

Operations & Maintenance of Urban Railways

Handbook

Operations and Maintenance of Urban Railways Handbook

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Purpose of the Handbook

The purpose of this Handbook is to improve the quality of future railway development assistance projects of the Japan International Cooperation Agency (JICA) by organizing specific knowledge that can be used in studies on the operations and maintenance (O&M) of urban railways. This serves as a reference material for the preparation of O&M business instructions and project supervision throughout various stages, guaranteeing a standard depth to be applied in studies. With this as a guide, the consistent implementation of support activities will contribute to the seamless O&M of urban railways in countries receiving assistance from JICA.

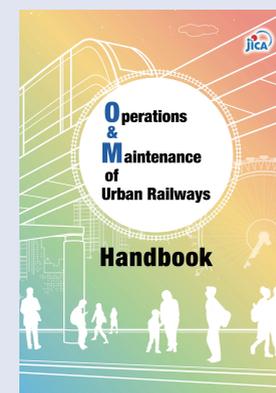
Lastly, this Handbook will be gradually enhanced based on the opinions of concerned stakeholders.

- Common understanding on both sides
- Standardized support activities

Issuer of Project Order



- JICA
- Regulatory, implementing, and operating entities involved in urban railway development projects in concerned countries



Receiver of Project Order



All technical assistance providers involved in studies and other technical assistance projects on O&M of urban railways

Using the Handbook

Overall Structure

① Basic Knowledge

This section covers the fundamental commercial and technical concepts required for O&M studies. The kinds of investigation that need to be carried out at each stage have been identified in the "Overview of O&M Studies in JICA Projects" diagram and detailed in succeeding discussions. Additionally, elements primarily used at different stages can be distinguished through the following tabs that appear on the upper right-hand corner of each page spread :

FS Feasibility Study (planning stage)

DD Detailed Design (design stage)

GC General Consulting (construction supervision stage and other support activities)

OM Operations and Maintenance (operational stage)

② O&M Case Studies

This section presents basic information on actual examples of O&M in the railway sector of Japan and other countries, as well as in other transport sectors. Insights can be gained from the various types of O&M initiatives by keeping the described key points for JICA assistance projects in mind.

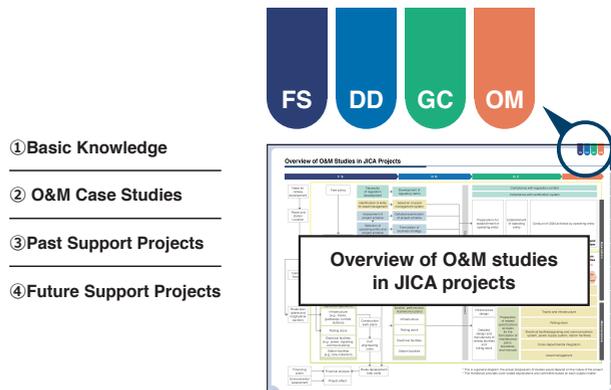
③ Past Projects

This section describes past and ongoing JICA assistance projects, as well as the insights gained from the resulting achievements and challenges that are key points for consideration when implementing future projects.

④ Future Projects

This section provides standard O&M and support plans, which include checklists for support details and key points for consideration during the O&M support implementation stage. Lastly, insights on future expansions in infrastructure maintenance management are presented.

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- ① Basic Knowledge
- ② O&M Case Studies
- ③ Past Support Projects
- ④ Future Support Projects

Examples of Applications

O&M study during FS stage

- Check the items to be examined for the operating entity using ① **Basic Knowledge** while considering the key points described in ② **O&M Case Studies**, ③ **Past Projects**, and ④ **Future Projects**. These refer to past cases on business scheme decisions, as well as reflect the necessary support mechanisms for prompt decision-making to be incorporated in the Terms of Reference (TOR).
- It is recommended to reflect the essential study items of the O&M plan in the TOR. Furthermore, the standard model of the support framework serves as a reference when selecting the optimal support framework.

O&M study during design and construction supervision stages and other technical assistance activities

- Carefully examine the contents of the FS from the previous stage and continue the indicated plans.
- Using ① **Basic Knowledge**, closely examine the items to be studied (e.g., personnel plan, system design, construction schedule). After sufficient discussions among concerned parties, use the support item checklist to delineate support tasks and set schedules, avoiding omissions in support items or insufficient confirmation of responsibilities.

O&M technical assistance before and after railway system opening

- Carefully examine the contents of the FS from the previous stage and continue the indicated plans.
- Using ① **Basic Knowledge**, a support plan can be created by referring to the items to be examined by each technical department. During the GC and O&M stages, it can also be used as a guide to assess the progress of the project being supervised.
- Using ④ **Future Projects**, a response policy can be determined after discussing the methods of developing manuals and regulations and carrying out capacity-building activities with the concerned parties.

Railway Operations and Maintenance

■ Railway Systems

A railway is a large system made up of various subsystems with facilities and equipment that generally include: civil structures; rolling stock that run on railway tracks; power equipment that supply and transmit electricity to the rolling stock and other facilities; signaling equipment that ensure safe railway operations; and station facilities like ticketing gates and passenger information equipment.

Highly skilled train drivers, station staff, controllers, and other railway personnel all work together to operate this system; while knowledgeable technical staff carry out maintenance activities to keep these facilities and equipment in optimal working condition. When all these equipment and personnel function collectively, the railway system can start serving as a mass transportation system.

Regulatory Bodies

Operating Entity

Train Operation Department

Station Operation Department

Tracks and Infrastructure Department

■ Railway Operations and Maintenance

In this Handbook, the term “operations” refers to the job of making a railway system function and managing the organization that operates the system (i.e., operating entity); while the term “maintenance” refers to the job of keeping the railway facilities and equipment in optimal working condition. Together, these make up what is called “Operations and Maintenance” (O&M). Given this definition of O&M, this Handbook features the different elements that need to be considered before establishing business schemes and regulatory systems, developing the railway system, and acquiring O&M readiness, which are integral to reliable and sustainable railway operations.

Electrical Facilities Department

CBTC

■ Railway Development in Developing Countries

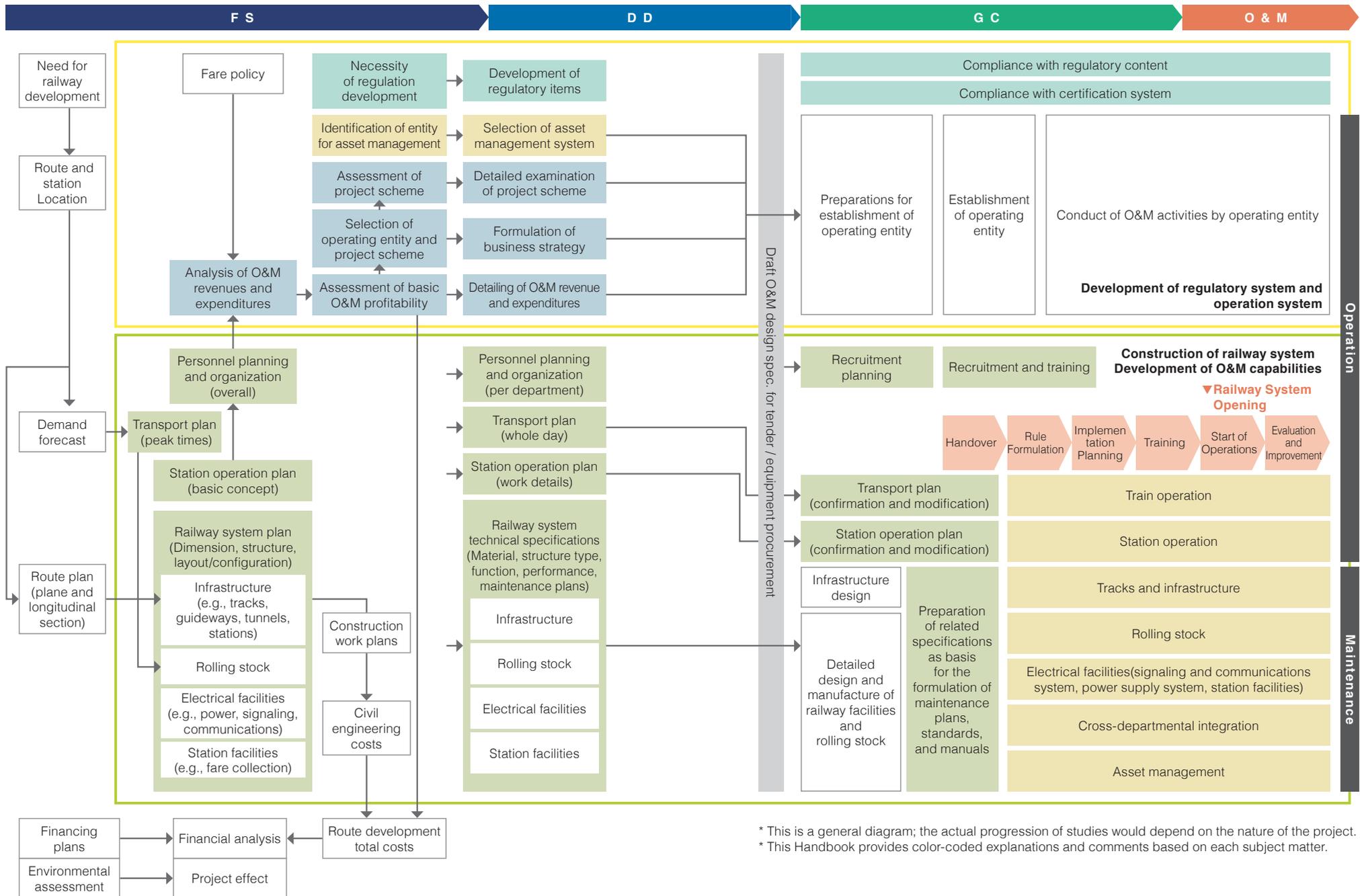
In developing countries, railway development tends to focus on the provision of infrastructure, facilities, and equipment. However, the smooth opening and sustainable O&M of a railway system can be ensured by starting O&M studies at the early stages of railway development. In line with this, it is important to provide O&M-related assistance to developing countries to enable their railway systems to have sustained operations well beyond the initial operational stage.

■ Proceeding with O&M Studies

Since important matters related to O&M are decided at the FS stage, it is necessary to carry out O&M studies in a phased manner. The next page presents an overview of the related studies to be done.

Rolling Stock Department

Overview of O&M Studies in JICA Projects



* This is a general diagram; the actual progression of studies would depend on the nature of the project.
 * This Handbook provides color-coded explanations and comments based on each subject matter.

Revenues and Expenditures

Revenue and Expenditure Structure

Analyzing the revenue and expenditure structure is the starting point of evaluating basic profitability; it starts at the FS stage and should be re-examined at every succeeding project stage. It is essential to design a project scheme that includes the projections of revenues and expenditures of the operating entity, which is finalized as part of the business plan at the pre-opening stage.

This is based on the operating cash flow and includes the following:

Revenues

(i.e., fare, non-fare)

O&M costs

(i.e., labor, energy, maintenance, administration)

Others

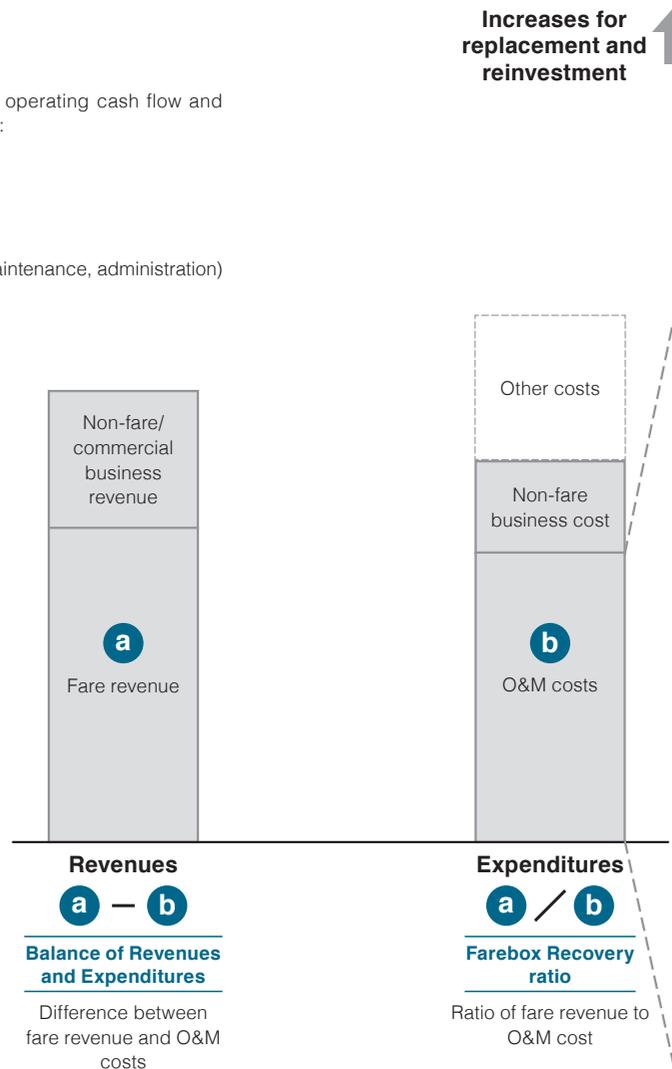
(e.g., taxes)

Non-fare/commercial business revenue

- In most cases, this is calculated based on a certain rate (e.g., 5%) of the estimated fare revenue. However, the period when development benefits take effect must be carefully simulated.
- This can be better estimated when based on the detailed plans for the commercial businesses, which is often difficult at the FS stage.
- Case studies provide useful baseline information to avoid the risk of overestimation.

Fare revenue

- This is estimated based on the demand forecast model.
- This can also be calculated by multiplying the projected number of daily passengers by the average fare.
- Fares should be properly determined and aligned with passengers' willingness or ability to pay.



Key Points in Structure Analysis

● Understanding demand risks

Demand forecasts tend to be overestimated compared to actual ridership.

● Demand retention

Demand forecasts, ridership, and fare revenue estimates are better examined using conservative scenarios and setting a demand retention rate or ramp-up factor based on case studies.

● Balance of revenues and expenditures

Revenues tend to be lower than expenditures in the initial years of operation, generally taking years or even over a decade to achieve an annual surplus (unless the city has already established a sufficient railway network). The balance between revenues and expenditures should be carefully reviewed to avoid having overly optimistic expectations on profits.



■ Labor cost

- This can be calculated by either multiplying the unit labor cost by the estimated number of respective manpower or multiplying the average salary by the total number of personnel.
- Detailed estimates can be drawn from the salary scale for each job class and the number of personnel in each job class.
- If the salary scale of a public institution is not regulated by the government, this can also be estimated based on the actual salaries in a similar organization.

■ Energy cost

- This primarily includes electricity costs, while fuel and water costs are minimal.
- This can be calculated by multiplying the average energy cost by the train kilometers travelled.
- Detailed estimates can be made by considering the amount of electricity consumption and the unit price of electricity.
- The required amount of energy for traction, stations, and depot are calculated separately.
- Detailed designs should calculate energy consumption for train operations.

■ Maintenance cost

- This includes the facilities and equipment upkeep costs required for day-to-day operations.
- Large-scale renewal and replacement costs are added when facilities and equipment reach the end of their respective useful lives.
- This is calculated at fixed rates of initial investment costs per subsystem.
- Detailed estimates require the maintenance and renewal costs of each item, which can be calculated at the detailed design stage.
- Figures are finalized by the contractors and suppliers of the respective subsystems.

■ Administration cost

- This includes general and administrative expenditures related to the operation of the operating entity.

* Note that these expenditure classifications are different from that of Japanese railway operators.

Summary

Operating entity

Regulatory system

Railway systems (overall)

Railway systems (each department)

O&M Projects

O&M Projects in Other Sectors

Past examples of development assistance

Provision of assistance in the future

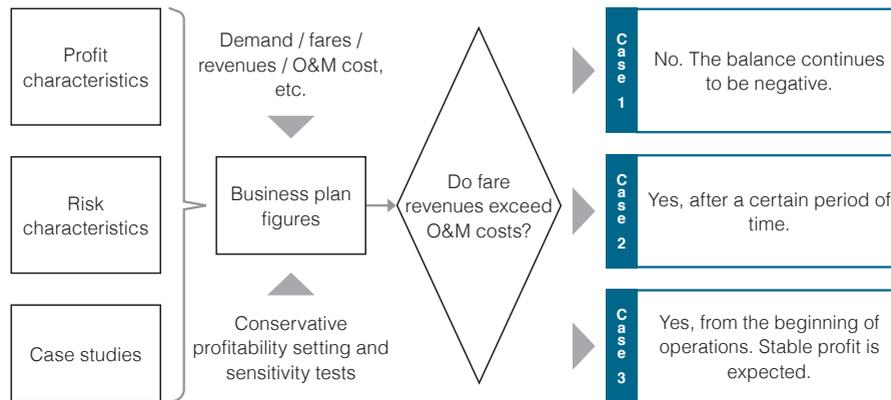
Overseas Expansion of O&M

Basic Profitability Assessment

Assessment Flow

Basic profitability should be evaluated based on the revenue and expenditure structure established at the FS stage. Project stakeholders should carefully review financial performance, considering the profit and risk characteristics of urban railways. Basic profitability can be better understood in the years after the start of railway operations when the fare revenue begins to exceed the O&M costs.

Basic Profitability Assessment Flow



Policy Perspective

Profitability of a single railway line and in the short-term

Railway construction is a capital-intensive venture; and fare revenues are unlikely to recover the capital expenditures. The significance of urban railways lies in its time-saving effect and reduction of social costs by providing a means of mass transportation with an efficient railway network. Since it takes time to increase the ridership by expanding railway networks and improving commuting convenience, railways are unlikely to profit in the short run and if it exists only as a single line.

Sustainable approach for railway development

From the perspective of urban railway policy, the following points should be considered:

- The government should be responsible for railway network development, especially since the backbone or trunk line will be a future source of revenue generation and eventually finance subsequent investments in transport network expansion.
- As such, urban railway development should start with the lines that show good profitability prospects.
- Urban railway construction is mainly financed through public funding. Subsidies for capital and operating expenditures are drawn from the increased central and local government tax revenues from urban railways.

