# Part III

## Recommendations for Further Actions toward M-MAP2

# 1. Overall Roadmap toward M-MAP2 Formulation

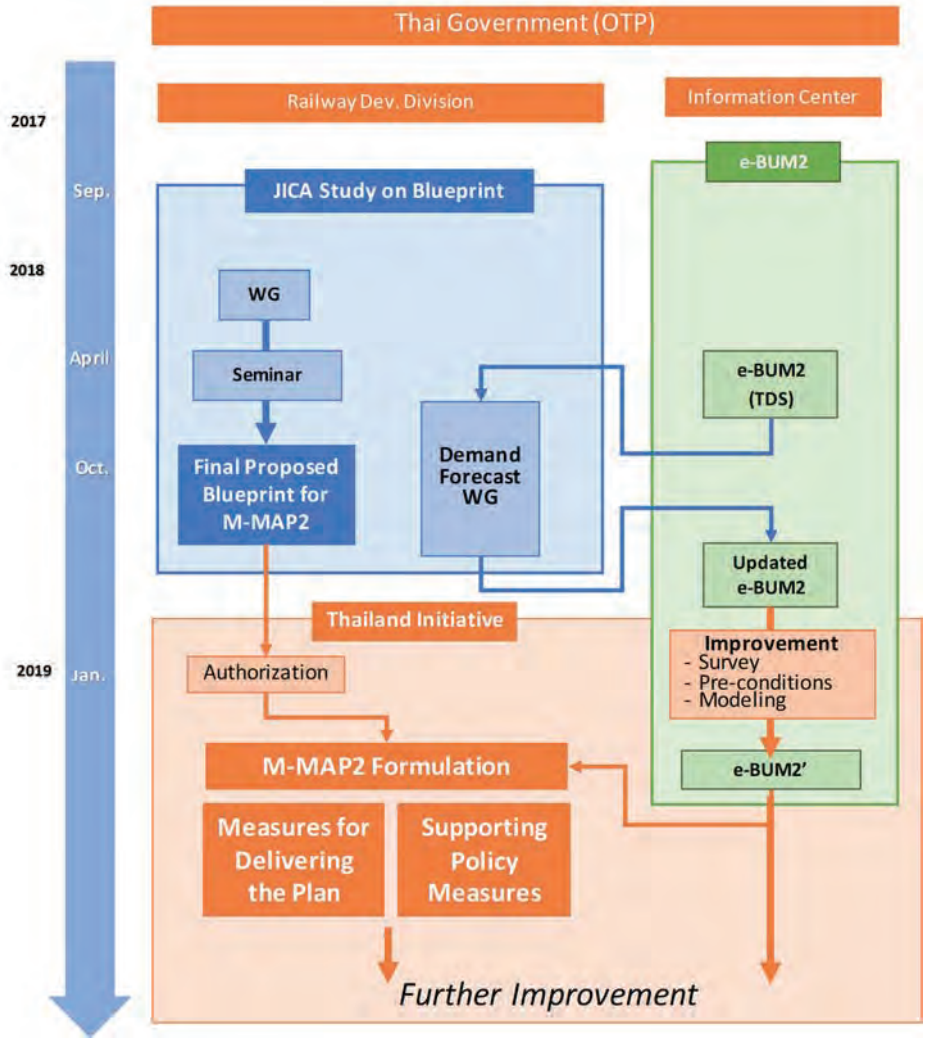
OTP and JICA Study Team started Data Collection Survey on the Development of the Blueprint for the Second Mass Transit Master Plan (M-MAP2) in September 2017. During the course of the Study, JICA Study Team and OTP has analyzed existing issues and identified core development policies of urban railway development in the BMR. Based on the data analysis and result of the discussion, the draft Blueprint for the M-MAP2 (M-MAP2 Blueprint) was presented.

After M-MAP2 Blueprint (Part I) was presented to the public in the seminar "The Blueprint for the 2nd Bangkok Mass Rapid Transit Master Plan (M-MAP2)" in April 2018, the Final M-MAP2 Blueprint was officially submitted to OTP and Minister Arkhom in October 2018. It was submitted to the Land Transport Committee in December 2018 and has been approved in January 2019.

Demand Forecast Sub-Working was established in May in order to discuss issues of traffic demand forecast in the BMR (e-BUM2) and to identify issues and necessary improvement together with academia both of Japan and Thailand. Through a series of sub-Working Group meetings, a long list of necessary improvement was identified, including improvement necessary for M-MAP2 and tasks for future improvement, while some of immediate improvements have been made by Thai Academia and Consultant Team.

Therefore, based on the M-MAP2 Blueprint, OTP-MOT will formulate the M-MAP2 and further examine the measures for the delivering the plan and supporting policy measures. Based on the recommendations suggested through discussion in the Demand Forecast Sub-Working Group, it is expected that OTP-MOT will continuously improve demand forecast model by involving Thai Academia.

Overall framework of M-MAP2 Blueprint and Demand Forecast Sub-WG and expected future actions under Thailand initiatives are shown in the Figure 1.1.




Note: M-MAP: the first mass rapid transit master plan which has been in-active since 2010.
Blueprint for the M-MAP2 : the policy directions proposed by JICA (this study), which will be further discussed for actual M-MAP2.
M-MAP2: the future mass rapid transit master plan
e-BUM2 (TDS): the demand forecast model, so called "the extended Bangkok Urban Model 2 (e-BUM2)" which was updated in early 2018 in Travel Demand Survey (TDS) project.
Updated e-BUM2: the e-BUM2 which is updated in this study with M-MAP2 Blueprint.
e-BUM2': revised version of the updated e-BUM to be developed by Thai side based on the recommendations of the JICA Study

**Figure 1.1 Overall Flow of the M-MAP2 Blueprint and e-BUM2 update**

# 2. Continuous Improvement of Demand Forecast Modeling for Scientific Planning

The result of the Demand Forecast Sub-WG will be further elaborated by OTP and be utilized to formulate the M-MAP2 and development plan of each future railway line under M-MAP2. To this end, it is highly expected that the continuous improvement of such demand forecast model be pursued utilizing this Demand Forecast Sub-WG structure driven by OTP and involving Thai academia.

During the course of the Demand Forecast Sub-WG, the overall framework and detail modeling structure of existing e-BUM2 and its result of demand analysis were reviewed carefully and shared with OTP, Thai Academia and Thai Consultant Team. After that, current issues of the existing e-BUM2 were identified, based on which a long list of improvement of the e-BUM2 was proposed as shown in Part II. The long list of improvement has been categorized into three types, namely (i) immediate improvement, (ii) improvement necessary for e-BUM2', and (iii) future improvement.

First one "(i) immediate improvement" has been completed as the updated e-BUM2 during the Study, which is summarized in Part II. Second one "(ii) improvement necessary for e-BUM2'" includes revisions with high priority and are expected to be revised in the short-term as e-BUM2' by Thai side so that M-MAP2 can be formulated based on the e-BUM2'. Proposed scope of works for the revision are proposed in Table 2.1 and Figure 2.1. Regarding the third one "(iii) future improvement", it would involve higher technical challenges which require long time. However, it is important to discuss and examine those issues continuously.

**Table 2.1 Proposed Scope of Work for the Revision of Demand Forecasting Towards M-MAP2**

| |
|---|
| **1. Revision of the Survey Area** |
| Since the study area of the model are not matched with the planned /targeted area of the M-MAP2, a suitable study area could be determined based on the proposed route in the M-MAP2 and the present and the future trip characteristics. Furthermore, access traffic to the airports and the major train stations will be determined by assigning a special zone for these major hubs. |
| **2. Implementation of The Additional Survey** |
| **2.1 HIS** |
| 2.1.1 Additional HIS |
| Since the current sample rate is only 0.3%, the concern regarding the accuracy has been raised. The rate of 5% is suggested, or at least, the rate of 1% need to be achieved. The low answer rate in the private trip purpose has been reported in the previous survey. The survey method to obtain the best answer need to be further considered. |
| 2.1.2 Data Analysis |
| Based on the HIS survey data, the trip characteristics in the BMR can be analyzed. Especially the modal split model, for each modal selection, what is the travel O-D pattern, and what kind of people are choosing, can be analyzed. This database is also one of the main requirements to determine the structure of modal split model. |

### 2.2 Survey on an Access to Major Transport Hub

To understand the situation of the movement to/from outside study area, a traffic count survey and O-D interview survey at the major transport hub such as Don Mueang Airport, Suvarnabhumi Airport, and Bangsue Station need to be conducted. As a result, the estimation of O-D table can utilize this database for higher accuracy.

### 2.3 Stated Preference (SP) Survey

2.3.1 Implementing SP Survey

SP Survey can be considered as a major requirement for the restructure of the modal split model and the railway (public transit) route assignment model. In SP survey, the main goal is to determine the value of time (VOT). However, not a general VOT, but the VOT of each trip component, such as waiting time, transfer time, as well as willingness to pay for comfortability need to be considered. To distinguish the characteristics of the people's behavior, analysis could be done separately between the captive and the selective group, so the survey should also take this into consideration. Also, the design of questionnaire should be considered so that the respondent can easily understand the question and answer with ease.

2.3.2 Data Analysis

The VOT of each trip component and the data of the captive and the selective group can be utilized as a database for the restructure of the modal split model.

## 3. Revision of Demand Forecasting Pre-conditions

### 3.1 Traffic Analysis Zone Revision

The traffic analysis zone at present does not reflect travel characteristics of some area. The large number of zones will take long time to caluculate the demand. Therefore it is required to revise zoning. Zoning can be based on the following considerations

- Area of zone should be determined based on similarity of the socio-economic characteristics.
- Since zoning should be able to describe the competition among railway lines and stations, one zone should have at most one station. In other words, a zone with more than two stations should be divided into one zone-one station.
- Calculation time can be main consideration to determine the number of zones.

### 3.2 Modal Classification

Since modal share of some modes are very low, classification of the transport mode should be reconsidered based on the following criteria

- Similarity in level of service (LOS)
- Modal Share (the modes with very low modal should be grouped as "others")

### 3.3 Transport Network

3.3.1 Road Network

Road network should be set based on several considerations such as competition between modes and routes, and access link to the station. Future roads should be also considered as additional links at the different time frame.

3.3.2 Bus Network

The current information on the bus network is still unclear. Further confirmation is needed and, if necessary, the bus network in the demand forecast should be revised based on the actual network.

### 3.4 LOS Setting

**Road**

In order to evaluate a variety of transport policies, the demand analysis models should be able to incorporate costs such as travel (fuel) cost, toll cost and parking cost in LOS calculation. Furthermore, the model should be able to incorporate a vehicle cost (cost paid to buy a vehicle) as one of the vehicle user cost if it is necessary, considering the model structure.

**Bus and Paratransit**

The current information on the bus network is still unclear. Further confirmation is needed and, if necessary, the bus and paratransit LOS for demand forecast should be further revised.

**Railway**

In order to evaluate a variety of fare policies, zonal fare system and additional charge at the designated section should be calculated.

## 4. Reproduction of the Current O-D Table

Based on the result of the updated HIS in 2.1. and the result of surveys in 2.2, O-D table can be estimated. Estimation method should be further discussed to improve the accuracy of the estimation. For example, the O-D table will be e estimated by using traffic count data.

## 5. Revision of Demand Forecasting Model

### 5.1 Review of Demand Forecasting Methodology

The review of the latest methodology on the related topic researches such as estimation of population, including land use model and travel behavior model should be conducted. These reviews will be utilized for the model restructure process.

### 5.2 Review and Revision of Demand Forecasting Model

5.2.1 Model Structure Overview

Based on the methodology used in the previous model along with the reviewed method from researches, the overview of the model can be considered.

5.2.2 Estimation of population

In the existing e-BUM2, forecasted population data was distributed to the TAZs based on the land use plan. As a result, future population density in some area is lower than the existing one. It is found that reliance only on the land use planning data is not sufficient for population forecast. Therefore, more disaggregate data should also be considered. Housing and condominium loan or building management data, the business registered and social security data registration could be used for the estimation of population. As the land use data, the available of land use statistics data or satellite image data should be also checked.

5.2.3 Generation/Attraction Model

Since Furness Method does not represent a realistic result as it is based only on the constraints in each category to reconcile the data. The model should be revised so that the number of households by the number of members and number of vehicle ownership can be calculated by a regression model. Furthermore, the trip rate should be revised based on the additional HIS mentioned in 2.1. After the revision, the accuracy of the traffic volume reproduction should be checked.

5.2.4 Distribution Model

In general, distribution model can be conducted based on the current travel pattern method. Revision can be further made if necessary after more review.

5.2.5 Modal Split Model

**Model Structure**

Since the present model cannot evaluate some policies, the more accurate modeling is required. The following conditions are needed for model restructuring:

- The model should be structured with the consideration of the present and the future modal conditions, especially the competition among modes should be reflected in the model.
- The explanatory variables such as onboard time, access/egress time and cost, transfer time, etc., should be included in the modal choice model. Not only that, based on the parking policy, the parking fee should be included in the model too.
- The model should be able to forecast the result by each hour of day. However, it is not required to forecast the demand by hour directly. It is also possible to calculate based on the traffic volume share by hour from O-D table.

**Model Validation**

The validity of the model can be checked based on the following validation examples:

- Based on the statistical index
- Estimated parameter should be reasonable, especially VOT
- Validate the model sensitivity by checking how much the modal share will change if LOS between zones has been varied. The rate of change must be within a reasonable range. For example, if the travel time is shortened only for 1 minutes, the share of its mode will increase by 50%, which can be said unreasonable.
- Consider the modal share in each zone. For example, it is expected that modal share of railway in the zones along railway lines will be higher. Thus, the result from modal split model in these zones can be checked.

## 5.3 Railway or Public Transit Route Assignment Model

The route assignment model should be able to reflect the competition of each railway or public transit routes. Furthermore, the scale of forecasted demand can be validated by checking the characteristics of railway lines (distance, existence of competitors etc.) and population along railway lines.

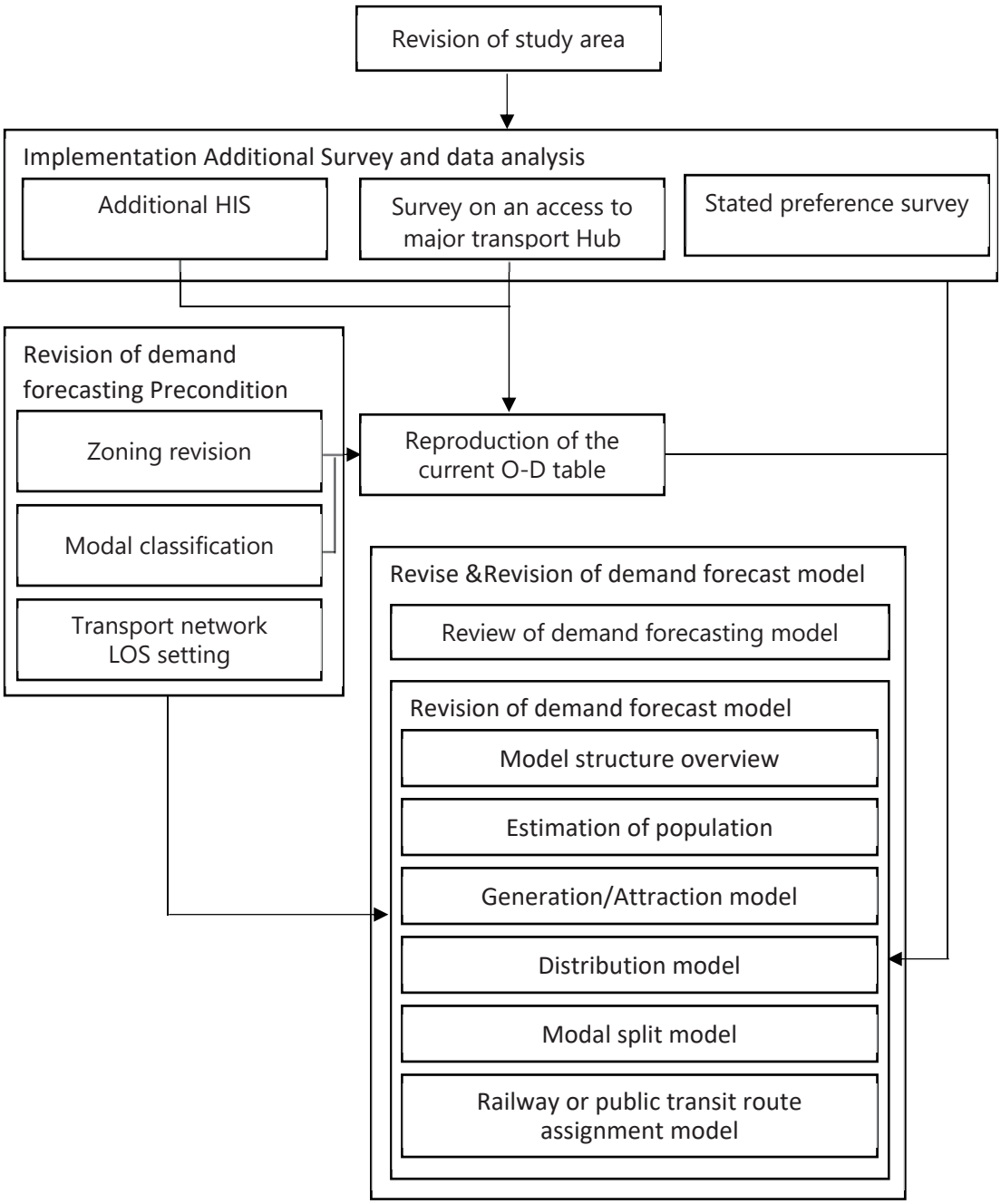



**Figure 2.1 Overall Flow for the Revision of Demand Forecasting Towards M-MAP2**

It is ideal to complete revision of all the scopes listed in Table 2.1 to fully improve the updated e-BUM2 as e-BUM2' to analyze modal shift more appropriately and thus to be used for the formulation of M-MAP2. However, some of the scopes may take long time and large input of expertise. Therefore, it is recommended to discuss with Thai Academia to prioritize scopes and identify necessary scope of the works depending on available time and budget in order to realize timely start of M-MAP2 formulation.

Demand forecast modeling needs to be upgraded continuously in parallel with planning work. In other words, next planning work, i.e. M-MAP2 formulation, will provide further issues of demand forecast modeling. For example, demand forecast modeling of the Tokyo Metropolitan Region has been continuously revised. In other words, lessons learned from the course of the planning process to formulate Railway Development Master Plan are

reflected in the subsequent revision of the plan. Like this, it is expected to identify future improvement issues from the planning process of the M-MAP2.

## 3. Structured Dialogue among Government, Operators and Academia for Policy Making

It is strongly recommended to establish a committee, e.g. Committee for Urban Railway Development", as a platform not only for current analysis and discussion but also for making a common understanding and decisions on urban railway development, as suggested in the Chapter 6 of Part I. Such committee can discuss railway master plan, development plan of each railway line, demand forecast for those planning, railway operation, access to the stations, integration with other public transport, and any other issues related to urban railway development. The expected members of the committee are as following;

- **Government agencies:** OTP as a planning agency, MRTA and BMA and SRT as railway developers, DPT and BMA as regional and urban planning agencies
- **Local Administrative Organizations:** 5 Provinces of BMR, major municipalities along urban railway, such as Nonthaburi, Pak Kret, Samut Prakan, etc.
- **Railway operators:** BEM, BTSC, SRTET
- **Academia:** transport planning experts, financial and economic experts, public policy experts
- **Consultant:** transport consultant

During the course of the Demand Forecast Sub-WG, expected roles of relevant parties have been discussed and recognized among those stakeholders. While it focused on demand forecast specifically, the necessity to discuss and make a mutual understanding among key stakeholders has been also well recognized. It is expected to maintain the Demand Forecast Sub-WG as a part of Committee for Urban Railway Development.

## 4. M-MAP2 Blueprint Core Policies Implementation

As described in the Part I, the M-MAP2 Blueprint has proposed overall direction and five key policies for mass transit development in the BMR as shown in Figure 4.1.

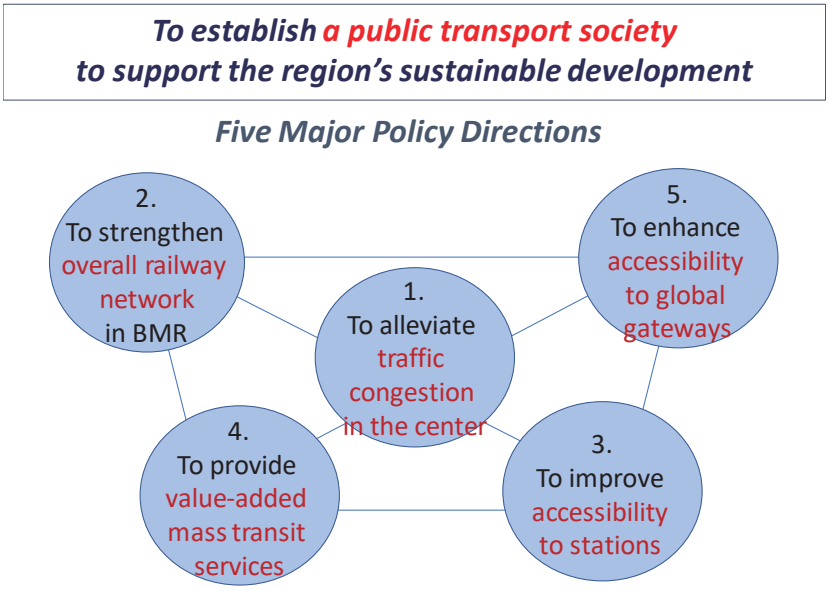



**Figure 4.1 Policy Directions for Mass Transit Development in BMR**

Since the M-MAP2 Blueprint has been approved by the Land Transport Committee in January 2019, it is important to discuss how to elaborate the proposed Blueprint policies among relevant authorities, such as OTP, railway development authorities, railway operators, urban development agencies and identify how, when and which agency will be in charge of implementation of key policy measures proposed in the M-MAP2 Blueprint. The proposed key measures are summarized in the Table 4.1.

**Table 4.1 Key Measures Proposed in the M-MAP2 Blueprint**

| Policy Directions | Key Implementation Measures |
|---|---|
| 1. To alleviate traffic congestion in the city center | A) Capacity expansion of the existing mass transit lines<br>B) Ensured implementation of the planned mass transit routes (M-MAP)<br>C) Additional line development in the railway-missing areas<br>D) Strengthening of multi-modal public transport network with bus transport, river transport, etc. |
| 2. To strengthen overall Railway Network in the BMR | A) To develop mass transit lines to the corridors with high demand<br>B) To develop mass transit lines to link sub-centers<br>C) To utilize the existing SRT lines and connect with mass transit network<br>D) To strengthen transport terminals |
| 3. To improve accessibility to the stations | A) To develop inter-modal facilities; terminal or parking spaces for feeder mode, parking spaces for private vehicle, pedestrian access<br>B) To provide safe and comfort feeder transport services<br>C) Integration with surrounding urban development at station area |
| 4. To provide value-added mass transit services to | A) Information provision on railway services for passengers<br>B) Flexible fare setting<br>C) Safety and amenity facilities |

| | |
|---|---|
| promote public transport | D) Express operation<br>E) Business-class train cars |
| 5. To enhance accessibility to global gateways | A) To develop alternative routes to access international airports<br>B) To reduce access time (express operation, etc.) |

While some of the above implementation measures require detail analysis under M-MAP2, other measures can be implemented for the short-term as below.

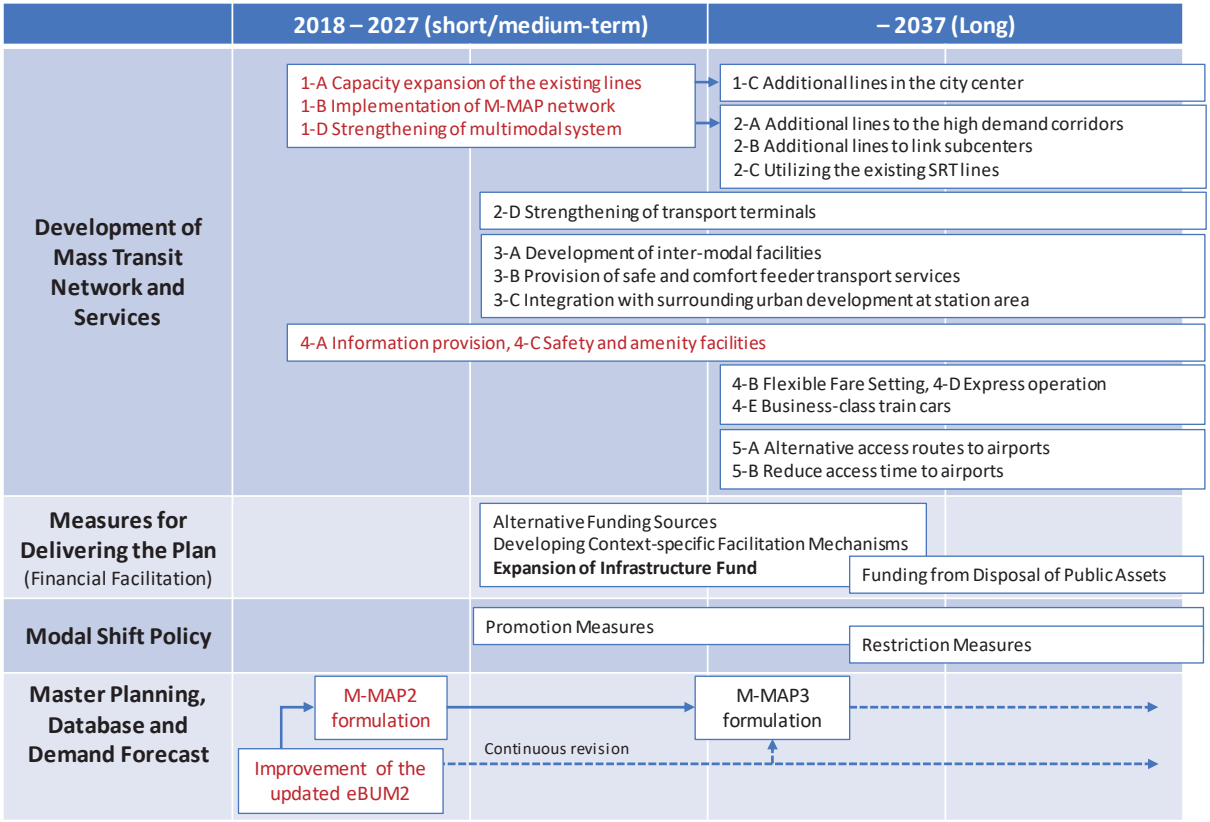
- **Value added services:** Information provision on railway operation and services by railway operators (BEM, BTSC, SRTET) and government authorities (MRTA, BMA, and OTP), installment of safety and amenity facilities by railway developers/operators (MRTA-BEM, BMA-BTSC, SRT-SRTET)
- **Modal Shift Measures:** Promotion of public transport by railway operators and government authorities (MRTA-BEM, BMA-BTSC, SRT-SRTET, OTP)

On the other hand, restricting measures may adversely affect mobility of people who live far from urban railway stations. In other words, those measures can be implemented for the long-term, once the public transport network is well developed.

While new line development requires M-MAP2 plan based on the demand forecast, some of hard ware development can start in the short-term as below;

- **Capacity expansion of the existing railway lines** (OTP, MRTA-BEM, BMA-BTSC, SRT-SRTET): OTP should evaluate congestions of the existing lines during peak hours appropriately and examine additional capacities required to keep the certain level of railway services. OTP should coordinate and negotiate with railway developers and operators to consider possibilities to increase transportation capacities of existing lines.
- **Strengthening of multimodal system (OTP, BMA)**: OTP and BMA should conduct joint-survey on comprehensive urban public transport network and to identify possible measures to integrate bus network and ferry network with railway development.

Figure 4.2 shows the schematic implementation schedule of the proposed components of the M-MAP2 Blueprint.




Source: JICA Study Team

**Figure 4.2 Schematic Implementation Schedule of the M-MAP2 Blueprint**

# 5. M-MAP2 Formulation

Based on the proposed M-MAP2 Blueprint, the M-MAP2 itself will be formulated by Thai side. The analysis for the M-MAP2 will be supported by the eBUM2', which is expected to be updated by Thai side as described in Chapter 2, based on the result of Demand Forecast sub-Working Group, composed of the OTP, members of the Thai academia, JICA Study Team, and others.

Detail scope and process to formulate the M-MAP2 is described in the Figure 5.1. Some of tasks, particularly for preparation works, have been discussed during the course of JICA Study to prepare the M-MAP2 Blueprint, however, it is important for OTP to make consensus on the basic conditions such as key planning issues, coverage of the plan, target of the plan with relevant agencies by themselves.

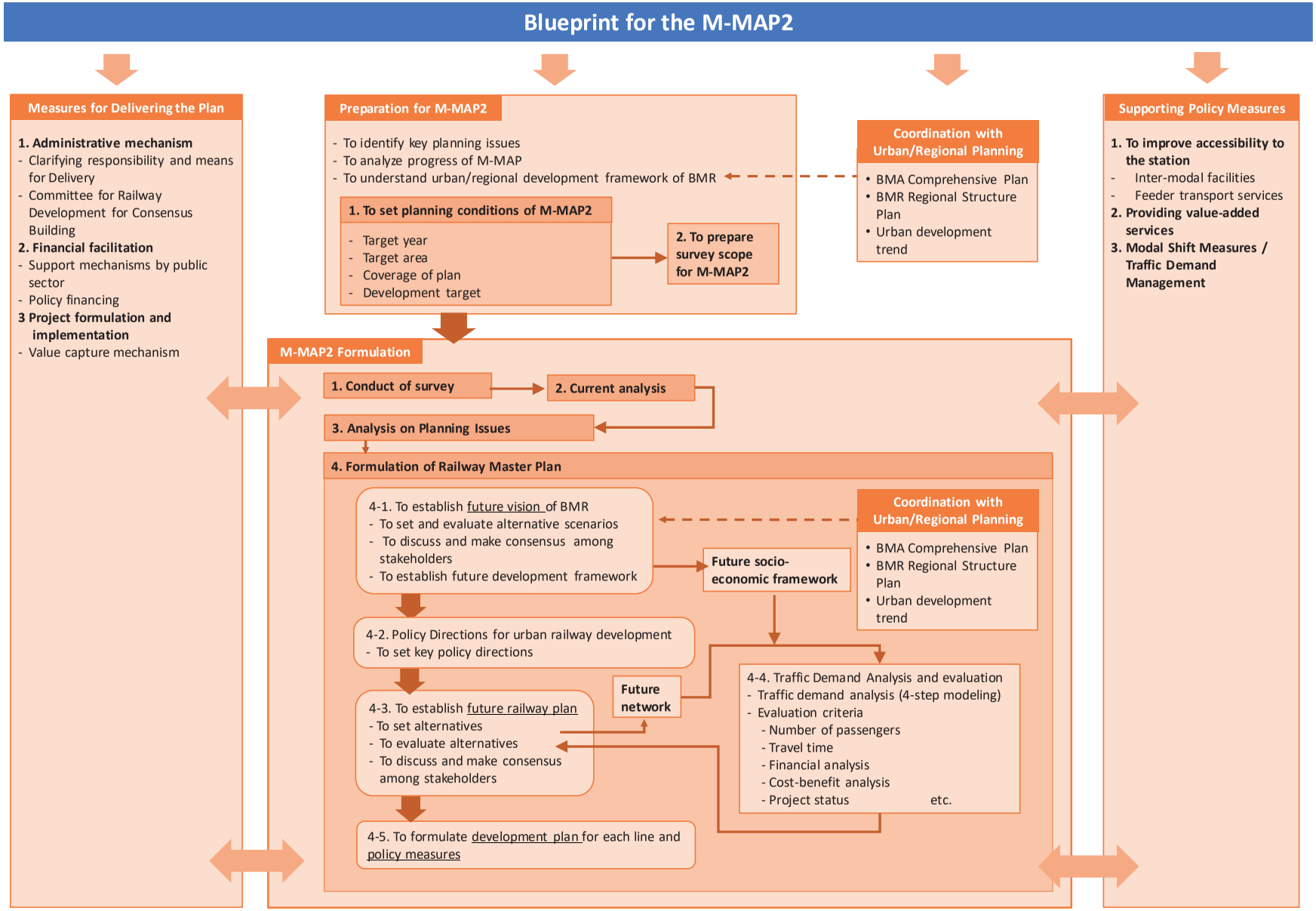



**Figure 5.1 Process of M-MAP2 Formulation**

Scope of the M-MAP2 formulation will start from "conduct of survey", including household interview surveys, stated preference survey, and so on. It can be supplemented by the result of additional surveys, which is proposed for the e-BUM2' as proposed in chapter 2 of Part III. "Current analysis" will examine current situation of urban development, urban transport, use of public transport, and thus identify key issues of public transportation in the BMR. Comparison with the past for about 10 years is useful for the analysis. Based on the current analysis, planning issues will be examined. In order to do this, planning issues should be well discussed at the preparatory stages and be reflected into the scope of the current analysis so that current analysis can describe the planning issues appropriately.

Formulation of Railway Master Plan will start from "to establish future vision of the BMR". It is necessary to examine urban and regional development trend and coordinate with future scenario of the BMA Comprehensive Plan prepared by Bangkok Metropolitan Authority and the BMR Regional Structure Plan prepared by Department of Public Works and Town and Country Planning. It is also expected to integrate people's opinion and needs on urban transport into the future vision. As a result of this task, "future socio-economic framework" will be prepared, which include night-time and day-time population by traffic zone.

Future policy directions for urban railway development will be set to realize the above set future visions of the BMR. It is important to prioritize key policy directions and make consensus on it among key stakeholders.

"To establish future railway plan" needs to set and evaluate a few alternatives. Traffic demand analysis is an important policy tool to evaluate network alternatives and each development project in a scientific way, which can be a basis to make consensus on the Future Railway Plan. Evaluation criteria can be number of passengers, travel time, financial viability of railway operation, cost-benefit analysis, and project status, and so on. Evaluation criteria can be also set depending on the priority policy issues, such as accessibility to the global gateway, congestion ratio, inter-modal transfer, etc.

Based on the future railway plan, "development plan for each line and policy measures" will be formulated. M-MAP2 will include a phased implementation of the remaining projects of M-MAP lines and development plan of the new lines together with developing bodies for each line.

In order to realize the M-MAP2 promptly, implementation measures and necessary policy measures will be identified. Implementation measures will cover administrative mechanism, financial facilitation, and project formulation, which are proposed in the Chapter 6 of Part I. Those measures need to be discussed and coordinated with respective organizations such as Public Debt Management Office and Ministry of Finance, and urban development agencies. It is recommended to start such coordination based on the M-MAP2 Blueprint in parallel with M-MAP2 formulation.

# Appendix 1

Proposed Blueprint for the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix 1

# PROPOSED BLUEPRINT
# FOR
# THE SECOND MASS RAPID TRANSIT MASTER PLAN IN BANGKOK METROPOLITAN REGION (M-MAP2)

## Topics

1. Introduction: What is M-MAP2 Blueprint?
2. Overall Framework of Draft M-MAP2 Blueprint
3. How Bangkok will be in future?
   - Planning Conditions for M-MAP2
4. Policy Directions to Promote Railway Development in BMR
5. Key Measures for Each Direction
6. Measures for Delivering the Plan
7. Modal Shift Policy
8. Schematic Implementation Schedule of the Proposed M-MAP2 Blueprint (tentative)

# 1. Introduction: *What is M-MAP2 Blueprint?*

**M-MAP**

***Railway Network Plan***

**How is traffic situation in BMR?**
- Serious traffic congestion
- Insufficient public transport network
- Poor quality of services (bus and railway)
- Lack of inter-modal accessibility

**How will BMR be in future?**
- Population increase
- Progressing ageing society
- Expanding urban areas

At present...

**Car-oriented Society**

**M-MAP2 Blueprint**

Railway Network

Metropolitan | CBD | Global accessibility

***Holistic Policy Directions to promote railway development in BMR***

Quality of Services | Inter-modal accessibility

Implementation Measures

Modal Shift Policy

**Public Transport Society**



# 2. Overall Framework of Draft M-MAP2 Blueprint

**Overall Framework of MMAP2 Blueprint**

Future Visions of BMR

Current Issues and Future Prospects (Urban and Transport)

**JICA Study**

**MMAP2 Blueprint**

**Planning Conditions**

- Target area: BMR, Ayutthaya and Chachengsao
- Target year: 2037
- Population: BMA 8.6 mil., BMR 15.6 mil. (2015)
  BMA 8.4 mil., BMR 17.8 mil. (2037)
- Urban structure:
  - BMR Structure Plan (being updated)
  - BMA Comprehensive Plan
- Target Modal share: 15% by Mass Transit

**Overall Direction of Mass Transit Development in BMR:**

***To establish a public transport society to support the region's sustainable development***

***Five Major Policy Directions:***

1. To alleviate traffic congestion in the center
2. To strengthen overall railway network in BMR
3. To improve accessibility to stations
4. To provide value-added mass transit services
5. To enhance accessibility to global gateways

Proposed Conceptual Network → Preliminary Route Evaluation

Measures for Delivering the Plan | Modal Shift Policy

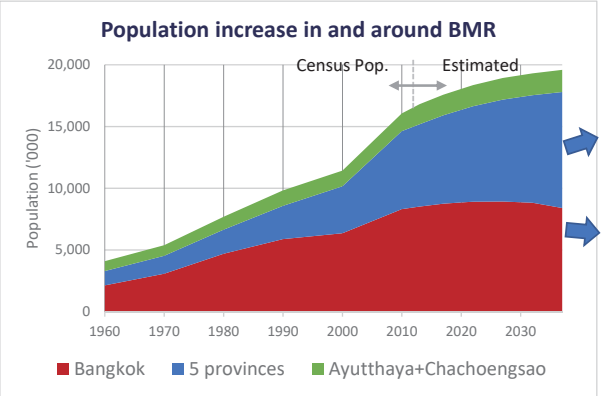
M-MAP2 (Medium/Long-term Mass Transit Development Plan)

Committee for Railway Development for Consensus Building

# 3. How Bangkok Metropolitan Region (BMR) will be in Future?
## *-Planning Conditions for M-MAP2*

- Increase of population particularly in outside of BMA
  - BMA's population will be saturated around 8.9 million and may start to decrease.
  - Outside 5 Provinces will accommodate additional 2.2 million people in next 20 years
  - Bangkok was visited by more than 20 million foreign visitors in 2016.

- Progressing ageing society.
  - Aged ratio (> 60) will be 23% in BMA and 28% in 5 provinces (in 2030)
  - ➔ Increasing needs of public transport with barrier-free access to secure mobility of seniors.

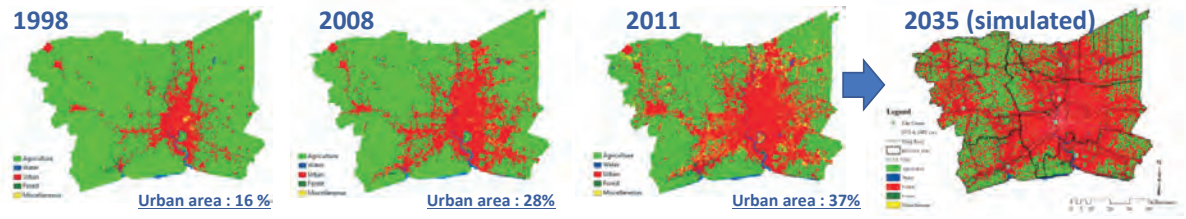



Source: Census, Population Forecast (NESDB)

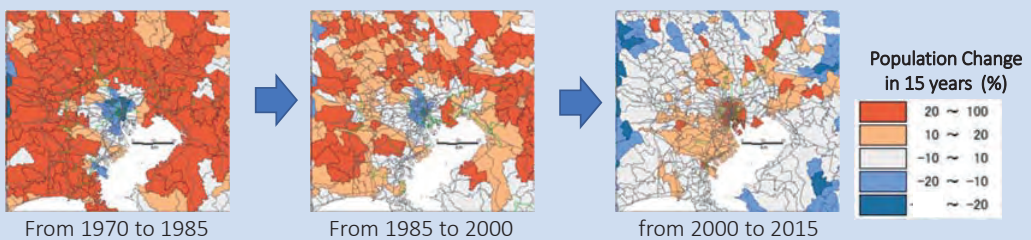


# 3. How Bangkok Metropolitan Region (BMR) will be in Future?
## *-Planning Conditions for M-MAP2*

- Expansion of urban areas.
  - More urban residential development in the outer area of Bangkok, along major roads and more people live in suburban areas.
  - Recently, redevelopment project in city center has been observed including residential areas.




A Case of Tokyo: From Suburbanization in the 1980s to reurbanization in the 2000s.

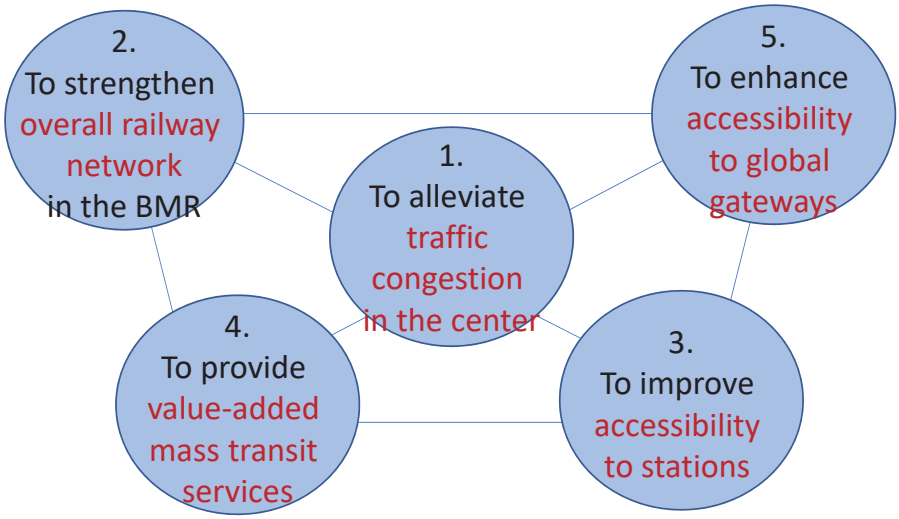



From 1970 to 1985 From 1985 to 2000 from 2000 to 2015

## 4. Policy Directions to Promote Railway Development in BMR

***To establish a public transport society to support the region's sustainable development***

***Five Major Policy Directions***






## 5. Key Measures for each Direction
### 5.1 Key Measures to alleviate traffic congestion in the city center

**Four basic measures to alleviate traffic congestions in the city center;**

**A) Capacity expansion of the existing mass transit lines (no. of train cars, frequency, etc.)**

**B) Ensured implementation of the planned mass transit routes (M-MAP)**

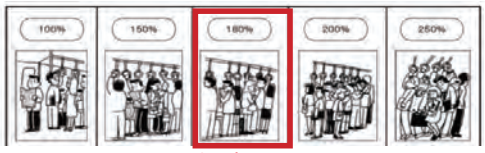
**C) Additional line development in the railway missing areas**

**D) Strengthening of multi-modal public transport network with bus transport, river transport, etc.**

# A) Capacity expansion of the existing mass transit lines

## ■ Current Issues

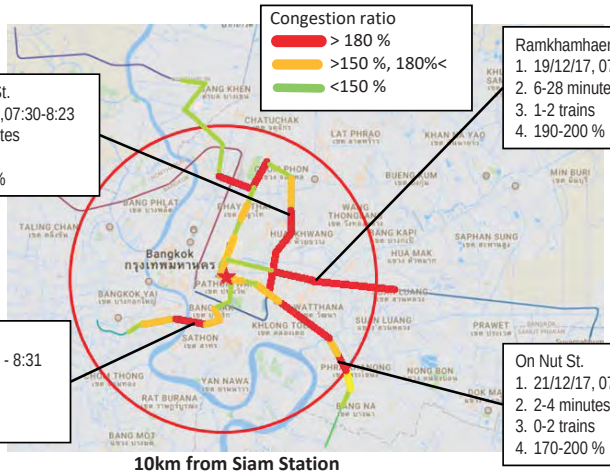
- Serious congestion inside train car and station in the peak hour, on the existing mass transit lines.




Tokyo's Target

Lat Phrao St.
1. 18/12/17,07:30-8:23
2. 3-4 minutes
3. 0-1 train
4. 90-200 %

Saphan Taksin St.
1. 22/12/17, 07:28 - 8:31
2. 3-6 minutes
3. 0-1 train
4. 180-200 %




10km from Siam Station

Ramkhamhaeng St.
1. 19/12/17, 07:48 - 9:08
2. 6-28 minutes
3. 1-2 trains
4. 190-200 %

On Nut St.
1. 21/12/17, 07:20- 8:10
2. 2-4 minutes
3. 0-2 trains
4. 170-200 %

*1. Survey date, time, 2. Head between trains (min), 3. Number of trains passengers miss due to congestion 4. Congestion Ratio (Japanese standard, see above)



# A) Capacity expansion of the existing mass transit lines

## ■ To increase transport capacity of the existing lines in order to reduce the congestion.

- **By increasing no. of train cars** for all existing lines.
- **By increasing frequency of train operation** of Blue, Purple lines and ARL.

| | Exiting operation | | Estimated Peak Transport capacity (pphpd) (A) | Improved operation | | Increased capacity (pphpd) (B) | Ratio (B)/(A) |
|---|---|---|---|---|---|---|---|
| | No. of rolling stocks | Peak Frequency | | No. of Rolling stocks | Peak Frequency | | |
| Airport Rail Link | 3 | 6 | 4,200 | 6 | 20 | 27,700 | 6.7 |
| Sukhumvit Line | 4 | 20 | 22,300 | 6 | 20 | 32,400 | 1.5 |
| Silom Line | 4 | 20 | 22,300 | 6 | 20 | 32,400 | 1.5 |
| Purple Line | 3 | 12 | 10,000 | 6 | 20 | 33,000 | 3.3 |
| Blue Line | 3 | 12 | 10,000 | 6 | 20 | 33,000 | 3.3 |

pphpd: passengers per hour per direction

# B) Ensured implementation of the planned mass transit routes (M-MAP)

■ **Current Issues:**

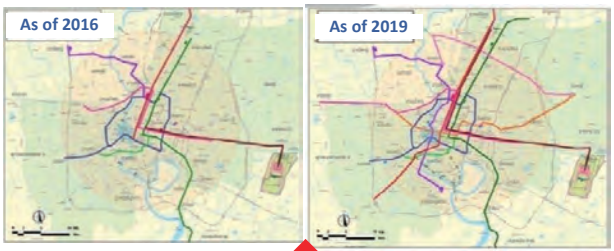
➢ **Delay of Implementation of the existing mass transit routes (M-MAP)**

**Comparison of Length of Mass-transit in Operation (km)**

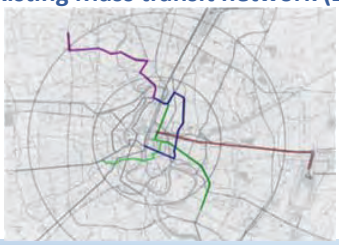
| Line | M-MAP plan | | Actual in operation |
|---|---|---|---|
| | 2016 | 2019 | |
| BTS | 46 | 53 | 36.8 |
| Blue | 47 | 47 | 20.8 |
| Purple | 23 | 42.8 | 23 |
| ARL | 28.5 | 28.5 | 28.5 |
| Dark Red | 42.8 | 60.8 | - |
| Light Red | 26 | 49 | - |
| Orange | - | 37.5 | - |
| Pink | - | 36 | - |
| **Total** | **213.3** | **354.6** | **109.1** |

Source: M-MAP, TDL, Railway Operators

**Mass transit network proposed in M-MAP**




**Existing Mass transit network (2018)**

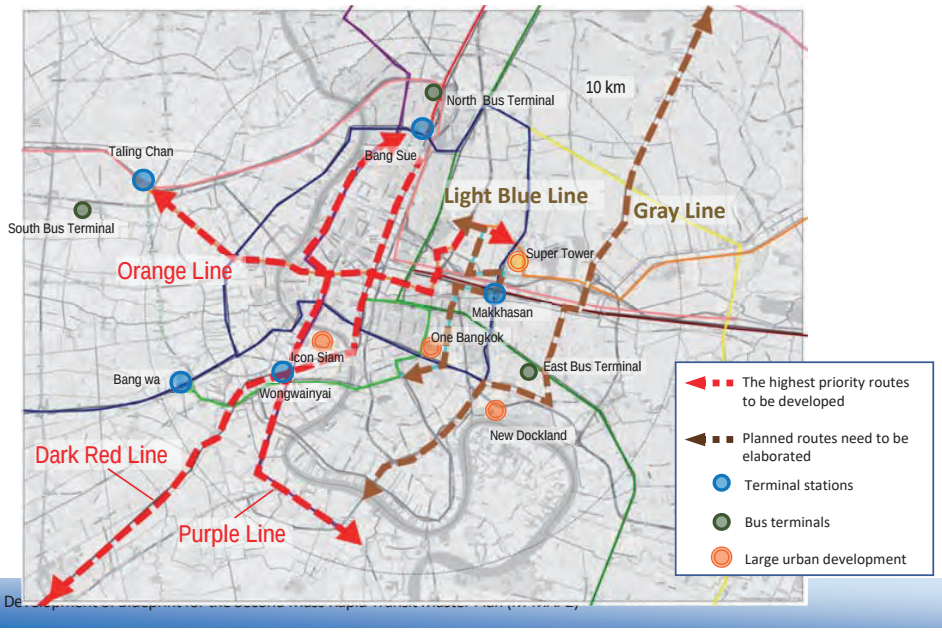




# B) Ensured implementation of the planned mass transit routes (M-MAP)

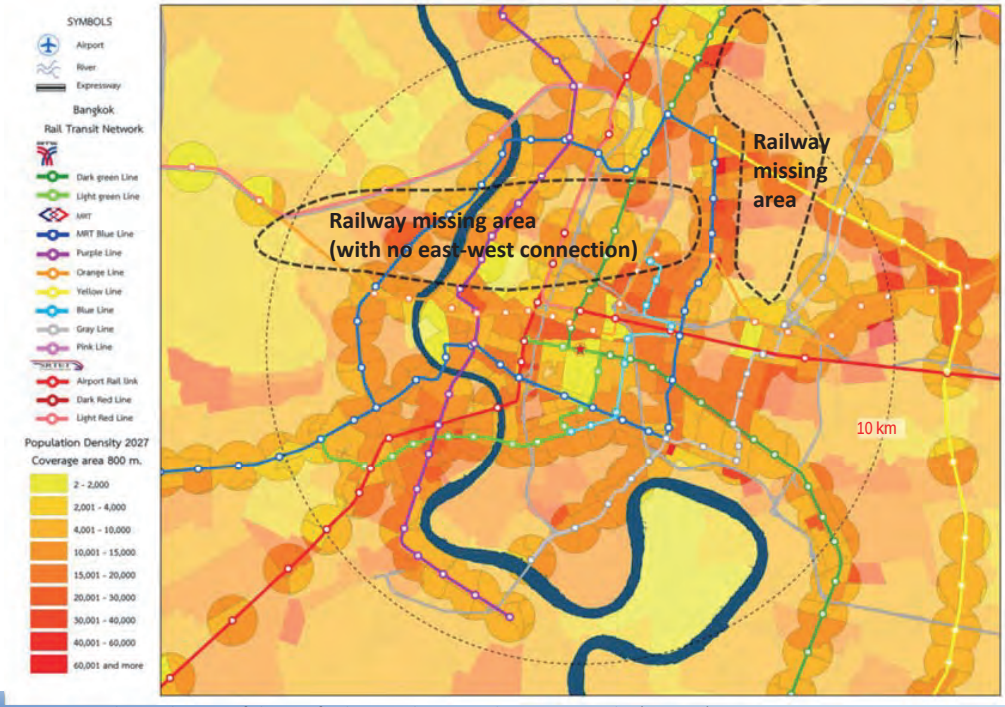
➢ Construction of remaining section of the started lines, **Dark Red Line, Purple Line,** and **Orange Line** at the soonest timing.

➢ Reconsideration of capacity and alignment of the non-committed M-MAP lines; **Gray Line** and **Light Blue Line**



## C) Additional line development in the railway missing areas

➢ Additional railway lines to serve for the railway-missing areas in the City Center



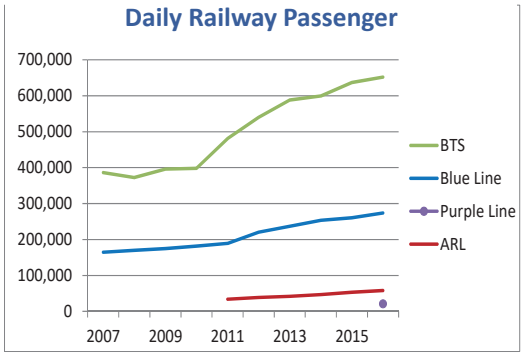



## D) Strengthening of multi-modal public transport network with bus transport, river transport, etc.

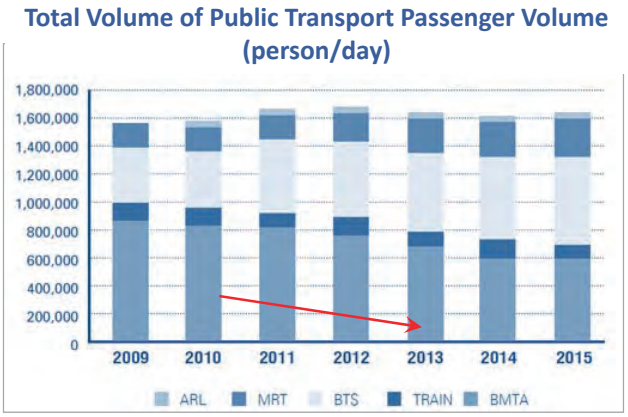
■ **Current Issues:**

➢ Steadily increase of railway passengers and decrease of bus passengers.

➢ As a result, the total number of public transport users have NO increase.



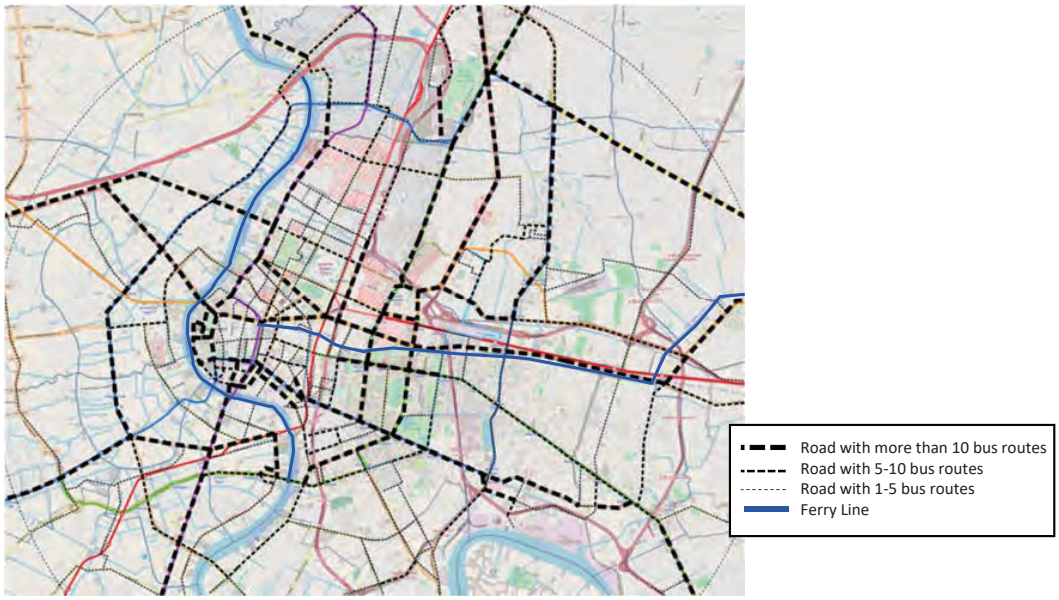

Note: Average daily passengers has increased to 46,800 in September 2017, after Tao Poon Station was opened.
Source: Annual Report of each railway operator




Source: BEM Annual Report

## D) Strengthening of multi-modal public transport network with bus transport, river transport, etc.

- To coordinate with bus route network and ferry network as public transport network. (ferry improvement is being considered by MRTA)
- To provide integrated information of overall public transport network






## 5.2 Key Measures to strengthen overall railway network in BMR

**Four basic measures to strengthen railway network:**

**A) To develop mass transit lines to the corridors with high demand-supply gap.**

**B) To develop mass transit lines to link sub-centers**

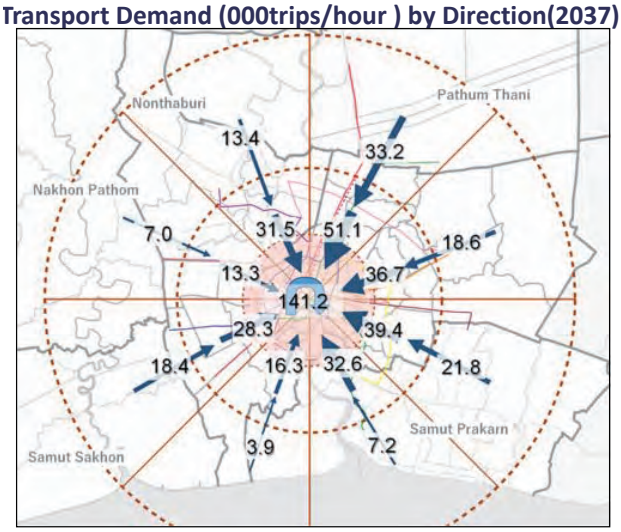
**C) To utilize the existing SRT lines and connect with mass transit network**

**D) To strengthen transport terminals**

# A) To develop mass transit lines to the corridors with high demand

## ■ Where Future Demand will be?

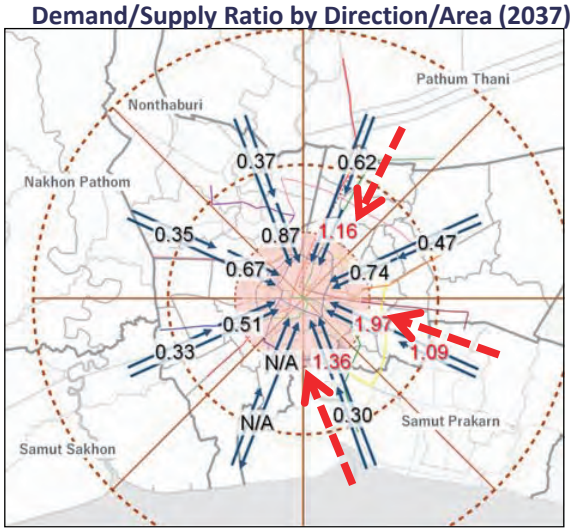
Transport Demand (000trips/hour ) by Direction(2037)




Source: eBUM and M-MAP
Note: Area with in 40km radius
Assuming railway modal share at 15% and peak rate at 20%.

