O&M Planning Standards (FS Stage)

This page illustrates the essential areas and depths of study for O&M as minimum requirements in the conduct of the FS. Ideas for the effective conduct of FS (e.g., the composition of the study team and items reviewed by railway operators), are incorporated.

Study items and study depth

Calculation of estimated route development cost

Presented as multiple proposals

Essential study items for railway system development

Differential analysis of basic items is essential for calculating the estimated amounts based on past results

◆O&M basic plan
- Route plan/Train operation type
- Train operation plan/ demand forecast
- Station operation plan
- Railway systems plan
- Maintenance plan, Asset management plan

◆Personnel and organizational plan

Essential study items for business plan

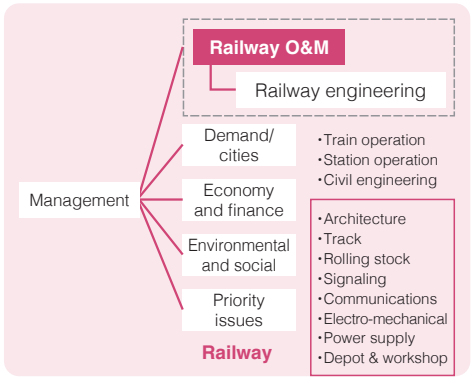
In addition to cost analysis, the selection of the operating entity and the existence of regulatory systems have significant impacts on the study conditions of the DD stage.

◆Business plan
- Project scheme framework
- Selection of operating entity

Smooth transition to DD stage

Early identification of essential study items

Investigation personnel



Bidders may propose composition of E&M experts based on man-months specified by JICA. Otherwise, the JICA can also assign corresponding position names (e.g., O&M system 1, O&M system 2)

Railway O&M

Necessary O&M study at the FS stage (arranged separately from railway engineering)

Personnel configuration
- 2 persons / 4PM ++ as required
- O&M plan
- O&M organizational and personnel plan

Tasks
- Confirm framework for implementing agency and operating body
- Study organizational structure of the operating body and estimate the number of personnel
- Assess technical, budgetary, and human resource capacities
- Propose O&M support scheme
- Crosscheck essential areas of study

Verification

At the preparatory survey stage, JICA should mandate consultants to embody the review structure, where members from railway operators check any omissions in O&M support and essential areas of study.

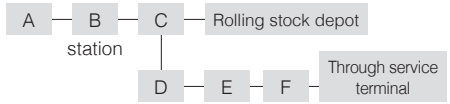
Survey team		Reviewer	
Consultant member	Railway operator A member 1	Railway operator A member 2	Review

Deliverables		
	Checklist	Check any omissions in O&M support
	Essential study areas	Check interface across essential areas of study

Essential Study Items and Basic Specifications

Route plan Through service plan

Through service plan
Route length and track layout
Station locations
Distance between stations
Depot locations and site area

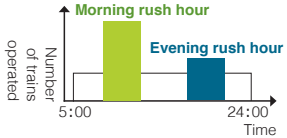


Train operation type

Grade of Automation
- (GoA) 1(driver + conductor)
- GoA2(driver)
- GoA3(security personnel)
- GoA4(unmanned)

Demand forecast Train operation plan

Peak transportation capacity (one- way passengers) = train capacity x no. of trains operated per hour x planned congestion rate
Required number of trains = ((round trip time + turnaround time) / operation interval)) x preliminary train rate



Station operation plan

Fare collection method (IC card, QR code, ticketless)
Station facility basic concept (security checks, ticket gates or not, passenger information, staffing)

Railway systems plan

Rolling stock main spec.

Car capacity
Rolling stock length and width
MT configuration
(future augmentation plan)
Acceleration / deceleration performance

Civil and track structures

Substation facilities

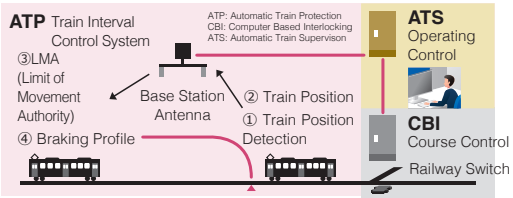
Power receiving voltage
Power substation layout
Power transmission and distribution equipment
Feeder voltage (1500V/750V)
Contact line system (i.e., overhead, cantenary system, third rail)

Mechanical facilities

Ventilation, drainage equipment
Conveyance equipment
PSD equipment
Fare collection system

Signal facilities

Signal facility type (e.g., track circuit type (automatic train control system), radio type (communications-based train control system))



Communications facilities

Wired communications facilities (e.g., contact phone, emergency phone)
Wireless communications facilities (e.g., train radio, protection radio)

Maintenance plan・asset management

Rolling stock depot(e.g., track layout, buildings, number of pits, inspection facilities)

Common study items
- Maintenance entity (direct management/ outsourcing)
- Maintenance content
- Maintenance cycle
- Maintenance equipment
- Special work vehicles
- Other equipment
- Maintenance yards
- Asset management system

Personnel and organizational plan
(Organizational structure, job descriptions, personnel numbers (total personnel by department))

Planning of O&M Support Programs

This page highlights the key points in planning for O&M support in the FS Stage. The checklist and the standard framework for O&M support help eliminate overlooked items during the implementation stage. The implementation framework and project scheme are the basis for designing O&M support programs.

