost of Rolling Stock, either actual or estimated. Estimates are prepared on lump sum basis and to say that Unattended Train Operation functionality involves only marginal cost, is unverifiable. Further, Platform Screen Doors is an essential feature[46] for Unattended Train Operation System. In Phase-I, out of three Lines executed during Phase-I, Automatic Train Operation was introduced on only Line-2. Later, the same was introduced on all new Lines of Phase-II i.e., Line-5 and Line-6, whereas, Unattended Train Operation was introduced in all new lines of Phase-III (Line-7, Line-8 and Line-9) without any prior experience.

2.3.1.4 Excess procurement of Rolling Stock in Phase-III resulting in its idling

DMRC awarded four contracts for the procurement of Rolling Stock during Phase-III. Three of them viz. contract RS-9, RS-11 and RS-13 were awarded to meet the procurement of 420 metro cars of existing lines (Line-1 to Line-6) and extension of

---

[44] ***Grade/level of automation wherein fully automated train operation but train driver will remain in cab for attending emergency situations***

[45] ***Grade/level of automation wherein fully automated train operation without driver in cab. In case of emergency situation, the same is handled by the operation control centre staff***

[46] ***In response to Board of Directors observation (91st meeting) on installation of Platform Screen Doors, Director (Operation) stated that Platform Screen Doors are becoming necessity in case of manual train operation also. Further, in response to Audit observation mentioned in para 3.11, DMRC stated that use of Platform Screen Doors is mandatory with Unattended Train Operation.***

existing lines during Phase-III. RS-10 contract was awarded for procurement of 504 metro cars for Line-7, Line-8 and Line-9.

Audit observed that DMRC estimated the requirement of Rolling Stock in the DPR prepared in February 2011, whereas the procurement was initiated in 2013-14. At the time of tendering, DMRC did not conduct any analysis for the projections of requirement of Rolling Stock on the basis of actual turnaround time of each line, actual length of metro line, actual speed of Rolling Stock (Automatic Train Protection, Automatic Train Operation, Unattended Train Operation mode), reserve stock criteria, and Peak Hour Peak Direction Traffic. Considering actual parameters i.e., actual operational plan, actual speed of Rolling Stock, actual reversal time on the lines, Audit had worked out (by using formula of DMRC for procurement of RS) that DMRC had procured 84 excess metro cars during Phase-III amounting to ₹739.20 crore.

Technical Consultant (IIT Delhi) stated that no mathematical/ scientific model was found to justify the excess purchase of Rolling Stock in Phase-III. DMRC's stand that it was done on the basis of their experience, appears to be unjustified. Thus, DMRC should consider a scientific model like "Rolling Stock Circulation Model for Railway Rapid Transit Systems" for procurement of metro cars.

Thus, DMRC did not analyse the requirement of Rolling Stock on the basis of actual parameters at the time of procurement. This has resulted in excess procurement of Rolling Stock and its idling.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that DPR is the only available document to determine Rolling Stock requirement. For factors like turnaround time, length of Line, speed of Rolling Stock, there is rarely any change from DPR provisions. The train operation plan had taken into consideration all these factors while assessing the requirement of cars. Traffic forecast considers several factors into account. All these assumptions may not materialise in the expected way. Further, the percentage of unutilised cars depends on several factors. The trains on Line-7 are not being operated fully owing to discontinuity at Trilokpuri due to Rehabilitation and Resettlement issue.

The Ministry/ GNCTD/ DMRC reply is not acceptable as the operational plan determined in the DPR differs from the actual operational plan. Hence, DMRC should have analysed the requirement of Rolling Stock on the basis of actual operational plan, turnaround facility available at terminal metro station, actual length of metro corridor, speed of Rolling Stock i.e., Automatic Train Protection, Automatic Train Operation, actual increase in ridership and Peak Hour Peak Direction Traffic during the period as Audit noticed inconsistencies in these parameters from DPR provisions. The contention of DMRC regarding partial operation of Line-7 is not tenable as the same headway (frequency), as mentioned in DPR, has been maintained.

2.3.1.5 Deficiencies in the Rolling Stock and Rail

(A) Quality issues of rails and wheel of Rolling Stock

(i) Hardness measurement (at site/ depot and laboratory) were conducted by the Technical Consultant (IIT Delhi) along with Audit Team the in the presence of DMRC team on Line-7 (IP extension metro station, Vinod Nagar Depot and Mukundpur Depot) which revealed that both the rails (NHH[47]-880 and HH[48]-1080) possess relatively low values of hardness as compared to the values as per set standards. As per Indian Railway Standard Specification (December 2009) and as per DMRC specifications, the hardness value of rail should not be less than 260 BHN[49] for HH 880 rail head (Depot area) and hardness value should be in the range of 340-390 BHN for HH 1080 (main Line). However, actual hardness values measured were in the range of 217-292 BHN (Depot area) and 260-360 BHN (main Line). This indicates that DMRC has used rails of relatively less hardness. This may result in increased maintenance cost for DMRC due to decreased life of rails and wheels.

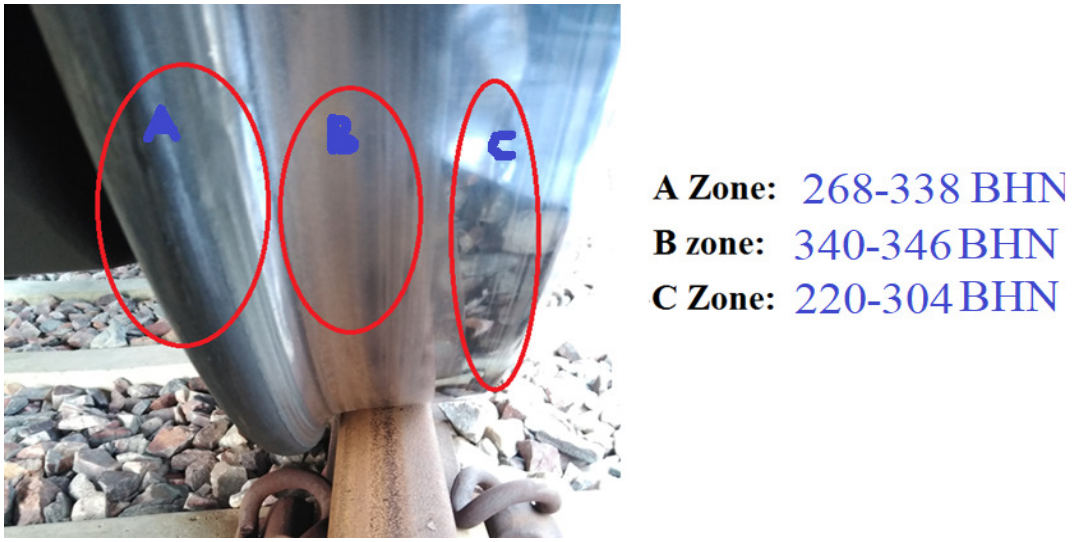
Figure 2.2
Measuring of rail surface hardness of Line-7 (IP extension metro station on 31 January 2020)

[47] ***Non-Head Harden***
[48] ***Head Harden***
[49] ***Brinell Hardness Number (BHN)- The Brinell hardness test is commonly used to determine the hardness of materials like metals and alloys***

(ii) DMRC stated that hardness of rail should be more than wheels, as through passes of runs, will lead to the wear and tear of wheels and rail, and replacing the worn rails would be easier than replacing the wheels. During on-site investigation, it was found that hardness of wheels (at the locations which contact rail) and rails were almost the same, which is good for longer wheel life. Keeping this in mind (i.e., increase in hardness at the contacts due to strain hardening during run), DMRC should have used rail and wheels with equal hardness (or may be even more) from the beginning itself in order to have good performance from running-in periods.

Figure 2.3

Photographic view of a wheel's surface hardness in three zones (A, B, and C) measured in presence of DMRC (Vinod Nagar depot on 31 January 2020)



(iii) DMRC sends wheels for grinding/ turning after they have run for some kilometres. It was observed that the decision on grinding/ turning of wheels should be taken after considering the permissible increase in noise and vibrations as well. After grinding/ turning, the harden layer of the wheel is removed with increased surface roughness. In such a case, DMRC did not have any technical means to increase the hardness of wheels and to improve the surface finish of the wheels and rails. Restoring the hardness on flanges of the wheels and rails (after grinding) is paramount as increase in vibration and noise was recorded after turning and grinding of wheels and rails, respectively.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that DMRC procures Rails and Wheels according to International Standards. Wheel profiling is measured as per the parameter provided by Original Equipment Manufacturers (OEMs). The Ministry added that DMRC is open to refer to the suggestions made to Rolling Stock manufacturers and Research Designs and Standards Organisation/ Ministry of Railways as no such technical instructions are available as of now.

The Ministry/ GNCTD/ DMRC reply is not acceptable as the rail samples (unused) were collected from DMRC for measurement of hardness in the IIT Delhi laboratory. Measurement of hardness revealed low value of hardness in critical areas. Technical

Consultant (IIT Delhi) observed that the Ministry/ GNCTD/ DMRC's reply regarding grinding and turning of wheels lacks technical explanation. DMRC should integrate the vibration and noise levels while deciding the time for turning the wheel and grinding the rails head. For this vibration and noise inside the car near the side wall and in the vicinity of floor should be picked-up. These two parameters will also reveal the quality (in terms of hardness and wear) of rails and wheels. Hence, DMRC may explore ways to restore the hardness of rails and wheels.

(B) Higher vibration and Noise

As per ISO 2631 norms, passengers should not be subjected to vibration level more than 0.315 meter per second squared (m/s^2). Audit along with the Technical Consultant (IIT Delhi) observed that vibration and noise levels were higher than permissible values at different locations of Line-7 (inside Rolling Stock, noise and vibration tests were conducted from Mayur Vihar Pocket -1 to Majlis Park and vice versa and outside Rolling Stock, noise test was conducted at Sarai Kale Khan and Majlis Park metro station). The vibration level was higher in several places with maximum value up to 2.5 m/s^2. This indicated that interface of wheels and rails was not proper, and the noise/ vibration absorption system needs attention. Exterior noise level was also found exceeding the permissible limit in the range of 69 decibel to 80 decibel.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the noise and vibration inside and outside of metro trains are measured as per the technical standards (specified in the Contract).

The reply of the Ministry/ GNCTD/ DMRC is not acceptable because if rails have less hardness (as found during the measurements), friction is found to increase at rail and wheel interfaces. Thus, DMRC may regularly review vibrations and noise levels inside and outside the Rolling Stock.

(C) Issue of lubricant waste on the track

Lubrication at the interface of rail and wheel flanges (during negotiating a turn) is achieved by spraying directed lubricant (synthetic chemicals). While the lubricant may be essential for machine contacts, it is hazardous for humans and the environment. Visual inspection of track revealed presence of contaminants at the side of railhead, which is for interfacing with wheel's flanges. Thus, DMRC did not have an integrated system of biodegradable lubrication based on bio-degradable oils.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that during Phase-III oil-based wheel flange lubricator was used which was technically defined as "Readily Biodegradable according to OECD[50] 301B".

The reply of the Ministry/ GNCTD/ DMRC needs to be viewed in the light of the fact that DMRC was unable to provide the FTIR[51] spectra of lubricant for understanding

---

[50] ***Organisation for Economic Cooperation and Development***

[51] ***Fourier-transform i.e., used for detecting degradation, dilution, or illegal additives in different types of oils***

whether lubricant used was biodegradable or not. DMRC further noted the suggestions for use of biodegradable oil.

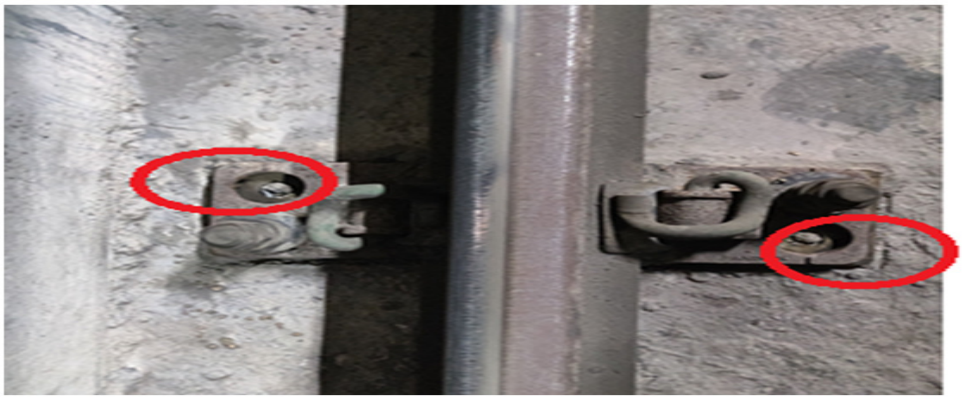
(D) Maintenance issues of Rolling Stock

(i) A visit of tunnel at Hauz-Khas metro station was conducted by Audit along with Technical Consultant (IIT Delhi) for assessing the maintenance aspects of rail track and related matters. It was noticed that there were corrosions of rail, tie plates, nuts and bolts indicating that there was presence of water/ moisture near the track. Hence, DMRC should have ensured prevention of water leakage during maintenance for good rail life.

(ii) For removing the contaminants/ingress from lubricated surface of head, there should be regular process, else lubricant will not be effective at the interface of rail and wheel. This will result in accelerated wear of wheel flange and side of rail head causing increase in the maintenance cost.

(iii) Missing bolts from the plate, besides damage on rail heads were also noticed during site visit, as shown in Figure 2.4.

Figure 2.4
Views of tie plates and bolts
(a) Missing bolts (b) corroded bolts & nuts
(Hauz-Khas station, l8 December 2019)



(a)

(b)

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that O&M wing of DMRC takes all needful action to ensure longer service life of Rails and ensured to take higher level of precautions as recommended. As per RDSO[52] approval, Pandrol fastening system has arrangements for four bolt holes in base plates but provision of two bolts is adequate for Tangent track & curves sharper than 500 meter. DMRC adopted two bolts for the Tangent track and curves sharper than 1,000 meter.

The Ministry/ GNCTD/ DMRC explanation of needful action taken is not convincing because Audit noticed corrosion of rail and contaminants/ ingress from lubricated surface of head on rails during verification and there should be a process for removing the contaminant and ingress. Further, using a plate of four holes in place of two holes and leaving two holes empty may allow moisture/ water and is a source of contamination & storage.

2.4 Signalling system

Signalling system is used to control traffic and to ensure safe operation of trains. The parameters of the system used in the project have been worked out keeping in mind the smaller headway of train operations and consequent safety requirements. In Phase-I and Phase-II, DMRC adopted Distance to Go, Automatic Train Protection, Automatic Train Supervision and Automatic Train Operations to optimise Rolling Stock operations. Detailed Project Report for Phase-III corridors envisaged adoption of Train Control & Signalling System based on Communication Based Train Control technology. This technology offers inherent built-in capability of better two-way communication between train locations on track and train. In this regard, Audit observed the following:

2.4.1 Avoidable expenditure of up to ₹23.97 crore due to deficient tender evaluation

Tenders for train control and signalling system for Line-7 and Line-8 were issued (28 September 2012 to 08 October 2012) by DMRC. The contract package CS 03 and CS 04 are given as under: -

Table 2.2

Tender	Line	Description of Sections	Route km	Number of stations	Estimated cost as per DPR (₹ in crore)	Estimated cost put to tender (₹ in crore)	Awarded cost per/ km (₹ in crore)
CS03	Line-7	Mukundpur-Maujpur-Shiv Vihar	58.59	38	568.69	435.28	6.09
CS04	Line-8	Janak Puri West-Botanical Garden	37.46	25	383.91	290.43	6.73

[52] ***Research Design & Standards Organisation: It is a research and development organisation under the Ministry of Railways of GoI, which functions as a technical advisor and consultant to the Railways Board, RITES, RailTel and IRCON International in respect of design and standardisation of railway equipment and problems related to railway construction, operations and maintenance.***

As per Para A 1.7 of Notice Inviting Tender (NIT), CS 03 and CS 04 may not be awarded to the same tenderer.

In this regard, Audit observed that:

(i) The cost per km for Line-7 and Line-8 was ₹6.09 crore and ₹6.73 crore, respectively. The financial bid of CS 03 was opened (05 June 2013) initially and followed by opening of the financial bid of CS 04 on 15 July 2013. Since the price bid of Line-8 was opened subsequently and DMRC was aware that M/s Bombardier has quoted less, efforts should have been made by DMRC to ask M/s Nippon Signalling to match the price quoted by M/s Bombardier. The price difference was ₹64 lakh per km in CS 03 and CS 04 tender. This may have resulted in a saving of up to ₹23.97 crore (37.46 km x ₹0.64 crore) to DMRC.

(ii) As per NIT, the work of Line-7 and Line-8 may not be awarded to one contractor. Once the lowest eligible tenderer is established for CS 03, the financial bid of CS 04 shall be opened. At this stage, the financial bid of the tenderer who has been established lowest in CS 03, shall not be opened. This condition put by DMRC was restrictive and did not ensure fair competition. Further, in contract CS 03, M/s Bombardier was L1 and M/s Nippon Signalling was L2. Due to restrictive condition put by DMRC, M/s Nippon Signalling who was L2 in CS 03 contract was bound to come L1 in CS 04 contract.

(iii) Calling of separate tenders resulted in two separate and distinct signalling systems for Line-7 & Line-8 for the same Rolling Stock (RS 10). Thus, DMRC has to maintain separate inventory, impart separate training to the personnel, and have separate train control system at the Operation Control Center etc. DMRC had to incur extra cost for inventory as well. Besides, rotating of personnel from one line to another may create operational difficulties due to differential understanding of the signalling systems.

Thus, the condition placed by DMRC was restrictive and did not ensure fair competition. This has resulted in avoidable expenditure of ₹23.97 crore.

The Ministry/ GNCTD and DMRC has accepted (January 2021 and July 2020) the Audit observation and stated that for similar contracts in future, after deciding L1 in the first tender, financial bids of all the bidders in the 2nd tender would be opened. If L1 is the same for both the tenders, then L2 would be asked to counter offer the rates of L1.

2.4.2 Deficiencies in the Communication Based Train Control System

As per the final Report (November 2013) of Sub- Committee on Standardisation of Signalling & Train Control System constituted by MoUD, the Communication Based Train Control System, as defined in the IEEE[53] 1474 standard, is a "continuous automatic train control system utilising high resolution train location determination, independent of track circuits, continuous, high capacity, bidirectional train-to- wayside data communications, and train borne and wayside processors capable of implementing vital functions. Communication Based Train Control system includes the following

[53] *the Institute of Electrical and Electronics Engineers*

subsystems, 1) train onboard system, 2) train-to-trackside radio system, and 3) backbone trackside signalling system. The subsystems work individually and, in case of failure, coordinates with each other without disturbing their operation.

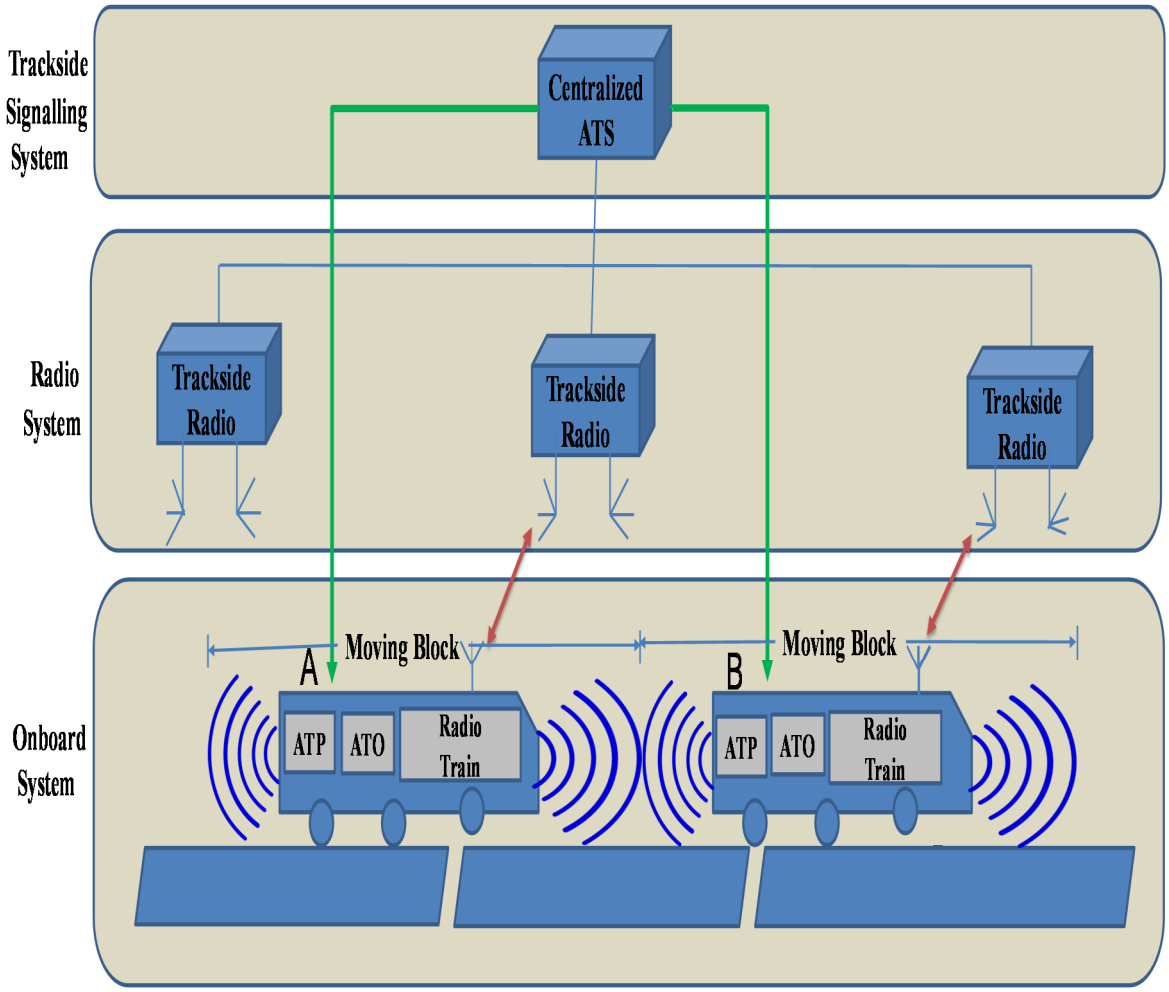
The onboard system contains Automatic Train Protection, which controls safety-related functions and determines movement authority and Automatic Train Operation, which controls the actual train driving functions and can be used to realise driverless operations.

The onboard system detects the train location and sends this information to the trackside signalling system, which further uses this information to form the control pattern (information) sent to each train. The onboard system calculates the control pattern and controls the speed of the train.

The trackside signalling system controls the train headway and controls interlock (route). It contains Automatic Train Supervision responsible for the overall centralised signalling and train operation data. Centralisation of the system improves the availability of the track operation by controlling all functions from a single processing unit.

Figure 2.5

Functional diagram of the Communication Based Train Control system



This technology has been approved by MoHUA and following is observed in this regard.

(i) Reduced reliability due to wireless connections of Access Points of the Communication Based Train Control system

During verification at Line-8, it was observed that Access Points are wirelessly connected inside the tunnels without any redundancy. Due to curvature in the tunnels, the wireless signal from one Access Point reaches another Access Point after getting reflected through multiple paths, resulting in multipath fading (interference from several reflected paths). This may result in severely reduced amplitudes at the receiver, decreasing the reliability of the link. Due to multipath fading, this architecture has a decreased reliability[54], which is a deficiency in planning or designing by DMRC. Thus, proper measurements and tests must be conducted to gain assurance regarding the possibility of fading in such architectures.

In Line-7, the Access Points are connected using optical fibres. The transmission mode of the free wave has the worst anti-interference capability to WiFi signals[55]. Thus, the architecture of the Line-7 has better reliability (due to no fading and low interference susceptibility to WiFi), and consequently, better up-times. However, DMRC did not put this (wired connections of the Access Points) as a requirement in their tender, leading to a less reliable architecture in Line-8.

There are also other noted advantages of using wired connections between the Access Points**,** such as longer link length, as a signal in free space suffers from a higher attenuation. Thus, a higher number of Access Points are typically required in wireless Access Points compared to the Access Points connected through wired infrastructure. During site visit from Hauz Khas metro station to IIT metro station at Line-8, discussion with the metro staff also revealed that the speed of the train is less in the tunnel as compared to viaduct. However, the actual up time data to assess the speed inside tunnels was not provided by DMRC. It is felt that one of the reasons for the speed being curtailed was due to non-installation of adequate number of signalling equipment. Thus, Access Points are wirelessly connected without any redundancy thereby reducing the up-times[56] of the Communication Based Train Control system which would pose reliability concerns in the required up-time.

The Ministry/ GNCTD and DMRC agreed (January 2021 and July 2020) that the system connected using wired cables is more reliable and is cost-effective in principle. However, it felt that only allowing the vendors who supply the system connected using wired connections will make the tender very restrictive.

---

[54] ***L. Ming, H. S. Wang, H. Zhao, and L. Zhu, "Test and analysis on the interference to the Communication Based Train Control systems by WiFi signals," International Journal of u-and e-Service, Science and Technology, vol. 8, no. 3, pp. 123-132, 2015***

[55] ***T. Wen, C. Constantinou, L. Chen, Z. Tian, and C. Roberts, "Access Point Deployment Optimisation in Communication Based Train Control Data Communication System," IEEE transactions on intelligent transportation systems, vol. 19, no. 6, June 2018***

[56] ***Availability of a system***

Reply of Ministry/ GNCTD/ DMRC is not acceptable as it is possible to create competitiveness amongst vendors who supply wired connections. In spite of an open tender (where both wired and wireless connectivity was allowed), a vendor with wired connectivity had qualified for Line-7, which indicate that vendors with wired connectivity are available. Thus, explicit demand for wired connectivity would have ensured the vendors to supply Communication Based Train Control system with wired connectivity. Moreover, considering the advantages that wired connectivity provides, this should be made as a requirement. DMRC further, agreed to specify certain reliability specifications that every prospective vendor must satisfy to achieve the desired performance. Technical Consultant (IIT Delhi) suggested that reliability needs be measured differently for tunnels and viaduct and to prescribe different sets of specifications for each scenario. The reliability needs should also consider the future evolution of the metro, e.g. if they plan to run the trains with headway of 90 seconds, the reliability parameter should take that into account. A proper study of the actual channel between the Access Points and the duration of its going into deep fade (when the received power is too low to receive accurately) must also be examined.

(ii) Excess values of Mean Time between Hazardous Events, Mean Time to Repair and Mean Time between Failures

DMRC must quantitatively estimate the Communication Based Train Control performance safety requirements as is outlined in IEEE1474.1TM-2004[57]. DMRC should ensure that the total calculated aggregate Mean Time between Hazardous Events (a total of all critical and catastrophic hazards) is less than 10^9 operating hours. Also, IEEE 1474.1 TM-2004 specifies a Mean Time to Repair level 1 of less than 30 minutes and Mean Time between to Repair level 2 of less than 2 hours.