## ■ Where is Demand-Supply Gap?

Demand/Supply Ratio by Direction/Area (2037)



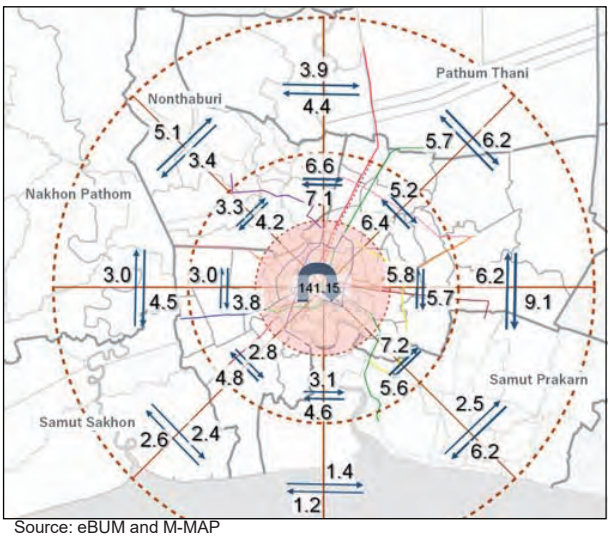

Note: Assuming completion of M-MAP Planned Route with the train design capacity

**Demand-supply gap in the south-eastern and north-eastern direction.**



## ■ Where Future Demand will be? (circular direction)

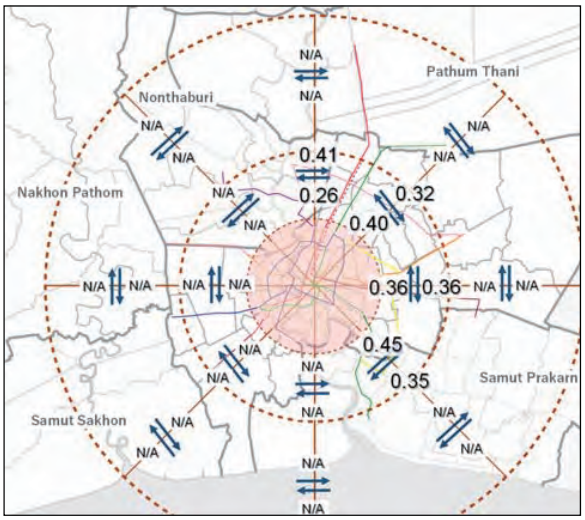
Transport Demand (000trips/hour ) by Direction(2037)




Source: eBUM and M-MAP
Note: Area with in 40km radius
Assuming railway modal share at 15% and peak rate at 20%.

## ■ Where is Demand-Supply Gap?

Demand/Supply Ratio by Direction/Area (2037)

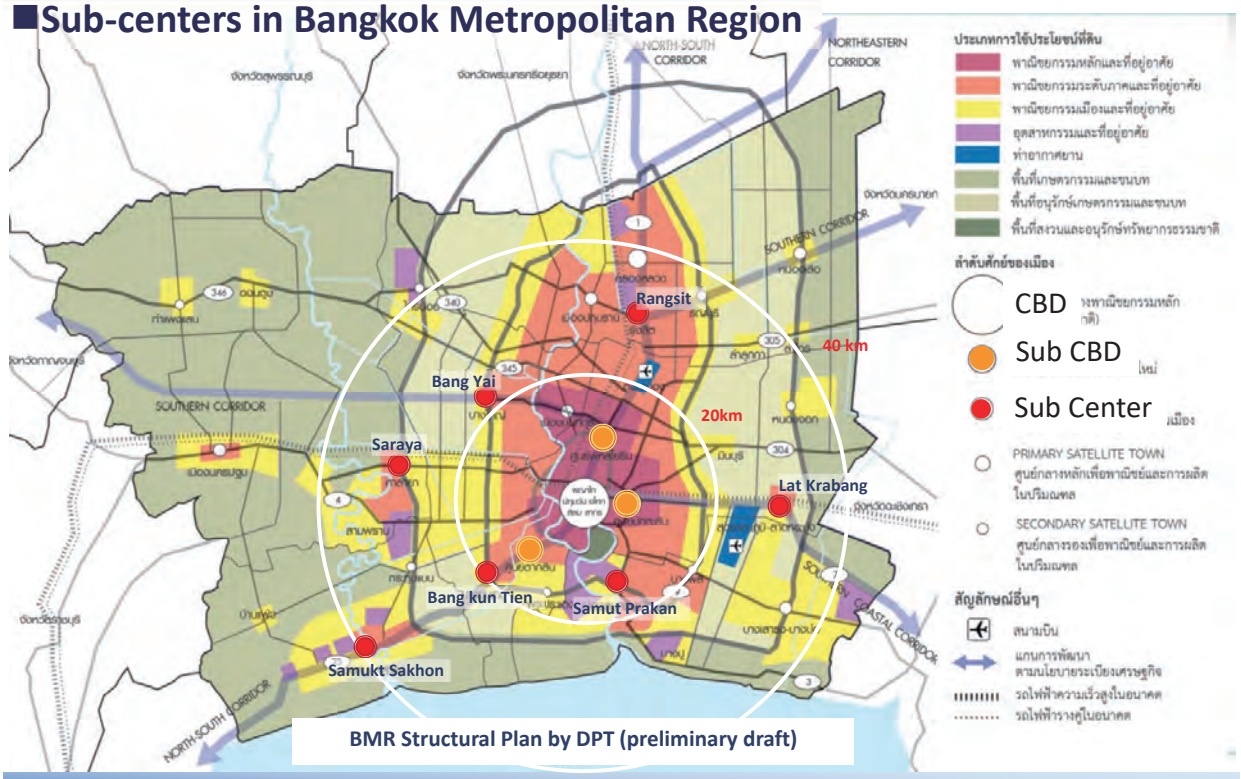



Note: Assuming completion of M-MAP Planned Route with the train design capacity

**Higher demand of circular lines can be mostly covered by M-MAP lines**

## B) To develop mass transit lines to link sub-centers

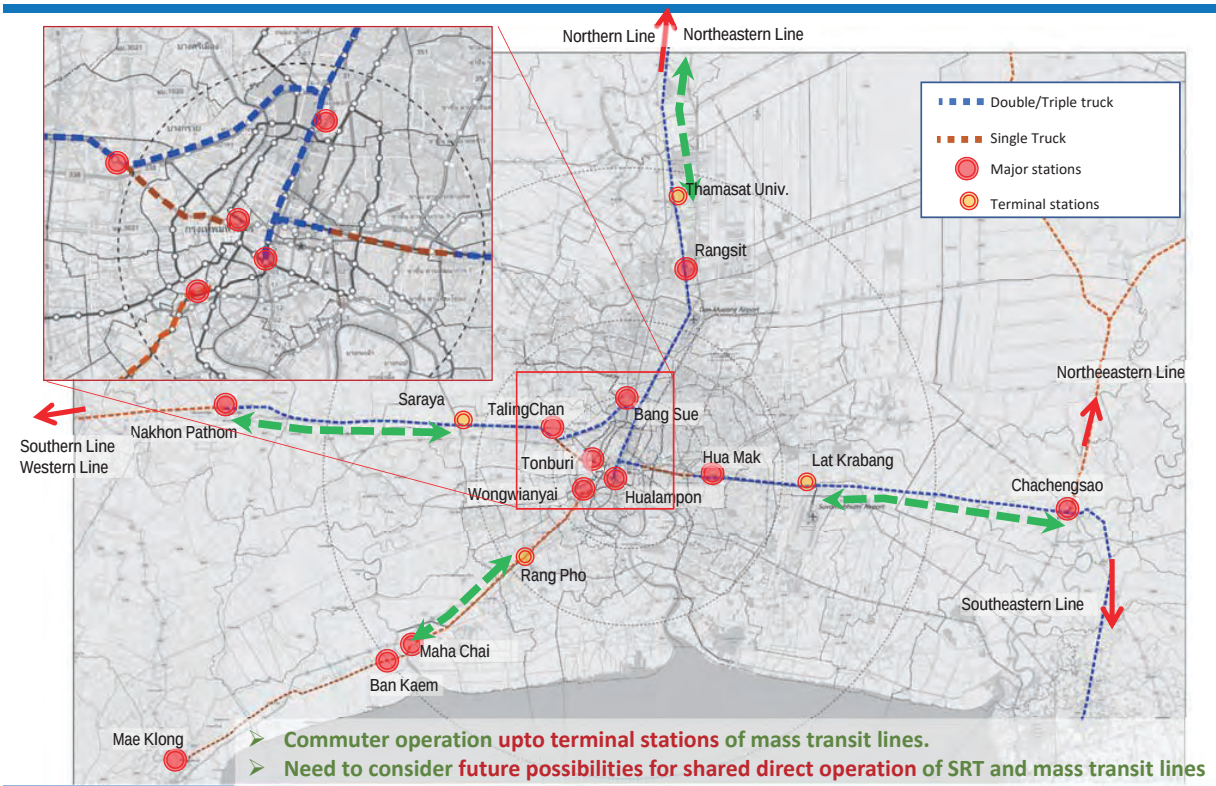
### ■Sub-centers in Bangkok Metropolitan Region




BMR Structural Plan by DPT (preliminary draft)



## C) To utilize the existing SRT lines and to connect with mass transit network



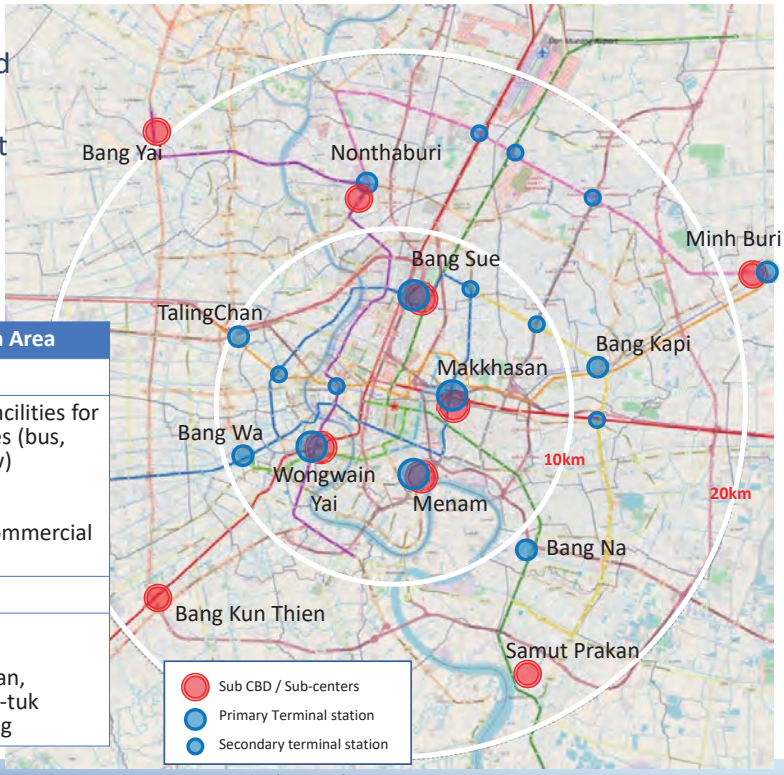

- Commuter operation upto terminal stations of mass transit lines.
- Need to consider future possibilities for shared direct operation of SRT and mass transit lines

## D) To strengthen transport terminals

- To ensure smooth transfer among mass rapid corridors and with other transport modes.
- To promote urban development at transit terminals and sub-centers.

**Typical Terminal Facilities**

| CBD | Sub-urban Area |
|---|---|
| **Primary terminals** | |
| • Easy transfer among railway lines<br>• Integration with the surrounding commercial/ office buildings<br>• Feeder service station (bike-taxi) | • Inter-modal facilities for feeder services (bus, van, songteaw)<br>• Park and Ride<br>• Kiss and Ride<br>• Large-scale commercial facilities |
| **Secondary terminals** | |
| • Easy transfer among railway lines<br>• Feeder services (bike-taxi) | • Park and Ride<br>• Kiss and Ride<br>• Bay for bus, van, songteaw, tuk-tuk<br>• Small shopping |






## Draft Proposal of Future Mass Transit Corridors for Policy Discussion Purpose Only（confidential）

**In JICA Study, Draft Proposal was discussed and identified based on the following planning considerations:**

**A) To promote future regional structure plan**

**B) To support development of CBD and sub-centers**

**C) To meet with future demand-supply gap by direction**

**D) To improve the traffic efficiency and railway coverage area in the City Center**

Confidential Information



Confidential Information

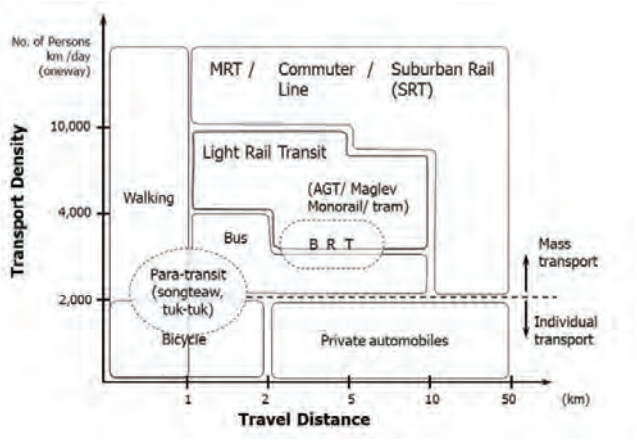
Confidential Information

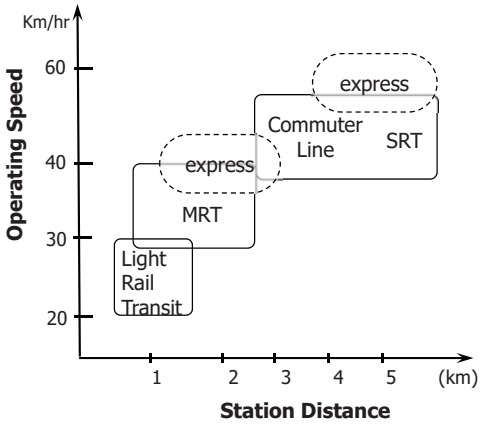


## ■ Hierarchy of Mass Transit System

➢ Need to introduce appropriate system to meet expected traffic demands.

**Transport Capacity and Travel Distance of each System**




MRT: Mass Rapid Transit
AGT: Automated Guideway Transit
Maglev: magnetically-suspended train
LRT: Light Rail Transit

## 5.3 Key Measures to enhance accessibility to the Stations

### A) To develop inter-modal facilities at all stations

- ✓ Transit bays and waiting spaces for feeder modes: bus, van, songteaw (silor-lek), kiss & ride
- ✓ Parking spaces for private vehicles: P&R for car, motorcycle and bicycle
- ✓ Pedestrian access: pedestrian deck, pedestrian path from all directions
- ✓ Barrier-free facilities: elevator/escalator to the stations, slope to the elevator,

### B) To provide Safe and Comfort Feeder transport services:

coordination with bus network, improvement of songteaw (silor-lek) and bike-taxi services

### C) Integration with surrounding urban development at station area



## A) To Develop Inter-modal Facilities
## B) To Provide Safe and Comfort Feeder Transport Services

### Conceptual Image of Inter-modal Facilities

**at typical on-road station**

- All stations of on-road lines (Green line, Orange line, Yellow Line, Purple Line, etc.)

**at stations on SRT Line (not along major roads)**

- All stations along Dark Red Line, Light Red Line, ARL

## A) To Develop Inter-modal Facilities
## B) To Provide Safe and Comfort Feeder Transport Services

### at terminal stations / sub-urban stations

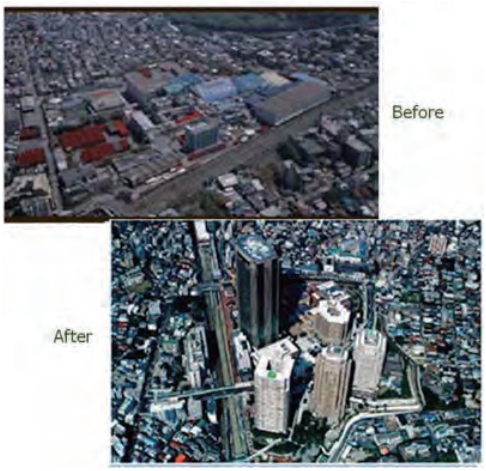
- Primary terminal stations
  (Nonthaburi, Minh Buri, Taling Chang, Bang Wa, Bang Na, Bang Kapi)
- Secondary terminal stations
  (Hua Mak, Lak Si, Bang Khunnon, Lat Phrao, etc)
- Terminal stations at sub-centers
  (Bang Yai, Bang Khun Thien, Samut Prakan, etc)


** Implementation mechanism for inter-modal facilities should be developed as below;*
- *Planning together with railway development,*
- *Authority to develop intermodal facilities,*
- *Institutional measures to secure public land for intermodal facilities (in return of financial/institutional incentives,*
- *Coordination among relevant agencies.*

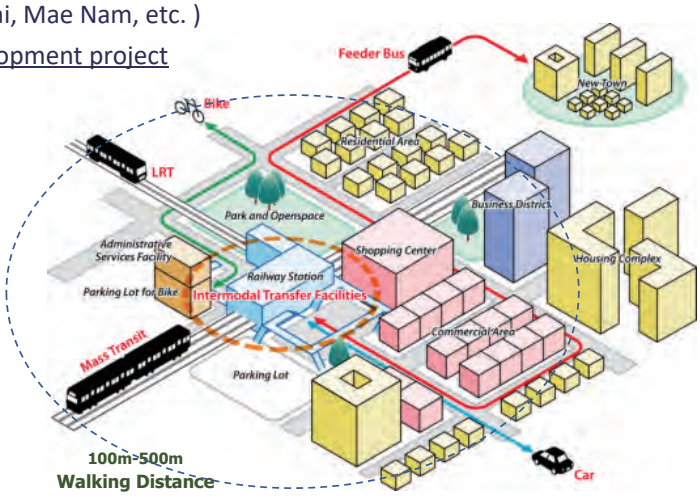


## C) Integration with surrounding urban development at station area

- Development attractive CBD and sub-centers integrated with public transport
- Secure of spaces for intermodal facilities and direct access from surrounding buildings
- Provision of various urban services (commercial, administrative, etc) for all citizens.
  - Primary terminal stations
    (Bang Sue, Makkhasan, Wongwain Yai, Mae Nam, etc. )
  - Other stations nearby urban redevelopment project




Re-Development integrated with railway station




** Institutional arrangement to integrate urban development and railway development is inevitable.*

# 5.4 Key Measures to provide value-added mass transit services to promote public transport

**A) Information provision for passengers**

**B) Flexible Fare Setting**

**C) Safety and amenity facilities**

**D) Express operation**

**E) Business-Class train cars**



## A) Information Provision on Railway Services for passengers

➢ Information to be provided by Railway Operators

- ✓ Basic information on railway operation (railway network, fare to all stations)
- ✓ Quality of services (frequency, congestion, travel time needed)
- ✓ Layout of Station (direction, facilities, barrier-free access)
- ✓ Safety measures

➢ Information to be provided by Government Authority

- ✓ Transportation record of all lines
- ✓ Quality of services of all lines
- ✓ Safety information

**Information Tools (example in Tokyo Metro)**

Information display at platform


Information display at concourse

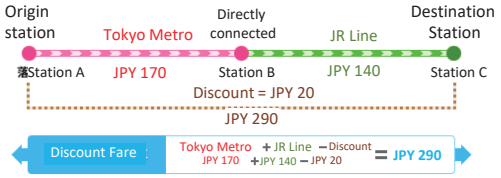

Metro network with fares


Information counter


Service manager

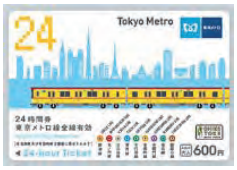
## B) Flexible Fare Setting

- Discount for transfer between lines




Discount for Transfer between Lines

- Special discount ticket (24-hour ticket)




**24-hour Ticket**

**11 Coupons at 10-ride fares**

- Dynamic fare setting with IC-card (for future)
  - With IC-card, travel pattern can be analyzed by minutes, by route, and by users.
  - Based on such demand analysis, railway fare can be adjusted flexibly depending on travel demand.
    - by direction: lower fare for going outside city in the morning
    - by time: lower fare during off-peak hours ,
    - by date: lower fare during weekend
    - by use of frequency: lower fare for frequent users, etc.



## C) Safety and amenity facilities

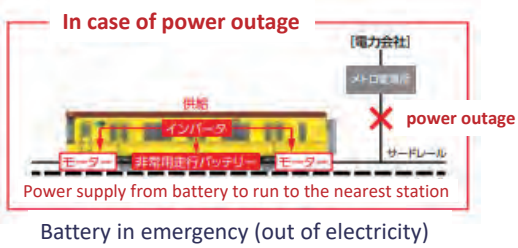
- Safety Facilities
  - ✓ emergency calling button on the platform and at crossing
  - ✓ platform screen doors
  - ✓ security camera
  - ✓ emergency battery , etc.


Emergency Calling Button

Security Camera

Visible trush bin


Security Staff




Battery in emergency (out of electricity)

- Clean and comfortable Railway Services
- Universal Design

**Barrier-free Route in the Station**

Slope

Wide gate for wheel chair /baby stroller

**On-board facilities**

Space for Wheel-chair

**Other Facilities**

Universal Toilet

## D) Express operation

■Express operation will be

- Express operation for commuter lines (SRT, Dark Red, Light Red)
- Express operation for longer- MRTs (Dark Green)

**[Merits of Express Operation]**

**1.Faster traveling time**

- Faster traveling time for long trip and strengthened railway network in metropolitan area
- Faster traveling time in urban mass transit.

**2.Demand distribution**

- Long-distance lines will be fully occupied by commuters from sub-urban area and cannot accommodate passengers at stations in city center. (Dark Green and Red Line)
- Express operation can distribute demand and can accommodate larger number of people at stations in city center

**[Demerits to be concerned]**

**1. Fewer accessibility for users at way-stations.**

**2. Higher skill to respond to accident/operational trouble**

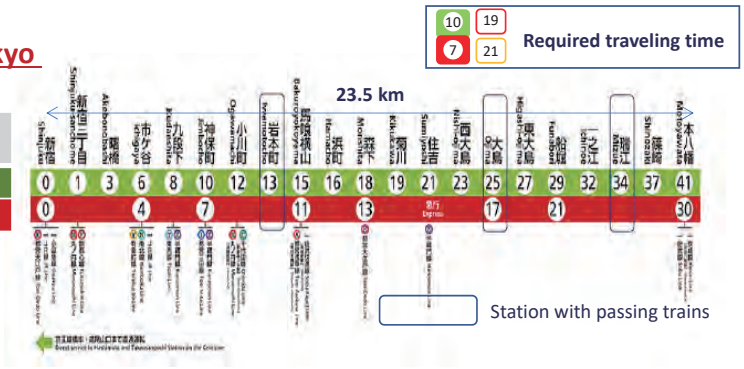
** Express operation requires stations with additional tracks for passing trains.*



## Examples of express operation in Tokyo

### Express Operation of Metro in Tokyo

| | Travel Speed | Average Station Distance |
|---|---|---|
| Local train | 34.3 km/h | 1.2 km |
| Express | 47.0 km/h | 3.4 km |




### Express Operation of Suburban Railway

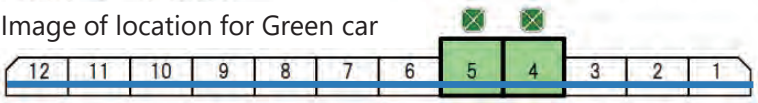
| | Travel Speed | Average Station Distance |
|---|---|---|
| Rapid | 77.7 km/h | 7.3 km |
| Com – R | 71.4 km/h | 4.9 km |
| Semi – R | 67.3 km/h | 3.9 km |
| Local | 61.4 km/h | 3.1 km |

## E) Business-class Train Cars - suitable for commuter lines and long distance MRTs

**Green Car (business class cars – secured seating) for SRT**

- Comfortable train car with special ticket in the normal train.

Image of location for Green car




Seat in the green car

Service in the green car

Source: JR-EAST

**Limited Express (only business class cars )**

- Express operation with comfortable train cars and seat reservation system
- Reservation and special express ticket are required

Ex. Limited Express "Romancecar“ in Tokyo.

Train car

Inside of first-class train car


Ticket-vending machine

Source: Odakyu

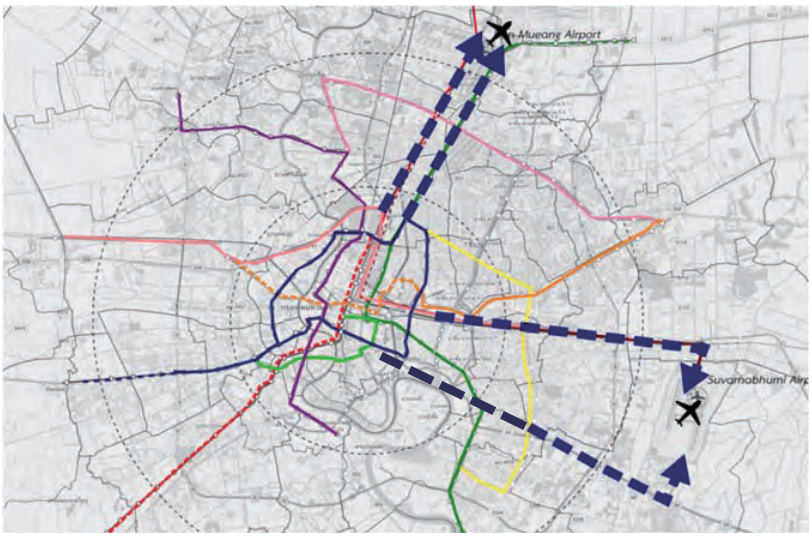


# 5.5 Key Measures to enhance accessibility to global gateways

## A) To develop alternative routes to access to International Airports

## B) To reduce access time (express operation, etc.)

**Alternative Mass Transit Route to Airports**



# 6. Measures for Delivering the Plan
## 6.1 Administrative Mechanisms Promote Implementation

### A) Clarifying responsibility and means for Delivery

"Who" will do it, and "how" it will be done, should be clearly mentioned in the Master Plan.

| Title: | Bangkok | Tokyo | London |
|---|---|---|---|
| Development Plan | Mass Rapid Transit Master Plan (M-MAP) | Council of Transport Policy Plan (CTPP) | Mayor's Transport Strategy |
| Drafting entity | Office of Transport and Traffic Policy and Planning (OTP), Ministry of Transport | Council of Transport Policy (conducts survey and deliberates essential policies in response to consultation from the Minister) | Transport for London (TfL), Greater London Authority |
| Endorsing entity | Prime Minister | MLIT Minister | Mayor of London |
| Implementation | • PPP license awarded private companies;<br>• SRT | Railway operator companies and / or municipal governments | TfL, in consultation with the central government and Boroughs. |
| Financial incentives | • SEPO, under the Ministry of Finance offers financial incentives to PPP projects. | Promotional measures such as subsidizing, pooling and low interest loans are available. Applicable promotional measures for each development project are specified in the plans. | • National government grants;<br>• Business Rates collected from non-commercial users of real estate properties (own fund). |

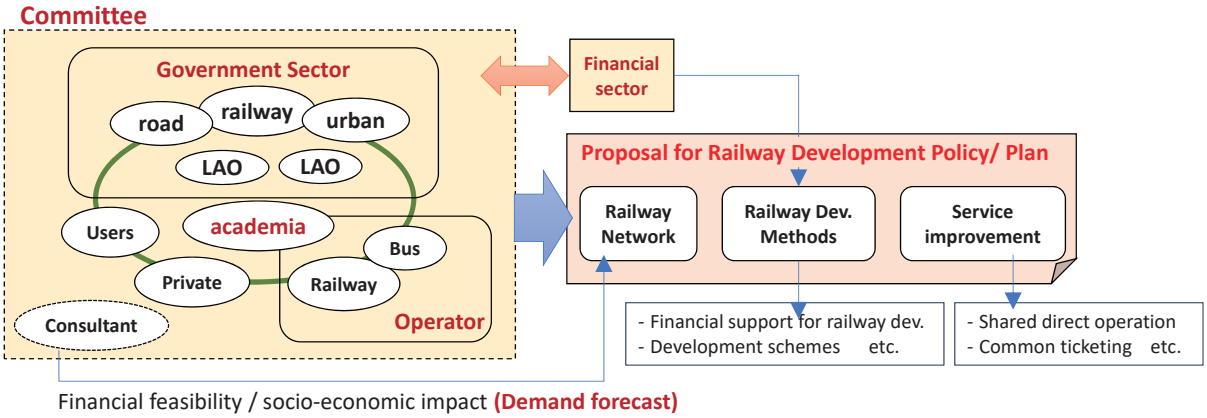
Examples:
Tokyo = Railway operators are the major actors. Central government provides supporting instruments.
London = possesses its own funding means.



### B) Committee for Railway Development for Consensus Building

- ✓ **The Committee for railway development** in BMR should be an arena not only for analysis and discussions but also for making decisions.
- ✓ Committee should involve **academia**, **railway operators**, and **users** in the planning process as well as relevant government organizations.
- ✓ Discussion through Committee can ensure neutrality of the plan, promote coordination, get consensus on development measures and each responsibility, including financial assistance by government.
- ✓ It is important to share the result of demand analysis, including relevant data and modeling.

**Proposed Committee and Planning Process for Railway Development in BMR**



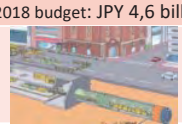
# 6.2 Financial Facilitation

**A) Support mechanisms:**

- Government grant support is essential for urban mass rapid transit development.
- Supports should be context-specific so as to facilitate intended investments.

**B) Policy financing:**

- Developed countries where infrastructure development has taken place are mostly furnished with policy financing instruments.
- A policy financing instrument can provide stable and long-term funding which is suitable for funding transport infrastructure development.

| Name | Support Program for Subway Development | Support Program for Urban Railways User Promotion |
|---|---|---|
| Subject | Total cost (minus manpower, admin, rolling stock, interest rate) x 1.02 x 80% x 90% | Construction + ancillary + land acquisition |
| Portion | Up to 35% (matching amount with subsidy from municipal governments) | Up to 1/3 (matching amount with subsidy from municipal governments) |
| | FY 2018 budget: JPY 4,6 billion | FY 2018 budget: JPY 11.6 billion |
| Example |  |  |

**Examples of grant support mechanisms**

Source: extracted and edited by JICA Study Team based on JRTT documents

| | US | Canada | UK | Germany | France | Japan |
|---|---|---|---|---|---|---|
| Comprehensive Programme | Federal Credit Program: FCP | - | - | - | - | Fiscal Investment & Loan Program |
| Infrastructure | - | - | - | KfW | Bpifrance | DBJ |
| Trade, overseas investment | EMIM | EDC | UKEF | KfW IPEX Bank, DEG, KfW | AFD, Bpifrance | JBIC , JICA |
| SMEs | SBA | BDC | BBB | KfW | Bpifrance | JFC |
| Housing | FNMA, FHLMC, FHLB | CMHC | | KfW | CDC | JHF |
| Outstanding balance of Policy Financing(FY 2015) | USD 6 trillion JPY 660 trillion | CAD 326 billion JPY 27 trillion | - | EUR 273 billion JPY 33 trillion | EUR 205 billion JPY 25 trillion | JPY 97 trillion |

Source: edited and translated by JICA Study Team based on MOF document



# 6.3 Project Formulation and Implementation

**A) Public-Private Partnership Fast Track Projects**

- Thailand already has good public-private partnership role-sharing models. Existing fast track projects should further be encouraged.
- Further market sounding should be conducted to attract more bidders.

**B) Balancing with auxiliary businesses**

- Mass rapid transit operation is advantageous in that the operator can easily reach out to a huge number of people, of all categories.
- By making use of opportunities to reach out to public in general, there is a full range of income earning businesses which can easily exceed the size of the transport business.

**Examples of auxiliary businesses with Japan's railway operators**

| Category | Example |
|---|---|
| Public relations | Advertising, marketing support |
| Retail | Convenience stores, supermarkets |
| Restaurants and catering | In-station restaurants, area catering |
| Real estate and housing | Property development and agents |
| Business support | Office renting, secretariat service, printing |
| Infant and senior care | Nursery / day care home services |
| Logistics | Courier, moving, distribution |
| Security | Security guard, remote supervision |
| Communication | Telecommunication, value-added network, ISP, CATV |
| Utility | Electricity and gas supply |
| Storage | Trunk room rental and delivery |
| Finance | credit cards and settlement |
| Accommodation | Hotels, apartments |
| Adult education | Community school, continuous learning |
| Entertainment | Event hall renting |
| Travel support | Travel agent, ticketing |
| Sports and health | Fitness gym, tennis court, golf course, swimming pool |
| Medical | Hospitals |
| Life stage support | Wedding hall, funeral hall |

Source: JICA Study Team based on information collected from railway operators' websites.

# 7. Modal Shift Policy: Possible Menu List based on Japanese experiences

## [Promotion Measures as initial actions]

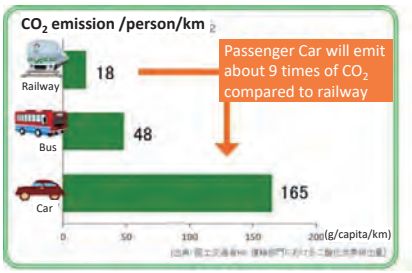
### 1. Information Provision to Promote Public Transport

- Campaign to promote "public transport society" with smart image of public transport.
- Promotion as an "eco-friendly transport mode" with information about $CO_2$ emission by mode.
- Promotion of "off-peak commuting" with information about peak congestion hour.


**Off-peak Promotion with Information of Peak-congestion by Station**

Source: Tokyo Metro

**Comparison of $CO_2$ Emission by Mode**




Source: MLIT, Japan



## [Promotion Measures for mid-to-long-term]

### 1. Promotion as an "eco-friendly transport mode"

- Certificate of "eco-friendly office" which promote employees to commute by public transport (ratio of public transport commuters, community allowance only for public transport)
- Educational program for students at school to use public transport

**Logo mark of Environmentally Sustainable Transport**

### 2. Modal Shift Measures for Office-Commuters

- Special commuting allowance only for public transport users to cover commuting cost
- Special allowance for NMT commuters
- Discouraging car-commuting for employees living within 2 km.

**Ex. Revision of Commuting Allowance for employees to promote Public Transport and Non-motorized Transport (JPY/month)**

| Distance from Home to office | Commuting allowance | | |
|---|---|---|---|
| | for Passenger car | Public transport | Motorcycle |
| - 5km | JPY 2,000➔ 1,000 | All required fares | JPY 2,100 ➔4,000 |
| 5-10 km | JPY 4,100 | All required fares | JPY 4,100 ➔8,200 |
| 10-15km | JPY 6,500 | All required fares | JPY 6,500 ➔8,200 |
| 15km- | JPY 8,900 | All required fares | ➔ JPY 8,900 |

## [Promotion Measures for mid-to-long-term]

### 3. Dynamic Pricing with IC-card

- Financial incentive provision with IC-card (discount for off-peak use, etc.)

### 4. Promotion as a Secured Transport Mode

- SNS/SMS will be sent to parents when kids pass the railway gate with IC-card.

Image of Station-Kids Services


Once kids enter railway station gate with IC-card,
SMS message will be automatically sent to the parents' mobile.

## [ Restriction Measures for long-term ]

### 1. Restriction of Use of Private Car/ motorcycle

- Increase of toll tax
- Increase of parking tax in city center,
- Increasing car tax and fuel tax
- Road pricing
- Car-free day

** Restriction measures can be introduced only when and where sufficient railway network is available for people to choose public transport as an alternative mode.*



# 8. Schematic Implementation Schedule of the proposed M-MAP2 Blueprint (tentative)

| | 2018 – 2027 (short/medium-term) | – 2037 (Long) |
|---|---|---|
| **Development of Mass Transit Network and Services** | 1-A Capacity expansion of the existing lines<br>1-B Implementation of M-MAP network<br>1-D Strengthening of multimodal system | 1-C Additional lines in the city center<br>2-A Additional lines to the high demand corridors<br>2-B Additional lines to link subcenters<br>2-C Utilizing the existing SRT lines |
| | 2-D Strengthening of transport terminals | |
| | 3-A Development of inter-modal facilities<br>3-B Provision of safe and comfort feeder transport services<br>3-C Integration with surrounding urban development at station area | |
| | 4-A Information provision, 4-C Safety and amenity facilities | |
| | | 4-B Flexible Fare Setting, 4-D Express operation<br>4-E Business-class train cars |
| | | 5-A Alternative access routes to airports<br>5-B Reduce access time to airports |
| **Measures for Delivering the Plan** (Financial Facilitation) | Alternative Funding Sources<br>Developing Context-specific Facilitation Mechanisms<br>**Expansion of Infrastructure Fund** | Funding from Disposal of Public Assets |
| **Modal Shift Policy** | Promotion Measures | Restriction Measures |
| **Master Planning, Database and Demand Forecast** | M-MAP2 formulation<br>Improvement of the updated eBUM2 | M-MAP3 formulation<br>Continuous revision |

# Appendix 2

Workshop on Implementation Mechanism of M-MAP2

Appendix 2

Data Collection Survey on the Development of Blueprint
for the Second Mass Rapid Transit Master Plan
(M-MAP2)

# Workshop on Implementation Mechanism of M-MAP2

5 September 2018, Bangkok

(revised for reporting)

JICA Study Team

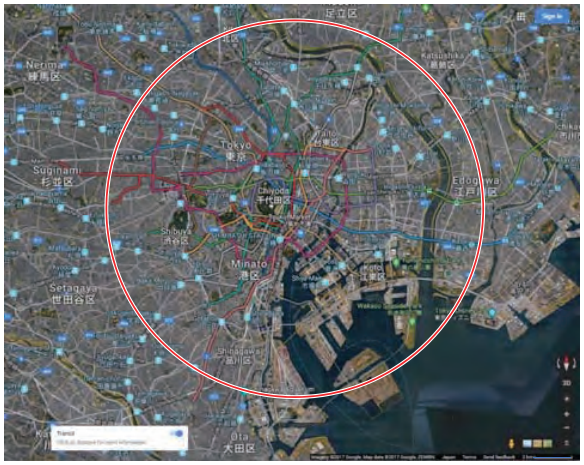


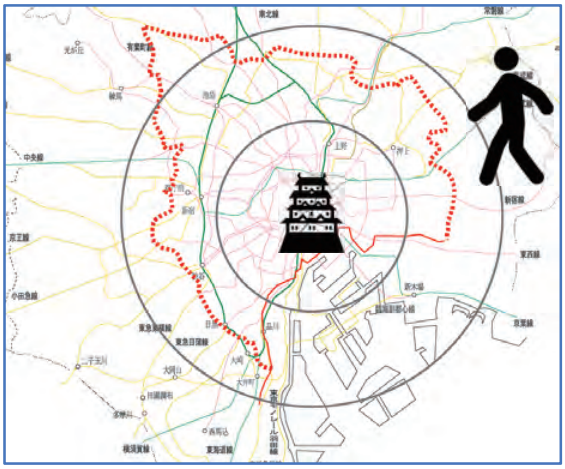
# 1. Introduction: Revisiting Tokyo Network

Summarizing our past

# 1-1. A Million Habitant City Since 17th Century

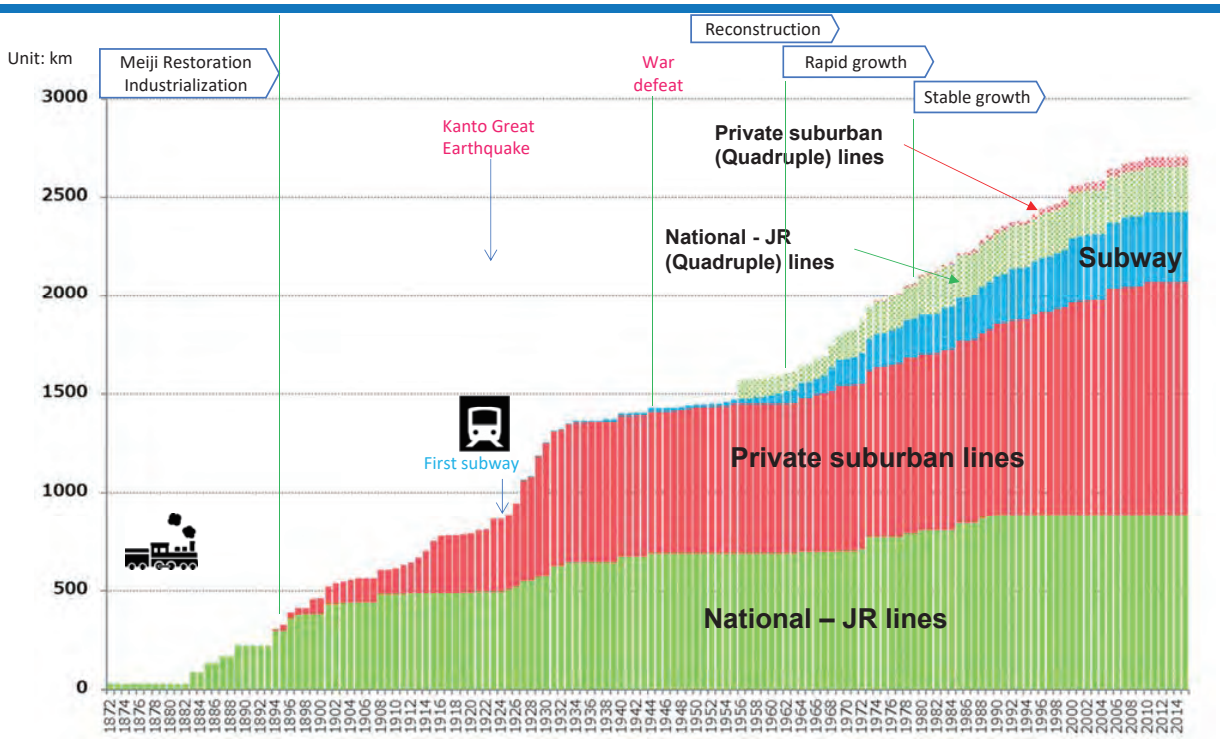
- Tokyo was already with a million habitants 300 years ago (from before year 1700), centering Edo Castle. The city center location has not shifted at all since then.





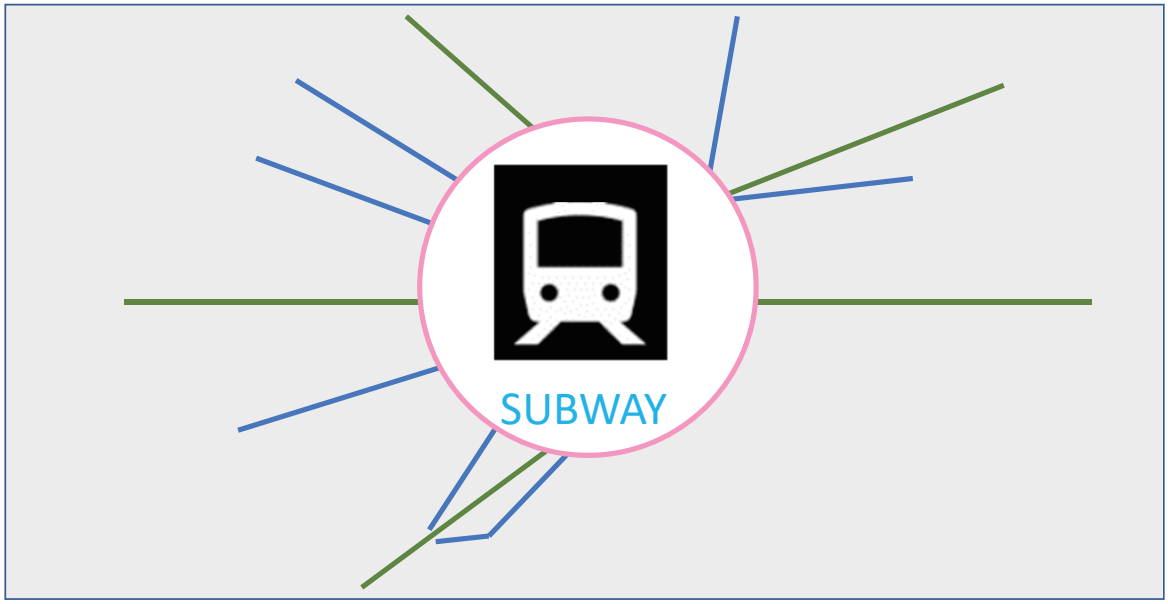
# 1-2. Chronology of Railway Network Development




Source: Compiled by JICA Study Team based on MLIT Annual Statistics of Transport

## 1-3. Tokyo 1950-1980: Urban Area

- Replace trams by Subway



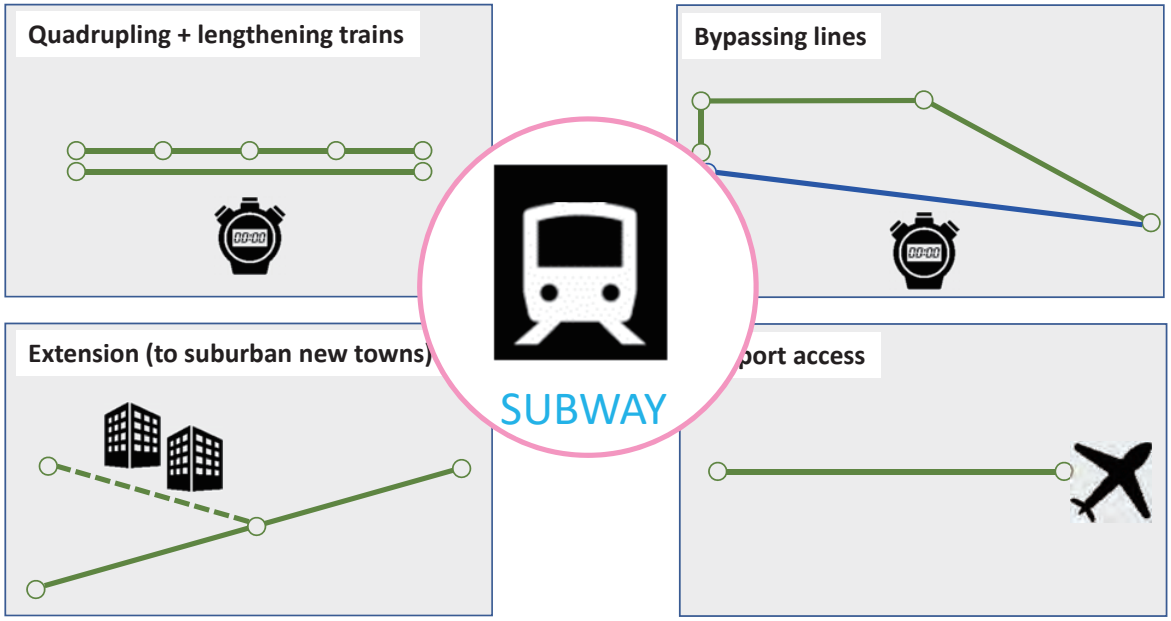



## 1-4. Tokyo 1950-1980: Suburban Area

- Fill up the vacuum area with housing and new rail connections.

## 1-5. Tokyo 1950-1980: Urban - Suburban Connection

- Connect suburban network with subway network

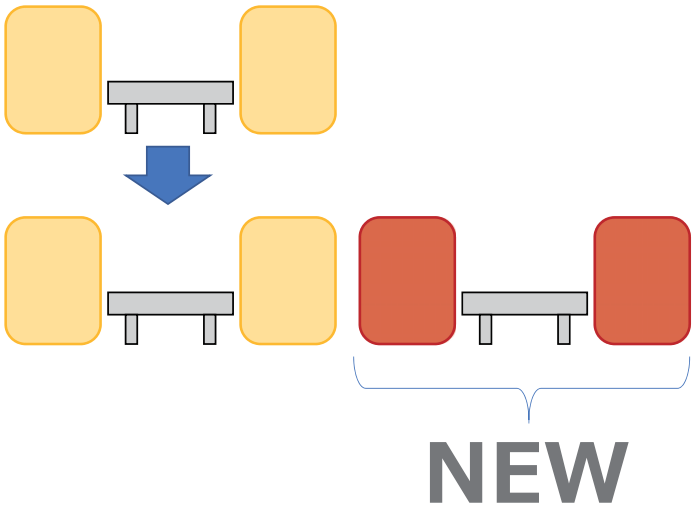





## 1-6. Functional Reinforcement (Quadrupling)

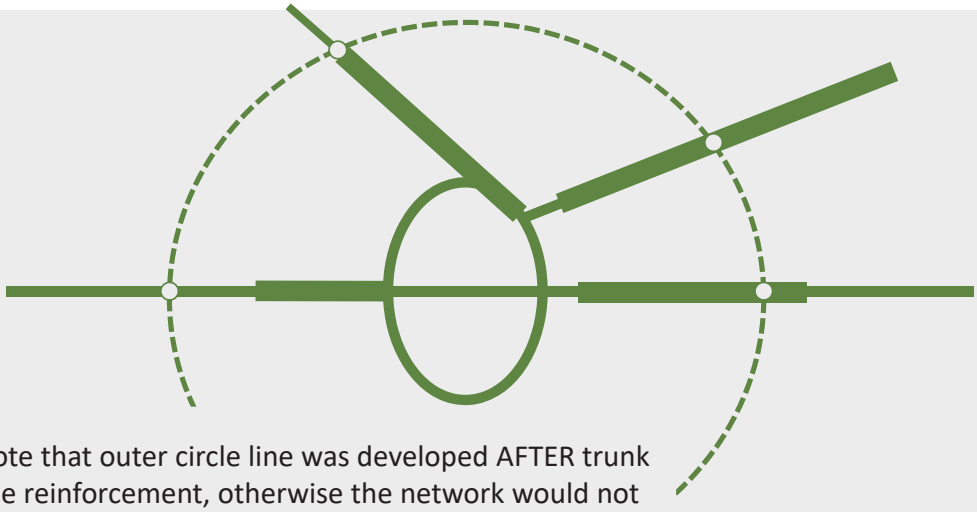
In Parallel:

Upgrading (quadrupling) 5 trunk lines
(under national rail management)

# 1-7. Functional Reinforcement (Circular link)

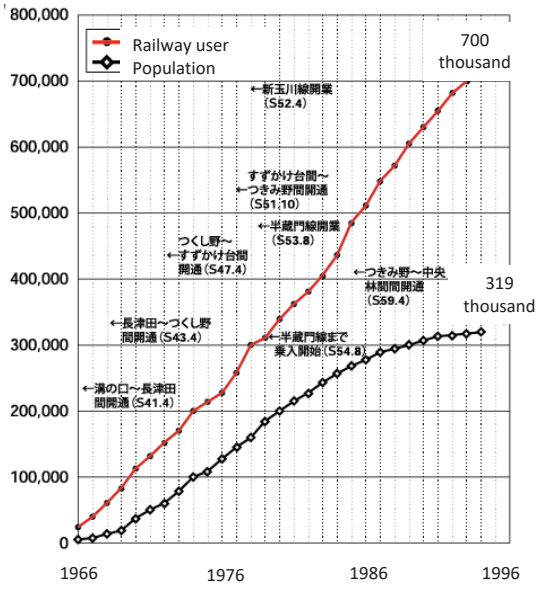
Also in parallel, development of outer circle line (making use of existing freight line)



※：Note that outer circle line was developed AFTER trunk line reinforcement, otherwise the network would not have functioned to cope with the rapidly increasing demand.



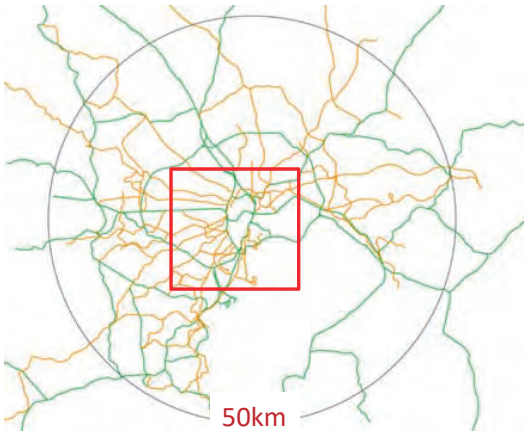
# 1-8. Consequence of the Urban- Suburban Network Dev't

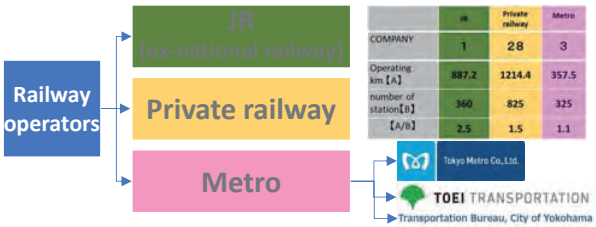




Source: Compiled by JICA Study Team from: Forum for Railway Development in Tokyo Metropolitan Area, Footsteps and Future of Railways in Tokyo Metropolitan Area

# 1-9. Network Today

Rail Network in the Tokyo Metropolitan Area



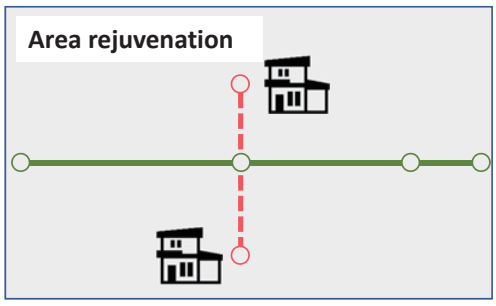



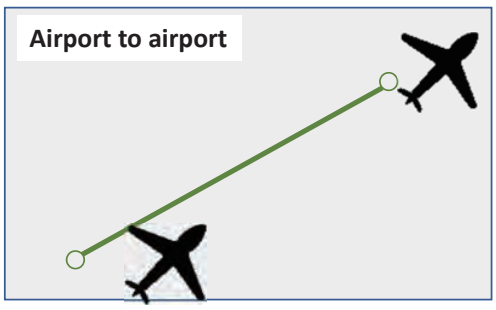

Urban Rail Network in Tokyo

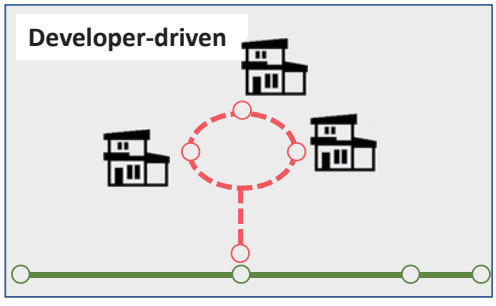


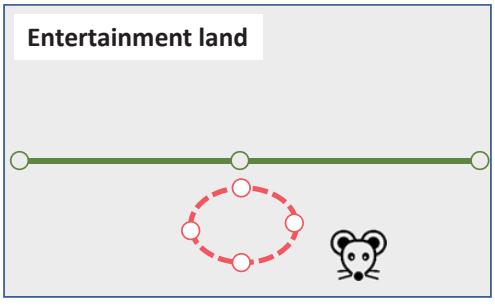
# 1-10. Other Recent Functional Developments

Some examples of recent (1990s onwards) developments



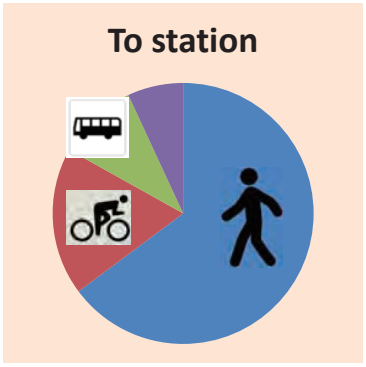



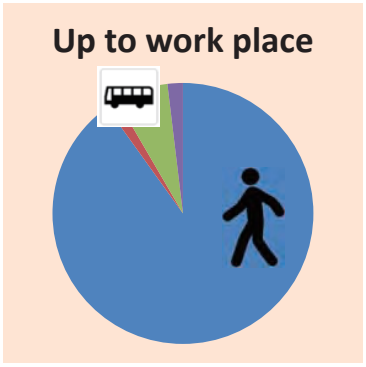



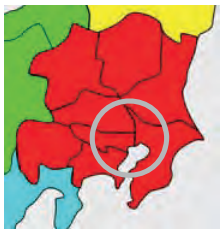
# 1-11. Consequence: Typical Commuting in TMA

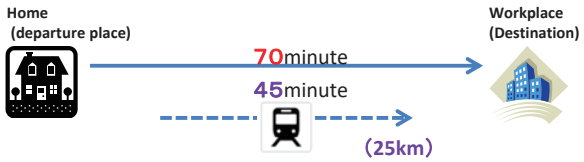
TMA is the area approximately within the 50 km radius.

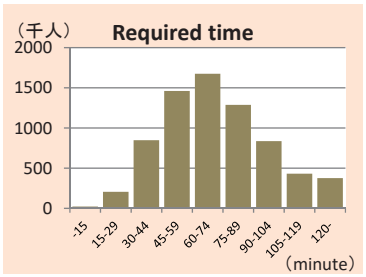
Average commuting time is 70 minutes, among which 45 minutes is spent on trains travelling for 25 km.






Source: Compiled by JICA Study Team based on MLIT Metropolitan Transport Census (2010)



# 1. Questions you may have on Introduction

11 Why is Tokyo urban underground railway network monopolized (precisely, oligopoly by two companies)? Isn't that unfair?