O&M Support Checklist

The sample framework below highlights the standard items necessary for future O&M support, including post-opening assistance.

O&M Plan						Personnel and Organizational Plan			Business Plan										Economic and Financial Analysis				Regulatory System							Contracts	
Demand Forecast	Route plan	Transport plan	Railway system plan	Station operation plan	Maintenance plan	Organizational designs	Personnel plan	Definition/delineation of duties/functions	Asset ownership and management	Project scheme	O&M revenue and expenditure	Selection of operating entity	Fare policy	Non-rail business	PR plan	Business strategy	Service level	Replacement and reinvestment costs	Subsidy	Cash flow analysis	Economic and financial analysis	Regulatory framework	Institutional development	Regulator capacity building	Technical standards	Safety management	Safety certification	Other rules and regulations	O&M contract	Outsourcing plan

Consulting service with respect to O&M

Concept of Support Framework

The GC, OMCS, or contractor should be in charge of carrying out capacity building activities for different personnel (e.g., managerial capacity building for head office personnel, on-the-job training for worksite personnel, and user training for equipment handling). In addition, post-opening support should be programed effectively, as several projects in the past required such interventions.

Planning of Support Framework

The O&M support framework is determined at the FS stage; and under this framework, the GC's scope of work for O&M must be made clear.
In terms of organizational development, institutional development, and establishment of training centers, the implementing entity and the JICA must agree as to whether these scopes should be within separate consulting packages or part of the GC. Parties should also agree as to whether these will be carried out through a Japan ODA loan or as a technical assistance project.
While various support programs can be explored for public operator models, support from the JICA may be less for private operator models.

Standard Form of Support Framework

O&M capacity is built with a variety of support activities in addition to GC and contractors. These include assistance with regulatory systems and technical standards, business plans, operational readiness, and post-opening support.
The figure on the right illustrates a comprehensive framework of O&M support in countries with little or no experience in urban railways.
The support package will be decided through the preparatory survey done at the FS stage, taking into account the local and market contexts of the railway sector.

Implementation Structure

The JICA's preparatory survey should identify which entity is viable to act as the operating body. The entity, however, is often not made clear at the FS stage. Project schemes usually require high-level executive decisions made as the result of extensive stakeholder coordination. If several alternatives for the implementing structure needs to be studied in detail a project scheme expert should be assigned to the O&M of the study team.

The following questions are answered on the corresponding pages.

- What is the team composition of O&M support? p.105
- What problems have occurred in the past with O&M support and how should they be addressed? p.106 p.107
- Who are the stakeholders involved? p.108
- What are the project performance indicators? p.108
- What is the proper use of technical assistance, project implementation assistance, and dispatch of professional experts? p.109
- What are possible destinations for overseas training in a third country? p.109
- What are some useful examples of past O&M support? p.110

- The O&M support checklist has been prepared and organized through the analysis of past TORs.
- The list is used to identify which entity can best provide the corresponding assistance when defining the support framework.
- In addition to the consulting packages, it is important to be aware of the sharing and delineation of roles with the implementing body, the operating entity, and the contractor.

Organizational Development and Recruitment						Operational Readiness																Post-Opening Support						Training Center			
Organizational development	Recruitment plan	Hiring of admin. and management personnel	Hiring of O&M personnel	Training of train drivers	Visits and technology transfer	Facility documentation(as-built drawings)	Facility handover	Training and readiness (Admin./Management)	Training and readiness (Operations)	Training and readiness (Maintenance)	Internal rules and regulations	Job manuals	Quality management plan	Maintenance plan and budgeting	Equipment procurement	Asset and resource management system	Practical training	Integrated testing and trial run	Operating license	Organizational management	Maintenance activities	Operations activities	Organizational improvement	Maintenance improvement	Operations improvement	Organizational and institutional development	Training center management	Training materials development	Training equipment procurement

Consulting package Detailed designs and construction supervision services

Consulting package Operation and maintenance consulting service (underlined are JICA funded.)

▼Standard form of O&M support

FS	BD	DD	GC	OM

Designing O&M support framework

GC
Specify user training and post-opening maintenance requirements in tender documents, Supervise integration tests and trial runs, and other related tasks

Institutional Development Consultant
Develop regulatory systems and technical standards

Management Consultant
Prepare O&M business plans

OMC 1
Build management capacity of headquarters and provide on-the-job training (operational readiness)

OMC 2
(Post- opening support)

E & M contractor
Provide user training for delivered equipment, prepare manuals and regulations

Maintenance contract
Maintenance services

Considerations

- Are regulatory systems and technical standards in place?
- Should management consultancy be provided in establishing the new operating company?
- Is the operating company necessary for the countries that already have operational urban railways?
- Should the GC also provide O&M support aside from construction?
- Is a Japanese railway operator interested in O&M support?
- Can GC secure sufficient manpower for O&M support?