Profit and Risk Characteristics

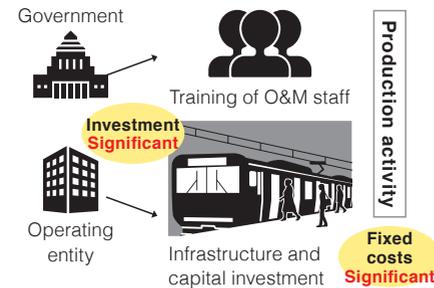
Profit Characteristics of Urban Railways

Urban railways are capital-intensive and network-based undertakings.

Profitability of Urban Railway Businesses

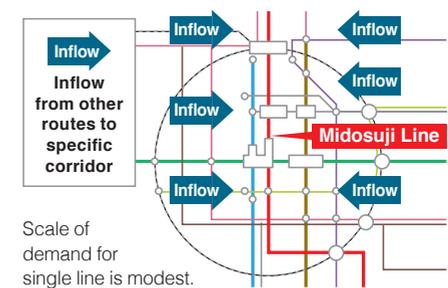
Characteristics of Capital-intensive Business

Breakeven point is high, and substantial revenue is required to generate profits.



Characteristics of Network Businesses

Significant ridership increase is expected once the railway network is structured.



Risk Characteristics of Urban Railways

The risks in urban railway projects are diverse. Among the O&M-related risks are the following:

Examples of Risks Apparent in Urban Railway Business

Delayed opening risk

Construction delays and cost overruns can make railway system opening fall behind schedule.

Example: Ho Chi Minh Line 1

Demand/ridership risk

Actual ridership is far below the demand forecast and takes time to grow.

Example: PUTRA LRT

Fare setting risk

Unreasonably low fares are introduced by policymakers and cannot be raised.

Example: Manila MRT Line 3

O&M cost risk

O&M costs soar due to sharp hike in wages and material costs.

Example: Manila LRT Line 2

Capital shortfall risk

Continuing deficits and lack of funds result in a reduced maintenance budget.

Example: Manila LRT Line 2

Government budget risk

Network development fails to progress due to delays or reduction of government budget.

Common to developing countries

Basic Profitability Assessment

Fundamental Assessment

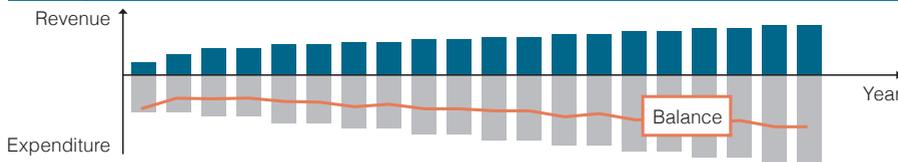
Basic profitability is assessed by examining the balance of revenues and expenditures, which is essentially the net fare revenues and O&M costs computed over the project period. Additionally, commercial business revenues and other items, such as subsidies, are factored into the revenue calculations; whereas project cost items like taxes (as in the case of private sector O&M) are incorporated in expenditure side of calculations.

Classification by trends

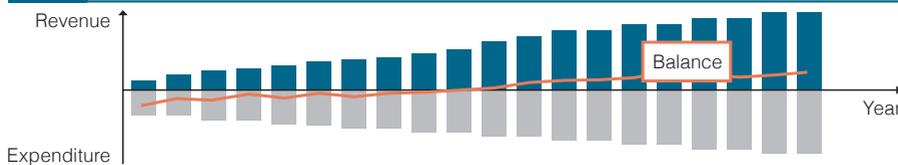
Basic profitability can be classified according to the resulting changes in the balance between the fare revenue and O&M costs. The recovery of the O&M costs through fare revenue is essential to sustain business operations, particularly in countries where the government has limited capabilities to provide financial support.

Classification Based on Changes in the Balance of Revenues and Expenditures¹

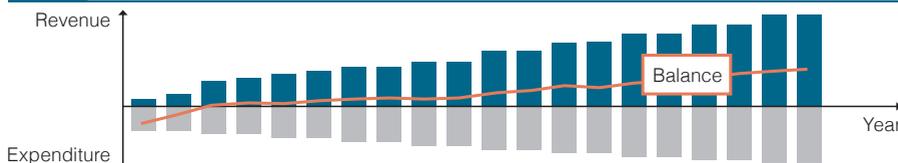
Case 1 Fare revenue does not exceed the O&M costs for an extended period of time. As such, the balance continues to be negative.



Case 2 Fare revenue exceeds O&M costs after a certain period of time.



Case 3 Fare revenue exceeds O&M cost even at the early stages of operations, and stable profit is expected.



¹ These illustrations do not include depreciation, replacement, and reinvestment costs.

Examples from Different Countries

Farebox Recovery Ratio (FBR)

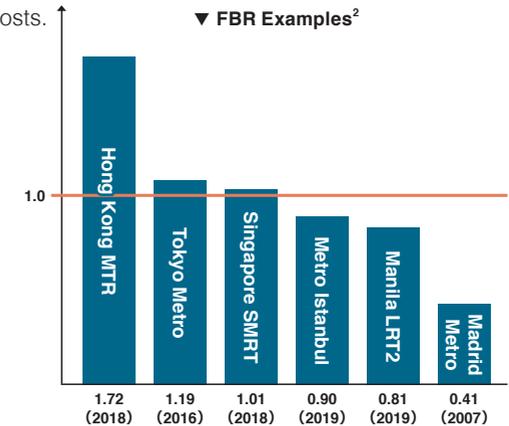
It is the ratio of fare revenue to O&M costs.

FBR below 1.0

Fare revenue cannot cover O&M costs; and subsidies are needed for operation, replacement, and reinvestment of the railway system.

FBR exceeds 1.0

Fare revenue can cover the O&M costs; but subsidies may still be needed for replacement and reinvestment costs.



Essential active involvement by government

In principle, both infrastructure construction and railway system procurement should be borne by public investments. Operations should likewise be carried out by a public sector entity. As such, the government is required to cover resource shortfalls for operations, replacement, and reinvestment activities of railway systems.

Madrid Metro (Public Investment/Public Operations Scheme)

With some exceptions, the railway line is operated by a company directly under the Department of Public Works, City Planning, and Transportation of the State Government. The Central Government, the State Government, and the City Government of Madrid provide subsidies for its operations.



Especially high risk after business opening until revenues balance out expenditures

Public management is desirable. However, private sectors can also be viable operating entities, especially when railway projects are carried out under a gross cost scheme wherein the initial investment was made entirely by the public. In some cases, Public-Private Partnership (PPP) net cost schemes involves private sector capital being utilized even at the stages of initial investment and replacement.

Bangkok Blue Line (PPP/Net Cost Scheme)

Fare revenue exceeded O&M costs six (6) years after its initial opening. However, the revenues and expenditures balance remained negative even after 10 years due to substantial management costs, depreciation costs, interest payments, among others. This led to business restructuring.



Private sector management with public financial support for initial investments and replacements

Gross and net cost schemes would only be feasible if the initial investment is drawn from the public sector. However, even if the private sector is unable to bear the costs of initial investment, replacement, and reinvestment, the government must step in and provide necessary financial assistance.

Mumbai Metro Line 3 (Public Investment/Public Operations Scheme)

The financial analysis indicated that the fare revenue would eventually exceed the O&M costs, as it had a solid demand forecast. Despite the possibility of either sector bearing the demand risk, the study concluded that a PPP scheme is not feasible due to the costly replacements, reinvestments, and loan repayments.



² This is a single-year index and does not necessarily reflect the profitability of the entire business.

Project Scheme Framework

Project Scheme Selection

Various project schemes can be compared if basic profitability reaches the threshold.

Vertical separation

This is a method wherein the public sector develops and owns the infrastructure facilities, while the public sector manages operations. In some cases, the operating entity procures a portion or the entirety of the railway system. This method aims to harness public sector resources in developing the needed infrastructure and tap private sector efficiencies for operations.

Selection framework

Three (3) parameters can be considered in selecting a project scheme: (1) asset development; (2) demand risk; and (3) operating entity.

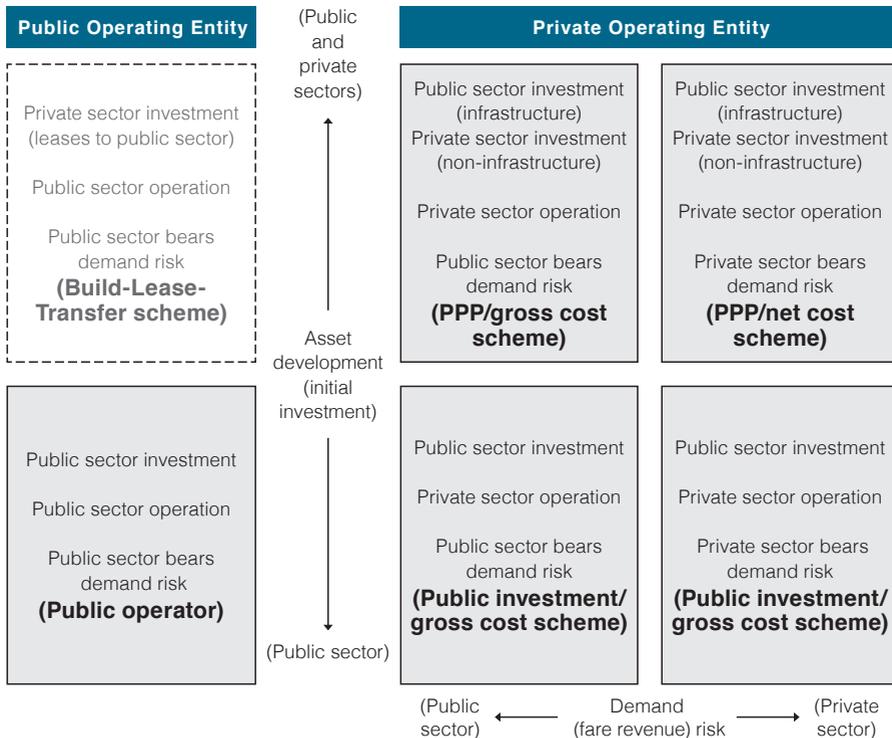
Options

Apart from public investments and operations, a project scheme is basically categorized by how the public entity and the operator share the initial investment requirements and embedded demand risks.

① Asset development

- **Public investment:** The public sector makes the entire asset investment.
- **PPP:** The public sector invests in a portion of the assets (e.g., civil works), while the private sector invests in the remaining assets (e.g., electro-mechanical (E&M) systems, rolling stock).

Project Scheme Variations



② Demand risk

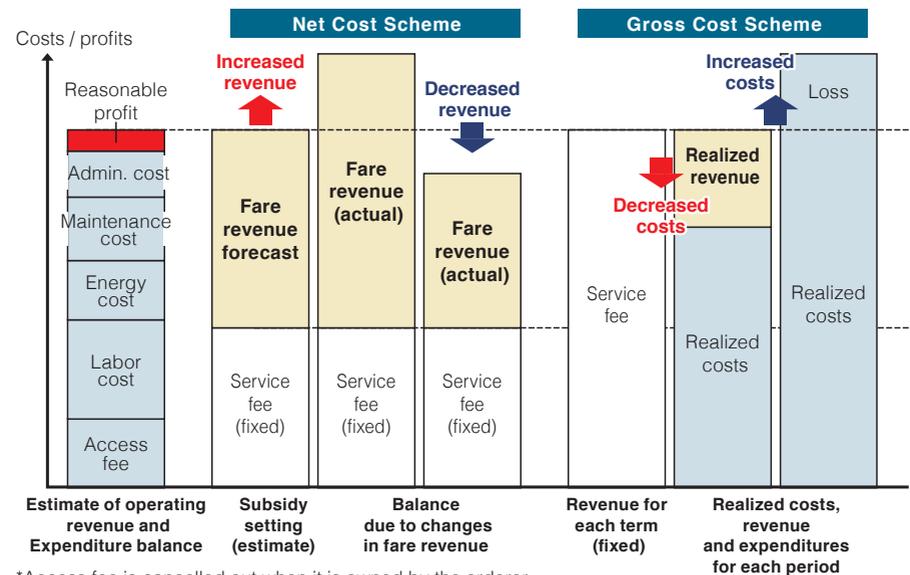
There are mainly two (2) schemes intended to address demand risk: (1) net cost scheme, which is ideal for financially free-standing projects; and (2) gross cost scheme, which is ideal for settings wherein railway services are sold to the public sector.

- **Net cost scheme:** The operating entity shoulders the risk. The operation consignment fee is set in advance as the difference between the estimated fare revenue and O&M costs. The profit is generated as a result of increasing fare revenue while reducing O&M costs.
- **Public Service Obligation (PSO) Scheme:** This is a variation of the net cost scheme wherein the compensation is determined by the transport costs per passenger. This scheme is used in countries such as Indonesia.
- **Gross Cost Scheme:** The operating entity does not bear the risk. The operation consignment fee is a fixed amount that is set by adding a reasonable profit amount to the operating entity's estimated O&M

costs. It incentivizes the operating entity to reduce costs from the original contract through efficient management and increase in operational profit.

- **Availability Payment (AP) Mechanism:** This can be a component of the gross cost scheme. The public sector pays a pre-established amount periodically to the operating entity, which may be adjusted depending on the operating entity's O&M performance. Appropriate performance indicators need to be set so that the private concessionaire is incentivized to meet certain standards of service laid out by the public sector.
- **Modified Gross Cost Scheme:** This is a variation of the gross cost scheme wherein a revenue-sharing arrangement is established between the partnering public and private entities. The private operating entity obtains partial returns if the actual performance exceeds the pre-defined target values (e.g., ridership, fare revenue). On the other hand, the private partner incurs penalties in case of underperformance.

Demand Risk Allocation and Operating Entity's Revenue and Expenditure Structure



*Access fee is cancelled out when it is owned by the orderer.

Project Scheme Selection

③ Operating entity

There are several considerations in selecting an operating entity.

Public or private sector

- **Public sector:** It has the advantage of being institutionally aligned with city and other government planning initiatives and having better access to subsidies that can minimize operating deficits. If a railway project is expected to generate low profits, an operating entity from the public sector is considered ideal.
- **Private sector:** It generally has inherent operational and management efficiencies.

Type of operating entity

- **Public operating entities:** These include government organizations, public corporations, state-owned enterprises established by law, public joint venture companies, among others.
- **Private operating entities:** These can be any allowable type of entity, provided these exist in accordance with corporate laws of respective countries.

- **Semi-public sector entities:** These can be public-private joint ventures and other similar public-private entities duly allowed by law.

If the operating entity will come from the public sector, the following factors should be considered:

Project implementing entity functioning as operating entity Entity responsible for the construction project

- **Project implementing entity³ will transition to the operating entity:** Existing resources can be optimized with greater flexibility (e.g., reassigning project personnel to O&M activities).
- **Separate operating entity will be established:** It should have the necessary institutional specialization in railway O&M.

Existing or new organization

- **Appointing existing organization:** It requires less effort, as there is no need to undergo procedures to establish a new organization and the existing workforce can be utilized.

- **Establishing new organization:** A new corporate culture can be fostered without being restrained by former ways.

Public or Private Sector O&M

- The policies of the government and implementing entity should be explained at the FS stage. If the preferred option is a public sector O&M, it will be much easier to conclude.
- The JICA may instruct consultants to conduct a market sounding exercise with Japanese firms at the FS stage (ideally after the submission of the Interim Report) to gauge the interest of potential O&M service providers.
- It may be better to avoid private sector O&M if the city has no past experience in urban railway O&M or prior records of contracting public transport services.
- If the policy for private sector O&M cannot be amended and the private sector in developing countries shows interests in providing O&M services, a competitive bidding process should be conducted or stronger partnerships should be established.

³ Entity responsible for the construction project

▼ Operating Entities of Urban Railways in Different Countries

Business	Operating entity	Build / operation	Existing / new ¹	Organizational form
Tokyo Subway	Tokyo Metro	Construction & operation	Existing	Joint stock company ⁵
Delhi Metro	DMRC	Construction & operation	New	Public corporation
MRT Blue Line, Bangkok	BEM	Operation	(Private sector)	Private sector enterprise
MRT Purple Line	BEM	Operation	(Private sector)	Private sector enterprise
Airport Rail Link (Bangkok)	AERA ⁶	Operation	New	Private sector enterprise
Manila LRT Line 1	LRMC	Operation ⁷	(Private sector)	Private sector enterprise
Manila MRT Line 3	DOT ⁸	Operation	Existing	Government organization
Manila Subway	(TBD)	Operation	(Private sector)	Private sector enterprise (planned)
Jakarta MRT	MRTJ	Construction & operation	New	Public corporation
Ho Chi Minh Line 1	HURC ¹	Construction & operation	New	Public corporation

¹ A new entity was established for the first railway system.
² Shareholders are national and local governments, body.
⁶ The business was transferred from SRTE to AERA1 in October 2021. ⁷ The extension work is being carried out by the implementing entity. ⁸ The operating entity is a project management office of the implementing entity.

■ Advantages and Disadvantages

The general advantages and disadvantages of each project scheme are shown on the right. Important considerations when selecting a viable project scheme are as follows:

- In determining the financial framework for an urban railway, risk sharing and the scale of financial burden should be confirmed. Additionally, the degree of efficiency that the private sector can achieve should be very carefully considered.
- Other factors include: requirements for additional government subsidy to fill the viability gap and attract the private sector; intention to standardize/integrate the different railway systems in the network; and government risks in the event of bankruptcy or other financial inabilities of the private operating entity.
- Decision makers should maximize the advantages and minimize the disadvantages of the preferred option by understanding the characteristics of each financial framework.