12 Why were there various (public and private) railway companies? How different are they?

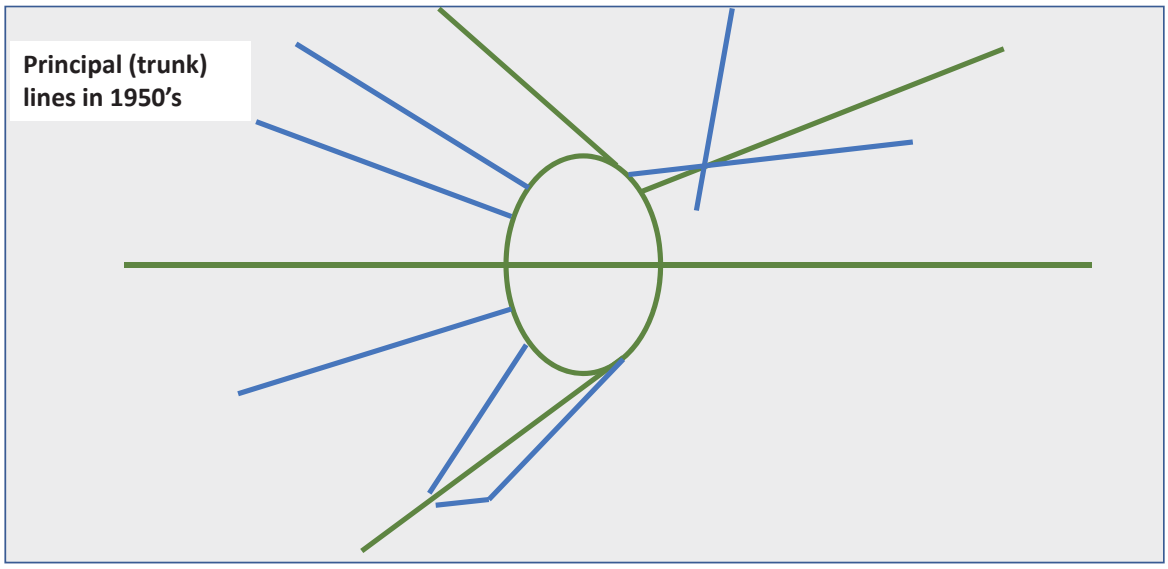
13 Will there be more new lines developed? When will the network be completed?

# 2. Institutional Setup

Who is doing it, and how?

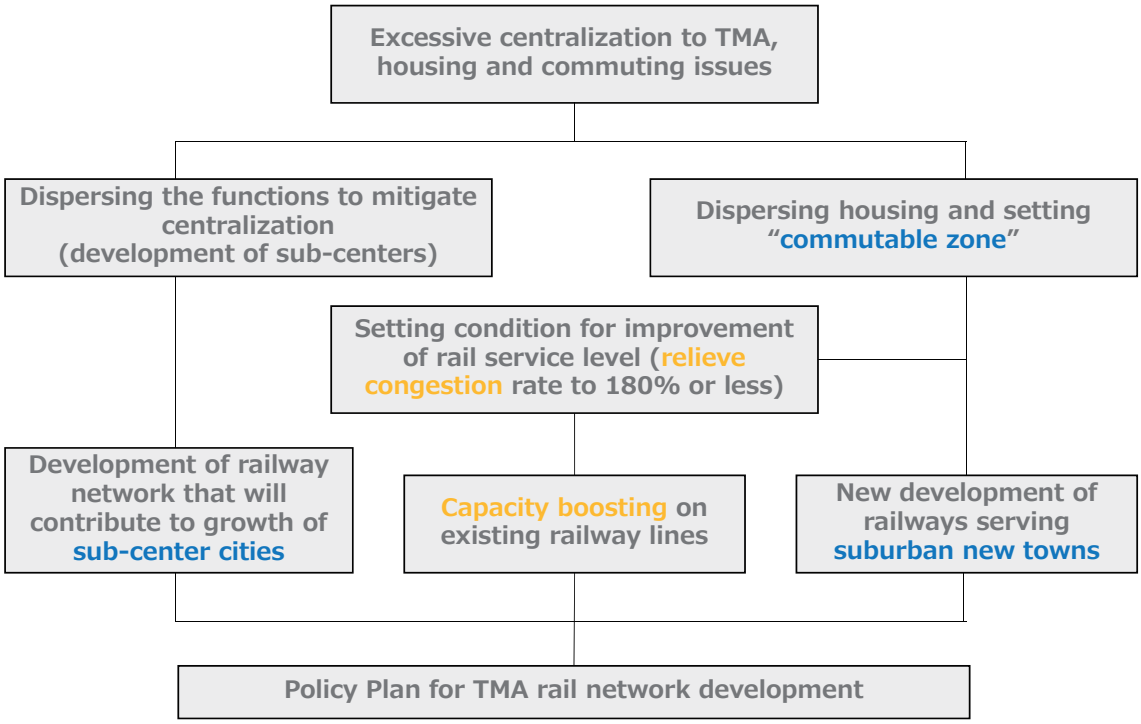
## 2-1. Council of Transport Policy

- A forum where government, academia, and other stakeholders can raise their concerns over transport network development.




https://www.sankei.com/photo/story/news/160414/sty1604140001-n1.html

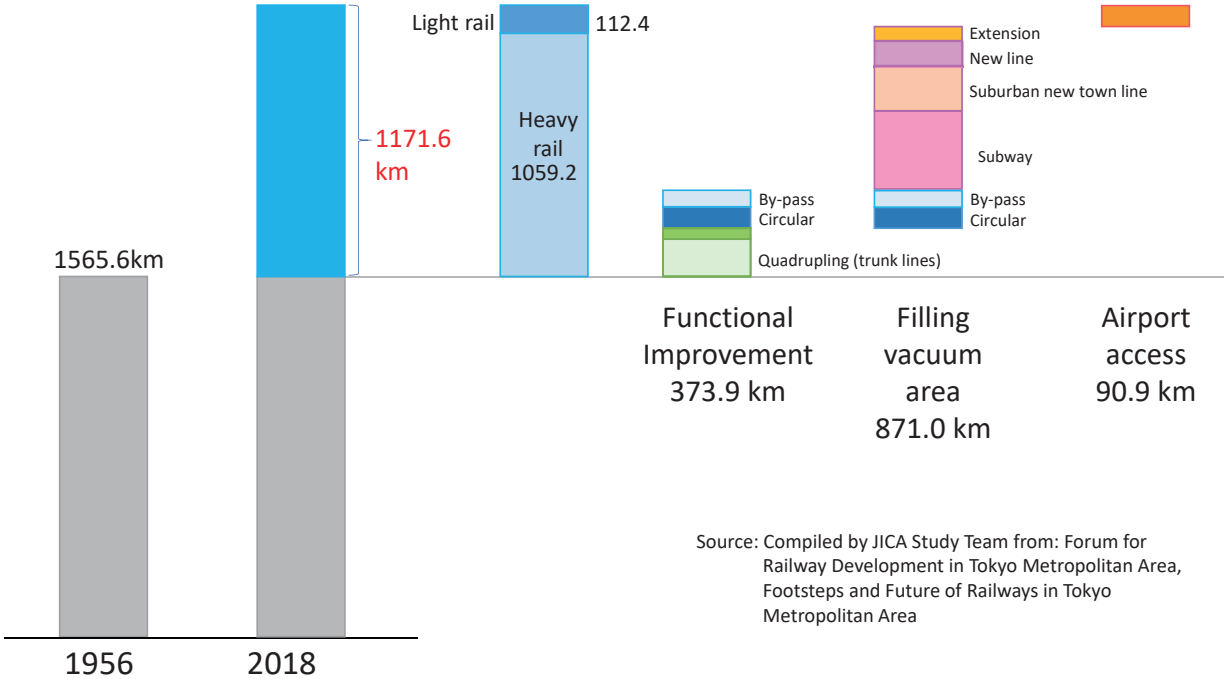
# 2-2. Issues and Solutions (1950-80)




Source: Compiled by JICA Study Team based on Japan Transport Research Institute Report

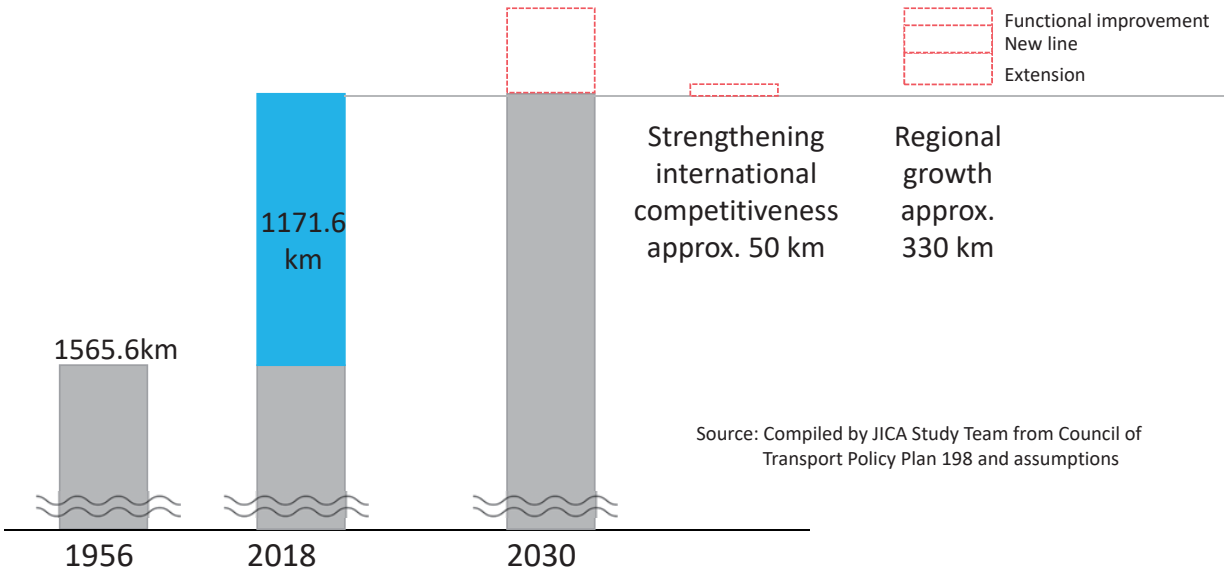


# 2-3. Council of Transport Policy (1950s-2010s): Outcome




Source: Compiled by JICA Study Team from: Forum for Railway Development in Tokyo Metropolitan Area, Footsteps and Future of Railways in Tokyo Metropolitan Area

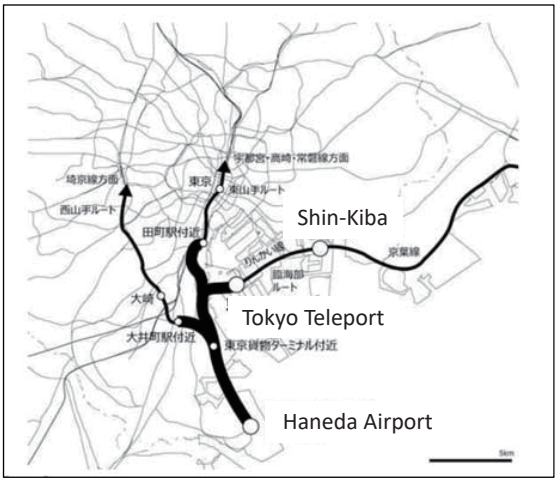
# 2-4. Council of Transport Policy (2016 onwards): Plan

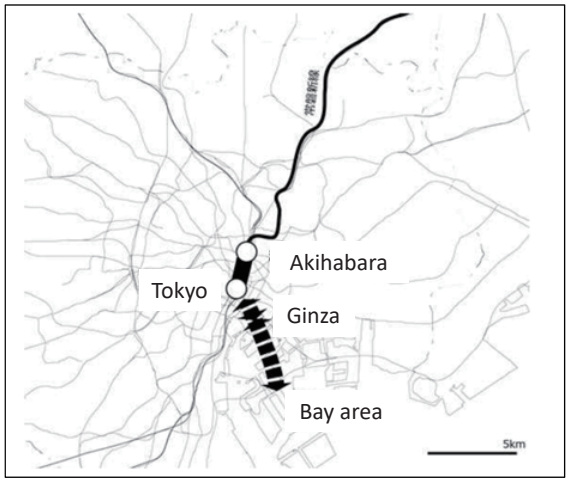



Source: Compiled by JICA Study Team from Council of Transport Policy Plan 198 and assumptions



# 2-5. Future Development Plan Towards 2030




Source: Extracted and translated from Council of Transport Policy Plan 198 by JICA Study Team

## 2-6. Responsibility for Implementation

- Cases of Tokyo and London show that there is a well-structured responsibility and incentive combination.

| Title: | Bangkok | Tokyo | London |
|---|---|---|---|
| **Development Plan** | Mass Rapid Transit Master Plan (M-MAP) | Policy Plan | Mayor's Transport Strategy |
| **Drafting entity** | Office of Transport and Traffic Policy and Planning (OTP), Ministry of Transport | Council of Transport Policy Planning<br>Role: survey and deliberation of essential policies in response to consultation from Minister (as stipulated in the MLIT Establishment Act) | Transport for London (TfL), Greater London Authority |
| **Endorsing entity** | Prime Minister | MLIT Minister | Mayor of London |
| **Implementation** | • PPP license awarded private companies<br>• SRT | Railway operator companies in collaboration with the central and municipal governments. | TfL, in consultation with the central government and Boroughs. |
| **Financial incentives** | • SEPO, under the Ministry of Finance offers financial incentives to PPP projects. | Promotional measures such as subsidizing are available. The measures are mostly tailored for certain projects. | • Government grant<br>• "Business Rates", which is a levy on non-residential property usage. |

Source: JICA Study Team



## 2. Questions you may have on Institutional Setup

21 Who is being influential in policy plan development? Is the government so strong, or is there a political pressure from an influential person?

22 How are the transport operators involved in the policy plan development?

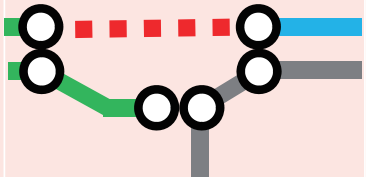
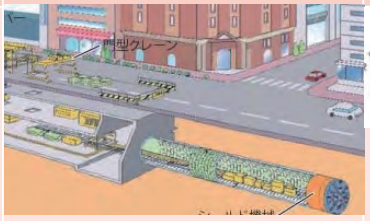
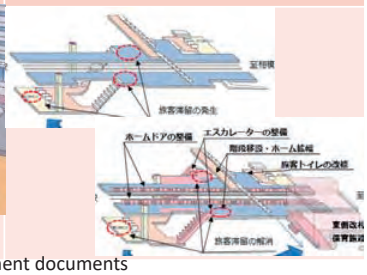
23 What motivates the transport operators to proceed with the projects? Does the Government "impose" the operators to conduct the projects? What if the operator refuses to implement a project?

# 3. Funding

Where is the money coming from?

## 3-1. Financial Support for Railways Development (1)

- Major on-going financial support programs for urban railway development

| Name | Support Program for Urban Railways User Promotion (improvement of rapidity and/or connectivity) | Support Program for Subway Development (new line, disaster resilience, barrier removal) | Support Program for Comprehensive Improvement of Railway Stations |
|---|---|---|---|
| Subject | Construction + ancillary + land acquisition | Total cost (minus manpower, admin, rolling stock, interest rate) x 1.02 x 80% x 90% | Civil, track, electric, station, ancillary, and land acquisition |
| Portion | Up to 1/3 (matching amount with subsidy from municipal governments) | Up to 35% (matching amount with subsidy from municipal governments) | Up to 1/3 (matching amount with subsidy from municipal governments), and up to 2/10 of the entire project cost |
| | FY 2018 budget: JPY 11.6 billion | FY 2018 budget: JPY 4,6 billion | FY 2018 budget: JPY 2.3 billion |
| Example |  |  |  |

Source: extracted and edited by JICA Study Team based on JRTT and Fukuoka City Government documents

# 3-2. Financial Support for Railways Development (2)

- Other financial support programs for urban railway “quality” improvements

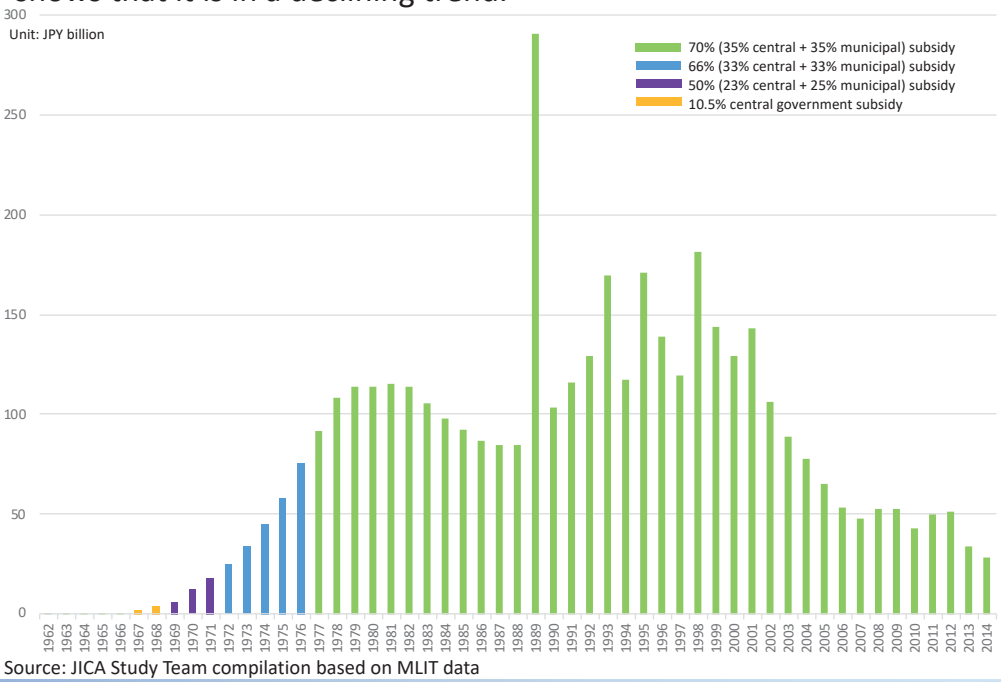
| Name | Support Program for Railway Facilities Safety Improvement (earthquake resistance) | Support Program for Maintenance of Regional Public Transport (for user environment improvement) | Support Program for Transport Service Convenience Improvement (nurturing favourable environment for inbound tourists) |
|---|---|---|---|
| Subject | Structural improvement of elevated track station (with connecting or terminating facility, daily users of more than 10,000) | Low-floor LRT, barrier-free station, and vibration reduction track | Introduction of common IC cards, multi-lingual information boards |
| Portion | Up to 1/3 (matching amount with subsidy from municipal governments) | Up to 1/3 | Up to 1/3 |
| | FY 2018 budget: JPY 4.0 billion | FY 2017s budget: JPY 2,5 billion | FY 2017s budget: JPY 5.0 billion |
| Example |  |  |   |

Source: extracted and edited by JICA Study Team based on MLIT document



# 3-3. Declining Trend of Support Program Disbursement

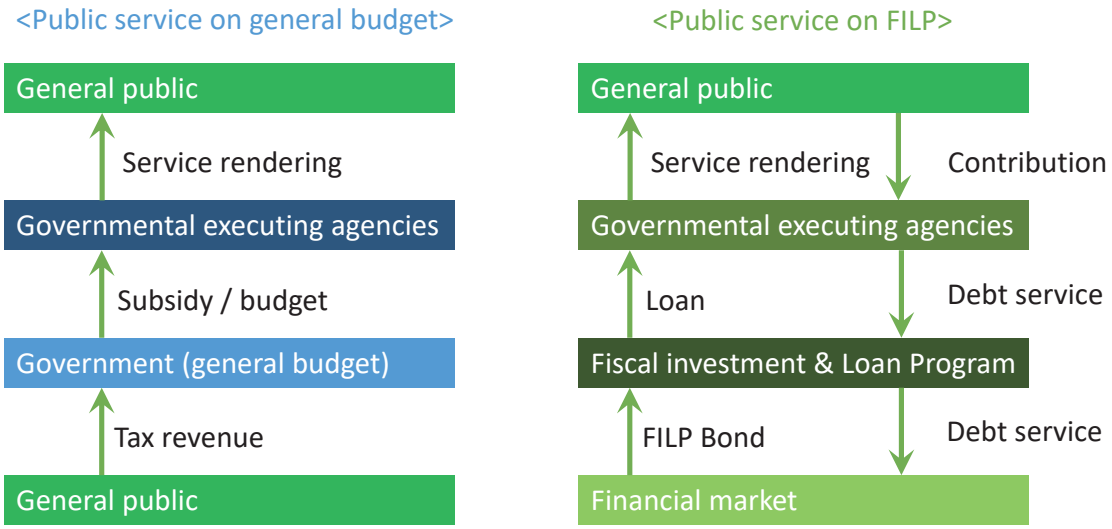
- An example of underground railway development support disbursement shows that it is in a declining trend.




Source: JICA Study Team compilation based on MLIT data

## 3-4. Sustainable Funding Source: Policy Financing

- Policy Financing, such as the "Fiscal Investment and Loan Program: FILP" has been offering long-term low interest finance for infrastructure development.
- Sustainable infrastructure funding with limited influence from tax revenue condition.




Source: translated by JICA Study Team based on MOF document



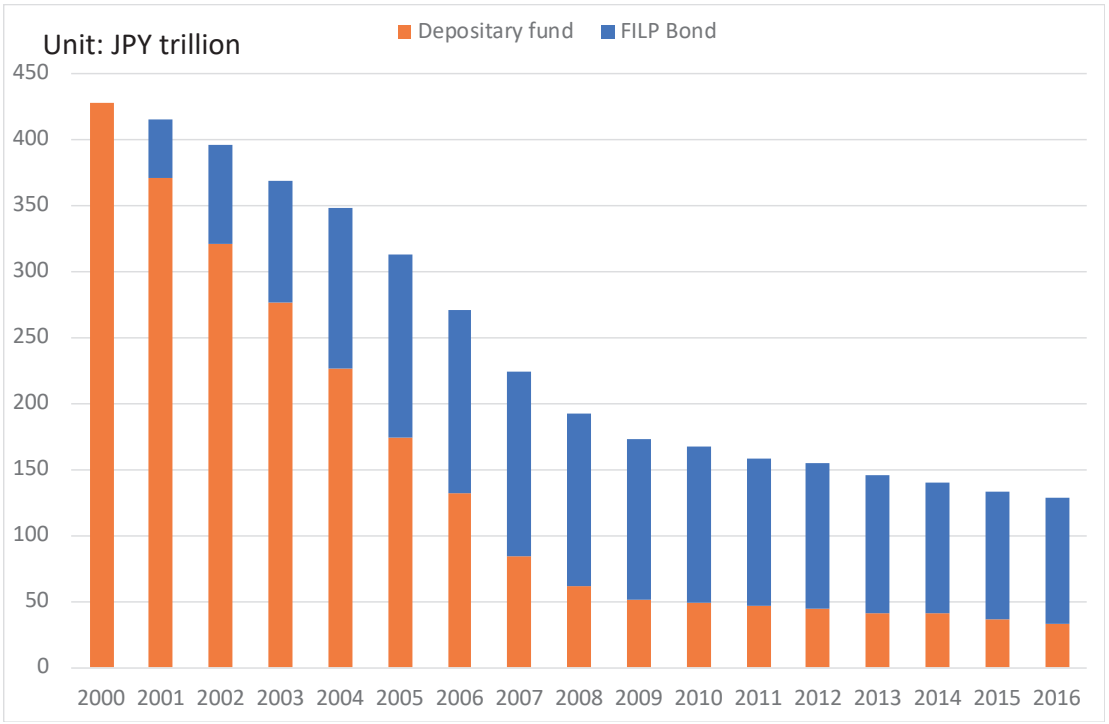
## 3-5. Policy Financing in Other Countries

- Countries where infrastructure development has taken place are mostly furnished with policy financing instruments.

| | US | Canada | UK | Germany | France | Japan |
|---|---|---|---|---|---|---|
| Comprehensive Programme | Federal Credit Program: FCP | - | - | - | - | Fiscal Investment and Loan Program: FILP |
| Infrastructure | - | - | - | KfW | Bpifrance | DBJ |
| Trade, overseas investment | EMIM | EDC | UKEF | KfW IPEX Bank, DEG, KfW Entwicklungsbank | AFD, Bpifrance | JBIC , JICA |
| SMEs | SBA | BDC | BBB | KfW | Bpifrance | JFC |
| Housing | FNMA, FHLMC, FHLB | CMHC | | KfW | CDC | JHF |
| Policy financing outstanding balance (FY 2015) | USD 6 trillion JPY 660 trillion | CAD 326 billion JPY 27 trillion | - | EUR 273 billion JPY 33 trillion | EUR 205 billion JPY 25 trillion | JPY 97 trillion |
| Reference: Domestic non-financial sector outstanding debt (FY 2015) | USD 45 trillion JPY 5 quadrillion | CAD 9 trillion JPY 746 trillion | GBP 8.7 trillion JPY 1.3 quadrillion | EUR 8.8 trillion JPY 1 quadrillion | EUR 13 trillion JPY 1.6 quadrillion | JPY 3.5 quadrillion |

Source: edited and translated by JICA Study Team based on MOF document

## 3-6. FILP is no longer a magical tool, but is sufficient




Source: JICA Study Team based on MOF data



## 3. Questions you may have on Funding Facilities

31 Aren't you criticized for subsidizing private companies' businesses? How do you justify the subsidies?

32 If the transport operators are taking all the operation risks including ridership risk, don't some of the transport operators go bankrupt?

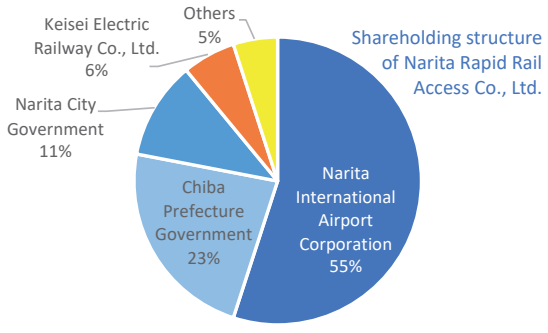
33 With the existing money running out, what will be Japan's next funding source? How are you going to make it sustainable?

# 4. Project Formulation

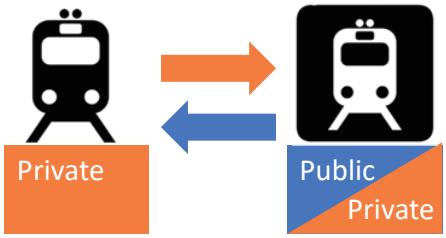
How to get it going

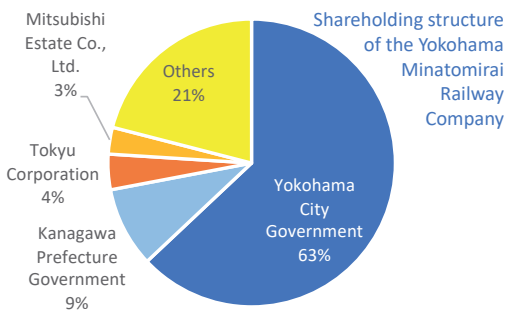
## 4-1. Various Types of Public - Private Collaborations

- Public-private jointly-owned railway facility company
  (leasing the facility for a private railway)

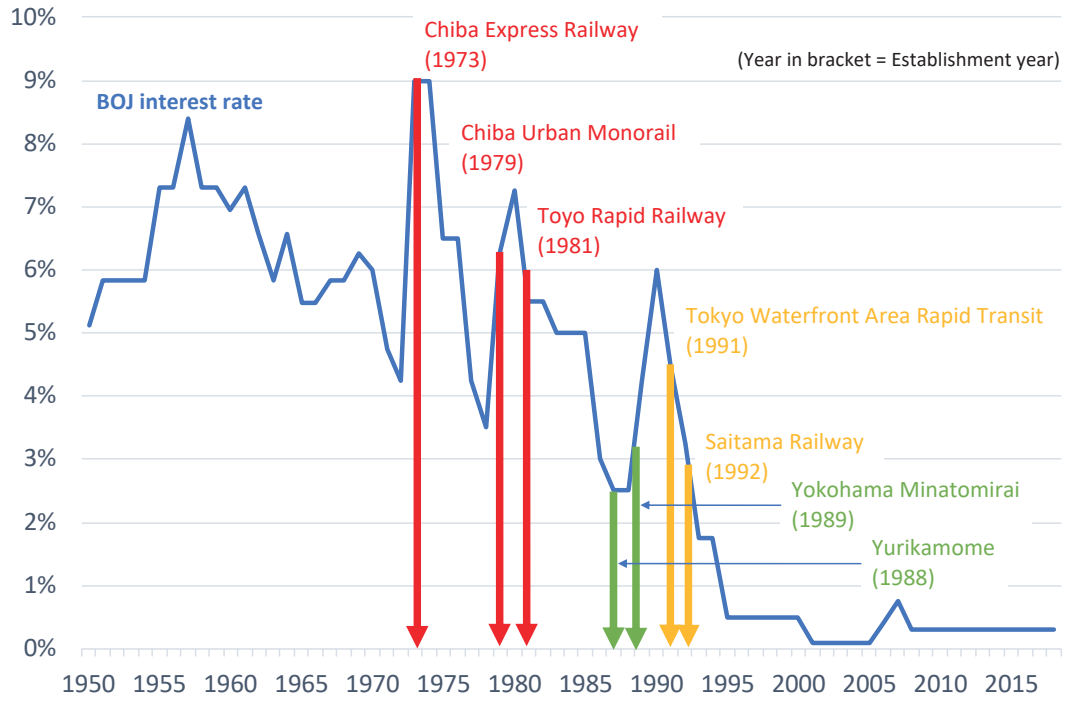

- Public-private joint investment (third sector) railway (with through service to a private railway)




Source: Compiled from Narita Rapid Rail Access Co., Ltd. and Yokohama Minatomirai Railway Company websites and disclosures.

# 4-2. Key for Success in Railways Development: Capital Cost




Source: JICA Study Team



# 4-3. Financial Status of Railway Companies

Similarities in cost per revenue level can be observed.


Source: JICA Study Team compiled from Annual Railway Statistics of Japan and financial disclosures.

## 4-4. Diversifying Business

- Railway operators have the advantage in capturing the customers.


Source: Tokyu Corporation website, September 2018



## 4-5. IC Card Automated Fare Collection (AFC)


Source: Tokyo Metro

IC Card AFC enables:

- O/D data and user behavior data collection;
- Small denomination fare collection – for **discounts** and **surcharges**;
- Introduction of **loyalty** points program, etc.

# 4-6. Flexible Fare Collection through IC Card

- With an IC card AFC, flexible and small denomination fare setting will be possible.
  An example of off-peak discount and $0.01 unit collection

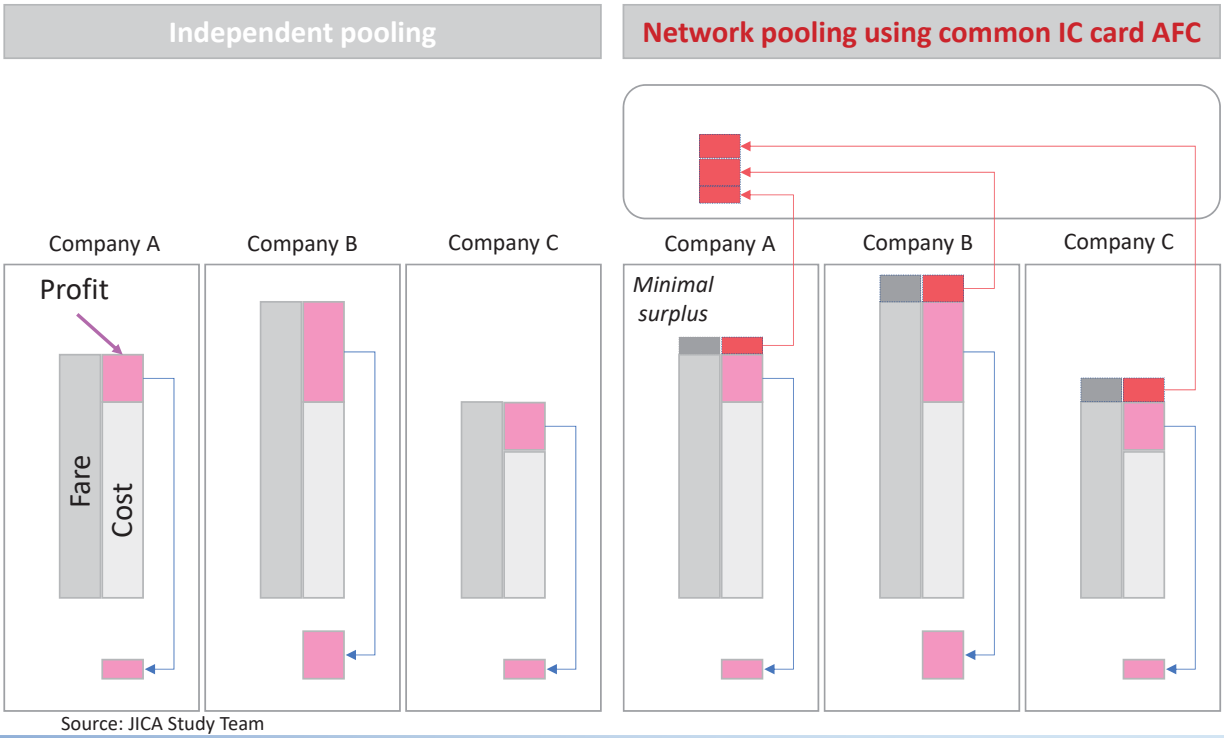
(AUD=THB 23.5)


| | 0-10km | 10-20km | 20-35km | 35-65km | >65km |
|---|---|---|---|---|---|
| Adult Opal card | $3.54 ($2.47 off peak) | $4.40 ($3.08 off peak) | $5.05 ($3.53 off peak) | $6.76 ($4.73 off peak) | $8.69 ($6.08 off peak) |
| Adult Opal single trip ticket | $4.40 | $5.40 | $6.20 | $8.20 | $10.60 |
| Child/Youth Opal card | $1.77 ($1.23 off peak) | $2.20 ($1.54 off peak) | $2.52 ($1.76 off peak) | $3.38 ($2.36 off peak) | $4.34 ($3.03 off peak) |
| Child/Youth Opal single trip ticket | $2.20 | $2.70 | $3.10 | $4.10 | $5.30 |
| Concession Opal card | $1.77 ($1.23 off peak) | $2.20 ($1.54 off peak) | $2.52 ($1.76 off peak) | $3.38 ($2.36 off peak) | $4.34 ($3.03 off peak) |
| Gold Opal card | $1.77 ($1.23 off peak) | $2.20 ($1.54 off peak) | $2.50 ($1.76 off peak) | $2.50 ($2.36 off peak) | $2.50 ($2.50 off peak) |

Source: New South Wales Government opal card website



# 4-7. Network Pooling Fund by IC Card AFC




Source: JICA Study Team

## 4. Questions you may have on Project Formulation

41 Who is bearing the cost of connection discount fare?

42 What are the merits and demerits of through train services?

43 Why don't you encourage competition by tendering out the railway development projects under PPP business scheme?

44 Who is coordinating connectivity improvement efforts?



# 5. Recommendations

Conclusions of the presentation today

## 5-1. Summary of Presentation

1. During the 140 years of history, initially the **national government** and consequently **municipal governments** have each been contributing to the railway network development.
2. A **common desire** for "reconstruction" has motivated the development of the TMA rail network.
3. **Responsibility sharing and collaboration** among urban (subway) and suburban (private) transport operators has been a key for an efficient network development.
4. A **continuous improvement** and value additions are taking place. Investment will be required even after the completion of a railway line.
5. Now, Japan is inclined to be resorting to **beneficiary payment** principle.



## 5-2. Recommendations

1. Based on social and economic issues in BMA, qualitative and **quantitative targets** can be set on the **service level of the network**. It will justify budgeting for the network development.

2. Under financial resources constraints, the basic principle of funding should be beneficiary payment basis. A **network pooling fund** will be a useful provision for future **value-addition** to the network (with a common IC card AFC, flexible discounts, surcharge and loyalty schemes becomes possible).

3. Sustainable funding source is nevertheless required. A **policy financing** mechanism for infrastructure development can be considered.

# Thank you for your attention

**Workshop on Implementation Mechanism of M-MAP2**

# Appendix 3

Review of Tokyo Metropolitan Area (TMA) Railway Development

# Appendix 3: Review of Tokyo Metropolitan Area (TMA) Railway Development

## Table of Contents

# 1. History of Railway Development in Tokyo Metropolitan Area (TMA)

The history of TMA railway network development dates to 1872 when the first steam railway line officially started its operation between Shimbashi Station located in central Tokyo and Yokohama Station in the center of the port city. This development, which can be regarded as one of the symbolic achievements of modernization in Japan, took place approximately half a century after the world's very first railway operation of the Stockton and Darlington Railway in 1825.

Today, Japan's railway network exceeds 27,000 km of operating lines of which approximately 2,700 km is within TMA. This network of railway lines in TMA was developed in consequence of the steps that can briefly described as follows.

## 1.1 Early Days (from end of 19th century to beginning of 20th century)

Following the success of the first railway line that served Tokyo and Yokohama, new lines were developed mostly in urban areas throughout the country. In those days, the railway business was profitable in most cases as it could become a dominant player in the transport of goods. All five radius trunk lines that extended from central Tokyo to the suburbs were developed during this period. In order to support the railway network expansion of TMA, the Tokyo Railway Investment Master Plan in 1903 was enacted. It may be considered as one of the earliest urban development plans in Japan. At the time, the railways were both government and privately owned. but following the enactment of the Railway Nationalization Act in 1906, majority of the railways became governmental except for some regional and urban lines that were not regarded as essential lines. In TMA's case, there were still many privately-owned lines that remained. In the beginning of 20th century, the railway network of TMA reached approximately 500 km.

## 1.2 Rapid Development (First half of the 20th century until the defeat in World War II in 1945)

With the rapid urbanization of TMA, the case of new railway lines construction increased significantly, especially among the private railway enterprises. It was also due to the country's modernization and under the government's slogan to build a wealthier and stronger country that industrial development was encouraged. Many of the development projects materialized just after the Great Kanto Earthquake, which hit TMA in 1923. The first subway train also entered service in 1927. By then, the network grew thrice to approximately 1,400 km in total length. Development slowed down after the defeat in World War II until the beginning of the 1950s.

## 1.3 Reconstruction (1950s to 1960s)

Railway development was one of the key elements to support the reconstruction of TMA. Nine years after the end of the war, the second subway line in Tokyo started operation in 1954 (Marunouchi Line). This was one of the remarkable achievements in the reconstruction

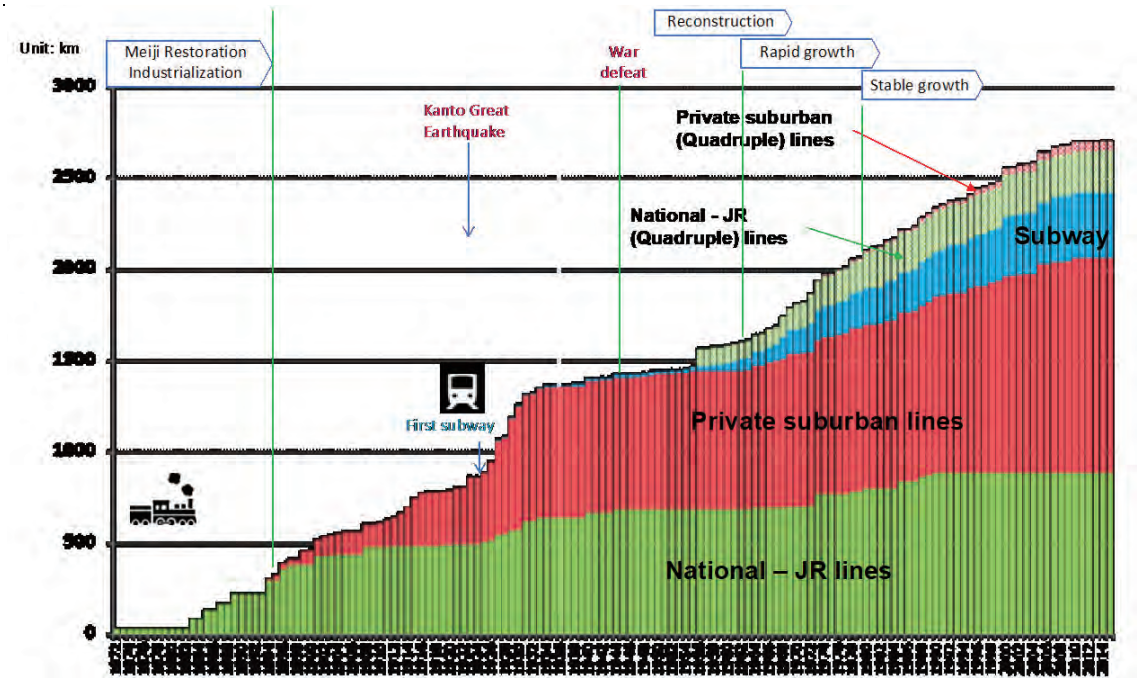
activities in Tokyo that was found to be effective in the promotion of economic development as it could replace trams that suffered from heavy traffic overground. With the success of this second subway line, the development of further lines soon followed. The third line is Asakusa Line that opened in 1960, fourth is Hibiya Line in 1961, fifth is Tozai Line in 1964, sixth is Mita Line in 1968, seventh is Chiyoda Line in 1969 and so on. As for the surface trunk lines, the quadrupling of the five major trunk lines were conducted, which contributed to the increase in transport capacity on these lines. Meanwhile, the suburban railways started through operation services with the subway lines so that the passengers from the suburbs could travel directly to the central business district (CBD) without train transfer.

## 1.4 Rapid Growth (1970s to 1980s)

Railway development during this period is closely related to urban and regional development. Some new extension lines were placed to link the suburban new towns (newly developed residential areas). In parallel with the new extensions, quadrupling of many of the existing lines were done to increase the capacity as well as to introduce faster services to reduce travel time. The opening of the outer circle (Musashino Line) significantly contributed to fill the vacuum in the outskirts of Tokyo, which were not accessible on trains. As such, both placement of new extensions and reinforcement of the existing lines were intensively conducted during this period of rapid growth.

## 1.5 Stable Growth (1990s onwards)

The network continued to grow mostly through contribution of the private railway enterprises, subway operators and the "third sector" railway companies, which were the public-private joint investment railway companies mostly under the initiatives and leadership of the municipal governments (mostly prefecture governments with some city governments). Airport connection lines were also further reinforced, offering more than one choice of rail access to both Narita and Haneda Airports. In the urban area, subway continued to enhance its network, resulting in most of the urban area being accessible to nearest railway station within walking distance.




Source: Minister of Land, Infrastructure, Transport and Tourism (MLIT) Annual Statistics of Transport.

**Figure 1.1 Chronology of Railway Development in TMA**

## 2. Railway Operators and Administrators

The railway network development started under central government ownership, but also with the participation of private enterprises. Although under the Railway Nationalization Act of 1906, the government could not respond to all the demand for railway development in TMA that they issued railway development and operation license to private companies for proposals not regarded as a threat for the development and maintenance of the national railway network. It was for this reason that by 1930s, the total length of the private railways in TMA surpassed that of the national railway.

Another law affected the railway operation and administration and it is the Land Transport Business Coordination Act of 1938 that virtually allocated the transport operators' business territory. The major aim of this act was to coordinate various transport operators' business activities to prevent conflict among them. It also functioned to guarantee the operators' business existence for that specific allocated area. A striking feature of the act to be noted was that the transport services of both road and rail in the urban area of Tokyo was to be handled by Tokyo Metropolitan Government (TMG), while the underground (subway) was to be monopolized by a public company newly incorporated for this purpose. This public company, Teito Rapid Transit Authority (currently succeeded by Tokyo Metro), was jointly owned by the central government and Tokyo Metropolitan Government. This arrangement made the entire subway network an oligopoly of Teito Rapid Transit Authority and TMG Bureau of Transport, which were both governmental organizations. Because the construction of subway network infrastructure costs more than the overground, a subsidy was essential. The TMA subway network was quickly developed by these two governmental companies under subsidization.

Meanwhile, the development of the suburban railway lines other than subways were mostly done either by privately-owned railway enterprises that are mostly unsubsidized or by newly set up "third sector" railway companies that are joint investment of public (prefectural governments or city governments) and private companies, with subsidy or in-kind support from the public sector. This way, various private and public entities and joint investors contributed significantly to the development of TMA railway network. They had different responsibilities, but collaborated with one another. Collaboration included through train services between subways and suburban railway lines, and fare discount for connecting passengers travelling on two or more railway companies.

Currently, (i) JR East (used to be the Japan National Railway [JNR]), (ii) Tokyo Metro (formerly Teito Rapid Transit Authority), (iii) Municipal Government Transport Authorities (specifically Tokyo Metropolitan and Yokohama City Governments), (iv) "third sector" railway companies (by joint investment among municipal governments and private companies), and (v) other private railway enterprises (which have been private from the beginning) collaborate to shape the railway network in TMA.

# 3. Urbanization and Further Development of the Railway Network

The development of railway network in TMA was closely related to the trend of rapid urbanization in the area. Tokyo, being a city with more than a million habitants for more than three centuries, has always been a built-up urban area. The first wave of rapid "modern" urbanization started around the turn of the century in year 1900s. During the 1920s up to the 1940s, Tokyo became an industrialized urban area; the capital that built itself up under the slogan to become wealthier and stronger. However, when World War II ended in 1945, the capital was burned down to ashes with only a limited infrastructure remaining (subway line avoided the destruction being underground). Reconstruction soon started and the railway network was restored to be expanded again from around 1950s, which is the beginning of the post-war urbanization, and continued until the 1990s. The development of the railway network in TMA in the context of urbanization is hereby explained.

## 3.1 Reconstruction and Formulation of Railway Network Development up to 1950s

The network at the time comprised of the inner circle overground railway line, the Yamanote Line (already started circular operation in 1925), and many radial lines that connected the urban with suburban areas in various directions. The area within Yamanote Line, by this time, could be regarded as an urban area with CBDs developed inside and on the line. Inside the line, a railway network was mostly developed as tramways (except for one subway line and one national railway traversing line). The network as of early 1950s can be considered as the main framework for future expansion. With reconstruction of the capital city's infrastructure, the economic activities had become vibrant that resulted in severe road congestions. To cope with the demand for a modern mass transport, the first post war subway line opened in 1954. This subway line significantly supported the economic activities in the center of Tokyo.

## 3.2 Urbanization and Railway network after 1955

Figure 3.1 describes the railway network length expansion from 1955 onwards. New railway lines were developed to solve various problems due to rapid urbanization, such as serious road congestion, increasing demands to link new town developments with the CBDs to support the rapid population growth, in-train congestions, and so on. Since 1955, more than 1,200 km of additional railway lines in TMA has been developed and the network is still continuously expanding. It should also be noted that the investments were not only for new line development but also for improvement of the existing lines, such as quadrupling, adding connection and by-pass links, and reinforcement of stations, etc. The long history and experience of railway development can be considered as foundation for the economic and social development of TMA.

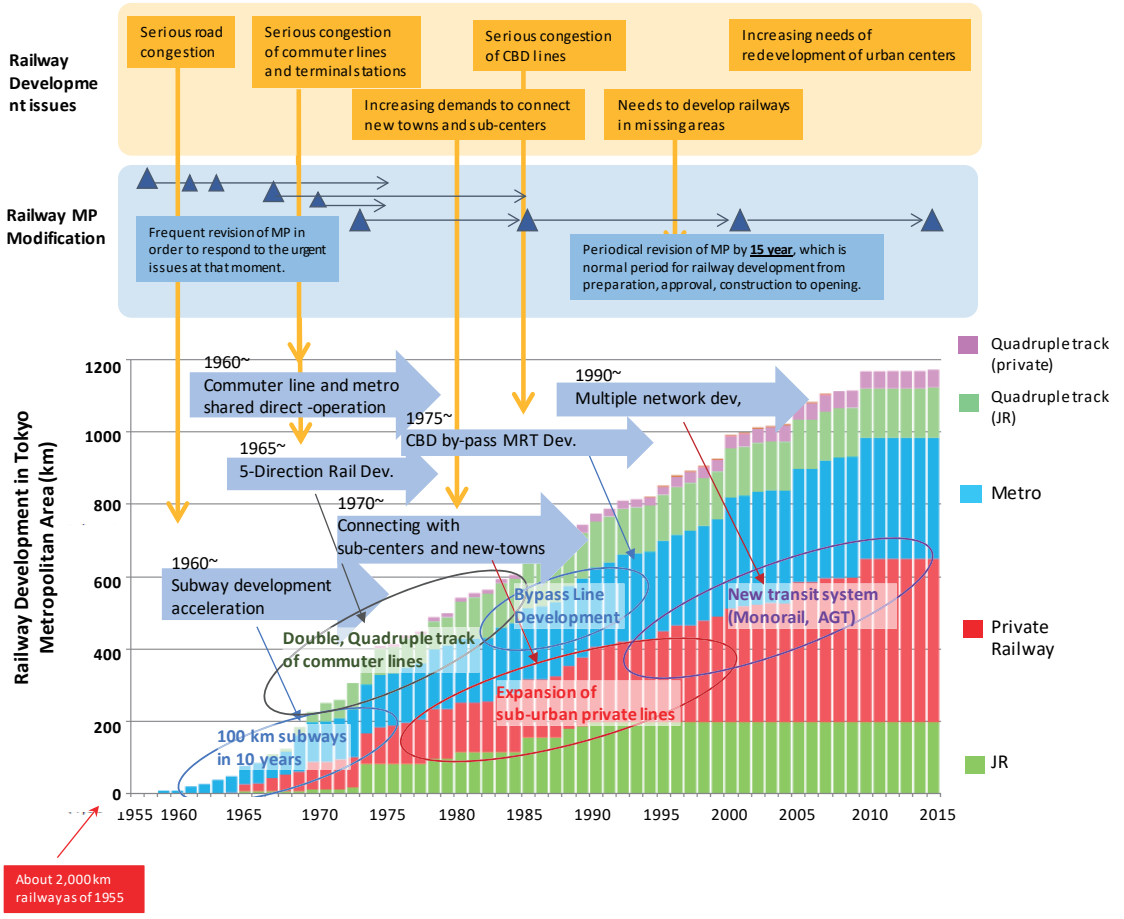



**Figure 3.1 Railway Development and Social Issues**

The first trend to cope with the rapid urbanization was to introduce subway lines across the urban area of central Tokyo. There was a desperate need to replace the trams that no longer functioned (as expected) because of serious traffic jams, so the subway development was accelerated through the participation of the Tokyo Metropolitan Government from what used to be a monopoly by Teito Rapid Transit Authority. Subway lines with a length of 100 km were developed in 10 years. These were mostly developed so that suburban radial railway lines could operate through-services. This through-services were found effective in realizing seamless transport for those commuting from the suburban new towns into CBDs without transfer at the connecting stations (congestion at suburban railway lines' terminal stations were already a serious problem). This concept of through service has now been applied to almost all of the radial suburban lines. Consequently, there was an efficient role-sharing between the governmental subway network development (which is, by far, capital intensive compared with the overground railway development) and private suburban network development. Private railway enterprises could provide direct service to CBDs without the need to invest in a cost-intensive subway, while governmental subway operators enjoyed the transfer of passengers from the outskirts on through-services from the suburban network. Both urban and suburban operators benefitted from this role-sharing model.

As for the overground network, in 1956, the five major radial lines that stretched out of Tokyo (all belonged to JNR that time) were quadrupled under a program named the Five-Direction Rail Development. This bold improvement program significantly boosted the transport capacity of these lines as well as shrink travel time duration by introducing fast train service on quadrupled tracks. The outer circle line was developed (by means of introducing passenger trains on what used to be a freight line) after the reinforcement of the radial lines that. As such, the whole network function was upgraded during the time.

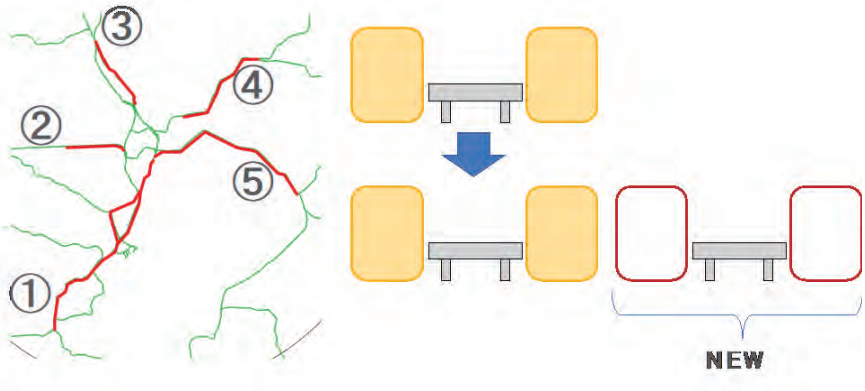
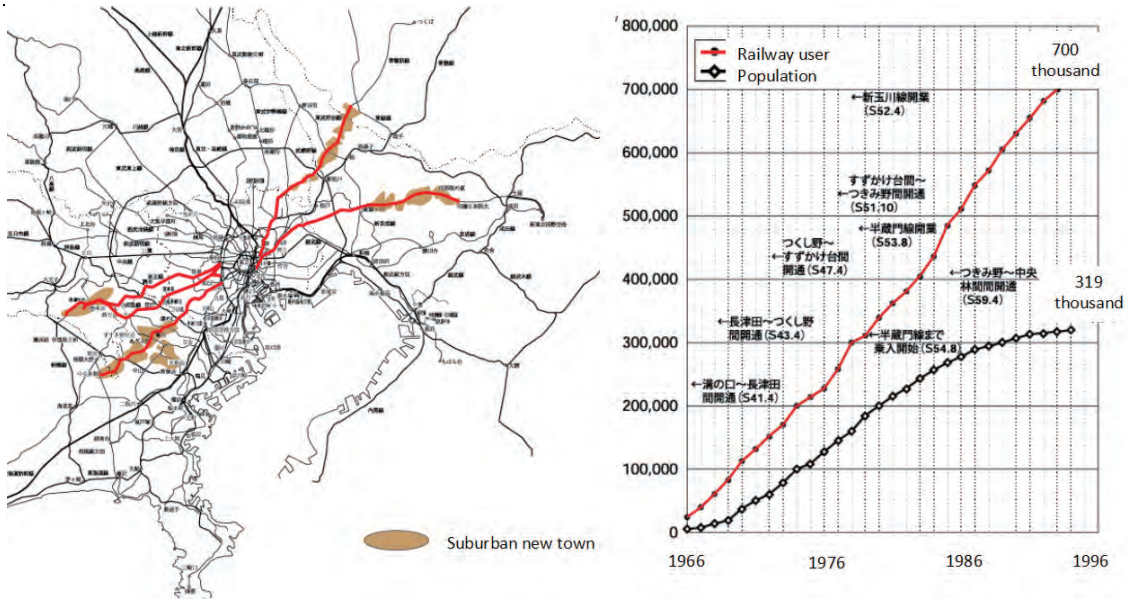



**Figure 3.2 Five Directions Rail Development (Quadrupling)**

From the latter half of 1970s onwards, the development of TMA rail network diversified to include various new functions including (i) subways by-passing conventional CBDs, (ii) third sector railway extensions to mass transit vacuum areas, (iii) airport connections, (iv) light rail development for rejuvenation of areas lacking in transport convenience, and (v) increase choices of routes through development of parallel lines. The diversification of railway network functions sustained urbanization in a wider area in TMA. Further rail network development in TMA was then pursued to underpin the trend of urbanization.




Source: Forum for Railway Development in Tokyo Metropolitan Area, Footsteps and Future of Railways in Tokyo Metropolitan Area.

**Figure 3.3 Network Development Linking Suburban New Towns and CBDs**

## 3.3 Railway Network Development and Socio-Economic Growth

Table 3.1 shows the comparison of growth of population, gross regional product (GRP), and railway network length in TMA for the past 60 years.

From 1956 to 2016, railway network length extended 1.73 times more from 1,566 to 2,705 km. From 1960 to 2010, the nighttime population in the four prefectures that belong to TMA increased from 17.8 to 35.6 million; furthermore, their total GRP increased 6.18 times more from 28.92 trillion yen to 178.8 trillion yen. This correlation could explain that railway network development has been one of the main foundations to the population and economic growth in TMA.

**Table 3.1 Transition in Railway Network Length and Socio-Economic Growth**

| TMA stats | 50+ years before | | Recent stat | | Times increase |
|---|---|---|---|---|---|
| **Nighttime Population (4 TMA prefectures[1])** | 1960 | 17,864,000 (19.8% of national population) | 2010 | 35,619,000 (27.8% of national population) | 1.99 times |
| **GRP(real) (4 TMA prefectures)** | 1964 | 28.92 trillion yen | 2011 | 178.80 trillion yen | 6.18 times |
| **Railway network length (TMA)** | 1956 | 1,566 km | 2016 | 2,705 km | 1.73 times |
| **Number of railway station (TMA)** | 1956 | 807 station | 2016 | 1,510 station | 1.87 times |

[1] Only Tokyo, Kanagawa, Saitama and Chiba were considered. The southern part of Ibaraki was excluded.

| | | | | | |
|---|---|---|---|---|---|
| **Motorway length (nationwide)** | 1960 | 0 km | 2011 | 7,920 km | - |
| **Highway length (nationwide)** | 1960 | 972,688 km | 2011 | 1,204,744 km | 1.24 times |
| **Sewage coverage（4 TMA prefectures）** | 1964 | 18.9% | 2012 | 94.2% | - |
| **Electric consumption (nationwide)** | 1964 | 157,208GW/h | 2010 | 1,031,799GW/h | 6.56 times |

Source: Yuichi MOHRI and Jun MORIO. Tokyo Metropolitan Area: Change for 50 years and Future Vision ～Change and Future of Metropolis according to the Data～ (Japanese).

## 3.4 Contributions from each sector towards railway investment and operation

Since 1872, the central government, local authorities, private railway companies, and other public-private railway enterprises cooperatively shape the railway network in TMA.

**1) Before World War II (until 1945): National railway period[2]**

Since the opening of the TMA railway network in 1872, its expansion has been continuously invested in by both public and private sectors. However, since the railway nationalization in 1906, railway in TMA was mainly invested in by the government until the end of World War II.

During this period, the characteristics of TMA railway are mainly trams in the CBD area and national railway and private railways in the suburban area.

**2) After World War II (after 1945): The development of the subway system**

Since the opening of Marunouchi Line (Ikebukuro–Ochanomizu section) in 1954 by Teito Rapid Transit Authority (currently Tokyo Metro), the development of subway lines inside the Yamanote Line is mainly conducted by Tokyo Metro and Bureau of Transportation of TMG.

Before WWII, the subway lines in the CBD area were constructed by many private firms (subway Ginza Line has been in operation since 1927). However, those private firms scattered and developed their own lines without integration. In order to have a systematic subway system, the government enacted the 1938 Land Business Adjustment Act to create Teito Rapid Transit Authority in 1941. Many private subway companies were integrated together and became a sole investor and operator in Tokyo subway.

In 2004, as one of the public corporations, Teito Rapid Transit Authority changed its name to Tokyo Metro Co., Ltd. but maintains the status of a public corporation. Therefore, it can be said that the development and operation cost of subway lines in Tokyo are financially supported by the government to maintain the good financial condition and the expected level of service.

**3) After the economic miracle (after 1950): Development of commuting lines by the public and private sectors.**

Due to the rapid city expansion during this period, there was a high demand for such

[2] Japan Transport Research Institute (JTRI). *TMA Railway: Course of History and Future*.

suburban developments in the center of Tokyo. In order to provide a smooth connection between residential and business area, public and private railway companies and other public-private railway enterprises constantly invested in new commuting lines.