Table 2.3
Mean Time between Failures and Mean Time to Repair data for Line-7 and Line-8

Equipment	Line-7	Line-8
Computer based Interlocking	48,551.13	33,748.63
Communication Based Train Control on Board	245.05	366.37
Communication Based Train Control Wayside	9,325.83	1,24,749.73
Automatic Train Supervision	3,817.87	20,605.23
Mean time to Repair (in hrs) for line-7 and line-8		
Computer based Interlocking	5.29	6.26
Communication Based Train Control on Board	4.19	5.08
Communication Based Train Control Wayside	4.71	7.31
Automatic Train Supervision	9.98	10.50

[57] *Institute of Electrical and Electronics Engineers (IEEE) P1474.1 is a Standard for Communications-Based Train Control Performance and Functional Requirements*

Data provided by DMRC (Table 2.3) indicates that the Mean Time between Failures[58] and Mean Time to Repair values are relatively high. For example, values of Mean Time to Repair are greater than 4 hours and extend up to 10 hours, which is high. Also, the availability values reported by DMRC in its reply was 98.32 *per cent* for Line-7 system and 98.63 *per cent* for Line-8 system. In contrast, the requirement in Safety Integrity Levels-4 standard is of 99.999 *per cent*. Thus, the availability of the system is also low as compared to norms.

DMRC agreed that these values are low, as this is their first experience with the Communication Based Train Control system. DMRC also agreed for regular tracking of these parameters in future and to take proper action if some parameters are not found meeting the standard requirements. DMRC, however, failed to provide any data on Mean Time between Hazardous Events. It is imperative to ensure continuously gathering the value of parameters, namely, Mean Time between Failures, Mean Time to Repair, and availability, and to take proper corrective measures (re-planning routes, e.g., by reducing the frequency of the trains) if any of these are found not within their proper limits as a poor design of the Communication Based Train Control system will raise safety and performance issues (the frequent breakdown of the Communication Based Train Control system).

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that DMRC is implementing Communication Based Train Control for the first time and that all teething problems regarding design will be identified and resolved within the Defect Liability Period. DMRC is also continuously gathering various parameters namely, Mean Time between Failures, Mean Time to Repair and taking corrective measures to improve performance of the system. During Exit Conference (September 2020), DMRC stated that there has been no failure so far for their signalling system in terms of safety. Therefore, there parameters related to Mean Time between Hazardous Events are satisfactory. However, they have not calculated this parameter as there is no hazardous event so far to some extent.

In view of above, it is suggested that the parameters may be gathered and monitored by DMRC continuously and corrective measures should be taken as and when required.

(iii) Vulnerability to Interference and Jamming in the Communication Based Train Control

Communication Based Train Control system uses 2.4 GHz, which has the same spectrum as WiFi. This is likely to cause interference with the increase in mobile WiFi, besides being prone to intentional jamming of the signal. Several incidents of jamming of the Communication Based Train Control system have been reported in other countries. The Communication Based Train Control system of different lines uses different technologies as mentioned below:

[58] ***Mean Time between Failures should be greater than one lakh hours for an MTTR of 2 hours, for an availability of 59 seconds***

Table 2.4
Features of various signaling systems adopted

System	Advantages	Disadvantages
Nippon signalling, Line-8	Radios are not IEEE 802.11n compatible Uses code division multiple access (CDMA) and frequency division multiple access (FDMA)	Only uses 2.48 GHz
Bombardier transportation, Line-7	Radios are not IEEE 802.11n compatible Uses a direct sequence spread spectrum (DSSS)	Only uses 2.48 GHz
Ansaldo ATS, Noida metro	Uses two bands 2.48 GHz and 5.8 GHz	Use simple differential phase-shift keying (DPSK)

Audit along with the Technical Consultant (IIT Delhi) noted that irrespective of the physical layer solution adopted, there is no system immune to jamming, which remains a challenge for the Communication Based Train Control system working in 2.4 GHz. Thus, the best solution is to adopt the Communication Based Train Control system at some other licensed band so that the manufacturing of equipment in that band is strictly prohibited. Also, DMRC must conduct a test to measure the power required to jam various systems and assess a possibility for that. It is also important to note that in case of failure of the Communication Based Train Control system, the signalling system operates on the manual mode using the axle detectors and the axle detector slows down the trains, thereby affecting the revenues of DMRC.

DMRC acknowledged their awareness of the problem of interference and jamming and indicated that they have considered using a licensed spectrum in the past. However, this was not followed up as it would not be cost-effective.

It is recommended to carry out proper tests on the possibility of jamming and to identify the power levels at which various systems could be jammed. Based on the test results, DMRC must take proper corrective measures. Thus, DMRC needs to remain alert about interference and jamming and take appropriate action, as that and the arrival of 5G may further compound the problem of interference and jamming.

The Ministry/ GNCTD and DMRC has accepted (January 2021 and July 2020) the Audit observation.

2.5 Electrical issues

Electrical energy[59] is required for operation of metro system. Various issues related to procurement of traction transformer and auxiliary main transformer of higher size and non-optimal location of Receiving Substation in Phase-III were noticed.

[59] ***Receiving substation comprises of Traction & Auxiliary substations where Traction substation is for running of trains and Auxiliary substations for station services including illumination of buildings, air conditioning of underground stations, ventilation of tunnels, lifts, escalators, signaling, telecommunication, fire fighting, workshops, depots and other maintenance infrastructure within the premise of metro systems.***

(i) Traction Transformer

As per the DPR, the projected power demand was estimated to be 150 MVA on Line-7 and 90 MVA on Line-8 for the year 2031 for nine car 90 second headway operation. This was the basis on which the capacity and design of the Traction Transformer was done by DMRC. After deliberation, Managing Director DMRC decided to have six car operations on Line-7 and Line-8 during Phase-III. At the time of calculating the requirement of Traction Transformer, DMRC had taken 90 seconds headway which was not envisaged till 2046 as per Phase-IV DPR. Detailed Traction Simulation sizing Study was conducted by Detailed Design Consultant, Ardanuy Ingenieria on Line-7 and SYSTRA on Line-8. Five new Receiving Substation were constructed on Line-7 and three new Receiving Substation on Line-8 while one Receiving Substation at Botanical garden was augmented for Line-8. The power supply by each Receiving Substation catering to several metro stations is shown in the picture below:

Figure 2.6

Line-7 (55.697 km and 38 metro stations)

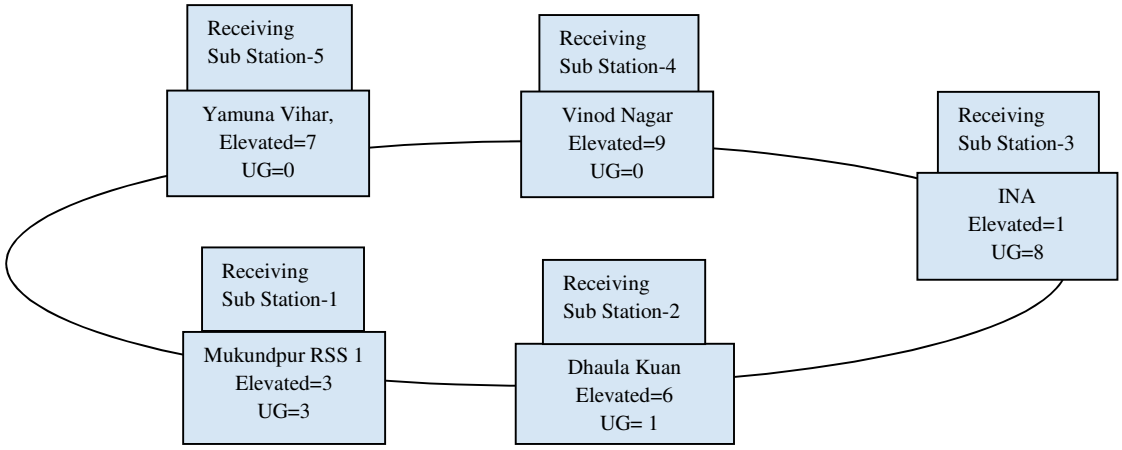


Figure 2.7

Line-8 (33.494 km and 25 metro stations)

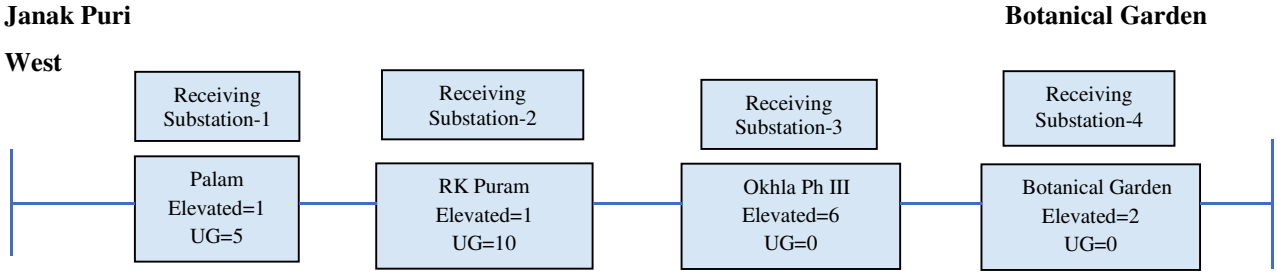


Table 2.5
Total power demand estimates as per DPR

Line	Corridor	2016	2021	2026	2031 (for 6 car)	Designed Headway of (9 car train at 90 Seconds)
7	Yamuna Vihar Mukundpur	69.9 (37.5+32.4)	80.6	89.8	110.7 (62.3+48.4)	198.7 (150.3+48.4)
8	Janak Puri West Kalindi Kunj	53.2 (18.5+34.7)	63	67.8	77.8 (31.4+46.4)	136.4 (90+46.4)

Audit along with Technical Consultant (IIT Delhi) observed that the estimated traction power for Line-7 is 62.3 MVA in 2031. The design of the Traction Power is mentioned as 150.3 MVA for 9 Car 90 seconds headway. Thus, higher value of designed power demand was assumed (150.3 MVA) for the traction purpose against required traction power of 62.3. For Line-8, requirement was 31.4 MVA and design was done for 90 MVA. This increase in power demand was without any proper justification. Any justification for this higher design for traction power was also not available in the DPR. Also, there exists an ambiguity in the number of car operation and headway[60] for deciding the traction power requirement for Line-7 and Line-8 within the DPR.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that Traction Power Requirement for nine Coach 90 second headway is 150 MVA (Line-7) and for six Coach 90 second headway is 100.2 MVA (Line-7). Five Receiving Substations were planned to feed a total of 54 km long Line-7. The total traction power requirement is 100 MVA for six Car configurations at 90 second headway. The capacity of Traction Transformer shall be designed based on N-1 configuration[61], therefore 40 MVA (100/5=20x2) traction transformer at each Receiving Substation is required and 40/ 50 MVA Traction Transformers have been installed.

The Ministry/ GNCTD/ DMRC reply is not acceptable as deciding the Traction Transformer capacity by the thumb rule and dividing the total power requirement with the number of Receiving Substation is technically not justified as observed by the Technical Consultant (IIT Delhi). Transformer capacity should be decided with proper simulation study for various train running conditions, load etc.

(ii) Traction Transformer for Line-7

a) Audit along with the Technical Consultant (IIT Delhi) observed that total Root Mean Square[62] power requirement for Line-7 is 75.352 Mega Volt Ampere (MVA). The maximum power drawn is for a very small time which depends on the gradient of the track, operating condition of the rail and other factors. It is observed that Root Mean Square loading of 12.114 MVA (Mukundpur), 19.605 MVA (Vinod Nagar) and

[60] ***In DPR Annexure 6.1 design of Receiving Substation considers nine car operation and Annexure 6.1.2 considers six cars***
[61] ***N-1 Configuration means when one Receiving Substation fails***
[62] ***Root Mean Square – The sizing of the Traction Transformers is done on the Root Mean Square power***

12.625 MVA (Yamuna Vihar), were well below the normal rating of 40 MVA. Hence, Traction Transformer can be of lesser capacity than 40/ 50 MVA in these stations.

b) Under normal operating condition (without contingency), the loading of all the Traction Transformers is not uniform, this could have been achieved at the planning stage, to make the loading uniform, thereby reducing the stress in contingency.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the study was done with six coach configurations at headway of 135 second whereas system was designed for nine car configuration with 90 second headway. So, for design condition and for six car configuration 90 second headway condition, maximum MVA requirement will be greater than 132.416 MVA. Transformer at Mukundpur and Yamuna Vihar Receiving Substation are kept of the same rating for separability/ standardisation purpose. Further, during Phase-IV of the project, extension of Line-7 is also planned from Mukundpur to Maujpur-Babarpur corridor for an approx. length of 12.6 km. The traction power requirement of this extended corridor was also envisaged at the time of selection of rating of Traction Transformer. Further, the traction power requirement (Root Mean Square value) under (N-1) conditions are generally in the range from 38 MVA (Mukundpur) to 55 MVA (Dhaula Kuan). Hence, Traction Transformer of rating 40/ 50 MVA were selected.

The Ministry/ GNCTD/ DMRC reply is not acceptable as power requirement at each of the Traction Transformer throughout the line will never attain the maximum value at the same time and the total maximum power demand will never reach 132.416 MVA. It is not technically clear why all the transformers are of same capacity for separability/ standardisation purpose. This view is also endorsed by the Technical Consultant (IIT Delhi). The calculation/ simulation of power requirement for the Phase-IV project, where the extension of Line-7 is planned from Mukundpur to Maujpur-Babarpur corridor was not provided to justify the size of Mukundpur Traction Transformer. Further, DMRC is referring to old study report (June 2012) while giving the Root Mean Square values, whereas Audit had considered the subsequent report (September 2013). In the Exit Meeting, it was discussed and recommended that DMRC being a world class metro operator should carry out technical study to decide on the sizing of Traction Transformer.

(iii) Traction Transformer for Line-8

The scope of the study as per the Detailed Design Consultant contract is to validate the location of Receiving Substation and sizing of the transformers and cables. All the N-1 contingency (when one Receiving Substation fails) has been studied for a minimum of 135 Second headway for a portion of Line-8.

In the case of N-1 contingency, the maximum loading of Palam Traction Transformer is around 30 MVA and for Okhla just around 20 MVA. Besides, Traction Transformer at R K Puram is just 40 MVA even in contingency. Hence, the sizing of the transformer at all the three stations is oversized as observed by Audit along with the Technical

Consultant (IIT Delhi). Also, location of Receiving Substation was predefined rather than finding the optimal placement.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the transformer of Palam Receiving Substation is at Dead End of the Line-8 and hence, its optimum capacity is not utilised. In Phase-IV, Botanical Garden-Janak Puri West corridor is proposed to be extended upto R K Ashram Marg. The traction power requirement of this extended portion will increase by 10 MW. Further, under (N-1) conditions, the Traction Transformer capacity works out generally in the range from 32 MVA (Okhla) to 55 MVA (R. K. Puram) at 90 second headway. Therefore, traction transformer capacity was decided based on the simulation report and with maximum capacity required under N-1 condition i.e., 40/ 50 MVA.

The reply of Ministry is not acceptable as no supporting calculation/ simulation document to justify why the additional size of 10 MW for Palam to dead end of the Line -8 (5 km approximately) was provided. Even additional loading of 10 MW (8 MVA) at Palam Traction Transformer will make the normal condition loading less than 30 MVA (17.143 + 8). The heavy loading at R K Puram and Okhla are during C2 and C3 mode, which are done at lower headway than C1 and C4 mode in N-3 contingency[63]. The study could have been done with the relaxation of these two modes to find the transformer loading. Hence, the sizing of all transformers is oversized, which would have resulted in the increase in size of the cables too.

(iv) Auxiliary Main Transformer

a) In Phase-I and Phase-II, DMRC constructed metro stations for eight car trains operations and the capacity of the auxiliary main transformer installed in the Receiving Substation was of 15 MVA and 30/ 45 MVA. In Phase-III, DMRC constructed metro stations for six car train operations on Line-7 & Line-8. However, each Receiving Substation has two auxiliary main transformer of 30/ 45 MVA.

b) For Line-7, Audit along with the Technical Consultant (IIT Delhi) observed that although the DPR envisages a total load demand of 48.4 MVA, the load demand based on which the auxiliary transformer (33 KVA) sizing was done by Ardanuy was 75.927 MVA. It was also observed that the maximum load required during the contingency is well below the capacity of 45 MVA. Some of the auxiliary main transformer could have been of lower rating as each Receiving Substation is of 30/ 45 MVA. Further contingency analysis done by the Detailed Design Consultant and DMRC are resulting in different MVA requirement. Hence, a proper sizing of the auxiliary main transformers at various Receiving Substation could have been achieved by making suitable number of stations attached to the auxiliary main transformer at a particular Receiving Substation.

c) For Line-8, Audit along with the Technical Consultant (IIT Delhi) observed that none of the auxiliary main transformer is reaching its natural rating of 30 MVA. The auxiliary main transformer at Okhla Phase-III is loaded to only 17 MVA and at Palam

[63] ***N-3 Configuration means when three Receiving Substation fails***

it is loaded to 21.5 MVA which are much below the normal rating of 30 MVA. Further, the contingency analysis is not found for the auxiliary main transformer by the Detailed Design Consultant. Further, with proper planning either the capacity of auxiliary main transformer at Palam or at Okhla could have been reduced.

Thus, the DMRC procured and installed auxiliary main transformer of higher capacity than the actual power requirement based on the size of stations of Line-7 and Line-8.

DMRC replied (July 2020) that in Phase-I & Phase-II, 15 MVA transformer were installed for the section supplying load to only elevated stations and 30/ 45 MVA auxiliary main transformers were installed for the section supplying load to both elevated and underground stations. Line-7 of Phase-III has a mixture of both elevated and underground Stations, therefore transformers of 30/ 45 MVA were installed. The Ministry replied (January 2021) that during detailed design stage, DMRC had considered load factor based on the past experience and demand of auxiliary power was reduced at each elevated station as 500 kW, at each underground station as 2,500 kW and at maintenance depot as 2,000 KW and was accordingly considered for calculating the rating of auxiliary main transformer at each Receiving Substation. To meet the requirement, 30/ 45 MVA transformer available as a standard product with the manufacturers was selected to cut down time as well as cost required for type testing for speedy completion of project.

The Ministry/ GNCTD/ DMRC reply is not acceptable as the size of the stations constructed during Phase–III were small as compared to stations constructed in Phase-I and II. Further, Technical Consultant (IIT Delhi) also stated that rather than deciding the capacity of the auxiliary main transformer based on the type of stations, it should be based on the power requirement calculation after proper study in the planning stage.

2.6 Heating, Ventilation, and Air Conditioning

Heating, Ventilation, and Air Conditioning is the technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality. Audit noticed the following in this regard:

2.6.1 Provision for Platform Screen Doors

Platform Screen Doors, also known as Platform Edge Doors, are used at train or subway stations to separate the platform from trains. Platform Screen Doors act as a physical barrier preventing people or objects from falling onto the tracks. Platform Screen Doors also improve climate control within the station. In Phase-III, DMRC adopted half height Platform Edge Doors, mainly from the passenger safety point of view. Since decision for investment in Platform Edge Doors infrastructure was already made, switching to full height Platform Screen Doors would not have caused any significant cost increment.

Figure 2.8

Full Height Platform Screen Doors and Half Height Platform Edge Doors

Audit along with the Technical Consultant (IIT Delhi) observed that the matter of using Platform Screen Doors is an important one for underground station design and Heating Ventilation and Air Conditioning energy savings, DMRC did not carry out an extensive study on the Platform Screen Doors in Phase-III, even though civil structure for the same was part of the DPR. This was despite availability of design experience from the two earlier Phases of DMRC, and other metro agencies in the country (Chennai Metro, Airport Line in Delhi etc.), going ahead with full height Platform Screen Doors for energy savings in similar timeframe.

It was also observed that tunnel cooling is only needed in extreme weather (ambient T>43^{o} C), and congested mode operation with trains stopping in the tunnel. Such short duration loads can be catered by tunnel ventilation and by thermal inertia of tunnel. But the use of Platform Screen Doors may help in reducing the station Heating Ventilation and Air Conditioning load substantially.

The station heat load summary for reviewed stations indicated that typically more than 60 *per cent* of station air conditioning load are Subway Environment Simulation loads, or heat coming from the tunnel. With the help of Platform Screen Doors, the station air-conditioning load would have reduced significantly, leading to smaller Heating Ventilation and Air Conditioning capacity requirement. This would also result in lower requirements of electrical infrastructure and space needed for the station Heating Ventilation and Air Conditioning equipment including ducting.

Thus, DMRC installed half height Platform Screen Doors without energy saving studies. This has resulted in installation of higher capacity electrical equipment and consequent higher operation & maintenance cost.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that with the introduction of full height Platform Screen Doors, the station loads are decreased but it necessitates the provision of tunnel cooling. Platform Edge Doors in Phase-III have been provided majorly to control crowd at the platform. It was also submitted that

based on this observation, during extreme ambient conditions, active tunnel cooling would be required. This is achieved by locally cooling tunnel air at a number of locations. The motion of the train carries the cooled air down the tunnels. The heated air at the end of the tunnel run is captured by the track way exhaust system and recirculated to an air handling unit for re-cooling. Cooled air is then also available to be directed across stalled trains during congestion. If the total cooling required per station to achieve design limits in this way is less than that evaluated as part of the non-Platform Screen Doors analysis, the plant capacity initially installed would be adequate to perform satisfactorily when platform screen doors are installed. Therefore, to deal with the congestion during the summer months (15 April to 15 July), it is required to regularly cool the tunnel so that cooled air is available to be directed by Tunnel Ventilation Fan in case of congestion. In Phase-IV, full height Platform Screen Doors has been considered in view of the increased headway of about four to five minutes of upcoming corridors.

The reply of the Ministry/ GNCTD/ DMRC is not tenable because their response on Platform Screen Doors was not justified through any studies so far. It seems more like an expectation or general statement about the suitability of Platform Screen Doors for increased headway in Phase-IV and needs to be qualified with more detailed studies. The active tunnel cooling and recirculation of heated air through Air Handling Unit also needs to be evaluated by DMRC more critically and carefully from all perspectives. With Phase-IV already underway, the strategy and detailed design calculations of implementation of Platform Screen Doors seem to have been much delayed.

2.6.2 Tunnel Ventilation and Fire safety

The importance of Tunnel Ventilation and Fire safety aspects in underground station design cannot be understated as it concerns with safety of human lives. It also received significant attention in the design documents reviewed. It could be said that there is no major concern with the tunnel ventilation, fire-safety and smoke extraction arrangements.

The Ministry/ GNCTD in its reply (January 2021) has accepted the Audit observation.

Conclusion

DMRC's funding plan for three Phase-III corridors was in contravention of National Urban Transport Policy, 2006 as GoI contribution towards capital cost exceeded the 20 *per cent* limit, resulting in excess contribution of ₹421.34 crore. DMRC recommended two financially unviable corridors (Badarpur-Faridabad and Maujpur-Shiv Vihar) with negative Financial Internal Rate of Return, one corridor (Najafgarh-Dhansa Bus Stand) having below benchmark Financial Internal Rate of Return of 8 *per cent* and considered inflated Fare Box Revenue to make the four corridors of (i) Dilshad Garden to Ghaziabad, New Bus Adda, (ii) Noida City Centre to Noida Sector-62, (iii) Kalindi Kunj metro- Botanical Garden, and (iv) YMCA Chowk (Faridabad) to Ballabhgarh viable.

Further, in violation of the MoUD Guidelines, a chapter on Comprehensive Mobility Plan highlighting the development of an integrated plan was not included in the Phase-III DPR formulated by DMRC. Resultantly, integrated planning with respect to land use and transport, integration of various modes (fares, routes, and facilities) and institutional framework for coordination was not ensured by DMRC.

In the absence of any internal guidelines/ Standard Operating Procedures of DMRC for preparation of DPRs, DPRs were prepared on different assumptions. Detailed Project Reports of three corridors (Dwarka-Najafgarh, Mundka-Bahadurgarh and Maujpur-Shiv Vihar) were prepared in contravention of guidelines of Working Group on Urban Transport and RITES study as other modes of transport like Light Metro/ Bus Rapid Transit were not explored. Resultantly, high capital cost was infused into the projects and consequent higher operation and maintenance cost. DMRC also recommended two financially unviable corridors (Dwarka-Najafgarh and Mundka-Bahadurgarh) after considering revenue from Property Development without ensuring the availability of required land.

DMRC changed the train operation from nine cars to six cars without detailed justification after sanctioning of Phase-III projects eliminating the possibility of further expansion to cater the increase in future ridership. DMRC procured rails of relatively low hardness which may result in increased maintenance cost due to decreased life of rails and wheels. DMRC also procured higher capacity of Traction Transformer due to estimation of higher projected demand, which resulted in higher capital expenditure. Further, DMRC procured and installed Auxiliary Main Transformer of higher capacity than the actual power requirement in Line-7 and Line-8. Half height Platform Screen Doors were installed instead of full height Platform Screen Doors resulting in installation of higher capacity electrical equipment and consequent higher operation & maintenance cost.

Thus, various deficiencies were noticed in the planning process adopted by DMRC adversely affecting the operations and financial viability of the MRTS as brought out in the chapter on operation and maintenance and Revenue Management. Besides, the deficiencies also affected the selection of the most appropriate technology.

Recommendations

1. ***DMRC should ensure at the project planning stage itself that Detailed Project Reports are prepared with realistic assumptions for computation of Financial Internal Rate of Return to ensure economic viability of the corridor.***
2. ***DMRC may formulate a policy for selection of type of corridor, interchange between two stations, and mode of interchange facility, which would benefit future Mass Rapid Transit System projects in the country. Also, the policy document may clearly define the circumstances under which deviations from the stated policies are allowed.***
3. ***DMRC may consider preparing Guidelines/ Standard operating Procedures for formulation of the Detailed Project Reports for future metro rail projects/***

expansion. The revised Detailed Project Reports may be approved by the Board of Directors before submission to Government of India and Government of National Capital Territory of Delhi.

4. *A Guideline/ criteria for selection of mode of transport for different scenarios like Light Metro, Bus Rapid Transit system based on viability and alternative analysis may be formulated.*

5. *DMRC should ensure timely availability of land for Property Development which is of paramount importance to make the project financially viable.*

6. *DMRC may consider optimising the sizing of Traction Transformers in Receiving Sub Stations instead of putting transformers of uniform capacity across all Receiving Substation on a Line.*

7. *DMRC may consider full height Platform Screen Doors including evaluation of its effect on Heating, Ventilation and Air Conditioning requirements in the under-ground station design studies.*

CHAPTER-3
CONTRACT AND PROJECT MANAGEMENT

Chapter 3
Contract and Project Management

3.1 A comprehensive framework of rules and procedures for tendering and contract management is essential for execution of works in an economic, efficient, effective and transparent manner. DMRC formulated (2012) and adopted Procurement Manual for procurement of goods and services. DMRC also formulated General Conditions of Contract, formats for Notice Inviting Tender, Instructions to Tenderers, and Schedule of Powers to different levels of officers. Besides, DMRC followed guidelines of Japan International Cooperation Agency (JICA) for JICA funded contracts.

Audit analysed the procurement of goods and services at the Pre-tender[64], tender[65] and execution stages by reviewing 47 selected civil contracts and 03 other contracts (CC-11, CC-86 R and CC-95) out of 127 civil contracts (more than ₹ 5 crore) executed during Phase-III to assess whether project execution and contract management was done with due care, economy and in a timely and transparent manner. The significant deficiencies noticed are brought out in the following paragraphs.