▼ Summary of Advantages and Disadvantages per Option

Parameter	Option	Advantages	Disadvantages
① Asset development	Full government funding	Easy access to low interest loans offered by international donors Easy fund management by the public sector Simple investment structure	Limits to budgeting and borrowing Numerous decision-making processes
	Some private sector funding	Potential to accelerate railway network development Potential to reduce government borrowing Risk transfer to the private sector	High initial investment costs Difficulty in controlling railway network development
② Demand risk	Net cost	Independent pursuit of profits by the private sector	Considerable demand risks Public sector difficulty in exercising control
	Gross cost	Easier and sustainable revenue generation by private sector enterprises	Additional contract management and business monitoring capabilities required of the government
③ Operating entity	Operated by a public sector entity	Sustainable operations without heavy dependence on profits Secured service levels regardless of corporate situations	Business knowledge required of the public sector Possibility of underperformance due to budget constraints Possibility of salary and personnel systems to become rigid
	Operated by a private sector entity	Easy implementation of performance-based salary structures and personnel evaluation	Higher operating costs when profit and taxes are accounted for (if efficiency level is the same in both public and private sectors)

Project Scheme Assessment

Project Scheme Assessment

The analysis of cash flows helps in the determination of the most viable project scheme. This section refers to "The Study on Financial Frameworks in Mass Transit System Project in Thailand" (2010) as an example in evaluating each project scheme.

Analysis overview

With the key assumption that the O&M performance of the private and public sectors are the same, the analysis compares the life-cycle cost (LCC) or long-term financial burden of the public sector in each financial framework. This is calculated by subtracting the present revenue value from the present expenditure value.

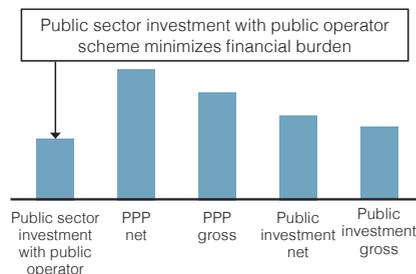
Parameters

These include the assessment period, concession period, corporate tax rate, inflation rate, discount rate, exchange rate, fare price, debt ratio (public/private sector), interest rate (for each financing source), repayment period, and return on equity (ROE).

Results

The financial burden on the public sector is minimal using the public investment scheme.

Financial Burden for Public Sector⁹



The findings obtained from the analysis are as follows:

Initial cost reduction for government

In the case of PPP, the government can reduce its initial investment burden, as the private sector bears part of the initial costs. On the other hand, if basic profitability is low, government subsidies are needed to help the

private sector. Therefore, compared to public investment schemes, PPPs tend to increase government financial burdens over the project life.

Advantage of public sector investment with public operations

In the case of the vertical separation, the private sector contributes part of the initial investment, while additional financial costs are shouldered by the public sector. Also, the private sector requires profits from business activities in the areas of railway operations. Therefore, unless the private sector achieves operational efficiency, Public Sector Investment with Public Operations is considered more advantageous than PPP.

Efficiency improvements by private sector

In order to bridge the gap between public operations and the government's financial burden under PPP arrangements, the private sector has to achieve efficiencies at both the construction and operational stages. However, there is little evidence to quantify the difference and generalize the performance of the public and private sectors.

Project scheme evaluation

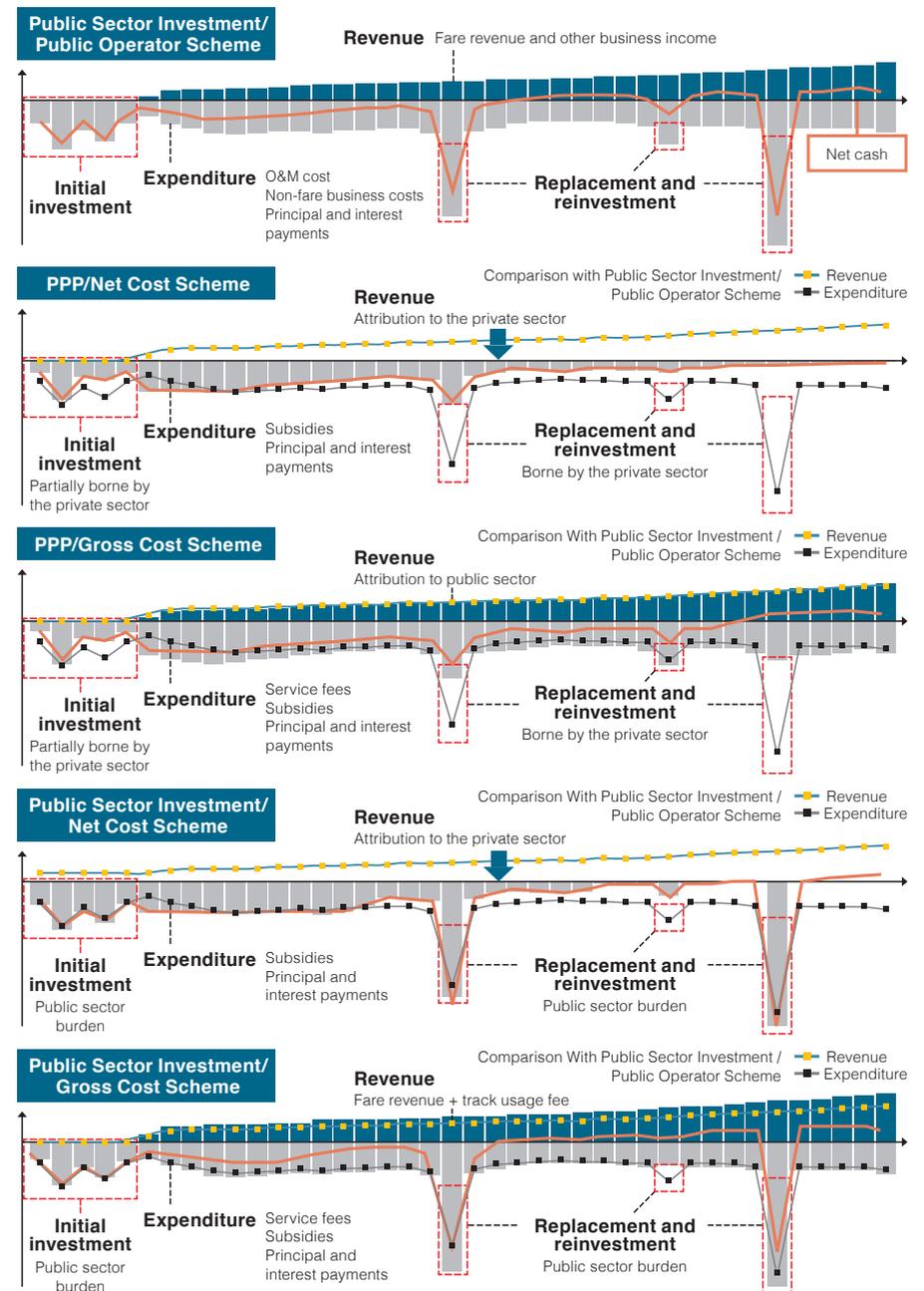
Given the capital-intensive nature of urban railways with a variety of risks in construction and operations, the high financial costs to the private sector tend to require high returns.

For this reason, PPP is generally difficult to pursue in the urban railway sector, particularly without sufficient financial support from the government.

Aside from understanding the likely extent of the financial burden on the public sector, the desired policy outcomes are also an important consideration when determining the preferred scheme.

⁹ This is in cases wherein the business is not financially profitable.

Public Sector Cash Flow by Scheme



Project Schemes: Examples from Different Countries

Project Scheme Selection

A variety of project schemes have been studied and implemented in different countries. The experiences of identifying and implementing these project schemes provide invaluable lessons in determining viable project schemes for future railway projects.

Public investment with public operations model

Cities introducing urban railways for the first time in their localities usually opt for a public investment model involving public sector as the operating entity. Such is the case of Jakarta and Ho Chi Minh. It is seen as a rational choice from a long-term perspective, as it allows the public sector to build its own O&M capabilities. Eventually, cities can then contract out O&M activities to private operating entities.

Other Options

Some cities opted for a PPP model even for initial urban railway projects in their localities. One such case is in Bangkok where the Ministry of Finance understood the viability of using a PPP-based scheme as the agency also manages their public debt.

On the other hand, some cities prefer engagements wherein the government bears the initial investment and having a private sector partner for O&M. Such option has been done in cities like Manila.

There is no single project scheme that perfectly applies to every urban railway project context. Corresponding forms of O&M engagements are designed on a project-to-project basis depending on different factors such as the scale of business activities, government policies, the investment and loan horizons, and the willingness of actors to participate in the urban railway O&M activities.

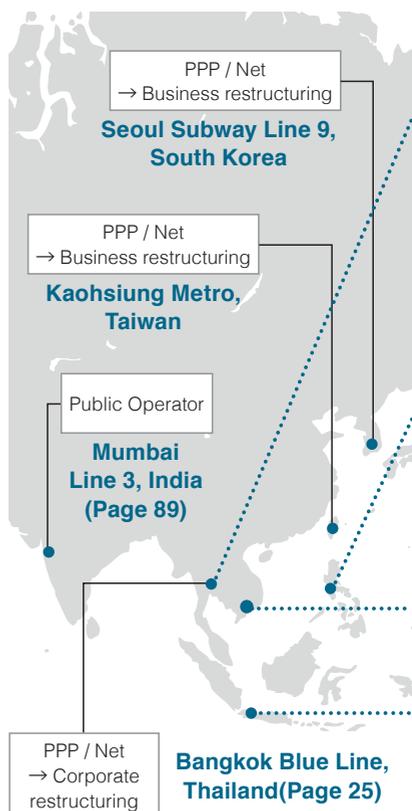
Vertical separation model

In the vertical separation model, financial structures are normally decided on a case-to-case basis. Considerations include how much the private sector pays for access charges to the government. Furthermore, how much subsidies can be provided by government, for instance as a portion of the construction or operating costs for the urban railway system.

Less emphasis on private sector's role

Many PPP projects that are structured 'BOT-type' modalities in the urban railway sector rely on the private sector for financing initial investments have experienced difficulties in operationalization. This can usually occur when the railway network has yet to be fully established. In such case, appropriate risk-allocation between the Public and private sectors should be closely considered, as in the cases of Kaohsiung and Bangkok.

Project Schemes in Different Countries



Bangkok Purple Line, Thailand



Opened in August 2016

PPP / Gross Cost Scheme

Close attention to public debt in implementing a PPP/gross cost scheme was selected. As a result, government fiscal burden increased partly due to sluggish demand growth after railway opening.

- At the study stages, consultants suggested a public investment/gross cost scheme as a viable scheme.
- A Cabinet decision confirmed usage of a PPP/gross costs scheme in consideration of public debt ratio to its Gross Domestic Product (GDP).
- Due to delays in the Blue Line extension to connect the new line, demand growth was sluggish immediately after opening resulting in an increase in government fiscal burden.

Metro Manila Subway, Philippines



Scheduled to open in 2026

Public Sector Investment / Gross Cost Scheme

Public sector capital investment with Private Sector O&M is being explored. Commercial risks for the private sector need to be addressed.

- Embedding AP mechanisms is likely needed to address commercial risks.
- Credit enhancement measures can make the project more attractive for private sector investments in O&M.
- Under a gross cost scheme, government bears demand and revenue risks during the demand growth period. This includes the risk of delays in station opening.

Ho Chi Minh City Railway Line 1, Vietnam



Opening schedule under discussion

Public Sector Investment / Public Operator Scheme

Risk of operating capital shortage from the side of the public operator can occur if the city's financial solvency is a concern.

- If financial solvency is a concern for the city, the public operator is exposed to the risk of operating capital shortages. In such case, fare revenues should at least be reserved for use of the operator.
- The city intends to increase the productivity of operations by setting performance indicators and linking this to payments. Such was the lesson gained from increasing subsidies to bus operators in the city.
- The operating body is closely reviewing business plan figures, paying close attention to demand forecasts and fare determination.

Jakarta MRT, Indonesia



Opened in March 2019

Public Sector Investment / Public Operator Scheme

The Government is responsible for investment and retained O&M roles for the North-South Line as their future' cash cow route."

- Rail line patronage in the opening year was about 80,000 passengers a day, which is significantly lower than the demand forecast of 150,000 daily ridership.
- Phase 2 development for the railway is underway. Once the MRT/LRT network is developed, this line is expected to be a significant source of revenues.
- An incentive scheme was created where the payments to the operator are done based on the transport cost per passenger.

Project Schemes: Public Operator Scheme

Summary

Operating entity

Regulatory system

Railway systems (overall)

Railway systems (each department)

O&M Projects

O&M Projects in Other Sectors

Past examples of development assistance

Provision of assistance in the future

Overseas expansion of O&M

Vertical Integration

- This applies when the public sector entity is responsible for both construction and operations. While generally difficult, the private sector can be amenable to this scheme in some cases.
- The government grants rights to the private entity to build and operate the system, including the development of civil structures and procurement of rolling stock and E&M systems. The private entity is also engaged in O&M after commissioning. The business entity covers O&M-related costs through both fare and non-fare revenues.

Jakarta MRT, Indonesia

Project scheme/contract format

- Mass Rapid Transit Jakarta (MRTJ) is the implementing agency that also operates and maintains the system.
- Most of the funding is sourced through JICA Official Development Assistance (ODA) loans with some of the financial requirements coming from Jakarta's state budget.
- Japanese companies (e.g., Shimizu, Obayashi, Sumitomo Mitsui Construction, Tokyu Constructions) worked on the project as civil works contractors; Nippon Sharyo manufactured the rolling stock, while Mitsui & Co. as well as Toyo Engineering supplied the E&M systems.
- The Special Capital Region of Jakarta (DKI Jakarta) provides the MRTJ with compensation

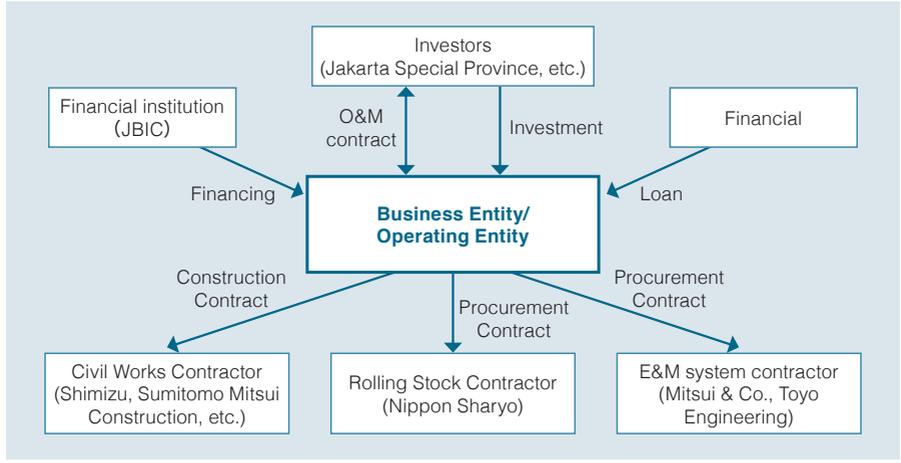
and subsidies under an O&M contract.

- Since the MRTJ owns the entire asset base of the system, the subsidies needed to cover operational deficits and depreciation costs is substantial. This likely requires a review of asset ownership model.

Dealing with risks

- Extension and network development of urban railway may encounter significant delays from struggling to secure government allocations.
- Expenditures incurred from asset development is a major factor in cost structures of projects. In the asset ownership framework, the operating entity should refrain from disproportionately large assets.
- The operating entity should be allowed to directly receive daily operating income to better manage budgetary risks.

▼ Jakarta MRT Public Sector Investment/Public Operator Scheme Diagram



Build-Lease-Transfer

- The business entity with a build-lease-transfer (BLT) agreement with the government is responsible for construction of civil works, procurement of rolling stock and E&M systems, and leasing of facilities to the government after the railway system is commissioned to operate.
- Operations is performed by the government or outsourced to an O&M contractor separate from the BLT partner. Maintenance may likewise be outsourced to private sector.
- The government pays lease fees to the business entity during the contract period.

Manila MRT Line 3, Philippines

Project scheme/contract format

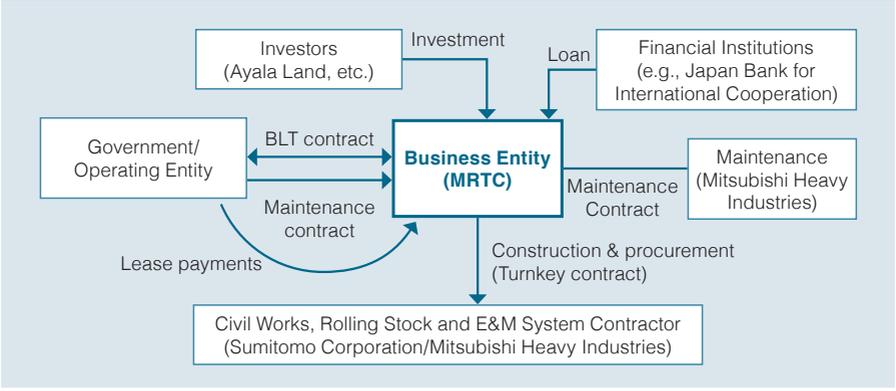
- The government agency overseeing the railway is the Department of Transportations and Communications (now called the Department of Transportation or DOTr).
- The concessionaire is the Metro Rail Transit Corporation (MRTC), which is a private consortium composed of local real estate companies. The DOTr, on the other hand, is in charge of operations.
- The contract is a 25-year BLT contract.
- The government pays lease and maintenance fees to the MRTC. The entire asset will be handed over to the government after the 25-year agreement expires.
- The concessionaire procured civil works and delivered the equipment under a turnkey arrangement. Construction and procurement were undertaken by Sumitomo Corporation and Mitsubishi Heavy Industries under a

- turnkey contract.
- 30% of MRTC's capital is mainly sourced from its own funds. The rest of its capital, were funded through loans from financial institutions such as the Export-Import Bank of Japan, Czech Export Bank, among others.
- The Department of Finance acts as a guarantor of the said loans. Hence, risks for both lenders and borrowers are reduced.

Dealing with risks

- Due to budget risks, challenges were encountered, such as insufficient working capital on the part of the operating entity and delays in the payment of maintenance contracts.
- Political interventions in fare setting led to unreasonably low fares that adversely affected the financial performance of the project.
- Use of low-interest loans by donor agencies and credit enhancement against government payment risks can be possible countermeasures.