In 1987, JNR was privatized in order to settle a huge debt. Since then, a portion of JNR in TMA was transferred to JR East company.

**4) Initializing the through-service (from 1960): Bridging the gap between suburban area and CBD area.**

The through-service to connect suburban commuting line with subway line in CBD was initially planned in 1956 in the Council of Urban Transport Plan (CUTP) No. 1. It was successfully implemented when the through-service between Toei Asakusa Subway and the Keisei Line started in 1960.

Since then, the collaboration between different railway companies to improve their facilities and service level has been formulated. Railway users can enjoy a smooth and convenient ride from their home to office without transferring through this collaboration.

**5) Roles of public and private sectors regarding railway investment: Extracts from the Council of Transport Policy Plan (CTPP) No. 19 (2000).**

"Generally, the railway investment should be conducted based on the business viability of such railway company."

"In the case of a private initiated project, based on the importance and the expectation of the project itself, the public entity should provide a certain level of support to ensure the success of the project."

**6) Aids from central and local governments: Extract from CTPP No. 19 (2000).**

"Regarding this, the amount of financial support from the central government and the local organization should be based on the roles and benefits of each sector."

# 4. Government Leadership in Railway Projects

## 4.1 Railway investment planning and promotion

After the end of World War II in 1945, the Japanese government tried to recover from the war damages by setting up the Committee on War Damage Reconstruction. In 1946, the Notification of War Damage Reconstruction No. 252, based on the Ministry of Interior Notification No. 49, was enacted as the first urban railway development plan in Tokyo. Since then, the committee of transportation was established in order to develop the TMA railway masterplan.

The railway master plan in TMA (hereafter, Tokyo and its vicinity of 50 km radius) was first formulated in 1956. Recent railway developments follow the direction given in the two recent plans, namely, CTPP Nos. 18 and 198. CTPP No. 18 was formulated in 2000 because of the synthesis from the previous eight master plans. As a result of emerging social issues such as aging society and policy towards globalization, the next master plan, CTPP No. 198, was formulated in 2016 by incorporating those issues along with the railway master plan. These master plans were formulated by committee members composed of the central and local governments and railway operators. With their efforts, policy towards financial support from the government as well as collaboration between private and public sectors have shaped the railway network as it is today.

As for CTPP No. 18, this plan was announced by the Ministry of Transport (MOT, but now MLIT) in 2000 and become active until 2015. The outlines of every TMA railway master plan are in the following tables.

**Table 4.1 Outline of TMA Railway Master Plan**

| Year | Master Plan | Features | Issues |
|---|---|---|---|
| 1956 | CUTP No. 1 | • Planning of subway and commuter line through service<br>• Change of regulation that allows Bureau of Transportation of TMG to invest in subway. Previously, only Teito Rapid Transit Authority was allowed. | • Business agglomeration in CBD and suburban sprawl.<br>• Rapid increase in commuting demand. |
| 1960 | CUTP No. 4 | • Prevention/Dispersion countermeasure to solve at-grade traffic problem.<br>• Discontinuation of several tram lines (change to subway or bus).<br>• Measurements to support the subway development in order to attract more public transportation users.<br>• Increase in road demand and countermeasures. | • At-grade traffic problem due to motorization. |
| 1962 | CUTP No. 6 | • Revision of CUTP No. 1 (add more proposed lines).<br>• Line extension with consideration of suburban sprawl in TMA. | • Rapid increase in trip demand to CBD due to high economic growth rate. |
| 1966 | CUTP No.9 | • Consideration of the commuting trip as the main trip purpose.<br>• Consideration of the express service and feeder system.<br>• Consideration of new line development in areas where congestion rate is already above 200%. | • Declining population growth rate in Tokyo 23 wards area.<br>• Population and business agglomeration in Yokohama and Kawasaki. |
| 1968 | CUTP No.10 | • Congestion relief countermeasure.<br>• Urban structure countermeasure (e.g. CBD expansion to the western part of Imperial Palace, development of the new sub-CBD) | • Underestimation of the population increase and suburban sprawl. |
| 1972 | CUTP No. 15 | • Expansion of railway network to new towns (NT), such as Kohoku NT, Tama NT, Chiba NT, and Kaihin NT.<br>• Promotion of sub-CBDs by investing in the new traverse line.<br>• Increase accessibility to airport and HSR station by railway connection. | • In-train congestion relief during rush hour.<br>• Long commuting hours due to suburban sprawl. |
| 1985 | CTPP No. 7 | • New line development for congestion relief in JNR lines.<br>• New line investment for new urban development (e.g. Minato Mirai 21).<br>• Strengthen accessibility to Haneda Airport. | • Multi-polarization of population growth in TMA.<br>• Urban structure change due to NT development.<br>• Internationalization.<br>• Promotion of satellite cities. |

**Table 4.2 Outline of TMA Railway Master Plan (continuation)**

| Year | Master Plan | Features | Issues |
|---|---|---|---|
| 2000 | CTPP No. 18 | • Congestion relief during rush hour.<br>• Speed improvement.<br>• Urban development and city function support<br>• Strengthen accessibility to airport and HSR.<br>• Universal design and seamless transfer. | • Although a lot of effort has been taken to promote sub-CBDs, but the business over-agglomeration in Tokyo CBD still continued.<br>• Continuation of suburban sprawl trend.<br>• Existence of high congestion lines<br>• Train delay caused by congested schedule.<br>• Existence of the area with low accessibility to Airport and HSR station. |
| 2016 | CTPP No. 198 | • Strengthen international competitiveness<br>- Increase connectivity to airport and HSR stations.<br>- Strengthen urban development in the international business hub area.<br>• Improvement of quality of life<br>- Congestion relief<br>- Speed improvement<br>- Seamless transfer<br>• Coordination with urban development<br>- Universal design<br>- Strengthening cooperation with suburban town development<br>- Ecodesign<br>• Station area improvement (invention of next-generation station)<br>- Station Management<br>- Next-level universal design<br>- Next-level foreigner support<br>- Station planning/structure renewal<br>- Integration with the city<br>• Reliability and Safety<br>- Visualization of train delay information<br>- Intensive to railway company when conducting a service improvement<br>- Cooperation with rail users<br>- Information sharing with rail users<br>• Strengthen disaster prevention measurements<br>- Visualization of disaster prevention measurements<br>- Disaster prevention measurements from tangible and intangible aspect | • Promotion of Tokyo as a traction city to strengthen international competitiveness.<br>• Promotion of Tokyo Olympics, Paralympics.<br>• Large-scale earthquake, climate change, or other large-scale disaster prevention measurement.<br>• Severe fiscal conditions. |

The CUTPs and CTPPs reflected the urbanization issues and the need for transport

infrastructure development in each of period they were drafted. An example of the issues, solutions, and targets summarized for CTPP No. 18 is in Figure 4.1. Excessive centralization in TMA caused housing and commuting issues. The solution was to develop suburban new towns and sub-center cities as the suburban CBDs with the aim to disperse the urban functions away from the conventional CBDs in the center of Tokyo. In parallel, the capacity of railway transport was planned to be increased so that in-train congestion would be relieved, enabling a decently commutable environment. A strategy encompassing these solutions was drafted as the development plan of the railway network in CTPP No. 18. Other CTPPs and CUTPs mostly followed a similar pattern to reflect the urbanization issues and possible solutions to be addressed. CTPPs and CUTPs, therefore, could be commonly recognized and shared among various stakeholders, which are the governments, academicians, transport operators, and most of all, transport users and citizens in general.

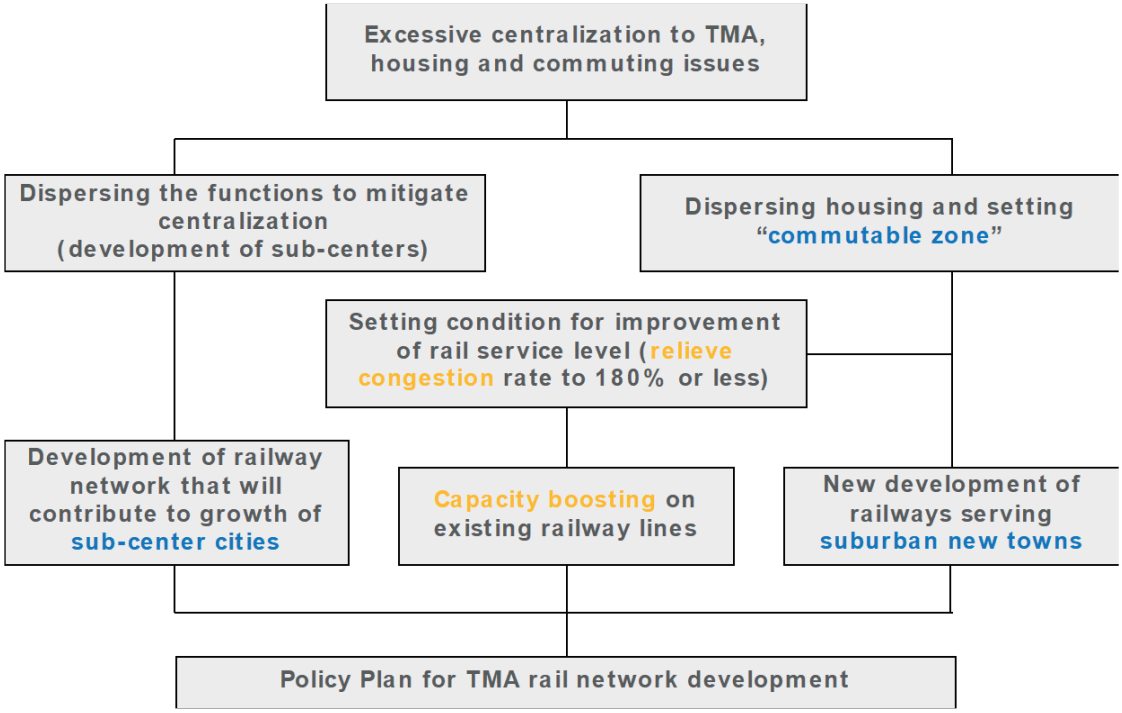



**Figure 4.1 Network Development Linking Suburban New Towns and CBDs**

## 4.2 Implementation Steps in Railway Investment Planning and Promotion

### 1) Preparation and discussion

The first committee meeting was held in November 1998 and the meetings took about a year until the last one in January 2000. The series of seminars on the railway master plan discussion was continuously organized by MoT. Furthermore, The Japan Transport Economics Research Center (JTERC, now JTRI) was established in 1997 to launch the research coordination among the academics, MoT bodies, railway companies, and local transport authorities.

### 2) Planning

**Committee members and related sectors**

During the planning stage, the mass media and potential users other than railway operators were also invited to be part of the committee members in order to fulfill the demand from the social sector.

**Public hearing process**

Railway development stakeholders (railway company, local government, etc.) must reveal information such as current operating issue and future plans to the public.

### 3) Content

Similar to M-MAP, besides the development of new lines, the improvement of existing services and facilities should be considered as one of the options in railway planning process as well. The contents of the master plan are as follows.

- Review of the previous master plan, especially the performance issue.
- Analysis of the given issues based on the current data.
- Organization of the future plans from each agency, such as the Fifth Metropolitan Area Development Master Plan.
- Demand forecasting, financial estimation, and cost-effectiveness analysis.

### 4) Implementation and follow up

- Railway development promotion system

【Main features of CTPP No. 19】
I Railway development and future direction
II Railway development and future task to be tackled
III Railway development and future supporting measurement
IV Railway development and future issue to be considered

CTPP No. 19 or the Mid-to-Long Term Railway Investment Policy (2000) was issued after the formulation of CTPP No. 18. This plan was formulated to provide the railway investment policy for smooth implementation in the future.

- Feasibility study of each line by government

In order to realize the development plan from CTPP No. 18, the government provided an additional budget for the feasibility study of each proposed line. In this feasibility study, the investment scheme, demand forecasting, financial estimation, and the consideration of other physical aspects such as route alignment and construction cost were further analyzed. The organization chart of the feasibility study is shown below.

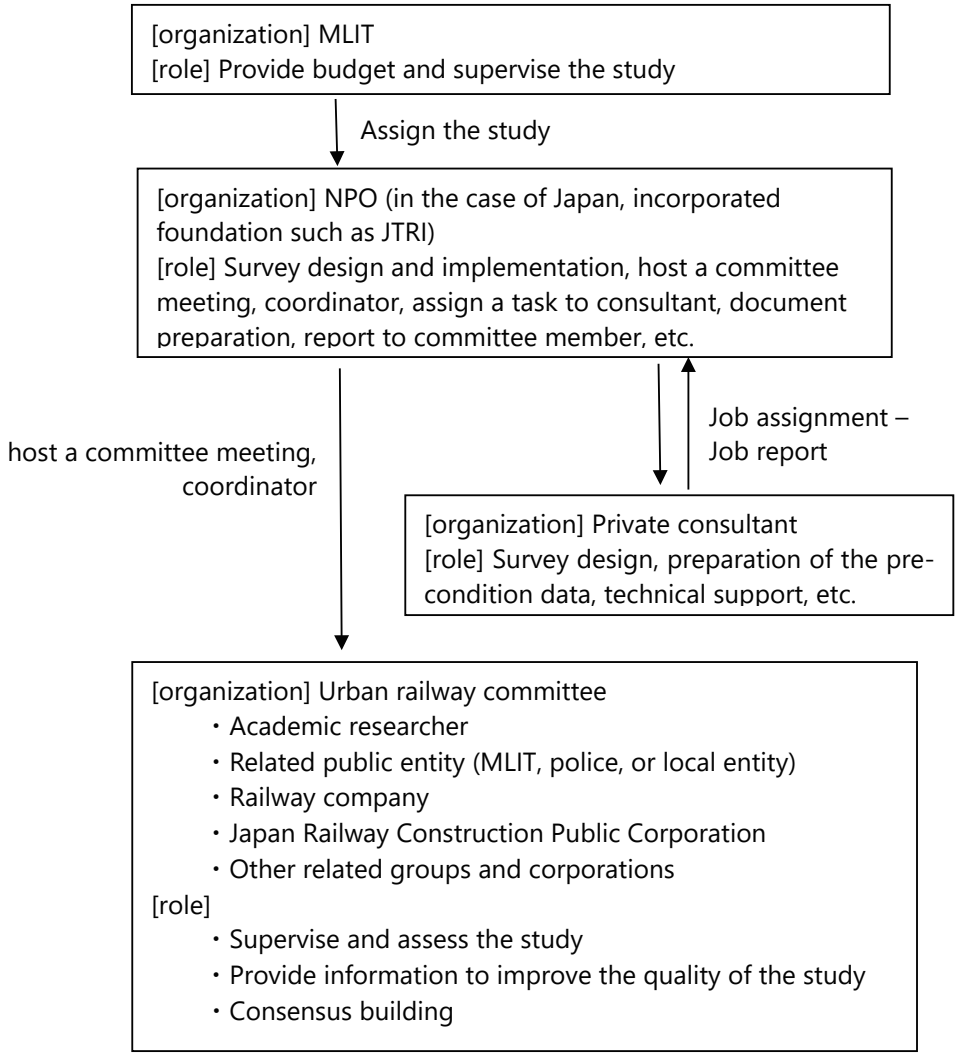



**Figure 4.2 Feasibility Study Committee Organization Chart**

## 4.3 Railway service, management, and safety

In Japan, the railway operators must comply with several regulations to maintain their railway operating license.

Before the authorization of the railway operating license by the MLIT, the licensing criteria[3] must be complied.

1. Such business plan must be appropriated from the operation and management viewpoint.
2. Such business plan must be appropriated from the transportation safety viewpoint.
3. In addition to the **1.** and **2.**, such business plan must be appropriated for the execution of its business.

[3] *The Railway Business Act*. Article 5: Licensing Criteria.

**4.** Such business must possess an adequate ability to appropriately execute the business.

## 4.4 Subsidies for Railway Network Development

Subsidizing the railway network development can be considered as one of the government leadership policies in Japan. Central and local governments consider railway subsidizing as one of the important national policies. In each line, a subsidized objective and target could be categorized in subsidy programs as shown below.

**Table 4.3 Railway Subsidy Program**

| Program | Objective | Content | Target |
|---|---|---|---|
| Support Program for Subway Development | In the CBD area with a high level of social overhead capital, it is important to improve the living conditions of the commuter. A social task such as in-train congestion relief and city structure promotion and preservation are some of the policies. In order to fulfill those needs, subway investment promotion is required. | A portion of the following cost<br>• New line construction<br>• Earthquake resistant structure construction<br>• Large-scale improvement/renewal | Public, public-private, and Tokyo Metro. |
| Support Program for Urban Railways User Promotion | To vitalize the city activity with a comfortable city life, improvements in the utilization of the existing railway network and station facility are needed. | A portion of the following cost<br>• New line construction between existing lines<br>• Construction of an additional extension to improve connectivity to other lines<br>• Construction of additional sidings for express operation<br>• Construction of relay service between existing stations | Public and public-private. |
| Support Program for Airport Access (former: Newtown Railway Development Support Program) | To increase the international competitiveness, to strengthen local connectivity, and to revitalize the local activity, along with the age of economic globalization, airport access investment promotion is needed. (the previous Newtown Railway Development Support Program was intended to support the increase in the demand of residential area) | A portion of the following cost<br>• New line construction<br>• Earthquake resistant structure construction<br>• Large-scale improvement/renewal | Public entity in a public-private enterprise. |

## 4.5 Railway development as a national strategy

***Airport access railway development for urban revitalization***

The Urban Renaissance Headquarters was established in April 2001 to increase the attractiveness and international competitiveness of Tokyo. The headquarters is where the Prime Minister acts as the Chairman and the related ministers as members.

Several projects issued in December 2001, such as the construction of additional runway and road access, were planned along with the additional railway access plan to Narita Airport. This railway access, so-called "Skyliner," reduces travel time from Nippori to Narita Airport 2nd Terminal from 51 to 36 minutes. It started operation in 2010.

Extracted from *"Urban Renaissance Projects"*

1. Strengthen the function of the airport
   - New parallel runway in Narita Airport.
   - Fourth runway in Haneda Airport.
2. Airport accessibility improvement
   - New Narita Airport access, Hosuku Line, aims to reduce the travel time between CBD and Narita Airport and between Haneda and Narita Airport.
   - New airport access road from TMA ring roads and the northern part of Chiba
   - New two airport link access via Toei Asakusa Line that aims to utilize Tokyo station as an access hub to both airports.
   - Station upgrade at Keikyu Kamata station for direct access service from Yokohama to Haneda Stations.

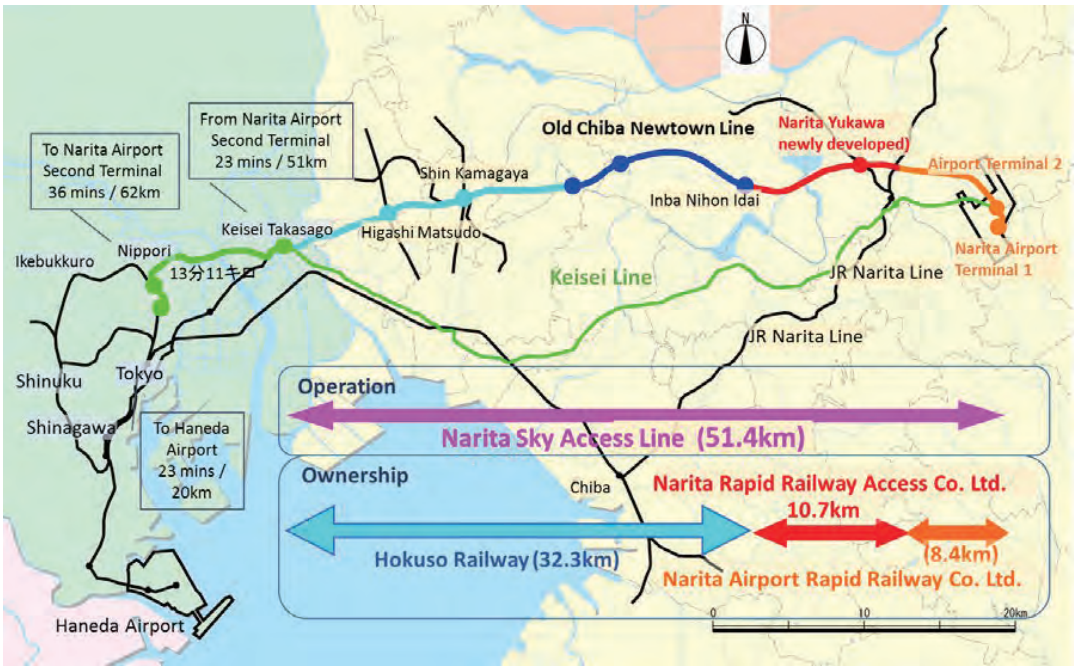
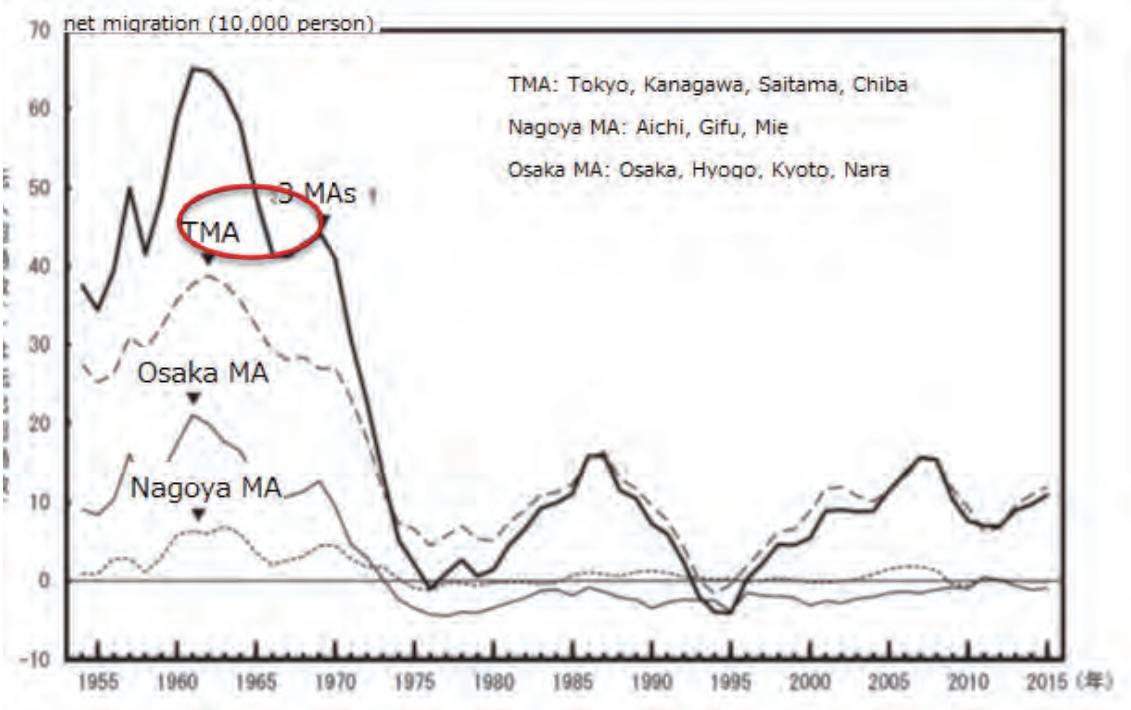



**Figure 4.3 Railway Access to Narita Airport**

# 5. Integration of railway and city planning

## 5.1 Rapid increase of migration to TMA

In the 1960s, the net number of people that moved to TMA was more than 300,000 persons per year. This created a huge demand for housing facility, so the policy on this issue became one of the main tasks.




Source: Ministry of Internal Affairs and Communications (MIAC)

**Figure 5.1 Transition of Population Migration During 1953–2016**

## 5.2 Example of railway projects as a promotion of urban development

Four examples of integration between urban development and railway investment are shown in Figure 5.2.

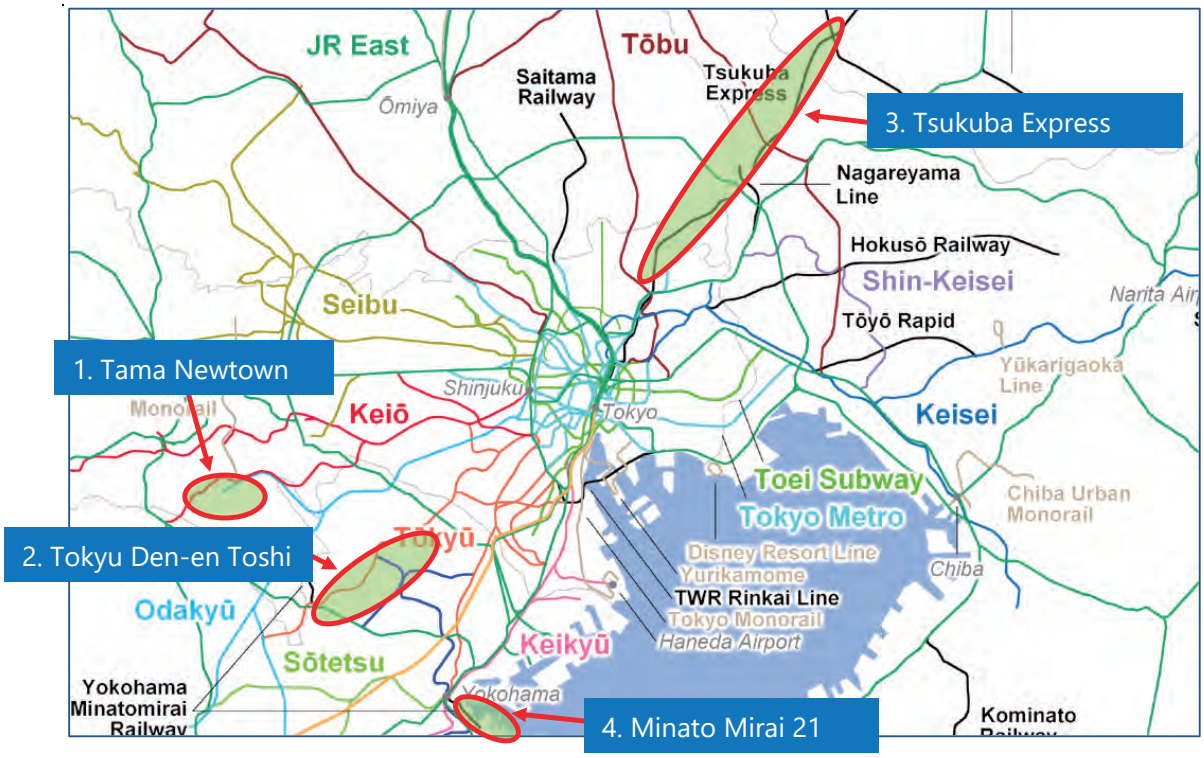



**Figure 5.2 Location of Railway Project Examples**

1. ***Tama Newtown.*** The collaboration between land development by government and railway investment by railway companies (Keio and Odakyu). This project was aimed to support the housing demand from a sharp population increase in TMA.

2. ***Tokyu Tama Den-En-Toshi.*** The example of development of both land and rail by a single railway company.

3. ***Tsukuba Express.*** The development based on the Act of Integration of Residential Area Development and Railway Investment in Metropolitan Area. Tsukuba Express was opened in 2005 with a length of around 58 km. This is also one of the examples of a collaboration between public and private sectors that invested in a new railway line with land development around the station.

4. ***Minato Mirai 21.*** An example of the integration of railway and new business district. In this project, the local government funded the land fill cost and each private firm developed their own structure. The railway service, which is a public-private entity, serves the new business district in this reclaimed land.

**1) Tama Newtown**

TMG, in cooperation with real estate companies, developed Tama Newtown located about 30 km from the CBD because of rapid population increase and unorganized residential development during the 1960s and 1970s. Originally developed as a residential area, around 220,000 residents currently live there with an integration of housing, offices, retailers,

schools, and cultural facilities.

In the same period, two railway companies, Keio and Odakyu, began the extension to connect Tama Newtown to CBD. This direct service connects to the center of Tama Newtown. Tama-Center Station was opened in 1974 by Keio and 1975 by Odakyu.

*Land development:* Tokyo Metropolitan Government (public)
*Rail development:* Private railway companies


Source: Bureau of Urban Development, TMG website.

**Figure 5.3 Tama Newtown Development and Railway Access**

*Development Timeline*

| | |
|---|---|
| 1963 | Southern Tama Area development zone plan |
| 1964 | Basic guideline of Tama area development policy |
| 1965 | New residential area development plan in Tama New Town |
| 1966 | Construction started in Tama New Town development project |
| 1971 | First tenant in Tama New Town development project (Suwa-Nagayama area) |
| 1974 | Odakyu Line extended its service to Nagayama Station |
| 1974 | Keio Line extended its service to Tama Center Station |
| 1974 | Population in Tama New Town reached 30,000 |
| 1975 | Odakyu Line extended its service to Tama Center Station |

### 2) Tokyu Tama Den-En-Toshi

Tokyo Tama Den-En-Toshi development is one example of which only one private company initiated both land and railway developments. This project was announced in 1953 by Tokyo Corporation to serve the (expected) increase in housing demand. Den-En-Toshi development, which is about 15–35 km from Tokyo CBD, currently comprises of a development area of 5,000 ha and has a population of 620,000.

*Land+Rail development:* Tokyu Corp. (private railway company)


**Figure 5.4 Den-En-Toshi Development**

*Railway Development Timeline*

1966 Mizonokuchi-Nagatsuta (溝の口 - 長津田)
1968 Nagatsuta-Tsukushino (長津田 - つくし野)
1972 Tsukushino-Suzukakedai (つくし野 - すずかけ台)
1976 Suzukakedai-Tsukimino (すずかけ台 - つきみ野)
Shibuya-Futako Tamagawa (渋谷 - 二子玉川)
1978 Through service with Hanzomon Subway Line
1984 Tsukimino-Chuo Rinkan (つきみ野 - 中央林間)

### 3) Tsukuba Express

Tsukuba express is one of the latest lines in TMA that serves Tokyo, Saitama, Chiba, and Ibaraki prefecture. With a maximum speed of 130km/h, Tsukuba Express connects Akihabara and Tsukuba (58.3 km) with only 45 minutes of travel time.

In 1989, the Act of Integration of Residential Area Development and Railway Investment in Metropolitan Area was enacted. Its objective is to support the issue regarding population increase in TMA, especially the measurements to promote the integration of residential area development and railway investment. Tsukuba Express was also planned based on the initiation of this law too.

*Land development:* Local government and Urban Renaissance (UR, public)
*Rail development:* Company's shareholders: Public 90%, Private 10%


Source: http://www.tsukubaexpress-ibaraki.jp/english/

**Figure 5.5 Map of Tsukuba Express**

**Table 5.1 Tsukuba Express Project Information**

<table>
<tr><td colspan="2">License granted</td><td>January 10, 1992</td><td rowspan="2">Passenger（thousand people/day）</td><td>Year 2009</td><td>270</td></tr>
<tr><td colspan="2">Opened</td><td>August 24, 2005</td><td>Year 2010</td><td>283</td></tr>
<tr><td rowspan="2">Contractors</td><td>Infrastructure</td><td>Japan Railway Construction, Transport and Technology Agency (JRTT)</td><td colspan="3">Population along the line（thousand people）</td></tr>
<tr><td>Operation</td><td>Metropolitan Intercity Railway Company</td><td rowspan="2">Nighttime population</td><td>Year 2000</td><td>1,974</td></tr>
<tr><td colspan="2">Termini</td><td>Akihabara-Tsukuba</td><td>Year 2010</td><td>2,121</td></tr>
<tr><td colspan="2">Length</td><td>58.3 km</td><td rowspan="2">Workers</td><td>Year 2001</td><td>1,304</td></tr>
<tr><td colspan="2">Construction Cost</td><td>808 billion yen</td><td>Year 2006</td><td>1,814</td></tr>
<tr><td colspan="2">Subsidy Program</td><td colspan="4">Urban Railway Investment Funds (都市鉄道整備事業資金)</td></tr>
</table>

**4) Minato Mirai 21**

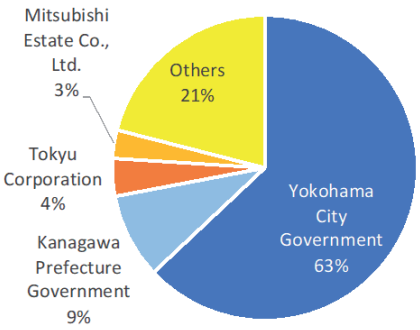
**Minato Mirai 21 area development**

Aimed to create the new business center in TMA, Minato Mirai 21 area development was initially a brownfield redevelopment in the Yokohama Port area. In 1979, the Yokohama Waterfront Area Comprehensive Development Plan was announced that included Minato Mirai 21. It began in 1983 in collaboration among the Yokohama City Government, UR, and other private entities. Currently, this 186-hectare development comprises of a business district with 190,000 workers and residential district with 10,000 residents. Civil works, mainly the land reclaim cost, was invested by the City of Yokohama. Area development was mainly conducted by UR.

**Minato Mirai 21 Line**

Minatomirai 21 Line was introduced to provide an access to Minato Mirai 21 development area. The service between Yokohama and Motamachi-Chukagai Stations, which has a length of 4.1 km, started its operation in 2004. It also provides a direct access to Tokyo's CBD areas such as Shibuya, Shinjuku, and Ikebukuro through a service to Tokyu Toyoko Line and the subway Fukutoshin Line.


*Land development:*
Land reclaim ->public
Structure -> private
*Rail development:*
Public 70%, Private 30%




Shareholding structure as of 2017

Source: Yokohama Minatomirai Railway

Note: Shareholding structure compiled by JICA Study Team from various disclosure materials.

**Figure 5.6 Minato Mirai 21 Development**

**Table 5.2 Minato Mirai 21 Line project information**

| | | | | | |
|---|---|---|---|---|---|
| **License granted** | | April 19, 1990 | **Passenger (thousand people/day)** | Year 2006 | 140 |
| **Opened** | | February 1, 2004 | | Year 2010 | 163 |
| **Contractor** | **Infrastructure** | JRTT | **Population along the line (thousand people)** | | |
| | **Operation** | Yokohama Minatomirai Railway | **Nighttime population** | Year 1999 | 190 |
| **Termini** | | Yokohama, Motomachi-Chūkagai | | Year 2009 | 223 |
| **Length** | | 4.1 km | **Workers** | Year 2001 | 312 |
| **Construction Cost** | | 257 billion yen | | Year 2016 | 320 |
| **Subsidy Scheme** | | Build-Transfer-Operate | | | |

## 5.3 Real estate development by private railway company

During the rapid population increase in TMA from 1960 to 2000, many railway companies

exploited this opportunity to expand their real estate business with their own railway lines. The table below shows the example of large-scale real estate development conducted by each railway company.

**Table 5.3 Example of Real Estate and Housing Development by Each Major Railway Company**

| | Revenue by category | History of real estate development |
|---|---|---|
| Tobu Railway | *Operating Revenue (2016)*<br>- Transportation 212.1 Bil.¥ (37.3%)<br>- Department Store 191.5 Bil.¥ (33.7%)<br>- Recreation 75.1 Bil.¥ (13.2%)<br>- **Real Estate 38.7 Bil.¥ (6.8%)**<br>- Others 51.4 Bil.¥ (9.0%)<br>- Total 568.8 Bil.¥ | 1954 The first housing development from the support of Housing Loan Corporation (20 units)<br>1966 Opening of Omocha-no-Machi development (52.9 ha)<br>1968 Opening of Noda-Kamawadai development<br>1974 Opening of Tobu-Kamagaya development (26ha)<br>1975 Opening of Misora NT development in Yotsukaido City, Chiba Prefecture<br>1978 Completion of Misora NT development (65 ha, 1,653 unit)<br>1984 Opening of Shin-Kashiwa NT development (33 ha) |
| Seibu Holdings | *Operating Revenue (2016)*<br>- Transportation and Business along railway lines 157.4 Bil.¥ (28.2%)<br>- Hotel and Recreation 188 Bil.¥ (33.8%)<br>- **Real Estate 49.7 Bil.¥ (8.9%)**<br>- Construction 105 Bil.¥ (18.9%)<br>- Hawaii Business Department 19.3 Bil.¥ (3.5%)<br>- Others 37.5 Bil.¥ (6.7%)<br>- Total 556.9 Bil.¥ | *Housing Lot*<br>1969 Shonan-Takatoridai (2,489 units)<br>1969 Kanazawa-Bunko (1,350 units)<br>1970 Kamakura-Zushi Highlands (1,846 units)<br>1973 Mabori Sea Heights (1,197 units)<br>1976 Hachioji NT Seibu Kitanodai (2,259 units)<br>1980 Seibu Sayama NT Kashiwara (1,333 units)<br>1981 Tokorozawa Matsugaoka (1,148 units)<br>1983 Seibu Bushi NT (1,141 units)<br>1988 Seibu Hanno, Seibu Hidaka 1,974 units)<br>1988 Seibu Greentown (Minami Boso, Onjuku) (1,515 units)<br>1995 Kisarazu Bayside Hills Seibu Konandai (2,000 units)<br>2000 Yokosuka NT Shonan Ikegami (463 units)<br>2008 Harmony Days Kotesashi SAKURA Premium (38 units)<br>*Condominium*<br>2000 Isoga Prince Heights (200 units)<br>2003 Lower Places Shimazuyama (34 units)<br>2007 HIBARI TOWER (332 units)<br>2007 Ercio Tamagawa-Josui (183 units)<br>2007 Park House ONE'S TOWER (182 units)<br>2008 Brillia L-sio Hagiyama (184 units)<br>2010 Kotesashi Towers (374 units) |
| Keisei Electric Railway | *Operating Revenue (2016)*<br>- Transportation 144.3 Billion Yen (50.0%)<br>- Department Store 68.4 Billion Yen (25.6%)<br>- Recreation 10.2 Billion Yen (3.8%)<br>- **Real Estate 17.5 Billion Yen (6.6%)**<br>- Construction 21.7 Billion Yen（8.0%）<br>- Others 5.1 Billion Yen (1.9%）<br>- Total 267.1 Billion Yen | |

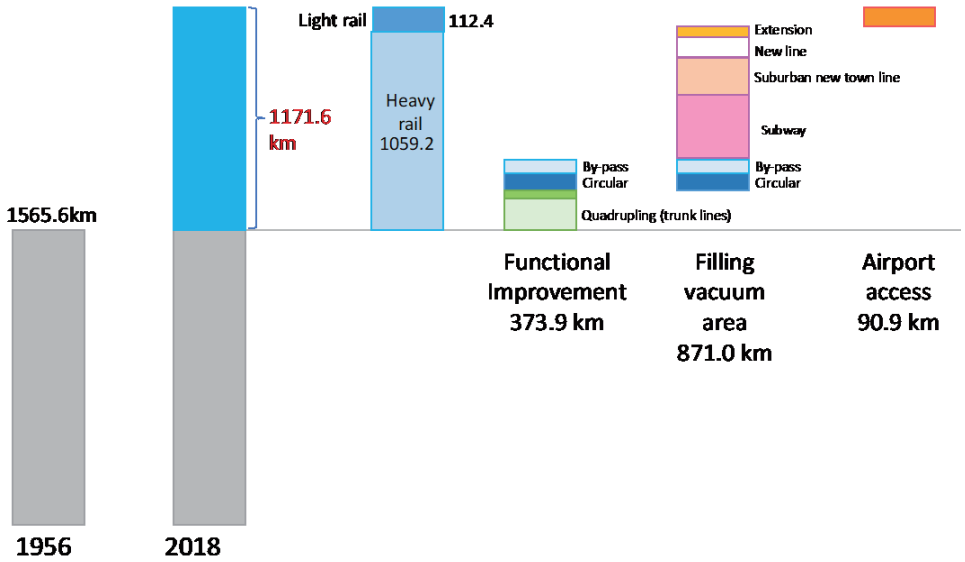
**Table 5.4 Size of residential development by each private railway company**

| | Developed area（ha） | | |
|---|---|---|---|
| | Before WW2 | Before WW2 | Total |
| Odakyu | 145 | 912 | 1,057 |
| Keio | 0 | 333 | 333 |
| Keisei | 25 | 256 | 281 |
| Keikyu | 70 | 1,616 | 1,686 |
| Seibu | 1,172 | 2,051 | 3,223 |
| Tokyu | 138 | 6,785 | 6,923 |
| Tobu | 43 | 402 | 445 |
| Total | 1,592 | 12,355 | 13,947 |

Source: Takashi Yajima and Hitoshi Ieda. How Railway Shapes the World's Greatest City, Tokyo (Japanese).

## 5.4 Functional Development of TMA Railway Network

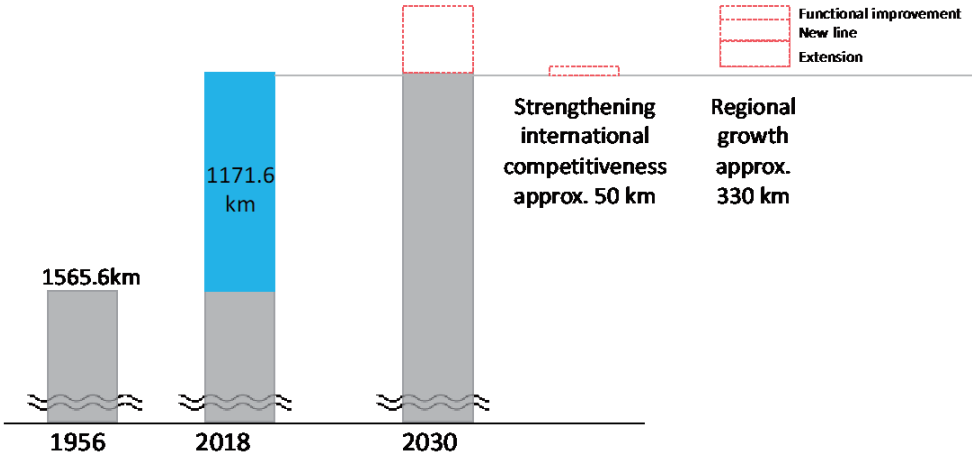
The railway network development outlined above took place as reflections of what were strategically planned in CUTPs and CTPPs from the mid-1950s. Categorizing developments into some of the major new functions with every development project added as a value, the developments can be shown broadly (Figure 5.7). Since the mid-1950s, a significant portion of the development was devoted to filling the vacuum area in mass rapid transport (including subway development in urban area if it is a replacement of the tramway network). In parallel, there has also been a good portion of functional development of the existing lines, which were quadrupling, and the introduction of by-passing and outer circular lines. The third function that can be added to the TMA railway network is access to airport.




Source: Forum for Railway Development in Tokyo Metropolitan Area, Footsteps and Future of Railways in Tokyo Metropolitan Area.

**Figure 5.7 Functional Development of TMA Rail Network since 1950s**

Likewise, the future development from now to year 2030, as outlined in the new CTPP No. 198, can also be displayed in a similar manner. Although the length of the new extension is not given in the CTPP, the JICA Study Team assumes it will be approximately 380 km. The 330-km portion can be categorized as promotion of regional growth with projects on functional improvement, introduction of a new line, and extension of the existing lines. The other 50 km was designated to strengthen international competitiveness of TMA that includes further improvement in the convenience of access to airports and other urban functions.




Source: CTPP No. 198 and JICA Study Team.

**Figure 5.8 Functional Development of TMA Rail Network Towards 2030**

# 6. Demand Forecasting and Railway Investment

## 6.1 Roles of Demand Forecasting

Implementation of demand forecasting can be observed in most of the stages in railway life cycle, such as planning, construction, and operation. Not only the public, but the private railway companies also request demand forecasting results for their investment decision in some cases. Demand forecasting is implemented for several considerations, such as financial balance, selection of transit system, route/alignment selection, expected LOS (fare, service pattern, and frequency), as well as an investment scheme.

Utilization of demand forecasting results can be described through the following.

**1) Demand forecasting for Railway Master Plan (central/local government-initiated plan)**

In general, an estimation of demand forecasting for these master plans will be conducted by the consultant company under the committee that includes related entities from the central and local governments, railway companies, academic researchers, and a representative from residents.

- *Demand forecasting for common recognition in TMA's future outlook*

The result from railway master plan as shown in CTPP No. 18, such as future population forecast, total trip forecast, railway modal share forecast, and demand forecast to CBD, will be utilized for railway network planning that is expected to give a common recognition in TMA's future outlook.

- *Demand forecasting for the railway network planning with logical consideration*

To ensure possible implementation of the railway network plan, the plan must be conducted under the consideration of demand forecasting and financial estimation. Detail analysis such as service level (fare and frequency) impact, through-service impact, and convenience of transfer should be considered during the railway network planning process. Other considerations include:

- ✧ Station location and route alignment must be decided based on user benefit maximization of the current O-D flow.
- ✧ The selection of a transit system must be decided based on the transport capacity that suits the expected demand.
- ✧ As for CTPP No. 18, transport capacity was set based on the demand forecasting. Furthermore, since in-train congestion became one of the social issues, this master plan incorporates this issue as one of the parameters in the model estimation. Based on this model, the TMA railway network with a target of 150% congestion rate improvement was proposed.
- ✧ Transport capacity design must consider future urban growth (as for M-MAP, 509 km of the network was planned until 2029).

- ✧ Investment priority should be set to support the transport demand. (In the case of CTPP No. 18, the demand forecasting, financial estimation, and cost-effectiveness analysis were considered together with the investment priority setting process.)
- ✧ Fare-setting based on the financial analysis. (TMA master plan analyzed the effect from scenarios with different fare setting.)
- ✧ The connectivity of railway network (station and route) was planned based on the demand. (In CTPP No. 18, seamless transfer network is one of its objectives, which network planning is based on demand forecasting.)
- ✧ Verification of the through-transfer operation to strengthen the network effect.
- ✧ Sensitivity analysis was applied for standard price setting. (Standard could vary across different railway companies.)
- ✧ New line investment could cause a demand change in the existing lines. In this case, unnecessary investment must be avoided by checking whether there is an unrealistic sharp decrease in demand in any lines.

- *Visualizing the achievement from railway investment*

Considering the impact of railway investment in a different perspective, such as the impact on the whole society, city, surrounding residence, and railway user, we can visualize the necessity of railway investment. As for visualization of the impact to the whole society, one example is the result from subsidy analysis that could be used as basis of the decision process of the amount of subsidy.

In CTPP No. 18, one of the objectives is the in-train congestion relief. In order to achieve this objective, the investment plan must be supported by a subsidy from the government and investment effort from the railway company. Such objective can be visualized through improvement factors as follows.

- ✧ Speed improvement: travel time per trip.
- ✧ Station accessibility: travel time per trip.
- ✧ Airport and HSR station accessibility: travel time per trip, number of transfers.
- ✧ Seamless transfer: transfer time per trip.

In Bangkok, a target of 15% share of public transit user has been set. To achieve this target, a policy such as vehicle ownership restriction should be incorporated into the model so that this problem can be visualized to stakeholders for further policy discussion.

- *Relationship with urban development*

A large-scale development could strongly affect railway demand. Therefore, urban development planning should also be considered in railway planning. As for CTPP No. 18, the generated demand from urban development project is based on the development plan given by the local government.

**2) Railway company business plan**

For a railway company, the following must be taken into consideration during investment

and implementation schedule planning processes.

1. Short to midterm revenue analysis.
2. Revision of train schedule and operating hours.
3. Investment of new line and transfer facility.
4. Analysis of the impact of the improvement or new line investment by other companies.
5. Station accessibility improvement.
6. In-station facility upgrade and analysis of in-station passenger movement (e.g. New Toranomon Station).
7. Consideration of through service, facility sharing, and investment cost sharing.

## 6.2 Demand forecasting for individual project

### 1) Example of different infrastructure owner and railway operator

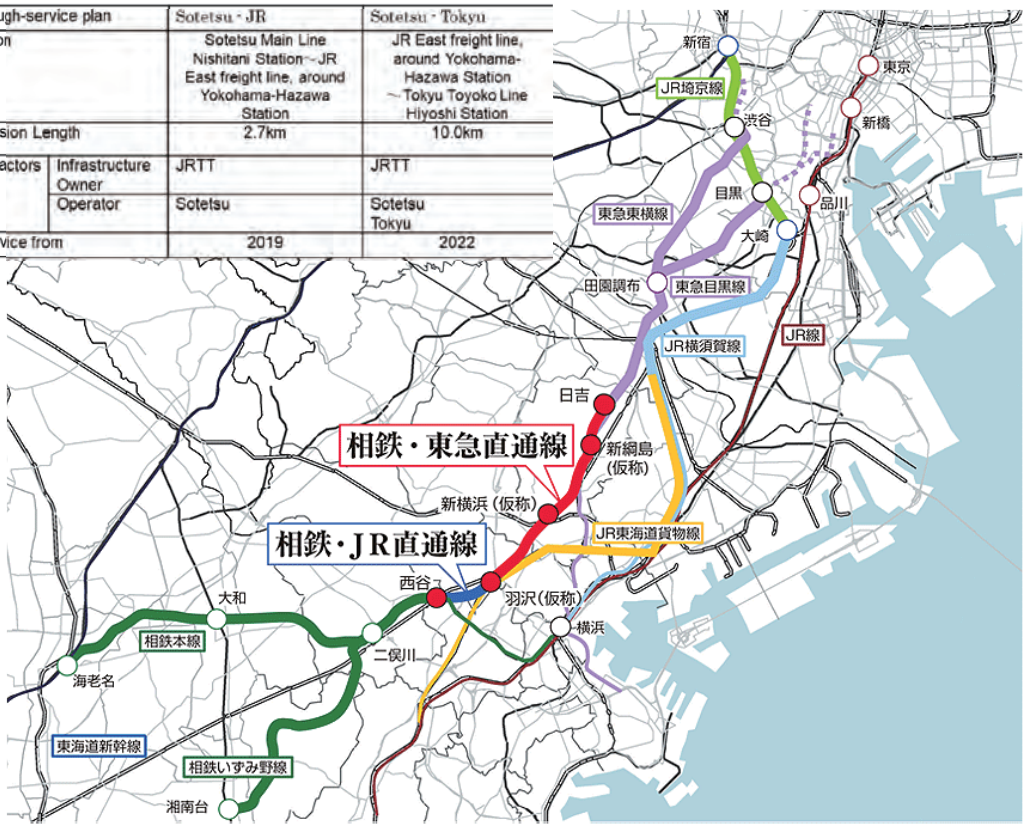
According to the Act of Urban Railway Efficiency Improvement Works, efficiency improvement such as travel time reduction and travel facilitation was targeted in the existing stock. The vertical separation investment scheme was also suggested in this act. The scheme is for the investment to improve efficiency of the existing lines that will be supported by central government by one-third and local government by another third. The rest will be committed by infrastructure owner (JRTT or other public-private enterprises). Railway operator pays the infrastructure usage cost to the infrastructure owner and infrastructure owner will use this to repay the debt caused by the investment loan.

For this reason, the railway company might want to consider the result from demand forecasting to evaluate whether revenue and profit will be desirable, especially the ability to pay the infrastructure cost.

Furthermore, the service level must be also included in the contract. Thus, to be able to decide an appropriate level of service, such as in fare and frequency, an analysis of multiple-scenario setting must be conducted to compare the impacts from a different level of service. Therefore, under the vertical separation investment scheme, consensus building between infrastructure owner and railway operator must be based on the result from demand forecasting.

The figure below exhibits an example of vertical separation investment project from the Efficiency Improvement Works in “Sotetsu-JR Line” and “Sotetsu-Tokyu Line.”

| Through-service plan | | Sotetsu - JR | Sotetsu - Tokyu |
|---|---|---|---|
| Section | | Sotetsu Main Line Nishitani Station~JR East freight line, around Yokohama-Hazawa Station | JR East freight line, around Yokohama-Hazawa Station ~ Tokyu Toyoko Line Hiyoshi Station |
| Extension Length | | 2.7km | 10.0km |
| Contractors | Infrastructure Owner | JRTT | JRTT |
| | Operator | Sotetsu | Sotetsu Tokyu |
| In service from | | 2019 | 2022 |




Note: Blue is Sotetsu-JR line and red is Sotetsu-Tokyu line.
Source: http://www.jrtt.go.jp/02business/construction/const-urbanIndex.html

**Figure 6.1 Map of Sotetsu-JR Line and Sotetsu-Tokyu Line Projects**

**2) Example of cooperative development between land developer and railway investor: A case study of New Toranomon Station Development**

The new Toranomon Station Development, which is currently under construction, is on the current Hibiya Subway Line. The target date for the development to commence service is before the 2020 Tokyo Olympics; however, the new station is scheduled to be 100% completed in 2022.

This development is one of the parts of the Special Designated Redevelopment Area. Besides to strengthen the international competitiveness of Tokyo, this area was also developed in the alignment of the TMA second ring road (Kanni-dori Avenue). Therefore, it can be also said that both road and rail connections were planned to increase the connectivity to this development. Construction of a privately-operated bus terminal that will connect to the current Toranomon Station in Ginza Subway Line was also included in the plan. The simulation analysis of in-station pedestrian flow was also conducted to test the performance of the plan based on the demand forecasting model of the whole TMA.

For an effective coordination among stakeholders, UR was appointed as the main implementing body with support from Tokyo Metro.


Source: City and Transportation Vol. 103 (Japanese), published by Japan Transportation Planning Association (JTPA)

**Figure 6.2 New Toranomon Station Development**

### 3) Example of a new line investment with through service for connectivity improvement in sub-center areas: A case study of Fukutoshin Subway Line

Objectives:
- Expand the railway network between Saitama and Yokohama.
- Connect three sub-centers (Ikebukuro–Shinjuku–Shibuya).
- Relieve the congestion of JR Yamanote and JR Saikyo Lines.

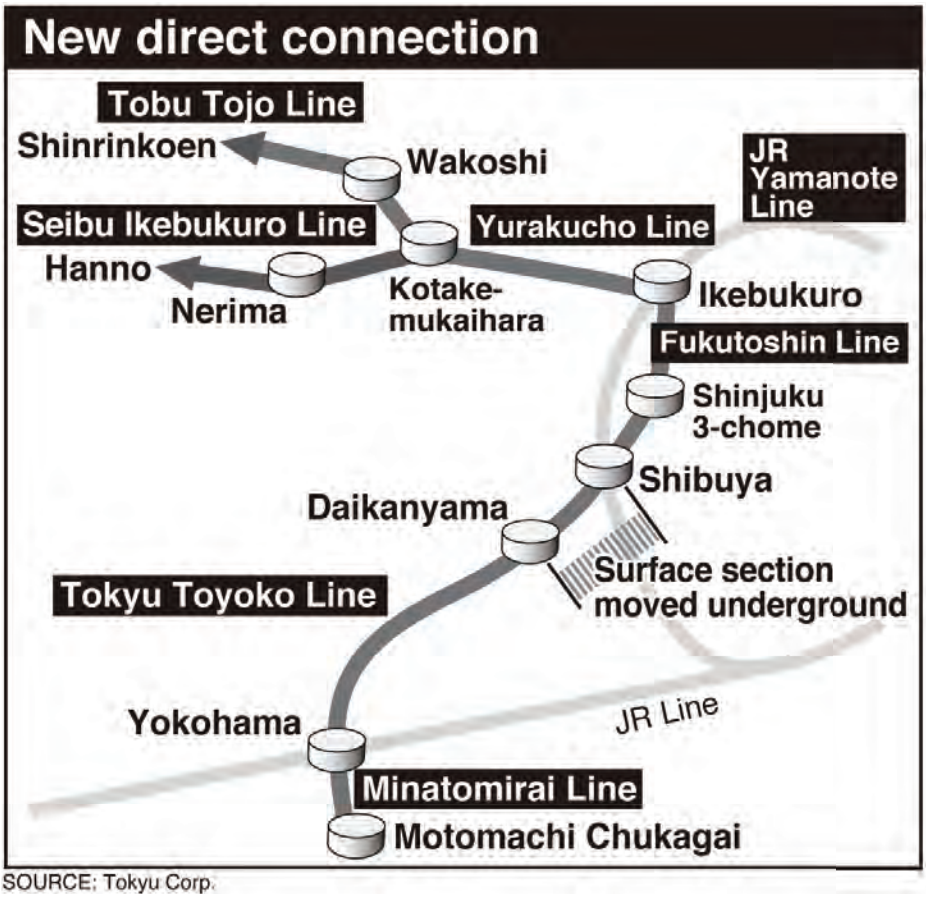



**Figure 6.3 Connectivity in Fukutoshin Subway Line**

**Table 6.1 Fukutoshin Subway Line project information**

| **Contractors** | **Tokyo Metro Corp.** |
|---|---|
| Section | Shibuya to Kotake-Mukaihara Station |
| Construction/Operation | 2001/2008 |
| Through service with | Tokyu Toyoko Line<br>Seibu Ikebukuro and Yurakucho Lines<br>Tobu Tojo Line<br>Minatomirai 21 Line |

# 7. Demand Forecasting and Model Improvement Initiatives

## 7.1 Research and development

In Japan, the history of demand forecasting model development[4] can be described as follows.

- The year 1955 was the time of Japanese economic miracle and start of motorization.
- The 1960s was the motorization age.
- Because of motorization problem, transportation infrastructure investment became an urgent policy.
- In order to provide an adequate transportation infrastructure, demand forecast must be conducted. Since then, research on demand forecasting has begun.
- The development based on the 4-step model (developed by MIT in 1962).

## 7.2 Demand forecasting workgroup

In the process of demand forecasting model development, the demand forecasting workgroup (WG) was established. WG members were composed of researchers, representatives from government agencies, consultants, and railway operators.