- OMCS functions may be consolidated into the GC, having the advantages of reducing additional coordination between different contract packages.
- On the other hand, Japanese railway operators may not be able to provide their best performance under GC as the latter's primary focus is on construction project.
- GC must secure sufficient resources for O&M support. Otherwise, a separate OMC service that involve Japanese railway operators is considered more effective.

▼ Past Examples of Implementation Framework and Project Scheme

Preparatory survey confirmed that a public entity will be the operating body		Preparatory survey could not clarify which entity will be the operating body		Preparatory survey confirmed that it will be run by a private sector operator	
Implementing agency became the operating body.	New operating entity created	With a public entity selected	Private sector entity to be selected through bidding	Public to build and private sector to operate	E&M investment + O&M by private sector
Jakarta MRT	Ho Chi Minh Line 1	Mumbai Line 3	Manila Subway	Manila future route	Bangkok Purple Line

Railway O&M Tasks

- Confirm framework for both the implementing agency and operating body
- If the framework is not made clear, **study alternatives on project scheme.**
- Study the organizational structure of the operating body and estimate the number of personnel
- Assess the technical, budgetary, and human resource capacities of the operating entity
- Propose viable O&M scheme
- Crosscheck essential areas of study

Actions in studying project scheme

- Evaluate alternatives to project scheme
- Confirm procedures for selecting project scheme
- Suggest the timeline to conclude project scheme
- Identify the risks for late conclusion of project scheme
- Clarify the tasks that the conclusion will be the condition precedent

Implementation of O&M Support

Examples of the assignments of GC (O&M support) and O&M consulting services are provided in this section. It provides relevant information on past experiences, key points for the preparation of manuals and regulations, as well as capacity building.

GC Team Composition

The GC O&M support team is involved in three work groupings: preparation of O&M manuals and training plans, interface (I/F) coordination between GC's O&M plan with the contractor, and development of the business scheme and/or business plan. Since the assignments of GC O&M support will depend on other programmed O&M support, whether TA or OMC is in place, presented below is an enumeration of expert positions, tasks, and other important information. Note that add to these, expertise in common ticketing systems, office IT systems, and asset management may be added, as needed.

▼Team composition (GC - O&M Team)

Position (example of MMSP-GC)	Task overview	Remarks
1. Manual Expert 2. Training Expert 3. Training Coordinator	• Describe specifications in bid documents • Prepare training plan and assist in training implementation	• These are the typical positions included the in GC contract. • Deliverables from the contractor are necessary to finalize the documents.
4. Station Operation Advisor 5. Rolling Rock and Depot Advisor 6. Signal & Telecommunication Advisor 7. Civil & Track Advisor 8. Train Operation Advisor 9. E&M Advisor 10. Advisory Engineer 1 11. Advisory Engineer 2	• Prepare O&M plan • Describe specifications in bidding documents • Coordinate interface with contractors • Coordinate subsystems across GC • Provide O&M advisory after opening	• Even if other consultant services provide operational readiness/ post-opening support, three (3) or more people assigned to the GC for coordination purposes (e.g., civil & track, rolling stock, and signaling experts)
12. O&M Rule Expert / PPP Expert 13. Finance & Business Management Advisor 14. PR & Mobility Management Expert 15. Transport Expert 2 16. Railway Business Expert	• Conduct studies on project scheme and assist in approval; procedures • Develop business plans and assist finalization process • Ensure financial soundness of the operating entity	• The actual nature of tasks depends on whether the implementation/ operation framework has been concluded or otherwise. • The positions may be reduced if technical assistance and/or O&M consulting service are provided beyond the support from GC.

O&M related OMC personnel composition (required specialist fields)

Enumerated below are the experts dispatched for the Jakarta MRT's OMCS (for field operations supported by Japan ODA Loan), as well as Technical Cooperation Project for the Ho Chi Mind City Railway Line 1 (head office management support), respectively.