3.1.1 Discrepancies in estimation of cost of work

In the DPR (February 2011), the estimated cost of elevated station and viaduct were ₹20.59 crore per station and ₹29.87 crore per km, respectively. These were assessed on the basis of the completion cost of Phase-II, duly updated to January 2011 price level by adding escalation of five *per cent* per annum. DMRC estimated (March 2012) the civil construction cost as ₹598.19 crore for CC-26R contract for construction of viaduct of 9.03 km and eight elevated stations.

In this regard, Audit observed that the cost estimation was made by escalating the awarded rates (awarded in 2006) of BC-7, BC-8 and BC-9 by five *per cent* per annum to obtain the estimated rate as in February 2012 (i.e., 34 *per cent* increase). These works were completed in 2009-2010. Computation of estimated price of CC-26R contract by escalating the six year' old rate by five *per cent* per annum, resulted in higher estimated cost by 23 *per cent* (i.e., 34 *per cent* calculated on the basis of five *per cent* per annum minus actual price escalation i.e., 11.02 *per cent*). DMRC invited (August 2012) Notice Inviting Tender at ₹537 crore (i.e., 90 *per cent* of estimated cost of ₹598.19 crore i.e., as per prevailing practice). Considering the actual escalation, the estimated cost was derived at ₹486.33 crore (598.19/ 1.23). Thus, the estimates were prepared on the higher side by ₹111.86 crore (i.e. ₹598.19 crore -₹486.33 crore).

The Ministry/ GNCTD and DMRC accepted (January 2021 and July 2020) that rates of completed projects are more reliable and should be considered for estimation of tender value of any work rather than using escalation @ five *per cent per annum*. Actual price escalation on the rates of completed similar work are more reliable and appropriate.

---

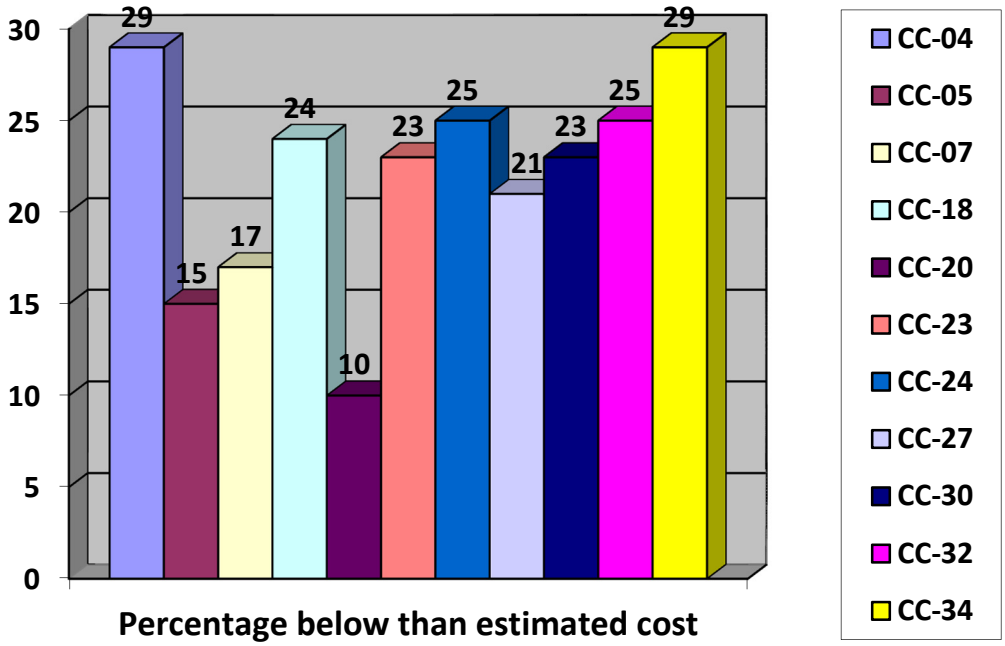
[64] ***Pre-tender stage includes cost estimation, finalisation of bidding criteria, preparation of Notice Inviting Tender etc.***

[65] ***Tender stage includes opening of bids, evaluation of bids, award of work etc.***

3.1.2 Non-preparation of justified cost estimates

The justified cost is prepared to ascertain if the bid price is reasonable and reflects the current market rates to ensure responsiveness of the bidder. The criteria could be to assign current market rates to the standard labour, material, and equipment coefficients. Since this process was not adopted in DMRC, it was not possible to be assured at any given point of time that the price quoted by the lowest bidder was justified or not. There was also the risk of susceptibility to manipulation in case of a cartel among the bidders. In case of contract CC-18, it was noticed that the contractor had quoted a rate of 24.4 *per cent* below the DPR provision and the work was awarded. There were many such cases where the tendered cost was well below the estimated cost as detailed in Chart 3.1.

Chart 3.1



It would be unreasonable to assume that the contractor quoted for such huge contracts at a prospective loss[66] or they were expecting to compromise the quality of the deliverables for the project. Had there been a system to estimate the justified cost, DMRC would have been able to know the likely cost.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the practice of making justified cost estimate is relevant when works are executed based on Bill of Quantity basis such as building works wherein the risk due to unpredictable scenario is substantially low or absent. However, in case of metro system, works are executed in an urban environment wherein the level of uncertainties regarding geotechnical strata, soil conditions, water-table, building conditions, utilities etc., are much higher. Besides, most of these works are high expertise works and cannot be

[66] ***i.e., quoting 10 per cent to 29 per cent lower than estimated price given by DMRC***

based on item rate schedules. Hence, last accepted rate of Phase-II completed works were adopted to derive the cost estimates for the works in reference.

The reply of the Ministry/ GNCTD/ DMRC needs to be viewed in the light of the fact that DMRC has been working in the same urban environment since 1996 and has gained adequate expertise to estimate costs of non-standard items like geotechnical strata, soil conditions, water-table, building conditions, utilities etc. Thus, the explanation of adopting last accepted rate is far from convincing and a progressive organisation like DMRC should not continue with it just because it is the adopted practice. Hence, DMRC may establish a cell to study the cost aspects of various projects and come up with a schedule like Delhi Schedule of Rates for metro projects. This would be a great contribution to the metro community across the country.

3.2 Appointment of General Consultant on nomination basis

During the implementation of Phase-I of Delhi MRTS project, DMRC appointed General Consultant[67] at a price of ₹208.15 crore. During the Performance Audit of Delhi MRTS Phase-I, Audit recommended (Recommendation No. 10) that the appointment of General Consultant should be based on a system where the best bid is selected based on both technical quality and financial cost.

Para 11.2.5.8 of DPR of Phase-III states that implementation of Phase-I and Phase-II has enabled DMRC to acquire expertise for implementation of metro projects. The need to engage an all-embracing team of 'General Consultant' for execution of Phase-III will therefore not arise. However, a few expatriate specialists may still be needed to assist in certain specialised areas like signalling, boring of tunnels by Tunnel Boring Machines, etc. Detailed Design Consultants for a few areas may, however, be engaged.

However, DMRC continued the consultancy service of the same General Consultant during the Phase-III project on nomination basis. Letter of Acceptance (LoA) was issued on 08 June 2012 for contract period of 51 months and their services continued upto 31 March 2020 with total expenditure of ₹235.83 crore. In addition, Detailed Design Consultants viz. M/s Ayesa and M/s Systra were also appointed for Line-7 and Line-8 and work was awarded (2011) to them at ₹64 crore. In this regard, Audit observed that:

(i) In violation of the DPR recommendations, DMRC continued the services of the existing General Consultant for the entire Phase-III and NCR extensions, in addition to appointment of Detailed Design Consultants for Line-7 and Line-8. Thus, even after 20 years in the field of execution of MRTS project, DMRC availed the services of General Consultant and Detailed Design Consultants during Phase-III indicating that DMRC was unable to develop/ strengthen its internal design or supervision mechanisms and had to depend on outside consultant. Besides, Central Vigilance Commission (CVC) guidelines restrict the award of tender on nomination basis and emphasised that

[67] ***a consortium of M/s PCI-PBI-TONICHI-JARTS-RITES***

appointment of consultant should be done in a transparent manner. Yet, DMRC did not explore the possibility of open tendering for appointment of consultant.

(ii) As per the Japan International Co-operation Agency (JICA) guidelines (Section 3.02), single-source selection may be appropriate only if it presents a clear advantage over competition in terms of natural continuation of previous work, emergency cases, very small assignment, and single eligible firm. However, a major part of the initial Phase-III corridors was based on state of art technology like Communication Based Train Control system, Unattended Train Operation based Rolling Stock, etc., which were not implemented during the earlier phases of DMRC and the length of Phase-III corridors was more than metro corridors constructed during Phase-II. Thus, the continuation of the existing consultant was not justifiable.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that to rope in the new technology of tunnelling in underground sections, Communication Based Train Control technology for Unattended Train Operation mode of operation (for the first time in India), necessitated the induction of General Consultant. The names of stations are mentioned in the DPR but design and construction method, integrating with the multi modal system required the expertise provided by General Consultant. The scope of Detailed Design Consultant was to stipulate the broad technology and assistance in preparation of Tender Documents while the role of General Consultant was to implement (including supervision of site) the project with the latest technology, construction method and assurance of high level of Safety and Quality. Since the award of contract to General Consultant was a natural continuation and the rates were negotiated in conformity with the prevailing rates, there was no need of bid comparison.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as the same technology was used in the construction of underground section of Phase-I. Even after execution of two phases of DMRC and supervision consultancy of other metros, DMRC still has to depend on supervision and monitoring by General Consultant. Further, without resorting to open bidding and comparison with other consultancy work, it is not clear how DMRC's negotiated rates were the prevailing rates. Further, Bangalore Metro Rail Corporation appointed General Consultant for Phase-I MRTS project based on Global tender/ competitive bidding basis. For Phase-II projects, Bangalore Metro Rail Corporation did not appoint any General Consultant and the work is being supervised by Bangalore Metro Rail Corporation Engineers. In case of Kochi Metro and Jaipur metro, DMRC itself is working as General Consultant. However, DMRC continued with the same General Consultant in Phase-III even after implementation of Phase-I and Phase-II of Delhi MRTS project.

3.3 Grant of special advance of ₹555.69 crore beyond contractual provisions

Audit observed that there was no provision in the contract agreements for providing special advance to the contractor. However, DMRC granted special advances of ₹555.69 crore in 13 contracts. As per the Standard Operating Procedure (December 1998) of DMRC, special advance is considered only under exceptional

circumstances in the exigencies of the progress of work with prior approval of Managing Director and finance concurrence and at an interest rate of State Bank of India Prime Lending Rate plus two *per cent* against bank guarantee of equal amount. Audit also observed that the special advance in 13 contracts were provided without analysing the financial statements of the contractors. Details of special advance paid to various contractors are given in **Annexure-IV**.

Audit further observed that there were two instances in contract CC-26 R (31 December 2016 and 25 July 2017) where outstanding advances availed by the contractor was more than the balance work to be executed.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that special advances were granted on genuine grounds after due diligence to facilitate the contractor to execute and complete the work. In addition, the contractor had to pay interest on such advance.

The reply of the Ministry/ GNCTD/ DMRC is not tenable as there was no provision in the contract agreement to provide special advance to the contractor.

3.4 Awarding of work with major change in structural drawing after award of work

DMRC floated (August 2014) Notice Inviting Tender (NIT) for construction of elevated stabling lines near Kalindi Kunj Depot and miscellaneous work (CC-90) at Jasola Vihar on Line-8 at a cost of ₹159 crore. Tender Committee evaluated (6 January 2015) the financial bids and found that the bid of M/s Afcons Infrastructure Ltd. was the lowest among three bidders at ₹184.4 crore. This offer of L-1 bidder was 15.78 *per cent* above the estimated cost of ₹159 crore. DMRC accepted the recommendation of Tender Committee to accept the offer of M/s Afcons Infrastructure Ltd., with condition to review the structure design to keep the cost within original estimates. In this regard,

Audit observed that the drawing of the elevated stabling line was revised after the opening of financial bid. After this change in structural drawing, the actual completion cost of the contract was ₹150.64 crore. Thus, there was possibility of reducing the cost by changing the drawing. However, this was not explored by DMRC prior to tender. It was only explored when the quoted price of L-1 bidder was above the estimated cost. DMRC procurement manual permits retendering only "When the lowest offer obtained exceeds the amount available under the administrative approval and it is proposed to modify the design and or specifications to bring down the cost". However, instead of re-tendering (with revised design), DMRC decided to change the design of the structure to keep the total cost within the original estimates.

Thus, DMRC has changed the structural design after the award of work. This has resulted in violation of DMRC Procurement Manual and undue favour to the contractor.

DMRC replied (July 2020) that Tender Committee minutes showed that there was possibility of bringing down the cost by suitably revising the design of structure such as span arrangement, foundation type and loading conditions. As the Tender was Bills

of Quantity based, decision was taken by the accepting authority to award the tender with necessary changes in the drawings while keeping the total cost within the original estimate. The Ministry/ GNCTD also submitted (January 2021) that discharge of tender & re-invitation would have resulted in abnormal delay in project execution as well as invite representation from L1 bidder.

The reply of the Ministry/ GNCTD/ DMRC is not tenable because the tender was Bill of Quantity based, there were significant changes in the drawing (i.e., span arrangement, foundation type, loading conditions) after opening of financial bids. These changes should have been brought to the notice to the prospective bidders to get the best quotation by re-inviting the tender as per DMRC procurement manual.

3.5 Delay in execution of Mayur Vihar Pocket I to Trilokpuri section due to indecisiveness in rehabilitating of project affected persons of Trilokpuri

As per the DPR (February 2011) of Phase-III, 18,612 square meter (sqm) government land and 685 sqm private land was required for Trilokpuri-Vinod Nagar alignment on Line-7. Social Impact Assessment study of Phase-III was conducted (June 2011) by RITES on behalf of DMRC after approval of DPR by the Board of Directors. DMRC did not envisage the relocation of 108 project affected persons in the DPR submitted (February 2011) to the MoUD and the GNCTD. In this regard, Audit observed that:

(i) As per the Social Impact Assessment study, only 88 project affected families were interviewed at two locations i.e., Shakurpur and Rajouri Garden on the Mukundpur-Yamuna Vihar section (55 km), while 325 affected structures (including 245 residential structures) were identified on the Mukundpur-Yamuna Vihar Line. However, at the time of execution, DMRC identified (September 2011) 364 structures/ units for relocation at a single location of Trilokpuri, which is over and above already identified 325 structures.

(ii) Due to delay in obtaining land from project affected persons, the work (300 meter viaduct at Trilokpuri) of ₹7.64 crore was de-scoped from CC-26 R contractor i.e., M/s ITD-ITDCEM JV and re-awarded (December 2019) to M/s Pragati Construction Consultant (CC-125 R2) at the cost of ₹20.59 crore (i.e., ₹10.28 crore[68] higher). Excess expenditure could have been avoided, if rehabilitation and resettlement of project affected persons had been done in a timely and planned manner.

(iii) Break in Line-7 at Trilokpuri affects the ridership as it was constructed for providing radial connectivity along with ring road, which connects majority of metro lines of DMRC and connects Ghaziabad/ East Delhi region directly to South Delhi/ Gurgaon region. Against the daily projected ridership of 11.11 lakh in 2019 as per the DPR, the actual ridership per day on Line-7 was only 1.73 lakh (i.e., 84 *per cent* shortfall). Thus, with the same assumptions as in DPR, DMRC has been losing estimated annual Fare Box Revenue of up to ₹1,369.16 crore[69]. Besides, DMRC was

---

[68] ***₹20.59 crore-₹10.31crore (escalated awarded cost ₹7.64 crore from 2012 to 2019)***

[69] ***11,11,133 (projected ridership of Line-7)-1,73,348 (actual ridership of Line-7) in 2018-19 X fare of average journey of 16 km i.e., ₹40X365***

also losing Non-Fare Box Revenue due to problems related to delay in awarding advertisement contracts, co-branding contracts etc.

(iv) There was also under-utilisation of Rolling Stock as out of 312 cars purchased for Line-7, only 239 cars were running/ operational in September 2019 due to low ridership.

(v) Contractor had partially completed pier and viaduct from Pier 52 to Pier 53. This work was descoped from the contractor and the balance work re-awarded to a new contractor. However, the overpayment of ₹1 crore has not been recovered till date.

Thus, Social Impact Assessment study conducted for Phase-III was deficient as it did not envisage 108 project affected person at Trilokpuri resulting in delay in rehabilitation and resettlement process. Due to delay in operationalisation of metro in this section for more than five years, DMRC has lost estimated annual Fare Box Revenue upto ₹1,369.16 crore as well as cost overrun of ₹10.28 crore.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that during Social Impact Assessment study, out of 686 (578+108) project affected families, 188 families (27.4 *per cent*) were surveyed. Further 108 plot holders having 364 project affected families at Trilokpuri did not figure in the Social Impact Assessment study due to non-cooperation of project affected persons. DMRC has been floating open e-tenders for advertisement and co-branding etc., of Line-7 and the quotes received are as per the market potential of the said inventory. Under-utilisation of Rolling Stock and depot facilities is due to non-completion of approximately 300 meter of viaduct at Trilokpuri which is in progress. DMRC has faced various problems in rehabilitation and resettlement at Trilokpuri. Rehabilitation and Resettlement is nearly complete and ongoing construction work of viaduct work will be completed by March 2021.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as non-consideration of project affected families at Trilokpuri in Social Impact Assessment study resulted in delay in planning and execution of Rehabilitation and Resettlement activities. Pre consultation with project affected families to obtain their willingness for alternative arrangements etc., which is essential for smooth rehabilitation and resettlement activities, was not done. Social Impact Assessment study which was conducted in June 2011 after approval of DPR by Board is silent on non-cooperation by project affected families of Trilokpuri. Only 88 project affected families were surveyed on Line-7 without considering 108 plot-holders having more than 500 project affected families at single location. The Ministry/ GNCTD/ DMRC has accepted that letter for recovery has been written to the contractor and final bill will be made to the contractor after making recoveries for the incomplete work.

3.6 Extra expenditure of ₹72.73 crore due to construction of elevated Majlis Park station

As per the DPR of Phase-III, Mukundpur station (now Majlis Park) was planned to be constructed at grade on the vacant land belonging to Delhi Police and Public Works Department (PWD). DMRC had to revise (21 March 2012) the alignment due to non-

availability of Delhi Police land. Thereafter, Mukundpur station (changed to elevated from at grade as mentioned in DPR) was shifted towards the left of PWD road no 51. Chief Project Manager office estimated (21 June 2012) the cost of ₹137.86 crore for construction of elevated Mukundpur metro station and depot entry, the same was approved (11 July 2012) by the Managing Director, DMRC against DPR provision of ₹62.15 crore while stating that additional financial implication of ₹75.76 crore shall be met from expected savings in civil tenders. The work was awarded (02 January 2013) to M/s Arvind Techno Pvt Ltd at ₹123.4 crore and completed on 31 May 2016 at ₹134.88 crore. In this regard, Audit observed that:

(i) DPR was not prepared with due diligence as the Consultancy Division of DMRC seemed unaware of Delhi Police's plans for the same land. Tender process for the Delhi Police Housing project was in an advance stage and going on since 2008 whereas DMRC submitted the DPR of Phase-III (containing at grade Mukundpur metro station on Delhi Police land) in February 2011. Due to non-availability of Delhi Police land for DMRC project, the alignment of Mukundpur station had to be shifted to the other side of the road, resulting in extra cost of ₹72.73 crore[70].

(ii) Mukundpur (now Majlis Park) station was constructed as an elevated station on vacant land of PWD instead of constructing at grade station, which could have saved ₹39.01 crore[71]. Elevating this station would also have repercussions for Phase-IV which would require new elevated interchange station and increase in height of piers for crossing the existing line, thereby substantially increasing the cost. Thus, DMRC did not plan Mukundpur station and alignment after exploring the possibility of at grade station.

(iii) It was also observed by the Technical Consultant (IIT Delhi) that no cost comparison of various alternatives was considered and justification for the chosen option was neither on record nor furnished. Such kind of issues can be avoided if there exists a policy for selection of a corridor. DMRC should, therefore, formulate a policy to address all the issues in connection with corridor selection. Further, the public has no option but to use whatever facilities are provided by DMRC either at ground level or at an elevation.

Thus, DMRC did not determine the location of Mukundpur station with due diligence at the time of preparation of DPR. DMRC also did not explore the possibility of construction of at grade station on the vacant land of PWD after denial of Delhi Police for construction of metro station on its land.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the Phase-III DPR was sent to the Government for approval on the basis of the Government land available at site. The Delhi Police issue came up only at the time of transfer of land. The best possible solution was, thus, adopted after leaving the Delhi Police land

---

[70] ***Completion cost ₹134.88 crore – estimated cost ₹62.15 crore***

[71] ***The amount was calculated after exploring feasible alternative i.e., at grade station, 600 meter at grade section and integrated depot entry and exit at present location of Majlis Park station***

while also keeping in view the integration of Phase-IV work. In case Majlis Park station is to be made at grade, the rail level just before Shah Alam Marg must be minimum nine meter to ensure minimum headroom of six meter as per PWD requirement/ norms. Further, the turnout/ cross over before the station and after the station are also to be accommodated in the length of 741.39 meter as per operation requirements including the length required for achieving a rail level of nine meter just before Shah Alam Marg which is 250 meter with maximum permissible gradient i.e., four *per cent*. Thus, technically the rail level at Majlis park station cannot be kept at grade.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable, in the absence of any records relating to permission/ approval for utilising the Delhi Police land before finalisation of DPR and approval stage. Further, DMRC stated that 741.39 meter length was available between end of ramp and start of Shah Alam Marg. Hence there was enough length for construction of Majlis Park station (140 meter), and front cross over facility (220 meter) at grade nine-meter headroom, with four *per cent* gradient could have been provided in 225 metre and the subsequent stretch could have been used for providing turnouts and crossover facilities. However, the same was not done resulting in extra expenditure of ₹39.01 crore to DMRC.

3.7 Construction of subway at the request of Delhi International Airport Limited at Indira Gandhi Domestic Airport

DMRC entered (March 2013) into a contract agreement with M/s ITD-ITD Cem JV for design and construction of tunnel by shield Tunnel Boring Machine, Palam and Indira Gandhi Domestic Airport underground stations (CC-32) by cut & cover method. The awarded cost of the contract was ₹752 crore. A meeting between DMRC & Delhi International Airport Limited (DIAL) was held (17 January 2013) to resolve transfer of land and other issues for construction of underground Indira Gandhi Domestic Airport station. DIAL requested DMRC to extend the passenger subway from Terminal 1C (Arrival Terminal) to Terminal 1D (Departure Terminal) with DMRC fund, and DMRC agreed to the proposal of the DIAL. A Memorandum of Understanding (MoU) was signed (30 March 2013) between DIAL & DMRC to provide the passenger tunnel from Terminal 1C to Terminal 1D. DMRC decided (August 2016) that the work of subway is to be done by inviting open tender. Accordingly, DMRC entered (July 2017) into a new contract (CC-32AR) with M/s Dharamraj Constructs India Private Limited to construct a subway from Indira Gandhi Domestic Airport metro station to Terminal 1C (arrival terminal) and Terminal 1D (departure terminal) at an awarded cost of ₹40 crore.

In this regard, Audit observed that:

(i) As per the original CC-32 contract, a subway was to be constructed from Indira Gandhi Domestic metro station to Terminal 1C (arrival terminal) of the airport only. DMRC, on the request (17 January 2013) of DIAL extended passenger subway from Terminal 1C to Terminal 1D, parking space of G+5 building and to the new terminal building which was under construction adjacent to Terminal 1C at a cost of ₹40 crore

which will be used by the DIAL for inter terminal connectivity. Thus, the actual expenditure incurred by DMRC on behalf of DIAL should be recovered from the DIAL.

(ii) The work of subway from Indira Gandhi Domestic Airport metro station to Terminal 1C (arrival terminal) was deleted from the scope of contract CC-32 (₹2.77 crore) and awarded to a new contractor at ₹40 crore citing that the alignment of Phase-IV station will be passing under the subway. Till January 2021, 98 *per cent* of 32-AR work has been completed. However, approval of the MoHUA/ GNCTD under Phase- IV was from Tughlakabad to Aerocity only.

(iii) DMRC has transferred (07 June 2013) the commercial rights to DIAL for display of advertisement panels in the underground tunnel connecting Indira Gandhi Domestic Airport station and Terminal 1C and the tunnel connecting 1C and 1D. This has resulted in undue favour to the DIAL. However, the operation and maintenance of the subway was to be done by DMRC.

(iv) It was also observed by Technical Consultant (IIT Delhi) that even though space was already available on the ground, it is not clear as to whether DMRC explored the possibility of connecting them at the ground level as opposed to the more uneconomical option of underground connection. Further, the requirement was perceived based on the estimated forecast of passengers and keeping the convenience of passengers in mind. The expected ridership has not been achieved so far. As against projected daily ridership of 1,16,002 as per DPR in 2019, the actual daily ridership in December 2019 was 5,830 only. The fact that DMRC is relying on future possibility of improvement in the situation with further development at the T1 terminal further reflects the lacuna of ridership estimation and planning based on such estimates.

Thus, DMRC constructed additional subway from Terminal 1C to Terminal 1D without any provision in the DPR on the request of DIAL at the cost of ₹40 crore. This needs to be recovered from the DIAL.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that in order to provide better accessibility to metro station from departure terminal, it was decided to extend the arrival subway up to the departure terminal and the underground subway was constructed solely on DMRC requirement to attract more commuters to the metro station. Hence, its cost is not required to be recovered from DIAL. Further, the work of subway was deleted from the scope of CC-32 because keeping the contract CC 32 open would have resulted in high idling cost as the decision of the interface issues are pending with DIAL. Provision is kept in the subway in advance for Phase-IV alignment. The Ministry stated (January 2021) that the purpose of the subway was to connect the Arrival and Departure Terminal with the existing metro station and not to interconnect the two terminals mutually. Further, definitive agreement (including commercial rights) shall be signed only after finalising all the balance minor interface issues related to integration of airport development plan with all stakeholders including DMRC.

The reply of the Ministry/ GNCTD/ DMRC is not tenable because construction of a subway tunnel for connecting Terminals at the airport is not within the mandate of DMRC but DIAL as they charge passenger service fees from passengers for the services provided for their comfort and convenience. Connection of Arrival and Departure building results in inter terminal connectivity only. Construction of subway within the airport is beyond the scope of DMRC's mandate, which is to provide facilities and amenities within the metro stations. The reply of DMRC in respect of deleted work from earlier contractor is also not acceptable as the same amount of time will be required for meeting the interface issue in both the scenarios (i.e., executed through variation or through new contractor). Further, it is evident from the reply that the work was deleted from CC-32 before finalisation of interface issues with DIAL. At the time (May 2007) of construction of Airport Line of Delhi metro during Phase-II, DIAL paid an upfront grant of ₹350 crore to DMRC towards civil works inside the airport. On the same analogy, DMRC should have demanded grant for the work done for the subway inside the airport. Till date, neither any DPR nor the alignment from Aerocity to Indira Gandhi Domestic metro station has been approved by the MoHUA/ GNCTD. The proposal of connecting Arrival and Departure Terminal with the existing metro station was done solely on the request of DIAL and that too in the unpaid area[72]. Moreover, a definitive agreement is to be signed within two months from the date of signing of MoU (30 March 2013). However, despite lapse of eight years, definitive agreement has not been executed till date.