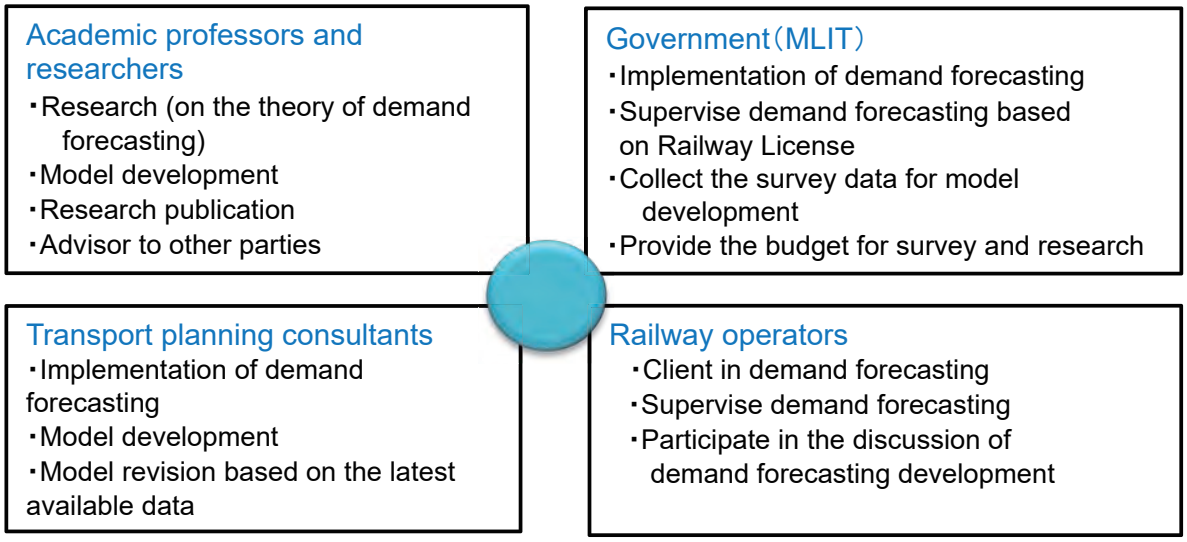



**Figure 7.1 Demand Forecasting Workgroup Members and Their Roles**

## 7.3 Demand forecasting validation from specialists

In the railway master plan (e.g. CTPP Nos. 18 and 198) development process, the contents of demand forecasting models, such as methodology, model, pre-condition setting, and the result, must be validated by specialists from the WG. The model validity will give a huge contribution to a smooth discussion during the consensus-building process.

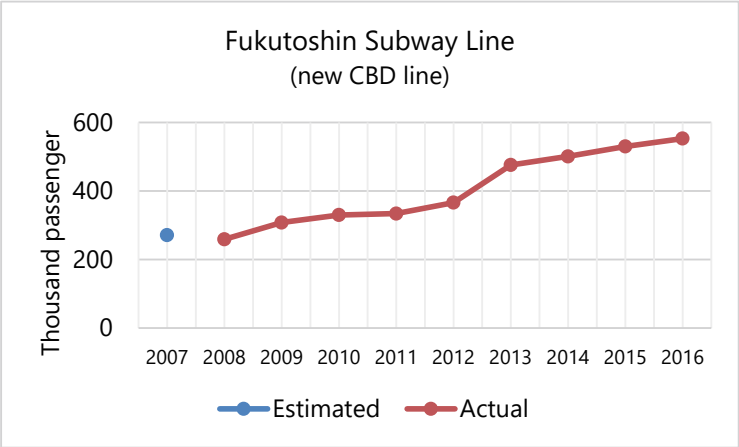
[4] *Demand Forecasting Handbook* (Japanese). First edition. 1981.

## 7.4 Demand forecasting and post-evaluation

Information regarding demand forecasting will be shared among the WG to ensure common understanding and to encourage the constant development of the model. After the planning process, the progress of the project as well as social and economic conditions could be different from what was planned. Changes could affect pre-conditions or the target set in the model; therefore, it is very important to consider the necessity whether or not the pre-conditions and target should be revised. As for CTPP No. 18, after a certain period, the Railway Bureau of MLIT initiated the post-evaluation process by conducting the survey based on the instruction from specialists.

## 7.5 Model precision

During the project im[lementation stage, the result from demand forecasting was required to estimate the future operating revenue and future business risks. This will be further utilized for the estimation of subsidy from the government. Therefore, estimation processes and pre-conditions setting should be clearly determined. Validation of the model based on the combination of improvement from past experiences and latest demand forecasting methodology is important for the best precision.



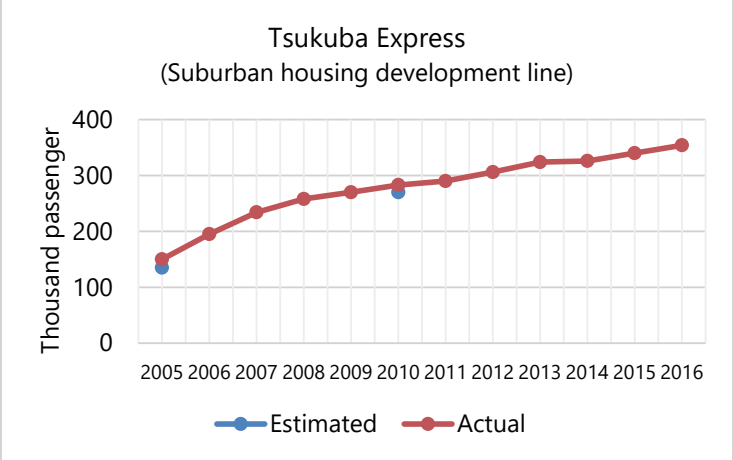



**Figure 7.2 Comparison of the Estimated and Actual Demand on the Selected Lines**

## 7.6 Demand forecasting model improvement

Serious congestion and rapid city expansion in TMA during the 1970s were the main drive force for railway network expansion. Thus, the master plan during this period must be planned to solve these problems. In each master plan, problem-related parameters must be included in the demand forecasting model to test the ability to solve the problem in each proposed policy. From past to present, not only problems and demand forecasting model that change, but the transportation technology, economic condition, and computational limitation also change. From 1972, the progress of TMA railway master plan development can be described by the table below.

**Table 7.1 TMA Railway Master Plan Development from 1972**

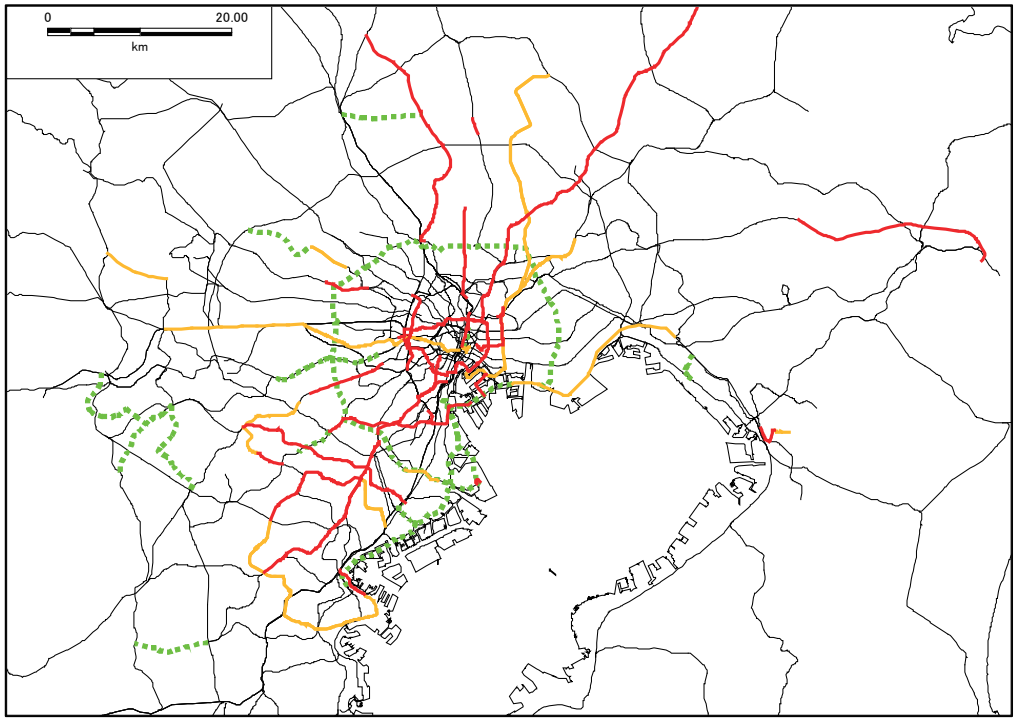
| Master Plan | Policy Agenda | Analysis | Features of Model |
|---|---|---|---|
| Council of Urban Transport Plan No. 15 (1972)<br><br>Target year 1985 | • Capacity expansion<br>• Commuting time reduction with the consideration of urban expansion (targeting lines to new suburban development area)<br>• Initiation of express service<br>• Planning of Fukutoshin Line<br>• Improvement of the accessibility to airport and HSR station | • Demand forecasting and other related analyses | • First introduction of 4-Step Model<br>• 40 zones |
| Council of Transport Policy Plan No. 7 (1985)<br><br>Target year 2000 | • Easing of the morning peak in-train congestion (for this, Tsukuba Express Line, Keiyo Line, and Saikyo Line were proposed)<br>• Access to new CBD (Minatomirai 21 Line)<br>• Access to Haneda Airport (Tokyo Monorail, Keikyu Airport Line extension) | • Evaluation of the congestion rate in the most congested section | • Analysis of morning peak-hours by considering only working and schooling commuter<br>• Introduction of Disaggregate Travel Demand Model<br>• 658 zones |
| Council of Transport Policy Plan No. 18 (2000)<br><br>Target year 2015 | • Easing of the morning peak in-train congestion<br>• Speed improvement<br>• Urban restructuring<br>• Improvement of the accessibility to airport and HSR station<br>• Seamless service<br>• Universal design service | • Congestion alleviation, time savings analysis<br>• Evaluation of railway service profitability<br>• Cost-effectiveness analysis (CEA)<br>• Service continuity | • Include daytime traffic analysis (for profitability estimation)<br>• Include congestion parameter<br>• Introduction of Probit Model<br>• Introduction of Airport and HSR access model<br>• 1812 zones |
| Council of Transport Policy Plan No. 198 (2016)<br><br>Target year 2030 | • Strengthen international competitiveness<br>• Design of new-generation station<br>• Reliability improvement | • Congestion alleviation, time savings analysis<br>• Evaluation of railway service profitability<br>• Cost-effectiveness | • Increase the types of trip destination<br>• Analysis by age groups (because of population aging) |

| | | | |
|---|---|---|---|
| | • Strengthen of the disaster countermeasure | analysis<br>• Service continuity | • 2843 zones |

## 7.7 Demand forecasting and city characteristics

### 1) Probit model in route assignment model

As shown in Table 7.2, more than 2,000 km of railway network was included in CTPP Nos. 7 and 18. The complex network provides multiple routes to go from one place to another. Therefore, it is inevitable to assign a multiple route combination in each O–D pair. However, with multiple choices, there is a high probability that IIA assumption will be violated because of route similarity. Therefore, CTPP No. 18 applied a probit model in route assignment model because of the relaxation of IIA assumption.




Note: Proposed lines are indicated in colors. Red indicates first priority lines. Yellow indicates second priority lines. Green dashes indicate lines for future consideration.

**Figure 7.3 Proposed Network in CTPP No. 18**

**Table 7.2 Fukutoshin Subway Line Project Information**

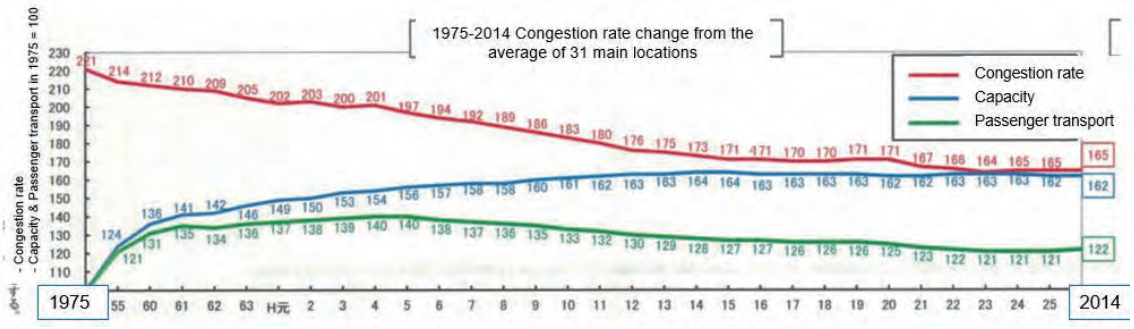
| Plan No. | (A) Total Length of Existing Line | (B) Total Length of Planned Line | (B)/(A) |
|---|---|---|---|
| Plan No. 18 (2000) | 2,246 km | 656 km | 29% |
| Plan No. 7 (1985) | 1,962 km | 616 km | 31% |

### 2) Morning rush hour and congestion parameter

Since 1970, in-train congestion during morning rush hour became one of the serious problems. Various countermeasures such as new line investment, longer train set, and a wider carriage train have been introduced to relieve in-train congestion.

The following model improvements were taken to evaluate the result of railway investment plan.

- ✧ CTPP No. 7: Demand forecasting model targeting commute (work and school) trip.
- ✧ CTPP No. 18: Congestion parameter (congestion rate × travel time$^2$) is included in the route assignment model parameter (as one of the route utility parameters). With this, the effect of in-train congestion relief can be evaluated.




*Congestion rate evaluation*
180% = passenger body contact each other, but still be able to read newspaper
200% = passenger body contact each other with a feeling of oppression. But still be able to read magazine
250% = cannot move body and arms even when the train shakes

**Figure 7.4 Congestion rate during 1975–2014**

### 3) Aging Society

Aging society becomes one of the main problems in recent years. In 2015, the senior population of ages over 65 is 26.7% of the total population in Japan. The following analyses were included in the model to capture the effect of aging society in Japan.

- ✧ Population estimation by age group.
- ✧ Trip generation-attraction model by age group.
- ✧ Trip distribution model (O–D estimation) by age group.
- ✧ Modal share model by age group.
- ✧ Route assignment model by age group.

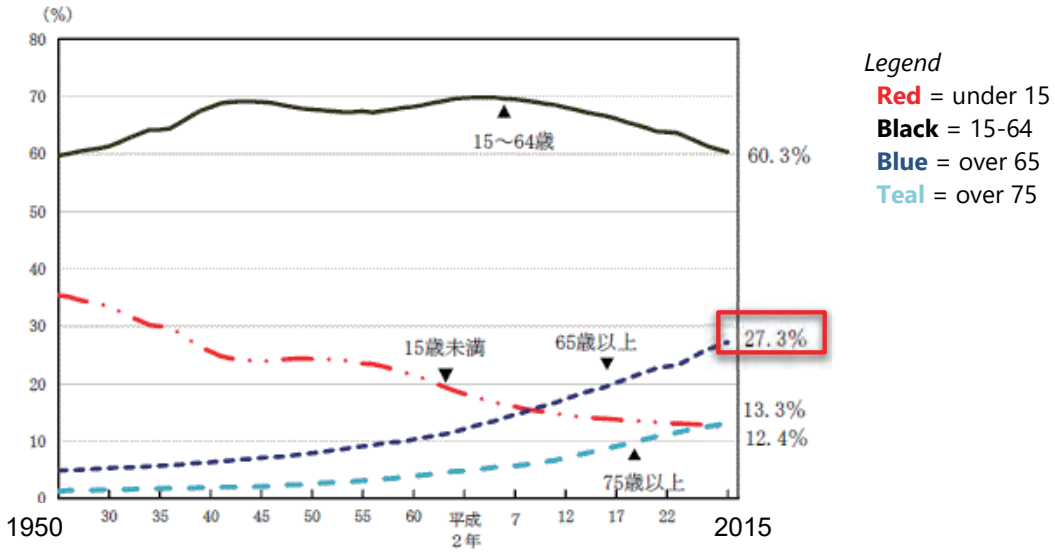



**Figure 7.5 Change of Population Share by Age Range from 1950–2015**

# 8. Railway Information Sharing and Research

## 8.1 Railway operating data

Private railway and subway operators (excluding JRs) must submit annual reports that contain operating information and safety records. The government agency can then constantly monitor the private railway operating performance. Furthermore, it also creates a close relationship between a government agency and railway operators that can result to a better environment for consensus-building process. The two annual reports include:

### 1) Railway statistics annual report

- Operating achievements
- Operating conditions
- Tax-related conditions
- Facility, rolling stock, electricity and fuel cost
- Personnel and annual salary payment
- Accidents

### 2) Urban transportation annual report

- Transport improvement record
- Operating condition by each line
- No. of station and station facility improvement record
- No. of passenger, no. of passenger by station, total passenger-kilometer, and average distance travel per passenger

## 8.2 Establishment of the research institute for railway policy: JTRI

JTRI was established to conduct a comprehensive research and survey on transportation-related policy issue. The research aims to develop the best transportation policy to improve the quality of life, increase local attractiveness, and boost economic activity. Contributions of JTRI to transportation in Japan are listed below.

### 1) Responsibility

1. Conduct research and survey on the transportation-related topics.
2. Transportation policy evaluation and suggestion.
3. Information collection, analysis, and sharing.
4. Transportation export and international transportation-related policy study.
5. Policy study on transportation as a tool for international exchange and regional connectivity.
6. Transportation consultant related works.
7. Hosting a lecture, conference, seminar on the transportation-related subject.

8. Research publication.
9. Any other required tasks to support numbers 1 to 8.

**2) JTRI and the development of demand forecasting model for CTPP**

As mentioned in section 6.4, JTRI gives a huge contribution to demand forecasting model development as a member of the demand forecasting WG.

**3) Publications and conferences**

Research outcomes from JTRI will be publicized through journals such as the quarterly published "Transport Policy Studies' Review" (left in Figure 8.1). JTRI also hosts several seminars and symposiums that aim to improve a common knowledge in transportation-related issue.


**Figure 8.1 Publications and Conferences by JTRI**

**4) Policy Suggestion**

Since JRTI is an independent body, the institute can provide policy suggestions that is "user experience-based" such as needs and requirements from railway users. Policy suggestions could be for service improvement that may be different from the perspective of the government or railway company. Figure 8.2 shows an example of a policy suggestion for the service improvement of Haneda Airport Access.

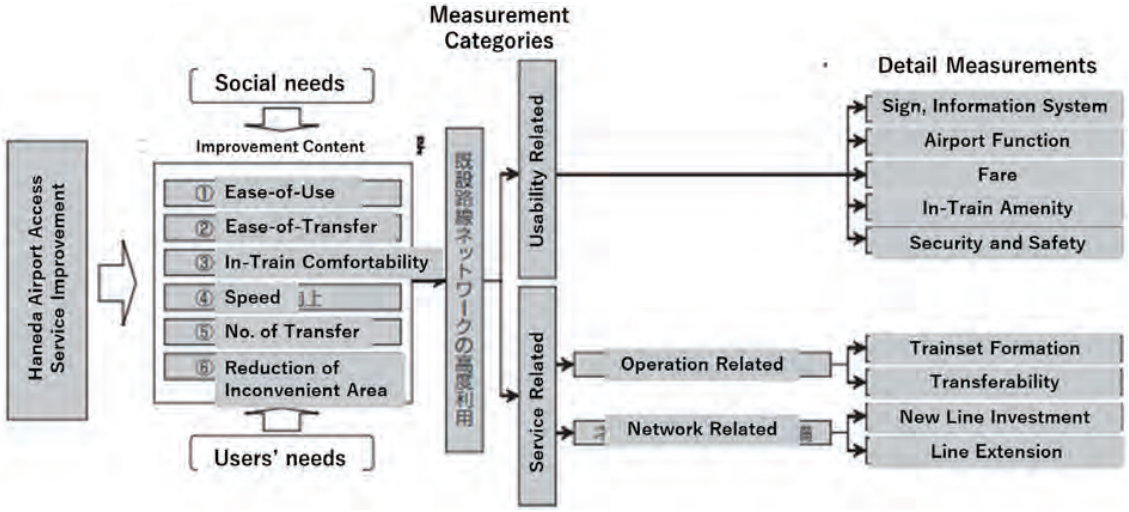



**Figure 8.2 Policy Suggestion for Haneda Airport Access Service Improvement**

### 5) Comprehensive planning study

With the commission from the government, JTRI also conducts a comprehensive railway planning study that includes the feasibility study on the investment scheme. As shown below, the vertical separation investment scheme, which has become the most popular railway investment scheme in Japan, was proposed by JTRI to many projects across the country.

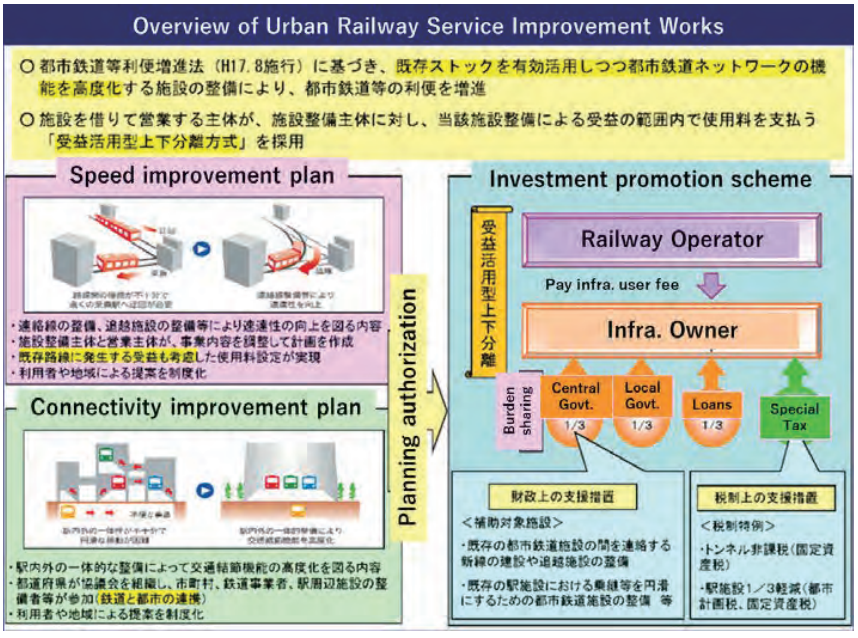
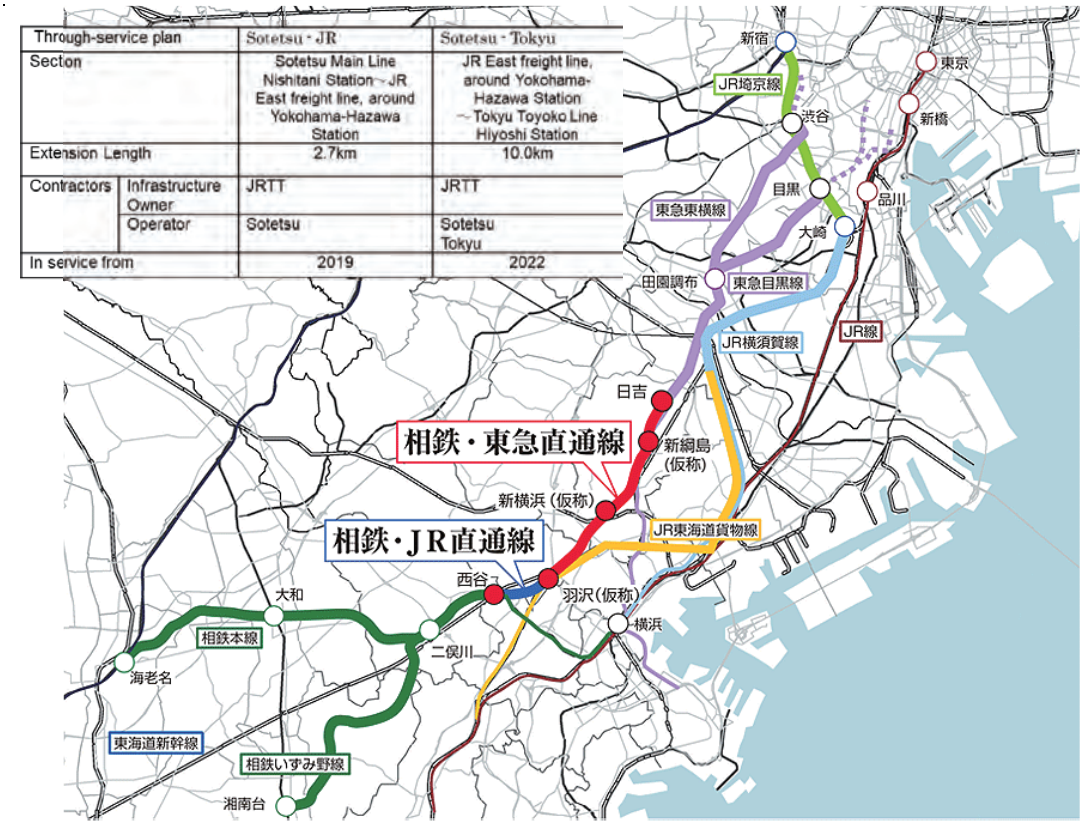



**Figure 8.3 Overview of Urban Railway Service Improvement Works**

The vertical separation scheme mentioned in section 6.4.2 for Sotetsu-JR Line and Sotetsu-Tokyu Line was also verified by a study from JTRI.




Note: Blue is Sotetsu-JR line and red is Sotetsu-Tokyu line.

**Figure 8.4　Map of Sotetsu-JR Line and Sotetsu-Tokyu Line Projects**

## 8.3 Survey data

In Japan, various socio-economic census and survey have been implemented. During the demand forecast process, frequently used data can be extracted from the following surveys.

**Table 8.1 Survey data from urban transport study**

| | Data from urban transport study | | | | |
|---|---|---|---|---|---|
| Survey Title | National Census | Person-Trip Survey | Metropolitan Transportation Census | Urban transportation Annual Report | Highway Census |
| Agency | Statistics Bureau, MIC | City Bureau, MLIT; local government | Policy Bureau, MLIT | Japan Transportation Research Institute | Road Bureau, MLIT |
| Objective | Provide the basic information for policy discussion in both national and local admin. level | To understand the current situation of transportation in an urban area in overall, for the best consideration in policy planning | To understand the volume of public transportation in major 3 metropolitan area, As the basic information for the public transportation investment plan | To understand the passenger volume and the actual capacity of public transportation, for the transportation management plan | To understand the current situation of the national highway and vehicle usage, as a basic information for every plan related to highway |
| Study Area | Nationwide | Urban Area, TMA | Tokyo MA, Chukyo (Nagoya) MA, Kinki (Osaka) MA | Tokyo MA, Chukyo MA, Kinki MA | Nationwide |
| Survey Target | A person, Person-trip (1day) | Person-trip (1day) | Rail, Bus, Tram passenger movement (1day) | Railway passenger volume, the actual capacity | Car movement (1day) |
| Staring year and period | Since 1920 every 5 years | Since 1967, each city every 10 years | Since 1960 every 5 years | Since 1920 every year | Since 1928, from 1980 every 5 years |
| Utilization in demand forecasting model | Commuting O-D (Municipality level) | ・Commuting, Private trip, Business related trip O-D (partial muni. Level)<br>・ individual trip data for the disaggregate model | ・individual trip data for disaggregate route choice model<br>・railway passenger volume by time period<br>・ station access data (access mode, origin zone) | ・railway peak-hour passenger, by section<br>・railway capacity | ・highway O-D and volume |
| Sample size | All resident | (2008)<br>Individual: 783,873 samples (respond rate 2.12%)<br>Household: 340,619 samples (respond rate 24.2%) | (2010)<br>Rail: 212,971 person<br>Bus, Tram: 23,009 person | Based on the annual report submitted by railway company | (2010)<br>O-D survey: 1,425,000 vehicle |
| Involvement from Professors | | YES | YES | | |

**Table 8.2 Survey Data from Urban Transport and Air Transport Study**

| | Data from urban transport study | | Data from air transport study | |
|---|---|---|---|---|
| Survey Title | Highway Census | Survey of trunk line passenger flow | Air Passenger Survey | International Air Passenger Survey |
| Agency | Road Bureau, MLIT | Policy Bureau, MLIT | Civil Aviation Bureau, MLIT | |
| Objective | To understand the current situation of the national highway and vehicle usage, as a basic information for every plan related to highway | To understand the flow of regional transportation on the trunk line, as a basic information for demand forecasting and policy planning. | To understand the characteristics of air passenger such as personal information, origin and destination, flight pattern, etc., as a basic data for airport development plan and other aviation promotion policies | |
| Study Area | Nationwide | Nationwide | Nationwide | |
| Survey Target | Car movement (1day) | Trunk line (Rail, Air, Ferry, Car), per passenger-trip (1day, 1year) | Domestic passenger-trip (weekend-weekday, one day each) | International passenger-trip (1 week) |
| Staring year and period | Since 1928, from 1980<br>Every 5 years | Since 1990<br><br>Every 5 years | Since 1973<br><br>Every 2 years | Since 1987<br><br>Every year |
| Utilization in demand forecasting model | ・Highway O–D and volume | O-D to HSR station by access mode | O-D to the domestic airport by access mode | O-D to the international airport by access mode |
| Sample size | (2010)<br>O–D survey: 1,425,000 vehicle | (2010)<br>*For Railway:*<br>Weekday 76,000 person (8.9%)<br>Holiday 192,000 person (9.0%) | | (2015)<br>The sample in Narita Airport is beyond the expected recovery rate |
| Involvement from Professors | | Yes | | |

**1) National Census**

The main objective of the National Census is to understand the population and household conditions that will be recorded as database for further national policy discussion. Since the workplace or school location of each household individual can be obtained from the survey, we can grasp the commuting pattern. This information can be further utilized in the demand forecast process. The following information can be obtained from the National Census.

- *Survey items*
  - Household member related information
    - Individual attributes: Name, gender, date of birth, relationship with the head of household, marital status, nationality.
    - Resident information: Living period in this residence, residence address five years ago (to check migration).

- Employment information: Employment status, affiliation and type of business, type of work, and position.
- Workplace or school location.

・ Household related information

- Household type
- Number of household member
- Housing categories
- Housing structure

- *Example of the result*

From the National Survey, we can understand the condition of daytime and nighttime population. In Tokyo 23 wards area, Chiyoda ward shows the highest ratio of daytime/nighttime population of 1460.6% (14.6 daytime population against 1 nighttime population)


**Figure 8.5 Daytime/Nighttime Population Ratio in Tokyo 23 Wards Area**

**2) Metropolitan Transport Census**

The Metropolitan Transport Census aims to understand the current public transport condition in the metropolitan area. This survey has been conducted in three metropolitan areas in Japan once every 5 years since 1960. The information from this survey will be further utilized for various policy consideration such as public transportation accessibility upgrade and service improvement policies.

- *Survey items*

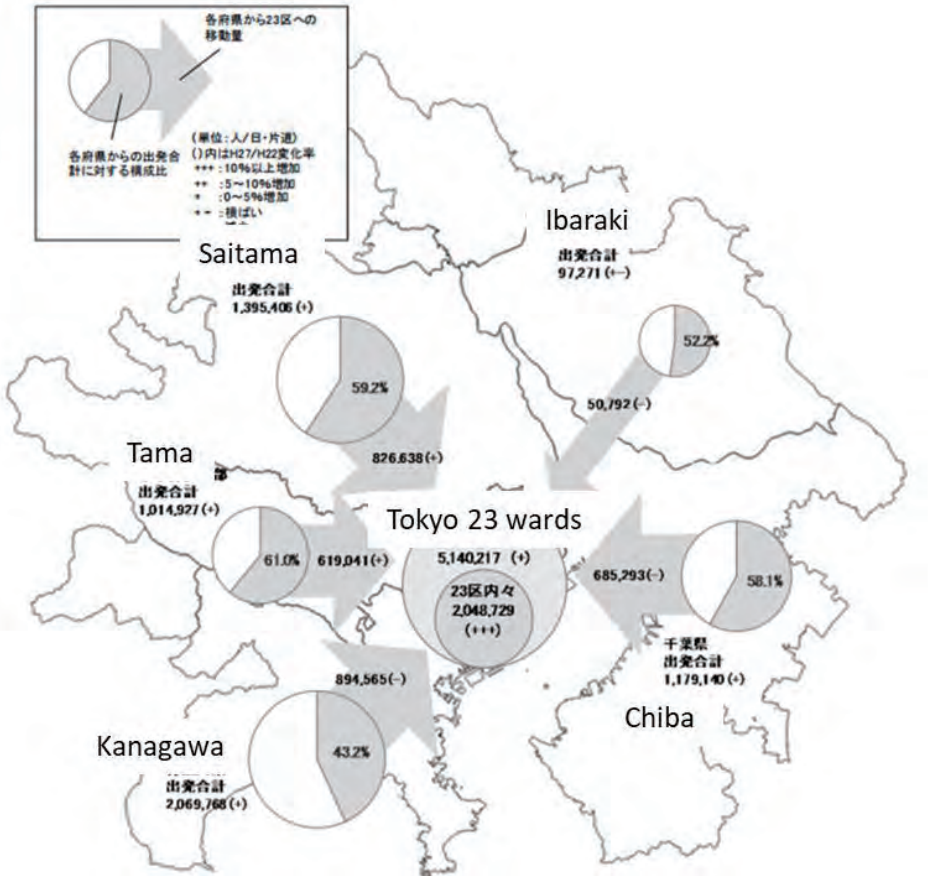
・ Railway survey: User survey, commuting ticket sales survey, O–D survey, and service condition survey.

- Bus survey: User survey, O–D survey, and service condition survey.

- *Example of the result*

  ✧ Change in commuting pattern

  The flow of commuters from Tokyo suburban to Tokyo 23 wards and other prefectures (by using commuter pass) are shown in Figure 8.6.




Note: Circle indicates the total generated trip from each zone. Shaded area indicates the share of generated trip to Tokyo 23 wards.

**Figure 8.6 Flow of Commuters to Tokyo 23 Wards**

✧ Commuting travel time

Figure 8.7 shows the transition of an average commuting time of commuters using commuter pass (including access time and egress time to/from the station) in 2005, 2010, and 2015.

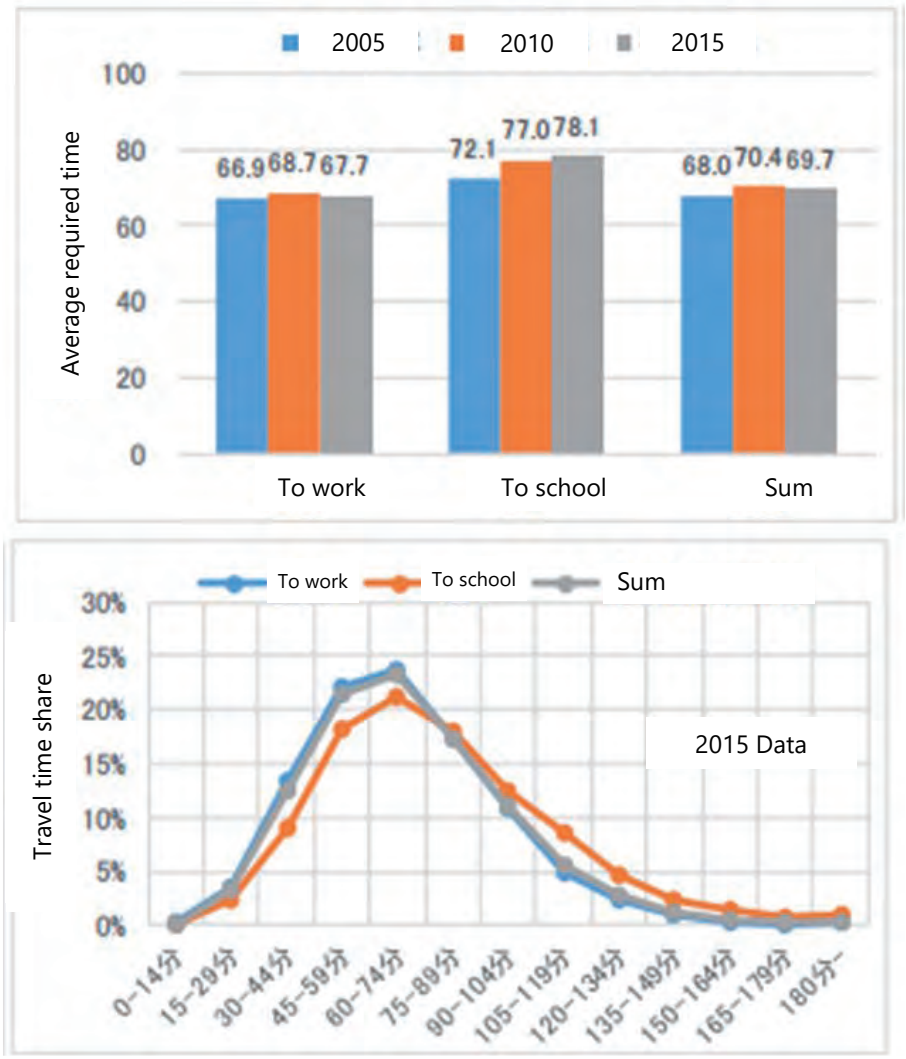



**Figure 8.7 Average and Distribution of Commuting Time of Commuter Pass User (including access time and egress time, in minute)**

✧ Transition of modal share of access and egress trip

Figures 8.8 and 8.9 show the change of modal share of access trip (from home to station) and egress trip (from station to workplace) in 2005 to 2015. For access trip, walking shares the highest modal choice, followed by bicycle. Bus share is around 10%. For egress trip, walking share is higher than share in access trip, up to around 90%.

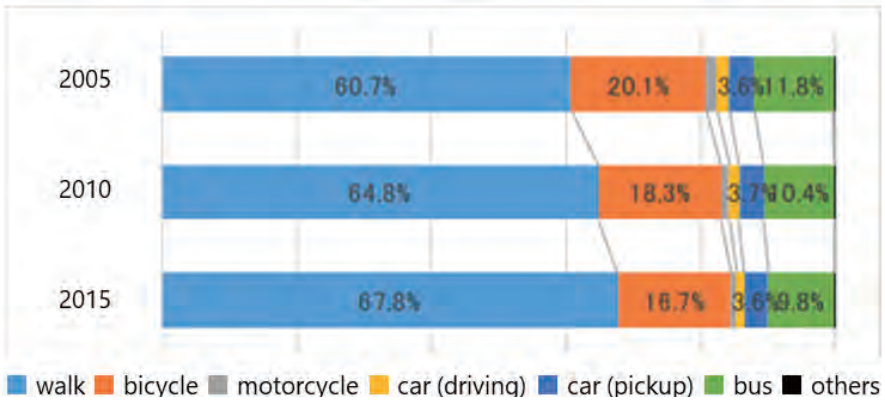



**Figure 8.8 Modal Share of Access Trip (from Home to Station)**

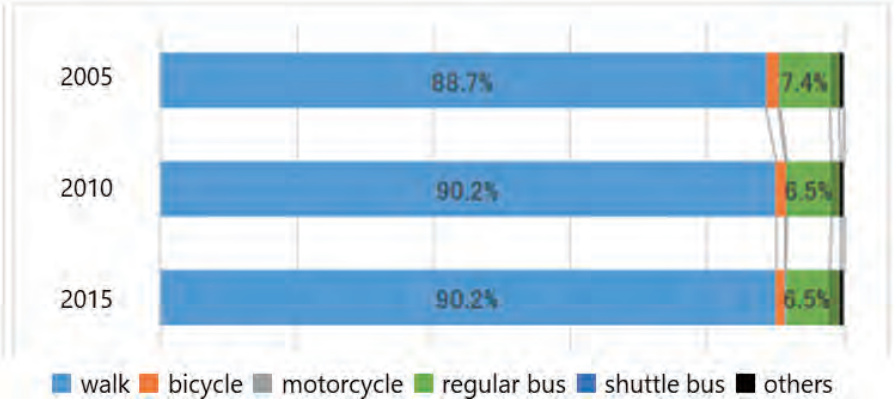



**Figure 8.9 Modal Share of Egress Trip (from Station to Workplace)**

✧ Transition of boarding and alighting time distribution

The distribution of boarding and alighting times for commuting and returning home trips are shown in Figures 8.10 and 8.11. It can be observed from the figures that the morning peak boarding is between 7:30 to 7:44 and alighting is between 8:00 to 8:44. Also, peak share decreases and the distribution gets more uniform each year. In the returning home trip, the peak share is less in the morning peak and the distribution is quite uniform across time especially for alighting time.

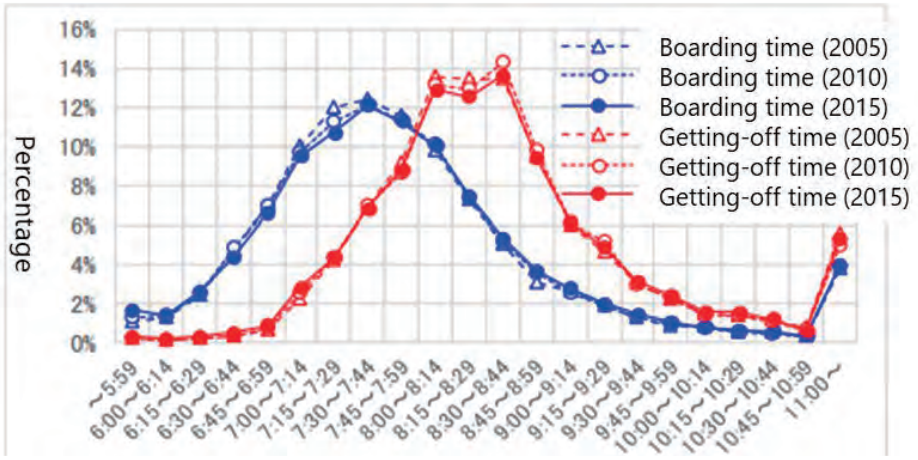



**Figure 8.10 Distribution of Boarding Time and Alighting Time for Commuting Trip (Work/School)**

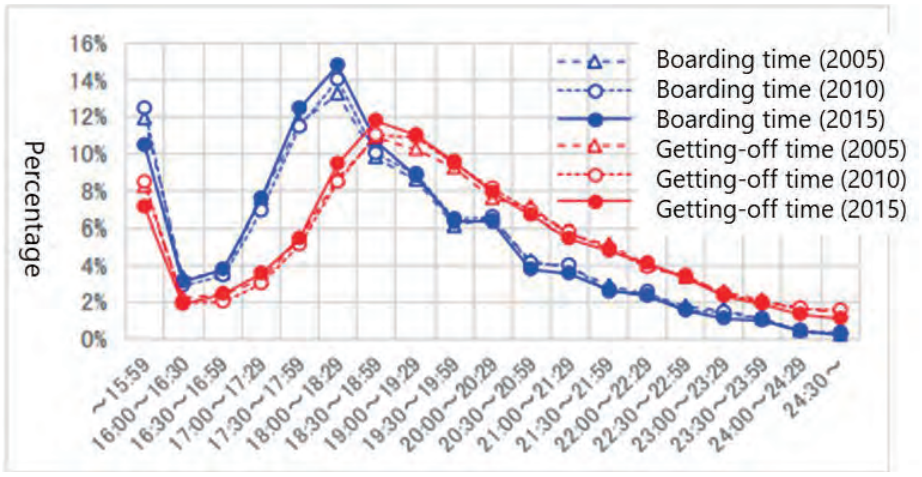



**Figure 8.11 Distribution of Boarding Time and Alighting Time for Returning Home Trip**

**3) Person-Trip Survey (PT Survey, known as household travel survey in other countries)**

The PT survey aims to determine every detail of trips conducted each day such as the trip purpose, trip origin and destination, mode of transportation, and even the attribute of the person who makes a trip. This survey can reveal modal share and traffic volume by each mode of transportation.

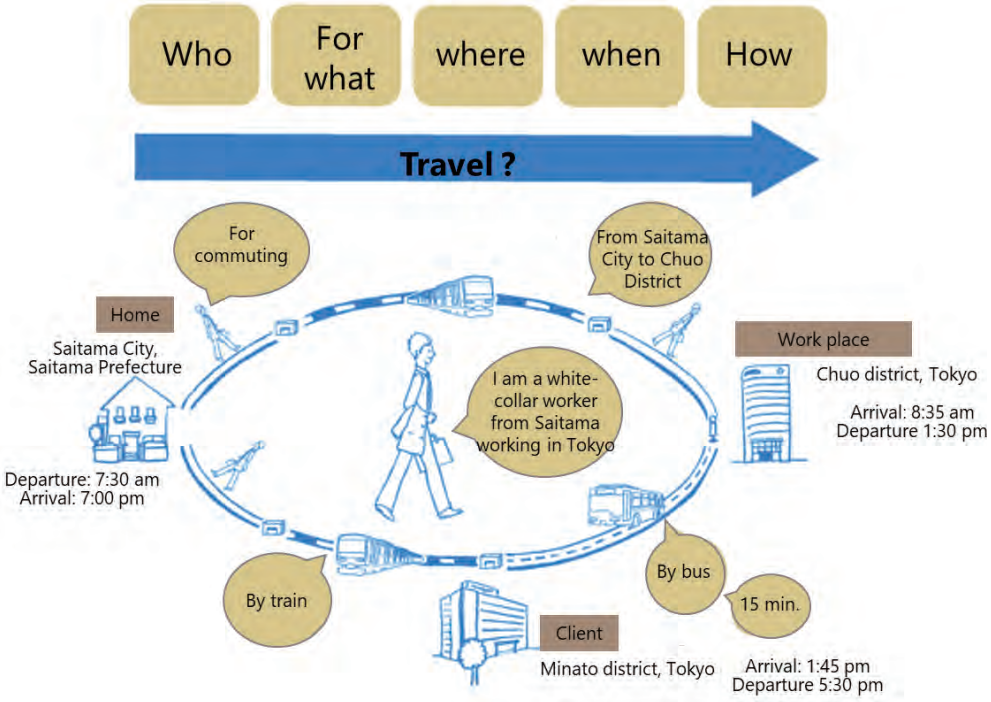



**Figure 8.12 Summary of the Contents in a PT Survey**

- *Survey items*

  Survey items in a PT survey include every trip detail in one day (on a weekday). Contents of the fifth PT survey in TMA is shown below.

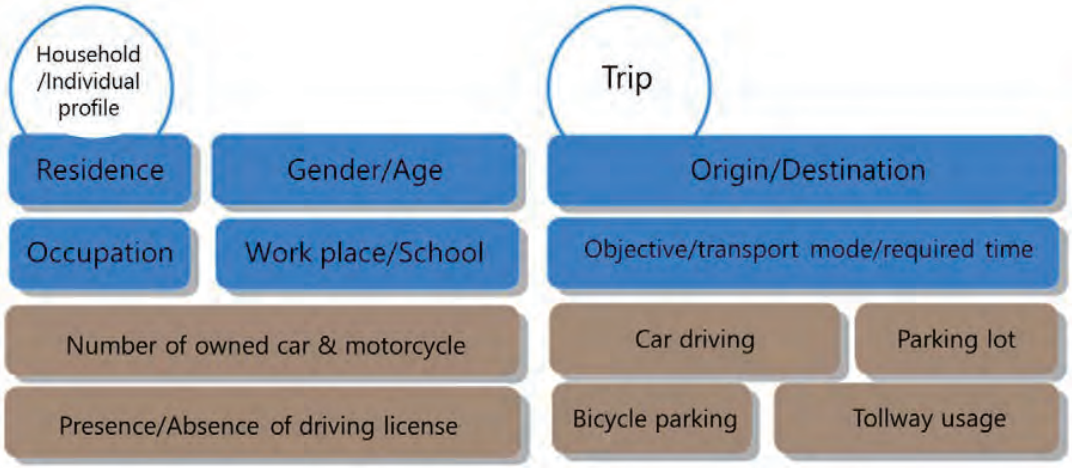



**Figure 8.13 Survey Items in PT Survey**

- *Example of the result*

  ✧ Travel flows

  In the figure below, the trips from/to Tokyo 23 wards area share the largest portion of trips in TMA. Also, we can observe a large amount of trips from/to Tama area, southern part of Saitama Prefecture, Yokohama City, Kawasaki City, and north-western part of Chiba.

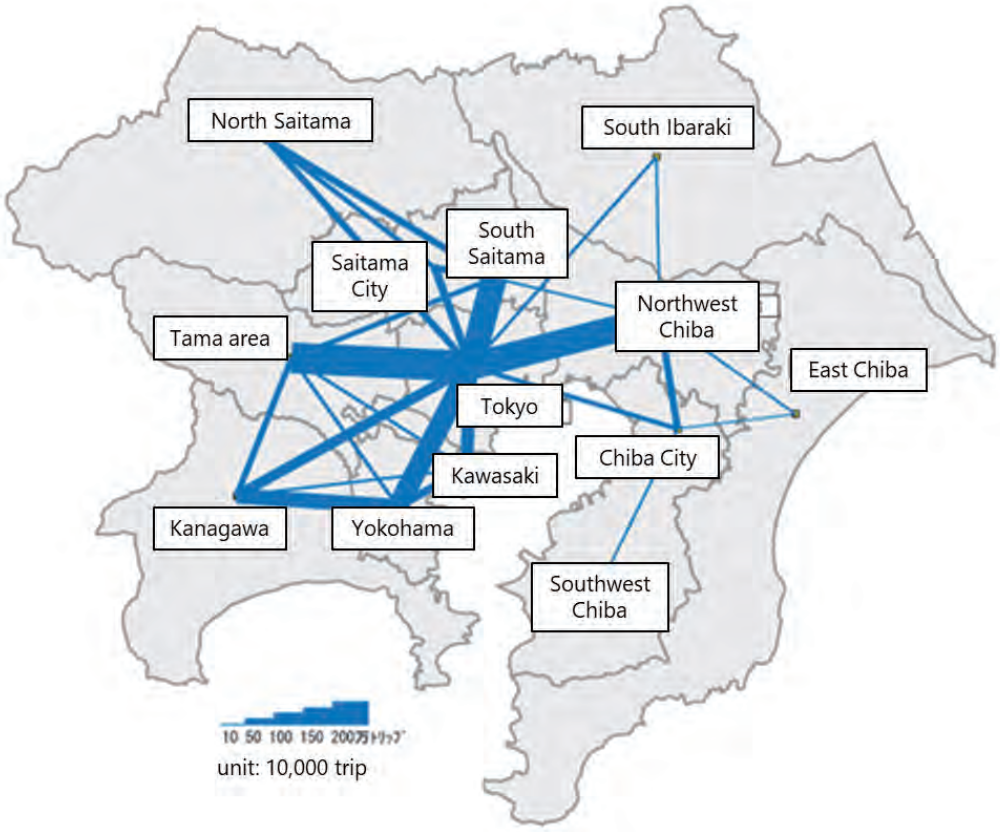



**Figure 8.14 Summary of Travel Flow from PT Survey**

✧ Modal share

Most of the commuters to Tokyo 23 wards area and other designated city areas use railways. Eighty percent of commuters use railways especially in Tokyo 23 wards area.

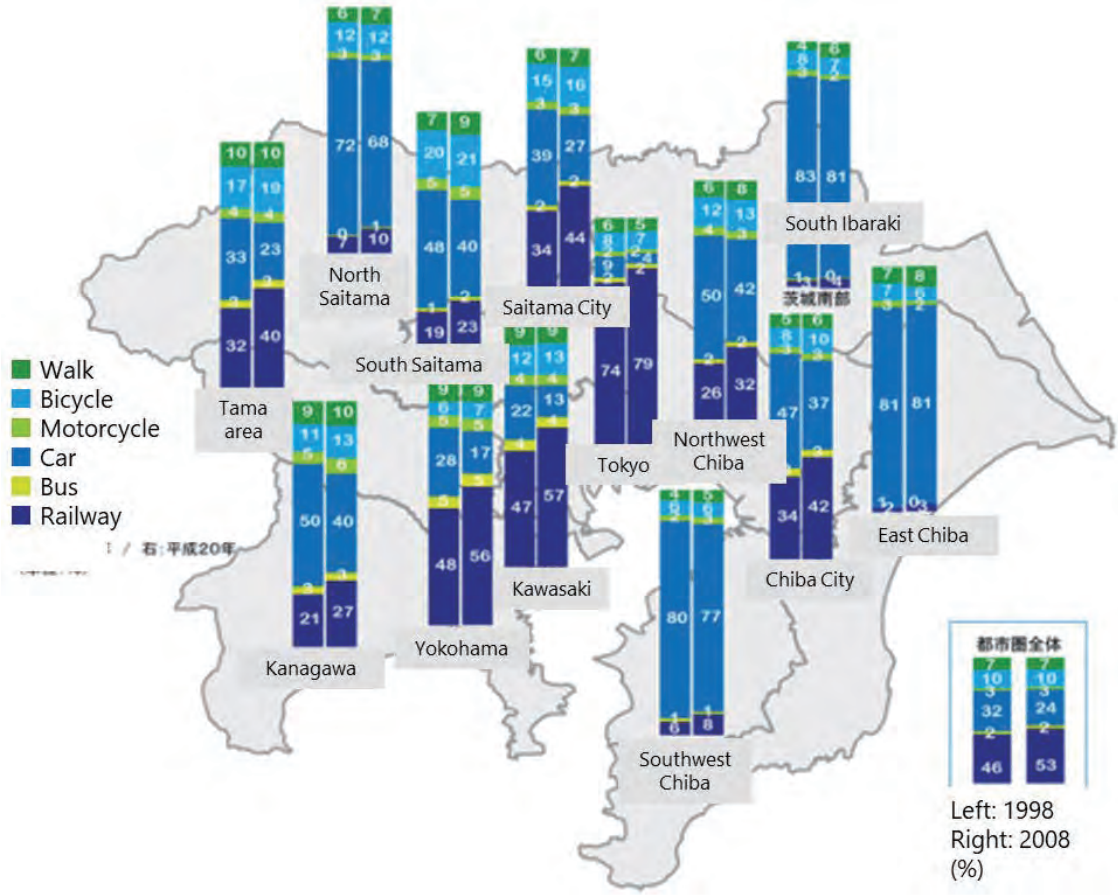



**Figure 8.15 Summary of Modal Share in Each Block from PT Survey**

# Appendix 4

Lecture on Demand Forecast Modeling in Railway Development Planning in Tokyo Metropolitan Area (TMA)

Appendix 4

**Data Collection Survey on the Development of Blueprint for the Second Mass Rapid Transit Master Plan (M-MAP2)**

**Sub-Workgroup for Demand Forecasting**

# A ONE-DAY LECTURE

# on

# Demand Forecast Modeling in Railway Development Planning in Tokyo Metropolitan Area (TMA)

August 2, 2018 JICA Study Team

Engineer Institute of Thailand, Bangkok

## Lecturer's Profile

社会システム株式会社

### Creative Research and Planning Co., Ltd. (CRP)

- Founded in 1978
- Transport planning consultant firm mainly dealing with traffic demand forecasting
- Assisting urban railway planning in several metropolitan areas in Japan for over 40 years

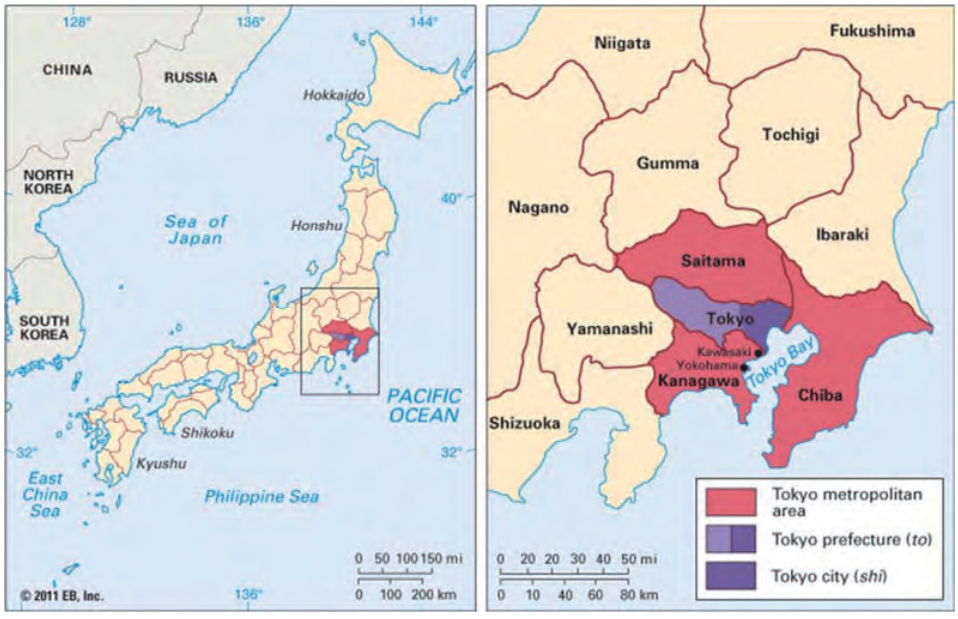
### Shio HAYASAKI

- Director, Creative Research and Planning Co., Ltd.
- With CRP since 1987
- 30 years of experiences in transport demand forecasting and project feasibilities study in Japan

### Jay WETWITOO

- D.Eng. in Civil Engineering
- Specialized in Transportation Economics and Operational Research

# Tokyo Metropolitan Area (TMA)

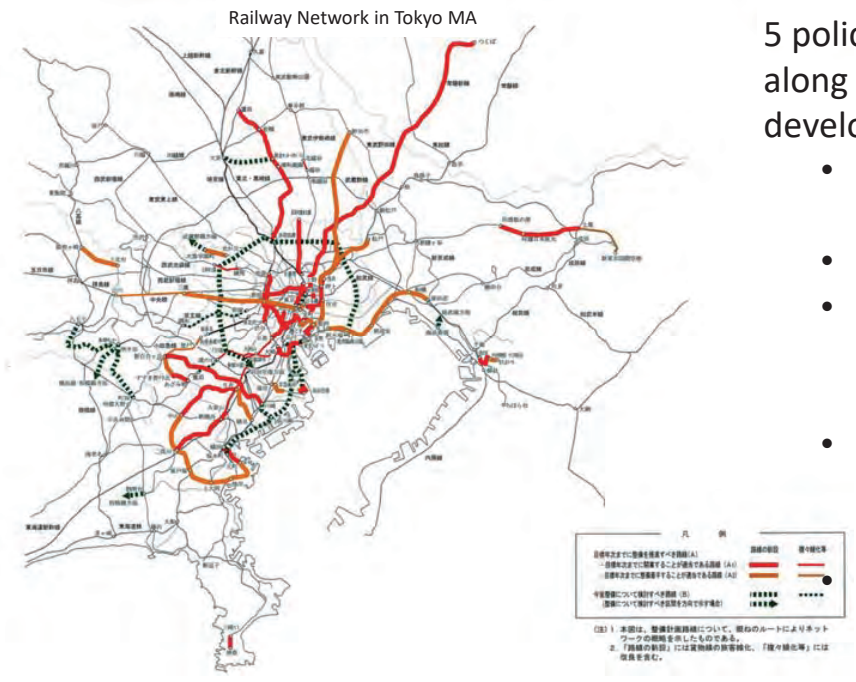





# Tokyo Metropolitan Area (TMA)

# Tokyo Metropolitan Area Railway Network Plan (2000)

Railway Network in Tokyo MA



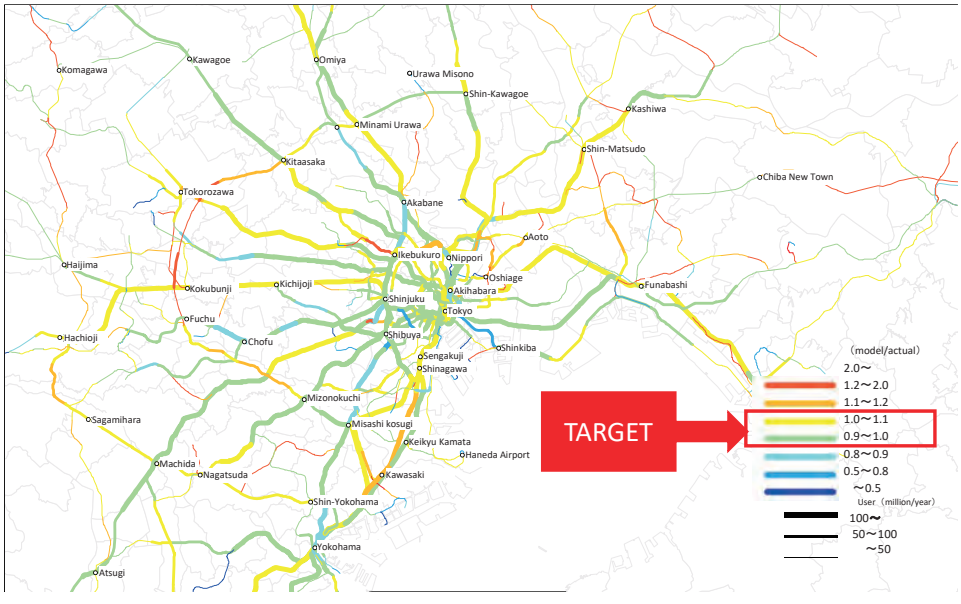
5 policy to be considered along with the railway development plan

- In-train congestion reduction
- Speed improvement
- Urban development and city function support
- Strengthen the accessibility to airport, HSR
- Universal design and seamless transfer



# Tokyo Metropolitan Area Railway Network Plan (2000)

## Congestion rate and model calibration



# Draft Proposal of Future Mass Transit Corridors for Policy Discussion Purpose Only (confidential)

| Policy Direction | Key Implementation Measures |
|---|---|
| **1. To alleviate traffic congestion in the city center** | A) Capacity expansion of the existing mass transit lines<br>B) Ensured implementation of the planned mass transit routes (M-MAP)<br>C) Additional line development in the railway-missing areas<br>D) Strengthening of multi-modal public transport network with bus transport, river transport, etc. |
| **2. To strengthen overall Railway Network in BMR** | A) To develop mass transit lines to the corridors with high demand<br>B) To develop mass transit lines to link sub-centers<br>C) To utilize the existing SRT lines and connect with mass transit network<br>D) To strengthen transport terminals |
| **3. To improve accessibility to stations** | A) To develop inter-modal facilities; terminal or parking spaces for feeder mode, parking spaces for private vehicle, pedestrian access<br>B) To provide safe and comfort feeder transport services<br>C) Integration with surrounding urban development at station area |
| **4. To provide value-added mass transit services to promote public transport** | A) Information provision on railway services for passengers<br>B) Flexible fare setting<br>C) Safety and amenity facilities<br>D) Express operation<br>E) Business-class train cars |
| **5. To enhance accessibility to global gateways** | A) To develop alternative routes to access international airports<br>B) To reduce access time (express operation, etc.) |



Confidential Information

# I

# History of The Development of Transport Demand Forecasting in Japan

1. History of Railway Development in Tokyo Metropolitan Area (TMA)
2. Comparison of demand forecasting model in Bangkok and Tokyo
3. History of Demand Forecasting
4. Demand forecasting WG members and their roles
5. Development of demand forecasting method
6. Demand forecasting and its effect to researchers
7. Practical implementation and Achievements
8. Roles of demand forecasting
9. City characteristics and demand forecasting
10. Demand Forecasting and Social Responsibility



# Main Issue to be Considered

## Main task to be considered in the development of Tokyo Metropolitan Area (TMA) demand forecasting model

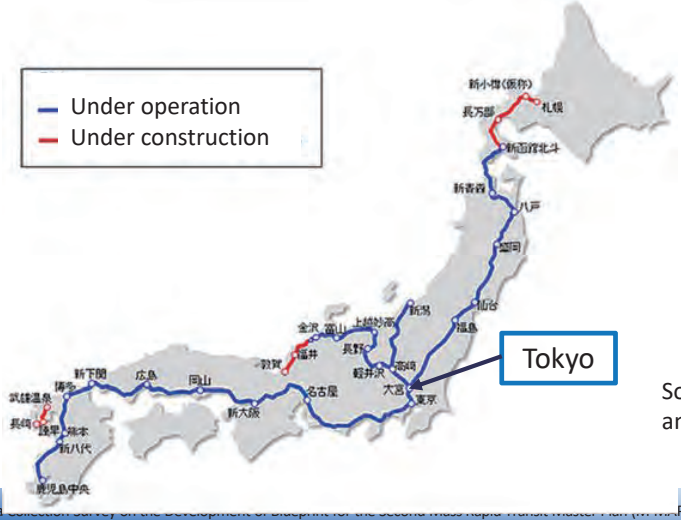
- Policy related task (to present the result from railway investment plan)
  - for the policy discussion in central and local government
  - to clarify the fiscal policy needed for the investment
  - to deal with the concern about tax spending

- Technical related task
  - Research and development on demand forecasting model (disaggregate model, probit model, etc.)
  - Utilizing the computational capability (peak data management, iteration)
  - Data surveying

# I-1 History of TMA urban railway development (current network)

## More than 50 years of high-speed rail (HSR) development in Japan

- The first line (Tokyo-Osaka) started its operation in 1964
- Currently, 7 lines with the length around 2,765 km are under operation
- Extensions of 403 km in 3 routes are under construction
- Connecting the capital city, Tokyo, with other cities around Japan



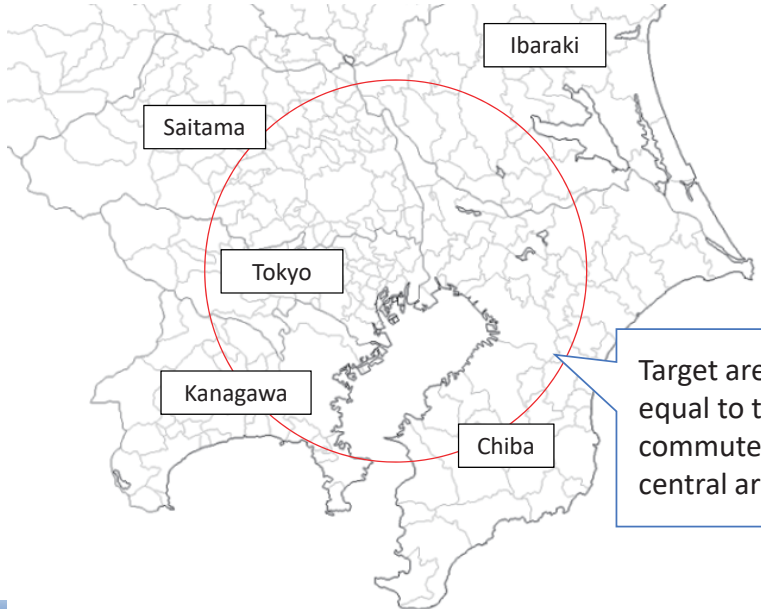

Source: Japan Railway Construction, Transport and Technology Agency (JRTT)



# I-1 History of TMA urban railway development (current network)

## Target Area of Urban Railway Development Plan in Tokyo area

- Area within 50 km radius of Tokyo central area (Tokyo, Kanagawa, Chiba, Saitama and south part of Ibaraki prefectures)




Target area is almost equal to the area where commuters to Tokyo central area live.