OMCS Experts for the Jakarta MRT

1. Project Manager
2. Urban Railway Train Operation Management Expert
3. Urban Railway Train Operation Planning Expert
4. Urban Railway Train Operation Handing Expert
5. MRT Safety System and security Expert
6. Electric Multiple Unit (EMU) Management Expert
7. Track Facility Maintenance Expert
8. Civil Structure Management Expert
9. Workshop/Depot Facility & Equipment Management Expert
10. Signal/Telecom. System Management Expert
11. Electrification System Management Expert
12. General Mechanical Equipment Management Expert
13. IT System Operation Expert
14. Passenger Service Management Specialist
15. Legal & Regulatory Administration Specialist
16. Environmental Management Expert
17. Organizetion Stryctur Planning/HR Expert
18. Operation & Maintenance Cost Specialist
19. Personnel Training Planning Expert
20. Non Railway Business Managing Expert
21. Tender Document Specialist

OMCS Experts for the Technical Cooperation Project for Ho Chi Minh City Railway 1

1. Project Manager
2. Urban Railway Regulations Specialist
3. Safety Management Expert
4. Human Resources and Training Expert
5. Finance Specialist
6. Planning & Strategy Expert (organization and management)
7. Urban Railway Operation Expert
8. Station Facility Management Specialist
9. Maintenance Expert (civil / track)
10. Maintenance Expert (rolling stock)
11. Maintenance Expert (electrical, signal & communication systems)
12. Maintenance Expert (mechanical systems)
13. IT Systems Specialist
14. Asset Management Specialist
15. Mobility Management Expert
16. Project Coordinator / Monitoring Evaluation Specialist

Preparation of Manuals, Rules, and Regulations

O&M manuals are finalized based on submissions of the contractor. O&M rules and regulations are prepared jointly by the contractor and the operator. Based on past experiences, the consultant assisting the operator may find difficulty receiving the contractor's submissions at the right time, usually due to contract terms. In such cases, the recourse for the consultant is to prepare relevant documents based on their assumptions, leaving out necessary inputs from the contractor. Developing standard documents to improve the efficiency of consulting services will help avoid these scenarios. It will also enable consultants to devote more effort to practical training for O&M personnel.

▼ Preparation of Manuals, Rules and Regulations

Manuals

Instruction Manuals / Work Procedures

Required for bid documents → Developed & submitted by the contractor → Finalized by the operating entity/ consultant

The consultant is left with much limited resources for practical training and technology transfer.

If not delivered on time, the consultant has to create these documents based on their own assumptions.

- It would be a significant decrease in efficiency for each expert to create these documents without a reference document.
- It would be effective to prepare a common template for manuals.
- Based on the template, the consultant can simply obtain necessary inputs from the contractor, thereby less efforts are required.

Rules and Regulations

Rulebook, implementation standards, servicing standards, maintenance standards

Required for bid documents → Developed & submitted by the contractor → Finalized by the operating entity/ consultant

Rules and regulations for head office management

Required in consultant's TOR → Developed / submitted by the consultant → Finalized by the operating entity

*In some cases, prepared by the operating entity.

Capacity Building

Capacity building will be more effective by placing multiple C/Ps in each field of discipline, mandating the practice of thorough reporting by C/P, and allocating dedicated training experts. There have been cases where the capacity building became less effective due to different factors (e.g., C/P turnover and reassignment, excessive reliance on expatriate experts for progress reporting, and lack of training experts for practical training). In line with this, the technical assistance project should clearly state the above requirements in the Record of Discussion (RD). Note however that in the case of ODA Yen Loan Projects, there can be instances wherein the terms and conditions under the OMCS contract may contradict the above requirements.

▼ Key Points for Better Capacity Building

Assign multiple counterparts for each field of discipline

Experts

The consultant must repeat training when C/P resigns or is relocated

Mandate C/P to report the progress of works

Assessment and evaluation — C/P manager — Progress reports

Experts — C/P Assignees

C/P often relies on experts for progress reporting, even for technical assistance projects.

Assign dedicated training experts from Japanese railway operator for practical training

Subsystems Experts
Delivery of reports and other submittals
Management of the project activities

Training Experts
Mobilized for the period of practical training

Trainees

Efficiency will increase if interpreters are assigned as local workers are usually not fluent in English.

Subsystems experts have to provide practical trainings instead of highly experienced training experts.

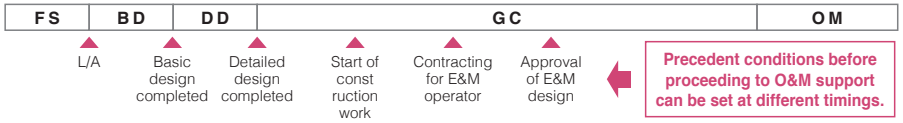
Implementation of O&M Support

The implementing entity and JICA should agree on the precedent conditions before initiating the O&M support to determine the required level of expertise and support.
This page touches upon the timeline for operational readiness and preparation for delay risks using past cases as reference. Additionally, it covers stakeholder coordination and project effectiveness/evaluation.

■ Ideal Conditions Before O&M Support

Decisions as to the overall implementation framework and project scheme should ideally be determined before the provision of O&M support. Determining the necessary amount and expertise for the O&M support is difficult if the framework of the implementing and operating entities is not confirmed at the FS stage.
Choices as to whether O&M will be done in-house or outsourced, and whether the implementing entity or a newly established organization performs O&M should likewise be established before the conduct of O&M support. Note, however, that these precedent conditions are not always possible, as there are instances when actual decision-making powers are well beyond the authority or mandate of the implementing agency.