3.8 Flawed design of Hauz Khas interchange station resulting in inconvenience to the commuters

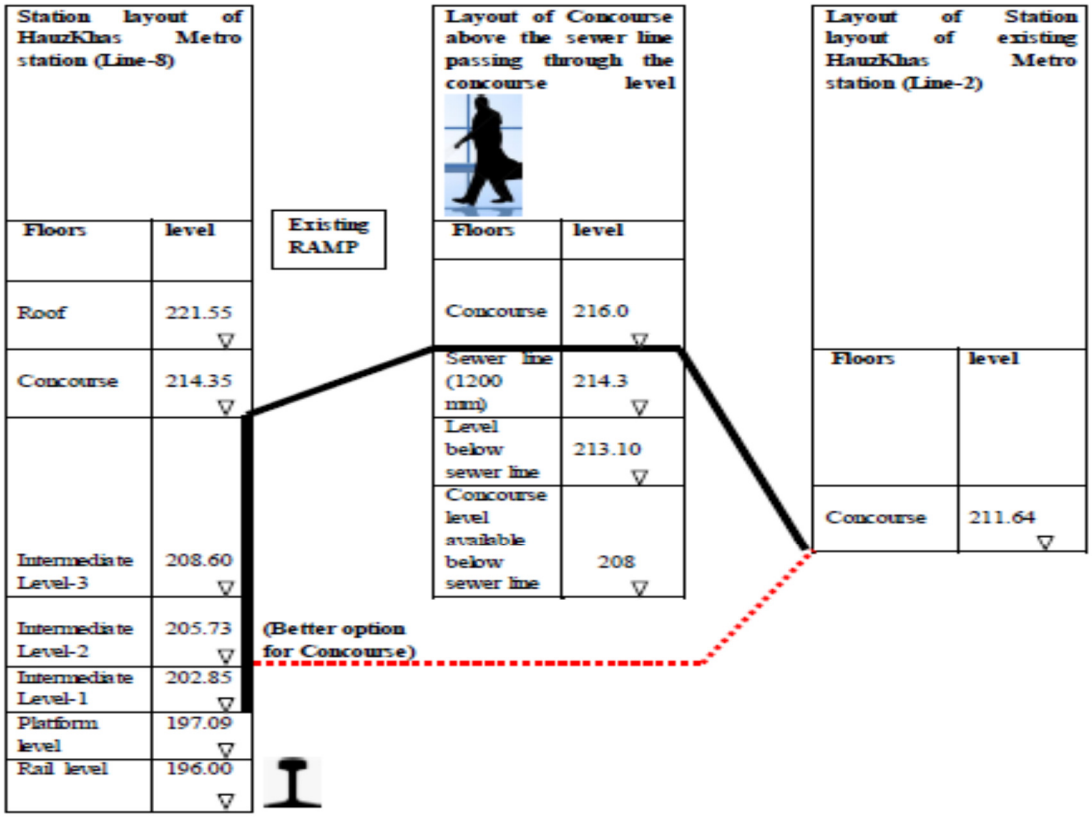
DMRC entered (January 2013) into a contract (CC 27) with M/s L&T- SUCG JV for design and construction of tunnel from end of underground ramp (near Shankar Vihar metro station) to Hauz Khas metro station on Line-8. The chainage of the new tunnel for Line-8 was passing below the existing tunnel of Line-2 constructed during Phase II. Hence, the rail level was provided at 196 meter with concourse and platform with three intermediate levels.

Audit noticed that for interchanging the metro from Line-8 to Line-2, the commuters have to come at the concourse level by passing through three intermediate levels after which they have to pass through the concourse level with ramp of two meter (above the sewer line) and then come down by using staircase/ escalator to connect the concourse level of the Line-2.

[72] ***Area outside Automatic fare collection system i.e., common area prior to ticketing***

Figure 3.1

Layout of interconnecting stations at Line-8 and Line-2



In this regard, Audit observed that:

(i) For interchanging facility at Hauz Khas metro station, commuters have to pass through three intermediate levels before passing through ramp over the sewer line to come down to the concourse level of the Line-2 (shown in above figure). If the concourse level connected to Line-8 and Line-2 passed below the sewer line, it would have been more convenient to the commuters.

(ii) By constructing the concourse level at 205.73 meter, instead of two intermediate levels, only one would have been sufficient. However, due to additional intermediate level, four environment control systems and three auxiliary sub stations had to be installed at Hauz Khas metro station (Line-8). This is in contrast to other underground stations where only two environment control systems and two auxiliary sub stations were provided. For additional intermediate level, extra lifts/ escalators/ staircases were also installed. There are several void areas at intermediate level which are presently of no use.

(iii) As per tender drawing, staircase was provided between two escalators (up and down) from concourse to intermediate level and symmetrical layout of escalators. Staircase was also provided from intermediate level to platform level. Layout of escalators and staircase from platform to intermediate level were kept as per tender drawing. However, from intermediate level to concourse, the staircase was provided

adjacent to the escalators (up & down). Thus, there was no symmetry in the layouts for both levels resulting in inconvenience to the passengers, as they cross each other.

(iv) Technical consultant (IIT Delhi) observed that the constraint of the presence of a sewer line of 1,200 mm diameter should not have been a major bottleneck as DMRC has shifted even larger sewer pipes of about 1,650 mm diameter for construction works, for example, near Jawahar Lal Nehru Stadium. The existing pipelines and other infrastructure facilities could have easily been shifted for the straight crossing thereby eliminating extra intermediate levels. Review of drawings also revealed that the concourse could have been connected with the previous level instead of taking it up and bringing it down to avoid the sewer line.

Thus, DMRC constructed the concourse level at 214.35 meter instead of at 205.73 meter. This has resulted in construction of two additional intermediate levels and inconvenience to the commuters.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that if the concourse level were provided below the sewer line, the concourse level would be 205.73 meter[73]. The concourse level of existing Hauz Khas station is 211.64 meter. Hence, there would still be a difference of 5.91 meter for passengers to travel. The top of roof slab would be 212.3 meter (214.3 meter-2 meter) and the overburden height would be 11.2 meter (223.5 meter-212.3 meter). Such a design would be very difficult and uneconomical. DMRC also stated that due to additional area of connecting subway, which is air-conditioned, the requirement of additional Environment Control Systems was unavoidable. Further, the diversion was not required if concourse was kept at 205.73 meter as suggested by Audit. DMRC had explored various option of Hauz Khas station before deciding the final design.

Reply of the Ministry/ GNCTD/ DMRC is not tenable as the sewer line of 1,200 mm diameter could have been diverted. Moreover, if the concourse level had been provided below the sewer line, the concourse level would be at 205.73 meter eliminating the need to construct two additional floors i.e., intermediate level-3 at 208.60 meter & Concourse level 214.35 meter. DMRC has accepted that two additional environment control systems and one auxiliary sub stations have been provided due to the additional area.

However, the facts remain that faulty layout of alignment of staircase and escalator causes inconvenience to the commuters.

In the Exit Conference, DMRC accepted and appreciated the Audit observation and stated that the option as pointed by Audit was not explored which would have been more convenient to the commuters.

[73] ***214.3 -2m (soil cushion)-5.5m (clear height) -1.5 m (slab thickness)***

3.9 Payment of ₹21.05 crore directly to sub-contractors/ vendors despite joint venture reservation/ refusal for the same

DMRC issued (19 June 2012) Letter of Acceptance (LoA) to M/s FEMC-Pratibha joint venture (JV Contractor) for design and construction of tunnels and four stations between Moti Bagh and Lajpat Nagar Stations (CC-18) at ₹1,089.59 crore. As per LoA, the work was to be completed by 24 December 2015. However, due to slow progress, labour unrest and other issues, DMRC offloaded the work and got them executed at the risk and cost of contractor. Managing Director, DMRC approved (September 2019) encashment of performance bank guarantee amounting to ₹54.48 crore for adjustment of liability amount spent at the risk and cost of joint venture and performance bank guarantee was encashed on 04 September 2019. Audit observed that DMRC released (September 2019) ₹21.05 crore to these sub-contractors/ vendors on the basis of joint venture letter dated 18 September 2018. But, from 01 February 2019, co-venture of joint venture was in suspension and the powers of its Board and all rights vests in Resolution Professional. Resolution Professional stated (August 2019) that more than 60 vendors have already filed their claims with the undersigned. Hence, until complete scrutiny of their claims, no amount can be released to the said vendors.

Thus, DMRC without reconciliation of the claims of sub-contractors/ vendors with Resolution Professional, released ₹21.05 crore to the sub-contractors/ vendors. This was based on JV's old letter, when Corporate Insolvency Resolution Process was not in place.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the release of ₹21.05 crore post completion of defect liability Period is merely honoring the contractor's request letter dated 18 September 2018. Further, the decision of not considering Resolution Professional as the authorised representative of the joint venture was taken based on the judgement of the Hon'ble High Court of Delhi in another case of M/s PIL-CRFG JV. Therefore, no cognizance has been given to the letter received from the Resolution Professional. Prior to transfer of the above amount, the contractor had already been asked (14 June 2019) to convey any deviations from their letter dated 18 September 2018. However, no reply was received.

The reply of the Ministry/ GNCTD/ DMRC is not acceptable as after commencement of Corporate Insolvency Resolution Process against one joint venture partner and receiving a letter from Resolution Professional, letter of 18 September 2018 does not have relevance. Further, without any contractual relationship, DMRC released ₹21.05 crore to these sub-contractors/ vendors in violation of contractual provisions. The judgement given in another case cannot be directly applied in this case, as the circumstances and merits of two cases may be different. Further, after being informed by Resolution Professional that more than 60 vendors have already filed their claims with them, it is imprudent to release any amount to the said vendor until a complete scrutiny of their claims is done. The confirmation/ receipt of letter dated 14 June 2019 from joint venture/ Resolution Professional/ contractor was not provided. As, DMRC has no contractual relationship with sub-contractor and vendors, any surplus amount

after adjusting DMRC claim should be transferred in the account of joint venture as per contractual provisions.

3.10 Construction of smaller width platform at Dwarka (new) and Nangli station

During review of Dwarka-Najafgarh corridors, the following inconsistencies were noticed:

Figure 3.2

Construction of Dwarka (new/ Line-9) platform with lesser width

As per the DPR of Dwarka-Najafgarh, all elevated stations are planned with two side platforms (4.5 meter wide each). Further, the DPR stated that stations have been planned following the norms and criteria being adopted by DMRC for Phase-I and Phase-II of Delhi Metro. Audit observed that the platform width of Dwarka (new station) and Nangli station was 2.9 meter (clear width 2.57 meter, which may further be reduced to 2.27 meter (approximately) post Platform Screen Doors facility in future), whereas platforms of existing Dwarka metro station constructed during Phase-I in 2005 is of more than four meter. New Dwarka station is an interchange station with front crossover facility, means boarding and de-boarding takes place from same side of the platform. Audit also observed that in other metros, platform widths have been worked out on the basis of holding capacity of the platform for worst-case scenario (i.e., two missed headways) in the design year. The same exercise/ calculation was not mentioned in DPR of Dwarka-Najafgarh section.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that detailed calculation of platform width is not required at DPR stage. However, the calculation details are reproduced now i.e., peak hour boarding/ alighting is given as 839.

Reply of the Ministry/ GNCTD/ DMRC is not tenable as it was clearly mentioned in the DPR that all elevated stations are planned around two side platforms (4.5 meter wide each). As per DPR, Peak Hour Peak Direction Traffic of 10,373 and 13,187 were mentioned from Dwarka to Najafgarh depot in 2021 and 2031, respectively, whereas in the calculation, Peak hour boarding/ alighting is given as 839 for Dwarka station. However, in addition to boarding/ alighting passengers, there are also interchange passengers who use the Dwarka (new) station platform.

3.11 Non-provisioning of Platform Screen Doors

In May 2012, DMRC proposed for procurement of a new type of Rolling Stock i.e., Unattended Train Operation based Rolling Stock on standalone Line-7 and Line-8. Director (Rolling Stock) apprised to the Board of Directors that for operation in GoA3/ GoA4, Platform Screen Doors are required to be provided to stop intrusion from the platform to the track. Audit observed that DMRC had planned to operate Unattended Train Operation based Rolling Stock on standalone Dwarka-Najafgarh corridor without installing Platform Screen Doors which is essential for Unattended Train Operation. DMRC also constructed lesser width platform at Dwarka (new) and Nangli station as against DPR provisions. Installation of Platform Screen Doors at a later stage would have higher cost implication, passenger safety issue and interface issue. It will also be a time-consuming process as already experienced by DMRC during the installation of Platform Screen Doors on existing operational Line-2.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that Dwarka-Najafgarh section is using Unattended Train Operation compliant Rolling Stock and Signalling System i.e., can be upgraded to fulfil Unattended Train Operation requirements in due course as and when required. Given the volume of traffic as of now, this section is not planned for Unattended Train Operation. Use of Platform Screen Doors is mandatory with Unattended Train Operation, which is not the case in this section.

DMRC reply regarding Platform Screen Doors is not acceptable as Unattended Train Operation based Rolling Stock was procured for the section. By constructing lesser width of platform and not installing Platform Screen Doors, DMRC is compromising passenger safety. Further, DMRC while responding to para no 2.3.1.3 stated that although not essential, under Indian conditions with Unattended Train Operation provision, Platform Screen Doors is expected to increase passenger safety against accidental falls and unauthorised entry to track.

3.12 Extra payment of ₹5.01 crore to the contractor

As per Letter of Award of contract CC-23, the contractor had to construct five underground stations and underground section between Kalkaji to Hauz Khas on Line-8. The horizontal and vertical track alignment between Panchsheel station and Chirag Delhi station was passing below a deep open nallah (drain). The tunnelling prior to the open nallah was to be made by Tunnel Boring Machine and beyond that (including open nallah and station box) by cut and cover. As the cushion between top

of tunnel structure and open nallah bed is only 1.3 meter which was grossly inadequate for tunnelling by Tunnel Boring Machine, it was proposed (21 December 2012) by Chief Project Manager that the depth of tunnel at nallah location may be lowered by about 2 meter, so that crossing of open nallah can be done using Tunnel Boring Machine as the cushion available will be 3.23 meter which can allow tunnelling by Tunnel Boring Machine and the track level of Chirag Delhi station may also be lowered by 2 meter. The recommendations of the Chief Project Manager were accepted (03 January 2013) by Managing Director, DMRC. The contractor submitted (26 March 2015) a claim for variation of ₹25.16 crore for the above variation against which DMRC paid an amount of ₹5.01 crore. In this regard, Audit observed that:

(i) As per the agreement, the tunnel crossing from West bank of nallah was to be constructed by cut and cover up to Chirag Delhi Station. However, instead of cut and cover method, DMRC decided to construct the tunnel by Tunnel Boring Machine by lowering the rail level by two meter. Due to this, the level of the Chirag Delhi metro station was also lowered by two meter.

(ii) The depth of the nallah between Chirag Delhi station and Panchsheel was known to DMRC prior to award of the contract. The tender alignment for nallah was finalised by DMRC. The construction of tunnel by cut & cover was part of Schedule-A, which was lump sum. Due to the above variation, DMRC incurred an avoidable expenditure of ₹5.01 crore.

Thus, DMRC incurred additional expenditure of ₹5.01 crore due to change in methodology of construction resulting in lowering the rail level by two meter against cut and cover method mentioned in the contract agreement.

The Ministry/ GNCTD and DMRC replied (July 2020/ January 2021) stated that in tender alignment, work was proposed by cut & cover method as the cushion between crown of tunnel structure and bottom of nallah was only 1.3 meter. This was grossly inadequate for tunnelling with Tunnel Boring Machine. At the time of excavation, it was found that the foundations of culvert are strip foundations infringing the alignment. The excavation of cut and cover section in this area would have disturbed the foundation of the culvert. If the details of foundations of road bridge were known prior to tender, then DMRC would have planned crossing nallah with Tunnel Boring machine in which case station level would have been kept two meter lower in tender drawings itself so that Tunnel Boring Machine can pass safely below Bridge foundation.

Reply of the Ministry/ GNCTD/ DMRC that the tunnelling was proposed through Tunnel Boring Machines to ensure safety of culvert is not acceptable as it is not possible to construct tunnel by cut and cover without disturbing the foundation of the culvert. Moreover, Strip Foundation is a common type of foundation, presence of which, in a structure, cannot be ruled out in designing at tender stage. As per tender drawing, if the tunnel was constructed through cut and cover method, contractor has to remove Tunnel Boring Machine through retrieval shaft and re-launch it through launching shaft. However, the effect of saving in this regard was not recovered from the contractor. If the construction was done as per tender drawing no additional financial burden would

have fallen on DMRC. Due to this variation, DMRC has to construct Chirag Delhi metro station at two meter below from the approved tender drawings. Besides, knowledge of foundations of the road bridge and flow of nallah are essential prerequisites for starting the project. This was also endorsed by the Technical Consultant (IIT Delhi).

3.13 Construction of Sadar Bazar cantonment and Shankar Vihar stations without the approval of GoI and GNCTD

Chief Project Manager submitted (February 2012) to the Managing Director, DMRC that as per DPR on Line-8, inter-station distance between Palam to Indra Gandhi Domestic Airport and Indra Gandhi Domestic Airport to Vasant Vihar stations were 5.213 km and 4.259 km, respectively. The inter-station distance was unusually high as the alignment was passing through defence area. Defence authorities requested DMRC to provide stations at Sadar Bazaar and Shankar Vihar to cater to the requirement of the large number of defence personnel living in these areas since there was a separate catchment of non-defence personnel in the vicinity of Sadar Bazaar. Providing two more stations rationalizes the inter-station distances and would bring additional traffic for Delhi Metro. As per the DPR estimates, there was an additional cost implication of ₹54.24 crore including the cost of electrical and mechanical works. The above proposal was approved (February 2012) by the Managing Director, DMRC. In this regard, Audit observed that:

(i) The decision to construct additional stations was without any study or survey for assessment and projection of ridership. Phase-III DPR was formulated on the basis of detailed report of Central Road Research Institute and RITES. However, no such supplementary study was conducted at the time of submission of proposal and the same was approved in one day by Director (Project) and Managing Director, DMRC.

(ii) As these two stations were not provided in the DPR, they were not approved by the GoI and the GNCTD. Fund provision for these two stations was also not made in the DPR.

(iii) As these stations were constructed on the request of Defence authorities, DMRC could have requested the Defence authorities for provision of funds for construction of the stations. DMRC took possession of 4.48 acre of permanent land for construction of station at a total cost of ₹13.46 crore and paid annual rent of ₹0.48 crore for temporary land instead of taking up the matter with Ministry of Defence (MoD) for waiver of land cost. Further, Defence land cannot be used for property development or any other commercial purpose. No lease deed has been signed between DMRC and MoD.

Thus, DMRC had constructed two stations on the request of Ministry of Defence without any provision in DPR, traffic study and without approval of GoI and GNCTD.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that DPR requirement of mid shaft at Shankar Vihar was eliminated with the construction of an elevated station at Shankar Vihar. The cost of mid shaft as per DPR was ₹29.96 crore and total cost of Shankar Vihar station is ₹31.55 crore which is comparable. The station

is also a source of revenue. By constructing the station inside Shankar Vihar, commuters and defence families living in the area now have access to public transport. Since the overall construction cost of two additional stations was within the funds provided in DPR, approval was taken from the Managing Director, DMRC. Property Development is being carried out through advertisements, Sulabh complex etc., inside the metro stations. However, external land of defence is not being used for commercial purpose, as it does not belong to them. The signing of lease deed between DMRC and MoD is under progress. The provision of Shankar Vihar and Sadar Bazar stations is more of technical requirement to break the long inter station distance of underground sections, hence no separate traffic study was found necessary.

Reply of the Ministry/ GNCTD/ DMRC is not acceptable because even at the time of approval from the Managing Director, DMRC for construction of Shankar Vihar station, there was neither such requirement for construction of mid shaft at Shankar Vihar station nor any approval for construction of metro station in lieu of mid shaft sought. Audit noticed that at Shankar Vihar station, entry and exit for general public is restricted, being a defence area. Due to permit system and being a landlocked metro station, the ridership was low and revenue was lowest among all stations on Line-8. In the absence of Property Development and Property Business, being located in defence area, the Non-Fare Box Revenue from these stations will be negligible. Further, DMRC has to incur the operational cost for running the station in the form of energy, manpower, maintenance and housekeeping. Thus, DMRC has already incurred the capex and would continue to incur operational expenses throughout the life of the station. The Ministry in its reply accepted that no separate traffic study was done. Besides, building stations is not an alternative to the mid shaft. Metro stations are built for operational requirement while construction of mid shafts is a technical requirement.

3.14 Variation in CC-04 amounting to ₹78.75 crore for unforeseen conditions

DMRC awarded (29 December 2011) the work of tunnel between Mukundpur and Shalimar Bagh section and underground station at Azadpur on Line-7 to M/S CEC-CICI JV (contractor) at the awarded cost of ₹416.80 crore on lumpsum basis. DMRC revised (21 March 2012) the alignment between Azadpur to Mukundpur due to non-availability of Delhi Police land. As per General Condition of Contract clause, in case of unforeseen physical condition, which could not have been reasonably foreseen by an experienced contractor, the contractor shall give written notice thereof to the Engineer and if, in the opinion of the Engineer, such conditions could not have been reasonably foreseen by an experienced contractor, the Engineer shall certify and the employer shall pay reasonable additional cost to which the contractor shall have been put by reason of such conditions.

During construction, two Tunnel Boring Machines were launched from tunnelling work between Azadpur and Mukundpur. After completion of 658.8 meter for Tunnel Boring Machines 1 and 595.2 meter for Tunnel Boring Machines 2 of the tunnel drive from Azadpur to Mukundpur, Tunnel Boring Machines -1 & 2 were stuck due to rock encounter beneath the Rameshwar Nagar Gurudwara and three houses. Accordingly,

the contractor after demolishing three houses and the Gurudwara, constructed a shaft to retrieve Tunnel Boring Machines.

The contractor submitted (29 June 2018) a claim of ₹242.35 crore on account of unforeseen physical condition due to shifting of horizontal & vertical alignment from Azadpur to Mukundpur by DMRC and encountering of rock strata at Rameshwar Nagar below Gurudwara. After scrutiny of claim of the contractor, DMRC approved (November 2019) the net variation amount of ₹78.75 crore. In this regard, Audit along with the Technical Consultant (IIT Delhi) observed that:

(i) Geological and geotechnical details of Delhi region are well known especially after the experience of Phase-I and Phase-II. Detailed geological maps are also available indicating the extension of ridge outcrops in North-East direction and extending up to the Yamuna river, very close to the alignment. Besides, it is common sense to expect rock outcrops in the vicinity at varying depths despite borehole data being available sparingly. The boreholes conducted by DMRC and the contractor along the alignment were spaced around 67 meter, however, the rock outcrop encountered at the said Rameshwar crossing under the Gurudwara and housing colony was only 32 meter width, indicating that they might have missed due to large spacing between the boreholes (67 meter).

(ii) The contractor conducted his own investigations and used DMRC's pre bid borehole data for selecting Tunnel Boring Machines which can cut only through soil strata. If DMRC changed vertical and horizontal alignment by few meter, it is the contractor's responsibility to make sure of the ground conditions and select the suitable Tunnel Boring Machine for the site rather than use something that worked elsewhere. Normally, any pre bid data provided by the owner along with the tender must be treated as first-hand information and the contractor should conduct detailed investigations for the designs. Also, as the said site was unapproachable for placing the drilling rig, they could have conducted indirect geophysical methods such as Ground Penetration Radar or Multi-Channel Analysis of Surface Waves, which are quick and accurate methods to differentiate between soil and rock. A prudent contractor would have assessed the ground conditions based on better refined geological and geotechnical methods and selected mixed Tunnel Boring Machines, as per prevailing practice in such conditions across the world. Hence, the Technical Consultant (IIT Delhi) was of view that the conditions are not latent requiring compensation.

DMRC replied (July 2020) that the present variation arose due to change in alignment because of non-availability of Delhi Police land and the alignment was shifted to the other side of road no. 51. Further, the depth of tunnel increases at the location where rock was encountered directly beneath the Gurudwara and three houses. As per the General Consultant report, a 30 meter length of rock was present along the length of tunnel alignment from Azadpur to Mukundpur. DMRC soil report comprised of 23 bore holes while the contractor's soil report comprised 15 further boreholes. Total 38 bore holes represented an average spacing of 67 meter along the alignment of 2.6 km which formed the basis for reasonable representation of the likely ground condition

along the alignment. The location of presence of rock was between the Gurudwara and three adjacent houses making it impossible to know about the rock. General Consultant Report also mentioned that it finds it difficult to argue that an 'experienced' contractor could have anticipated rock along either the tender or revised alignments from a review of the pre & post contract borehole data samples at site. Suggesting that the contractor should have foreseen rock when there is a clause to unforeseen ground conditions would be illogical. General consultant report clearly mentioned that there was confined patch of intact rock encounter during tunnelling & this constitutes an unforeseen ground condition. Therefore, it was decided to construct emergency escape shaft on that location and retrieve Tunnel Boring Machine.

Thus, contractor relied upon bore hole data at the distance of 67 meter instead of application of latest geophysical methods for assessing ground conditions. Resultantly, DMRC had to incur additional expenditure of ₹78.75 crore.

The Ministry/ GNCTD/ DMRC further stated (January 2021) that Geological map showed extent of rocks at 2.89 km away from alignment. Hence, extension of ridge outcrops along alignment could not be anticipated as confirmed from 38 boreholes which were made since none of them showed any rock. Application of Ground Penetration Radar and Multi-Channel Analysis of Surface Waves are considered not accurate in case of geophysical investigation works due to various limitation[74]. However, the Audit observations have been noted for further optimisation of geotechnical & geological records in future.

Reply of the Ministry/ GNCTD/ DMRC is not acceptable as the variation had resulted due to change in alignment post tender stage. Delhi Police intimated (September 2011) inability to provide land to DMRC before finalisation of tender CC-04 in December 2011. But DMRC intimated the change in alignment in March 2012 after awarding of work. If DMRC had intimated the change in alignment during tendering stage, soil investigations and other risks would have been the responsibility of the contractor. Notwithstanding the cited reasons, when the alignment is changed, fresh investigations should be conducted along the new routes unless the stratigraphy is known. Further, the mentioned limitations of the geophysical methods in the present situation are not convincing.

3.15 Non-compliance of various environment requirements

DMRC is required to comply with various environmental provisions under the National Environment Policy, the Central Water Commission, Water (Prevention & Control of Pollution) Act, and Air (Prevention & Control of Pollution) Act etc.

As per the National Environment Policy (14 September 2006), environment clearance is required for activities based on their potential environmental impacts as indicated in

[74] ***Ground Penetration Radar has been found to perform satisfactorily up to a depth of 4 meter to 5 meter, MASW required a flat ground within at least one receiver spread length i.e., minimum 30 meter for analysing up to depth of 10 meter to 20 meter below the ground surface also the receiver spacing is to be maintained 1 meter to 2 meter, which was not possible in congested area.***

the Schedule to the notification of Rule 5, sub-rule (3) of the Environment (Protection) Rules, 1986. As per the Schedule, environment clearance was required for building and construction projects having built up area of more than 20,000 sqm.