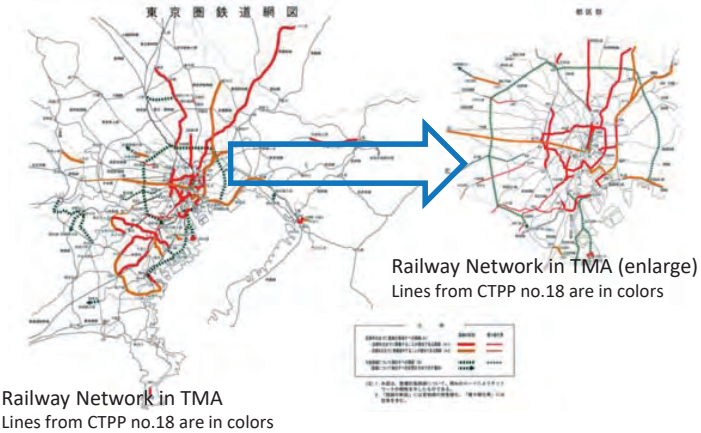
# I-1 History of TMA urban railway development (current network)

**TMA (radius around 50 km)**

- Population (2010): around 37.24 million
- Railway Network (2016): 2,705 km
- Council of Transport Policy Plan No.18 (2000): the whole 96 railway lines are included in the demand forecasting model

**Bangkok MA**

- Population (2016): around 10.76 million
- Railway Network (2017): 112 km (SRT excluded)




Railway Network in TMA
Lines from CTPP no.18 are in colors

Railway Network in TMA (enlarge)
Lines from CTPP no.18 are in colors

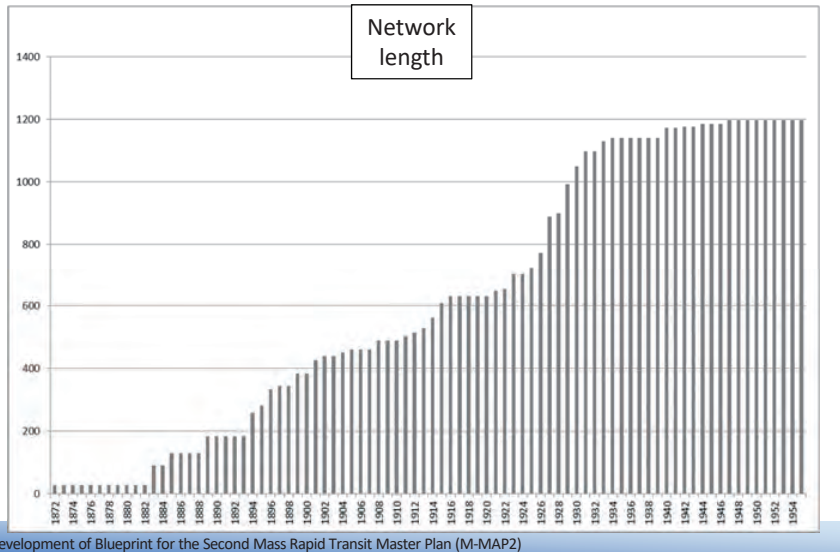

Rapid transit network in BMA



# I-1 History of TMA urban railway development (before WW2)

Railway network in TMA was extensively developed before WW2 by both public and private

- First railway service started in 1872
- Since the nationalization of railway in 1906, railway development in TMA saw a rapid growth period until WW2
- In CBD, most of them are on-street tram, while suburban lines are provided by both public and private

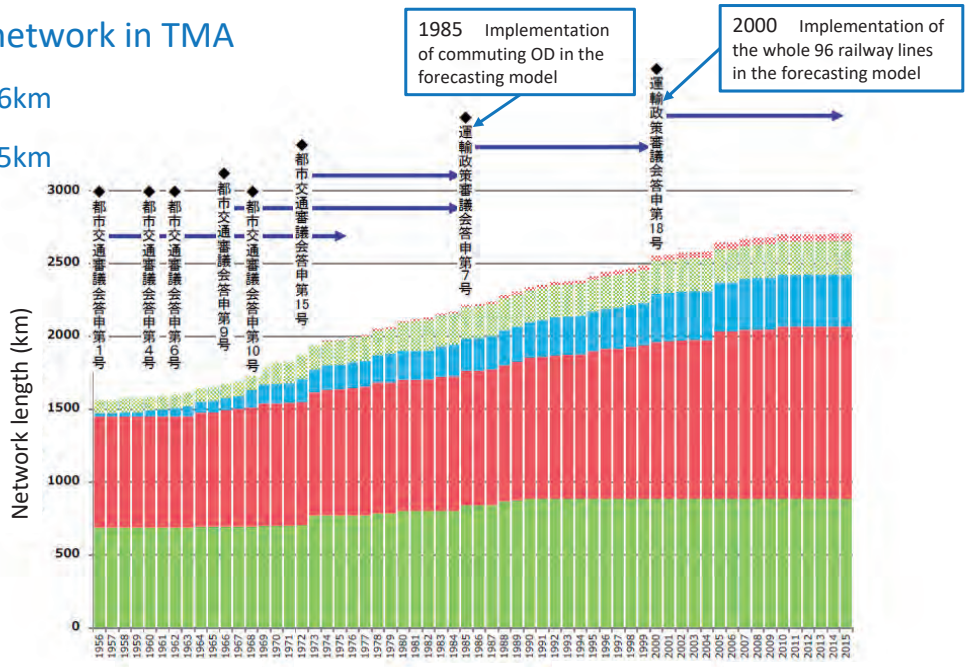


# I-1 History of TMA urban railway development (after WW2)

## Railway network in TMA

1956: 1,566km

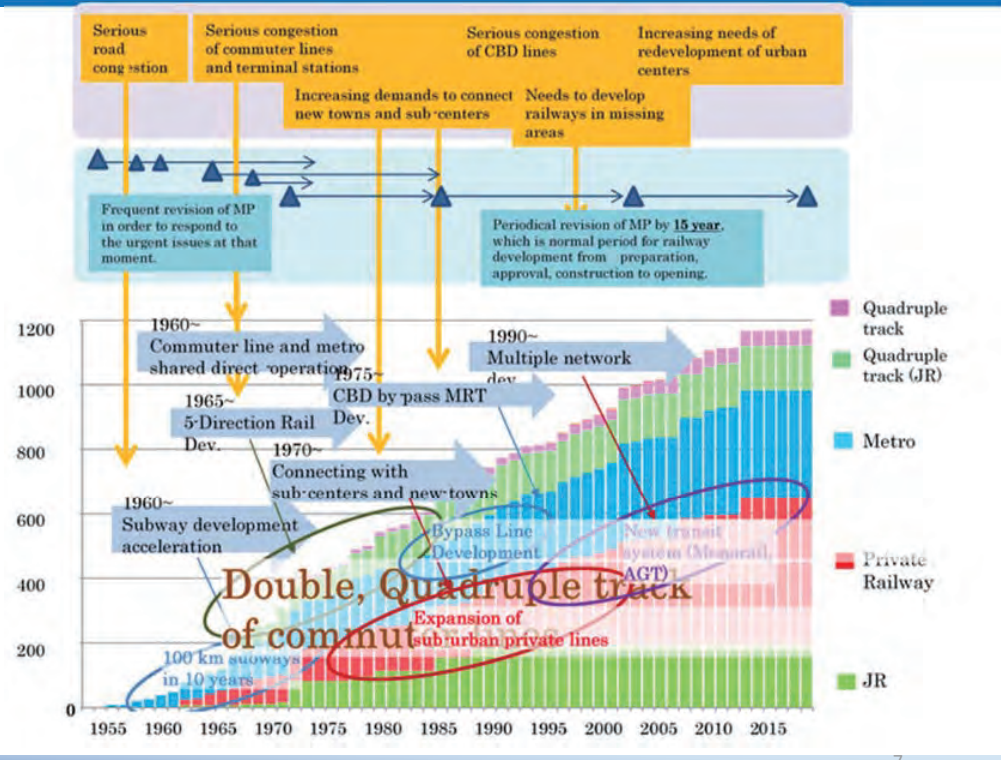
2016: 2,705km




*JNR = Japan National Railways
JR = Privatized JNR after 1987



# I-1 History of TMA urban railway development (after WW2)



# Railway Investment and Urban Development

# Example of Urban Development by Public and Private Agencies



## Reference: Tokyo and 50 Years of evolution

Tokyo and 50 Years of evolution

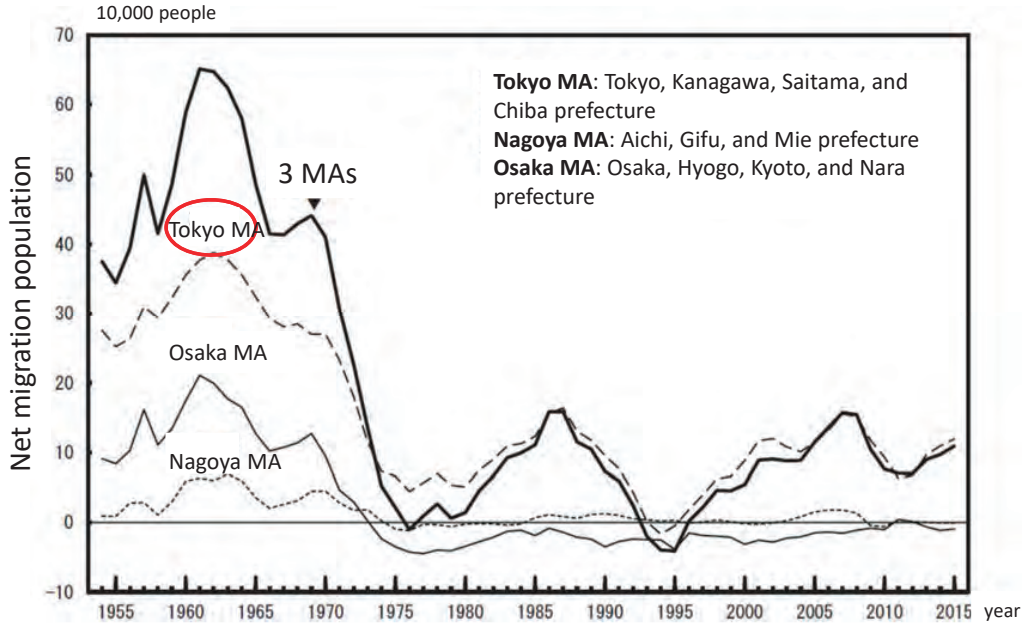
- Production increase by 6.2 times
- Railway network increase by 1.7 times

| TMA stats | 50+ years before | | Recent stat | | Times increase |
|---|---|---|---|---|---|
| Nighttime Population (4 TMA Pref.) | 1960 | 17,864,000 (19.8% of national population) | 2010 | 35,619,000 (27.8% of national population) | 1.99 times |
| GRP (real) (4 TMA Pref.) | 1964 | 28.92 trillion yen | 2011 | 178.80 trillion yen | 6.18 times |
| Railway network length (TMA) | 1956 | 1,566 km | 2016 | 2,705 km | 1.73 times |
| Number of railway station (TMA) | 1956 | 807 station | 2016 | 1,510 station | 1.87 times |
| Motorway length (nationwide) | 1960 | 0 km | 2011 | 7,920 km | - |
| Highway length (nationwide) | 1960 | 972,688 km | 2011 | 1,204,744 km | 1.24 times |
| Sewage coverage (4 TMA Pref.) | 1964 | 18.9% | 2012 | 94.2% | - |
| Electric consumption (nationwide) | 1964 | 157,208GW/h | 2010 | 1,031,799GW/h | 6.56 times |

Source: Tokyo Metropolitan Area: Change for 50 years and Future Vision - Change and Future of Metropolis according to the Data (Yuichi MOHRI and Jun MORIO, in Japanese)

# I-1 History of TMA urban railway development (population agglomeration in TMA)

## In early 60's, population in TMA increase by 300,000 annually




Source: Ministry of Internal Affairs and Communications (MIC)

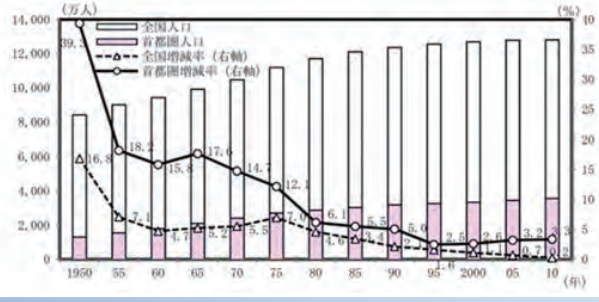


# I-1 History of TMA urban railway development (population agglomeration in TMA)

## From 1950 to 2010, population in TMA increased by 2.7 times

| Year | Total Population (A) | Pop. Growth Rate (%) | Population in TMA (B) | Pop. Growth Rate (%) | Pop. Share (B/A) |
|---|---|---|---|---|---|
| 1950 | 84, 114, 574 | | 13, 050, 647 | | 15. 5% |
| 60 | 94, 301, 623 | 12. 1 | 17, 863, 859 | 36. 9 | 18. 9% |
| 70 | 104, 665, 171 | 11. 0 | 24, 113, 414 | 35. 0 | 23. 0% |
| 80 | 117, 060, 396 | 11. 8 | 28, 698, 533 | 19. 0 | 24. 5% |
| 90 | 123, 611, 167 | 5. 6 | 31, 796, 702 | 10. 8 | 25. 7% |
| 2000 | 126, 925, 843 | 2. 7 | 33, 418, 366 | 5. 1 | 26. 3% |
| 01 | 127, 316, 043 | (0. 3) | 33, 687, 162 | 0. 8 | 26. 5% |
| 02 | 127, 485, 823 | (0. | 33, 904, 514 | 0. 6 | 26. 6% |
| 03 | 127, 694, 277 | (0. | 34, 147, 519 | 0. 7 | 26. 7% |
| 04 | 127, 786, 988 | (0. | 34, 327, 612 | 0. 5 | 26. 9% |
| 05 | 127, 767, 994 | (△0. 0) | 34, 478, 903 | 0. 4 | 27. 0% |
| 06 | 127, 770, 000 | (0. 0) | 34, 634, 000 | 0. 4 | 27. 1% |
| 07 | 127, 771, 000 | (0. 0) | 34, 826, 000 | 0. 6 | 27. 3% |
| 08 | 127, 692, 000 | (△0. 1) | 34, 990, 000 | 0. 5 | 27. 4% |
| 09 | 127, 510, 000 | (△0. 1) | 35, 080, 000 | 0. 3 | 27. 5% |
| 10 | 128, 057, 352 | 0. 9 (0. 4) | 35, 618, 564 | 1. 5 | 27. 8% |

2.7 times

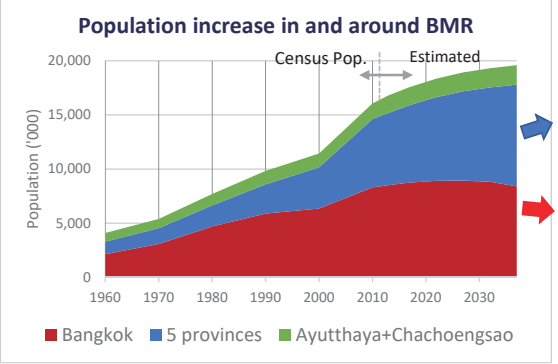



Source: Cabinet office of Japan (CAO)

# How Bangkok Metropolitan Region (BMR) will be in Future? -Planning Conditions for M-MAP2

- Increase of population particularly in outside of BMA
  - BMA's population will be saturated around 8.9 million and may start to decrease.
  - Outside 5 Provinces will accommodate additional 2.2 million people in next 20 years
  - Bangkok was visited by more than 20 million foreign visitors in 2016.

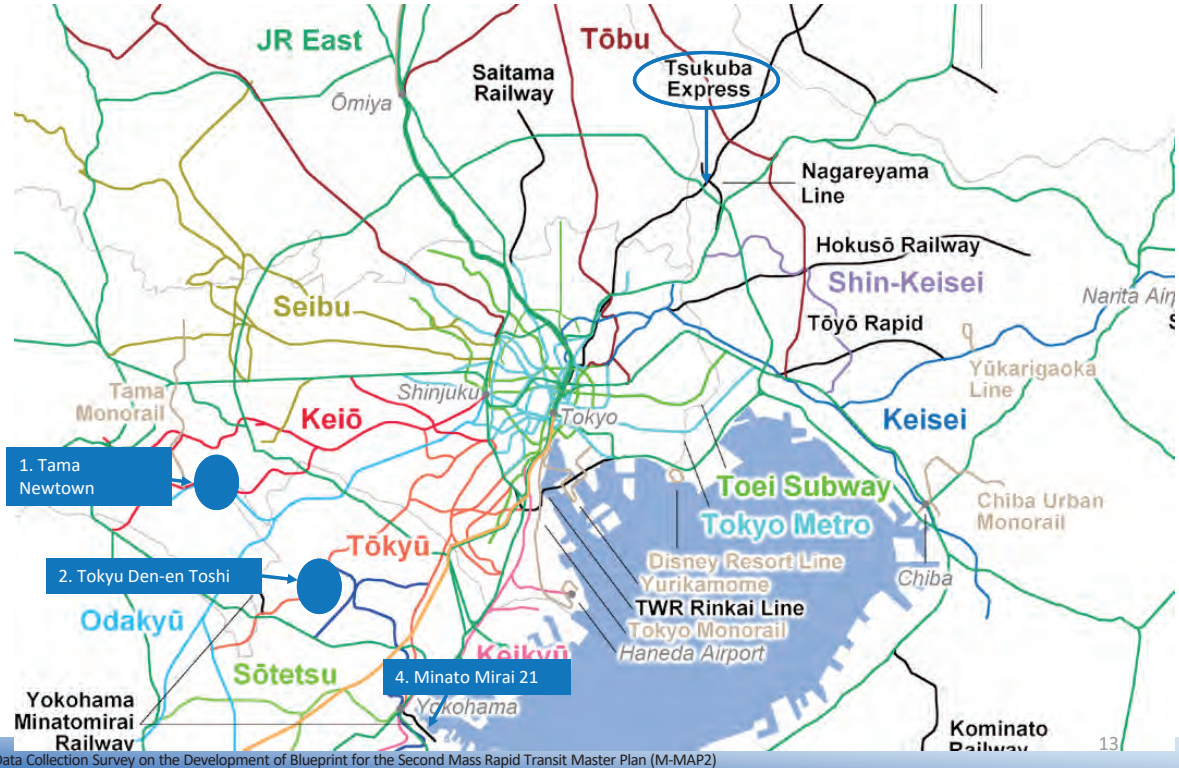
- Progressing ageing society.
  - Aged ratio (> 60) will be 23% in BMA and 28% in 5 provinces (in 2030)
  - ➔ Increasing needs of public transport with barrier-free access to secure mobility of seniors.




Source: Census, Population Forecast (NESDB)



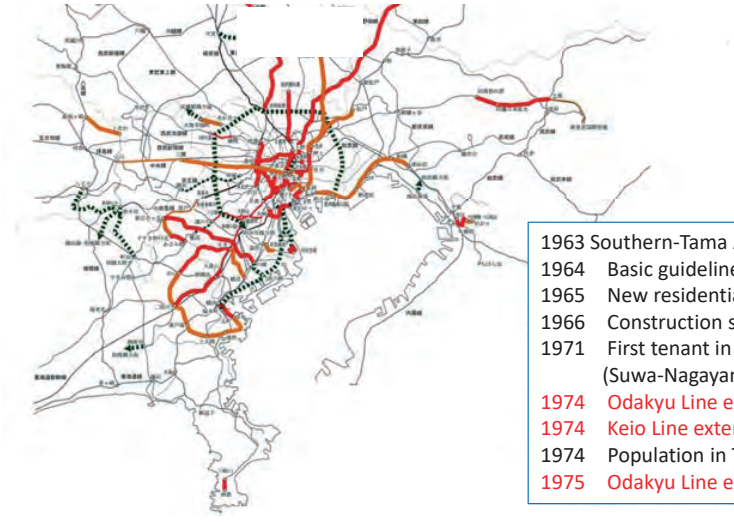
# I-1 History of TMA urban railway development Example of Urban development project



# I-1 History of TMA urban railway development – Example of Urban development during 1960-1980

**Tama Newtown**: to handle with the rapid increase in population and disorganization development from 1963

- Tokyo Metropolitan Government and private developers corporately developed the new town development plan, located around 30 km from CBD
- In the same time, the railway access was also developed along with the new town



*Land development:* Tokyo Metro. Govt. (public)
*Rail development:* Private railway companies

1963 Southern-Tama Area development zone plan
1964 Basic guideline of Tama area development policy
1965 New residential area development plan in Tama New Town
1966 Construction started in Tama New Town development project
1971 First tenant in Tama New Town development project (Suwa-Nagayama area)
1974 Odakyu Line extended its service to Nagayama Station
1974 Keio Line extended its service to Tama Center Station
1974 Population in Tama New Town reached 30,000
1975 Odakyu Line extended its service to Tama Center Station



# I-1 History of TMA urban railway development – Example of Urban development during 1960-1980

**Den-en Toshi**: One company railway + land development by Tokyu Corporation

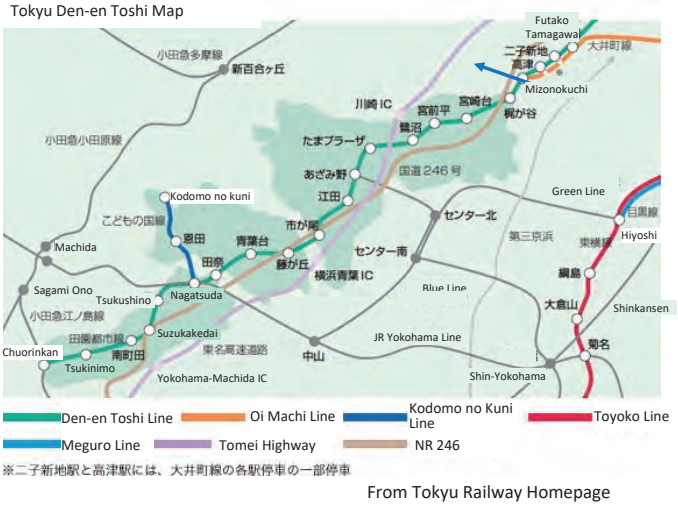
- 1953: With the expectation of overcrowded population in Tokyo, Tokyu Corp. announced the plan to develop a residential in this area
- The "Tokyu Tama Den-en Toshi" plan is the largest scale urban development by private company in Japan
  - 15-35km from CBD, developed area of 5,000ha, population of 620,000 (2017)

*Land+Rail development:* Tokyu Corp. (private railway company)

- Railway development timeline

1966 Mizonokuchi-Nagatsuta
1968 Nagatsuta-Tsukushino
1972 Tsukushino-Suzukakedai
1976 Suzukakedai-Tsukimino
Shibuya-Futako Tamagawa
1978 Through service with Hanzomon Subway Line
1984 Tsukimino-Chuo Rinkan

Tokyu Den-en Toshi Map




From Tokyu Railway Homepage

# I-1 History of TMA urban railway development – Urban development by private railway company

## Development has been started since before WW2

| | Developed area (ha) | | |
|---|---|---|---|
| | Before WW2 | Before WW2 | Total |
| **Odakyu** | 145 | 912 | 1,057 |
| **Keio** | 0 | 333 | 333 |
| **Keisei** | 25 | 256 | 281 |
| **Keikyu** | 70 | 1,616 | 1,686 |
| **Seibu** | 1,172 | 2,051 | 3,223 |
| **Tokyu** | 138 | 6,785 | 6,923 |
| **Tobu** | 43 | 402 | 445 |
| **Total** | 1,592 | 12,355 | 13,947 |

Source: Takashi Yajima and Hitoshi Ieda (2014). *Transit oriented development Tokyo.* The Institute of Behavioral Science.



# I-1 History of TMA urban railway development – Example of Urban development during 1980-2000

### Tsukuba Express

Integration between residential and railway development:

Railway development and demand forecasting with the consideration of the urban development

*Land development:*
Local govt. and UR (public)
*Rail development:*
Company's shareholders: Public 90%, Private 10%

| | | | | | |
|---|---|---|---|---|---|
| License granted | | January 10, 1992 | passenger (thousand people/day) | Year 2009 | 270 |
| Opened | | August 24, 2005 | | Year 2010 | 283 |
| contractors | construction | JRTT | Population along the line (thousand people) | | |
| | operation | Metropolitan Intercity Railway Company | Workers | Year 2000 | 1,974 |
| Termini | | Akihabara-Tsukuba | | Year 2010 | 2,121 |
| Length | | 58.3km | | Year 2001 | 1,304 |
| Construction Cost | | 808 billion yen | | Year 2006 | 1,814 |
| Subsidy Scheme | | Urban Railway Investment Funds | | | |

# I-1 History of TMA urban railway development – Example of Urban development during 1980-2000

## Minatomirai Line

### Reclaimed urban development in Yokohama Waterfront:

Railway development and demand forecasting with the consideration of the urban development

| | | | | | |
|---|---|---|---|---|---|
| License granted | | April 19, 1990 | passenger (thousand people/day) | Year 2006 | 140 |
| Opened | | February 1, 2004 | | Year 2010 | 163 |
| contractors | construction | JRTT | Population along the line (thousand people) | | |
| | operation | Yokohama Minatomirai Railway | Nighttime pop. | Year 1999 | 190 |
| Termini | | Yokohama, Motomachi-Chūkagai | | Year 2009 | 223 |
| Length | | 4.1km | Workers | Year 2001 | 312 |
| Construction Cost | | 257 billion yen | | Year 2016 | 320 |
| Subsidy Scheme | | Build-Transfer-Operate | | | |


Map source: Yokohama Minatomirai Railway

*Land development:*
Land reclaim -> public
Real estate -> private
*Rail development:*
Public 70%, Private 30%


Map source: Yokohama Minatomirai Railway



# I-2 Comparison of demand forecasting model in Bangkok and Tokyo

The model used in Bangkok is quite similar to model used in TMA!

TMA Model → introduce to → BMA Model???

Data, Model Structure, Model Consideration, Implementation, etc.

| | BMA | TMA |
|---|---|---|
| **Method** | 4 Step Model | 4 Step Model |
| **Number of Zones** | 1771 (e-bum) | 2843 |
| **Generation Model** | | Generator Method |
| **Distribution Model** | Gravity Model | Present Pattern Method<br>Analogy Pattern Method<br>Gravity Model |
| **Modal Split Model** | Disaggregate Model | Disaggregate Model (Logit Model) |
| **Route Assignment Model** | ? | Disaggregate Model (Probit Model) |

# I-2 Comparison of demand forecasting model in Bangkok and Tokyo

Zone definition and number of zones → Not so different

| BMA | | TMA based on CTPP No.198 (No.18 in bracket) | | |
|---|---|---|---|---|
| definition | No. of zones | definition | No. of zones | Application |
| Province<br>• BMA<br>• BMR | 8 | Block | 34<br>(13) | Sub-region and designated cities<br>・Control total value for population forecasting |
| District | 91 | L zone | 269<br>(333) | Municipality level<br>• Commuting O-D from National Census<br>• Estimated value from National Institute of Population and Social Security Research |
| Sub district | 645 | M zone | 628<br>(651) | PT survey zone<br>• O-D from PT survey in commuting, business, leisure purpose |
| Traffic Analysis Zone | 1771<br>eBUM? | S zone | 2843<br>(1,812) | Forecasting zone<br>• No. of resident registration in village/cho-me level |



# I-3 History of Demand Forecasting

## Researches and Studies

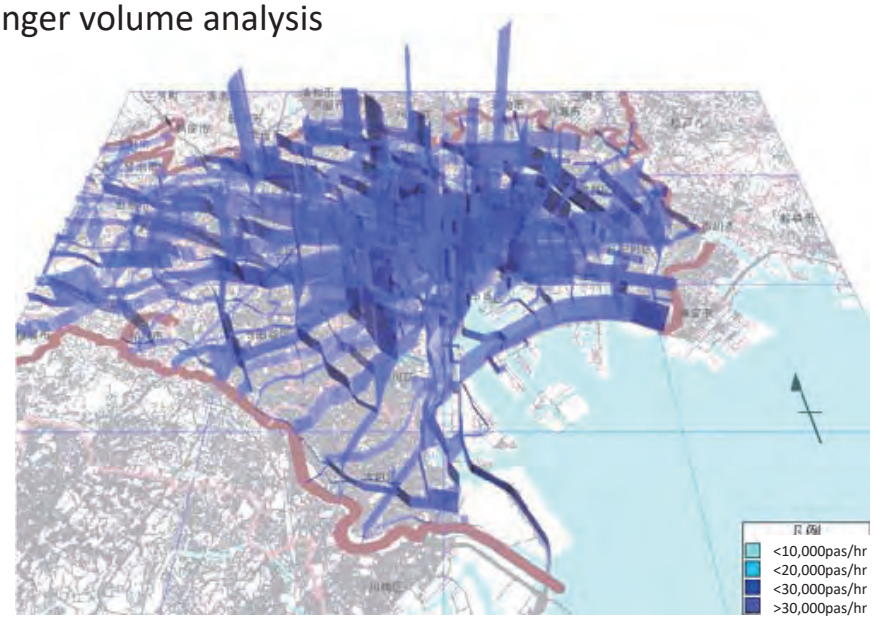
- From 1955: Economic revival and spread of car usage
- 1960's : Motorization period in Japan
- More investment in mass transit became an urgent task
- In order to estimate the capacity of the new mass transit, research on the demand forecasting model and method was needed
- First implementation of 4-step model in Japan
  - Based on MIT 4-step model (1962)

## Development of surveys for passenger flow data

- PT survey: from 1967, once every 10 years in each city
- Hiroshima MA (1967), Tokyo MA (1968)
- Since then: TMA 5 times, other 65 MAs = 140 times
- Metropolitan Transportation Census: from 1960, once every 5 years
- Urban Transportation Annual Report: from 1959, annually
- Highway Census: from 1928 upon the road improvement committee meeting; from 1980, once every 5 years
- National Census: from 1920, once every 5 years

# I-3 History of Demand Forecasting

Passenger volume analysis






# I-3 History of Demand Forecasting

## Demand forecasting and the railway master plan

first implementation of 4-step model (simplified model) in CUTP No.15

| | Master Plan | Issue to be considered |
|---|---|---|
| 1956 | The Council of Urban Transport Plan (CUTP) No.1 | ・Direct operation among several train operators (Keisei, Toei, and Keikyu)<br>・Expansion of subway operator |
| 1960 | CUTP No. 4 | ・Problems from motorization (on-street tram service, etc.) |
| 1962 | CUTP No. 6 | ・Development of the urban railway network to ease traffic congestion<br>・Response to the dispersion of the population into the suburbs |
| 1966 | CUTP No. 9 | ・Response to the dispersion of the population into the suburbs<br>・Increase of population agglomeration in Yokohama and Kawasaki |
| 1968 | CUTP No.10 | ・Response to the rapid population increase |
| 1972 | CUTP No.15 | ・Development of subcenters<br>・Improvement of access to new towns, airports, and stations for high-speed railway |
| 1985 | The Council of Transport Policy Plan (CTPP) No. 7 | ・Response to the airport plan and the dispersion of the population into the suburbs<br>・Development of subcenters and business core cities<br>・Utilization of existing railway stock |
| 2000 | CTPP No.18 | ・Development of subcenters and business core cities<br>・Continuation of the dispersion of the population into the suburbs<br>・Response to heavily congested lines and its timetable<br>・Accessibility increase to airport and HSR station |
| 2016 | CTPP No.198 | ・Increase international competitiveness<br>・Response to 2020 Tokyo Olympics<br>・Countermeasure to natural disasters<br>・Fiscal condition problems |

More than 40 years, demand forecasting has been implemented in the railway master plan

# I-3 History of Demand Forecasting - demand forecasting model by each master plan

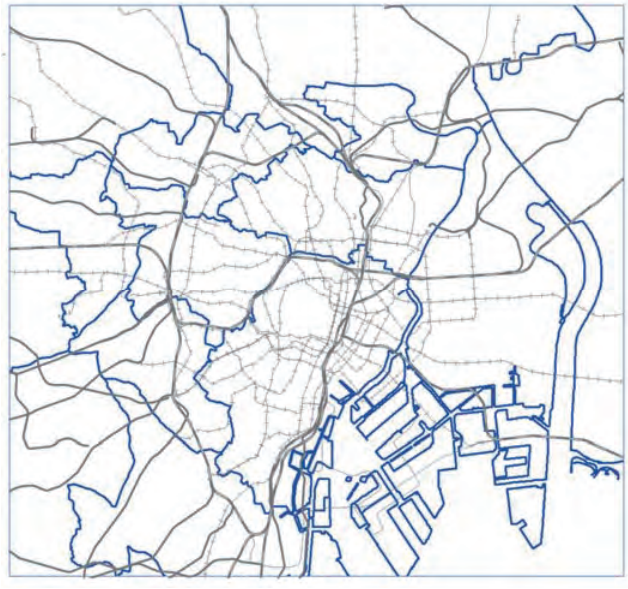
- Demand forecasting model is developed in order to test the policy given by the government.
- In each master plans, the working group (WG) for demand forecasting was established.
- In this working group, consultants worked together with scholars from many university.
- With the advance of technology, demand forecasting with higher precision can be achieved.
  For example, more railway lines, more zones can be analyzed

| | Policy Agenda | Analysis | Features of Model |
|---|---|---|---|
| Council of Urban Transport Plan No.15 (1972)<br><br>Target year 1985 | • Capacity expansion<br>• Commuting time reduction with the consideration of urban expansion (targeting lines to new suburban development area)<br>• Initiation of express service<br>• Planning of Fukutoshin Line<br>• Improvement of the accessibility to airport and HSR station | • Demand forecasting and other related analyses | • First introduction of 4-Step Model<br>• 40 zones |
| Council of Transport Policy Plan No.7 (1985)<br><br>Target year 2000 | • Easing of the morning peak in-train congestion (for this, Tsukuba Express Line, Keiyo Line, and Saikyo Line were proposed)<br>• Access to new CBD (Minatomirai 21 Line)<br>• Access to Haneda Airport (Tokyo Monorail, Keikyu Airport Line extension) | • Evaluation of the congestion rate in the most congested section | • Analysis of morning peak-hours by consider only working and schooling commuter<br>• Introduction of Disaggregate Travel Demand Model<br>• 658 zones |
| Council of Transport Policy Plan No.18 (2000)<br><br>Target year 2015 | • Easing of the morning peak in-train congestion<br>• Speed improvement<br>• Urban restructuring<br>• Improvement of the accessibility to airport and HSR station<br>• Seamless service<br>• Universal design service | • Congestion alleviation, time savings analysis<br>• Evaluation of railway service profitability<br>• Cost-effectiveness analysis (CEA)<br>• Service continuity | • Include daytime traffic analysis too (for profitability estimation)<br>• Include congestion parameter<br>• Introduction of Probit Model<br>• Introduction of Airport and HSR access model<br>• 1812 zones |
| Council of Transport Policy Plan No.198 (2016)<br><br>Target year 2030 | • Strengthen international competitiveness<br>• Design of new-generation station<br>• Reliability improvement<br>• Strengthen of the disaster countermeasure | • Congestion alleviation, time savings analysis<br>• Evaluation of railway service profitability<br>• Cost-effectiveness analysis<br>• Service continuity | • Increase the types of trip destination<br>• Analysis by age groups (due to the effect of population aging)<br>• 2843 zones |



# I-3 History of Demand Forecasting - demand forecasting model by each master plan

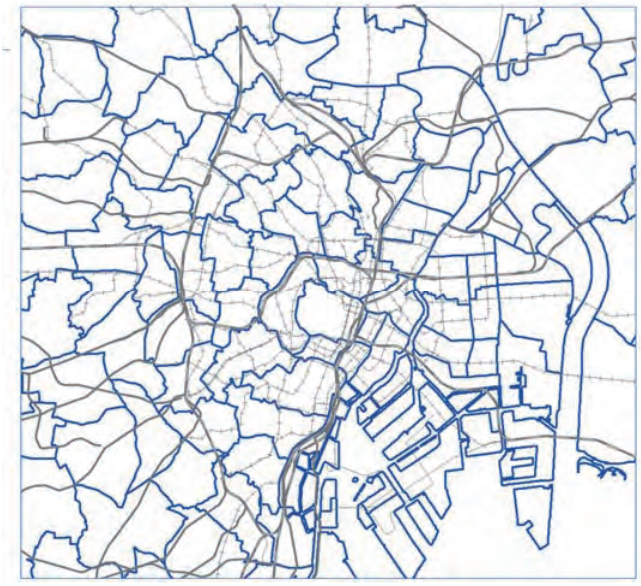
1972 CUTP No.15 (target year 1985)



No. of zone = 40

# I-3 History of Demand Forecasting
# - demand forecasting model by each master plan

1985 CTPP No.7 (target year 2000)



No. of zone = 658



# I-3 History of Demand Forecasting
# - demand forecasting model by each master plan

2000 CTPP No.18 (target year 2015)

No. of zone = 1,877

# I-3 History of Demand Forecasting
# - demand forecasting model by each master plan

2016 CTPP No.198 (target year 2030)

No. of zone = 2,907



# I-4 Demand forecasting WG members and their roles

## Organization of the WG members

**Academic professors and researchers**
- Research (on the theory of demand forecasting)
- Model development
- Research publication
- Advisor to other parties

- Government (MLIT)
- Implementation of demand forecasting
- Supervise demand forecasting based on Railway License
- Collect the survey data for model development
- Provide the budget for survey and research

**Transport planning consultants**
- Implementation of demand forecasting
- Model development
- Model revision based on the latest available data

**Railway operators**
- Client in demand forecasting
- Supervise demand forecasting
- Participate in the discussion of demand forecasting development

# I-5 Development of demand forecasting method

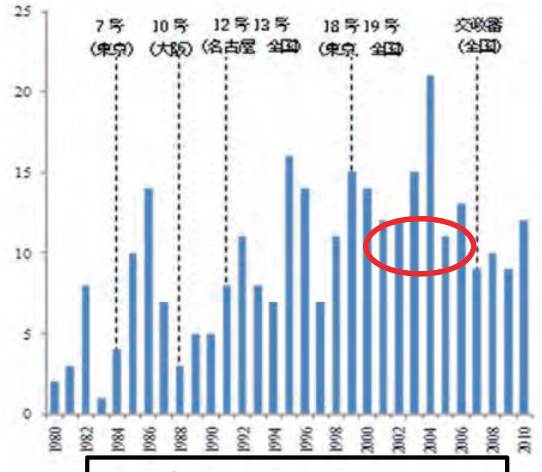
## Development of demand forecasting method - towards better forecasting reliability

- 2001: The committee of urban railway study "WG for demand forecasting method improvement" (Chairman: Prof. Tetsuo Yai)
    - Reorganization of current method
    - Assessment of the changing factors
    - Comparison between forecasted data from the past study and actual data
    - Revision of the targeting policies
- 2004: The feasibility study on the urban railway development "WG for demand forecasting method improvement and utilization policy" (Chairman: Prof. Tetsuro Hyodo)
    - Revision of the targeting policies (from policy and technical viewpoint)
    - Clarification of the model requirements (Clarification of the data prediction methodology)
    - Assessment of the initial demand setting (cannot set after service opening)
    - Revision of the LOS setting in demand forecasting model (based on the actual condition)

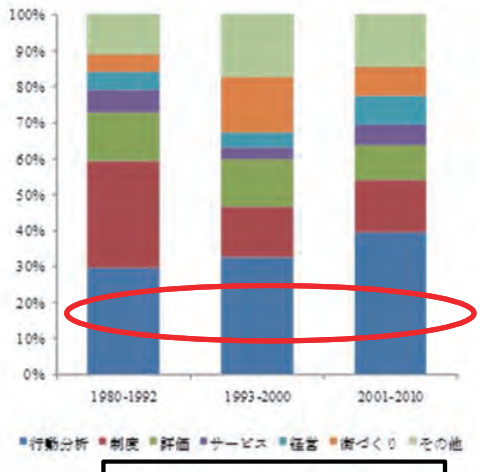


# I-6 Demand forecasting and its effect to researchers

Number of published academic paper regarding urban railway sharply increase around a decade (1995-2005) after the publishing of the CTPP no. 18.




No. of published paper by year




Content
(blue=behavioral analysis)

# I-7 Practical implementation and Achievements

## TMA railway demand forecasting by Creative Research and Planning Co.,Ltd. (Selected projects since 2003)

| | | |
|---|---|---|
| ・Wide area transport network integration plan | Tokyo Metro. Government | (2012-2016) |
| ・Prefectural public transport network investigation survey | Saitama Pref. Government | (2013-1016) |
| ・Eastern Kanagawa railway investment feasibility study | JRTT | (2015-2016) |
| ・Evaluation of the Southern Tokyo railway investment | JRTT | (2007-2013) |
| ・Northern Kanagawa railway investment feasibility study | JRTT | (2007-2016) |
| ・Demand forecasting and financial analysis of new Haneda airport access | JTRI | (2016) |
| ・Demand forecasting and CEA of new Narita airport access | JTRI | (2016) |
| ・Demand forecasting and financial analysis of Tokyo No.8 line (Toyosu-Sumiyoshi) | JTRI | (2013-2016) |
| ・Yokohama city railway promotion | JTRI | (2015) |
| ・Demand forecasting of Oedo line extension | JTRI | (2014) |
| ・Demand forecasting of Tsukuba Express | Metropolitan Intercity Railway Company | (2013-2016) |



# I-8 Roles of demand forecasting

In railway planning, many components from demand forecasting such as modelling, output, sensitivity analysis, etc., are utilized as a reference for decision making

**Demand forecasting**

- General railway planning: characteristics of transport mode, feasibility analysis
- Financial / Operating balance: passenger service revenue
- Mode and system selection: scale of users
- Route and station location selection: flows, scale of demand, user's characteristics
- Required capacity (frequency, car per train): transport volume
- Desirable service level (fare, frequency): transport demand, user's benefit
- Cost-benefit analysis: generalized cost, value of time
- Section, line priority setting: scale of users
- The effect of station area development: passenger service revenue

# I-8 Roles of demand forecasting

## 1. Demand forecasting by each master plan in Japan
### Example of Council of Transport Policy Plan No.18 (2000)

(1) TMA future common recognition

- Estimation of future population, total transport volume and railway share
- Demand forecasting of the railway passenger flow to CBD

(2) Railway network planning based on demand forecasting

- Railway service supply needs for TMA based on demand forecasting
- Selection of implementation area, station location and rail routes
- Selection of transport modes and systems (railway, monorail or AGT)
- Priority setting (based on comparisons of demand forecasting, profitability analysis, and cost-effectiveness analysis)
- Estimation of service income
- Fare sensitivity analysis
- Investigation of the effect of through-service between two connected lines
- Effect to the existing lines from the introduction of the new lines

AGT: automated guideway transit



# I-8 Roles of demand forecasting

## 1. Demand forecasting by each master plan in Japan
### Example of Council of Transport Policy Plan No.18 (2000)

(3) Visualizing the accomplishment

- Speed improvement: travel time per trip
- Station accessibility: travel time per trip
- Airport and HSR station accessibility: travel time or no. of transfer per trip
- Seamless service: no. of transfer per trip

(4) Urban development plan related issues

- Consideration of the urban development plan into the demand forecasting model

# I-8 Roles of demand forecasting

## 2. New line feasibility study

### (1) Demand forecasting for financial estimation

Objective

In order to realize the development following the Council of Transport Policy Plan No.18, several criteria such as demand forecasting, cost-effectiveness analysis and profitability analysis are needed to be considered. With the strong leadership from the government, the plan will be conducted based on the consensus building from various stakeholder.

Roles of WG members

- Academics and professionals: technical guidance, evaluation, advice
- MLIT (Railway Bureau, Policy Bureau, City Bureau, Road Bureau): consensus building support
- Tokyo Metropolitan Government and other local governments: provide the coordination as a local administrative, share the subsidy (if possible)
- Contractors and Operators: participate in consensus building activities

Points to be considered

- New lines: degree of necessity, construction cost, service detail
- demand forecasting, cost-effectiveness analysis, profitability analysis, etc.



# I-8 Roles of demand forecasting

## 2. New line feasibility study

### (1) Demand forecasting for financial estimation

The Study on a strategy development for a large-scale railway development plan (2002)

- TMA airports access
- Connectivity in Eastern Kanagawa area (through service between Sotetsu and Tokyu lines are under construction)

  - In this project, demand forecasting is used for rail usage fee and business evaluation

- TMA East-West corridor express service

| Through-service plan | | Sotetsu - JR | Sotetsu - Tokyu |
|---|---|---|---|
| Section | | Sotetsu Main Line Nishitani Station-JR East freight line, around Yokohama-Hazawa Station | JR East freight line, around Yokohama-Hazawa Station -Tokyu Toyoko Line Hiyoshi Station |
| Extension Length | | 2.7km | 10.0km |
| Contractors | Infrastructure Owner | JRTT | JRTT |
| | Operator | Sotetsu | Sotetsu Tokyu |
| In service from | | 2019 | 2022 |

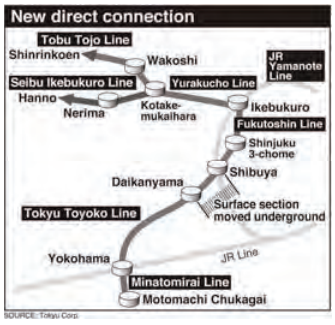
# I-8 Roles of demand forecasting

## 2. New line feasibility study

### (1) Demand forecasting for subsidy estimation

The study on the connectivity between Fukutoshin line and Tokyu Toyoko line, and Tokyu Tamagawa line and Keikyu Airport line (2001)

Objective
- Expand the railway network between Saitama and Yokohama
- Connecting three sub-centers (Ikebukuro-Shinjuku-Shibuya) together
- Relieve the congestion of JR Yamanote line and JR Saikyo Line




| Contractors | Tokyo Metro Corp. |
|---|---|
| Section | Shibuya to Kotake-Mukaihara |
| Construction/Operation | 2001/2008 |
| Through service with | Tokyu Toyoko line<br>Seibu Ikebukuro and Yurakucho lines<br>Tobu Tojo line<br>Minatomirai 21 line |




# I-8 Roles of demand forecasting


## 3. Railway Operator`s Business Plan
### - For investment decision making
### - For consensus building

- Revenue analysis in short to Long term
- For the consideration of re-scheduling plan
- For the planning of investment period
- For the impact analysis of the new investment from competitors
- For the consideration of the access improvement plan
- For the analysis of the inside-station redesign plan
- For the budget sharing analysis (when two or more companies jointly develop the hub-station together)

# I-9 City characteristics and demand forecasting

## To solve the transport problem

Master plan analysis -> Many data is needed

But what data should be included?

As for Bangkok……

- How to shift from car oriented to mass transit?
  - Even the mass transit is available, some people still prefer car. How to deal with issue in the model?
  - Destination survey: from 3rd WG meeting
- How to deal with aging society
- How to deal with large-scale urban development



# I-9 City characteristics and demand forecasting

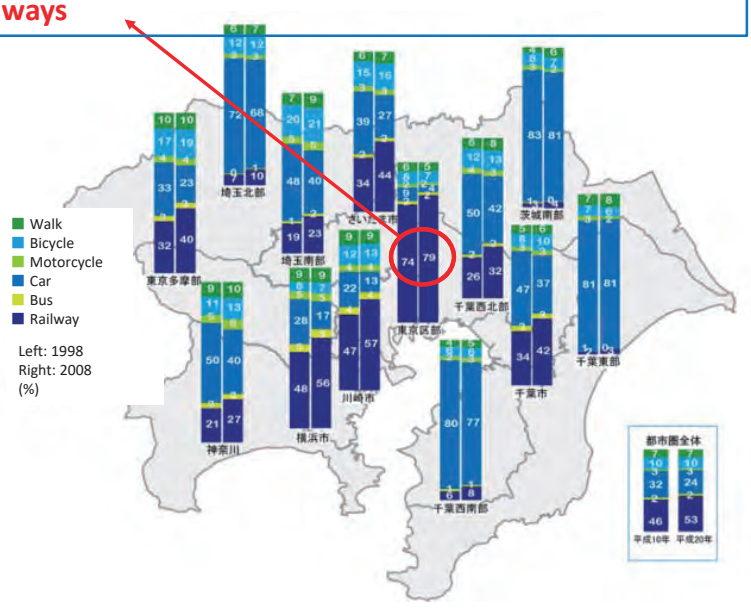
**In case of TMA**

- Most of the commuters to Tokyo and 12 major cities use railways. Especially in Tokyo, **80 % of commuters** use **railways**

*Therefore,*

Road congestion and railway development are separately considered.

- In the model, no traffic distribution to road



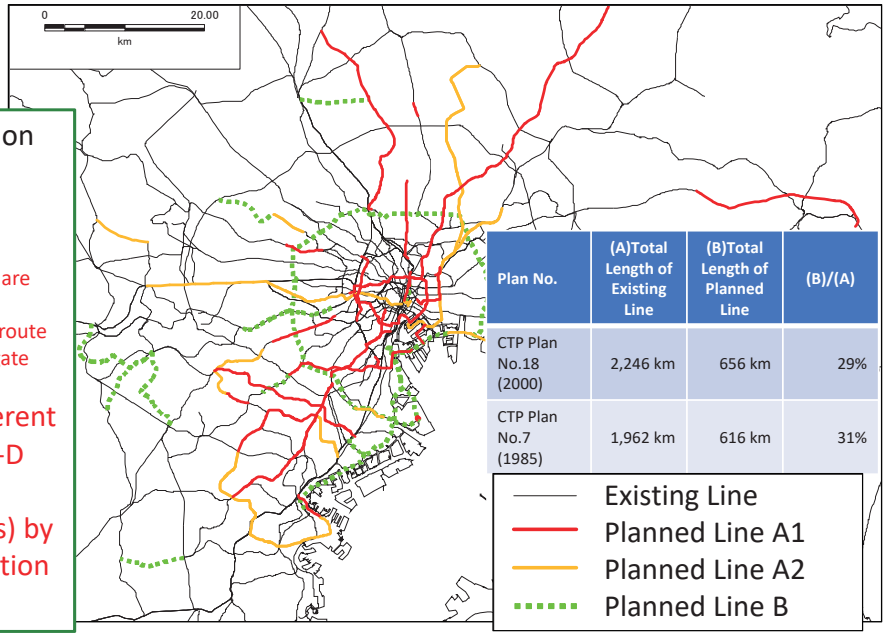
# I-9 City characteristics and demand forecasting

Based on the current plan, railway network in TMA will be extended to a total length of 2,906 km

To increase the precision in railway route assignment model,

1) In each O-D pair,
- Several alternative routes are given
- Probability to select each route is distributed by disaggregate model

2) In CTPP No.18, different lines with the same O-D are also considered together (parallel lines) by probit model (assumption is relaxed)




| Plan No. | (A)Total Length of Existing Line | (B)Total Length of Planned Line | (B)/(A) |
|---|---|---|---|
| CTP Plan No.18 (2000) | 2,246 km | 656 km | 29% |
| CTP Plan No.7 (1985) | 1,962 km | 616 km | 31% |



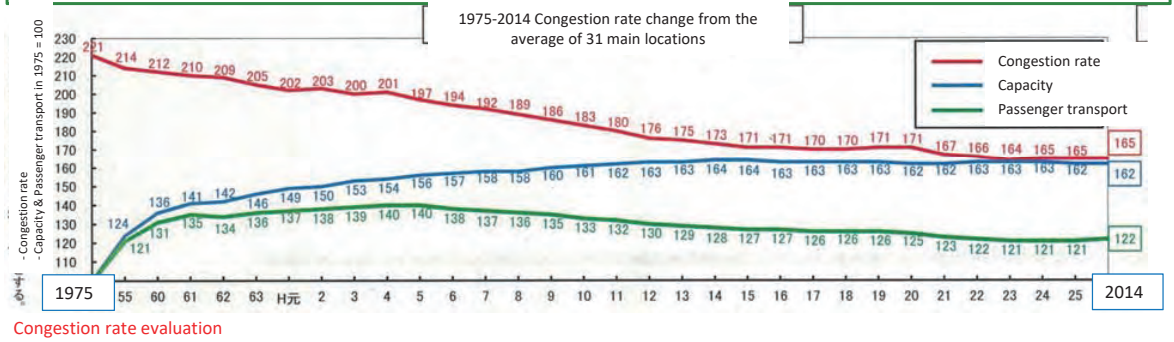
# I-9 City characteristics and demand forecasting

Since 1970, train congestion in the morning became one of the national issue. Many countermeasure such as more railway construction, long-term station and track alignment improvement, and rolling stock investment have been conducted.