▼ Manila MRT Line 3 Private Investment/Public Operator Scheme Diagram



Project Schemes: Public-Private Partnership/Private Operator Scheme

Vertical Separation: Build-Operate-Transfer (Net Cost Scheme)

- The government is responsible for infrastructure development by assigning contractors for the majority of civil works and trackworks. The rolling stock and E&M systems are procured by a business entity with a build-operate-transfer (BOT) contract with the government.
- The business entity contracted by the government subsequently operates the facilities for a certain period after the contract period ends, the facilities are then transferred to the government after concession period.
- Basically, the government does not recover the infrastructure investments from the fare revenue as the rail system, in effect, is received by the business entity. For this reason, the business entity virtually pays for facility access charges to the government through its own investment after the service commencement.

PPP/Net Cost Scheme: Bangkok Blue Line, Thailand

Project scheme/contract format

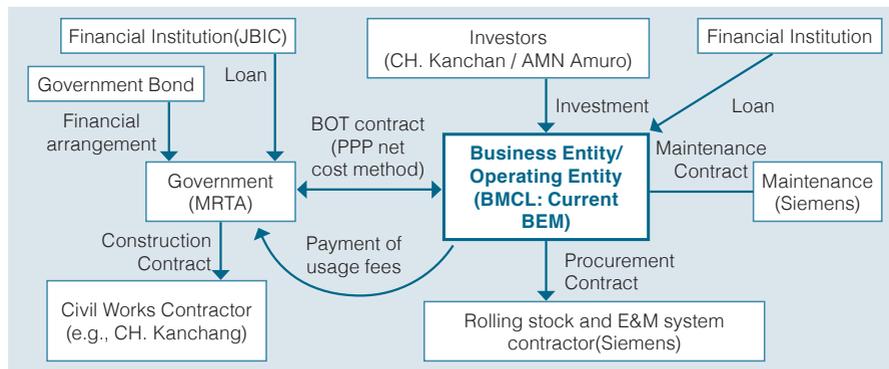
- The Mass Rapid Transit Authority of Thailand (MRTA) carried out the civil works, tunnelling, trackworks, and station equipment provision.
- The concessionaire, Bangkok Metro Company Limited (BMCL), is a consortium of construction companies, banks, and other private entities.
- BOT contract period is 25 years.
- With the business entity receiving the fare revenue, it is expected to carry out O&M activities to recover the initial investment and pay the access charge.
- The concessionaire pays the MRTA access charge and a share of fare profits and commercial revenues.
- Fare level is adjusted based on the Consumer Price Index (CPI) in comparison with the

original fare. At the time of opening, the CPI served as a basis for evaluation.

Dealing with risks

- The operator shoulders ridership risks under this scheme.
- BMCL had been in a deficit mainly due to demand shortages. The government and private shareholders provided support such as debt deferral in 2008.
- BMCL had a merger with the Bangkok Expressway Limited (BECL) in December 2015, forming the Bangkok Expressway and Metro (BEM). BMCL retained rail operations.
- In the early years of operations, the financial risks of the business entity were particularly high, up until the difference between the revenues and expenditures balanced out.
- Project schemes should be designed based on conservative ridership projections.

▼ Bangkok Blue Line PPP/Net Cost Scheme Diagram



Vertical Separation: Build-Transfer-Operate (Gross Cost Method)

- The government was responsible for infrastructure development, including majority of the civil works and trackworks, by assigning contractors. The rolling stock and E&M systems were then procured by a business entity with a build-transfer-operate (BTO) contract with the government.
- The government undertook the infrastructure development and directly receives the fare revenue.
- The business entity does not bear any of the ridership risks as the entity receives pre-determined service fees with the amount of O&M costs plus an appropriate profit share.

PPP/Gross Cost Scheme: Bangkok Purple Line, Thailand

Project scheme/contract format

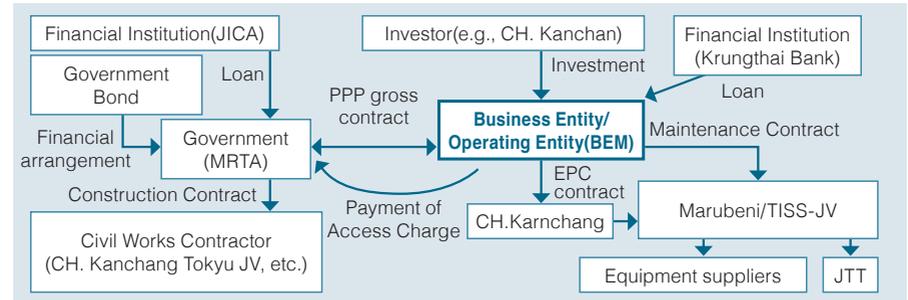
- The government undertook the civil works, including works for the viaduct, station buildings, depots, and tracks.
- The concessionaire selected suppliers, procured the rolling stock and the railway systems. The suppliers were also in charge of the post-opening maintenance services.
- The JICA ODA loan funded majority of the government portion (approximately 70%), and the remainder was funded by the Government of Thailand.
- The contract period is 30 years, this included the construction and procurement period.
- In terms of service fees, a fixed rate of profit was added to the operations and maintenance costs.
- All fare revenue proceeds are received by the government, while the business entity operates and maintains the system at a fixed amount.
- The concessionaire's initial investment amount and pre-operation costs are refunded by the government in full every month for 10 years of the rail line's opening.

- The business entity is BCML (now BEM), which has already been engaged as the Blue Line Operator at the time the contract was awarded.
- The JV of Marubeni and Toshiba Infrastructure Systems & Solutions (TISS) received the procurement orders including the maintenance services for 10 years from rail line opening. Japan Transport Technology (JTT), comprised of two (2) other companies and JR East, is engaged as the maintenance provider.

Dealing with risks

- Ridership risk is completely borne by the government.
- Due to delays in extending the Blue Line, the demand growth was slow since railway opening. This has led to an increase in financial burden for the government.
- After the opening, the government had to shoulder the risks until the difference between the revenue and expenditures are balanced out.
- The attempt to reduce the government's initial investment often translates to a significant increase in financial burdens and risks over the project life span.
- Project schemes should be designed based on conservative ridership projections.

▼ Bangkok Purple Line PPP/Gross Cost Scheme Diagram



Summary

Operating entity

Regulatory system

Railway systems (overall)

Railway systems (each department)

O&M Projects

O&M Projects in Other Sectors

Past examples of development assistance

Provision of assistance in the future

Overseas Expansion of O&M

Project Schemes: Public Sector Investment/Private Sector Operator Scheme

Public Sector Investment/Net Cost Scheme

- The government is responsible for all construction and procurement activities.
- The public sector carries out civil works as well as procurement of rolling stock and E&M systems.
- The private sector operator carries out the O&M after railway opening and uses fare and non-fare revenues to cover all the related costs of operation and maintenance.
- Subsidy provisions for O&M can be considered depending on the balance between revenues and expenditures.

Melbourne Subway, Australia

Project scheme/contract format

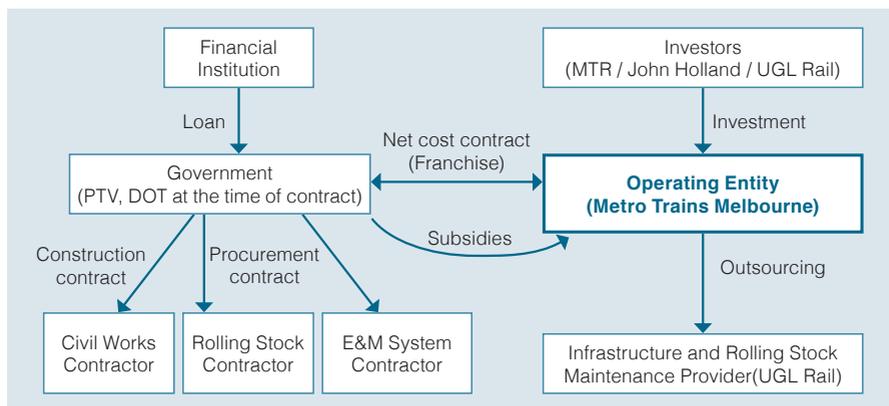
- The tracks, signaling system, and rolling stock are all procured and owned by the government. On the other hand, the operator is free from any responsibility related to railway development works.
- The operator (Metro Trains Melbourne) is entrusted with a franchise agreement from the government (Public Transport Victoria or 'PTV').
- The Metro Trains Melbourne is owned by Hong Kong MTR (60%), John Holland, an Australian private rail operating company (20%) and UGL Rail, an Australian railway equipment supplier and operating service provider (20%).
- The railway services opened on November 30, 2009. The contract period is eight years with an option to extend the franchise for another seven years.

- The land and infrastructure are leased by the asset owner, VicTrack, a state-owned company of the Victoria State Government.
- Ticket fares and fees are collected by the government PTV (the franchisor).

Dealing with risks

- Fare revenue from passengers account for only 24% of the entire revenue of the operator, and the remainder is covered by government subsidies.
- The operator can bear a certain degree of ridership risks. However, the government should be ready to cover any excessive demand fluctuation risks.
- While O&M cost risk is basically borne by the operator, subsidies from the government can cover excessive fluctuations.
- In essence, the railway assets necessary for operations are leased from the government. The government on the other hand, bears the risks of asset restoration and rehabilitation.

Melbourne Subway Public Investment/Net Cost Scheme Diagram



Public Sector Investment/Gross Cost Scheme

- The government is responsible for construction and procurement activities.
- The public sector undertakes the civil works and procurements of the rolling stock and E&M systems.
- The private sector operator does not bear any ridership risks as the entity receives pre-determined service fee with the amount of O&M costs plus an appropriate profit.

Examples of Public Sector Investment/Gross Cost Scheme

- The Metro Manila Subway and other projects aim to introduce this type of scheme.
- The Bangkok Mass Transit System (BTS) initially chose the BOT/Net Cost Scheme but adopted the Public Investment/Gross Cost Method for the extension sections.

- reduction penalty that is linked to a set of Key Performance Indicators (KPI).
- Part of the initial investment, pre-operating costs, replacement, and reinvestment during the contract period, and other cost items may be included in the AP payment.
- The operating entity can share profits with the government for the revenues derived from the commercial businesses and other non-fare revenues.

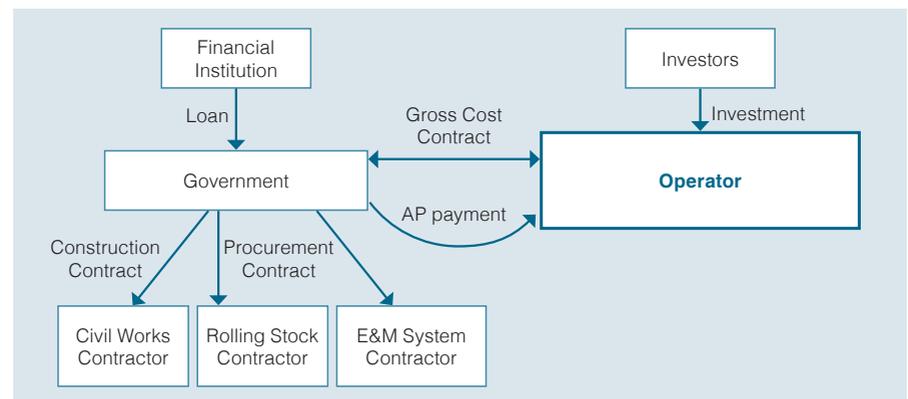
Dealing with risks

- The government bears all ridership risks.
- The burden on the government can increase significantly in case the fare revenues are significantly lower than expected. This may pose a risk of default in settling payments for the operating entity.
- In such cases, credit enhancement versus government payment risk may be considered.
- The operating entity should be protected from the risks of possible delays in railway opening. Expenditures associated with such delays must be appropriately compensated.

Project scheme/contract format

- The government undertakes the civil works, rolling stock, E&M systems, among others.
- The operating entity is selected through a bidding process.
- All fare revenue is received by the government, and the operating entity receives an availability payment (AP) as specified in the O&M contract as it carries out operation and maintenance. The AP amount typically includes a payment

Public Investment/Gross Cost Scheme Diagram



Long-Term Business Strategy

General

A business strategy is typically developed during the design stage. It is based on both the project scheme identified at the FS stage and the business case prepared during the design stage.

After the type of operating entity is established at the construction stage, a more detailed business strategy is formulated at the pre-opening stages.

During the operational stage, the operating entity should review the business strategy from time to time to reflect changes in the socio-economic conditions, trends in the external business environment, and technological innovations, among other factors.

Business Strategy Formulation Process by Stage



Business Strategy Development Overview



Management Plan (Action Plan)

All organizations need a management plan based on its business strategy. New organizations in the urban railway sector requires professional advice from industry experts.

At the project implementation stages, project stakeholders have the tendency to direct its focus mainly on construction works rather than pay due attention to the operation and maintenance aspects of the system. Additionally, it is hard to anticipate any practical business strategies other than "safe and reliable transport" if the entity does not have actual O&M experience. Such is the case if the railway to be developed is the first urban railway line for the city.

Ambitious business development concepts such as non-fare commercial businesses, transit-oriented development (TOD), and technological innovations have been promoted for urban railways. However, these remain impractical, or in some instances unattainable, without sufficient organizational, human resource and financial capacities.

Operating entities need to envisage business strategies according to the level of maturity of the local socio-economy, railway industry, and existing railway organizations. While referring to examples of structures and formulation procedures, the management of the operating entities should refrain from conveniently mimicking and applying the plans and strategies of the other operators.

Example of Management Plan and Major Measures (Tokyo Metro, 2021)



Business Operations, Technology, and Safety: Regulatory and Supervisory Systems

■ Necessity For Regulations

The railway business is made up of important social infrastructures, since it is public in nature, the ensuring high levels of safety in order to transport involving a large number of passengers is needed. Imposing appropriate regulations are necessary to ensure activities of railway operators does not go against public interest.

■ Japanese Regulations

In general, the railway business in Japan is vertically integrated as the business owner of the railway infrastructure also serves as the train operator. Since each business operates exclusively in a specific area, the provisions of the Railway Business Act and the Railway

Operation Act, under the jurisdiction of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), stipulates various matters that emphasize safe and stable operation.

■ Regulations in Developing Countries

The provisions of the regulations vary depending on the history of the railway development in the country. In some developing countries, the creation of legislation for a regulatory authority may not be sufficiently advanced. It is therefore necessary to create and impose such legislations that are referenced to the regulatory systems that are already set in place in Japan. The assistance for Dhaka MRT Line 6, which are described in the latter parts of

this Handbook, is a case of developing railway business legislation based on existing Japanese laws.

■ Flow of Regulation Development

FS Stage: recommendation on the necessity of legislation

A clear understanding of existing regulations in concerned countries would be needed to determine the need to recommend new legislation that support railway operations. In Japan, railway operators have shared technical and operational responsibilities (shown in blue section of the diagram). Certified railway business operators in particular are responsible in conducting conformity assessments of railway systems. As needed, operators are bound to submit assessment results to the MLIT. Europe follows a different mode of practice in railway regulations.

DD Stage: examination and development assistance for regulation contents

Assistance is often provided to concretize the content proposed at the FS stage. Due

consideration is given to the specific contents of regulations covering the five (5) items shown in the figure (see next page). Development of appropriate regulations for railway operations is a key requirement that should be conducted in the early stages of development works. If the development of appropriate regulations incur delays, compliance assessments of the railway system could not be properly undertaken in the succeeding stages. This consequently results in delays in developing internal regulations within the operating entity and would snowball into delays in the opening of the railway as well.

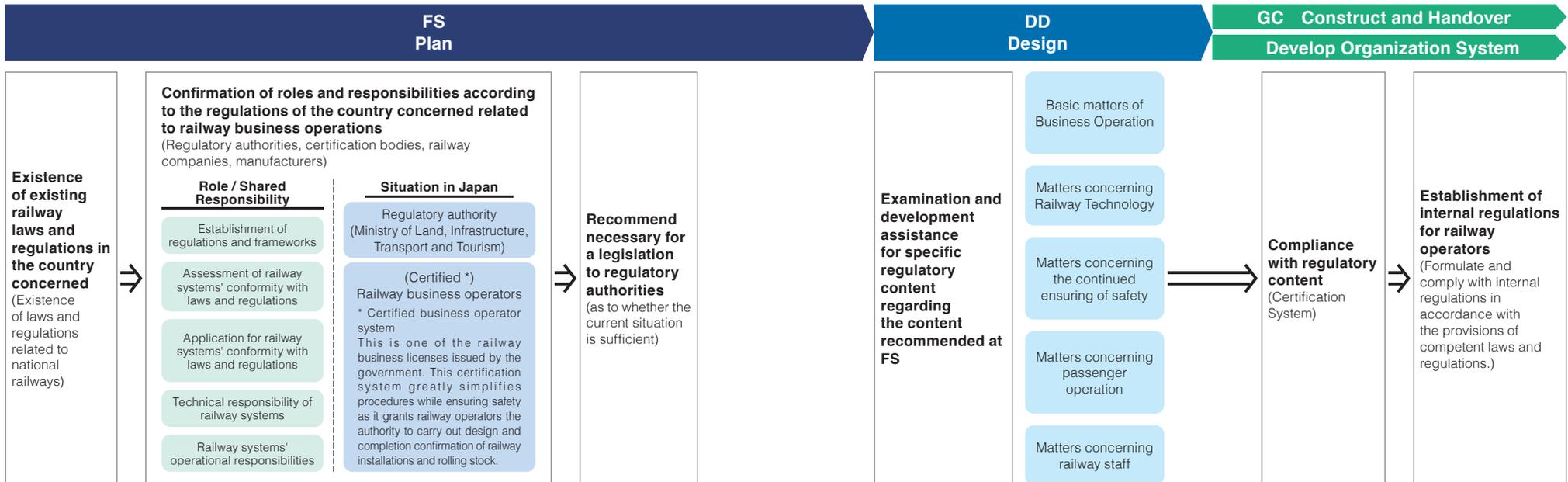
GC Stage: conformity with regulation contents

Procedural processes are undertaken to secure permission to implement O&M in accordance with the established laws and certification systems in the country.