▼ Precedent Conditions for O&M support

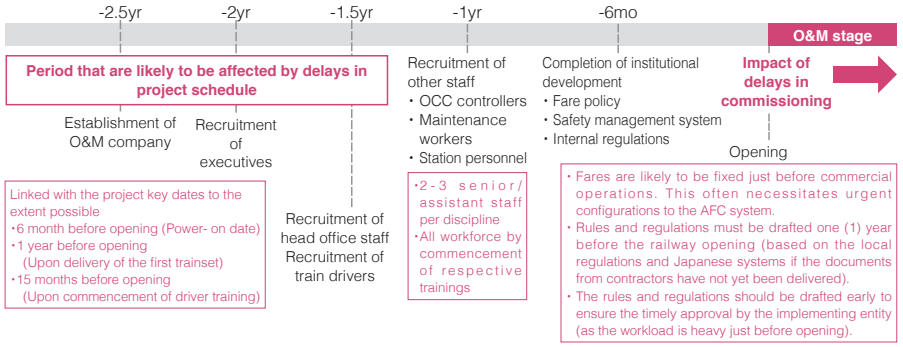


Mumbai Line 3	Jakarta MRT	Metro Manila Subway
Operating entity was not identified at the FS stage. Alternative frameworks were examined in the JICA study.	Operating entity was not clarified during the provision of the management service.	The choice of public or private operator was not concluded at the FS Stage.
The scope of GC on the extent of O&M support remained unclear. The need to arrange additional O&M support for operational readiness was uncertain.	Scope of OMCS included a study of alternative implementation frameworks. Target personnel to be trained by OMCS was unclear.	GC scope included a study on PPP alternatives. Another entity was eventually assigned to carry out O&M tender assistance.

■ Timeline for Operational Readiness

Even as O&M support is programmed based on the project timeline, delays in construction schedules often necessitate substantial adjustments. Therefore, conditions to start and resume O&M support activities should be made clear in advance. Prime examples of operational readiness timelines include that of the Tsukuba Express in Japan and the Jakarta MRT in Indonesia, as these encountered no critical delays in commissioning. If the schedule is delayed or likely to be delayed, the implementing entity and JICA should see to it that conditions for resuming O&M support are met (e.g., O&M company establishment and personnel recruitment) such that the support is optimized and will not go idle. If support is extended with the minimum number of experts, JICA may need to consider a review of resources for the follow-up period and corresponding compensation for consultants for foregone opportunities.

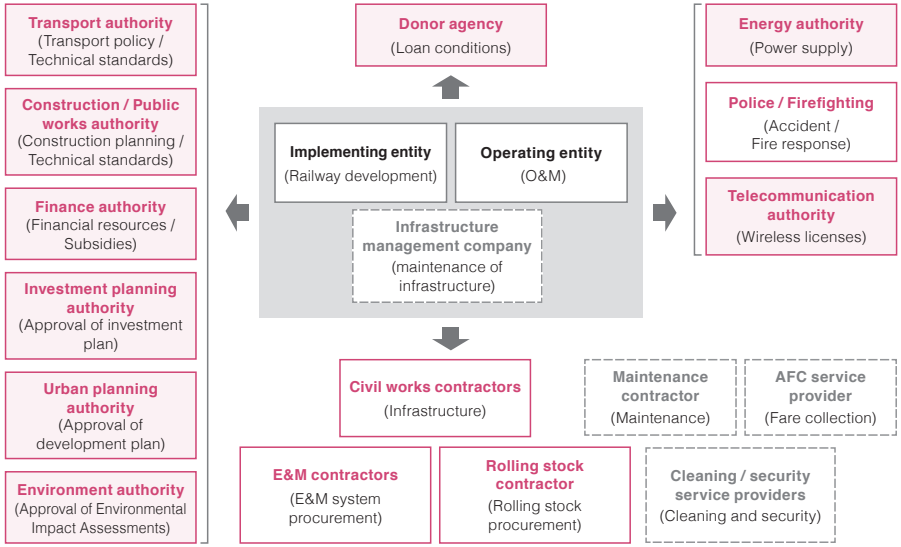
▼Operational readiness timeline



■ Stakeholder Coordination

All key stakeholders should be involved during stakeholder coordination activities in project management. In most cases, there are similar stakeholders for railway construction projects and O&M support activities. On the technical side, provisions for uninterrupted power supply and dedicated frequency bands for communication systems are often raised as issues. Additionally, authorities that have jurisdiction over the state-owned enterprises and/or civil servants can get involved in cases wherein a public sector entity is the operator of the railway.

▼ Stakeholder Coordination



■ Project Effectiveness and Evaluation

Per JICA's guidelines on project effectiveness/evaluation, additional indices may be required to measure O&M performance, this includes the number of service suspensions, system failure rates, and the number of serious accidents as operational indices. Benchmarks for carbon emission reduction and gender mainstreaming can also be used as effect indices.