Consideration of "Congestion" in the demand forecasting model

1) In CTPP No.7, as for commuting purpose, peak hour volume is considered in the model,

2) In CTPP No.18, by incorporating the congestion parameter in the model, it is possible to evaluate the congestion mitigation/relieve policy. (congestion rate x on-train travel time)




Congestion rate evaluation

180% = passenger body contact each other, but still be able to read newspaper

200% = passenger body contact each other with a feeling of oppression. But still be able to read magazine

250% = cannot move body and arms even when the train shakes

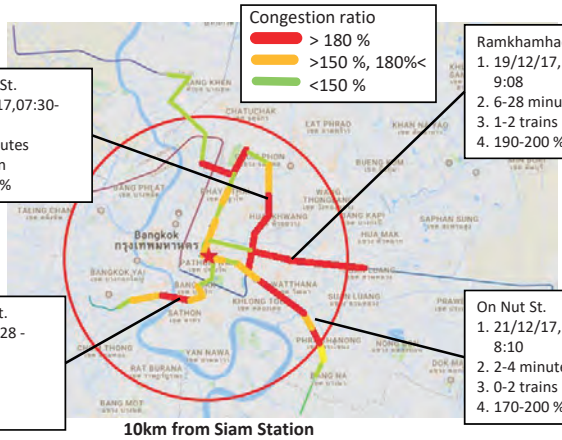
# (reference) Congesting Rate from Bangkok

- **Current Issues**
  - Serious congestion inside train car and station in the peak hour, on the existing mass transit lines.

Tokyo's Target

Lat Phrao St.
1. 18/12/17,07:30-8:23
2. 3-4 minutes
3. 0-1 train
4. 90-200 %

Saphan Taksin St.
1. 22/12/17, 07:28 - 8:31
2. 3-6 minutes
3. 0-1 train
4. 180-200 %



10km from Siam Station

Ramkhamhaeng St.
1. 19/12/17, 07:48 - 9:08
2. 6-28 minutes
3. 1-2 trains
4. 190-200 %

On Nut St.
1. 21/12/17, 07:20-8:10
2. 2-4 minutes
3. 0-2 trains
4. 170-200 %

*1. Survey date, time, 2. Head between trains (min), 3. Number of trains passengers miss due to congestion 4. Congestion Ratio (Japanese standard, see above)



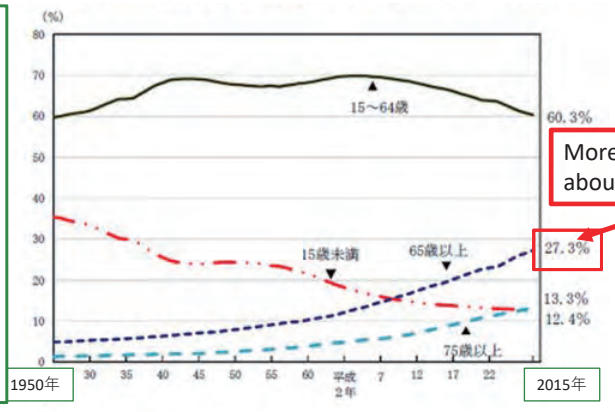
# I-9 City characteristics and demand forecasting

Into the aging + low birth rate society
Aging population → railway demand = increase? or decrease?

Considering age range separation

These analyses have been conducted by age range separation:
- population forecast
- generation & attraction
- O-D (distribution)
- modal split
- route assignment

Change of population share by age range from 1950-2016

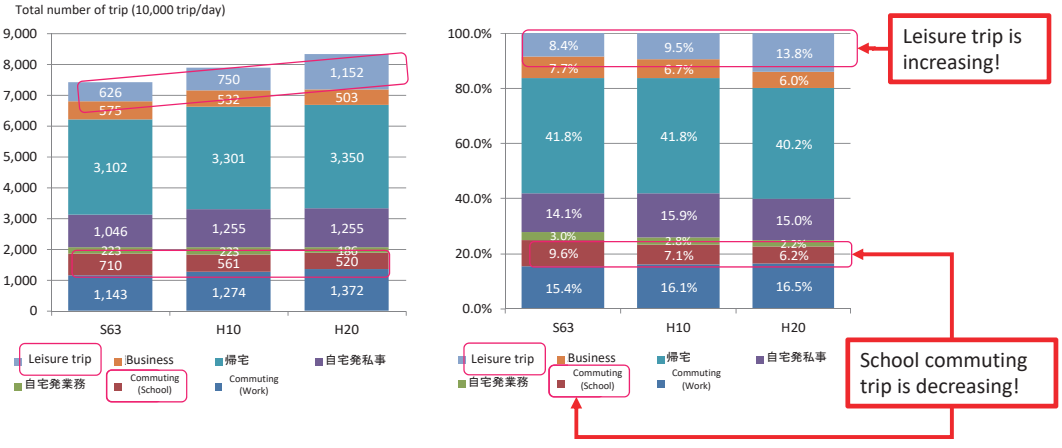



More than 65 y.o. = about 30%！

# I-9 City characteristics and demand forecasting

Due to the birth rate declining in Japan, school commuting trip shows declining trend. Furthermore, due to the aging population and changing in lifestyle of women, leisure trip (personal related trip after work) shows the increasing trend.

Decreasing in school commuting trip + Increasing in leisure trip after work




Comparison of change in trip generated by each purpose

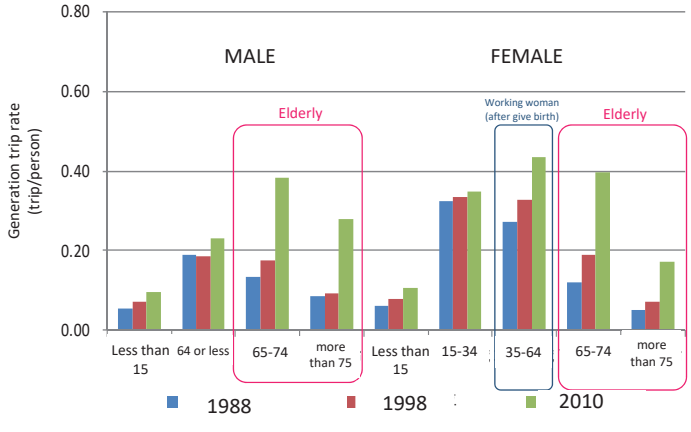
Source: TMA Person-Trip Survey (in Japanese)



# I-9 City characteristics and demand forecasting

Trip from the elderly (both male, female) and trip women age 35 y.o. or more show an increasing trend.

Leisure trip (personal related trip after work) purpose

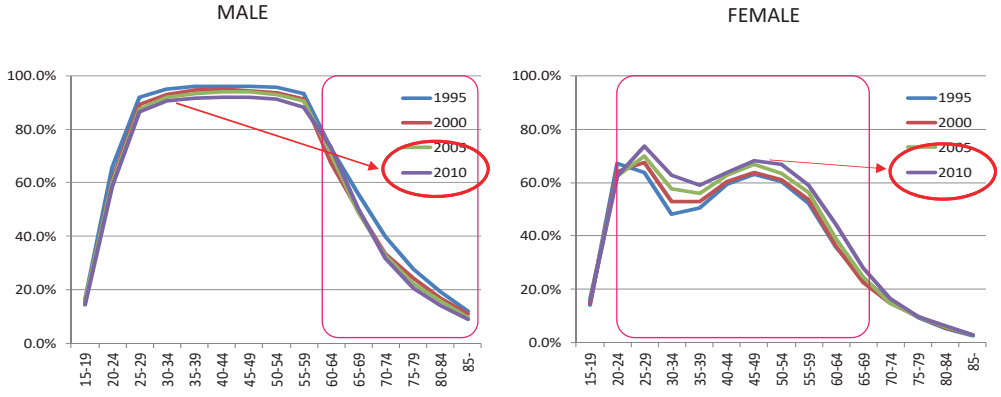



Generation trip rate by gender and age group

Source: TMA Person-Trip Survey (in Japanese)

# I-9 City characteristics and demand forecasting

## Employment rate in elderly and women shows an increasing trend



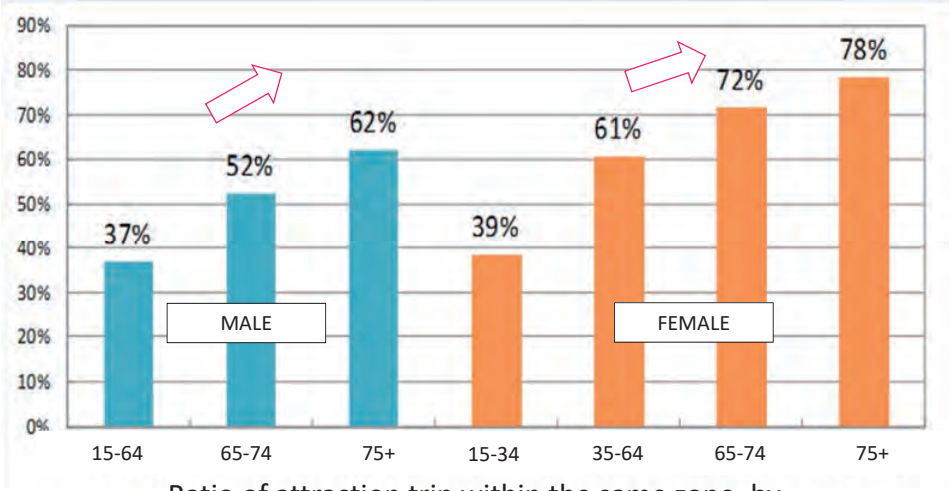

Employment rate by gender and age group

Source: Japanese National Census



# I-9 City characteristics and demand forecasting

## As age increase, people tends to live/work closer to workplace/home

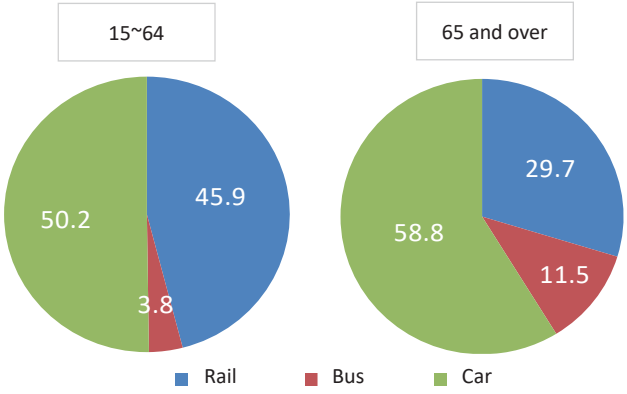



Ratio of attraction trip within the same zone, by gender and age group (2008)

Source: TMA Person-Trip Survey (in Japanese)

# I-9 City characteristics and demand forecasting

## In short distance trip, elderly tends to use more bus and car




Comparison of modal share between working population and elderly (2008)

Source: TMA Person-Trip Survey (in Japanese)



# I-10 Demand Forecasting and Social Responsibility

## Mandatory of CEA towards public services

### - Implementation of railway CEA based on demand forecasting

History

- 1997：Based on the requirement from the Ministry of Transport, CEA for any new public service investment must comply with the social impact analysis
- 1997：Establishment of The study group for railway CEA development by Prof. Shigeru Morichi of the University of Tokyo at Japan Transport Research Institute (JTRI)
- March, 1998: Publication of the first CEA manual, followed by many revisions after that

Background

- In order to respond with the social criticism about the transparency, the flexibility of the plan, and the necessity of the public service investment
- In order to respond with the criticism about the problems occurred during the investment of the mega-projects in metropolitan area

Expected Results

- To ensure that the decision making of the public service investment possess enough rationality, transparency and compatibility with other projects
- CEA which could take the planning steps, the construction steps and the post-service evaluation into account

# I-10 Demand Forecasting and Social Responsibility

## (Reference) Criticisms and efforts to improve the model

### Background

- Demanding of transparency towards model development
- Details about forecasting model should be publicized
- Criticism towards public works→background of demand forecasting structure
- Some suit by local people such as the case of Shizuoka Airport and Sendai Subway (actual users does not reflect the forecasted figure)

### Reaction towards criticism and model improvement

- Future improvement of demand forecasting method
  - Planning for project implementation: separation of "forecasted value" and "planned/expected value"→In order to handle with uncertainty, demand forecaster must consider both "forecasted value" with different scenarios and "planned value" from project owner
  - Evaluation of planned value

Source: Japan Transport and Tourism Research Institute (2003). Criticism on Transport Demand Forecasting, *Transport Policy Studies*, Vol.6 No.3, 54-59.

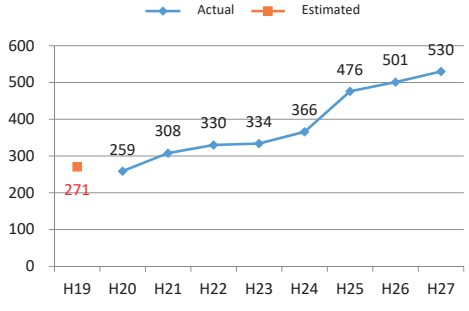


# I-10 Demand Forecasting and Social Responsibility

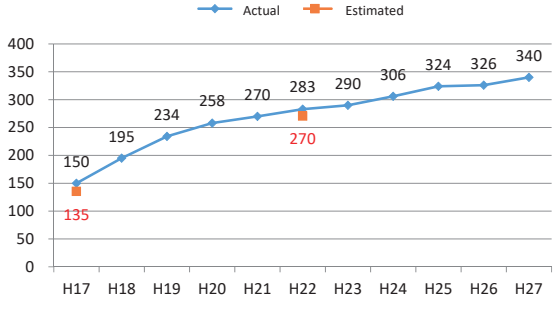
## Follow-up of the forecasted result and actual value

**Comparison between forecasted value and actual value**

- As for Tsukuba Express, the demand of 400,000 user/day was forecasted 30 years before the service started
- After than, it was re-estimated due the change in socio-economic structure in TMA
- Not only the demand forecasting, but the investment scheme was revised too




Tokyo Metro Fukutoshin Line




Tsukuba Express

# Ⅱ

# Demand Forecasting Framework

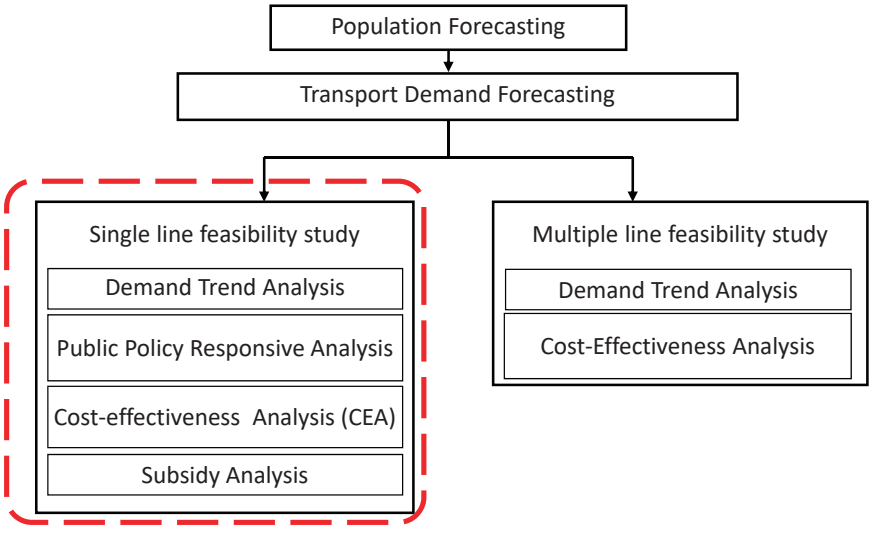
## Railway Development Planning in Tokyo Metropolitan Area (TMA)

- Investment Priority and Demand Forecasting
- Demand Trend Analysis
- Public Policy Responsive Analysis
- Cost-Effectiveness Analysis (CEA)
- Subsidy Analysis
- Demand Forecasting Framework in CTPP no.18 and no.198



## II-1 Investment Priority and Demand Forecasting (The Transport Policy Plan No.18)

- Demand Forecasting is one of the main criteria in the priority setting process (which line will be invested first)
- In the Transport Policy Plan No.18, in line with the demand forecasting, other four analyses was also conducted in the same time.



# II-1 Investment Priority and Demand Forecasting (The Transport Policy Plan No.18)

## 4 Related Analyses: Contents and Outputs

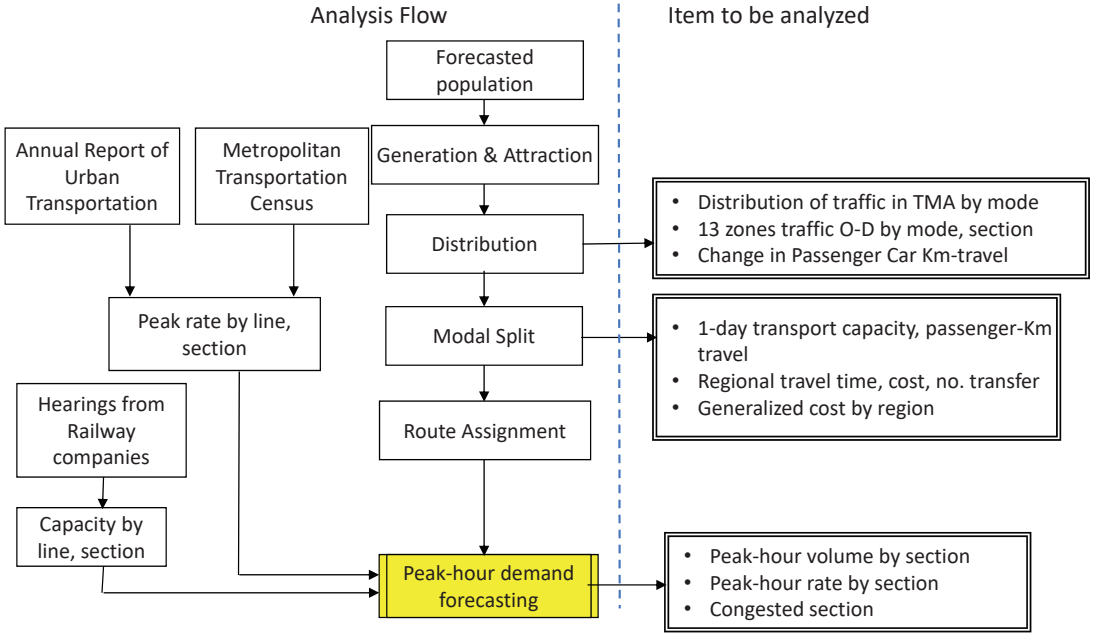
| | Content | Output |
|---|---|---|
| Demand Trend Analysis | Size | Net transport demand 、※ Transport density、※person-kilometer travel、※ Average trip distance |
| | Characteristics、Connectivity | Station O-D、Transfer lines and volume、※Demand change in nearby competitors |
| Public Policy Responsive Analysis | Congestion rate and section | ※Peak-time sectional volume |
| | Travel time reduction (in-train, access, egress)、Change in transfer time | ※Regional transport volume、※Regional average railway travel time ( in-train, access, egress)、Average No. of Transfer |
| Cost-effectiveness Analysis | Generalized Cost | ※Change in average utility (travel time, cost, congestion) by O-D |
| | Environmental Effect | ※Change in Passenger Car Km-travel |
| Subsidy Analysis | Revenue | Station O-D、※Passenger-Km travel |
| | Required train set(no. of train set, car per set) | ※Peak-time sectional volume |

* New output in Transport Policy Plan No.18



# II-1 Demand Trend Analysis

## Demand Trend Analysis: Flow and Analysis



# II-1 Demand Trend Analysis

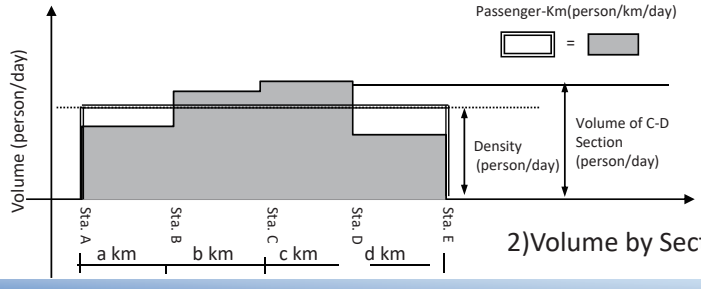
Index in Demand Trend Analysis

1. Transport Demand (person/day): number of passenger
2. Transport Volume by Section (person/day): number of passenger by section. Required transport capacity will be calculated from the volume from the peak section.
3. Transport Density (person/day): average transport volume by section
4. Passenger-Kilometer (person/km/day): Sum total of Transport Volume by Section. In Tokyo, the average travel distance is used as an index for fare setting. However, passenger-km can be also used as another alternative as well.

* Validity, Accuracy and Explicability of the demand forecasting model can be checked by simulating the current situation with the model. The checking can be conducted by comparing the result of the forecasted transport volume by section 2) from the model simulation with the actual transport volume

** Thus, if there is a significant difference between actual and forecasted value, the cause of such error should be removed in order to increase the accuracy of the model

*** If the forecasted value of 2) correspond with the actual value, 3) and 4) must be too




2)Volume by Section, 3)Density, 4)Passenger-Kilometer



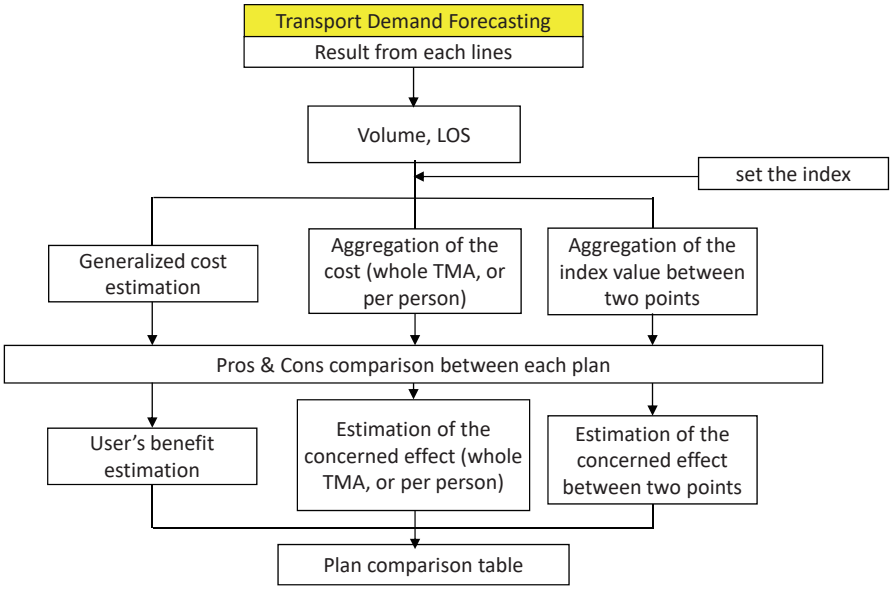
# II-1 Public Policy Responsive Analysis

- In the Transport Policy Plan No.18, there are 5 policy to be considered along with the railway development plan
- In this analysis, a combination of the result from demand forecasting will be considered together in these following issues

- In-train congestion reduction
- Speed improvement
- Urban development and city function support
- Strengthen the accessibility to airport, HSR
- Universal design and seamless transfer

# II-1 Public Policy Responsive Analysis

## Analysis process

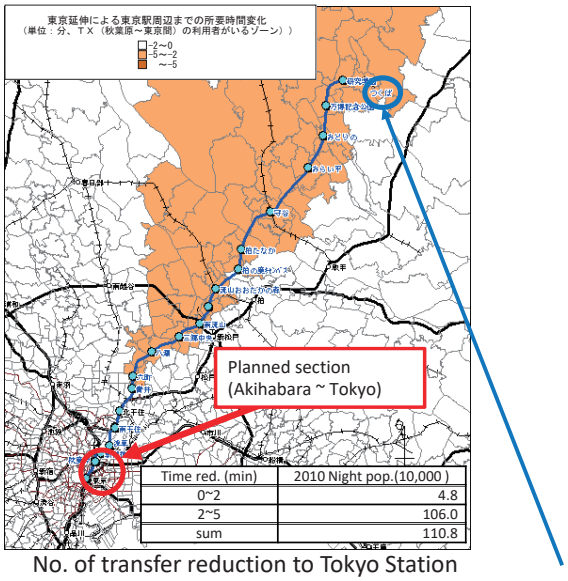





# II-1 Public Policy Responsive Analysis (Example)

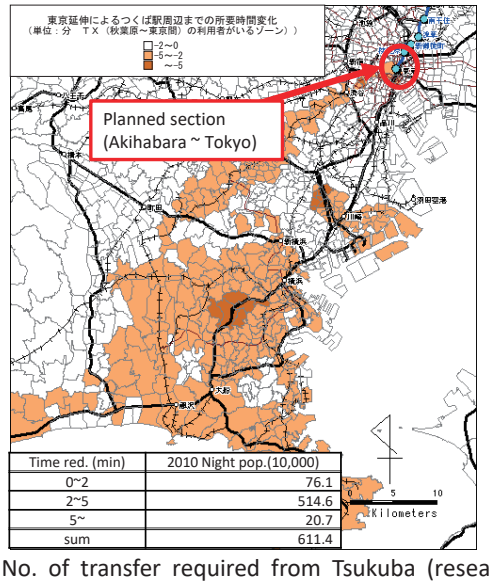
## Example of Tsukuba Express Extension Plan: the whole TMA must considered

### Travel time reduction to Tokyo Station




| Time red. (min) | 2010 Night pop.(10,000 ) |
|---|---|
| 0~2 | 4.8 |
| 2~5 | 106.0 |
| sum | 110.8 |

No. of transfer reduction to Tokyo Station



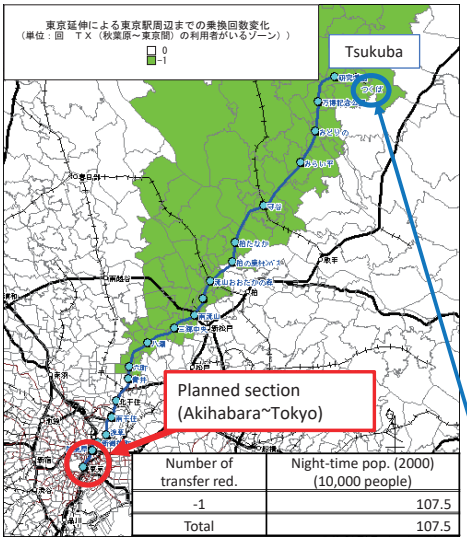

| Time red. (min) | 2010 Night pop.(10,000) |
|---|---|
| 0~2 | 76.1 |
| 2~5 | 514.6 |
| 5~ | 20.7 |
| sum | 611.4 |

No. of transfer required from Tsukuba (research & technology city) is also decreasing

# II-1 Public Policy Responsive Analysis (Example)

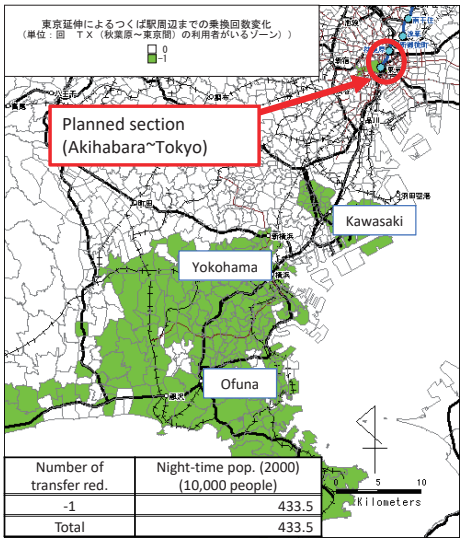
## Example of Tsukuba Express Extension Plan : the whole TMA must considered

### Number of transfer reduction to Tokyo Station




| Number of transfer red. | Night-time pop. (2000) (10,000 people) |
|---|---|
| -1 | 107.5 |
| Total | 107.5 |

No. of transfer reduction to Tokyo Station




| Number of transfer red. | Night-time pop. (2000) (10,000 people) |
|---|---|
| -1 | 433.5 |
| Total | 433.5 |

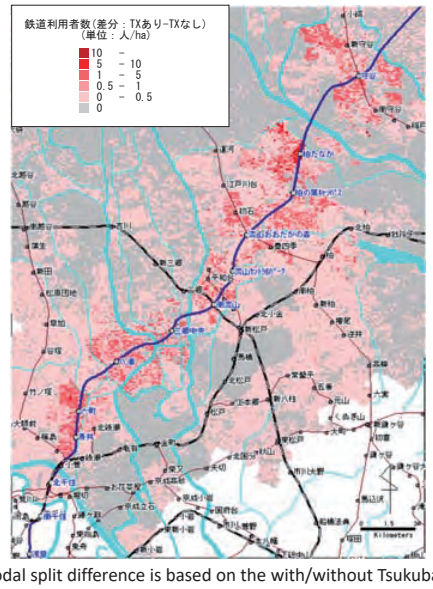
No. of transfer required from Tsukuba (research & technology city) is also decreasing



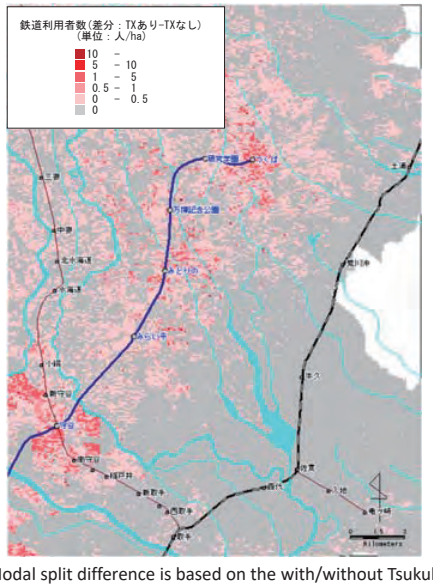

# II-1 Public Policy Responsive Analysis (Example)

## Example of Tsukuba Express Extension Plan : the whole TMA must considered


### Increase in railway user (100m mesh data, unit: person/hectare)




Modal split difference is based on the with/without Tsukuba Express (Akihabara-Moriya Section is shown)

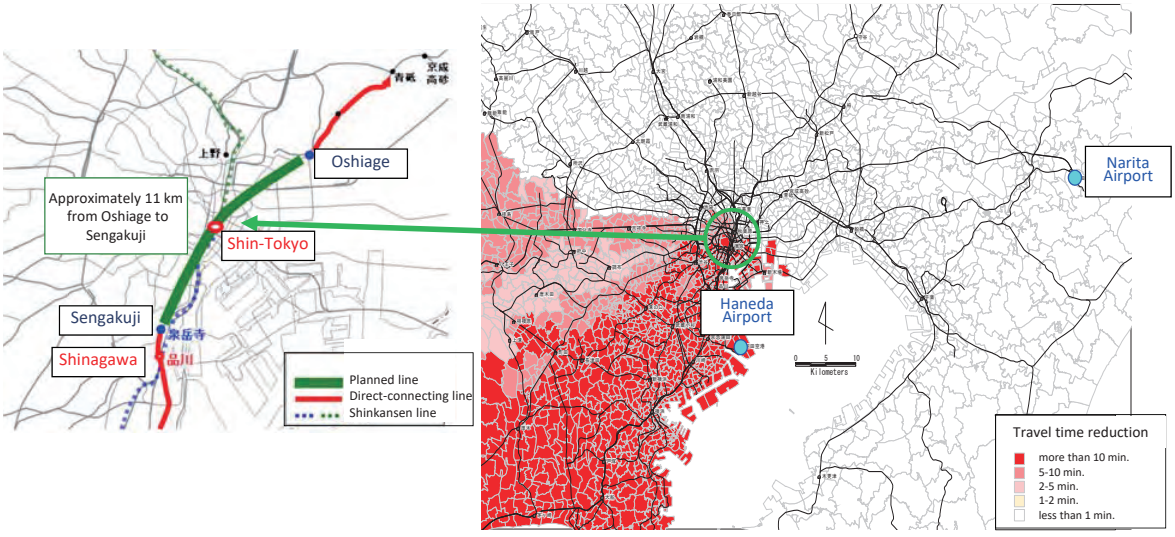



Modal split difference is based on the with/without Tsukuba Express (Moriya-Tsukuba Section is shown)

# II-1 Public Policy Responsive Analysis (Example)

## Example of Oshiage-Shin Tokyo-Sengakuji plan: Connecting Narita airport and Haneda airport with Skyliner

Travel time reduction to Narita Airport

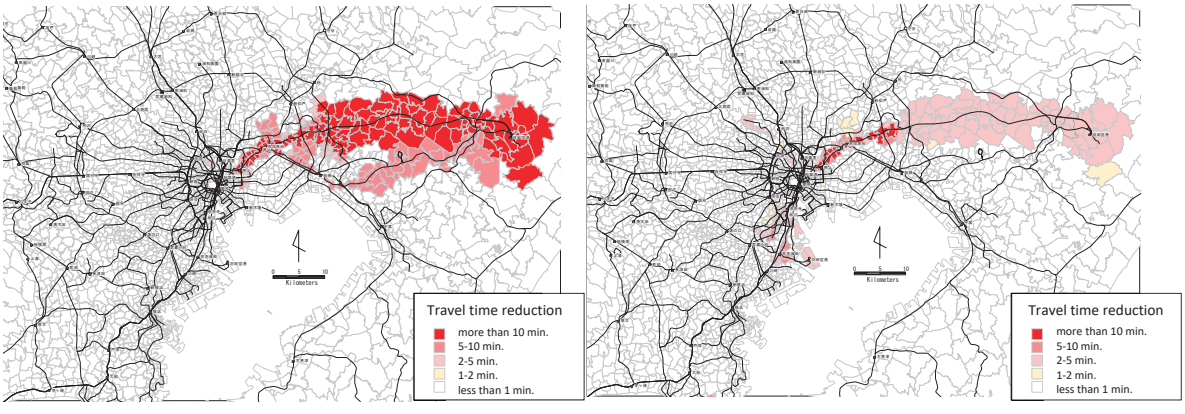






# II-1 Public Policy Responsive Analysis (Example)

## Example of Oshiage-Shin Tokyo-Sengakuji plan: Connecting Narita airport and Haneda airport with Skyliner


Travel time reduction to Haneda Airport

Travel time reduction to Tokyo Station

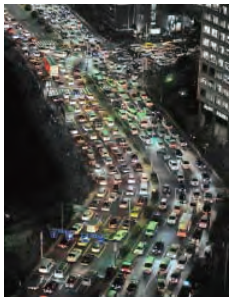
# II-1 Public Policy Responsive Analysis - Natural Disaster Responsive

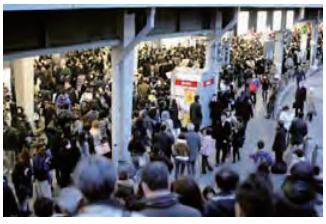
## Roles of demand forecasting at the time of transport system failure

Roles of railway demand forecasting

1. Be able to understand the bottleneck section
2. Be able to roughly estimate the economic loss
3. Be able to understand the improvement effect from railway investment
4. Be able to understand the characteristics of each parallel line and the priority whether the support should be assigned to which line first
5. Be able to index the importance of each CBD and airport access line, in order to understand the scale of the effect at the time of system failure

Highway condition at the time of 2011 Tohoku Earthquake





Shibuya station at the time of 2011 Tohoku Earthquake

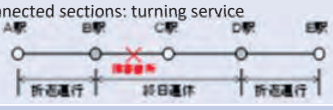
People waiting for taxi at the time of 2011 Tohoku Earthquake

* selected from 2014 GRAPE report



# II-1 Public Policy Responsive Analysis - Natural Disaster Responsive

## "Whole-day transport system failure" scenario setting

| | Whole-day transport system failure |
|---|---|
| Year Forecast | 2010 |
| Analysis unit | Whole day |
| Failure section | Depends on the objective |
| Service pattern at the time of failure (base case) | · Failure section: no service for a whole day<br>· Connected sections: turning service  |
| Modal choice pattern | · Railway users still use rail service as usual (no change in mode at the time of system failure)<br>· In case if failure in access/egress to train station, access/egress to new train station will be set based on the shortest road distance |
| Railway route choice method | Separate whole-day O-D table into multiple tables, and then redistribute the route selection by each tables |
| Service impact due to in-train congestion | Based on the route selection result, multiply the estimated volume with the usual peak/normal ratio to calculate the congestion rate. If the result of congestion rate is over 250%, set at 250% and re-estimate the route choice model. |
| Fare | Follow the selected route fare |

# II-1 Public Policy Responsive Analysis - Natural Disaster Responsive

## Case Setting: Northeast TMA

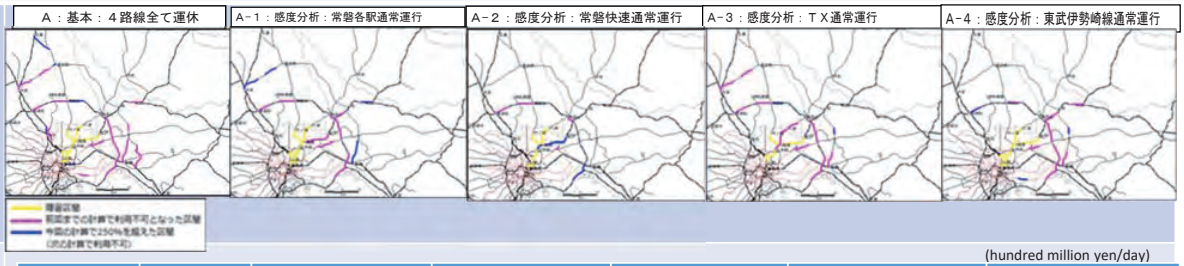
| | |
|---|---|
| Detail | ○ As for base case, all lines to Northeastern part of TMA stop their service.<br>○ As for sensitivity analysis cases, only one line per case is still operated. |
| Failure conditions | ○ Failure area: northeast area of Kita-Senju Station<br>○ Affected lines: Joban Local line (including connected Chiyoda Line), Joban Rapid line, Tsukuba Express, Tobu Isesaki Line<br>○ Operating pattern: turning operation |




# II-1 Public Policy Responsive Analysis - Natural Disaster Responsive

## Analysis result

congestion

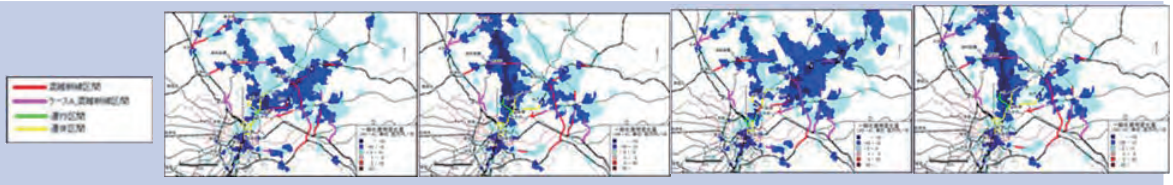



Gen. cost

(hundred million yen/day)

| | As Usual | Base case | A-1 | A-2 | A-3 | A-4 |
|---|---|---|---|---|---|---|
| Generalized cost | 995 | 1,036 | 1,015 | 1,011 | 1,020 | 1,013 |

Difference in Gen. cost



# II-1 Cost-Effectiveness Analysis

## Objective of Cost-Effectiveness Analysis (CEA)

In order to estimate the subsidize fund, it is required to make sure that such rail service will produce the significant impact to the economy

## First implementation of CEA

- As for railway development masterplan: Transport Policy Plan No.18
- Consider all of the 96 lines in the plan
- Concurrent with the formulation of the manual in 1997, this technique was implemented to solve the technical problem during the formulation

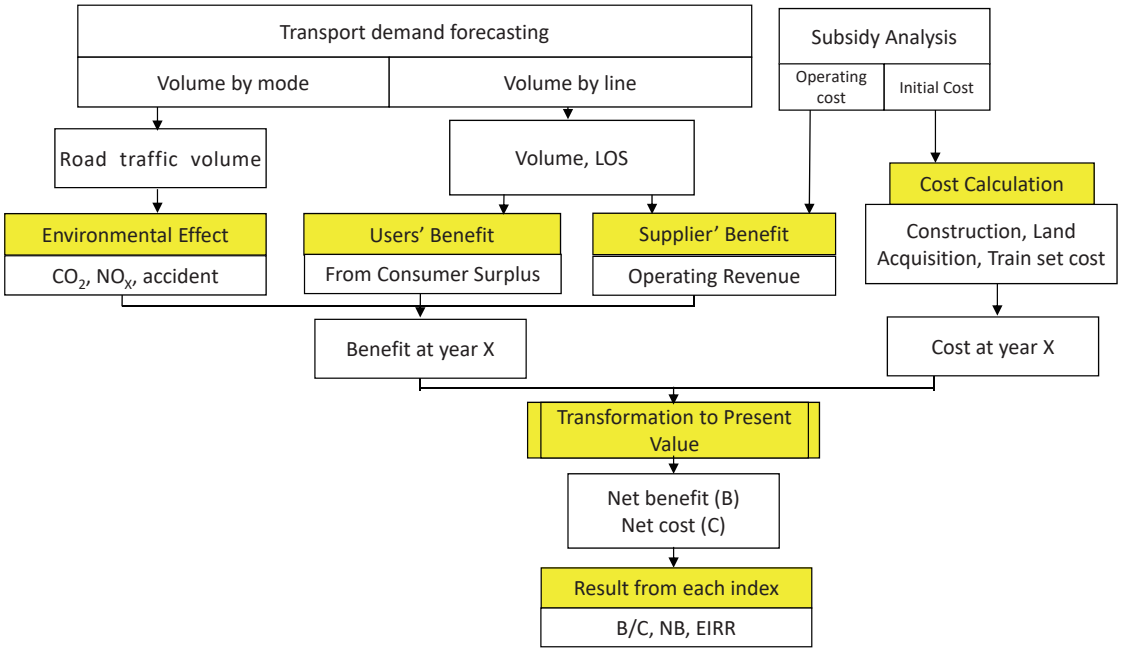
Milestone

- 1997: In order to clarify the social impact, Ministry of Transport (Current MLIT) authorized that CEA must be included in the evaluation of any new project.
- 1997: Establishment of The study group for railway CEA development by Prof. Shigeru Morichi of the University of Tokyo at Japan Transport Research Institute (JTRI)
- March 1998: First publication of the "97 CEA manual for Railway Projects"
- 2000: Council of Transport Policy Plan No.18



# II-1 Cost-Effectiveness Analysis

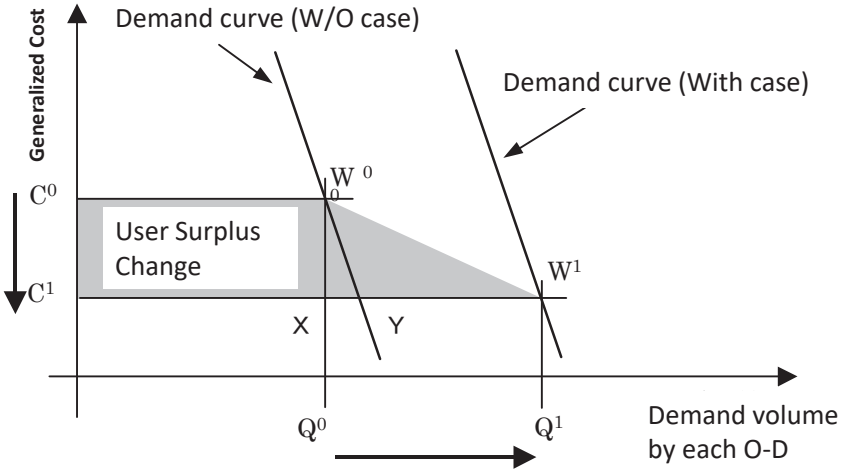
## Analysis process of CEA based on the result of demand forecasting



# II-1 Cost-Effectiveness Analysis

**User benefit from consumer surplus change**

- New transportation yields the new GC, thus gives the new demand curve






# II-1 Cost-Effectiveness Analysis

## CEA: A comparison between the generalized cost and social benefit of the different plans

### 1. Value of Time (VOT)

- Gain from time saving can be considered in monetary term
- Thus, the effect from railway development can be calculated through VOT

### 2. VOT estimation method

- Expected Value Methods: Estimated from demand forecasting model parameter
- Realized Income Methods: Estimated from income and working hours

# II-1 Cost-Effectiveness Analysis

## Calculation of The Net Benefits in NPV

$$B = \sum_{tb} \frac{UB_{tb}}{(1+i)^{T+tb}} + \sum_{tb} \frac{SB_{tb}}{(1+i)^{T+tb}} + \sum_{tb} \frac{EB_{tb}}{(1+i)^{T+tb}} + \sum_{tb} \frac{SV}{(1+i)^{T+Z}}$$

$B$ : Net benefit (yen)
$UB_{tb}$ : User Benefit at each year *tb* (yen/year)
$SB_{tb}$ : Supplier Benefit at each year *tb*(yen/year)
$EB_{tb}$ : Environmental Improvement Benefit at each year *tb*(yen/year)
$SV$ : Salvage Value (yen)
$Z$ : Operation period (30 years)
$T$ : Construction period
$i$ : Social Discount Rate (Japan=0.04, Thailand=0.12)



# II-1 Cost-Effectiveness Analysis

## Calculation of The Net Benefits in NPV

$$C = \sum_{tc} \frac{CC_{tc}}{(1+i)^{tc}}$$

$C$ : Net cost (yen)
$CC_{tc}$ : Cost at each year *tb* (yen/year)

# II-1 Cost-Effectiveness Analysis

## 3 Indices in CEA

- Cost-Benefit Ratio (CBR) → Scale Independence Index
  - Value of over 1.0 means the effect (benefit) is exceed the investment (cost), so this investment is productive
  - In the Transport Policy Plan No.18, CBR is utilized in CEA

$$CBR = \frac{B}{C}$$

- Net Present Value (NPV) → Consider the scale of effect

$$NPV = B - C$$

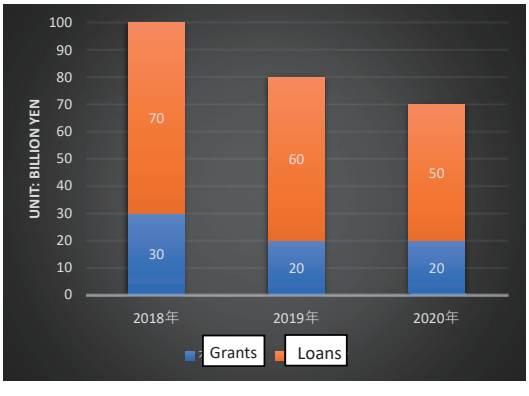
- Economic Internal Rate of Return → Comparison with the interest rate
  - EIRR= Interest rate at which the cost and economic benefits of a project, discounted over its life, are equal



# II-1 Subsidy Analysis

- In order to maintain a healthy balance within the operation period (30 years), subsidy from the government is needed to railway operator.
- As for the central and local government, this subsidy analysis is essential for their plan budget to estimate the grants and loans in each year.

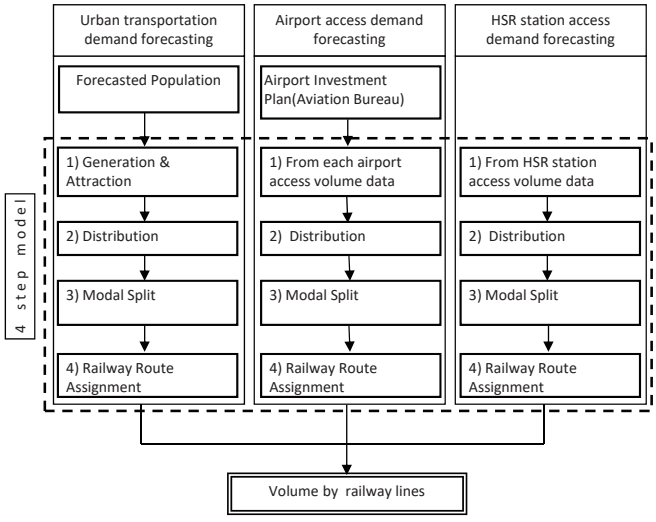
| Expense item | Investment Structure | | |
|---|---|---|---|
| Construction, Land aquisition ( tax, interest excluded) | Non-repay α% | | Loan 100－α% |
| | Existing Capital 20% | subsidy α－20 % | |
| Rolling Stocks | Existing Capital 20% | Loan 80% | |
| Interest during construction period | Short-Term Loan 100% | | |



# II-1 Demand Forecasting Framework
# (The Council of Transport Policy Plan No.18, No.198)



Transport demand from three models, namely, urban transportation model, airport access model, and HSR station access model, are estimated separately by using 4-step model method.



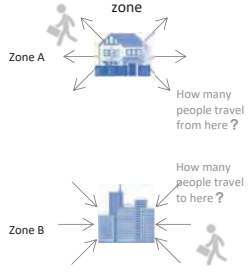


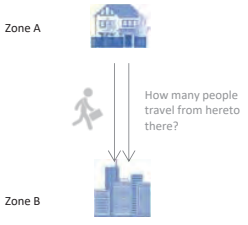

# II-1 Demand Forecasting Framework
# (The Council of Transport Policy Plan No.18, No.198)

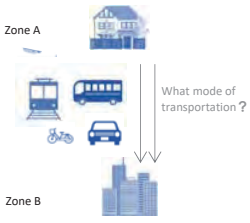
Model Structure | Population Forecast | Required Condition | Urban Trans. Model | Airport & HSR Acc. Model

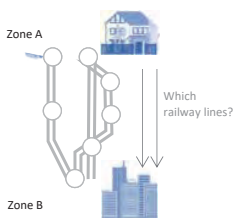
4-Step Model: the estimation method which structure the travel decision into 4 steps

| 1) Generation & Attraction | 2) Distribution | 3) Transportation Modal Split | 4) Railway Route Assignment |
|---|---|---|---|
| Estimation of Generation volume from each zone and Attraction volume to each zone | Travel volume between each zone (Total O-D table) | Travel volume between each zone by mode of transportation | Railway volume between each zone by railway lines |

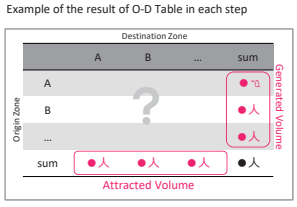


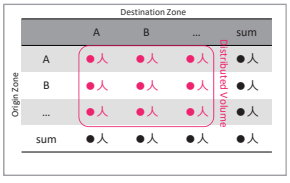



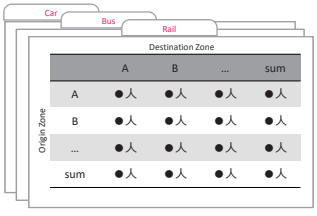



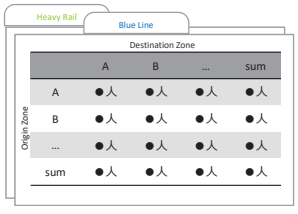




Example of the result of O-D Table in each step



# II-1 Demand Forecasting Framework
# (The Council of Transport Policy Plan No.18, No.198)

Model Structure | Population Forecast | Required Condition | Urban Trans. Model | Airport & HSR Acc. Model

## Three sub-model in Urban Transportation Demand Forecasting

### Urban Transportation Demand Forecasting Model

Based on a trip for commuting (work, school), shopping and other daily life activities

| 1) Generation & Attraction | | 2) Distribution | | 3) Modal Split | | 4) Route Choice (Railway) | |
|---|---|---|---|---|---|---|---|
| Method | Data Requirement | Method | Data Requirement | Method | Data Requirement | Method | Data Requirement |
| • Adjustment Factor Method | • 2010 National Census<br>• 2008 PT survey | • Present Pattern Method<br>• Gravity Model | • 2010 National Census<br>• 2008 PT survey | • Walking/bicycle split curve<br>• Disaggregate logit model | • 2008 PT survey | • Disaggregate probit model | • 2010 Metropolitan Transportation Census |

### Airport Access Demand Forecasting Model

Based on an access trip from every modes to Haneda Airport and Narita Airport

| 1) Generation | 2) Distribution | | 3) Modal Split | | 4) Route Choice (Railway) | |
|---|---|---|---|---|---|---|
| Data Requirement | Method | Data Requirement | Method | Data Requirement | Method | Data Requirement |
| Based on the result from the sub-committee of aviation (September, 2013) | • Present Pattern Method | (Domestic)<br>• 2013 Air Passenger Survey<br>(International)<br>• 2013 International Air Passenger Survey<br>• 2013 Lodging Travel Survey | • Disaggregate logit model | (Domestic)<br>• 2013 Air Passenger Survey<br>(International)<br>• 2013 International Air Passenger Survey | • Disaggregate probit model | (Domestic)<br>• 2013 Air Passenger Survey<br>(International)<br>• 2013 International Air Passenger Survey |

### High-Speed Rail Station Access Demand Forecasting Model

Based on an access trip to HSR and Maglev Train Station

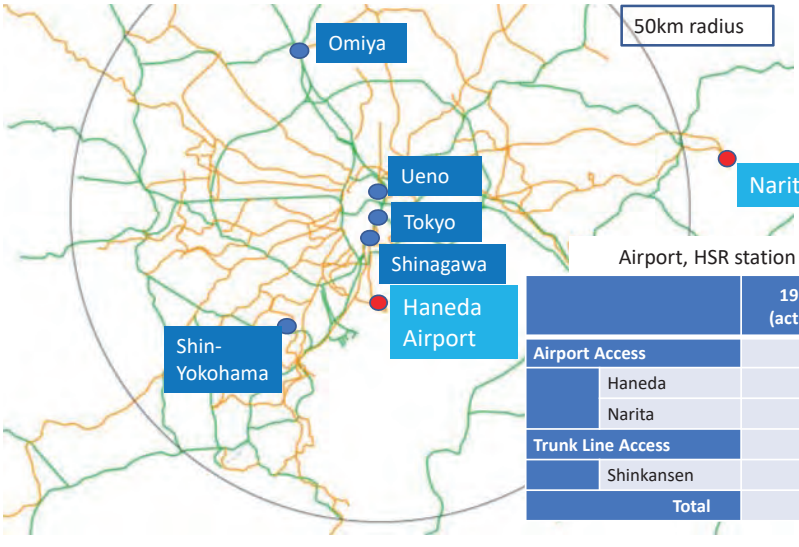
| 1) Generation | 2) Distribution | | 3) Modal Split | | 4) Route Choice (Railway) | |
|---|---|---|---|---|---|---|
| Data Requirement | Method | Data Requirement | Method | Data Requirement | Method | Data Requirement |
| [Tohoku, Joetsu, Hokuriku Shinkansen]<br>Based on the result from the sub-committee of Shinkansen development (March, 2012)<br>[Tokaido, Chuo (Maglev) Shinkansen]<br>Based on the result from the sub-committee of Chuo Shinkansen (October, 2010) | • Present Pattern Method<br>• Gravity Model | • 2010 Survey of trunk line passenger flow | • Disaggregate logit model | • 2010 Survey of trunk line passenger flow | • Disaggregate probit model | • 2010 Survey of HSR passenger flow |



# II-1 Demand Forecasting Framework
# (The Council of Transport Policy Plan No.18, No.198)

## Traffic Volume to Airports and HSR stations in TMA

- Accessibility improvement to airport and HSR station is one of the important policy to strengthen the international competitiveness
- Large impact to the simulation of the current traffic flow (they are important nodes)

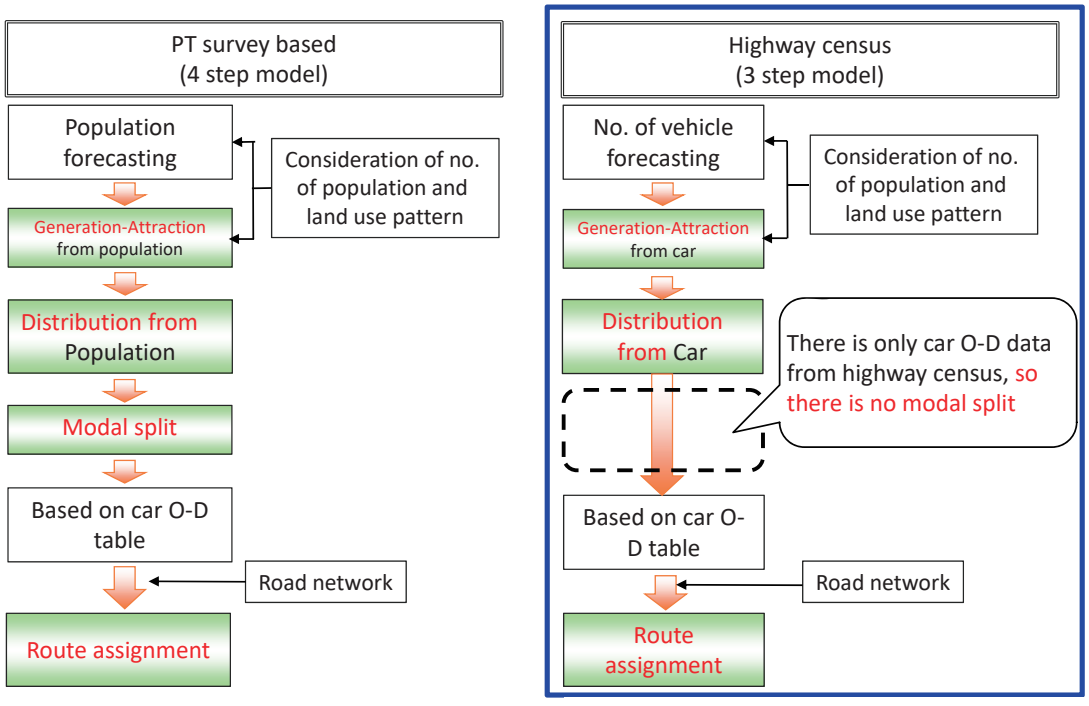



Airport, HSR station transport volume (1,000 person/day)

| | 1995 (actual) | 2015 (CTPP 18) | Increase rate | Growth rate (%) | Annual growth (%) |
|---|---|---|---|---|---|
| **Airport Access** | 180 | 284 | 104 | 57.8 | 2.3 |
| Haneda | 120 | 177 | 57 | 47.5 | 2.0 |
| Narita | 60 | 107 | 47 | 78.3 | 2.9 |
| **Trunk Line Access** | 421 | 530 | 109 | 26.0 | 1.2 |
| Shinkansen | 353 | 445 | 92 | 26.0 | 1.2 |
| **Total** | 601 | 814 | 213 | 35.4 | 1.5 |

## (Reference) comparison with highway demand forecasting

- highway demand forecast calculation is mainly based on highway census
- car (no. of vehicle) based forecasting
- assume no change in mode (only car is assumed)

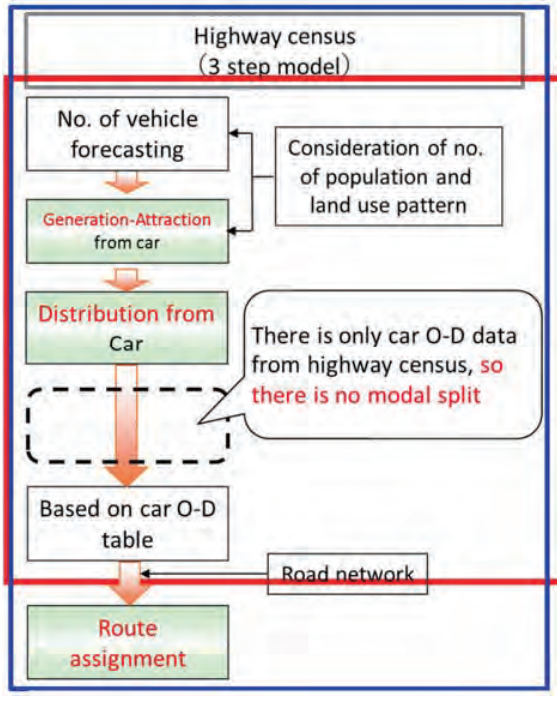



Forecasting method based on Road Bureau



## Roles of road demand forecasting – Contribution to National and Local government

- National and local share the road investment
- Demand forecasting is also included in these processes (EIA → planning process), (investment priority selection → detail planning process) (re-evaluation, project authorization → land acquisition process)




MLIT

Road Bureau, MLIT is in charge only for vehicle forecast, generation & attraction and distribution

<<our company's (CRP) involvement>>
Our company are usually requested to estimate the distribution step

Local Govt.