GC Stage: development of internal regulations of railway companies

The internal regulations of railway companies are to be developed in line with established laws and regulations.

▼ Development Flow of Railway O&M-Related Regulations



Business Operations, Technology, and Safety: Regulatory and Supervisory Systems

■ Examination Of Specific Regulations

Main regulations in Japan

The main regulatory items in Japan as well as their main contents, are shown in the table. In this table, the main items are classified into five headings: Basic items of Railway Business and Operation, Matters related to Railway Technology, Matters related to the Maintenance of Safety, Matters related to Passenger Operation, as well as Matters related to Railway Staff. Each subject is provided summarized information on the contents of the regulations, the authority of the regulatory organizations, and the obligations of the railway operator.

Examples of contents of regulations

In the case of in Japan, the railway operator must secure a license for a new railway business from the regulatory authority. But for Southeast Asian countries, it is the government that formulates the overall plans with a mandated government agency operating the railway. As such, there are cases where the license system itself does not exist. In Japan, railway operators set their own technical standards and submit these to the regulatory authority for appraisal. Other countries on the other hand, adopted a system wherein necessary documents are submitted to certification bodies and assessed in accordance to a specific Safety Certification System rather than with technical standards. Such is the case in European-style regulatory systems. Details of this system are provided in pages 57 and 58.

Key points for application in other countries

The Japanese system cannot be applied in other countries in its entirety. It however serves as reference of the contents that have to be included in the regulations. The column "Main regulatory content" as shown in the table may serve as a checklist to verify whether existing regulations in developing countries are sufficient for urban railway operations.

► Major Regulatory Items and Contents in Japan

Main Regulatory Items	Japanese Laws And Regulations	Main Regulatory Content	Authority Of Regulatory Organizations	Duties Of O&M Operators	
Basic matters concerning railway business and operations	Railway Business Act	License required to start a railway business	Business operation license	Submit (←) / Approve (→)	Business license application
		Design, construction, completion, change of railway installations and rolling stock	Construction works authorization	Apply (←) / Authorize (→)	Railway infrastructure construction plan
			Railway facility inspection	Apply (←) / Pass (→)	Railway infrastructure inspection application
			Rolling stock confirmation	Confirm (→)	
	Railway Accident Reporting Rules	Passenger fare and train operation plan	Passenger fare limit	Apply (←) / Authorize (→) / Notify (←)	Fare upper limit application Fare / operation plan
		Construction of safety management system		Notify (←)	Safety management regulations
		Accident reporting		Notify (←)	Accident reports
		Information disclosure related to railway safety			Publish (→) / Safety reports
Matters concerning railway technology	Technical Regulatory Standards on Japanese Railways	Establishment of structural standards for railway infrastructure and rolling stock	Technical standards Performance regulation / Interpretation criteria	Notify (←)	Technical standards relating to rolling stock, electricity, track, civil engineering and train operation
		Establishment of maintenance standards for railway infrastructure and rolling stock		Refer (→)	
		Establishment of train operation handling standards			
Matters concerning the continued ensuring of safety	Railway Business Audit Rules	Audits to confirm operational status	Safety / business audit	Audit (→)	
	Act for Establishment of the Japan Transport Safety Board	Accident investigation system	Investigation of cause of accidents	Investigation and recommendations for measures to be taken (→)	
Matters concerning operation and passenger	Railway Operation Act Railway Transport Regulations	Fares and other conditions of transport		Publish (→)	Carriage terms and conditions
Matters concerning railway staff and passengers	Railway Operation Act	Duties of railway personnel		Enact (→)	Staff service regulations

Personnel Planning And Organization

Basic Concept

An O&M entity is expected to have low profits from its establishment until the retention of passengers after its railway system opening. Since preparations and operations at the onset require a limited number of personnel, the gradual expansion of manpower and the organization as a whole is advisable.

Points for Consideration

Personnel planning and recruitment

FS stage

Calculations of manpower requirements (based on the total estimated number of necessary

personnel using the basic unit per kilometer) and corresponding cost should be included in O&M costs.

DD stage

Along with the gradual refinement of the O&M plan, the personnel plan is updated, personnel requirements are detailed, and staff dispatch from related organizations are coordinated. At this point, it is desirable that 80-90% of the necessary details (including the number of personnel based on equipment quantity and specifications) have been organized.

Post-GC stage

After hiring management department personnel, the railway O&M department personnel are gradually hired according to the training schedule. The ③ Past Projects section and department workflows in succeeding discussions can serve as reference on the schedule of recruitment activities within the project development process.

Organizational Structure Development

The fundamental departments required for urban railway O&M are the General Management, Train Operation, and Maintenance Departments. Pages 39 to 50 provide specific organizational examples of these.

FS stage

A system for urban railway O&M is proposed at this stage. The organizational structure differs depending on the business scheme and whether or not to outsource this particular function.

Post-DD stage

Necessary departments and organizational structures are sequentially established at this stage. The personnel plan and organization structure are also refined in parallel.

Training

This is carried out to obtain the licenses and qualifications mandated by relevant laws and regulations.

FS stage

This involves introducing case studies on personnel development from past projects.

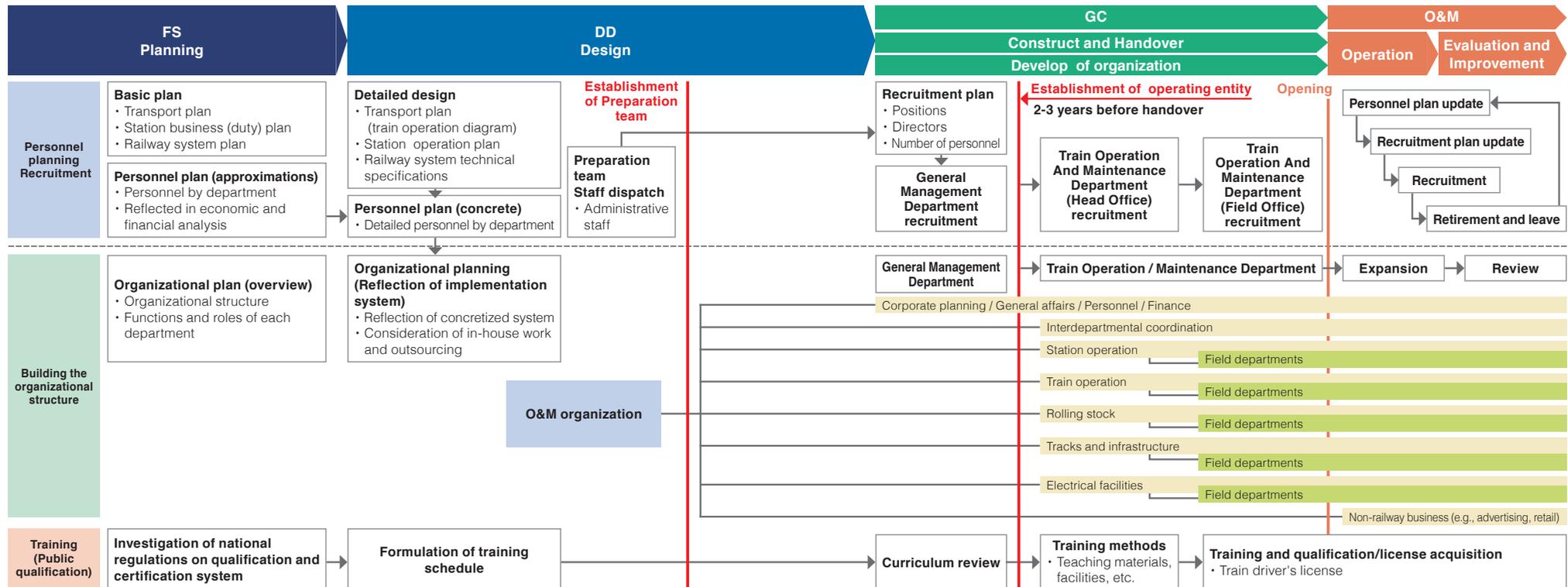
DD stage

This involves developing necessary timeframes for personnel development.

Post-GC stage

This involves formulating detailed methods for personnel development. Coordination is essential to avoid overlaps or shortages in contractor-provided training.

Flow Of O&M Personnel Planning And Organizational Structure Construction



Railway System and O&M Plan Review

Basic Concept

Railway system and O&M plans are examined in phases leading up to the construction stage: at the FS stage, the basic plan required for the calculations of the business costs is prepared; at the DD stage, the basic O&M plan required for facility design and specifications are confirmed and tendered; and at the post-GC stage, detailed design and manufacturing activities are performed. Afterwards, the railway system is constructed with the necessary documentation for train and station operations, and facilities are prepared for handover to the operating entity.

Points for Consideration

Basic policy of route development

The first step is to verify the need for railway development by aligning the basic policy with the city's development vision. Based on demand forecasts and service vision, the necessary transport capacity or maximum transport volume after opening all railway systems in the network is calculated to anticipate and plan for the maximum values and specifications of elements that are difficult to expand (e.g., infrastructure, depot) when keeping pace with the required transport capacity in the future.

Railway system/O&M basic plan

While train operation experts are formulating a basic plan for train operation, various engineering experts are also formulating a basic plan for facilities and equipment provision and maintenance needed for O&M implementation. These plans serve as the basis of O&M cost calculations.

Railway system design and specification review

To concretize the basic plan, further investigation needs to be carried out. This includes the formulation of a full-day transport plan (train operation diagram) and station operation plan, as well as the detailed designs of rolling stock and other important facilities and equipment. The deliverables created at this stage form part of the bidding specifications to be used for procurement.

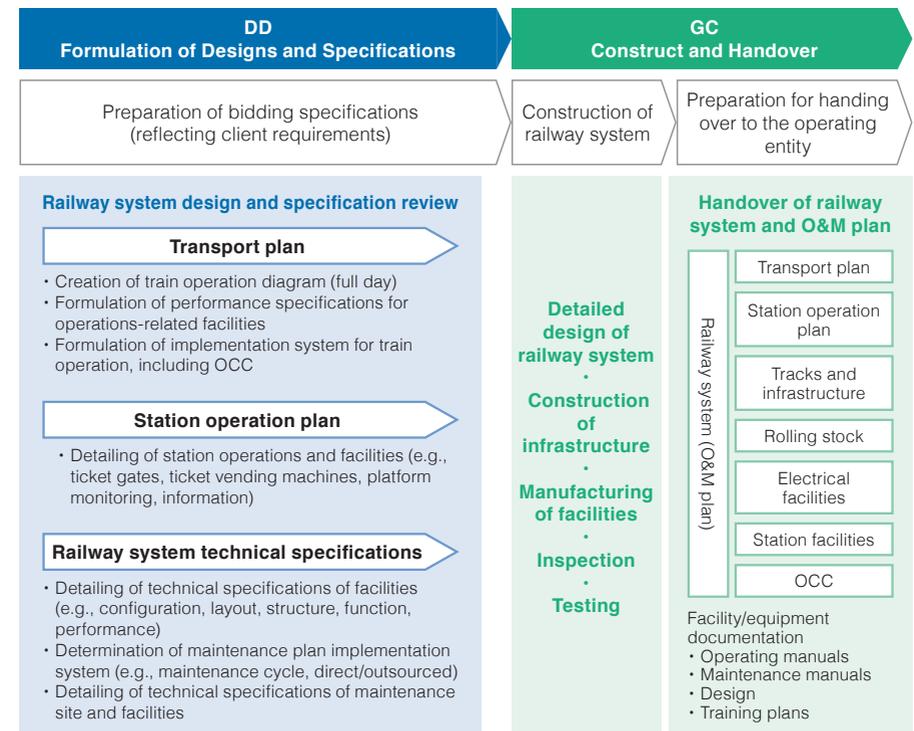
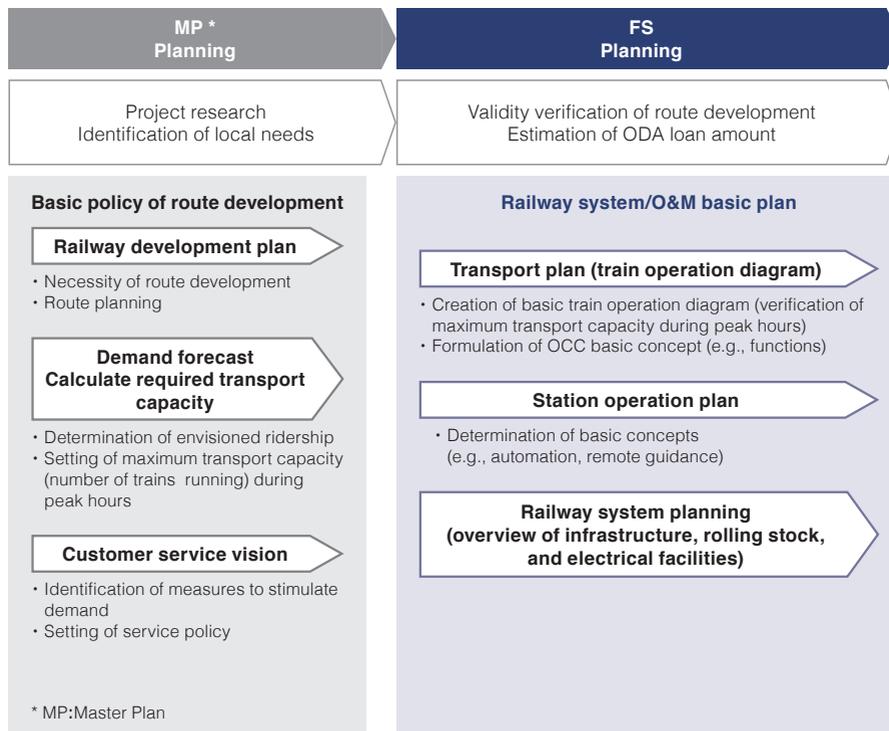
Additionally, since these facility requirements will be. Additionally, since there facility requirements will be constructed and manufactured based on the maintenance plan (as per bidding specifications) and maintained by the operating entity, parts replacement and supply methods should be given due consideration.

Railway system construction and handover

The maintenance service provider is selected through competitive bidding. After which, the detailed design, manufacturing, inspection, and testing stages are carried out. Once the pertinent documents have been prepared, the railway system is handed over to the operating entity.

Additional detailed explanations per department are provided in the succeeding pages.

Development Flow for Railway System and O&M Planning



Train Operation Department

Basic Concept

Upon receipt of the transport plan (train operation diagram), the Train Operation Department carries out advance preparations before the opening of a railway system. At this stage, there are instances wherein plans may be revised. It is therefore essential for all departments to work together closely as the non-involvement of even just one department can jeopardize the reliability of train operations.

This process is also done to determine failures or defects during post-opening assessments. In such cases, the necessary modifications must be reflected in the revised plans. Thus, it is essential to have a system that continuously implements the Plan-Do-Check-Act (PDCA) cycle involving all concerned departments of the operating entity for reliable train operation.

Points for Consideration

Transport plan (train operation diagram)

When opening a railway system, each department's plan is checked for adherence to train operation requirements based on the initial train operation diagram, which is fine tuned as necessary. Afterwards, train operation diagram data are entered into the OCC's train operation management system; and these serve as the basis of trial runs for train operation. During the post-opening stage, improvements to train operation diagrams are made after completing a PDCA cycle.

Cooperation with maintenance departments

Interdepartmental cooperation during the pre-opening stage is described under "Basic Concept." The same is also necessary during the post-opening stage, as improvements are initiated through the presentation of requirements for the new transport plan to the concerned maintenance departments (e.g., infrastructure, electrical facilities, rolling stock). These departments are responsible for conducting a detailed review of these plans and discussing the necessary measures.

Personnel planning

This generally refers to the hiring of personnel needed for the OCC and operation of trains, as well as the preparation of daily duty/shift schedules and work instructions. If there is a need for additional personnel due to post-opening changes in the train operation diagram, advance discussions with the human resources department are necessary in anticipation of the preparation period required for hiring.

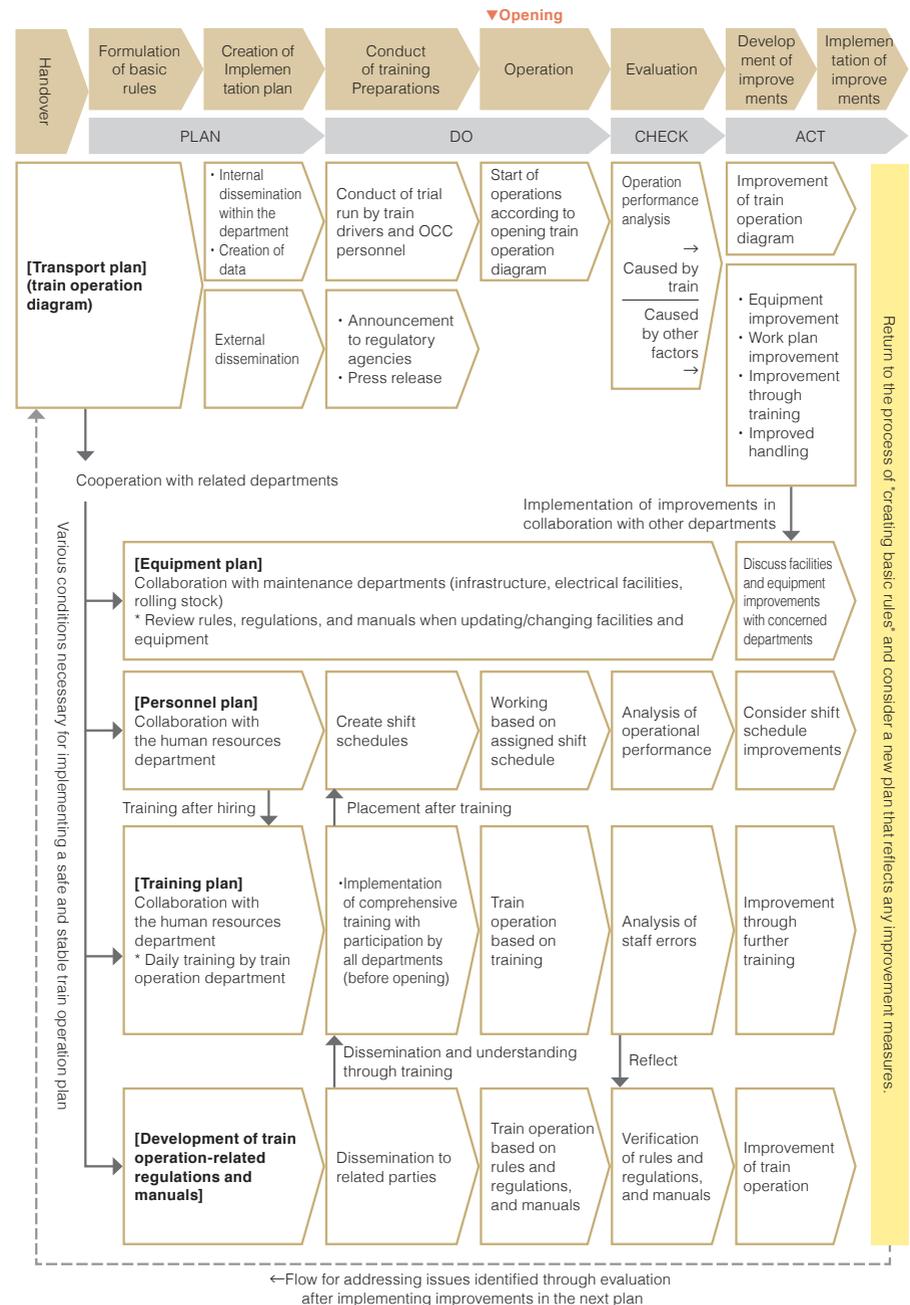
Training plan

This outlines the strategic acquisition of knowledge and skills for train operations. As a standard in many countries, train drivers and OCC personnel cannot engage in this line of work without special qualifications. As such, it is necessary to consider these particular qualifications when developing a training plan.