"General Guidelines for Water Audit & Water Conservation" by the Central Water Commission (2017), Ministry of Water Resources recommends water audit as an important management tool for effective conservation of water. DMRC Water Policy (2013) also provides to minimise wastages by carrying out half yearly water audits at selected stations and depots.

Central Water Commission and Central Ground Water Board recommends that supplies to industries should be from surface water and if ground water supply is considered essential, it should be managed by a Government Agency.

In this regard, Audit observed the following deficiencies regarding compliance to the above provisions:

(i) No environment clearance was obtained by DMRC for the Phase-III project even though it had constructed four metro car maintenance depots[75] each having built up area of more than 20,000 sqm.

(ii) DMRC uses water for construction work (project) and operation & maintenance purpose. However, it did not conduct any water audits at stations, depots and construction sites from 2011 till date. It neither assessed the extent of water losses and efficiency of system nor performed any cost benefit analysis for optimum recovery of water nor any benchmarking of suitable parameters for water use. It also did not formulate a Water Management Plan.

(iii) It is DMRC's responsibility as per its water policy to manage extraction and supply of ground water to the contractors. However, during the entire Phase-III project, no details and records were maintained either by DMRC or the contractors for water extracted, consumed or loss of water. The agreements signed by DMRC with the contractors also did not have any provision for maintenance of such record. Thus, there were no checks and balance for extraction and consumption of water by the contractors. Further, although the agreement included that the contractor had to meet the water cost from his own funds, DMRC permitted the contractor to extract water from ground resulting in undue benefit and cost saving to contractor.

(iv) Further, General Conditions of Contract provisions under Clause[76] 2.1.6 were also not honoured for installation and operation of Sewage Treatment Plant as DMRC did not ensure that Consent to Establish and Consent to Operate are obtained by the contractors.

---

[75] ***Mukundpur (45,686 sqm), Kalindi Kunj (29,310 sqm), Vinod Nagar (32,104 sqm) and Badli (46,063 sqm)***

[76] ***As per GCC 2.1.6 (Scope of Works), it was agreed that "obtaining statutory permissions for consent to establish and consent to operate including all costs, fees for obtaining such permission from Pollution Control Board" was a part of the lump sum price of contract***

Thus, DMRC did not adhere to various environment requirements including obtaining environmental clearances, conducting water audit and maintaining records of water extracted, consumed and lost during Phase-III.

Regarding environment clearance, DMRC stated (July 2020) that metro project is a physical infrastructure project as per Schedule of Environmental Impact Assessment Notification, 2006 and exempted from seeking environment clearance from the State and Central authorities. It accepted that there is no formal water management plan of DMRC. It added that Phase-III contracts had no provision to quantify consumption of water through instrumentation of water meters. As such neither water meters were installed, nor records maintained. Hence quantity and cost are not available. However, in Phase-IV contracts under Safety, Health and Environment, provision for installation of meters and maintenance of records has been incorporated.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the previous phases of DMRC also had similar clause in the contract regarding usage of water; water for construction was always drawn through borewells with contractors at their own cost, and that contractors have not saved money by pumping water from ground. No prior environment clearance is also required. The Audit observation implies that the project is linear, which is not the case. Lastly, there is no specific category under which metro rail can approach the State/ Centre for environment clearance. Wherever borewell existed, records were maintained. However, contractor's record keeping was not robust. This will be strengthened in future. For Phase-IV of Delhi Metro, specific clauses have been incorporated in the Conditions of Contract for better water management at construction site.

The reply of the Ministry/ GNCTD/ DMRC regarding environment clearance is not acceptable as the comments of Ministry of Environment, Forest and Climate Change on the Phase-III DPR forwarded (November 2015) by MoHUA to DMRC clearly mentioned that while metro rail projects are not covered under the Environment Impact Assessment Notification, 2006, if the total built up area is more than 20,000 sqm, prior Environment Clearance is required from the State. Further, DMRC's claim that they are not required to follow the environmental clearance is incorrect as DMRC itself came into existence after complying with the "Guidelines for Environmental and Social Considerations" of an international funding organisation which are based on the World Bank Operational Policy (OP 4.01). DMRC operations are classified under Category A, which refer to projects likely to have significant adverse impact on the environment and society.

3.16 Discrepancies in tree cutting estimation, compensatory afforestation and disposal of wood

During the execution of Phase-III of Delhi MRTS project, 100 *per cent* plantation is being done by the Forest Department of GNCTD. As per permission letters issued by Forest Department, 1,74,550 trees were to be planted under compensatory afforestation by DMRC during the period from 2011 to 2019. Planting of these many trees by DMRC alone could contribute 2.69 sq km (1,74,550/ 65,000) increase in forest and tree cover

of Delhi[77]. DMRC deposited ₹51.76 crore as security deposit for cost of compensatory plantation in lieu of 17,455 trees[78] to be cut during the period from 2011-12 to 2018-19. DMRC had actually cut 12,646 trees[79] on the basis of actual requirement. However, in the absence of proper records relating to tree plantations by Forest Department and monitoring by DMRC, Audit could not verify whether Forest Department planted the required number of trees on behalf of DMRC. The corridor/ line wise details of estimation of compensatory afforestation and actual tree felled is given in **Annexure-V**.

In this regard, Audit observed that:

(i) There is no approved policy and Standard Operating Procedure for tree cutting, disposal of wood/ timber after tree cutting, preservation and plantation after execution of three Phases by DMRC. Forest Department, GNCTD provides for social auditing and departmental monitoring of compensatory plantations. However, no site visit/ inspection was conducted by DMRC officials for monitoring purposes during April 2011 to December 2018.

(ii) In the absence of any follow up or data maintained by DMRC regarding actual tree plantation, it can be said that claims of DMRC regarding number of compensatory tree plantation in its website (Sankalp Report 2018-19) is misleading as it is stated that 1,90,688 trees have been planted during Phase-III.

(iii) There was inconsistency in the figure of number of trees to be cut in respect of initial four corridors as provided in DPR submitted to the Board of Directors, GoI, GNCTD and the Environment Impact Assessment study conducted by RITES in this regard (**Annexure-V**).

(iv) There was vast difference in the cost of compensatory afforestation as assessed in DPR (₹1.44 crore @ ₹1,250 per tree) in comparison to Environmental Impact Assessment study (₹46.50 crore @ ₹28,000 per tree).

(v) In the DPR of Dwarka-Najafgarh, Mundka-Bahadurgarh (Delhi portion) sanctioned in 2012, the estimated cost of one tree was taken as ₹1200 and ₹700, respectively, as against ₹28,000 per tree. Whereas, in case of Kalindi Kunj-Botanical Garden, which was executed on the request of Government of Uttar Pradesh, the estimated cost of compensatory afforestation was assessed as ₹11.96 crore @ ₹28,000 per tree. But no actual expenditure was incurred on compensatory afforestation on this corridor, as the same was done by Government of Uttar Pradesh at its own cost. Details regarding number of trees to be felled and estimated expenditure on compensatory afforestation was not mentioned in the DPR/ Feasibility Report of Shiv Vihar, Najafgarh-Dhansa Bus Stand and Faridabad-Ballabhgarh corridors.

(vi) As per the permit condition, permit holder (i.e., DMRC) shall transport the wood, and loops arising out of felling of trees at their expense to the nearest public crematorium managed by Municipal Corporation of Delhi (MCD)/ New Delhi

---

[77] ***Considering 65,000 tree for increase in 1 km for forest and tree cover of Delhi***
[78] ***As per Forest Department of GNCTD***
[79] ***As per information furnished by DMRC***

Municipal Corporation (NDMC) to give them free of cost and under proper receipt from such crematorium and submit a copy of such receipt to the Forest Department. DMRC produced some receipts for delivering the wood to crematoria operated by a Non-Government Organisation instead of MCD as per permission letter. Further, at Chief Project Manager-2, Inderlok, wood was auctioned/ sold to private parties and revenue amounting to ₹5.82 lakh was realised, which is in contravention of permit condition.

(vii) DMRC had deposited advance payment for the cost of compensatory afforestation for 17,455 trees and reallocation of 746 trees. But during the execution, only 12,646 trees were cut/ felled, and 484 trees were reallocated by DMRC. Hence, the excess amount of ₹14.20 crore for 5,071 trees[80] should have been recovered from the Forest Department, GNCTD (**Annexure-VI**).

Thus, in absence of any approved Policy/ Standard Operating Procedure there were inconsistency in tree cutting estimation, compensatory afforestation and disposal of wood. Further in absence of monitoring, claim of DMRC regarding the compensatory tree plantation cannot be ensured.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that approved policy or standard operating procedure on this issue cannot be formulated by DMRC as DMRC is fully dependent on terms and conditions imposed by the Forest Department. DPR contains the preliminary survey data. However, Environmental Impact Assessment study is conducted after the approval of the corridor by the Government. Hence, there was variation in the data & number of trees. Small plants like shrubs are also included as tree while obtaining tree felling permission from the Forest Department, GNCTD. However, it is not possible to keep account of these trees while executing the work. Since majority of permission letters for tree cutting have been obtained during 2011-12, identification of saved trees (i.e., for which permission of cutting were taken from Forest Department, but not actually cut due to change in alignment or entry/ exit gate location etc) and convincing Forest Department is not feasible. DMRC ensures compliance of conditions in the permission letter while disposing cut wood. Since insignificant amount has been realised by disposal of cut wood in few cases, it has been facilitated to public crematorium free of cost and receipt obtained from public crematorium has been kept on record.

The reply of the Ministry/ GNCTD/ DMRC needs to be viewed in the light of the fact that DMRC had formulated various internal policies in consonance with applicable Act/ Rules for example water policy. Hence, they could have framed a suitable policy in this regard also. Further DMRC on one hand has claimed savings in the number of trees to be cut, while on the other hand it states that they have not maintained record of small plant/ trees and time gap between permission and execution. As such the entire process needs streamlining.

[80] ***17,455+746-12,646-484 trees***

Conclusion

Thus, number of deficiencies were noticed which adversely affected the contract management and project execution of Phase-III of Delhi MRTS. There is no protocol for estimating the cost of upcoming projects in a scientific manner as DMRC used the concept of derivation of cost estimate based on last accepted rates of 'similar project'. This led to sanctioning of higher funds. Social Impact Assessment study conducted for Phase-III was deficient as it did not envisage 108 project affected persons at Trilokpuri resulting in delay in Rehabilitation and Resettlement process and operationalisation of metro in this section for more than five years. Further, DMRC did not determine the location of Mukundpur station with due diligence at the time of preparation of DPR and did not explore any possibility of construction of at-grade station on the vacant land of PWD. DMRC constructed additional subway from Terminal 1C to Terminal 1D, on the request of DIAL and also constructed Sadar Bazar and Shankar Vihar stations on the request of Ministry of Defence, without any provisions in DPR and without approval of GoI and GNCTD. Flawed design of Hauz Khas interchange station resulted in construction of two additional intermediate levels and inconvenience to the commuters. Besides, DMRC did not adhere to various environment requirements including obtaining environmental clearances, conducting water audit and maintaining records of water extracted/ consumed. There was also inconsistency in tree cutting estimation, and compensatory afforestation.

Recommendations

8. ***DMRC may ascertain cost estimates of projects on the basis of scientific method; establish a cell to study the cost aspects of various contracts and may consider formulating a schedule of rates like Delhi Schedule of Rates for metro projects.***

9. ***DMRC may formulate a policy on grant of special advances to the contractors.***

10. ***DMRC should ensure efficient planning and timely completion of rehabilitation and resettlement activities for smooth completion of project.***

11. ***DMRC may ensure adherence to relevant environmental requirements of obtaining environmental clearance, carry out water audit, maintain records for water consumption and prepare Water Management Plans for future projects.***

CHAPTER-4
PROJECT MONITORING

Chapter 4
Project Monitoring

4.1 Implementation of Project

4.1.1 Audit assessed the project implementation to examine whether an adequate mechanism was in existence to monitor the project, to ensure timely completion and conformity of works executed with laid down specifications. The significant deficiencies are brought out in the following paragraphs.

4.1.1.1 The Ministry of Urban Development (MoUD) stated (12 July 2013) that the 50:50 joint ownership metro companies are essentially Board run companies. It is desirable that the various issues/ agenda be first deliberated in detail in the Board Sub Committees before these are brought to the Board of Directors. This will facilitate Board of Directors to take decision in a short period of time. In pursuance of this purpose, a Project Management Committee was constituted (November 2013) in DMRC with Terms of Reference (ToR) as suggested by the Ministry. The ToR prescribed by MoUD and Audit observations[81] thereto are as follows:

i. To review the project cost periodically and determine the cost escalation and make suitable recommendations to Board.

ii. To review Risk Management Strategy for DMRC.

iii. To review the physical and financial progress of the projects.

iv. To identify the impediments responsible for delaying the projects.

v. To suggest measures for expediting the projects.

vi. To monitor whether all the safety measures are being taken.

vii. Review preparatory activities for operation and maintenance and Commissioner of Metro Rail Safety (CMRS) clearance.

viii. Review documentation to be submitted to CMRS.

ix. Any other matter as may be referred by the Board.

4.1.2 As per sanction letter (26 September 2011), Phase-III of Delhi MRTS was to be taken up for implementation and was to be commissioned by 2016. It was planned that total work can be completed within a period of 36 months to 48 months from date of start. The work was to start by April 2011 and various sections were planned to be opened in phases by 31 March 2016. Originally four corridors were taken up under MRTS Phase-III. Subsequently, nine more corridors were undertaken for extension of existing corridors. Status of implementation of corridors is depicted in Table 4.1 below:

[81] ***Refer paras 3.1.1, 3.5, 3.11, 4.1.2, 4.3.1***

Table 4.1
Delay in completion of corridors

Sl. No.	Corridors	Date of sanction	Length (in km)	Proposed Opening	Actual Date of opening	Delay in months
1	Central Secretariat to Kashmiri Gate (Line-6 Extension)*	September 2011	9.370	December 2015	Central Sect-Mandi House (June 2014) Mandi House-ITO (June 2015) ITO-Kashmiri Gate (May 2017)	-- -- 17
2	Jahangir Puri to Badli (Line-2 Extension)*	September 2011	4.373	December 2014	November 2015	11
3	Mukundpur (Majlis Park) to Yamuna Vihar (Line-7) *	September 2011	55.69	March 2016	Majlis Park-DD South Campus March 2018 DD South campus-Lajpat Nagar August 2018 Shiv Vihar-TrilokPuri October 2018 Vinobha Puri-Mayur Vihar Pocket-I December 2018	24 to 33
4	Maujpur to Shiv Vihar (Line-7 Extension)	September 2012	2.9	March 2016		
5	Janak Puri West to Kalindi Kunj (Line -8)*	September 2011	33.94	February 2016	May 2018	27
6.	Kalindi Kunj-Botanical Garden (Line-8 Extension)	December 2017	4.3	December 2017	December 2017	--
7	Badarpur-Faridabad Extension (Line-6 Extension)	September 2011	13.875	December 2014	September 2015	9
8	Mundka-Bahadurgarh (Line-5 Extension)	September 2012	11.182	March 2016	June 2018	27
9	Dilshad Garden-New Bus Adda, Ghaziabad (Line-1 Extension)	February 2019	9.635	January 2019	March 2019	2

10	Noida City Centre-Noida Sector-62 (Line-3 Extension)	June 2018	6.799	September 2018	March 2019	6
11	Escorts Mujesar (Faridabad-Ballabhgarh (Line-6 Extension)	March 2017	3.205	December 2018	November 2018	--
12	Dwarka-Najafgarh (Line-9)	September 2012	4.295	December 2015	October 2019	46
13	Najafgarh to Dhansa Bus Stand (Line-9 Extension)	May 2017	1.180	December 2020	Yet to be put into operation as on 31 March 2021	3
Total			**160.745**			

*** Initially sanctioned Phase-III corridors having length of 103.05 km**

4.1.3 In this regard, Audit observed the following:

(i) There were delays ranging from 2 months to 46 months in completing the corridors as per scheduled dates. The significant reasons for the delay were;

- delay in land acquisition;
- delay in Rehabilitation & Resettlement activities;
- change in alignment/ scope; and
- slow progress of work by contractor etc.

(ii) DMRC was requested to form the Board Sub Committee on Project Management comprising of Managing Director DMRC as Chairman, Additional Secretary, (Delhi & Urban Transport) MoHUA, Additional Member Works, Railway Board, Director (Projects) and Director (Works) of DMRC to have detailed deliberations on various subject before these were brought to the Board of Directors. The Committee was constituted during November 2013. However, no periodicity was fixed for conducting the meeting. Meetings were held on need basis. During the implementation of Phase-III project, only two meetings (November 2013/ February 2014) of the Committee were conducted up to March 2020. During these meetings, the physical and financial progress of the corridors were reviewed along with discussions on various impediments i.e., non-availability of land, tree cutting permission and forest clearance affecting the projects and measures for expediting the projects were suggested. Though the projects were implemented and completed during the period September 2015 to October 2019, meeting of the Project Management Committee was not conducted after February 2014.

Thus, DMRC failed to complete the corridors within stipulated time-period due to various impediments like delay in land acquisition, Rehabilitation and Resettlement activities, slow progress of work by contractors etc., resulting in foregoing of Fare Box and Non Fare Box Revenue. Besides, the Board Sub Committee on Project Management

did not meet at regular intervals to monitor the progress of work and suggest measures to expedite the projects.

4.2 Audit along with Technical Consultant (IIT Delhi) reviewed the quality controls measures in DMRC and observed the following:

4.2.1 Lack of uniform project Quality Management Plans

The Project Quality Management Plan documents, the necessary information required to effectively manage project quality from project planning to implementation. In DMRC, project Quality Management Plans were prepared by the executing agencies and there was no uniformity in these documents across projects. Resultantly, the quality of the end product is dependent on the contractor executing the project.

The end product should be of the same quality irrespective of the contractor executing the project. Hence, there is a need for DMRC to formulate a standard template for Quality Management Plan and ensure its implementation. It should also involve government testing laboratories and reputed engineering institutions with good testing facilities for testing and third-party quality services.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that in Phase-III, as per contract conditions, each contractor has to submit Quality Management Plans based on employer requirements. However, at the approval stage of Quality Management Plan by DMRC, uniformity was more or less maintained. Standard formats of Project Quality Management Plan were made part of Phase-IV tender document in order to bring uniformity. Besides, a dedicated 'Quality Cell'' has been set up in Phase-IV to improve quality assurance systems in DMRC.

The Ministry/ GNCTD/ DMRC has agreed to implement the observation.

4.2.2 Poor quality of civil structure

The Audit team along with Technical Consultant (IIT Delhi) and DMRC officers visited Hauz Khas station and other stations. Site inspection and review of the design and drawing documents revealed instances of poor quality civil structure such as bulging, honey combing, and exposed reinforcement indicating absence of a proper formwork[82] system. In the absence of proper formwork system, the quality, safety, and economy of reinforced cement concrete structures cannot be ensured. DMRC responded that the defects have been repaired. Further, DMRC while accepting that the shuttering was not proper at some locations stated that such defects will be eliminated by proper formwork and stringent supervision in future projects.

It is recommended that DMRC may formulate a detailed specification for the system of formwork to be used in its projects. The safe load carrying capacity of the formwork members should also be checked periodically as part of the quality assurance system.

[82] ***Formwork is the term used for the process of creating a temporary mould into which concrete is poured and formed under civil construction***

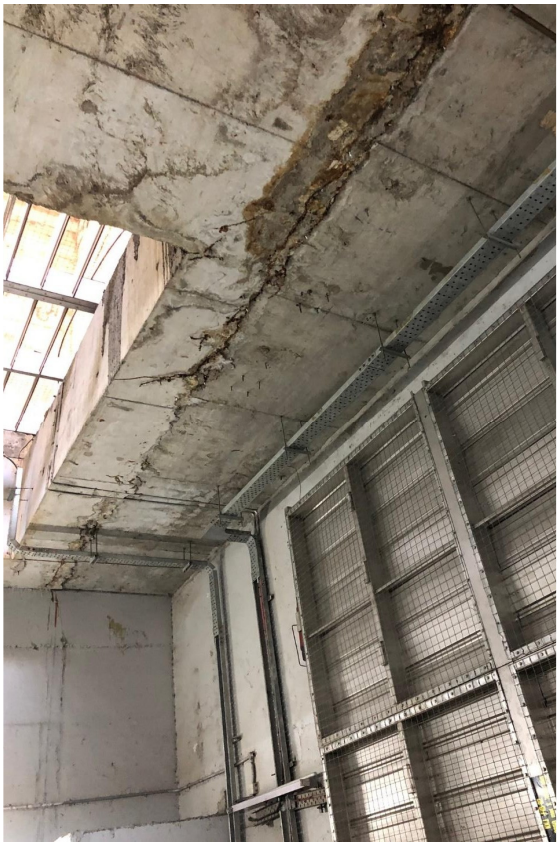
This would not only ensure quality but also ensure safety as most accidents at construction site involving reinforced cement concrete are primarily on account of formwork failure.

4.2.3 Non-optimisation of quantities of construction materials

Review of the design and drawings of station buildings, viaducts and tunnels revealed that optimisation of quantities was not attempted and there was overdesigning. Further, Technical Consultant (IIT Delhi) observed instances of honeycombing and bulged concrete, in Malviya Nagar, Najafgarh, Hauz Khas, Kalkaji metro stations etc., as indicated in figures below:

Figure-4.1

Civil work at Kalkaji Metro Station



Honeycombing and bulged concrete surface

Honeycombing and poorly made formwork joints

The Ministry/ GNCTD/ DMRC has accepted the observation.

4.2.4 Uneconomical design of structures

Review of adequacy of quality assessment mechanism of DMRC for assessment of execution of work by Technical Consultant (IIT Delhi) revealed that the columns were not aligned and stub columns were used which tend to transfer the load to the supporting beams instead of directly to the footings indicating uneconomical design. Exposed reinforcement was also noticed due to improper cover blocks during concreting.

The Ministry/ GNCTD/ DMRC has noted the observation for future compliance.

4.2.5 Absence of real time performance monitoring, capacity control, energy saving strategies

DMRC opted for Building Management System which is a control system installed in buildings that typically controls and monitors the building's mechanical and electrical equipment such as Heating, Ventilation and Air Conditioning, lighting, power systems, fire systems, and security systems. This helps in automation for more efficient and safe operation of the stations.

In this regard, Audit along with Technical Consultant (IIT Delhi) observed that;

(i) The station Building Management System assesses real time station air temperature and relative humidity data. for capacity modulation. However, the data logged in Building Management System is not being reviewed and analysed with the perspective of improving energy efficiency. Instead, the temperature and relative humidity conditions on platform and concourse levels are recorded manually at regular intervals. The significant investment in a real time performance monitoring system with data being logged into a Central Building Management System continuously becomes meaningful only if the data is reviewed and analysed. It would also help DMRC to improve its productivity factor, potentially leading to lowering of its fares for common people.

(ii) Performance of chillers at stations can be assessed by using real time data. The data provided by DMRC was found to be inaccurate and incomplete and does not seem to be in order as it showed very low and intermittent loading of chillers. On an average, 25 *per cent* of total installed capacity is being used at Hauz Khas and Hazrat Nizamuddin stations. In peak season (August) only 40 *per cent* of the chillers capacity has been utilised for Hauz Khas station. Similarly, there was lower utilisation for other stations. The aim of Environmental Control System should be to maintain the comfort conditions at low capital and operational costs. Over sizing of equipment not only leads to higher capital investment but also poor efficiency due to part load operation. An accurate assessment of the percentage loading of chillers may provide actual demand on the equipment. Monitoring and analysis would have provided actual validation of the same. This could not be satisfactorily concluded during this review due to inaccurate and missing data.

(iii) It was also observed that while there were component level energy efficiency requirements such as minimum efficiency, Coefficient of Performance etc., posed to the

contractors, the system level optimisation, possible through effective monitoring and controls for energy savings was totally overlooked by DMRC.

(iv) Further, the design comfort conditions were not being maintained at the station including both platform and concourse.

Thus, in the absence of monitoring of logged data in Building Management System, energy efficiency measures cannot be ensured. Installation of higher size chiller at the stations resulted in not only higher capital cost but also higher Operation & Maintenance cost.

The Ministry/ GNCTD and DMRC has accepted (January 2021 and July 2020) the Audit observations at (i) to (iv) above.

4.2.6 Absence of testing and maintenance of Heating Ventilation and Air Conditioning equipment

Audit along with Technical Consultant (IIT Delhi) and DMRC officers visited Hauz Khas station and observed that the station temperature and humidity sensors were placed in the false ceilings. This can lead to deviation of the recorded reading from the station's actual condition due to formation of a stagnant zone inside the false ceiling.

DMRC stated that the false ceiling team changed the type of false ceiling. Hence, the sensors got above the perforated false ceiling. The same sensors are now planned to be shifted.

Various deficiencies were also noticed in the testing of the equipment, such as:

(a) Equipment Performance test reports showed large difference in rated and measured values (e.g. Chiller Coefficient of Performances varying from five to nine) in many cases but there were no corresponding remarks/ comments on the same. Thus, there is a need for detailed investigations behind the seemingly unrealistic values.

(b) Temperature of chilled water seem to varied significantly from 19°C to 24°C at the inlet and 14°C to 19°C at the outlet, while the design value is 15°C at inlet and 8°C at the outlet.

(c) The test report shows that velocities of air are near 0.5 m/s around some grilles. This seems to be rather low for a reasonable grille size but was still found acceptable. The deviations in performance during testing were not looked into.

The Ministry/ GNCTD and DMRC has accepted (January 2021 and July 2020) the Audit observation.

4.2.7 Non-utilisation of optimisation methods for life cycle cost minimisation

Life cycle cost is the process of compiling all costs that the owner of an asset will incur over its life span. These costs include initial investment, future additional investment and annual recurring cost minus salvage value. In this regard, Audit along with Technical Consultant (IIT Delhi) observed the following:

(i) The methods for duct design such as equal friction are very simplistic without any optimisation, and the detailed explanations were not provided by DMRC. DMRC stated that the design is based on an equal friction method (i.e., taking the same value

of pressure loss per unit length of duct). However, there are optimisation methods available such as the T-method recommended by American Society of Heating, Refrigerating and Airconditioning Engineers for life cycle cost minimisation which can help in space, material or operating cost savings.

The Ministry/ GNCTD/ DMRC has accepted the Audit observation.

(ii) The method used for Heating, Ventilation and Air Conditioning load calculations under Phase-III was based on the older Carrier handbook in comparison to the now well-established state of the art hourly load calculation methods using software such as Hourly Analysis Programme, Trane etc. This was considered quite comprehensive at the time when it was published (in the 1950) but is completely outdated in the current scenario. The new methods require computer simulations and provide hourly varying load estimates.

The Ministry/ GNCTD/ DMRC has accepted the Audit observation.

(iii) For the Hazrat Nizamuddin station, the calculated loads of the selected equipment are much lower than their installed capacities.

The Ministry/ GNCTD/ DMRC has accepted the Audit observation.

(iv) The inside conditions for Back of House areas such as ticketing office, station manager etc., are taken as 25°C and few others as 24°C, which is low and not as per DPR (28°C). This would lead to higher capacity requirement of Heating Ventilation and Air Conditioning system and more energy consumption.

The Ministry/ GNCTD/ DMRC has accepted the Audit observation.

(v) Further, no humidity control mechanism has been provided in the equipment rooms. Also, a very large number of multiple conventional Fan Coil units have been installed due to these having high flow rates. Hence, it could be better designed to meet the need rather than over sizing.