▼ Operation and Effect Benchmarks

Operation indices		Effect indices	
Basic indices	No. of passengers (passengers per year)	Patronage of major stations (persons per year)	
Basic indices	**Service disruptions over 30 min. (times)** **Failure rate ** (train kilometers)** **No. of serious accidents**	**Basic indices**	**CO2 emissions reduction (tons per year)**
No. of trains (trains per day) Operating rate (%)* Car kilometers (kilometers per year)* Cars per trainset Train kilometers (kilometers per year)	The indicator is effective to evaluate performance (including safety management) of the O&M activities. Continuous efforts will be required to satisfy the performance target.	Travel time for a specific section (minutes) Fare revenue (per year) Freight revenue (per year)	No. of trainings provided No. of projects / amount of assistance on O&M **Ratio of female employees and directors in the operating entity**
		Supplemental indices Maximum speed (km/h) Scheduled speed (km/h) Passenger transport volume (passenger -km)	

*1 If the project involves rolling stock procurement ** Also called Mean Kilometer Between Failure (MKBF)

Different Formats of Technical Cooperation

The features and scopes of the different technical cooperation schemes are summarized herein. Several ideas for overseas training in third countries are also highlighted. Precedent case studies are useful to meet the different needs for future O&M support activities.

Characteristics of Each Scheme/Arrangement of O&M Support

Technical assistance projects are suitable for capacity building including the establishment of an O&M company. On the other hand, project implementation assistance aims to provide support in developing regulatory systems, technical standards, and business plans. Furthermore, the dispatch of experts should contribute to the formulation of these support programs.

Technical Assistance	Project Implementation Assistance	Expert Dispatch
• To establish the operating entity • To establish training centers • To build other capacities	• To develop regulatory systems and technical standards • To develop business plans • To address other strategic issues	• To explain the necessity of regulatory systems and technical standards • To introduce Japanese best practices • To give guidance on other specific issues
C/P play a leading role	Improve effect of the ODA Yen Loan Project	Advocate the advantages of Japanese technology
Main purpose is capacity building	Create more opportunities for Japanese enterprises	Identify needs and provide ideas for assistance programs

Input : Large — Input : Small

Overseas Training in Third Countries

Taking advantage of existing and operational lines and training centers, the JICA can arrange overseas training opportunities in third countries for implementing agencies who are implementing or are intending to implement urban railway development and O&M projects. Effective training programs can be arranged involving previously implemented projects in third countries carried out as JICA Technical Cooperation and ODA Yen Loan Projects. Destinations are chosen according to the training objectives and the characteristics of each urban railway as shown below. Since the JICA provides a wide range of O&M support to many cities and countries, training on various subjects can be offered.

Subject	Destination for Overseas Training
Training and skill development for operational readiness	• Jakarta MRT • Delhi / Bangalore Metro
Establishment of training center	• Philippine Railways Institute
Fundamental training for project implementation	• Jakarta MRT • Philippine Railways Institute
Operational management	• Jakarta MRT • Delhi / Bangalore Metro
Maintenance management	• Bangkok Purple Line
Project scheme	• Bangkok (Department of Rail Transport)
Safety management	• Philippine Railways Institute • Bangkok Purple Line
Organizational development and staff recruitment	• Jakarta MRT • Delhi / Bangalore Metro
Training of train drivers	• Jakarta MRT • Philippine Railways Institute
Development of manuals and regulations	• Bangkok Purple Line

▲Jakarta MRT

▲ Philippine Railways Institute

Support for Institutional Development and Formulation of Technical Standards

For countries unable to enforce control in the urban railway sector due to the absence of a regulatory system and technical standards, the JICA can facilitate assistance programs to enhance the results of project implementation and contribute to exporting Japanese railway systems.

Support for the Development of Metrorail Act and By-laws in Dhaka

The JICA provided support for the enactment of the Metrorail Act and other supplementary rules for the Dhaka Transport Coordination Authority, which is the regulatory and supervisory body of urban railways, thereby the government successfully established a regulatory system and technical standards.

◀Cabinet Deliberation on the Metrorail Act

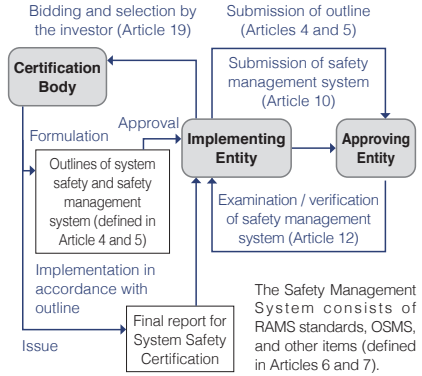
Safety Certification

Due to differences between Japanese and European "Safety Management System" (SMS), a special arrangement may be required to assist in safety certification. In most cases, the recipient country stipulates compliance with the local SMS, which is greatly influenced by the European approach through the law, or through the procuring party's requirements in the tender documents. To be prepared for such cases, the JICA should further accumulate track records and expand resources.