Regulations and manuals

Establishing rules and regulations in relation to train operations, as well as creating manuals on operating and troubleshooting procedures according to the specifications of rolling stock and other equipment, is done during the preparatory stages before the opening of a railway system. It is important that these rules, regulations, and manuals are updated whenever there are any post-opening changes to the railway system or procedures to avoid safety and operations risks.

Overview of Train Operation Department Workflow



Station Operation Department

Basic Concept

Station operation services are considered the closest to passengers. These include activities such as ticket selling, security inspections, safety confirmation on platforms, customer information, and lost property handling. Aside from ensuring passenger safety, stations are required to provide comfortable services within the stations. The degree of services provided is measured through quantitative observation such as a set of KPIs related to customer satisfaction.

Points for Consideration

Station operation plan

Related duties include external coordination with regulatory entities (e.g., fares, new service implementation, application, accident reporting) and internal coordination with other departments (e.g., mid-term plan, budget management, establishment of station service implementation system). Aside from the typical activities mentioned under "Basic Concept," other activities that are often included in the station operation plan are the following: accident response; possible introduction of new services; fare revenue management; and other duties performed on the platform.

Regulations and manuals

Every task should be appropriately performed based on established regulations and manuals. One of the most important rules in station operations is "Conditions of Carriage," which is a transport contract with the passengers. Internal rules and work manuals required for station operation implementation are confirmed and prepared in line with pertinent laws and in coordination with concerned departments.

Personnel planning

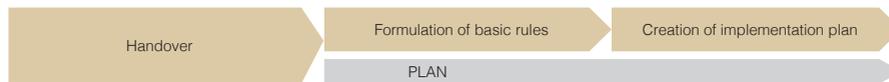
The staffing, division of duties, and duty/shift schedules of head office and field department staff (including contracts for outsourced services) based on the personnel plan are reviewed in detail. Any excess or deficiency in personnel deployments should be adjusted before the opening of the railway system. Additionally, appropriate training should be provided to

help ensure different station-related activities are carried out efficiently and effectively. If operations are not functioning smoothly within the department, another study should be done separately to review staffing and division of duties.

Station facilities/equipment operation

All technical specifications of related facilities and equipment (e.g., ticket gates, platform screen doors (PSD), information devices) are reviewed and improved. These, along with related design documents from the DD stage, serve as the basis of corresponding operating rules and manuals. All assigned personnel should be appropriately trained to operate station facilities and equipment, as well as perform different tasks related to station operations, leading up to the opening of the railway system.

Overview of Station Operation Department Workflow



[From planning dept.]

(Station operation plan)
Formulation of fare
Planning of station service

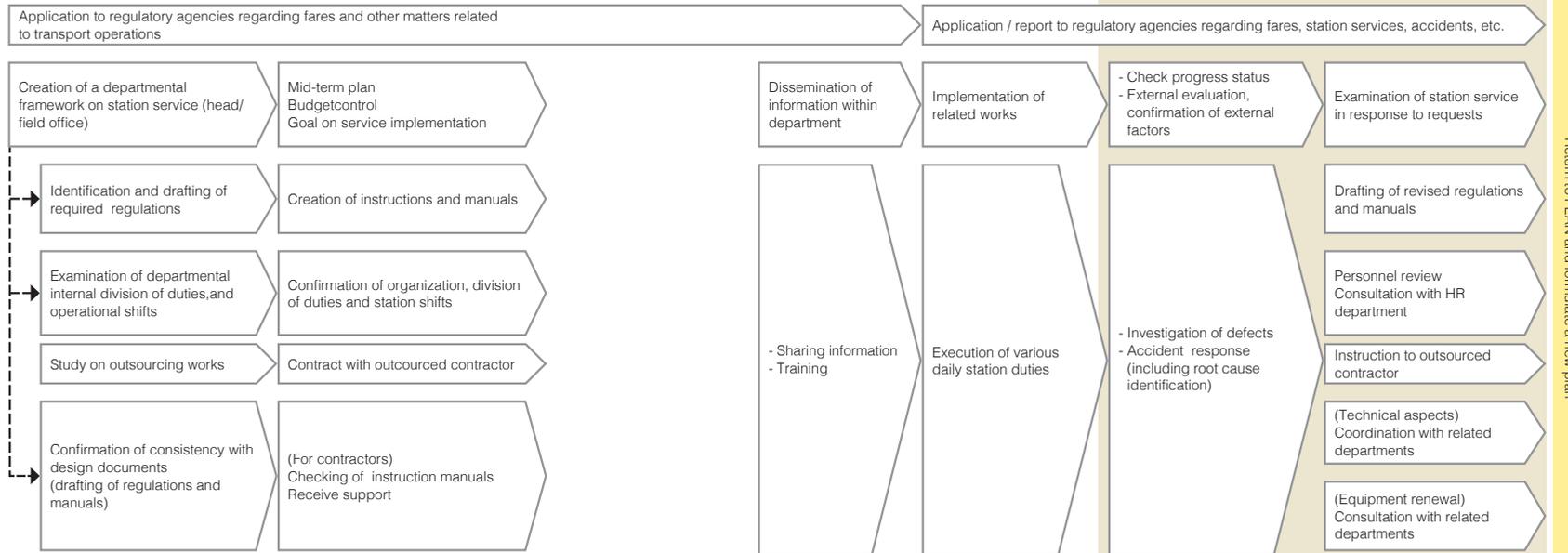
(Regulations and manuals)
Drafting of Conditions of Carriage
Outlining of equipment specifications

[From personnel / planning organization dept.]

(Personnel planning)
Planning of personnel per department
Decision on role per section

[From the department on DD stage]

(Station facilities/equipment operation)
Equipment specification
Equipment layout



Tracks and Infrastructure Department

Basic Concept

Railway structures made of steel and concrete cannot easily be demolished and rebuilt, so timely repairs and reinforcements need to be carried out so that they can maintain their functions. On the other hand, wears, failures, and irregularities on railway tracks directly affect the safety and comfort of passengers; as such, it is very important to regularly inspect the tracks more frequently than civil structures. The tracks should be refurbished after a certain period of time. Nonetheless, it is imperative to have regular maintenance cycles based on inspection results for both railway structures and tracks

Points for Consideration

Thorough inspections and confirmations of the different facilities and ancillary equipment should be carried out, especially during handover of the railway system. Design drawings, construction methods, and completion inspection results are important references for conducting proper maintenance.

Plan

The following items are related to basic rules and should be considered at the initial project stages: planning of division of duties in each workplace; stipulation of necessary implementation items based on relevant laws and regulations; establishment of methods for construction cost estimation and ordering, procurement of goods, and asset management system to ensure proper procurement and management of resources; and stipulation of items on maintenance operations (e.g., inspections, repair works) to ensure tasks are properly carried out as an organization. Budgets are formulated according to the mid- and long-term plans for inspections and

repairs, which should comply with the required procedures. Training plans are required for standard training across all departments (e.g., accident prevention measures), induction training for new personnel, and upskilling workshops to enhance their expertise. It is also important to secure reliable suppliers and service providers to guarantee reliable maintenance works.

Do

At the initial operational stage, training and technical support on facility/equipment handling is provided by the construction contractor and equipment suppliers.

The necessary maintenance-related measures are implemented based on the inspection data, so it is extremely important to properly and systematically record inspection results. When repair works are required, track components like rails and

sleepers are replaced; and track irregularities are also corrected. As for railway structures, the necessary repairs are carried out immediately upon discovery of any signs of deformation, such as water leakage and cracks.

In the event of an accident or natural disaster, recovery is the first priority; as such, construction activities are planned to ensure this. Management of supplies to be used in emergencies (e.g., damaged rails) is likewise an important consideration for immediate recovery. Furthermore, it is necessary to regularly update and relay information on the condition of fixed assets in accordance with any improvement works carried out.

Check

Results of inspections and improvement works over the years should be analyzed to improve inspection and construction methods.

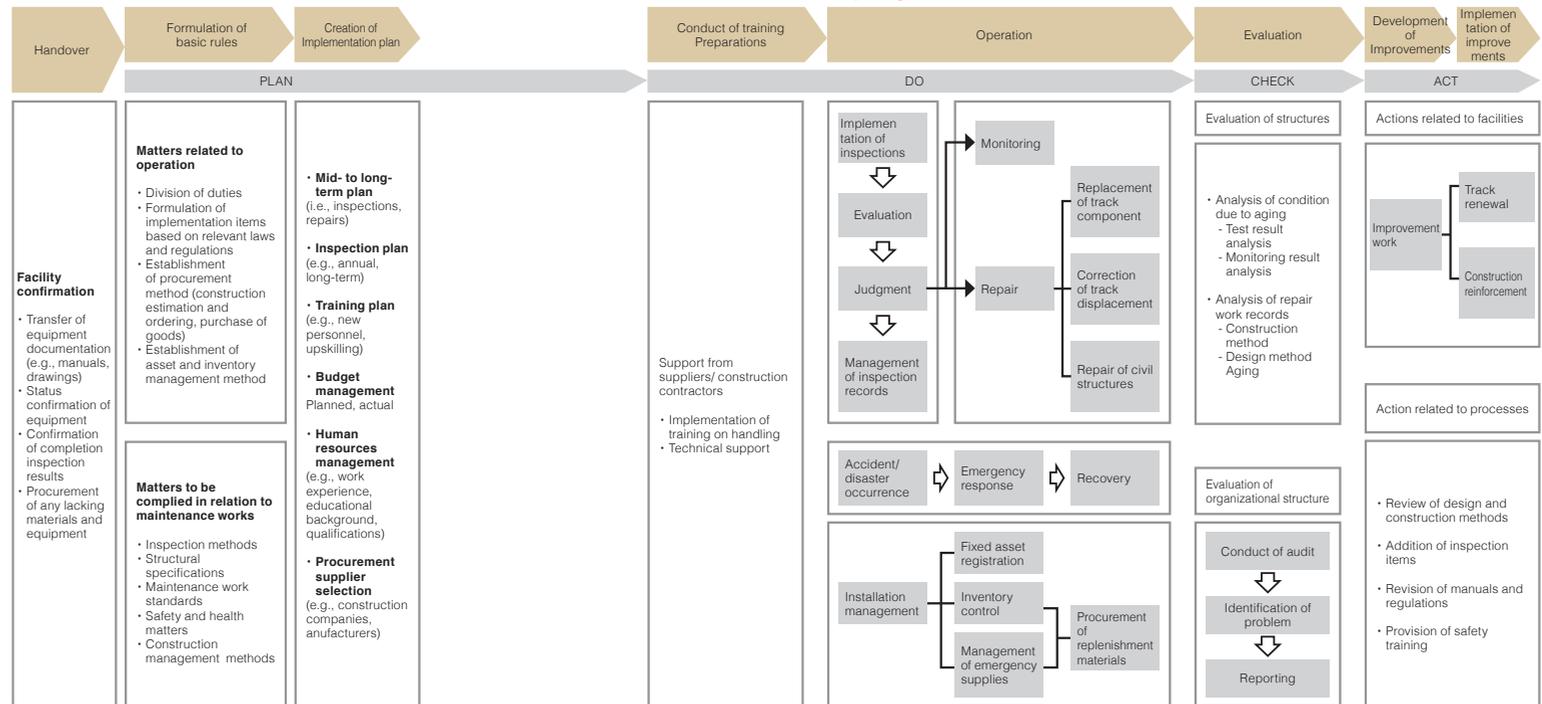
Emergency management measures are likewise analyzed in the same manner.

In relation to the organizational structure, regular internal audits by upper management and audits by relevant government agencies are done to ensure that duties are being properly carried out.

Act

If repairs are assessed as insufficient for a structure or component to function as per specifications, further improvement works are carried out: appropriate activities (e.g., assessment, work procedures, construction methods, inspection methods) are reviewed; manuals and regulations are revised; and necessary training is provided to thoroughly disseminate information updates and, in the case of accidents, prevent recurrence.

Overview of Tracks and Infrastructure Department Workflow



Rolling Stock Department

Basic Concept

Rolling stock maintenance, parts supply, equipment maintenance

Rolling stock maintenance can be divided into two (2) broad categories: (1) preventive maintenance, wherein regular inspections are performed according to a schedule; and (2) corrective maintenance, wherein repairs are performed in the event of an accident or failure. To reliably implement these maintenance activities, the following should be formulated: mid- to long-term renewal plans for rolling stock; process plans for inspections; troubleshooting and emergency management plans; and implementation system. Spare parts, special equipment, and their management are indispensable for maintenance. Furthermore, daily maintenance data are collected and analyzed to detect the early signs of failure, implement the necessary measures, and reflect these in the improvement plan.

Technical training

Rolling stock personnel (e.g., engineers, technicians) must have the necessary knowledge and expertise to carry out their respective duties effectively. This can be achieved by conducting theoretical and practical training using easily understandable training materials.

Points for Consideration

The figure below illustrates the series of activities, beginning with the receipt of the rolling stock and inspection equipment up to the deployment of improvements needed after the railway system opening.

Rolling stock inspection system

Utilizing the inspection books prepared by suppliers, the following should be prepared: regulations and manuals; inspection plans; revenue line failure response plans; and pre-opening training and other activities in preparation for conducting actual inspections. The high quality of rolling stock inspections and

troubleshooting activities must be maintained and continuously enhanced by continuously finding improvement points and making corrections even well beyond the railway system opening.

Parts supply system

Lists of parts with the necessary details (e.g., names, model numbers, quantities, replacement cycles) are obtained from the suppliers. Based on the formulated inspection plan, a procurement plan for acquisition of the spare parts necessary for maintenance and contracts with corresponding suppliers should be formalized. The control of goods and appropriate stock of spare parts are maintained based on this plan.

Equipment maintenance system

Pertinent equipment documentation is obtained from the manufacturer, and an equipment maintenance plan is developed in line with the inspection plan. Regular inspections are conducted to maintain the integrity of the equipment.

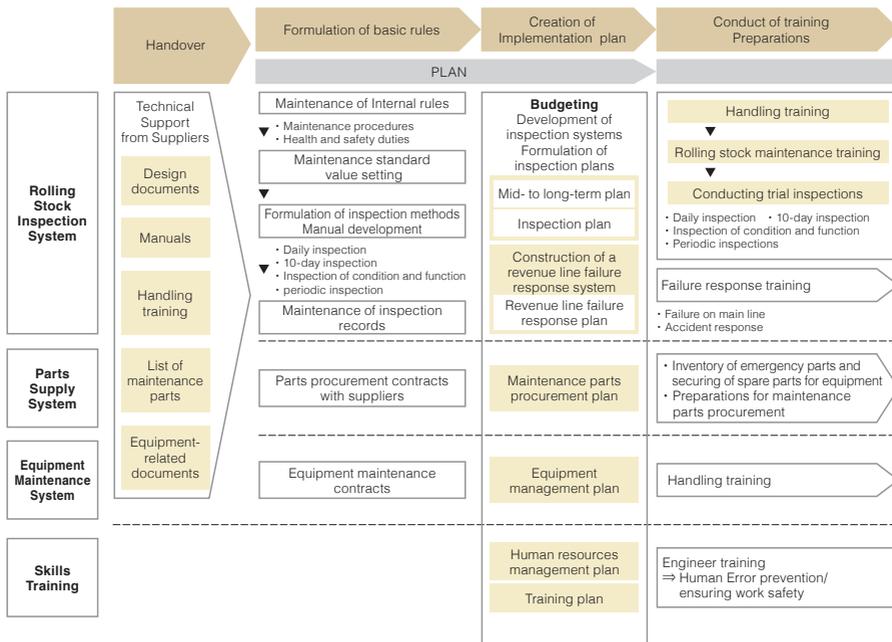
Skills training

A human resources management and training plans are formulated for the acquisition of knowledge and skills that are necessary for rolling stock maintenance. The training contents must be developed in accordance with the years of experience and level of skills of each trainee, as well as the necessary licenses for maintenance activities. For safety training, it is important to foster culture and awareness through constant repetition.