The Ministry/ GNCTD/ DMRC has accepted the Audit observation.

4.2.8 Lack of real time monitoring of Heating, Ventilation and Air Conditioning in Rolling Stock

Audit along with Technical Consultant (IIT Delhi) analysed the real time monitoring of Heating, Ventilation and Air Conditioning in Rolling Stock and observed the following:

(i) Real time performance of Rolling Stock Heating Ventilation and Air Conditioning systems including the energy being consumed by it and the conditions being maintained were not recorded by DMRC and could not be obtained. DMRC submitted the verification testing done in the climate control chamber during Guaranteed Energy Consumption type testing. While verification testing is only required for proving equipment capability to meet the requirements, real time monitoring provides insights on the real-world system efficiency with varying passenger load, ambient conditions etc., which could be potentially utilised for energy saving.

(ii) It was noticed during site visit at Kalindi Kunj depot that DMRC was not doing any real time monitoring. It was also observed that the suction line of the Heating, Ventilation and Air Conditioning system in Rolling Stock was kept uninsulated.

(iii) There was no record of the fresh air being introduced or the CO_2 levels maintained inside the coaches and the energy consumption of the Heating Ventilation and Air Conditioning system in the Rolling Stock.

(iv) As per report on Cooling Capacity, test was carried out only three times instead of nine times due to urgency. DMRC submitted that since there was not much variation between tests, the number was reduced to three instead of nine, based on mutual understanding between DMRC and supplier (Toshiba). Although a single test would give all the desired information, repeatability remained an important parameter, which was not adhered to. The reply of DMRC is not correct as multiple tests are conducted to ascertain repeatability and check variations in range parameters.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the present system of power measurement does not bifurcate the total power consumption into individual power consumptions in the sub-components, e.g. for Heating Ventilation and Air Conditioning, Traction motors, etc., separately. The suggestion is noted and the possibility to incorporate the same in future procurements shall be explored. Insulation of the suction line will be considered for improving the performance of the Heating Ventilation and Air Conditioning. Fresh airflow and energy consumption are measured during type testing of Heating Ventilation and Air Conditioning. After the commissioning of trains, exercises are taken up to monitor airflows, CO_2, cooling performance, energy consumption, etc., and corrective actions are taken accordingly.

The Ministry/ GNCTD/ DMRC has accepted and assured to explore the possibility of incorporating power consumption in the sub-components in future procurement. Regarding measurement of fresh air flow and energy consumption after commissioning of trains, records of such exercises/ measurements were not made available. It is recommended that fresh air for both passenger comfort and energy savings, based on varying conditions in real time operation is controlled and monitored.

4.3 Other Issues

4.3.1 Non-approval of Risk Management Policy of DMRC by the Board

Risk management is an integral part of strategic planning, business planning and investment/ project appraisal procedures. Section 134(3)(n) of the Companies Act, 2013 stipulates that the Board's Report shall contain a statement indicating development and implementation of a risk management policy for the company including identification of elements of risk. Audit observed that although DMRC has formulated a Risk Management Policy, the same has not been approved by the Board of Directors. Further, no such statement in pursuance of Section 134(3)(n) of the Companies Act, 2013 was disclosed in the Board report.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the Board of Directors (23 March 2015) considered the Risk Management Policy and authorised Managing Director to constitute a committee to oversee the risk management functions of DMRC. Further, continuous efforts are being made by the Director level committee to identify risks to the company and mitigation thereof before submission to Board of Directors. Disclosure as per provisions of Section 134(3)(n) of the Companies Act, 2013 is made in the Board Report every year and the same will be put up to the Board of Directors for approval.

4.3.2 Non-formulation of hedging policy

Para 5.8 of the Risk Management Policy of DMRC related to financial risks stipulates that the financial risk is the risk related to liquidity, treasury, foreign currency and interest rate fluctuation. To mitigate this risk, DMRC may frame a hedging policy. This will make the system financially viable without dependence on external cash subsidy for its operation from the stakeholders. Board of Directors in the 108th meeting (24 June 2014) was apprised that impact of fluctuation in exchange rate on project cost involving foreign currency payment was ₹8,172 crore. Due to depreciation of the rupee in the concerned years, the impact of exchange rate variation was computed as ₹740 crore by the management. Audit observed that DMRC did not formulate a hedging policy to safeguard its financial interest in violation of Risk Management Policy of the DMRC. Further, no cost benefit analysis was conducted to ascertain the cost involved and benefit for entering into a hedging contract. There was also no separate provision for foreign exchange rate variation in the DPR for the Phase-III.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that due to negligible exposure in foreign currency the creation of hedging policy was not felt required, and since there was no requirement of entering into any hedging contract, question of cost benefit analysis does not arise.

Reply of the Ministry/ GNCTD/ DMRC is not tenable as the Risk Management Policy recommends creation of a hedging fund to mitigate risks related to liquidity, treasury, foreign currency and interest rate fluctuation. Further, during the period from 31 March 2011 to 31 March 2019, DMRC has booked a loss of ₹56.76 crore on account of foreign exchange variation which cannot be called negligible.

4.3.3 Non-entering of Integrity Pact with the contractors by DMRC

Central Vigilance Commission (CVC) has emphasised the necessity to adopt Integrity Pact in Government organisations in their major procurement activities. The Commission had also directed that in order to oversee and monitor the compliance of obligations under the Pact, by the concerned parties, Independent External Monitors should be nominated with the approval of the Commission. Independent External Monitors are vital to the implementation of Integrity Pact and at least one Independent External Monitor should be invariably cited in the Notice Inviting Tender. A maximum of three Independent External Monitors would be appointed in Navratna Public Sector Enterprises and up to two Independent External Monitors in other Public Sector

Enterprise. The 2nd Administrative Reforms Commission, in its 4th Report (January 2007) on "Ethics in Governance" has also recommended the adoption of Integrity Pact. Despite this, Audit observed that DMRC has neither entered into any integrity pact with the contractors nor appointed Independent External Monitors as per the guidelines of CVC.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that various provisions of the contract entered into with the contractors meet the requirement of integrity pact. DMRC has a Vigilance Department headed by Chief Vigilance Officer. Hence, it has been decided not to adopt Integrity Pact in DMRC.

Reply of the Ministry/ GNCTD/ DMRC is not acceptable because making a provision in the contract does not obviate the requirement of Integrity Pact. Further appointment of Independent External Monitors cannot be replaced by having a provision in the contract.

Conclusion

There were deficiencies in DMRC's mechanism for project monitoring which adversely affected timeliness in completion of works and conformity of executed works with laid down specifications. Thus, there were delays ranging from 2 months to 46 months in completing the corridors as per the scheduled dates in DMRC MRTS Phase-III. Besides, the Quality Management Plans were prepared by the executing agencies and there was no uniformity across these documents across the projects. Also, Real time performance of Rolling Stock Heating Ventilation and Air Conditioning systems including the energy being consumed had not been analysed, which would have helped in introducing energy saving strategies.

Recommendations

12. ***DMRC may strengthen the monitoring mechanism by ensuring periodic review by the below Board level Sub Committee on Project Management and follow up thereon, to ensure timely completion of the projects.***

13. ***DMRC may formulate a template for (i) Quality Management Plans and (ii) specifications for the system of formwork.***

14. ***DMRC may ensure optimal utilisation of Building Management System for better monitoring of the ambient conditions at the metro stations to achieve anticipated energy savings, and to render maximum comfort to the commuters.***

15. ***DMRC may adopt latest method of load calculations for Heating Ventilation and Air Conditioning for simulation and better estimations.***

16. ***DMRC may consider real time monitoring and data logging of parameters relating to Rolling Stock Heating, Ventilation and Air Conditioning.***

CHAPTER-5
OPERATION AND MAINTENANCE AND REVENUE MANAGEMENT


ELDECO
JUNCTION
PROJECT BY ELDECO AND KAPOOR DEVELOPERS
FASHION
PRAD
THE MOBILE STORE
Adidaas
Raymand
FINE FABRICS
KFC

Chapter 5
Operation and Maintenance & Revenue Management

5.1 DMRC follows a mixed approach for operation and maintenance wherein the core operation and maintenance of major assets are done in-house with the regular staff specially recruited and trained for this purpose, while non–core and offline activities are generally out-sourced though some of them are managed in-house. Revenue generation through Property Development by metro projects is a global practice as the metro projects are highly capital intensive and they can remain financially sustainable, without government subsidies, by generating Non-Fare Box Revenue from property development activities viz advertisements, retailing, real estate at metro stations. DMRC has Property Development and Property Business divisions for earning Non-Fare Box Revenue. DMRC has been mandated to generate 4.5 *per cent* of the project cost in Phase-III from Property Development. Property Business division is responsible for generating revenue for meeting operation & maintenance expenses. Property Development division conducts studies for estimation of reserve price or action plan for generating revenue to meet the targets set by Ministry. Generally, Property Business division does not conduct any studies as they have to lease the area which is constructed by the Project division on the metro stations. Audit reviewed the actual ridership vis-a- vis the DPRs projections, operational efficiency of DMRC and the guidelines of Unified Traffic & Transportation Infrastructure Planning & Engineering Centre in respect of Multi Modal Integration.

Audit noticed inefficiencies in operation and maintenance, shortfall in achievement of planned targets in respect of Property Development and estimated earnings and Property Business after commercial operation as brought out in the succeeding paras.

5.2 Operation and Maintenance

5.2.1 Non-maintenance of line-wise operational profit/ loss statements and non-claiming of operational loss from respective State Government

Secretary, MoUD directed (April 2012) DMRC to prepare line-wise profit and loss account. Extracts from sanction letters issued by MoUD/ MoHUA during 2011 to 2019 regarding bearing/ sharing of operation loss are shown in the **Annexure-VII.** Comparison of projected ridership and actual ridership which indicated shortfall of 15 *per cent* to 88 *per cent* during 2019-20 of various lines/ corridors under Phase-III is shown in Table 1.1.

However, Audit observed that all the corridors/ lines (except Dhansa Bus Stand extension) constructed during Phase-III including NCR extensions are operational as on 31 March 2020. DMRC did not prepare line-wise operation profit and loss, in the absence of which it could neither apprise the Board of Directors of the operational profit/ loss nor make necessary claims with the respective State Governments, wherever required, thereby making the recovery of past years' operational loss from respective State Governments as per sanction letters seems doubtful.

The Ministry/ GNCTD while accepting the Audit observation replied (January 2021) that it has been decided and approved at the 138th meeting of Board of Directors (12 November 2020) to apportion operating loss from 2020-21. However, the fact remains that in the absence of line wise operational profit and loss, past year's operational losses, if any, could not be claimed from respective State Governments.

5.2.2 Non-accomplishment of projected ridership after completion of Phase-III and National Capital Region extensions

Government of India sanctioned (26 September 2011) four corridors of 103.05 km of metro lines and nine extensions (within Delhi and to NCR) of 57.70 km (September 2011 to March 2020). As on 31 March 2020, all the corridors except Dhansa Bus Stand are operational. The corridor/ section wise projected ridership and actual ridership of initial Phase-III corridors NCR/ other extensions is shown below:

Figure 5.1
Projected Ridership and Actual Ridership

NAME OF CORRIDOR/ SECTION	PROJECTED DAILY RIDERSHIP IN 2019-20 as PER DPR	ACTUAL DAILY RIDERSHIP DURING 2019-20	% SHORTFALL
DWARKA-NAJAFGARH	97,070	12,012	87.63
MUKUNDPUR (MAJLIS PARK) – MAUJPUR-SHIV VIHAR	11,63,191	1,83,044	84.26
BADARPUR-FARIDABAD-BALLABHGARH	3,38,873	60,648	82.10
MUNDKA-BAHADURGARH	1,27,776	22,968	82.02
DILSHAD GARDEN- NEW BUS ADDA (GHAZIABAD)	1,72,679	43,617	74.74
CENTRAL SECTT. - KASHMIRI GATE	2,42,688	62,578	74.21
JANAKPURI WEST-KALINDI KUNJ	6,50,188	1,71,262	73.66
JAHANGIR PURI-BADLI	52,081	27,600	47.01
NOIDA CITY CENTRE-NOIDA ELECTRONIC CENTRE	93,312	67,978	27.15
KALINDI KUNJ-BOTANICAL GARDEN	51,917	44,068	15.12

In this regard, Audit observed that:

(i) As against the projected ridership of 18.56 lakh in 2016 (20.89 lakh in 2019-20) from initially sanctioned four corridors of Phase-III, the actual ridership in 2019-20 was only 4.38 lakh, which is 79.02 *per cent* lower than projected ridership as per DPR. Similarly, in case of NCR/ other extension, the actual ridership on these corridors was 15.12 *per cent* to 87.63 *per cent* lower than projected ridership as per DPRs. DMRC had selected the Heavy Metro system for Delhi MRTS based on ridership projection in the DPR. However, since the shortfall in ridership during operation ranged from 15.12 *per cent* to 87.63 *per cent*, DMRC may henceforth consider adopting an objective and rational method for selecting the most suitable form of transportation from the available modes like Light Metro and Bus Rapid Transit System as suggested by the Working Group on Urban Transport.

(ii) As per the DPRs of Phase-III and NCR extensions, the total ridership of entire DMRC network (Phase-I, Phase-II and Phase-III) after completion of the project in the year 2016 was estimated as 43.79 lakh (53.47 lakh in 2019-20). Whereas, after completion of entire Phase-III and NCR extensions, except for a small portion of Dwarka-Dhansa Bus Stand (1.2 km), the actual ridership of DMRC was 27.79 lakh (2019-20) only i.e., 51.97 *per cent* of projected ridership.

(iii) Ridership of Dwarka-Najafgarh (Line-9) section was 11,972 (November 2019) after its opening in October 2019 whereas the ridership in the existing Dwarka Mor and Dwarka station reduced[83] by 11,074 from September to November 2019 indicating that only 898 new passengers (0.92 *per cent* as per DPR projected ridership of 97,070) were added after incurring an estimated expenditure of ₹1,065 crore and recurring significant operation & maintenance expenditure. Similarly, after opening of Mundka-Bahdurgarh section in June 2018 and actual ridership was 17,304, there was reduction of 5,762 in ridership[84] of existing Mundka station during May and July 2018. Thus, only 11,542 new passengers (i.e., 10.93 *per cent* of projected ridership of 1,05,6,00) were added after incurring an estimated expenditure of ₹1,991 crore.

(iv) Total ridership of the entire DMRC network was on an increasing trend for the period 2011-12 to 2016-17 (**Annexure-VIII**) when no fare was revised. However, there was steep increase in fare by 91 *per cent* during 2017-18 as per Fourth Fare Fixation Committee which impacted the ridership. The actual ridership of 25.21 lakh during 2018-19 was lower than actual ridership of 25.94 lakh during 2015-16 indicating that there was no incremental growth in ridership despite addition of new lines/ sections of 131 km length during this period and annual growth of ridership as per DPRs.

(v) After completion of Phase-III, ridership per km for the year 2019-20 was 8,543 which was far lower than 9,921 for the year 2011-12.

---

[83] ***Daily ridership of Dwarka mor station September 2019–44,729, November 2019-35,478 Daily ridership of Dwarka station September 2019–9963, Nov. 2019-8140 Net reduction in ridership of existing Dwarka and Dwarka mor station-11,074***

[84] ***Difference in ridership of Mundka station for the month of May 2018 and July 2018***

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that ridership decreased due to various reasons including opening of Phase-III in a phased manner, discontinuity at Trilokpuri, implementation of recommendation of Fourth Fare Fixation Committee, operation of cab services etc., which were not considered at the time of preparation of DPR. However, DMRC has not only regained its ridership but also achieved maximum average ridership of 27.79 lakh in Financial Year 2019-20. Initially high-density regions were covered which led to high passengers/ network length. Moreover, some of the expansions were designed to ease out passenger load on some of the densely used corridors of DMRC which was otherwise overcrowded. However, DMRC is taking a number of measures to attract passengers and to increase its ridership. DMRC also uses scientific four stage traffic modelling for projection of ridership which is duly established.

The reply of the Ministry/ GNCTD/ DMRC needs to be viewed in the light of fact that the opening of Phase- III in a phased manner was considered at the time of formulation of Phase-III DPR. Out of 103.05 km length of initial Phase-III corridors, only a small portion of 300 meter at Trilokpuri is still under construction. Whereas, against projected ridership of 20.89 lakh in 2019-20, actual ridership in 2019-20 from Phase-III corridors was only 4.38 lakh i.e., 21 *per cent*. DMRC did not provide any document to substantiate shifting of number of metro commuters to other mode of transport like cab. Besides, other reasons for low ridership include poor last mile connectivity, lack of Multi Model Integration facilities etc. DMRC reply is silent regarding reduction in passenger per km after implementation of Fourth Fare Fixation Committee recommendations. Even though the projected ridership could not materialise in Phase-I and Phase-II after applying the same model, DMRC still continued with the same traffic modelling without any modification.

5.2.3 Last mile connectivity services to the commuters

The feeder buses project was undertaken by DMRC to ensure last mile connectivity in the interior areas of the city. Its major envisaged benefit was improvement in ridership, partly due to increased supply and partly due to more attractive and convenient vehicles. DMRC awarded (May 2012/ January 2013) contracts to procure, operate and maintain 400 Midi DMRC Feeder Buses to two operators, M/s Rajdhani Coach Clusters Service Private Limited for 300 buses and M/s Prasanna Purple Mobility Solutions Private Limited for 100 buses. As per the terms and conditions of the agreement, these buses will operate from 73 State Transport Authority approved routes.

In this regard, Audit observed the following:

(i) Till date only 174 Midi feeder CNG Non-AC buses out of 400 buses (43.5 *per cent*) were procured by the private operators for providing last mile connectivity. Due to availability of lesser buses, DMRC was operating buses on 32 routes, out of 73 routes. Further, the operators have requested (January 2021) for termination of contracts citing Covid-19 pandemic and GNCTD scheme for free travel by women passengers.

(ii) About 800 electric-rickshaw were operational prior to lockdown and Covid-19 scenario; at present about 250 electric-rickshaw are operational. Similarly, cab aggregator and electric-scooter services are operational from 11 and 6 metro stations only, respectively (out of 254 stations). Auto aggregator service is yet to be operationalised.

(iii) During 2018-19, in order to strengthen the last mile connectivity, DMRC also floated (13 April 2018) a wholly owned subsidiary company 'Delhi Metro Last Mile Services Limited (Company)' with which it proposed to run AC Electrical/ CNG buses as feeder services with viability gap funding by GNCTD. Two Operators for North and East clusters on 10 routes comprising 100 electric-buses AC low floor have been selected (December 2019) but buses are yet to be put to operation. As on 31 March 2020, there was no operational income and expense of the Company.

Thus, commuters were denied the envisaged benefits of last mile connectivity.

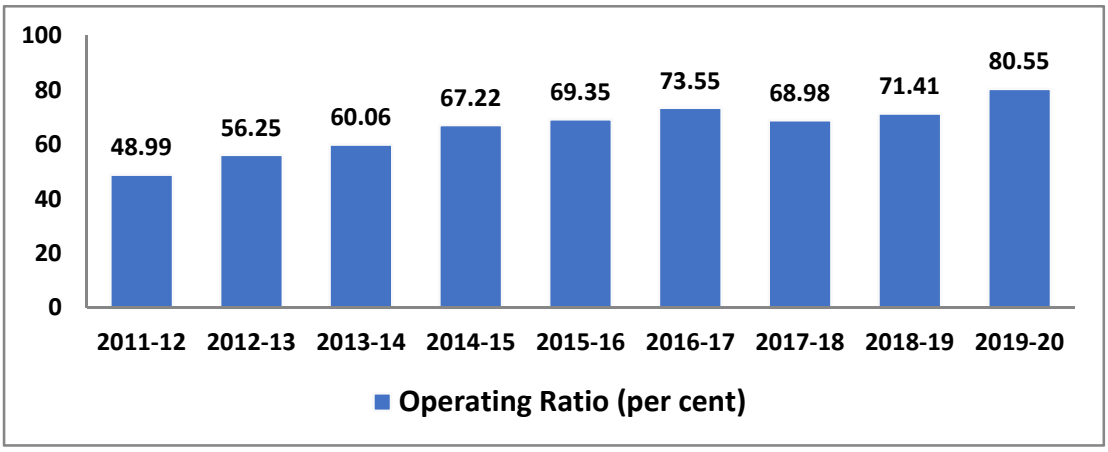
The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that DMRC awarded contracts to procure, operate and maintain 400 Midi DMRC Feeder Buses. Meanwhile, operators requested to reduce the scope of work on account of various factors. Subsequently, the number of Midi Feeder Buses was reduced and DMRC allowed the operators to operate the existing 174 Non-AC Midi feeder buses with signing of addendum to the contract agreements. The buses could not be procured by the operator as the specifications of buses released by MoHUA were not readily available in the market.

The statement of DMRC regarding non-availability of buses with tendered specifications is not acceptable as it was the responsibility of DMRC to ensure availability of buses in the market before floating and finalisation of tender process.

5.2.4 Inefficient operational performance of DMRC

Operating Ratio establishes the relationship between operating costs i.e., cost of revenues from operations plus operating expenses and revenue from operations. The objective of operating ratio is to assess the operational efficiency of the business. A rise in the operating ratio indicates decline in efficiency.

Chart 5.1
Operating ratio of DMRC (Phase-I, Phase-II and Phase-III)



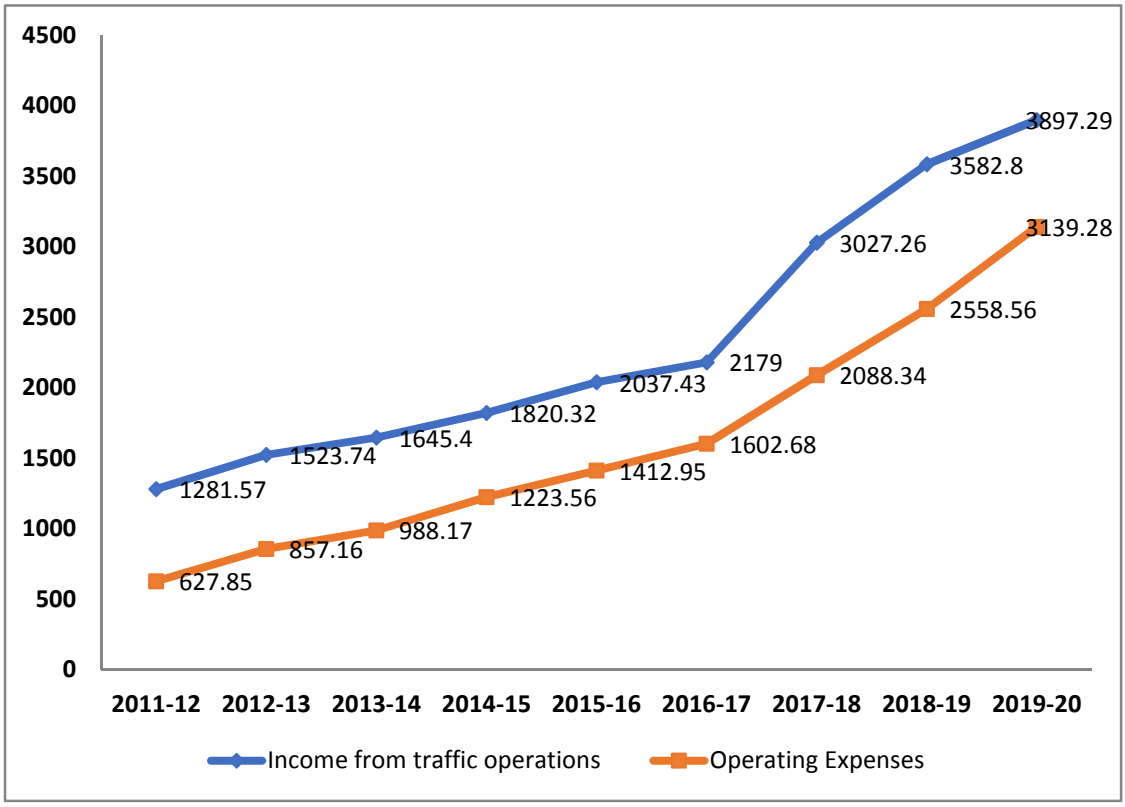
In this regard, Audit observed that:

(i) As per Generally Accepted Accounting Principles, operating profits refer to an accounting statistic that calculates the profit earned by a company/ corporation from its core business operation including depreciation and amortisation but excluding interest and tax deductions. Further, as per Fourth Fare Fixation Committee report (September 2016), Operation & Maintenance cost of Delhi metro have been categorised under the five major heads i.e., staff cost, maintenance cost, energy cost, interest charges and depreciation. Hence, depreciation & amortisation and interest cost are part of the operating expenses. While calculating operating ratio, DMRC excluded the depreciation & amortisation expenses and interest cost as part of the operating expenses thereby reducing the operating expenses. Thus, DMRC was rather suffering operational loss instead of earning operating profit as reported in its annual report as shown in **Annexure–IX**.

(ii) Even without considering the depreciation and interest expenses, there has been a consistent increase in the operating cost ratio (barring 2017-18), which indicates inefficient operational performance of DMRC.

Chart 5.2
Details of DMRC income from traffic operation and operating expenses

(₹ in crore)



The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that the profit/ loss incurred after considering the interest and depreciation during the financial year is reflected in the financial statement of DMRC. The calculation of operating ratio shows

the efficiency and recoverability of operating expenses excluding depreciation and interest from the revenue earned while running the metro trains.

Reply of the Ministry/ GNCTD/ DMRC is not acceptable because a rise in the operating ratio indicates decline in efficiency of the organisation. DMRC has also accepted that while calculating the operating ratio, the operating expenses relating to depreciation and financing cost were excluded, which resulted in operating profits.

5.2.5 Non-implementation of all components of Multi Modal Integration

One of the objectives of GoI's National Urban Transport Policy, 2006 was enabling the establishment of an integrated and quality focused multi modal public transport system providing seamless travel across modes. On all new stations of Phase-III metro corridors, necessary components of Multi Modal Integration[85] are to be incorporated as per Unified Traffic & Transportation Infrastructure Planning & Engineering Centre Street Design, Connectivity and Pedestrian Design Guidelines (2009).

Figure 5.2

Multi Modal Integration

In this regard, Audit observed that:

(i) DMRC neither envisaged implementation of complete Multi Modal Integration in the DPR stage nor included any budget provision or additional land areas. It also did not include the same even at the time of finalisation of tenders for Phase-III of the MRTS.

(ii) As implementation of Phase-III works was delayed by almost two years, focus of DMRC was on immediate road restoration work only and not on implementation of

[85] ***The objective of Multi Modal Integration includes seamless interchange between various modes of transport, availability of safe pedestrian crossing facilities near metro stations, creation of traffic calming measures, improving access and last metro connectivity, walk ability, safety, improve short term parking and drop off facilities, creation of Non-Motorised Vehicle (NMV) lanes, bus shelters, public toilets and to promote green and clean transport.***

complete Multi Modal Integration. In the name of Multi Modal Integration, DMRC carried out road restoration work on the land at all new stations of Phase-III.

(iii) Thirty metro stations of Phase-I and Phase-II facing traffic congestion throughout the day were identified in February 2019 for retrofitting. Audit observed that complete Multi Modal Integration has not been implemented in any of them except Chhatarpur station.