Strengthening Management Ability of O&M Company for the Opening of Urban Railway Line 1 in Ho Chi Minh City

Due to differences between Japanese and European "Safety Management System" (SMS), a special arrangement may be required to assist in safety certification. In most cases, the recipient country stipulates compliance with the local SMS, which is greatly influenced by the European approach through the law, or through the procuring party's requirements in the tender documents. To be prepared for such cases, the JICA should further accumulate track records and expand resources.

▼ Safety Certification System in Vietnam



Training Equipment

The JICA can contribute to human resource development by providing support for the procurement and delivery of training equipment. Support is provided regardless of whether the project involves introducing new training facilities equipment along with new line construction or if the project involves repurposing an existing training center for urban railways. Training equipment includes driving simulators, mock-up stations, signal system diorama, and cut models of bogies and track structures. Also, JICA may offer training software with Digital Transformation/Virtual Reality technologies which have been developed by Japanese railway operators.

ODA Loan, Grant Aid, and Technical Assistance for the Philippine Railways Institute

As part of the Metro Manila Subway Project, a training center building is being constructed and training equipment is being procured for the Philippine Railways Institute through a Japan ODA loan. In addition, Japan provided grant aid for the procurement of dynamic full-sized and desk-based train simulators. Overall, comprehensive support is being provided, including technical assistance to establish the institute and develop training curricula and other training materials.

◀PRI Training Equipment (Dynamic Simulator)

Overseas Expansion of O&M

■Importance of Infrastructure Maintenance

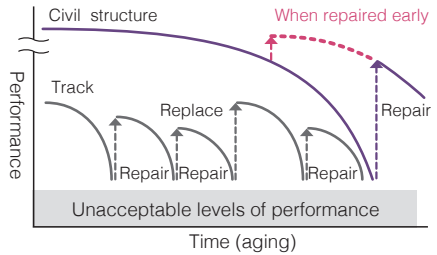
Civil structures

It is difficult to completely rebuild railway civil structures (e.g., tunnels, elevated sections), considering the potential financial and social impacts of service suspension along the section. In addition, there are already existing structures in city centers that may pose challenges in securing construction space. Therefore, in order to ensure the reliable performance and prolong the useful lives of these civil structures at low cost, it is necessary to carry out assessments through regular inspections, timely and appropriate repairs, and necessary reinforcements.

Tracks

Railway tracks directly impact the safety of train operations. These deteriorate faster than other railway infrastructure, so regular repairs are required. To extend the repair cycle at a low cost while maintaining the performance of the tracks, it is necessary to understand the deterioration progress by conducting regular inspections and timely repairs.

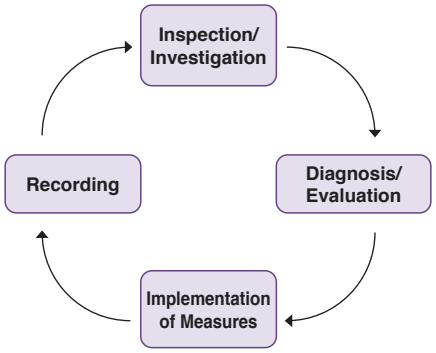
▼ Changes in Performance Over Time (RTRI, 2013)



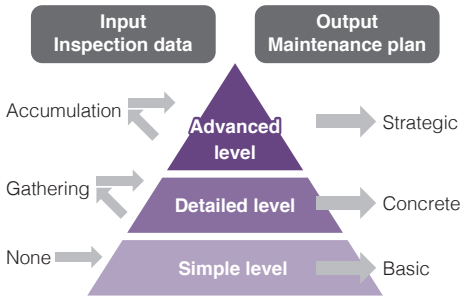
■Basic Cycles and Management Levels

For both civil structures and tracks, it is important to initially run a basic maintenance cycle. First, accurate information is gathered through the proper conduct of inspections and investigations. After which, the structure's condition is evaluated; and the corresponding measures (which can include observation of ongoing repairs and reinforcements) can be determined and taken. Lastly, the activity and results are precisely recorded for future reference.
A basic maintenance plan can be formulated at first. Once inspection data and technical knowledge within the organization is acquired over time, a higher level of maintenance management can be reached.

▼Basic Cycle



▼ Infrastructure Maintenance Management Levels (Infrastructure Maintenance)



■Characteristics of Structural Deterioration

Civil structures

- Steel structures: The kinds of damage that impair the performance of these structures can be roughly based on the effects of corrosion, fatigue cracks, loosening of high-strength bolts and rivets, bearing damage, and abnormal external forces during earthquakes and collisions.
- Reinforced concrete structures: Defects on these structures may be due to neutralization (carbonization), salt damage, and alkali-aggregate reaction, which can cause rust or breakage of the reinforcing bars.
- Prestressed concrete bridge: Corrosion may develop in the sheath tube, which is the case of high-strength steel wire used for inducing prestress, leading to steel wire breakage.