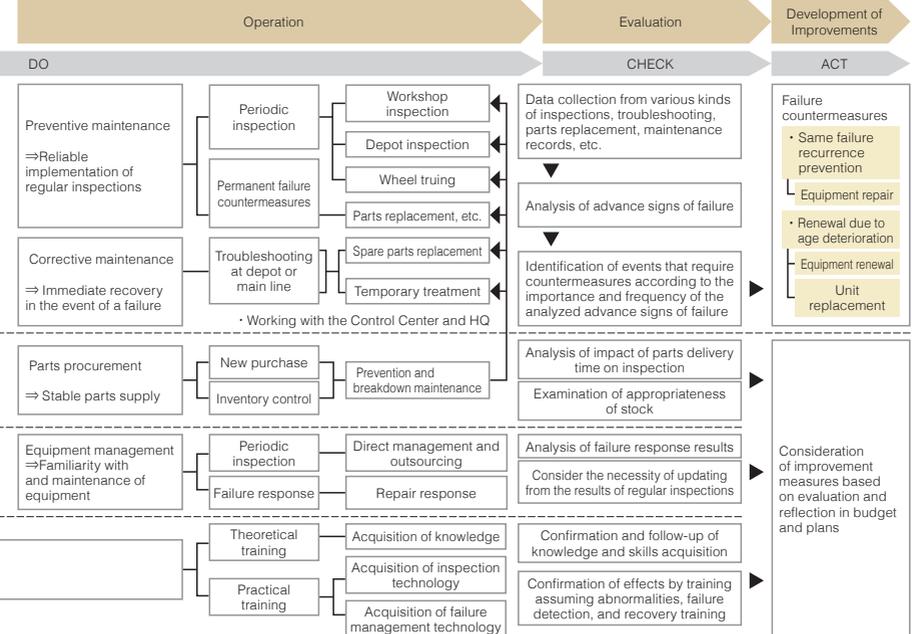
Example of Scheduled Rolling Stock Maintenance in Japan

Inspection Venue	Inspection Type	Inspection Cycle
Workshop	General overhaul inspection	8 years
	Critical part overhaul inspection	4 years or 600,000 km
Depot	Inspection of condition and function	3 months
	10-day Inspection	10 days

Overview of Rolling Stock Department Workflow



Opening



Electrical Facilities Department

Basic Concept

The Electrical Facilities Department covers a wide range of subsystems that are broadly divided into three (3) categories¹⁰: (1) **power supply and transmission to the entire railway system**; (2) **signaling and communications that ensure safe train operations**; and (3) **station facilities that passengers can use comfortably and safely (e.g., electro-mechanical facilities and automatic fare collection)**. In line with this, it is ideal to assign experts in the department to the category in line with their field of expertise and workload.

Points for Consideration

The figure below shows the basic workflow of the Electrical Facilities Department, which is common to all categories, before and after the opening of the railway system. The coverage workflow until railway pre-opening is further explained below.

Formulation of regulations

There are regulations specifically for the O&M of electrical facilities (e.g., electric power), as well as regulations that apply across different railway O&M fields (e.g., duties to be performed after the last train of the day, maintenance vehicle handling). Manuals define the procedures intended for maintenance works and applications, among others.

Maintenance system

It must cover the said three (3) categories and also include the necessary personnel and their designated duties.

OCC organization

The OCC typically has different controllers for train operation, station operation, rolling stock, and power. In line with these, the Electrical Facilities Department must establish organizations for the power controller; while establishing organizations for the facilities controller should be done in collaboration with the Infrastructure Department.

Outsourced maintenance items

Tapping outsourced technical expertise is typically in response to a need for highly specialized capabilities or cost reduction. This is required in specialized areas, particularly those that require advanced knowledge product handling skills or corresponding licenses/qualifications, such as extra high voltage, radio, PSD, and AFC. Therefore, it is necessary to confirm the existence of relevant licensing systems and qualified subcontractors in the concerned country. On the other hand, activities like inspecting lighting and replacing old equipment are outsourced to external companies. This strategy can lead to possible cost reductions as a result of improved efficiency or reduced labor costs.

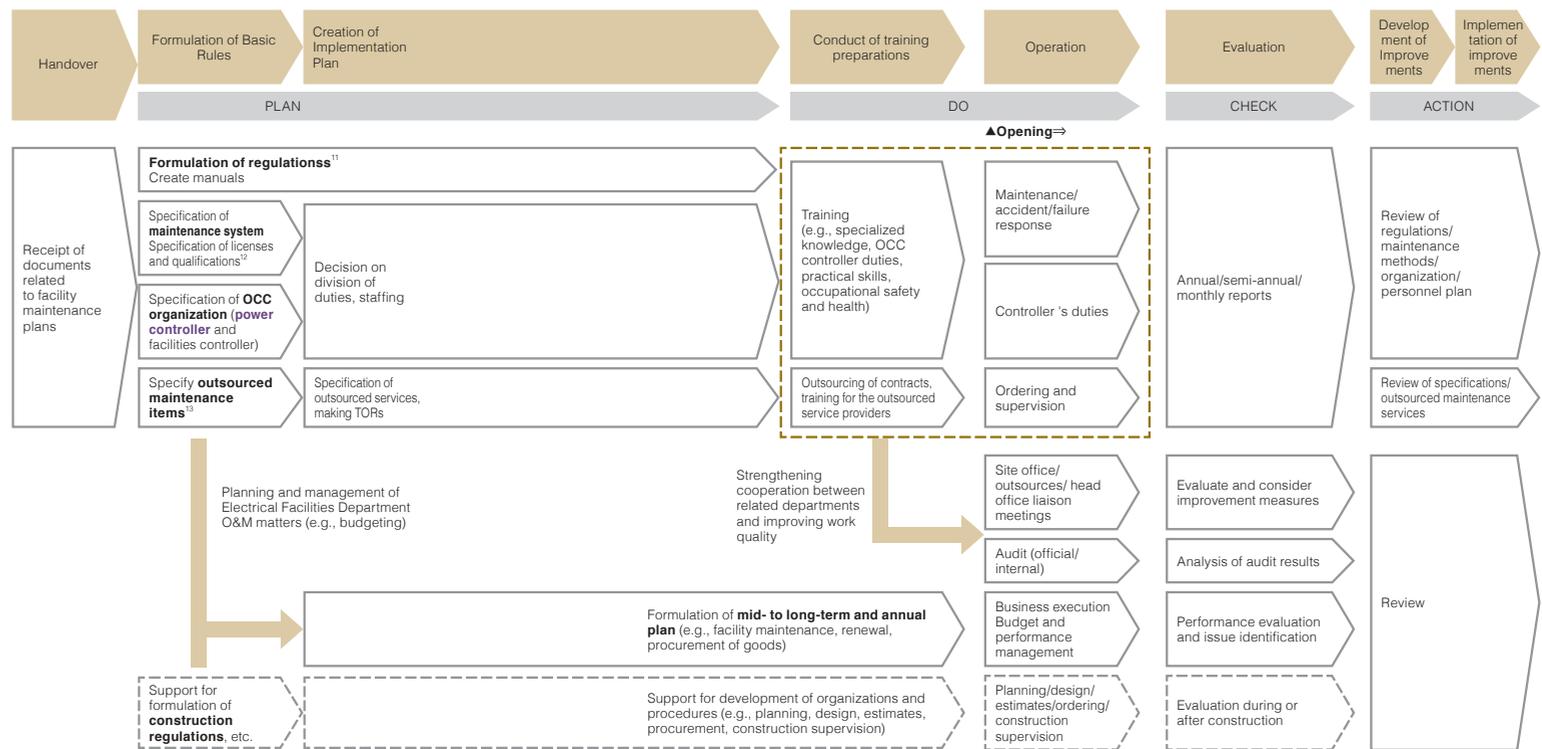
Mid- to long-term and annual plan

Budgeting plans for facility maintenance, renewal, and procurement must be formulated in accordance with the organization's mid- to long-term and annual plan also business plans, among other relevant plans.

Construction regulations, etc.

Some components, such as mechanical or storage battery equipment, require relatively earlier repairs due to faster wear and deterioration, among other factors. Support is provided in creating construction regulations that cover multiple years after the railway system opening.

Overview of Electrical Facilities Department Workflow



¹⁰ The three (3) categories are color-coded throughout the discussion

¹¹ Electrical Facilities Department alone): maintenance of electrical facilities, **electrical power operations, radio (wireless) use**; Cross-departmental: working on tracks, working on trains after operations, handling of maintenance vehicles

¹² Licenses/qualifications (e.g., **chief electrical engineer, radio use, EV/ES**, handling dangerous materials, ordinary driving license, occupational safety and health)

¹³ O&M of **extra high-voltage facilities and radio stations, maintenance of power supervisory control and data acquisition (SCADA), operation management devices and data transmission network devices**, specification of cooperating companies to undertake construction works, and other tasks. **For many station facilities (e.g., EV/ES, PSD, AFC), outsourcing needs to be considered, so it is particularly necessary to provide support for outsourcing contracts and assume that training for outsourced companies will be needed.**

Department for Cross-Departmental Integration

Basic Concept

The previously mentioned departments for the train operations, station operations, infrastructure, rolling stock, and electrical facilities carry out their respective duties, which include the management of the assets under their jurisdiction. However, passengers see the railway system as a single entity that provides transport services and not as individual departments providing individual services. Therefore, it is ideal to have a special department that is

responsible for cross-departmental cooperation by establishing goals and rules that integrate the different O&M departments. In current O&M support activities, the department for this is still unclear, so caution is therefore advised in tackling this matter.

Points for Consideration

Formulation of common departmental rules

Formulating and implementing unified rules that apply to all departments, such as safety

management and emergency management, is essential to achieving integration. Basing department regulations on these common rules can help in monitoring and traceability.

Budget management and inter-departmental coordination

Budgets required for each department are aggregated so the Budgets required for each department are aggregated to determine the overall budget for the entire organization. This integration is expected to optimize overall management of the organization and railway system.

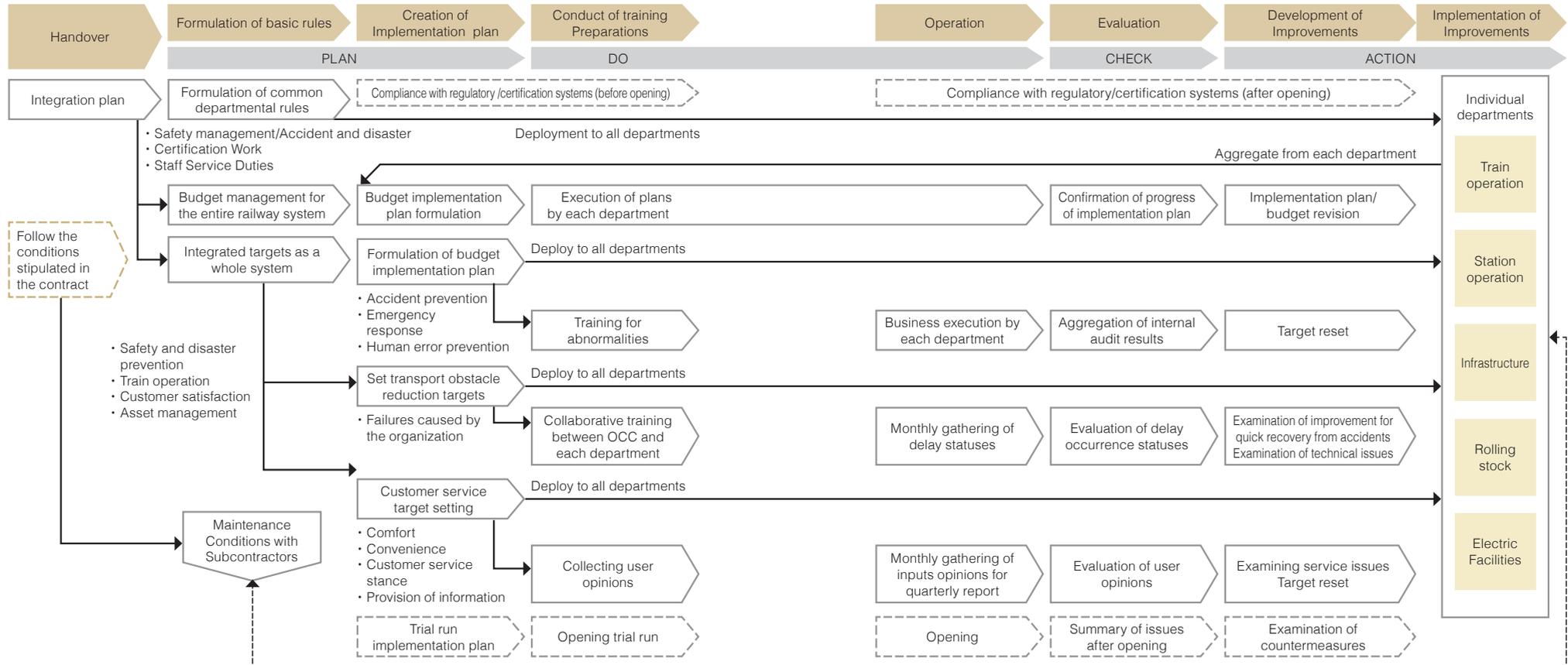
Cross-departmental integration targets

Safety targets are set for accident/disaster prevention, train operation stability, customer service improvement, and asset management quality. In this management process, activities to solve technical and service issues across departments are also conducted. It is necessary for all of the said activities to be carried out using the PDCA cycle in the same way as other departments.

Coordination of maintenance conditions and other related aspects

When outsourcing maintenance services, contract terms are negotiated. In case of newly opened railway lines, plans for overall trial runs are created.

Overview of Cross-Departmental Integration Department Workflow



Asset Management

Basic Concept

In order to effectively utilize railway assets owned by governments and other implementing entities during their useful life and maintain the financial stability of operating entities, it is necessary to support the preparation and implementation of asset management by the said entities through JICA projects. This section describes the related basic concept and points to be considered during the preparatory stages (until the GC stage) and the operational stage.

What is an asset?

This generally refers to the properties necessary for railway operations, such as stations, tracks, signaling system, and rolling stock.

What is asset management?

This pertains to the maintenance of the condition of assets at a specified level, consisting of a series of work cycles, such as planning, implementation, evaluation, and improvement.

Points for Consideration

Examination of asset management policy

The process of examining the asset management policy by the implementing entity is supported through JICA projects by presenting references on asset management work and examples. ISO 55000 (ISO55k), the international standard for asset management system, may be applied, as it is used in the railway industry. On the other hand, the Asset Management Working Group of the International Union of Railways has deemed Japan as the most certified country in 2019, so Japanese cases can be considered an international standard worth considering¹⁴.

¹⁴ While this page describes management works related to tangible assets of railway, ISO55k is a standard for asset management that includes both tangible and intangible assets (e.g., intellectual property rights).

Formulation of overall contract details

The implementing entity considers the scope of jurisdiction (e.g., scope of assets, form of ownership, business operation) of the operating entity in terms of asset management; and JICA projects support this process by providing relevant case studies from Japan and other countries.

Formulation of specific contract details

The implementing entity details contract for asset management; and JICA projects support this process by providing relevant case studies from Japan and other countries. The use of information systems can be considered in areas with concerns of staff turnover, as it is possible for business process flows to be created and a certain business operation level can be secured without depending on personnel. The said systems can be expected to keep the evidence for securing the budget with transparency and objectivity by designing appropriate information management in relation to asset management plans and achievements between operating and implementing entities.

Preparations for asset management operation

The implementing entity confirms if the preparation status of the asset management work conducted by the operating entity aligns with the contract details previously agreed upon. JICA projects provide relevant assistance in business process flow and procedures, as well as preparations or procurement activities needed for information system utilization.

Implementation, evaluation, and improvement of asset management operations

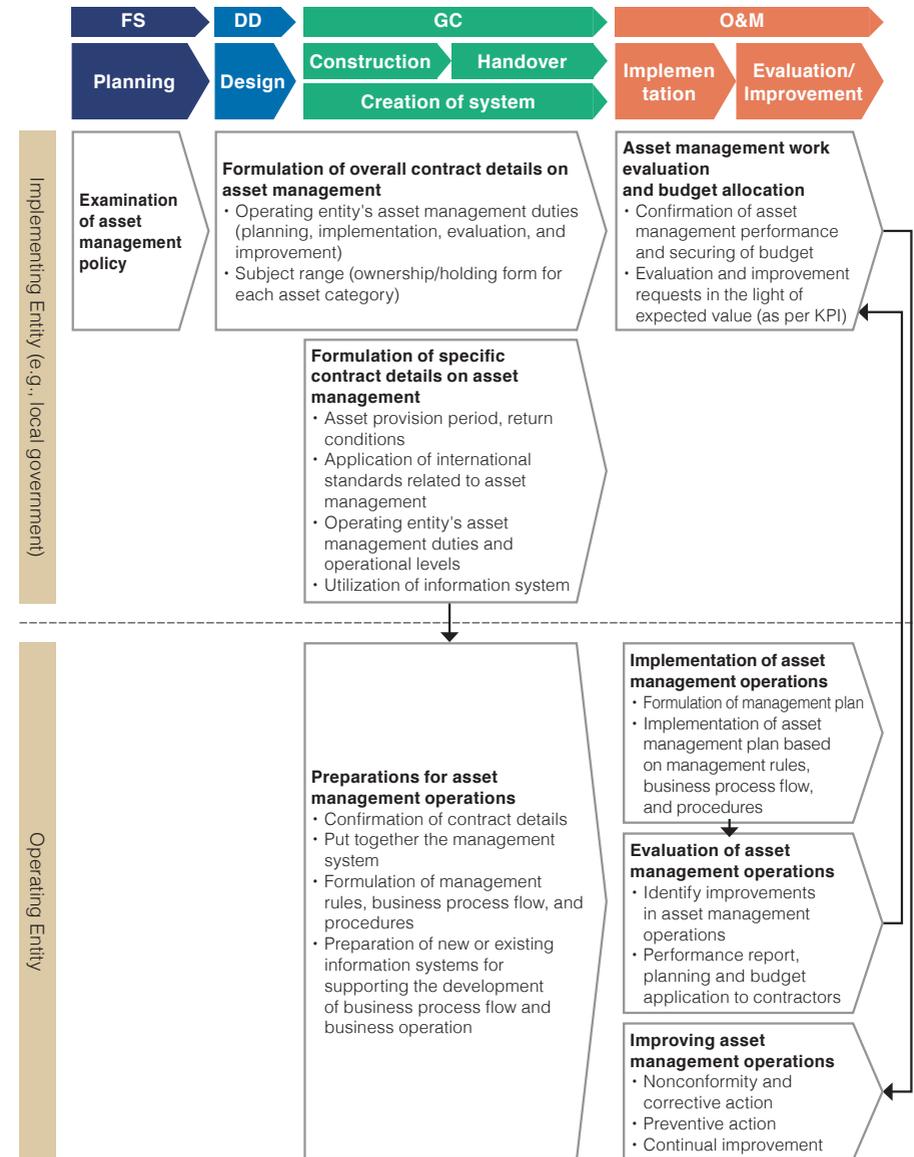
The implementing entity confirms if the operation cycle for asset management is appropriately established by the operating entity. JICA projects support this particular action by providing relevant confirmation points for the implementing entity. By using the assessment viewpoint of ISO55k, a set of confirmation.