(iv) The conceptual drawing of Multi Modal Integration plan for Chhatarpur metro station was approved on 28 February 2012. The tender for implementation of same was floated (05 April 2017) by DMRC and Letter of Acceptance was issued on 09 August 2017. As per the contract, the work was to be completed within 10 months from 14 August 2017 i.e., by 13 June 2018. However, the work was completed in August 2019. While DMRC took five years in floating of tender, there was delay of more than one year in completion of work of Multi Modal Integration at Chhatarpur Station.

Thus, in absence of complete multi model integration, the envisaged benefits could not be achieved.

During the Exit Conference (January 2021) for this report, Ministry agreed for implementation of all components of Multi Modal Integration.

5.3 Revenue from Property Development and Property Business

5.3.1 Short fall of revenue of ₹1,847.87 crore from Property Development

As per the directive of Administrative Ministry (MoHUA), revenue generated from Property Development was to be used for funding of Phase-III Project and 4.5 *per cent* of project cost is to be met out from Property Development. DMRC has projected an amount of ₹2,505 crore (including short fall of ₹751 crore of Phase-II) to be generated through Property Development during Phase-III.

Accordingly, DMRC appointed (21 June 2012) consortium of M/s KPMG Advisory Services Private Limited & M/s Knight Frank (India) Limited (the consortium) to advice on formulation of an actionable strategy to generate targeted revenue for Phase-III through Property Development. The consortium submitted (May 2013) their final report by identifying three sites[86] for Property Development to be developed during the Phase-III.

In this regard, Audit observed that even after lapse of seven years, as on 31 March 2020, so far only ₹657.13 crore has been earned by DMRC against the targeted earning of ₹2,505 crore. Therefore, there was an overall shortfall of ₹1,847.87 (₹2,505-₹657.13) crore (i.e., 73.77 *per cent*). Audit also observed the following:

(i) DMRC has not explored any possibility for Property Development at site of Vasant Vihar site which alone has the potential earning of ₹2,292 crore.

[86] ***Vasant Vihar, Bhikaji Cama Place, Anand Vihar***

In response, DMRC stated that it had requested (March 2014) DDA for allotment of plot at Vasant Vihar. However, DDA suggested that in lieu of land, it will be appropriate if DMRC seeks funds corresponding to Property Development Budget. Accepting this proposal, DMRC communicated demand of ₹2,505 crore for Phase-III to DDA. Despite follow up, DDA has not taken any favorable action. However, the facts remain that DMRC was unable to get either the plot at Vasant Vihar or any amount as suggested by the DDA.

(ii) Although land of 14,000 sqm for Property Development has been identified at Bhikaji Cama Place, till date no tender has been finalised.

In response, DMRC stated that Property Development at Bhikaji Cama Place is envisaged above the station box. After initial delay by Land & Development office, land has been allotted on 16 April 2019. The project is on hold as the land use of the area has not been changed from 'District Park' to 'Transportation'. Further, an application against the proposed commercial development has been filed in the Hon'ble National Green Tribunal which has ordered to maintain 'status-quo' in this area. DMRC is pursuing with DDA for change of land use and also in National Green Tribunal for vacation of stay. However, the fact remains that the envisaged revenue from Property Development could not be materialised.

(iii) At Anand Vihar, as against the proposed land of 1.5 hectare (15,000 sqm), only 1,358 sqm land has been identified for Property Development and no proposal has been initiated for the Property Development.

In response, DMRC stated that at Anand Vihar, an area of approximately 9,000 sqm has been identified for commercial development in the station box of Phase-II metro station. The project could not be taken up due to upcoming interchange of Phase-III station. Tenders for leasing of the vacant space shall be invited soon. The reply of DMRC is not tenable as the station under Phase-III was started for commercial operation on 31 December 2018 while the area identified for Property Development was pertaining to Phase-II. Thus, fact remains that DMRC failed to lease out the identified area to meet the project cost of Phase-III.

Thus, considering the potential upfront and lease income from these plots, necessary approval and planning should have been completed earlier so that loss of potential revenue could have been mitigated.

5.3.2 Non-accomplishment of revenue from the Property Development area constructed at a cost of ₹151.49 crore

The Ministry of Urban Development sanctioned (13 September 2011) the extension of Line-6 from Badarpur (in Delhi) to YMCA Chowk (Haryana) over a route of length of 13.875 km comprising nine stations[87]. Four hectares of land was to be provided by the Government of Haryana free of cost for Property Development for augmenting the

[87] ***Sarai, NHPC Chowk, Mewala Maharajpur, Sector 27 A, Badkal Mor, Old Faridabad, Ajronda, Faridabad New Town and YMCA Chowk***

earnings and making the corridor viable. As per the DPR (February 2007), two plots of land owned by Government were identified for Property Development and commercial utilisation which were expected to generate ₹234.22 crore. DMRC was also allowed commercial exploitation of the air space above the metro stations and parking area for early re-coupment of loan taken for Rolling Stock. The corridor was further extended to Ballabhgarh with a length of 3.25 km with two stations viz NCB Colony and Ballabhgarh (now Raja Nahar Singh). The corridor from Badarpur to YMCA Chowk (nine stations) and NCB colony to Raja Nahar Singh (two station) were opened for commercial operation on 06 September 2015 and 19 November 2018, respectively. Property Development areas of 44,751 square meter (sqm) were constructed with expenditure of ₹151.49 crore[88] on 11 stations of the above mentioned corridors. In this regard, Audit observed that:

(i) An area of 44,751 sqm constructed on metro stations including three additional floors each at Sarai and Raja Nahar Singh stations at a cost of ₹151.49 crore which was exclusively created for Property Development remained idle as DMRC has not been able to lease them out till date.

(ii) Land at Sector 5 and Sector 20 of Faridabad handed over by Haryana Urban Development Authority for Property Development have not been leased out by DMRC till date. Thus, DMRC has not been able to generate ₹234.22 crore from Property Development as estimated in the DPR.

(iii) As per the Para 12.8 of DPR for Badarpur-Faridabad corridor, there was negative cash inflow of ₹798 crore in a period of 30 years. Hence, the extension of metro line up to YMCA Chowk was not recommended. It was recommended that DMRC should be permitted to commercially exploit the land made available for the project and air rights above stations without sharing of revenues with any other authority/ body/ organisation. This will enable repayment of the commercial loan taken by DMRC for procurement of Rolling Stock. However, DMRC failed to generate any Property Development revenue from the two plots allotted by Government of Haryana and the Property Development area constructed on the eleven stations at a cost of ₹151.49 crore.

Thus, DMRC was unable to let out 40,071 sqm (out of 44,751 sqm) during the last five years which is approximately 90 *per cent* of total areas constructed exclusively for Property Development.

DMRC stated (July 2020) that cost of construction for the framework which was required to attain the height cannot be attributed to Property Development and that ₹151.49 crore have not been spent on construction of Property Development area.

---

[88] ***Property Development area construction cost in respect of nine station were obtained from the cost sheet prepared by DMRC and in respect of two stations viz. Sant Surdas (NCB Colony) & Raja Nahar Singh (Ballabhgarh) the actual cost of construction was not provided by DMRC, the same have been considered on the basis of actual construction cost of Ajronda and Sarai station respectively.***

DMRC had successfully floated tenders for Property Development spaces at five stations in 2015-16. For Sarai and Neelam-Chowk Ajronda stations, tenders have been floated thrice. Continuous efforts are being made by Property Development department by way of re-tendering based on experience gained, besides efforts to lease out spaces to Government departments of Government of Haryana and other PSUs.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that Audit contention that an amount of ₹151.49 crore has been spent on creation of Property Development spaces is not agreed to as the methodology used by Audit to work out the cost of creating the Property Development spaces is wrong. In the recent past, Property Development plot measuring 7,615 sqm in Sector 20-B has been leased out and an up-front payment of ₹6 crore has been received along with requisite security. Similarly, the floor space measuring 4,680 sqm at old Faridabad metro station has been leased out and an up-front payment of ₹2 crore has been received along with requisite security. As regards early recoupment of loan, the cost of Rolling Stock was met by DMRC from its internal resources. On the issue of negative cash flow, it is stated that DMRC never projected that with Property Development.

Reply of the Ministry/ GNCTD/ DMRC is not tenable because Audit did not adopt any methodology of its own for calculation of Property Development area construction cost. Rather, the cost of construction of nine stations were obtained from the cost sheet prepared by DMRC. The area of 44,751 sqm was constructed exclusively for Property Development at the cost of ₹151.49 crore which was over and above the construction cost of stations. Government land pockets have been identified in the DPR of 2007 and the line opened for commercial operation in September 2015. Yet, till date DMRC is not able to let out the properties. It was clearly mentioned in the DPR para 12.8 that the project was not recommended and DMRC should be permitted to commercially exploit the land made available for the project and air rights above stations for early repayment of commercial loan.

5.3.3 Undue benefit to the single bidder

DMRC invited (24 February 2016) bids for Property Development of 12,219 sqm plot at Malviya Nagar for lease period of 50 years (including three-year moratorium) and upfront payment was assessed as ₹120 crore. The tender was opened (11 May 2016) but no bid was received. The revised tender was floated (September 2016) on the revised parameters by reducing the upfront fee to ₹50 crore. Only one bidder i.e., M/s Eldeco Infrastructure & Properties Limited (EIPL) has submitted its bid upto closing date (01 December 2016). M/s EIPL quoted monthly lease fee of ₹19.70 per square feet per month (₹212 per square meter per month). The Tender Committee accepted the offer of M/s EIPL and Letter of Acceptance (LoA) was issued (13 February 2017) to M/s EIPL. In this regard, Audit observed that:

(i) Prior to opening of financial bid (27 January 2017), the bidder has submitted (15 November 2016) their financial proposal of monthly lease fee of ₹19.70 per square feet per month along with fixed upfront lease fee of ₹50 crore. This was prior to the evaluation of the technical bid (20 January 2017). Since the price bid was known to

DMRC before opening of technical bid, the tender should have been cancelled by DMRC. Instead, the work was awarded to the single bidder. The fact that the contractor had submitted its financial proposal was known to the Director (Business Development) who was also the member of Tender Committee. Yet, this fact was neither brought to the notice of Tender Committee nor apprised to the Managing Director, DMRC while seeking his approval.

(ii) As per the modified bid parameter for inviting Property Development tender for standalone plots, the upfront lease should be kept up to 30 *per cent* to 35 *per cent* of the Project Net Present value (NPV). There were no criteria for reducing the upfront fee in the approved bid parameter. However, the upfront fee has been consistently reduced from ₹120 crore to ₹60 crore and then to ₹50 crore by DMRC, without any justification.

(iii) DMRC engaged three consultants[89] to provide details of prevailing rentals of constructed properties at five locations near Malviya Nagar metro station. However, DMRC considered only the rental rate of ₹151 per square feet per month of the Square One mall which was the second lowest among rental rates of the five locations for tendering purpose. Based on rental of Square one Mall of ₹151 per square feet per month[90], DMRC computed the Reserve Price[91] of ₹41.47 per square feet per month[92] (as it was a vacant plot, cost of construction, upfront fee etc. was considered for its calculation) with upfront fee of ₹60 crore. However, this was further reduced (January 2017) to ₹14.21 per square feet per month[93] considering rental of ₹110 per square feet per month by the Reserve Price Committee without any justification though quoted price of ₹19.70 per square feet per month was known ((November 2016) to DMRC. This indicates the undue benefit to the sole bidder.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that any additional financial information if submitted by bidder with the technical package cannot be treated as financial offer. Post demonetisation, the Real Estate market was in bad shape for a long time. DMRC could have lost huge revenue if that bid was not processed. DMRC further stated that achieving 30 *per cent* to 35 *per cent* of project NPV through upfront was not possible during the previous invitation of tender and therefore, moderation of upfront amount was done to make it more attractive, and the NPV was reduced. Average rates of areas which are similar in location and size was accordingly kept as base for reserve price estimation of ₹110 per square feet per month.

The reply of the Ministry/ GNCTD/ DMRC is not tenable as Dy. Chief Engineer and Executive Director/ Contract had brought to the notice of Director (Business Development) that the sole bidder has submitted its financial bid. DMRC reply is also silent about withholding of information from the Tender Committee. Four tenderers had submitted tender security up to the stipulated date i.e., 1 December 2016. Thus, there was ample response for the tender. If the market was in bad shape, DMRC should

---

[89] ***M/s JLL, M/s CBRE and M/s Knight Frank (I) Private Limited***
[90] ***Potential monthly lease income of ready to move in property***
[91] ***Minimum reserve price below which tender can't be awarded***
[92] ***₹446.38 per sqm per month***
[93] ***₹153 per sqm per month***

have extended the bid submission date instead of evaluation of single bid. The bidding parameters were revised in such a way that nominal upfront payment would be received during the construction period and maximum recurring lease fee would be received over the operational period. The upfront fee received by DMRC will help in reducing the project cost and the lease fee will enhance the operating income of DMRC over the lease period. Instead of considering the average rent as suggested by the consultant, lowest rent was considered by DMRC which resulted in fixation of lower reserve price. Thus, to give undue benefit to M/s EIPL, reserve price was fixed at ₹14.21 per square feet per month below the known price bid of ₹19.70 per square feet per month of single bidder.

5.3.4 Transfer of lease right to a third company

M/s EIPL submitted their proposal (3 July 2017) to execute the Malviya Nagar Project through Special Purpose Company. Accordingly, they requested DMRC for executing the lease deed in favour of Special Purpose Company. DMRC granted (7 August 2017) approval for formation of Special Purpose Company for implementation & monitoring of the project through M/s Best View Infracon Limited (BVIL) (a subsidiary of EIPL). For this purpose, an addendum to agreement was signed (22 November 2017) among DMRC, EIPL, and BVIL and they entered (27 March 2018) into supplementary lease agreement where it was decided that BVIL will execute the project and advance lease fee will be submitted by them. In this regard, Audit observed that:

(i) Since Request for Proposal (RFP) does not provide for the transfer of project to subsidiary company/ Special Purpose Company, the transfer of development rights to BVIL was in violation of tender conditions. Thus, DMRC granted the development rights to BVIL who had not participated in the bidding process.

(ii) BVIL was not a new Special Purpose Company created for the specific purpose but an existing subsidiary of EIPL which was incorporated in 2008. This fact was not brought to the notice of DMRC while seeking approval for transfer of project to BVIL. Executive Director (Property Development) also rejected (10 March 2017) the proposal of formation of any Special Purpose Company as RFP documents does not have such a provision. Besides, while transferring work to the BVIL, the financial and technical capacity was not evaluated. Reviewing the financial results (half yearly) for the year ended 2016 and 30 September 2017 revealed that BVIL does not have any operational income. Thus, BVIL was not financially competent to enter into the bidding process.

(iii) Further, Clause 3 of supplementary lease agreement executed (27 March 2018) among DMRC, EIPL and BVIL states that "all rights transferred to the EIPL/ Lessee vide lease agreement dated 29 June 2017 shall now vest with BVIL". Thus, DMRC granted the development rights to BVIL who did not participate in the bidding process and was also not financially competent to enter into the bidding process. EIPL participated in the tender process and work was granted to them but later transferred to BVIL.

Thus, EIPL participated in the tender process and then the work was granted and transferred to BVIL.

DMRC replied (July 2020) that formation of Special Purpose Vehicle/ Special Purpose Company for a company was not mentioned in the contract agreement. But, for effective implementation & monitoring of the project, EIPL submitted proposal of wholly owned subsidiary company (controlling 99.99 *per cent* equity share of Special Purpose Company). Hence, modification was made in the contract condition to allow SPC by taking the approval of Managing Director. The Ministry/ GNCTD endorsed (January 2020) the replies of DMRC.

The Ministry/ GNCTD/ DMRC has accepted that there was no provision in the agreement for formation of Special Purpose Company. No new Special Purpose Company was formed but the work was transferred to BVIL (existing subsidiary of EIPL). Reply of DMRC is silent on financial and technical capacity of BVIL.

5.3.5 Construction of Property Development space over Vinod Nagar depot without market survey/ analysis

As per DPR (September 2011) of Phase-III, a new at-grade Depot at Mayur Vihar (presently Vinod Nagar) was proposed. But, due to land constraint during execution stage, DMRC planned (July 2014) and constructed elevated Vinod Nagar depot and Property Development area above the depot.

Audit observed that DMRC had made provision of ₹37.71 crore for strengthening of structures for Property Development area at Vinod Nagar depot. However, no market analysis on potentiality of the plan and future probability was carried out before deciding for Property Development in the Depot. This Property Development space has not been let out till date even though the depot work is operational since 2018.

The Ministry/ GNCTD and DMRC replied (July 2020 and January 2021) that the provision for future Property Development over double deck stabling was considered due to its location on NH-24 with good connectivity from all directions. The system was planned for stabling of trains on the first two floors and Property Development after market survey on the four floors over these floors.

Reply of the Ministry/ GNCTD/ DMRC is not acceptable as in the absence of any market survey/ analysis, potentiality of Property Development in future cannot be relied upon. Further, no records relating to marketing survey was furnished along with response.

5.4 Revenue from Property Business

5.4.1 Shortfall in revenue generation of ₹1,841.19 crore from Property Business divisions

Detailed Project Report of Phase-III stipulates that the revenue from Property Business[94] and advertisement during the operation stage would be 25 *per cent* of the

[94] ***In July 2012 a new division namely Property Business was carved out from existing Property Development division***

Fare Box collection. During 87th Board of Directors meeting held on 15 March 2012, it was stated that non-operational revenue of DMRC constitute only 21.6 *per cent* of the total revenue and there is tremendous scope for increasing non-operational revenue to at least 30 *per cent* of total revenue in the next five years. In this regard, Audit observed that:

(i) DMRC had no Standard Operating Procedure/ approved plan/ strategy for generating Non-Fare Box Revenue as estimated in DPR for Phase-III including extensions and for guidance and decision making of Property Development/ Property Business Divisions.

(ii) Detailed Project Report of Phase-III and other extensions had a target of ₹1,917.25 crore for Non-Fare Box Revenue during 2016-17 to 2019-20 **(Annexure-X)**, out of which, major portion of earning pertained to semi-naming rights/ co-branding rights of Phase-III stations, which was a new concept and was not contemplated in DPRs. Against this target, DMRC earned only ₹76.06 crore (3.97 *per cent*) till March 2020. Hence, there was shortfall of ₹1,841.19 crore (₹1917.25 crore–₹76.06 crore) from Property Business revenue during 2016-2020.

(iii) Inputs/ suggestions were not taken by Consultancy Division from Property Development/ Property Business division at the time of preparation of DPRs for estimated Property Development/ Property Business income. For example, Property Development/ Property Business area was planned and constructed at Haiderpur Badli Mor station and Vinod Nagar depot, which are located near a landfill site without duly considering that they were underdeveloped areas and with traffic connectivity issues. Besides, space for advertisement, kiosk, ATMs etc., inside and outside the proposed stations on the corridors of Phase-III was not ensured.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that 25 *per cent* of the Fare Box Collection was to flow from recurring payments on the leased properties, advertisement rights, leasing of kiosks, ATMs, semi-naming rights of stations, etc., on full commissioning of Phase-III. Non-fare Box Revenue was estimated on the presumption that the entire Phase-III network will be operational by the year 2016-17. However, Phase-III Project could only be completed by December 2018 except a small portion of 1.5 km. The total Property Development/ Property Business earning up to March 2020 for Phase–III contracts is approximately ₹76.06 crore. The architecture wing provides a tentative list of spaces marked for Property Business activities. However, the final list of the spaces is ascertained after opening of said section/ line/ station. Property Business is a volatile activity and depends upon the existing market conditions.

DMRC accepted that DPR target has not been achieved. The facts remain that there was no coordination between Consultancy Division and Operation Department regarding location, area for Property Development/ Property Business activities. At the time of preparation of DPR, a fixed *per cent* of Fare Box Revenue like 1 *per cent* to 25 *per cent* was fixed for computation of Financial Internal Rate of Return/ viability without mentioning the area for Property Business activities, market trends, expected

rental in the vicinity. Property Development/ Property Business income is estimated at the time of preparation of DPR i.e., before commencement of construction of particular line section/ corridor without any market analysis and demand projections. Reply of the Ministry/ GNCTD/ DMRC is silent on other issues like formulation of Standard Operating Procedure/ Property Development manual. Further, the DPR containing the targets for Property Business was approved by the BoDs, the Board has not reviewed periodically the achievement of target of Property Business division as mentioned in the DPRs and did not take necessary action for accomplishment of the same.

5.4.2 Loss of revenue of ₹15.80 crore due to delay in award of contract

Co-branding contracts: Vigilance Circular (06 October 2012) of DMRC regarding procedure order for calling of Tender/ Award of Tender/ Extensions/ Execution in Property Development and Operation & Maintenance Contracts states that the administrative approval of the proposal should commence at least four months in advance of the contract closure and tenders should be floated at least three months in advance. Further, it was stipulated that Tender Committee should be constituted well before calling of tenders. Property Business division awarded several contracts for co-branding of metro stations constructed during Phase–III with delays ranging from 71 days to 1,270 days in awarding of the 15 co-branding contracts (**Annexure-XI**). As a result, DMRC had to forgo revenue of ₹15.80 crore which could have been earned if the vigilance circular was adhered to and contract of the said metro stations were awarded in scheduled time.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that Co-branding is a very innovative concept of advertisement introduced by DMRC in 2014. The process of calling of tenders of co-branding as well its awarding started well before the completion of Phase-III and is a continuous process. Hence, considering the delay from the date of floating of tender to the date of operation of an individual station is not reasonable. The tender for licensing Semi Naming Rights of metro stations are being called on the principle of expression of interest. Only those metro stations for which expression of interests are received are included in the tender to avoid unnecessary expense of valued revenue of DMRC.

The reply of Ministry/ GNCTD/ DMRC is not correct as vigilance circular was introduced in 2012 whereas DMRC introduced the co-branding concept in 2014 for Phase-I and Phase-II stations existing at that time. Therefore, advance planning for tendering process should have been done so that time frame as per the circular could be adhered to. Further, till scheduled date of completion of Phase-III i.e., March 2016, tenders for only seven stations (excluding above mentioned) Semi Naming Rights contracts were finalised as there was sufficient time (two years/ four years) before scheduled opening of Phase-III corridors i.e., March 2016 and majority stations were opened in 2018-19. But due to delay in finalisation of semi naming rights tenders and awarding before commencement of revenue operation of Phase-III stations, DMRC had to forego revenue amounting to ₹15.80 crore.

5.4.3 Non-utilisation of advertisement space on Platform Screen Doors installed on metro stations of Line-7 and Line-8

In May 2012, DMRC proposed for procurement of Unattended Train Operation based Rolling Stock on Line-7 and Line-8, besides suggesting for installation of Platform Screen Doors on all the stations of Line-7 and Line-8. The proposal of Platform Screen Doors was placed (July 2012) in the 91st meeting of Board of Directors. The Board of Directors appointed sub-committee deliberated that since the initial cost of Platform Screen Doors is high, earning from advertisement has been estimated to explore the method of funding. The sub-committee recommended (August 2012) for installation of Platform Screen Doors on 63 stations on Line-7 and Line-8 with the facility to use space for advertisement and after considering 15 square meter area per station available for advertisement, the potential earning from advertisement on Platform Screen Doors on 63 stations of Line-7 and Line-8 for 30 years was assessed to be ₹225 crore. There was an average advertisement space of 200 sqm on stations as intimated by DMRC. Audit observed that as per NIT of inside advertisement rights for selected 49 metro stations on Line-7 and Line-8, minimum area of advertisement of 40 square meter to 80 square meter is given to licensee after categorisation of each station on the basis of projected ridership, without specifying the actual area of advertisement available at each station including Platform Screen Doors.

The Ministry/ GNCTD and DMRC replied (January 2021 and July 2020) that despite offering the optimum area, more than 40 *per cent* to 45 *per cent* of advertisement inventories are generally lying vacant but successful licensee has to pay the fixed license fee according to contract conditions. Floating separate tender for advertisement rights of Platform Screen Doors and inside stations may attract conflict of interest between the parties which may lead to unnecessary litigation for DMRC. Moreover, the basic thrust of the installation of Platform Screen Doors was to prevent accidental fall or jump by commuters on the track. Earning from the advertisement was envisioned with a noble concept to earn revenue.

The reply of Ministry/ GNCTD/ DMRC is not acceptable as DMRC never floated tender exclusively for Platform Screen Doors advertisement which was envisaged by Board of Directors at the time of approval for installation of Platform Screen Doors. DMRC calculated the estimated price of Line-7 and Line-8 in advertisement contracts on the basis of existing lines wherein Platform Screen Doors was not installed. The conflict of interest between two advertisers is presumption of DMRC and DMRC had already awarded separate tender for digital advertisement other than inside station advertisement contract at ITO station. As potential of Platform Screen Doors advertisement is high, instead of awarding separate contract as recommended by Board of Directors, DMRC allowed existing contractors for station to utilise this huge area without specifying the advertisement area of Platform Screen Doors.

Conclusion

Thus, there were deficiencies in operation and maintenance and shortfall in achievement of planned benefits after commercial operation. DMRC did not prepare

line-wise operational profit/ loss statements and not claiming operational losses, if any from the respective State Governments till March 2020. The actual ridership after completion of Phase-III was only 4.38 lakh against projected ridership of 20.97 lakh in 2019-20, which was 79.03 *per cent* less than the projections. In the NCR and other extensions, the actual ridership was 15.12 *per cent* to 87.63 *per cent* lower than the projections. The operational efficiency of DMRC was also declining with the operating cost ratio rising from 48.99 *per cent* in 2011-12 to 80.55 *per cent* in 2019-20.

DMRC's method of calculating operating expenses excluded the depreciation and amortisation expenses and interest cost, resulting in reduced operational expenses and depicting operating profit although in reality they were incurring operational losses. DMRC not only failed to provide last mile connectivity services, but also did not comply with extant guidelines and was unable to provide Multi Modal Integration facilities.

There was shortfall of ₹1,847.87 crore[95] in earning from Property Development, against the targeted earning of ₹2,505 crore. Further, there was shortfall of ₹1,841.19 crore in Non-Fare Box Revenue generation through Property Business against the estimated Non-Fare Box Revenue of ₹1,917.25 crore during 2016-17 to 2019-20.

Recommendations

17. ***DMRC may prepare line-wise profit and loss account and claim operation loss, if any, from respective State governments.***

18. ***DMRC may also ensure last mile connectivity for augmentation of ridership through various modes including planned feeder bus services.***

19. ***DMRC may enhance its efforts to increase operating efficiency by reducing the operating ratio and also estimate more realistic ridership for future DPRs.***

20. ***DMRC may ensure implementation of a complete Multi Modal Integration as per extant guidelines with integrated planning of land use and various modes of transport.***

21. ***A structured and approved Property Development and Property Business manual may be formulated for ensuring uniformity and consistent decision making. DMRC may also consider preparing a road map to accomplish targeted Non-Fare Box Revenue on the basis of combined experience of Phase-I, Phase-II & Phase-III.***

22. ***There should be a member/expert with marketing skill in Board for efficient dealing with Property Development and Property Business related activities.***

[95] ***₹2,505crore -₹657.13 crore***

CHAPTER-6
CONCLUSION

Chapter 6
Conclusion

Delhi Mass Rapid Transit System implemented by DMRC is a landmark step in the sphere of mass urban transportation in India and revolutionised the mass transportation sector across the Country. Delhi Mass Rapid Transit System Project Phase-I covering 65 km was conceptualised (September 1996) and completed (November 2006) by DMRC. This was followed by Phase-II (124.93 km during 2006-2011), Phase-III (160.74 km during 2011-2019) and Phase-IV covering 103.93 km which is under implementation and scheduled to be completed by December 2024.