Tracks

The most characteristic deterioration is the development of distortion on the rail surface. Aside from the said component's deteriorations that are similar to that of civil structures (i.e., physical, chemical), the condition of ballasts can also decline as a result of compaction and movement of crushed stones due to external forces (e.g., train loads).
In addition to track wear management, track maintenance management should include train tonnage as a basic element. Even if the rails are only slightly worn with no visible damage, it is important to make a replacement plan so that the cumulative tonnage of running trains does not exceed the prescribed value.

■Necessity of Maintenance System Development

An established maintenance system that is sustained and followed will promote proper and sustained upkeep of assets and processes. Alternately, the absence of such a maintenance system will result in an uncertain outlook for the railway system even if there are no current apparent problems. In a business environment with standards, budgets, personnel, and human resource development are stretched, it is necessary to develop a maintenance system in the future even if at present, there are no events that hinder operations.
In Japan, implementation items are based on prevailing laws, standards, and regulations drawn up by the government, railway operators, and other stakeholders. One such implementation item based on these is maintenance.

▼ Maintenance Laws, Standards, and Regulations in Japan

Entity	Type	Title
State	Ministerial ordinance	Technical Regulatory Standards on Japanese Railways
	Notice	Notification Regarding Regular Inspection of Facilities and Rolling Stock
Railway operator	Regulations	Implementation standards (created by each company)
(Railway Technical Research Institute)	Standards	Maintenance standards for railway structures etc.
Railway operator	Manuals	Inspection method, maintenance work method, and other manuals are formulated according to the situation of each respective company

Overseas Expansion of O&M

■Points for Consideration when Diagnosing Defects/Deterioration

Necessity of diagnosis each case

The ages of a city's structures vary vastly, ranging from just a few years old to around 30 years since its construction. However, structural deterioration is not solely dependent on the number of years that have passed. Therefore, it is necessary to determine the soundness of each structure through inspection. In the case of concrete structures, there is a possibility that they have become neutralized and—depending on the location—have suffered deterioration due to salt damage even if there is no superficial damage.

Impact on third parties

In diagnosing the soundness of a structure, it is important to consider the repercussions on third parties. Railways in urban areas often have elevated tracks, so there is a high risk of concrete debris falling on road intersections and other locations under the elevated tracks. It is important to consider possible impacts or hazards on third parties during diagnosis.

▲ Example of Road Intersections

■Civil Structures of Urban Railways

Bangkok BTS (Green Line)

Opening year	Extension	Structure extension	Gauge
1999	67.2 km	Elevated sections: 67.2 km	1435 ㎜



Jakarta MRTJ

Opening year	Extension	Structure extension		Gauge
2019	15.7 km	Tunnels: 5.6 km	Elevated sections: 10.1 km	1067 ㎜



■Expansion Possibilities

Database use for maintenance management

For infrastructure maintenance, it is important to diagnose based on a variety of specifications (e.g., facility material, construction method, inspection, and repair history), the management of which is a common practice by many Japanese railway operators. In order to slow down deterioration, lengthen the period between needed repairs, and generally prolong the useful life of infrastructure to maintain performance, it is necessary to regularly inspect the degradation and determine its extent, carry out appropriate evaluations, and conduct adequate repairs and reinforcements as needed.

Proven inspection system and repair method

In Japan's railway infrastructure, a unified inspection system has been established through the application of technical standards. Individual railway operators have established a series of maintenance cycles for inspection, appraisal, repair planning, and conducting actual repairs. By applying both the Japanese inspection system and proven repair methods overseas, it is expected that reliable maintenance cycles can be implemented. The initial assumption is that by establishing and implementing basic inspection and repair systems applicable to all lines and organizations, the needed practices and techniques will naturally be developed. This can then be further expanded as the conditions or requirements evolve.

Support for technology establishment

For maintenance management, it is necessary to consider the local climate, environmental conditions, usage conditions as well as the details of the design and construction of a structure. Based on extensive knowledge and experience, engineers involved in infrastructure management also need to develop a deep sense of practical reasoning or imagination. With the international expansion of infrastructure management, transfer of inspection, diagnostic, and also specific technologies are expected. Furthermore, knowledge on management approaches, application of acquired data, and technologies accumulated from on-the-job training need to be strengthened.

Utilization of advanced technology

Basic knowledge and experience are important for infrastructure management, but the development of technologies that support this field continues to evolve. The use of tablet terminals and augmented reality (AR) technology, the inspection of infrastructure with drones, and monitoring of track conditions by ordinary operating trains are just some of the many examples of these advanced technologies. By utilizing these technologies, inspection data can be collected efficiently and will lead to improved capacities to identify problem areas and optimize repair plans.

▲ Use of AR technology

▲ Using Drones for Inspection

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