Asset management work evaluation and budget allocation

The implementing entity regularly receives performance reports from the operating entity based

on a pre-established asset management business plan. In addition to the ISO55k assessment, JICA projects can also consider supporting other asset management activities based on the KPIs (see page 59) of the implementing entity.

Overview of Asset Management Preparations and Operations



Asset Management: Examples from Different Countries

The following are examples from Australia and the United Kingdom (UK), where ISO55k is the de facto standard in the railway industry¹⁵. In addition, the utilization status of the information systems, which is an important matter in the said standard¹⁶, is explored in this section.

Australia

A government-affiliated company owns the land, infrastructure, E&M system, and rolling stock of the Metropolitan Rail Service in Melbourne. In accordance with the O&M contract with the state government implementing entity, an O&M entity conducts their business using these assets for a certain period of time.

Content of the asset management work

The O&M entity, Metro Trains Melbourne Pty. Ltd. (MTM), has leased these assets from the implementing entity from 2017 to 2024 and are contractually required to return the assets in a usable condition by the end of the contract period. For this reason, the O&M entity formulated an asset management plan and is conducting asset renewal and maintenance work pursuant to the said plan.

Application of international standards

The implementing entity contractually required the O&M entity to obtain an ISO55k certification, which the MTM has acquired. The MTM previously obtained a PAS55 certification, which is a British Standard, the basis of ISO55k certification, and eventually transition to a ISO55k certification within the contract period. In line with this, the MTM has systematized its management regulations and business processes as a part of its asset management system framework. In accordance with ISO55k standards, the MTM performs a series of operations from planning to internal audit, as well as conducts regular performance evaluation of its asset management operations in management reviews; nonconformity items are improved, which are then reflected in succeeding plans.

Utilization of information systems

The MTM has implemented a packaged information system built around the ISO55k standard that manages pertinent information on assets leased from the implementing entity. Some of the information being managed include: registration and condition of assets and maintenance activities; acquisition price and book value of replacement and spare parts; and inventory statuses and utilization schedules of spare parts. Since the MTM and implementing entity are mutually connected to each other's asset management information systems, the said information can be immediately obtained from the implementing entity. In addition, since the data are also used for performance and accounting reports in the asset management plan, accurate information can be immediately obtained, thus enabling timely budget preparation and approval.

United Kingdom

First MTR South Western Trains Ltd. manages the assets mainly for the stations and related facilities of the South Western Railway as an O&M operating entity¹⁷. Similar to the case of the MTM in Australia, ISO55k certification is a requirement, and an ISO55k-based packaged information system is utilized.

¹⁵ This standard is used in Australia and several other parts of the world in the other fields (e.g., electric power utilities, water treatment and sewage systems) as well.

¹⁶ In ISO55k, information systems are positioned as enabling mechanisms and considered one of the most important items to address. As for the case of other railway systems overseas, adapting packaged information systems based on the ISO55k has become the conventional approach.

¹⁷ The asset management system is expected to be further reviewed by the "Great British Railways" plan announced by the British Ministry of Transport in May 2021.

Examples of Asset Management in Different Countries

		Australia	UK
O&M operating entity (Abbreviation: Lead investor)		Metro Trains Melbourne Pty. Ltd. (MTM: Hong Kong MTR 60%)	First MTR South Western Trains Ltd. (FMSWT: UK First Group 70%)
Implementing body concluding contract with O&M operator		Public Transport Victoria	Department for Transport
Name of railway line		Melbourne's metropolitan rail service	South Western Railway
Asset owner	Land	Government-affiliated company	Government-affiliated company
	Infrastructure	Government-affiliated company	Government-affiliated company
	E&M system	Government-affiliated company	Government-affiliated company
	Rolling stock	Government-affiliated company	Private sector enterprise (rolling stock leasing company)
	Stations	Government-affiliated company	Government-affiliated company (partly O&M operators)
Overview of asset management contract	Contract period	2017 until 2024	2017 until 2024
	Assets to be managed by the O&M operator	Assets owned by government-affiliated companies	Assets owned or leased by O&M operator (stations and station equipment)
	Special note	Under the terms of the lease agreement, ownership is transferred to the O&M operating entity. Upon termination of the contract, the assets are to be returned in a condition in which they may continue to be used.	<ul style="list-style-type: none"> • Collaboration in maintenance management work for assets owned by government-affiliated companies and private sector enterprises
O&M operator's asset management work	Main work contents	<ul style="list-style-type: none"> • Formulation of asset management plans • Implementation and recording of asset renewal and maintenance work 	<ul style="list-style-type: none"> • Formulation of asset management plans • Implementation and recording of equipment renewal and maintenance work
	Tasks related to budgeting for asset maintenance and renewal	<ul style="list-style-type: none"> • Mid to long-term asset management planning in line with business KPIs • Detailed annual work plan based on asset management plan (including financial plans such as for material procurement and maintenance costs) 	<ul style="list-style-type: none"> • Annual business plan for stations and station asset (including financial plans for material procurement, maintenance costs, etc.)
	Compliance with international asset management standards	Certification required	Certification required
	Systems currently in use	ABB Ability Ellipse EAM	Infor Asset Management System
Asset management information systems	Methods of use	<ul style="list-style-type: none"> • Management of asset information and work information • Information sharing with asset owners 	<ul style="list-style-type: none"> • Management of asset information and work information

Overseas O&M Projects: Implementation System and Business Development Strategy

■ O&M Implementation System per Organization

As shown in the table below highlighting related O&M case studies, even in cases where maintenance of the railway facilities and rolling stock are originally segregated, a business scheme can have actual O&M functions divided several JV member companies instead of being performed by a singular company. Pages 63 to 77 provides examples of Japanese companies.

▼ Overview of O&M Case Studies

Name of Operating Entity(Country of Origin)	Arriva(UK)	First Group(UK)	Keolis(France)	Hong Kong MTR(Hong Kong)	
O&M Implementation Cities	Netherlands	UK cities	Dubai	Melbourne	
Legal System	European certification system	European certification system	European licensing system	TSV (Transport Safety Victoria) carries out safety supervision work, in accordance with the Rail Safety (Local Operations) Act 2006 (Vic).	
O&M Implementation System	Arriva formed a JV with a local small railway operator (Openbaar) and is responsible for train operation and rolling stock procurement. Infrastructure maintenance is handled by Prorail.	Only the train operation business is conducted, and infrastructure maintenance is handled by Network Rail, and rolling stock procurement and maintenance are handled by ROSCO (a vehicle leasing company) and the rolling stock manufacturers.	Carries out Dubai O&M business in a JV with a Japanese company. Keolis is in charge of the train operation business, and maintenance is handled by MHI.	Melbourne O&M work carried out in collaboration with local companies John Holland and UGL. Equipment maintenance is handled by John Holland and UGL.	
Business Scheme					
Business Scheme Framework	Public investment/gross cost	Public investment/gross cost	Public investment x gross cost	Public investment x gross cost	
The general trends of each company are described below.		The general trends of each company are described below.		The general trends of each company are described below.	
Risk Management	The company has offices all over Europe involved in the operation of large coaches. The company has extremely knowledgeable about the regulatory requirements of each country and have systems in place that can respond to concerns promptly.	Management is conducted based on franchise contracts. ¹⁸	Considering the acquisition or future acquisition of an existing local railway operator, the company initially plans to form a partnership ¹⁹ to avoid escalation of its own risk.	The Melbourne O&M business uses a risk sharing method with the ordering party. The operator takes the risk related to the upper and lower limits of the agreed upon fare income plan. Burdens in excess of these limits is split between the state government and the operator.	
O&M Business Development Strategy	They conduct their bus operation business first, and acquire knowledge about target destinations. As a JV participant in the railway business, the company further grows their business by acquiring local companies.	Currently working to maximize profits within franchise agreements. ¹⁸	In addition to the home base, France, the company aggressively pursues business opportunities in other European countries and in the US, Middle East, and Asia. They implement extensive training in-house. Through this transfer of knowledge to their employees, they are conducting O&M operations in various regions across 14 countries.	The focus is on projects where they can operate and maintain existing routes with relatively small investments, even if the profit margin is not high.	

■ O&M Business Development Strategy

It appears that the trend for developing O&M businesses is that these are mainly structured without large asset holdings, but are more based on the acquisition of local knowledge and the continuous capacity advancement of personnel responsible for the O&M operations. Under this this kind of business model, while the profit margin is considered low (around 2-3%), the risk margin is likewise considerably small. Such model also features a more stable cash flow — one of the important considerations for O&M businesses.

¹⁸ Contract details are expected to be revised in the future due to the “Great British Railway Plan” announced by the British Ministry of Transport in May 2021.

¹⁹ Keolis Netherland (Netherlands), Keolis Norge (Norway), Keolis Denmark (Denmark), among others, are possible.

European Authorization and Certification System

■ European System

Distinct from the Japanese practice, the third-party certification body under this system involved in the authorization and certification proceedings follows the European custom. Risk-based explanations and certification body reviews are fundamental for this style. Such system is highly applicable for instances wherein authorization and certification systems are within the purview of regulatory entities that cannot secure evaluation skills and resources. The practice of this system is found in various countries and regions, such as Southeast Asia. The flow of the European-style of authorization and certification is shown in the figure on the right. From the perspective of a donor country, if there is already an existing railway project funded by another country, it is necessary to pay attention to the trend of the licensing system in the recipient country concerned.

■ Adoption in Vietnam

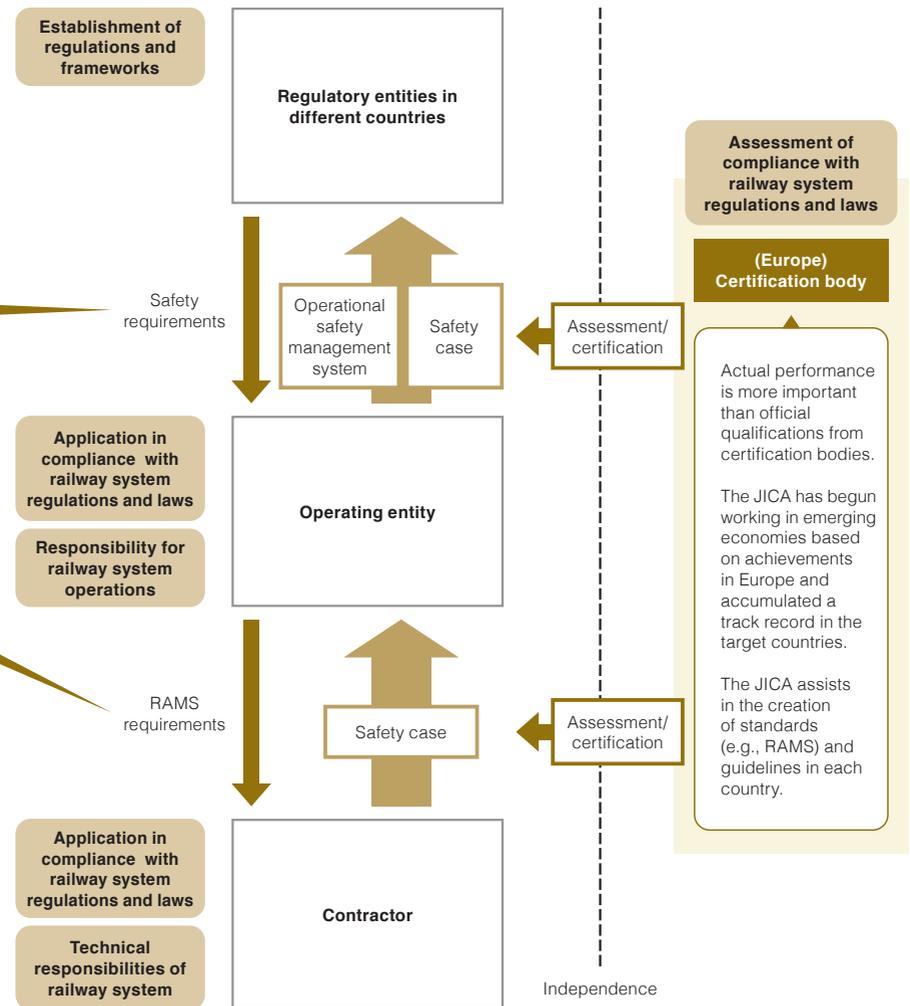
Issued in 2016, a ministerial ordinance entitled "Regulations on Assessment and Certification of Urban Railway System Safety" requires measures based on risk assessments to be carried out in relation to the railway system and its operation. Furthermore, it requires that the response is appropriately assessed by a certification body. As described above, the European-style authorization and certification system is a major prerequisite for the introduction and operation of the railway system.

■ Japanese System

Evaluating a railway system using the Japanese system entails performing design validation based on Japanese design standards (e.g., rolling stock, infrastructure, and electrical structural implementation). This method involves checking the structures, functions, and performance of equipment against design standards; and it requires significantly fewer

documents compared to the European system. However, if the railway system is using the Japanese system but the licensing framework is patterned after the European system (or vice versa), the actual implementation of different regulations and standards will be highly challenging to manage.

▼ Flow of European-Style Licensing in Emerging Economies



There may be cases wherein the recipient country's laws stipulate requirements for railway O&M or safety evaluation is stipulated in project implementation. As to safety and performance requirements for railway systems, there are cases wherein conformity to standards related to Reliability, Availability, Maintainability, and Safety (RAMS; e.g., IEC62278), submission of documents, and assessment by a certification body are also required. As for O&M requirements for railway systems, the establishment of an operational safety management system is required in Europe, which has been similarly adopted in Vietnam. There is also a possibility that this trend will spread among emerging economies in the future.

The requirements for operation safety management system is directly carried out by the operating entity; while contractors are required to meet the safety and performance requirements of railway systems based on the risk assessment, as stipulated in RAMS-related standards. Contractors submit a document called safety case after being assessed by a certification body, as necessary.

■ Key Points for JICA Project Utilization

The use of the certification body is a major premise, so it is essential to remember conducting project management that is in sync with the licensing process; scheduling must take into consideration the necessary interaction with the certification body. In some cases, certification bodies participate in sharing recommendations, conducting training, and preparing guidelines with regulatory entities. When it is necessary to comply with the certification or licensing based on the European standard, it is crucial to show that the design development and operations are based on risk

assessments; as such, numerous documentary requirements need to be submitted to the regulatory entity. In addition, it is necessary to show to the certification body that the risk can be appropriately mitigated in the various phases of design and development; as such, the resulting costs tend to significantly increase. Given these points, it is important to properly understand the goal of authorization and certification because the licensing cost will be high if this is not properly studied at the FS stage.

Key Performance Indicators

■ Kinds

There is a wide range of KPIs related to O&M, as seen in the figure on the right, which include those related to operations (e.g., safety, punctuality), customer satisfaction, assets (e.g., rolling stock, station facilities), personnel, and social impact (e.g., environment, corporate social responsibility).

■ Role

There are some cases wherein KPIs are stipulated in the O&M contract; while in other cases, these are set by the operating entity. The role of KPIs is to serve as a baseline for service levels and O&M performance, as well as a criteria for awarding bonuses or penalties based on the attainment of this baseline if stipulated in the contract. If set by the operating entity independently, KPIs can also help with the improvement of O&M performance and management.

■ Sample Application

An example of KPI application overseas is Hong Kong MTR's use of KPIs as a tool and evidence of social contributions (e.g., inclusion of KPIs in sustainability reports) to countries in which it invests. Aside from business use, KPIs are also utilized for index fare adjustments.

■ Sample Definitions, Formulas, and Specific Numerical Values

Often used as the basis for awarding performance bonuses or imposing penalties, reliability and punctuality can be defined as the ratio of trains running in accordance with the set timetable and ratio of arrivals within a given lead

time from the specified schedule in the timetable, respectively.

Since there are variations in KPI calculations, a standard formula is not presented; however, some examples can be seen below.

Reliability (Train Operation Rate)

= (actual number of running trains) / (planned number of running trains) x 100

Punctuality

= (number of passengers when train arrival is delayed within given lead time) / (total number of passengers) x 100

■ Definitions of Punctuality

There are many different considerations when defining punctuality as a KPI. One such definition is whether the train arrives at the terminal station within five (5) minutes of the scheduled time or through assessing train arrival delays at a station under observation. In some cases, reference values are adjusted based on the specific trains and lines involved.

For cases where punctuality is assessed only at specific stations, there are instances wherein trains tend to skip stations to improve punctuality. In this case, customer satisfaction surveys come into play.

In addition, there are cases wherein electricity consumption per mileage and CO₂ emissions per passenger-kilometer are used as KPI for social impact.

Note that it is important to properly indicate the preconditions and definitions when explaining the quality of O&M using these KPIs.

■ Key Points for JICA Project Utilization

As overseas operating entities use KPIs

related to railway operations mainly as sales and marketing tools, these KPIs can be useful in quantitatively demonstrating the benefits of JICA's assistance to recipient countries by measuring KPIs at fixed points within JICA's O&M activities while gathering and utilizing relevant data.

It is important to set appropriate KPIs while considering the overall condition

of the recipient country. It is more likely to establish a clear roadmap for O&M support by utilizing a set of KPIs. Deleted – this was already covered in the previous paragraph.

This is with the assumption that this is a sample definition, as the definition is the more standard definition of reliability.

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▼ Examples of O&M-related KPIs