Performance Audit of Delhi Mass Rapid Transit System Phase-III was taken up during November 2018 to March 2020 with the objective to examine whether (i) planning was done in a rational manner to ensure economic viability of corridors and selection of the most appropriate technology; (ii) implementation in terms of project execution and contract management was done with due care, economy, and in a timely and transparent manner; (iii) an adequate mechanism was in existence to monitor the project, and (iv) the operation and maintenance were efficient, and the planned benefits were achieved after commercial operation of Phase-III.

Audit observed that there were inconsistencies in recommending and approval of corridors as the benchmark of eight *per cent* of Financial Internal Rate of Return was not adhered to. The Detailed Project Reports of three corridors were prepared in contravention to recommendations of Working Group on Urban Transport & RITES Study in terms of the mode of selection of transport. After sanctioning of Phase-III projects for Lines 7 & 8 and its extensions, the train operation was changed from nine cars to six cars, thus eliminating the possibility of catering to the increased ridership in future. Further, in case of selection of technology, rails of relatively low value of hardness, as compared to standards, were procured, which may result in increased maintenance cost. Traction Transformers and Auxiliary Main Transformer of higher capacity were procured due to estimation of higher projected demand and size of stations, respectively. Also, half height Platform Screen Doors were installed instead of full height Platform Screen Doors resulting in installation of higher capacity electrical equipment and consequent higher energy cost.

With regard to project execution and contract management, Audit observed that the cost of projects was not estimated in a scientific manner; they were estimated on the basis of the last accepted rate. In case of Line-7 (Mukundpur-Maujpur corridor), the Social Impact Assessment study was deficient to the extent of identification of project affected persons at Trilokpuri, which led to more than five year's delay in operationalisation of the entire section. In case of Line-8 (Janak Puri West-Kalindi Kunj corridor), Sadar Bazar & Shankar Vihar stations and additional subway from Terminal 1C to Terminal 1D were constructed, without any provisions in DPR and without approval of GoI and GNCTD. Additionally, the design of Hauz Khas interchange station was flawed, resulting in inconvenience to the commuters. Besides, DMRC did not adhere to various environment requirements including obtaining environmental clearances, conducting water audit and maintaining records of water extracted/ consumed.

Audit noticed delays ranging from 2 months to 46 months in completing the corridors as per the scheduled dates. The Board Sub Committee on Project Management did not meet at regular intervals to monitor the progress of projects and suggest measures for expediting the same. Besides, the Quality Management Plans were prepared by the executing agencies without uniformity across the projects. Real time performance of Rolling Stock Heating, Ventilation and Air Conditioning systems including the energy being consumed has not been analysed in the real conditions, which could help in introducing energy saving strategies.

DMRC did not prepare line-wise operational profit/ loss statements as per the sanction letters. Due to this, DMRC is unable to claim the loss, if any, from the respective State Governments. The actual daily ridership of different corridors was 15.12 *per cent* to 87.63 *per cent* lower than the projections. DMRC not only failed to provide last mile connectivity services, but also did not adhere to the guidelines relating to Multi Modal Integration facilities. There was shortfall of ₹1,847.87 crore in earning from Property Development and ₹1,841.19 crore from Property Business, against the projections for Phase-III.

Thus, Performance Audit of Implementation of Phase-III Delhi Mass Rapid Transit System by DMRC indicated execution of unviable corridors without exploring the other modes of transport, lower ridership and short realisation of Non-Fare Box Revenue than projected which may lead to operational loss for DMRC and extra burden on the Government exchequer even after incurring an expenditure of ₹45,468.89 crore.

Based on the shortcomings and the implications of such deficiencies, 22 Audit recommendations have been proposed for further improvement of the performance of the DMRC.

New Delhi
Dated: 29 October 2021

(R G Viswanathan)
Deputy Comptroller and Auditor General
and Chairman, Audit Board

Countersigned

New Delhi
Dated: 2 November 2021

(Girish Chandra Murmu)
Comptroller and Auditor General of India

ANNEXURES

Annexure-I (Reference: Para 1.10)
(a) Selection of Contract (in number)

Department/ Division	Contract value range	above ₹500 crore	₹100 crore-₹500 crore	₹5 crore-₹100 crore	Total contract	No. of contracts selected
Civil	Total no. of Contract	10	29	88	127	
	No. of Contract Selected	10	15	22		**47**
Rolling Stock	Total no. of Contract	4	0	1	5	
	No. of Contract Selected	4	0	0		**4**
Electrical	Total no. of Contract	0	18	35	53	
	No. of Contract Selected	0	9	8		**17**
Signalling & Telecom	Total no. of Contract	0	7	24	31	
	No. of Contract Selected	0	3	7		**10**
Track	Total no. of Contract	0	5	18	23	
	No. of Contract Selected	0	3	5		**8**
Operation & Maintenance	Total no. of Contract	0	0	17	17	
	No. of Contract Selected	0	0	4		**4**
Property Development	Total no. of Contract	3	0	0	3	
	No. of Contract Selected	3	0	0		**3**
					259	**93**

(b) Selection of Contract (in money value)

Department/Division	₹5 crore-₹100 crore	₹100 crore-₹500 crore	Above ₹500 crore	Total
Civil	710	4,179	8,575	13,464
Rolling Stock	0	0	7,938	7,938
Electrical	181	2,005	0	2,186
Signaling & Telecom	219	1,004	0	1,223
Operation & Maintenance	89	0	0	89
Track	144	572	0	716
Property Development (Revenue contract)	**No expenditure involved**			
	1,343	**7,760**	**16,513**	**25,616**

Annexure-II (Reference: Para 2.1.2)

Statement showing Financial Internal Rate of Return and Non Fare Box Revenue of corridors executed during Phase III

	Sr. No.	Corridors	Sanction date	Financial Internal Rate of Return (Including Central and State Tax) as per DPR	Non Fare Box Revenue as proportion of Fare Box Revenue as per DPR
		Initial Phase III corridors			
Sanctioned up to August 2013	1	Jahangir Puri -Badli	26.09.2011	0.08 %	25%
	2	Central Sectt-Kashmiri Gate			
	3	Mukundpur (Majlis Park)-Yamuna Vihar			
	4	Janak Puri West-Kalindi Kunj			
		NCR/ other extensions			
	5	Badarpur – Escort Mujessar	13.09.2011	**(-)798 crore**	10%
	6	Mundaka- Bahadurgarh	11.09.2012	6.04% (Delhi) 2.29% (Haryana)	12.5%
	7	Maujpur- Shiv Vihar	11.09.2012	**(-) 0.11%**[1] **(-) 755 crore**	25%
	8	Dwarka-Najafgarh	11.09.2012	1.18%	**126% to 296%**
Sanctioned After August 2013	9	Faridabad to Ballabhgarh	27.03.2017	11.01%	5%
	10	Najafgarh to Dhansa Bus stand	09.05.2017	3.4%	10%
	11	Kalindi Kunj- Botanical Garden	20.12.2017	9.85%	10%
	12	Noida city center to Noida sector 62	15.06.2018	8.63%	10%
	13	Dilshad Garden to New Bus Adda Ghaziabad	14.02.2019	12.23%	**1%**

[1] *FIRR of Maujpur-Shiv Vihar was not available. Hence, FIRR of phase III corridors including Maujpur Shiv-Vihar was taken from DPR.*

Annexure-III (A)(Reference: Para 2.1.4.1)

Statement showing different assumptions considered at the time of preparation of various DPRs

Assumptions taken while preparing DPRs	Phase III Corridors Feb, 2011	Maujpur to Shiv Vihar - Nov 2011	Dilshad Garden to Ghaziabad - October 2014	Faridabad to Ballabh garh - December 2014	Kalindi Kunj to Botanical Garden - October 2014	Najafgarh to Dhansa Bus Stand - December 2014	Dwarka - Najafgarh - March 2009	Mundka-Bahadur Garh April 2012	Noida City Center-Noida Sec-62 October 2014	Badarpur-Faridabad February 2007
Escalation Factor (per annum)	5%	5%	7.5%	7.5%	7.5%	7.5%	7%	5%	7.5%	5%
Replacement Cost (Equipment-S&T) After 20 Years	50%	50%	50%	50%	50%	50%	10%	10%	50%	10%
Replacement Cost (Equipment-Electrical) After 20 Years	25%	25%	25%	25%	25%	25%	10%	10%	25%	10%
Staff Deployment (Per Km)	35	35	35	35	35	35	45	35	35	45
Escalation of other expenses based on the O&M unit cost	5%	5%	7.5%	7.5%	7.5%	5%	7%	5%	5%	5%

Annexure-III (B)(Reference: Para 2.1.4.1)

Fare slabs and distance range considered at the time of preparation of various DPRs

Phase III Corridors Feb, 2011		Maujpur to Shiv Vihar - Nov 2011		Dilshad Garden to Ghaziabad - October 2014 and Kalindi Kunj to Botanical Garden - October 2014		Faridabad to Ballabhgarh - December 2014		Najafgarh to Dhansa Bus Stand – December 2014		Dwarka – Najafgarh - March 2009		Mundka-Bahadur Garh April 2012		Noida City Center-Noida Sec-62 October 2014		Badarpur-Faridabad February 2007	
Fare Structure (2016) Escalation Factor @ 7.5% at the end of every 2 Years		Fare Structure (2016) Escalation Factor @ 7.5% at the end of every 2 Years		Fare Structure in 2017-18 Escalation Factor @ 15% once in two Years		Fare Structure in 2017-18 Escalation Factor @ 15% once in two Years		Fare Structure Escalation Factor @ 15% once in two Years		Fare Structure in 2010-11 Escalation Factor @ 5% for every two Years		Fare Structure Escalation Factor @ 7.5% per annum at the end of every 2 Years		Fare Structure Escalation Factor @ 7.5% per annum at the end of every 2 Years		Fare Structure in 2010-11 Escalation Factor @ 5% per annum for every two Years	
Distance (Km)	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Distance (Km)**	**Fare (₹)**	**Dist-ance (Km)**	**Fare (₹)**
0-2	10	0-2	10	0-3	10	0-2	14	0-2	14	0-2	7	0-2	11	0-3	20	0-2	7
2-4	12	2-4	12	3-6	20	2-4	17	2-4	17	2-4	10	2-4	14	3-6	20	2-4	9
4-6	15	4-6	15	6-12	30	4-6	21	4-6	21	4-6	11	4-6	17	6-12	30	4-6	10
6-9	19	6-9	19	12-18	30	6-9	26	6-9	26	6-9	13	6-9	21	12-18	40	6-9	13
9-12	20	9-12	20	18-24	40	9-12	28	9-12	28	9-12	15	9-12	22	18-24	40	9-12	14
12-15	22	12-15	22	24-31	40	12-15	31	12-15	31	12-15	16	12-15	25	24-31	50	12-15	15

Phase III Corridors Feb, 2011		Maujpur to Shiv Vihar - Nov 2011		Dilshad Garden to Ghaziabad - October 2014 and Kalindi Kunj to Botanical Garden - October 2014		Faridabad to Ballabhgarh - December 2014		Najafgarh to Dhansa Bus Stand – December 2014		Dwarka – Najafgarh - March 2009		Mundka-Bahadur Garh April 2012		Noida City Center-Noida Sec-62 October 2014		Badarpur-Faridabad February 2007	
15-18	24	15-18	24	>31	50	15-18	33	15-18	33	15-18	17	15-18	26	>31	60	15-18	16
18-21	26	18-21	26			18-21	37	18-21	37	18-21	18	18-21	30			18-21	17
21-24	27	21-24	27			21-24	38	21-24	38	21-24	19	21-24	31			21-24	19
24-27	29	24-27	29			24-27	40	24-27	40	24-27	21	24-27	32			24-27	20
27-31	31	27-31	31			27-31	44	27-31	44	27-30	22	27-31	35			27-30	21
31-35	34	31-35	34			31-35	47	31-35	47			31-35	39			30-33	22
35-39	36	35-39	36			35-39	49	35-39	51			35-39	40			33-36	23
39-44	39	39-44	39			39-44	51	39-44	54			39-44	41			36-39	24
>44	40	>44	40			>44	52	>44	56			>44	42			>39	25

Annexure-IV (Reference: Para 3.3)

Statement showing special advance beyond contractual provisions paid to various contractors during Phase III

Contract No.	Name of the Contractor	Date of LOA	Amount of special advances paid to contractor (₹ in crore)
CC-126	M/s STEC-SUCGIN	12-10-2017	15
CC-66	M/s Hindustan Construction Company Ltd.	11-04-2014	31.25
CC-24	M/s J. Kumar CRTG-JV	16-07-2012	25
CC-30	M/s Hindustan Construction Co. Ltd	22-10-2012	20
CC-20	M/s J. Kumar-CRTG-JV	12-07-2012	15
CC-04	M/s CEC-CICI(JV)	29-12-2011	30
CC-18	M/s FEMC- Pratibha JV	22-10-2012	50
CC-64R	M/s Vijay Nirman Company Pvt. Ltd	30-04-2014	8.5
CC-32	M/s. ITD-ITD Cem JV	01-03-2015	60
CC-23	M/s FEMC-Pratibha JV	29-01-2013	70
CC-27	M/s L&T-SUCG JV CC 27 Delhi	01-11-2012	50
CC-15	M/s Afcons Infrastructure Limited	09-05-2012	40
CC-26 R	M/s ITD-ITD CEM JV	09-09-2012	140.94
Total			**555.69**

Annexure-V (Reference: Para 3.16)

Statement showing details of tree cutting estimation in DPR, permission taken from Forest Department, Actual tree cutting and amount deposited with Forest Department

Name of corridor/ Section	Number of trees to be cut as per DPR (A)	Number of trees to be felled as per Environment Impact Assessment study conducted by M/s RITES (Aug 2011) (B)	Cost of one tree plantation as per DPR (in ₹) (C)	Estimated cost of compensatory afforestation as per DPR (₹ in crore) (D)	Permission for tree cutting granted by Forest deptt. (E)	Actual tree cut (F)	Actual amount paid for compensa-tory afforestation (₹ in crore) (G)	Actual expenditure on compensatory afforestation over DPR projection (in %) (H) = (G)/(D)/100
Mukundpur-YamunaVihar	2,470	7,123	1250	1.44	7,091	5,266	17.91	3,083.33
Janak Puri West-Botanical Garden	8,205	7,891			6,381	4,650	20.23	
Kashmiri Gate-Central Sectt.	695	1,049			1,629	807	4.92	
Jahangir Puri-Badli	141	546			427	230	1.34	
Dwarka-Najafgarh	176		1200	0.04	240	225	0.77	1,925
Mundka-Bahadurgarh	700		700	0.021	567	550	1.96	9,333.33
Najafgarh-Dhansa Bus Stand	0		0	0	178	157	1.01	0
IT Park, Shastri Park	0		0	0	97	101	0.82	0
Badli depot	0		0	0	845	660	2.80	0
Total	**12,387**	**16,609**		**1.50**	**17,455**	**12,646**	**51.76**	

Annexure-VI (Reference: Para 3.16)
Statement showing excess payment deposited with Forest Department

Name of corridor/ Section	Name of Chief Project Manager office	Number of tree cutting permission was granted by forest department (A)	Number of tree relocation permission was granted by forest department (B)	Actual number of tree felled/cut (C)	Actual number of tree relocated (D)	Total number of trees which were either not cut or relocated/ transplanted, but payment made to forest department [(A-C) +(B-D)}	Total excess payment made to forest department after considering ₹ 28,000 per tree
Jahangir Puri-Badli	CPM-2	427	53	230	0	250	70,00,000
Badli Depot	CPM-2	845	22	660	50	157	43,96,000
Mukundpur-YamunaVihar	CPM-2	2,455	166	1,770	46	805	2,25,40,000
	CPM-3	1,323	0	1,159	128	36	10,08,000
	CPM-4	3,313	304	2,337	175	1,105	3,09,40,000
Janak Puri West-Kalindi Kunj	CPM-5	1,330	114	936	63	445	1,24,60,000
	CPM-6	3,901	30	2,566	0	1,365	3,82,20,000
	CPM-7	1,150	4	1,148	0	6	1,68,000
Kashmiri Gate-Central Sectt.	CPM-8	1,629	31	807	0	853	2,38,84,000
Dwarka-Najafgarh	CPM-1	240	0	225	0	15	4,20,000
Najafgarh-Dhansa Bus Stand	CPM-1	178	0	157	0	21	5,88,000
IT Park, Shastri Park	CPM-1	97	0	101	0	-4	-1,12,000
Mundka-Bahadurgarh (Delhi portion)	CPM-9	567	22	550	22	17	4,76,000
Total (Delhi)		**17,455**	**746**	**12,646**	**484**	**5,071**	**14,19,88,000**

Annexure-VII (Reference: Para 5.2.1)

Statement showing extract from various sanction letters regarding bearing of operational loss

Name of corridor	Date of sanction letter	Length (in km)	Scheduled date of completion	Actual date of Completion and commercial operation date	Relevant clause regarding bearing operation loss as per sanction letter.
Initial Phase III having 4 corridors	26-09-2011	103.05	March 2016	Opened in phased manner from November 2015 to December 2018 (except 0.3 km approx at Trilokpuri)	Clause 1 (v) (f) of sanction letter stated that operating losses of Phase III, if any shall be borne by GNCTD only.
Dwarka-Najafgarh	11-09- 2012	5.5	December 2015	October 2019	Clause 1 (v) (e) of sanction letter stated that operating losses of this line shall be borne by GNCTD only.
Badarpur- YMCA Chowk (Faridabad)	13-09-2011	13.875		06-09-2015	Clause 2(i) of sanction letter stated that DMRC will work out what sort of mechanism is feasible for operational profit/losses for a particular line in future. If there is a case of operational losses for a particular line in future, the Board of Director of DMRC would consider the issue with specific inputs from the chief Secretary, GNCTD and chief Secretary, Haryana.
Maujpur- Shiv Vihar extension	11-09-2012	2.717		31-10-2018	Clause 2 (f) of sanction letter stated that DMRC will work out what sort of mechanism is feasible for operational profit/losses for a particular line in future. If there is a case of operational losses for a particular line in future, the Board of Director of DMRC would consider

Name of corridor	Date of sanction letter	Length (in km)	Scheduled date of completion	Actual date of Completion and commercial operation date	Relevant clause regarding bearing operation loss as per sanction letter.
					the issue with specific inputs from the chief Secretary, GNCTD and Chief Secretary, Uttar Pradesh.
Faridabad-Ballabhgarh	27-03-2017	3.21	31-12-18	19-11-2018.	Clause 6 (i) of sanction letter stated that DMRC will work out what sort of mechanism is feasible for operational profit/losses for a particular line in future. If there is a case of operational losses for a particular line in future, the Board of Director of DMRC would consider the issue with specific inputs from the chief Secretary, GNCTD and chief Secretary, Haryana.
Kalindi Kunj-Botanical Garden	20-12-2017	3.96	31-12-17	25-12-2017.	Clause 6 (h) of sanction letter stated that GoI would not not finance cash loses and capital expenditure during the operational phase and its requirements would be financed by SPV and/or the State Government from its own resources.
Noida City Centre to Noida Sector-62	15-06-2018	6.675	30-09-18	09-03-2019.	Clause 6 (h) of sanction letter stated that GoI would not not finance cash loses and capital expenditure during the operational phase and its requirements would be financed by SPV and/or the State Government from its own resources.
Dilshad garden to New Bus Adda (Ghaziabad)	14-02-2019	9.41	31-01-19	09-03-2019.	Clause 6 (h) of sanction letter stated that GoI would not not finance cash loses and capital expenditure during the operational phase and its requirements would be financed by SPV and/or the State Government from its own resources.

Name of corridor	Date of sanction letter	Length (in km)	Scheduled date of completion	Actual date of Completion and commercial operation date	Relevant clause regarding bearing operation loss as per sanction letter.
Mundka-Bahdurgarh	11-09-2012	11.182		25-06-2018	Clause 7 (f) of sanction letter stated that DMRC will work out what sort of mechanism is feasible for operational profit/losses for a particular line in future. If there is a case of operational losses for a particular line in future, the Board of Director of DMRC would consider the issue with specific inputs from the chief Secretary, GNCTD and chief Secretary, Haryana.

Annexure-VIII (Reference: Para 5.2.2)
Year-wise ridership, annual growth and ridership per km of entire DMRC network from 2011-12 to 2019-20

Year	Average Daily Ridership (in lakh)	Yearly growth (in *per cent*)	Route length (in km) excluding Airport line	Maximum Ridership in a single day (in lakh)	Section/corridor opened during the year (in km)	Passenger/ridership per km {daily ridership/length in km}
2011-12	16.60	--	167.33	20.84 (12.08.11)	--	9,921
2012-13	19.26	15.68	167.33	23.05 (11.02.13)	--	11,510
2013-14	21.91	13.75	167.33	26.51 (19.08.13)	--	13,094
2014-15	23.86	8.9	170.36	28.87 (08.09.14)	3.03	14,006
2015-16	25.94	8.73	189.50	31.72 (28.08.15)	19.14	13,689
2016-17	27.61	6.95	189.50	33.69 (17.08.16)	--	14,570
2017-18	25.37	-8.11	228.98	31.13 (08.08.17)	39.48	11,080
2018-19	25.21	-0.63	320.79		91.81	7,859
2019-20	27.79	10.23	325.29		4.5	8,543

Annexure-IX (Reference: Para 5.2.4)
Operational Performance *(₹in crore)*

Year	Income from traffic operations (1)	Operating Expenses (2)	Operating Profit (3) = (1)-(2)	Operating ratio (4) = (2)/(1)	Depreciation (5)	Interest Cost (6)	Operating expenses (including Depreciation and interest cost) (7) = (2) +(5) +(6)	Operational Loss (8) = (7)-(1)
2011-12	1,281.57	627.85	653.72	48.99	800.87	200.58	1,629.3	347.73
2012-13	1,523.74	857.16	666.58	56.25	819.22	216.56	1,892.94	369.2
2013-14	1,645.40	988.17	657.23	60.06	900.78	222.04	2,110.99	465.59
2014-15	1,820.32	1,223.56	596.76	67.22	1,288.55	226.81	2,738.92	918.6
2015-16	2,037.43	1,412.95	624.48	69.35	1,480.80	264.07	3,157.82	1,120.39
2016-17	2,179.00	1,602.68	576.32	73.55	1,541.12	240.13	3,383.93	1,204.93
2017-18	3,027.26	2,088.34	938.92	68.98	1,718.19	262.50	4,069.03	1,041.77
2018-19	3,582.80	2,558.56	1,024.24	71.41	2,415.39	311.68	5,285.63	1,702.83
2019-20	3,897.29	3,139.28	758.01	80.55	2,382.85	451.89	5974.02	2076.73

Annexure-X (Reference: Para 5.4.1)
Statement showing Non-Fare Box Revenue (Property Development & Advertisement) as per DPRs

(₹ in crore)

Name of section/corridor	2016-17	2017-18	2018-19	2019-20
Phase III Corridors including Shiv Vihar Extension - November, 2011	199.37	418.75	460.05	483
Badarpur-Faridabad	13.78	14.33	15.46	15.46
Dilshad Garden - Ghaziabad October 2014	1.27	1.33	1.54	1.62
Faridabad- Ballabhgarh December 2014	0	0	2	2
Kalindi Kunj to Botanical Garden - October 2014	0	3	5	7
Mundka-Bahadurgarh	5	6	7	8
Dwarka- Najafgarh 2009	38.75	46.88	54.23	48.31
Najafgarh-Dhansa Bus stand 2014	0	6	6	8
Noida City Center -Noida Electronic City 2012	0	7	7	8
Advertisement from Platform Screen Doors as per decision of BoD meeting	3.6	3.97	4.17	4.38
Total	**261.77**	**507.26**	**562.45**	**585.87**

Grand total ₹ 1917.25 crore

Annexure-XI (Reference: Para 5.4.2)

Statement showing delays in awarding of the co-branding contracts

Sl. No.	Name of the Station (A)	Date on Tender floated (B)	Date of start of commer-cial operation (C)	Delay in days/prior to start of commer-cial operation D(B-C)	Date of award the Co-Branding Contract (E)	Delay in award of contract F (E-C)	Actual Date of Handing over of station (G)	Scheduled date of start of License Fee (H)	Actual Date of start of License Fee (I)	Delay in start of license fee date due to delay awarding of contract J (I-H)	Rate quoted by successful bidder (Annually) (in ₹) (K)	Per day revenue (in ₹) L (K/365)	Loss of revenue (in ₹) M (J x L)
1.	Vasant Vihar	25-07-18	28-05-18	58	16-01-19	233	21-02-19	25-09-18	21-06-19	269	55,00,000	15,068	40,53,292
2.	Durgabai Deshmukh South Campus	25-07-18	06-08-18	-12	11-01-19	158	06-08-18	04-12-18	31-03-20	483	2,69,95,555	73,960	3,57,22,680
3.	Nehru Enclave	25-07-18	28-05-18	58	17-01-19	234	21-02-19	25-09-18	21-06-19	269	1,83,00,000	50,137	1,34,86,853
4.	ITO	28-04-16	08-06-15	325	05-08-16	424	19-08-16	06-10-15	17-12-16	438	75,50,000	20,685	90,60,030
5.	Badkal Mor	23-06-15	06-09-15	-75	27-09-16	387	23-05-16	04-01-16	19-09-16	259	61,20,000	16,767	43,59,420
6.	Delhi Gate	23-06-15	28-05-17	-705	19-12-17	205	10-01-18	25-09-17	10-05-18	227	1,50,00,000	41,096	93,28,792
7.	Hauz Khas	25-07-18	28-05-18	58	07-08-18	71	10-09-18	25-09-18	08-01-19	105	75,00,000	20,548	21,57,540
8.	Ajronda	23-06-15	06-05-15	48	27-04-16	357	22-06-16	04-01-16	20-10-18	1020	51,00,000	13,973	1,42,52,460
9.	Janpath	23-06-15	28-06-14	360	19-12-17	1270	08-02-18	26-10-14	08-06-18	1321	62,00,000	16,986	2,24,38,506
10.	Mewla Maharajpur	23-06-15	06-09-15	-75	29-12-17	845	31-01-18	04-01-16	31-05-18	878	46,00,000	12,603	1,10,65,434
11.	Bata Chowk	Negotiation basis	06-09-15	-	06-07-18	1034	14-08-18	04-01-16	12-12-18	1073	45,00,000	12,329	1,32,29,017
12.	NHPC Chowk	23-06-15	06-09-15	-75	27-04-16	234	23-04-18	04-01-16	21-08-18	960	61,30,000	16,795	1,61,23,200
13.	Sarai	23-06-15	06-09-15	-75	19-12-17	835	23-01-18	04-01-16	23-05-18	870	36,00,000	9,863	85,80,810
14.	Escorts Mujesar	Negotiation basis	06-09-15	-	08-02-17	521	15-02-17	04-01-16	15-06-17	528	18,00,000	4,932	26,04,096
Total Revenue Loss due to delay in award of Co- Branding contracts													**₹15,79,80,519**