

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 observations⁸¹ 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	24 to 33
4	Maujpur to Shiv Vihar (Line-7 Extension)	September 2012	2.9	March 2016	Shiv Vihar-TrilokPuri October 2018 Vinobha Puri-Mayur Vihar Pocket-I December 2018	
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 formwork⁸² 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 CO₂ 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, CO₂, 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.*