MLIT regional office

Local government and MLIT regional office estimated route assignment in their own area

# II-1 Demand Forecasting and Line Evaluation (The Transport Policy Plan No.18-Priority Selection)

Based from the four analyses mentioned in CTPP no.18, railway line evaluation can be conducted. From the evaluation, investment priority of A1, A2 and B can be evaluated as follows

A: The project must be initiated before target year (2015)

A1: Based on the current situation, these lines are already well-planned and ready for operation before the target year (2015)

A2: Based on the current situation, plan for these lines are not reaching the mature state yet. Some lines might be ready for operation before the target year (2015)

B: The project for later consideration

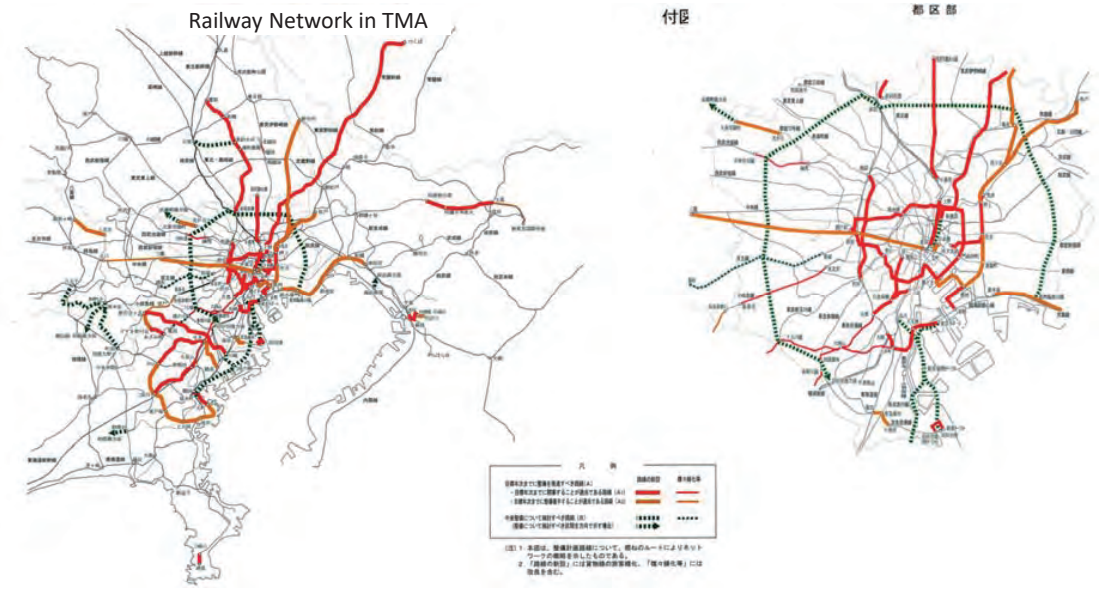
Based on the current progress, demand forecasting, and investment capability, the service necessity and investment plan should be further considered



# II-1 Demand Forecasting and Line Evaluation (The Transport Policy Plan No.18-Priority Selection)

Railway network investment plan
Priority: A1(red) → A2(orange) → B(dotted green)

Railway Network in TMA



# II-1 Evaluation Table

In the Transport Policy Plan No.18, based on four related analysis, the railway investment priority was determined as follows:

**新線、既設線延伸等に係る評価検討表（試算）（総括表）**

| 番号 | 路線 | ケース番号 | 区間 | 整備キロ | 需要 輸送密度 千人 | 社会・経済的効果 混雑緩和 | シームレス化 | 速達性向上 | 都市機能強化等 | 高速交通アクセス | 他路線との主な関連 | 費用便益比（B/C） | 収支採算性 開業年 営業損益比（償却前） | 収支採算性 無償資金率 | 収支採算性 総事業費 平成10年度価格 億円 | 熟度 現在の検討状況等 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ⅰ．高速鉄道 | | | | | | | | | | | | | | | | |
| 1．混雑緩和、シームレス化、速達性向上、都市機能強化等に資する路線 | | | | | | | | | | | | | | | | |
| 1 | 東北・高崎・常磐線の東海道本線乗り入れ | 235 | 上野～（ノンストップ）～東京（東海道本線相直） | 3.6 | 319 | ○（山手等） | △ | △ | △ | ○（新） | — | 6.7 | 5.4 | 0% | 628 | 事業主体未定。開係自治体が要望。一部区間」長東日本の引込線あり。運輸省都市鉄道調査の対象。 |
| | | 23C | | 3.6 | 182 | | | | | | | 3.4 | 3.9 | 25% | 602 | |
| ※ 2 | 常磐新線の延伸 | 240 | 秋葉原～東京 | 2.1 | 59 | | | | | ○（新） | 常磐新線の需要培養効果。 | 1.1 | 1.3 | 100% | 1,241 | 事業主体未定。ルート未検討。開係自治体が要望。 |
| 3 | 東京12号線の延伸 | 220 | 渋谷～品川～東京テレポート | 8.5 | 95 | | | | | | — | 1.0 | 2.4 | 80% | 3,236 | 事業主体未定。ルート未検討。 |
| 4 | 区部周辺部環状公共交通（リニアメトロ） | 434 | 葛西臨海公園～亀有～井荻～田園調布～羽田空港 | 73.3 | 58 | | | ○ | △ | ○（羽） | 羽田空港乗入れ部分は蘇々新線（35）、京急空港線と競合。また、東京４号線の延伸（5）、竹の塚・王子・池袋線（14）と類似の機能。 | 1.1 | 1.7 | 80% | 16,073 | 事業主体未定。開係自治体が強く要望。区間概位未定。 |
| 5 | 東京４号線の延伸 | 011 | 荻窪～朝霞 | 11.4 | 91 | △（埼京等） | | ○ | | | 区部周辺環状交通(4)と相当部分で重複。 | 2.3 | 2.7 | 50% | 2,282 | 事業主体未定。ルート未検討。 |
| 6 | 横浜３号線の延伸 | 270 | あざみ野～新百合ヶ丘 | 6.6 | 75 | △（南武等） | | △ | △ | | 横浜市交３号線の需要培養効果。 | 3.0 | 1.7 | 80% | 1,351 | 事業主体一横浜市交通局。開係自治体が強く要望。一部区間は、川崎市域。基金設置（横浜市）。 |
| | ケーススタディ（コスト：３セク） | | | 6.6 | 75 | | | | | | | 3.1 | 2.1 | 75% | 1,351 | |
| | ケーススタディ（既設線増収分加算） | | | 6.6 | 75 | | | | | | | 3.0 | 2.3 | 60% | 1,351 | |
| ※ 7 | 神奈川東部方面線 | 281 | 二俣川～新横浜～大倉山 | 12.3 | 111 | ○（東海道等） | ○ | △ | △ | △（新） | 相鉄の需要への影響。 | 2.8 | 2.6 | 50% | 2,750 | 事業主体一開係自治体が上下分離方式で検討中。開係自治体が強く要望。基金設置（横浜市）。 |
| | | 282 | 二俣川～新横浜～大倉山、新横浜～川崎 | 22.4 | 107 | | | | | | | 1.8 | 2.6 | 60% | 5,745 | |
| ※ 8 | 横浜環状鉄道 | 298 | 日吉～鶴見、元町～根岸～中山 | 34.3 | 94 | | | | | | | 2.0 | 1.6 | — | 8,363 | 事業主体一横浜市交通局及び横浜高速鉄道。開係自治体が強く要望。基金設置（横浜市）。東戸塚、上大岡等都心の拠点開発との関連。区間概位未定。 |
| | | | 日吉～鶴見、根岸～中山（ﾘﾆｱﾒﾄﾛ） | 28.4 | 104 | ○（横浜等） | | ○ | ○ | | MM２１線等の需要培養効果。 | — | 1.7 | 75% | 7,011 | |
| | | | 元町～根岸（MM２１線延伸） | 5.9 | 46 | | | | | | | — | 1.3 | 100% | 1,352 | |
| | ケーススタディ（コスト：３セク） | | 日吉～鶴見、根岸～中山（ﾘﾆｱﾒﾄﾛ） | 28.4 | 104 | | | | | | | — | 2.0 | 70% | 7,011 | |
| | ケーススタディ（開発の熟成考慮） | | 日吉～鶴見、根岸～中山（ﾘﾆｱﾒﾄﾛ） | 28.4 | 110 | | | | | | | — | 1.7 | 75% | 7,011 | |
| 9 | 川崎縦貫高速鉄道 | 301 | 新百合ヶ丘～宮前平～元住吉～川崎 | 21.6 | 146 | ○（南武等） | | △ | ○ | △（羽） | 武蔵野南線の旅客線化(48)と類似の機能。 | 1.5 | 1.6 | 75% | 6,467 | 事業主体一川崎市交通局。開係自治体が強く要望。基金設置（川崎市）。新川崎地区開発計画との関連。 |
| | ケーススタディ（コスト：３セク） | | | 21.6 | 146 | | | | | | | 1.6 | 2.2 | 60% | 6,467 | |
| 10 | 東京６号線（都営三田線）の延伸 | 023 | 志村坂上～武蔵浦和～大宮 | 17.2 | 58 | △（埼京） | △ | | | | — | 1.0 | 1.8 | 85% | 3,822 | 事業主体未定。開係自治体が要望。 |
| 11 | 東京７号線（埼玉高速鉄道）の延伸 | 032 | 浦和美園～岩槻～蓮田 | 12.9 | 43 | △（東北） | | | ○ | | 埼玉高速鉄道線の需要培養効果。 | 1.6 | 1.3 | 90% | 1,595 | 事業主体一埼玉高速鉄道。開係自治体が強く要望。基金設置（岩槻市、蓮田市）。国際アメニティタウン開発等との関連。 |
| | ケーススタディ（開発の熟考慮） | | | 12.9 | 61 | | | | | | | — | 1.3 | 75% | 1,595 | |
| | ケーススタディ（既設線増収分加算） | | | 12.9 | 43 | | | | | | | 1.6 | 1.7 | 70% | 1,595 | |



# II-1 Evaluation Table

15. 新線、既設線延伸等に係る評価表（需要動向、財務分析、政策課題に対する改善効果）

| 番号 | 路線名 | ケース番号 | 区間（輸送密度、ピーク時最大断面輸送量、開業年収入／営業費については下線区間で算定） | 整備キロ | 需要動向 ピーク時最大断面輸送量 千人/h | 需要動向 1人当たり平均トリップ長 km | 財務分析 開業年収入／営業費 | 政策課題に対する改善効果 混雑緩和 42区間の混雑率の変化（区間：H9最混雑区間 混雑率：H27ネットワーク） | 混雑緩和 混雑区間長の変化(km) 150～179% (H27ネットワーク：273km) | 混雑緩和 混雑区間長の変化(km) 180～199% (H27ネットワーク：88km) | シームレス化 乗換回数の総数の変化 200%以上 (H27ネットワーク：24km) | シームレス化 乗換回数の総数の変化 (鉄道間) 全体比 | シームレス化 乗換回数の総数の変化 (鉄道間) ネットワーク | シームレス化 乗換回数の総数の変化 (鉄道間) 整備路線 全利用者比 | シームレス化 主要駅間での所要時間の短縮、乗換回数の減少 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ⅰ．高速鉄道 | | | | | | | | | | | | | | | |
| 1．混雑緩和、シームレス化、速達性向上、都市機能強化等に資する路線 | | | | | | | | | | | | | | | |
| 1 | 東北・高崎・常磐線の東海道本線乗り入れ | 235 | 上野～（ノンストップ）～東京（東海道本線相直） | 3.6 | 319 | 34 | 49 | 5.4 | 東浜東北194→176　山手193→154 | +4 | +14 | ▲3 | -51 | -0.2% | -3.4% | 大宮→東京（40→31分、1→0回） |
| ※ 2 | 常磐新線の延伸 | 240 | 秋葉原～東京 | 2.1 | 59 | 7 | 36 | 1.3 | | ▲2 | ±0 | ±0 | -26 | -0.1% | -4.6% | 柏北都中央→東京（45→37分、1→0回） |
| 3 | 東京13号線の延伸 | 220 | 渋谷～品川～東京テレポート | 8.5 | 95 | 10 | 29 | 2.4 | 東急東横175→169　山手160→155 | ▲7 | +4 | ±0 | -49 | -0.2% | -3.0% | 所沢→品川（64→54分、1→1回） |
| 4 | 区部周辺部環状公共交通（リニアメトロ） | 434 | 葛西臨海公園～亀有～井荻～田園調布～羽田空港 | 73.3 | 58 | 8 | 20 | 1.7 | 南武199→192　常磐緩行178→172 | ▲22 | +4 | ▲4 | -39 | -0.2% | -1.3% | 赤羽→荻窪（32→24分、1→0回） |
| | | 436 | 葛西臨海公園～亀有～赤羽 | 28.3 | 30 | 4 | 19 | 0.9 | 常磐緩行178→173　京武伊勢崎162→156 | ▲6 | +5 | ▲1 | -14 | -0.1% | -1.5% | |
| | | 437 | 赤羽～井荻～田園調布～羽田空港 | 45.0 | 67 | 8 | 21 | 2.0 | 埼京214→207　南武199→192 | ▲15 | +1 | ▲3 | 0 | 0.0% | 0.0% | |
| 5 | 東京４号線の延伸 | 011 | 荻窪～朝霞 | 11.4 | 91 | 11 | 22 | 2.7 | 埼京214→205　京武東上177→167 | ▲4 | ±0 | ±0 | -26 | -0.1% | -2.9% | 荻窪→朝霞（51→22分、2→0回） |
| 6 | 横浜３号線 | 270 | あざみ野～新百合ヶ丘 | 6.6 | 75 | 8 | 23 | 1.7 | 南武199→189　横浜175→167 | ▲7 | +3 | ▲3 | 5 | 0.0% | 1.2% | あざみ野→新百合ヶ丘（41→10分、2→0回） |
| ※ 7 | 神奈川東部方面線 | 281 | 二俣川～新横浜～大倉山、新横浜～川崎 | 12.3 | 111 | 21 | 25 | 2.6 | 東海道181→173　横浜貨151→138　相鉄本線143→113 | +9 | ▲18 | ±0 | -114 | -0.5% | -12.6% | 二俣川→大手町（58→54分、2→0回） |
| | | 282 | 二俣川～新横浜～大倉山、新横浜～川崎 | 22.4 | 107 | 19 | 26 | 2.6 | 南武199→192　京浜東北189→183 | +7 | ▲13 | ±0 | -83 | -0.3% | -6.5% | |
| ※ 8 | 横浜環状鉄道 | 298 | 日吉～鶴見、元町～根岸～中山 | 34.3 | 94 | – | 24 | 1.6 | 南武199→193　横浜175→143 | -1 | ▲10 | ▲3 | 88 | 0.4% | 6.5% | センター北→鶴見（39→21分、1→0回） |
| | | | 日吉～鶴見、根岸～中山（ﾘﾆｱﾒﾄﾛ） | 28.4 | 104 | 20 | – | 1.7 | —— | – | – | – | – | – | – | —— |
| | | | 元町～根岸（MM２１線延伸） | 5.9 | 46 | 5 | – | 1.3 | —— | – | – | – | – | – | – | —— |
| 9 | 川崎縦貫高速鉄道 | 301 | 新百合ヶ丘～宮前平～元住吉～川崎 | 21.6 | 146 | 37 | 24 | 1.6 | 南武199→132　横浜貨151→174　横浜175→159 | +4 | ±0 | ▲3 | 21 | 0.1% | 1.5% | 多摩センター→川崎（60→43分、2→1回） |
| 10 | 東京６号線（都営三田線）の延伸 | 023 | 志村坂上～武蔵浦和～大宮 | 17.2 | 58 | 8 | 27 | 1.8 | | ±0 | +7 | ▲7 | -62 | -0.3% | -3.6% | 武蔵浦和→大手町（42→33分、1→0回） |
| 11 | 東京７号線（埼玉高速鉄道）の延伸 | 032 | 浦和美園～岩槻～蓮田 | 12.9 | 43 | 7 | 34 | 1.3 | 東北本160→153 | ±0 | +2 | ▲2 | -30 | -0.1% | -3.3% | 鳩ヶ谷（国際アミティタウン）→東京（79→56分、3→1回）（バスアクセスを含む） |
| ※12 | 東京12号線（リニアメトロ）の延伸 | 073 | 光が丘～大泉学園町～東所沢 | 12.5 | 65 | – | 24 | 1.4 | 埼京214→209　京武東上177→171　西武池袋線134→125 | ▲2 | ▲2 | ±0 | -23 | -0.1% | -2.5% | 東所沢→青山一丁目（62→47分、2→0回） |
| | | | 東京都部分：光が丘～大泉学園町 | 4.2 | 101 | 14 | – | 1.2 | —— | – | – | – | – | – | – | —— |
| | | | 埼玉県部分：大泉学園町～東所沢 | 8.3 | 47 | 8 | – | 1.5 | —— | – | – | – | – | – | – | —— |
| ※13 | 埼京線の延伸 | 092 | 大宮～宮原 | 4.0 | 40 | 6 | 44 | 0.7 | 高崎198→178 | +2 | +4 | ▲4 | -5 | 0.0% | -0.9% | |
| 14 | 竹の塚・王子・池袋線（リニアメトロ） | 261 | 竹の塚～王子～池袋 | 10.3 | 77 | 13 | 21 | 1.9 | 日比谷170→163　京武伊勢崎162→151 | ▲5 | +3 | ▲3 | -23 | -0.1% | -1.7% | 越谷→池袋（53→39分、2→1回） |
| ※15 | 東京８号線（営団有楽町）の延伸 | 040 | 豊洲～住吉・押上～亀有～野田市 | 36.6 | 81 | 39 | 24 | 2.3 | 京浜東北184→169　京成押上171→144　常磐緩行178→159 | ▲14 | +4 | ▲2 | -27 | -0.1% | -1.2% | 野田市→錦糸町（59→35分、2→0回） |
| 16 | 東京10号線（北千葉線）の延伸 | 050 | 本八幡～新鎌ヶ谷 | 9.3 | 53 | 9 | 27 | 1.5 | 京成押上171→158　都営浅草163→153 | ▲3 | +2 | ±0 | 21 | 0.1% | 4.6% | 新鎌ヶ谷→新宿（57→48分、1→0回） |
| ※17 | 東京11号線（営団半蔵門）の延伸 | 060 | 押上～松戸 | 12.0 | 128 | 32 | 25 | 2.8 | 常磐緩行178→154　京成押上171→144　常磐快速178→161 | ▲13 | +1 | +2（総武線） | -102 | -0.4% | -5.8% | 松戸→錦糸町（33→14分、1→0回） |
| 18 | 総武・京葉接続新線１ | 110 | （有楽町線相直）新木場～海浜幕張～稲毛（総武緩相直） | 30.3 | 45 | 8 | 29 | 1.5 | 京葉197→129 | ▲9 | ▲13 | ▲3 | -32 | -0.1% | -6.8% | 千葉→東京ﾃﾚﾎﾟｰﾄ（64→48分、3→1回） |
| 19 | 総武・京葉接続新線２ | 120 | （臨海副都心線相直）新木場～新浦安～船橋～津田沼（総武緩相直） | 21.8 | 94 | 19 | 39 | 3.0 | 京葉197→148　総武快速181→167 | +7 | ▲14 | ▲3 | -72 | -0.3% | -4.6% | 千葉→東京ﾃﾚﾎﾟｰﾄ（64→42分、3→0回） |
| 20 | 野田・吉川・八潮線 | 100 | 野田～レイクタウン～八潮（常磐新線相直） | 20.1 | 32 | 9 | 27 | 1.0 | 京武伊勢崎162→157 | ▲4 | ±0 | ±0 | -12 | -0.1% | -5.4% | 野田市→錦糸町（62→49分、2→1回） |
| 21 | 京成金町線を活用した東京８号線の代替ルート | 410 | 野田市～京成金町（亀有代替）～（京成金町線）～高砂（京成本線相直） | 24.3 | 26 | 8 | 25 | 0.8 | | ▲3 | ±0 | ±0 | 7 | 0.0% | 2.0% | —— |
| 22 | 北総線を活用した東京11号線の代替ルート | 420 | 松戸～北総高矢切～（北総線）～高砂（京成本線相直） | 3.4 | 20 | 4 | 25 | 0.5 | | ±0 | ±0 | ±0 | -9 | 0.0% | -4.1% | —— |
| 23 | 都心と臨海を結ぶ公共交通（リニアメトロ） | 340 | 有楽町～馬喰～勝どき～晴海～豊洲～国際展示場 | 5.4 | 24 | 4 | 18 | 0.6 | | ±0 | ±0 | ±0 | 3 | 0.0% | 1.8% | —— |
| ※24 | 相鉄いずみ野線の延伸 | 250 | 雅南台～倉見（新幹線駅未設定） | 7.8 | 10 | 3 | 22 | 0.2 | | ±0 | ±0 | ±0 | 9 | 0.0% | 12.9% | —— |
| ※25 | 小田急多摩線の延伸 | 310 | 唐木田～相模原～上溝 | 8.8 | 10 | 1 | 26 | 0.3 | | ±0 | ±0 | ±0 | 3 | 0.0% | 2.2% | —— |
| 26 | 川崎アプローチ線 | 440 | 川崎～浜川崎 | 3.4 | 16 | 4 | 23 | 0.3 | | ±0 | ±0 | ±0 | 6 | 0.0% | 3.8% | —— |
| 27 | 京王相模原線の延伸 | 450 | 橋本～相模中野（淵久井地区） | 9.0 | 10 | 1 | 22 | 0.3 | | ±0 | ±0 | ±0 | 2 | 0.0% | 14.7% | —— |
| ※28 | 京急久里浜線の延伸 | 460 | 三崎口～海豊 | 2.1 | 8 | 1 | 38 | 0.1 | | ±0 | ±0 | ±0 | 0 | 0.0% | -1.3% | —— |
| ※29 | 京成千原線（田千葉急千葉乗行線）の延伸 | 470 | ちはら台～海士有木 | 7.8 | 3 | 1 | 32 | 0.1 | | ±0 | ±0 | ±0 | -1 | 0.0% | -1.1% | —— |

# Ⅲ

# Data and Survey Requirements for Transport Demand Forecasting

1. Transport Demand Forecasting and Surveys/Study
2. Major Survey in Japan and Its Utilization in Demand Forecasting Model
3. Overview of Data Requirements in Transport Demand Forecasting
   1. National Census
   2. Metropolitan Transportation Census
   3. Person-trip (PT) Survey
4. National Development Plan and Travel Demand Forecasting



## III-1 Transport Demand Forecasting and Surveys/Study

Data requirements for each demand forecasting sub-model (Based on The Transport Policy Plan No.198)

### Urban Transportation Demand Forecasting Model

Based on a trip for commuting (work, school), shopping and other daily life activities

| 1) Generation & Attraction | | 2) Distribution | | 3) Modal Split | | 4) Route Choice (Railway) | |
|---|---|---|---|---|---|---|---|
| Method | Data Requirement | Method | Data Requirement | Method | Data Requirement | Method | Data Requirement |
| • Adjustment Factor Method | • 2010 National Census<br>• 2008 PT survey | • Present Pattern Method<br>• Gravity Model | • 2010 National Census<br>• 2008 PT survey | • Walking/bicycle split curve<br>• Disaggregate logit model | • 2008 PT survey | • Disaggregate probit model | • 2010 Metropolitan Transportation Census |

### Airport Access Demand Forecasting Model

Based on an access trip from every modes to Haneda Airport and Narita Airport

| 1) Generation | 2) Distribution | | 3) Modal Split | | 4) Route Choice (Railway) | |
|---|---|---|---|---|---|---|
| Data Requirement | Method | Data Requirement | Method | Data Requirement | Method | Data Requirement |
| Based on the result from the sub-committee of aviation (September, 2013) | • Present Pattern Method | (Domestic)<br>• 2013 Air Passenger Survey<br>(International)<br>• 2013 International Air Passenger Survey<br>• 2013 Lodging Travel Survey | • Disaggregate logit model | (Domestic)<br>• 2013 Air Passenger Survey<br>(International)<br>• 2013 International Air Passenger Survey | • Disaggregate probit model | (Domestic)<br>• 2013 Air Passenger Survey<br>(International)<br>• 2013 International Air Passenger Survey |

### High-Speed Rail Station Access Demand Forecasting Model

Based on an access trip to HSR and Maglev Train Station

| 1) Generation | 2) Distribution | | 3) Modal Split | | 4) Route Choice (Railway) | |
|---|---|---|---|---|---|---|
| Data Requirement | Method | Data Requirement | Method | Data Requirement | Method | Data Requirement |
| Tohoku, Joetsu, Hokuriku Shinkansen<br>Based on the result from the sub-committee of Shinkansen development (March, 2012)<br>Tokaido, Chuo (Maglev) Shinkansen<br>Based on the result from the sub-committee of Chuo Shinkansen (October, 2010) | • Present Pattern Method<br>• Gravity Model | • 2010 Survey of trunk line passenger flow | • Disaggregate logit model | • 2010 Survey of trunk line passenger flow | • Disaggregate probit model | • 2010 Survey of HSR passenger flow |

# III-2 Major Survey in Japan and Its Utilization in Demand Forecasting Model

- In Japan, data needs for the demand forecast and other urban transportation development planning are mostly conducted by the government.
- During the survey method and question design process, participation of university professors and experts is essential.

| | Data from urban transport study | | | | |
|---|---|---|---|---|---|
| Survey Title | National Census | Person-Trip Survey | Metropolitan Transportation Census | Urban transportation Annual Report | Highway Census |
| Agency | Statistic Bureau, MIC | City Bureau, MLIT; local government | Policy Bureau, MLIT | Japan Transportation Research Institute | Road Bureau, MLIT |
| Objective | Provide the basic information for policy discussion in both national and local admin. level | To understand the current situation of transportation in urban area in overall, for the best consideration in policy planning | To understand the volume of public transportation in major 3 metropolitan area, As the basic information for the public transportation investment plan | To understand the passenger volume and actual capacity of public transportation, for the transportation management plan | To understand the current situation of national highway and vehicle usage, as a basic information for every plan related to highway |
| Study Area | Nationwide | Urban Area, TMA | Tokyo MA, Chukyo (Nagoya) MA, Kinki (Osaka) MA | Tokyo MA, Chukyo MA, Kinki MA | Nationwide |
| Survey Target | Person, Person-trip (1day) | Person-trip (1day) | Rail, Bus, Tram passenger movement (1day) | Railway passenger volume, actual capacity | Car movement (1day) |
| Staring year and period | Since 1920<br>every 5 years | Since 1967, each cities every 10 years | Since 1960<br>every 5 years | Since 1920<br>every year | Since 1928, from 1980<br>every 5 years |
| Utilization in demand forecasting model | Commuting O-D (Municipality level) | ・Commuting, Private trip, Business related trip O-D (partial muni. Level)<br>・individual trip data for disaggregate model | ・individual trip data for disaggregate route choice model<br>・railway passenger volume by time period<br>・station access data (access mode, origin zone) | ・railway peak-hour passenger, by section<br>・railway capacity | ・highway O-D and volume |
| Sample size | All resident | 2008<br>Individual:783,873 samples (respond rate 2.12%)<br>Household: 340,619 samples (respond rate 24.2%) | 2010<br>Rail: 212,971 person<br>Bus, Tram: 23,009 person | Based on the annual report submitted by railway company | 2010<br>O-D survey: 1,425,000 vehicle |
| Involvement from academics and experts | | YES | YES | | |

Source：edited from"Kōtsū keikaku-gaku(Transport Planning) by Yuichiro Kaneko"



# III-2 Major Survey in Japan and Its Utilization in Demand Forecasting Model

Not only the data from urban transportation, but the data from air transport is also utilized

| | Data from urban transport study | | Data from air transport study | |
|---|---|---|---|---|
| Survey Title | Highway Census | Survey of trunk line passenger flow | Air Passenger Survey | International Air Passenger Survey |
| Agency | Road Bureau, MLIT | Policy Bureau, MLIT | Civil Aviation Bureau, MLIT | |
| Objective | To understand the current situation of national highway and vehicle usage, as a basic information for every plan related to highway | To understand the flow of regional transportation on the trunk line, as a basic information for demand forecasting and policy planning. | To understand the characteristics of air passenger such as personal information, origin and destination, flight pattern, etc., as a basic data for airport development plan and other aviation promotion policies | |
| Study Area | Nationwide | Nationwide | Nationwide | |
| Survey Target | Car movement (1day) | Trunk line(Rail, Air, Ferry, Car), per passenger-trip (1day, 1year) | Domestic passenger-trip (weekend-weekday, one day each) | International passenger-trip (1 week) |
| Staring year and period | Since 1928, from 1980<br>every 5 years | Since 1990<br>every 5 years | Since 1973<br>every 2 years | Since 1987<br>Every year |
| Utilization in demand forecasting model | ・highway O-D and volume | O-D to HSR station by access mode | O-D to domestic airport by access mode | O-D to international airport by access mode |
| Sample size | 2010<br>O-D survey: 1,425,000 vehicle | 2010<br>Railway: Weekday 76k person (8.9%)<br>Holiday 192k person (9.0%) | | 2015<br>Sample in Narita Airport is beyond the expected recovery rate |
| Involvement of academics and experts | | YES | | |

Source：edited from"Kōtsū keikaku-gaku(Transport Planning) by Yuichiro Kaneko"

# III-3 Overview of Data Requirements in Transport Demand Forecasting

1) National Census

2) Metropolitan Transportation Census

3) Person-trip (PT) Survey



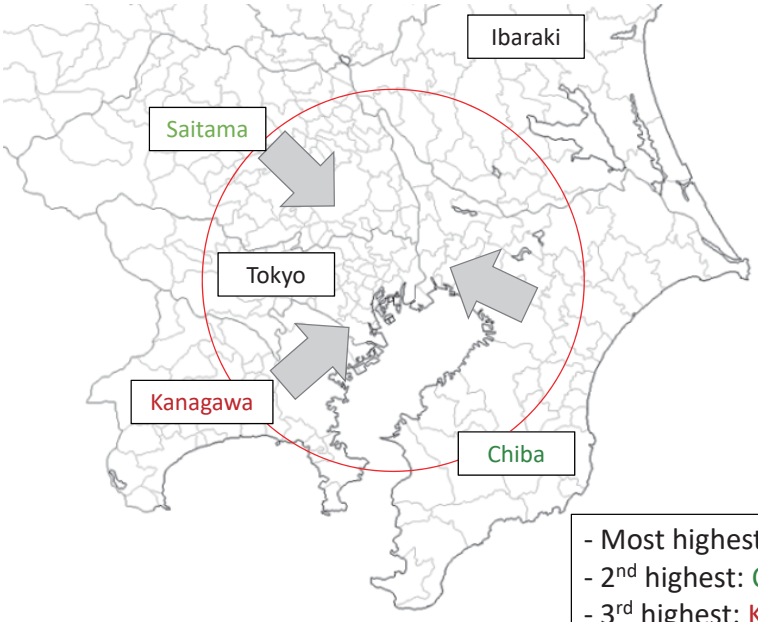
# III-3 National Census (1): Commuting Data

- Objective: to understand the actual number of population and households in Japan, and to obtain the base data for administrative policies
- Key point: to understand the commuting pattern (from home to workplace/school)

| Question asked to each household member | Question asked to household |
|---|---|
| (1) Name | (1) Type of household |
| (2) Gender | (2) Number of household member |
| (3) Year and month of birth | (3) Housing categorization |
| (4) Relationship with the head of HH | (4) Type of housing construction |
| (5) Marital Status | |
| (6) Nationality | |
| (7) Duration of current residence | |
| (8) Address of residence 5 years before | |
| (9) Occupation | |
| (10) Affiliation and its type of business | |
| (11) Type of occupation | |
| (12) Job position | |
| **(13) Address of workplace/school** | |

# III-3 National Census (2): Flow To Tokyo CBD

- Percentage of people who commute to outside of each prefecture



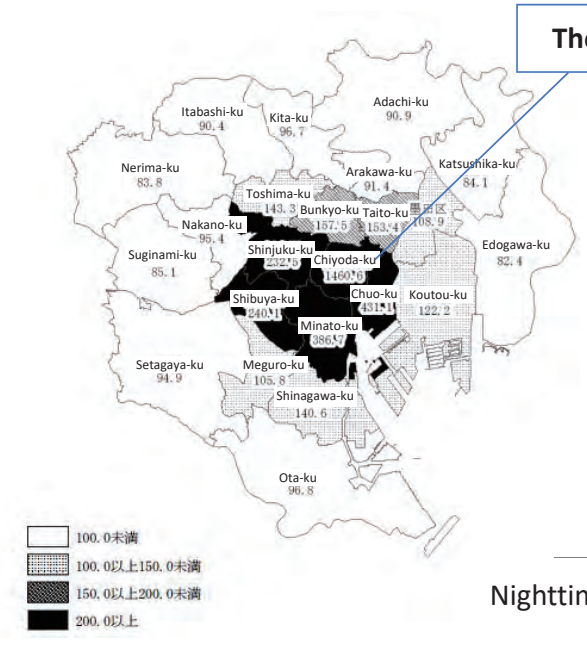

- Most highest: Saitama Prefecture (16.5%)
- 2nd highest: Chiba prefecture (15.1%)
- 3rd highest: Kanagawa Prefecture (14.4%)



# III-3 National Census (3): Business Agglomeration in Tokyo CBD

- The ratio of daytime population against nighttime population in the 23 wards of Tokyo

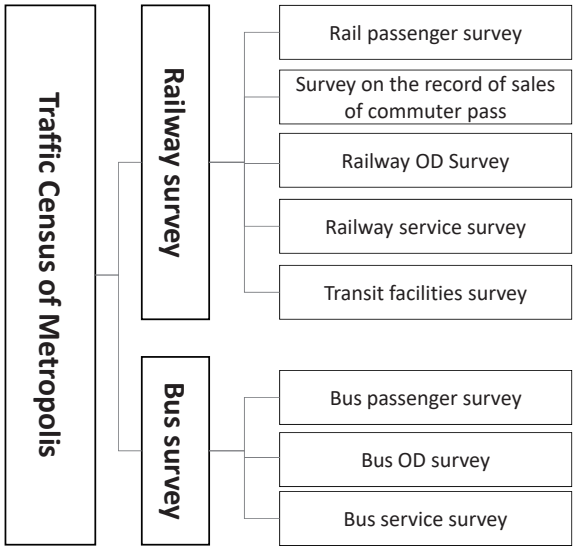
**The most highest: Chiyoda District (1460.6%)**




Nighttime Population Daytime Population

# III-3 Metropolitan Transportation Census (1): Framework

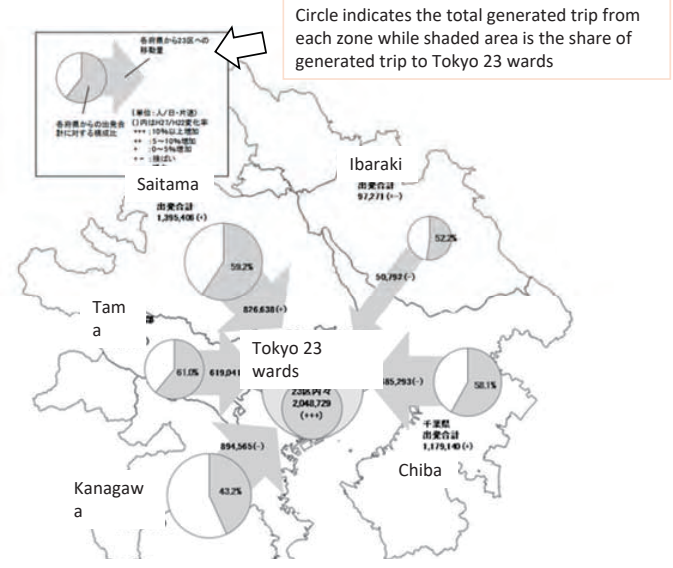
- Metropolitan Transportation Census has been conduced every 5 years since 1960.
- Objective: (1) to know actual usage of mass public transport
  (2) to provide the base information for the public transport policy to improve the convenience of public transport network and transport services



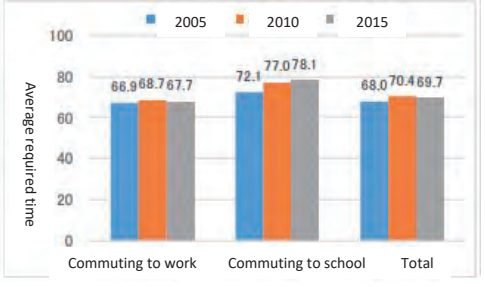

* Bus survey was conducted only for airport access buses in capital region



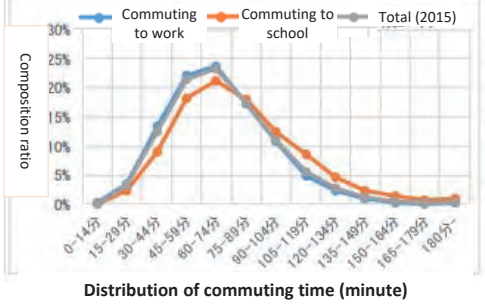
# III-3 Metropolitan Transportation Census (2): Commuting Pattern




**Flow of commuters to Tokyo 23 wards from Tokyo suburban and other prefectures (by using commuter pass)**




**Average commuting time of commuters using commuter pass (minute) (including access time and egress time)**

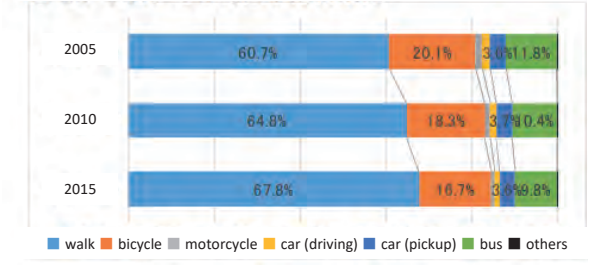



**Distribution of commuting time (minute) (including access time and egress time)**

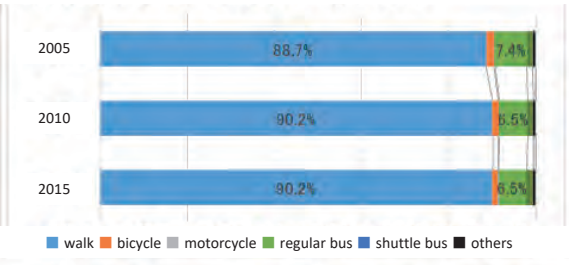
# III-3 Metropolitan Transportation Census (3): Access Mode to Station

Modal share of access and egress trip of commuter pass users

**Modal Share of Access Trip (from home to station)**




**Modal Share of Egress Trip (from station to work place)**




Access trip

- Walking share is the highest one
- Followed by bicycle
- Bus share is around 10%

Egress trip

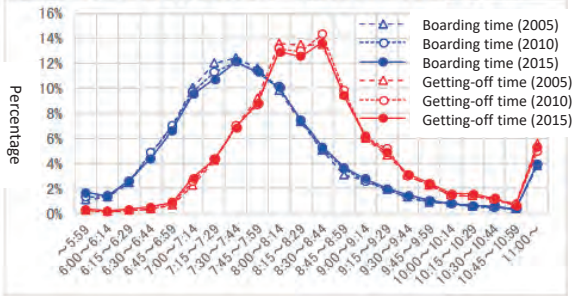
- Walking share is higher up to around 90%
- Bicycle is less common in egress trip



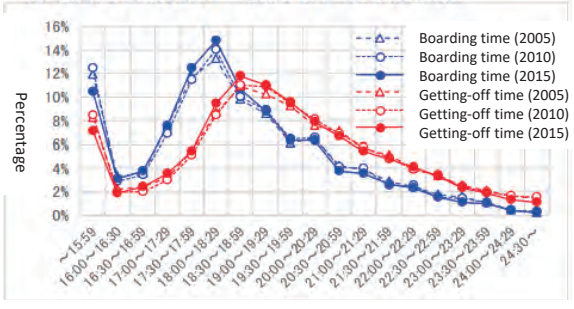
# III-3 Metropolitan Transportation Census (4): Commuting AM/PM Peak

Distribution of boarding time and getting-off time for commuting and returning home

Distribution of boarding time and getting-off time for commuting to workplace/school




Distribution of boarding time and getting-off time for returning to home




To workplace/school

- Boarding peak time is 7:30-7:44
- Getting-off peak time around 8:00-8:44
- Peak share is decreasing each year

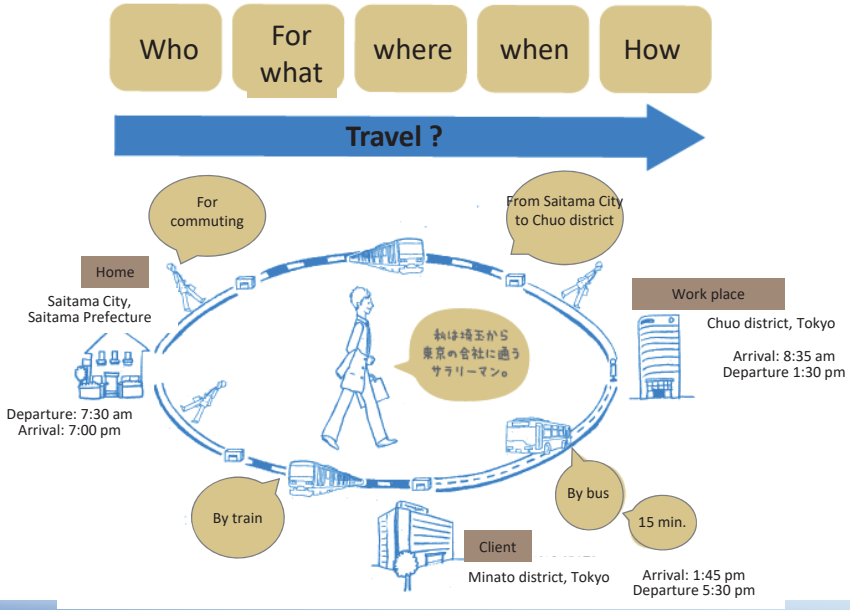
Back home

- Peak share is less than the morning
- Distribution is quite uniform.

# III-3 PT Survey (1): Travel Flow Data

Person trip survey can reveal **Modal Share** and **Traffic Volume** of each transport mode

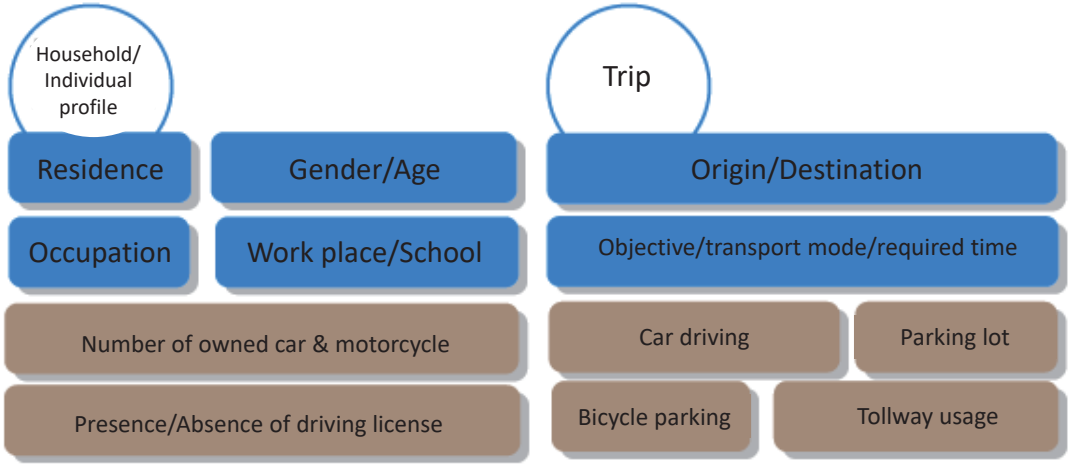
- Aggregate data from this survey can be used as O-D data
- Each trip data can be used in disaggregate traffic demand model






# III-3 PT Survey (2): Objective

- Person Trip Survey is a conducted only on weekday trip.
- Target: about 1,400,000 households (over 5 years old) among 16,000,000 households living in Tokyo metropolitan area are randomly selected.
- Contents of 5th Person Trip Survey in Tokyo metropolitan area is shown as below.



# III-3 PT Survey (3): History and Accomplishment

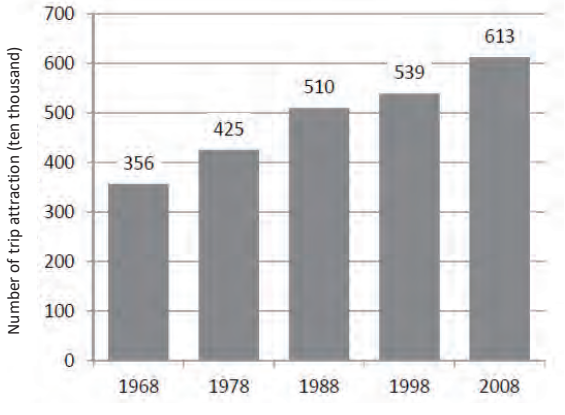
- Person-trip survey in TMA has been conducted for 5 times
- Conducting every 5 years from 1968
- Since the 2nd survey, the sample rate maintains higher than 2%

| | | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|---|
| Year | | 1968 | 1978 | 1988 | 1998 | 2008 |
| Study area | | Tokyo, Kanagawa, Saitama, Chiba | Tokyo, Kanagawa, Saitama, Chiba, Southern part of Ibaraki | Tokyo, Kanagawa, Saitama, Chiba, Southern part of Ibaraki | Tokyo, Kanagawa, Saitama, Chiba, Southern part of Ibaraki | Tokyo, Kanagawa, Saitama, Chiba, Southern part of Ibaraki |
| TMA population | | 21,310,000 | 28,770,000 | 32,490,000 | 34,470,000 | 34,620,000 |
| Method | Distribution | interview | interview | Interview | Interview | post |
| | Collection | interview | Interview | interview | Interview | Post, website |
| Effective sample(est.) | | 315,000 | 588,000 | 668,000 | 883,000 | 735,000 |
| Effective sample rate | | 1.5% | 2.0% | 2.5% | 2.6% | 2.1% |

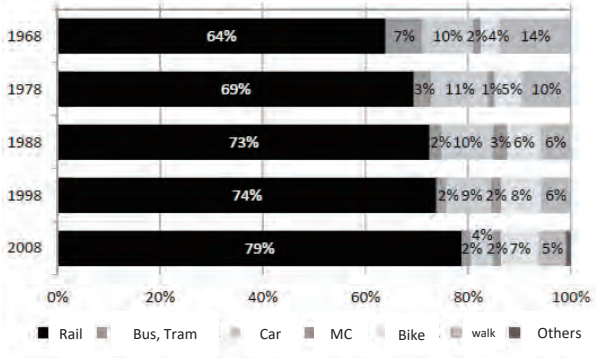
Source：Tokyo Metropolitan Area: Change for 50 years and Future Vision
Change and Future of Metropolis according to the Data
(Yuichi MOHRI and Jun MORIO, in Japanese)



# III-3 PT Survey (4): Change from the past 50 years




Growth of trip attraction to Tokyo 23 ward area




Modal share of trip attraction to Tokyo 23 ward area

Source：Tokyo Metropolitan Area: Change for 50 years and Future Vision
Change and Future of Metropolis according to the Data
(Yuichi MOHRI and Jun MORIO, in Japanese)

# Reference: Tokyo and 50 Years of evolution

Tokyo and 50 Years of evolution

- Production increase by 6.2 times
- Railway network increase by 1.7 times

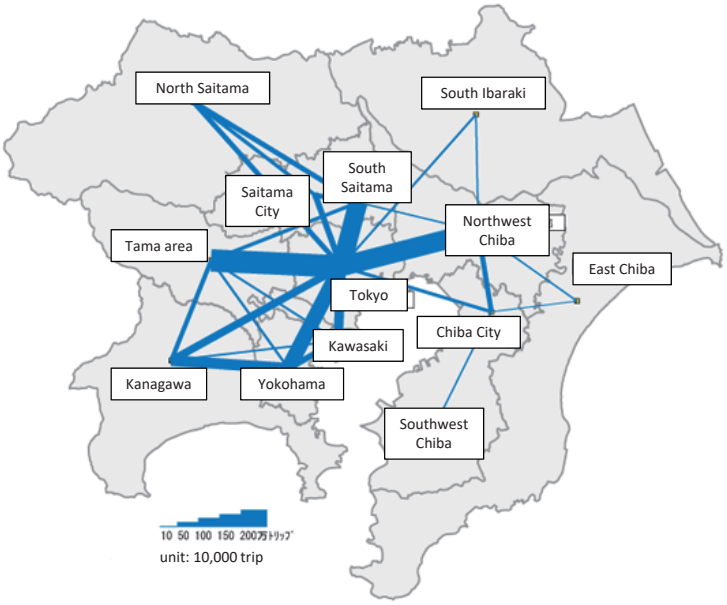
| TMA stats | 50+ years before | | Recent stat | | Times increase |
|---|---|---|---|---|---|
| Nighttime Population (TMA) | 1960 | 17,864,000 (19.8% of national population) | 2010 | 35,619,000 (27.8% of national population) | 1.99 times |
| GRP (real) (TMA) | 1964 | 28.92 | 2011 | 178.80 | 6.18 times |
| Railway network length (TMA) | 1956 | 1,566 km | 2016 | 2,705 km | 1.73 times |
| Number of railway station (TMA) | 1956 | 807 station | 2016 | 1,510 station | 1.87 times |
| Motorway length (nationwide) | 1960 | 0 km | 2011 | 7,920 km | - |
| Highway length (nationwide) | 1960 | 972,688 km | 2011 | 1,204,744 km | 1.24 times |
| Sewage coverage (TMA) | 1964 | 18.9% | 2012 | 94.2% | - |
| Electric consumption (nationwide) | 1964 | 157,208GW/h | 2010 | 1,031,799GW/h | 6.56 times |

Source：Tokyo Metropolitan Area: Change for 50 years and Future Vision - Change and Future of Metropolis according to the Data (Yuichi MOHRI and Jun MORIO, in Japanese)



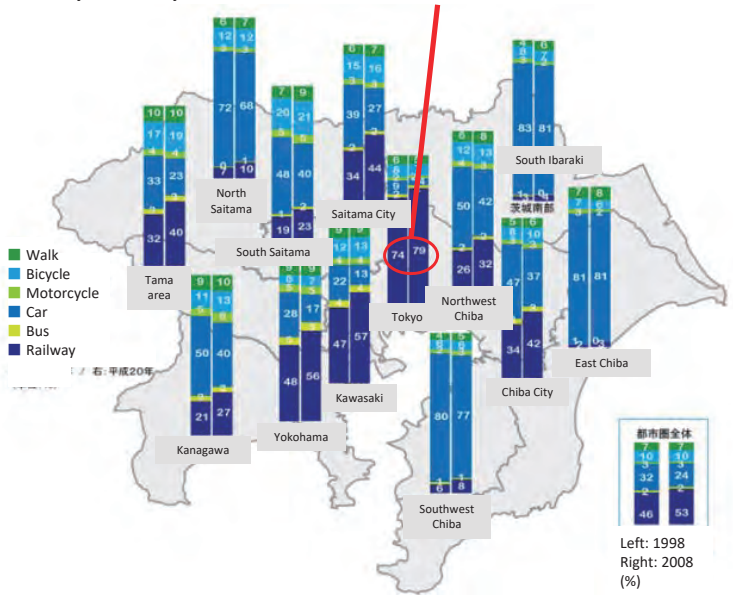
# III-3 PT Survey (5): Travel Pattern in TMA

- The highest share is trips **from/to Tokyo**.
- Most of trips originate from Tama area, south part of Saitama Prefecture, Yokohama City, Kawasaki City, north-west part of Chiba.



# III-3 PT Survey (6): Modal Share

- Most of the commuters to Tokyo 23 wards area and other designate city area use railways. Especially in Tokyo 23 wards area, **80 % of commuters** use railways.






# III-4 National Development Plan and Travel Demand Forecasting

Better airport access is needed to increase international competitiveness

Build the model to predict number of passenger to airport
- International flight
- Domestic flight

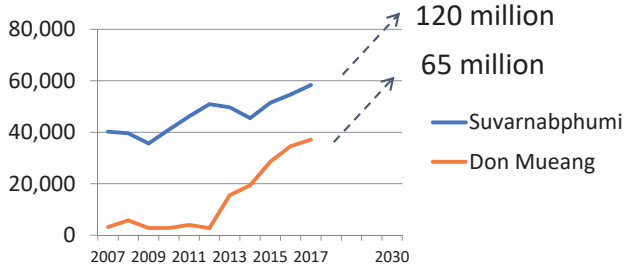
**In Japan, "The Urban Renaissance Headquarters" was established in April 2001 in order to promote the urban renaissance projects and to increase international competitiveness**

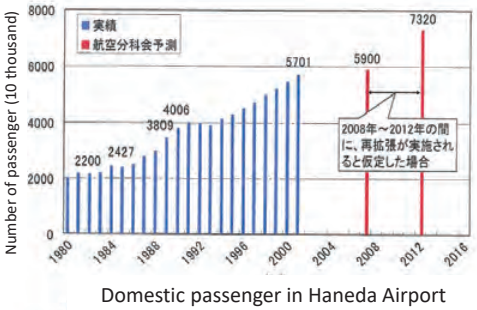
**Examples of urban renaissance projects**

**1.Increase the function of airport**
- Completion of the new parallel runway in Narita Airport
- Introduction of the fourth runway in Haneda Airport

**2.Increase the efficiency of the airport access**
- Increase the connectivity between two airports and CBD
- New road and rail access to Narita Airport
- Utilization of Tokyo station as an access hub to both Airport
- Provide a direct access between Yokohama area to Haneda Airport

**Annual Passenger of Airport (excluding transit )**



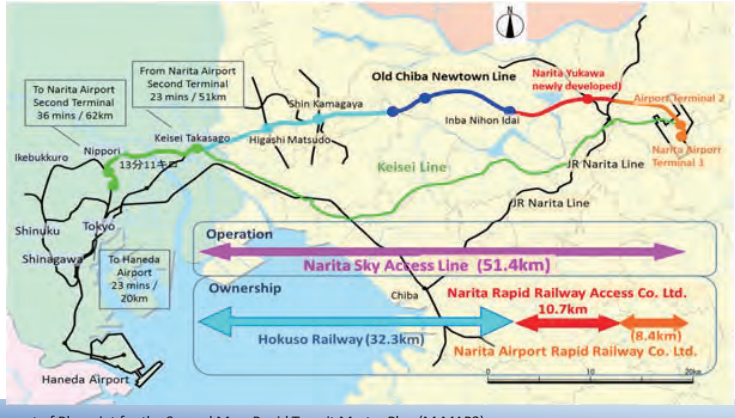

Domestic passenger in Haneda Airport

# III-4 National Development Plan and Travel Demand Forecasting

## The importance of railway demand forecasting in airport access projects

Utilization of urban transport model & airport access model

1. These models were developed in the Transport Policy Plan No.1 for a priority selection process (which line will be invested first)
2. With the consideration of vertical separation investment
   - Cost-effectiveness analysis for subsidy estimation
   - Service profitability analysis
   - To decide the share of investment






# III-4 National Development Plan and Travel Demand Forecasting

## Data collection for the model construction

○ The comprehensive study on TMA airport access volume (MLIT, 2004)

Problem recognition

- Mode of transportation could be different between a trip to airport (mostly, rail) and a trip from airport (higher share in bus)
- Awareness of road user in travel time reliability
- Separation of travel demand forecast between a trip to airport and a trip from airport

Haneda airport users

- Questionnaire (Personal information, access mode of transportation, access route, reason of using – not using, difficulties in transferring and other difficulties.
- Sample: Departure 5,312 samples (27%); Arrival 5,978 samples (30.2%)
- Limousine survey (Personal information, place of destination, origin, having a flight transfer or not)
- Parking lot survey(Personal information, airport purpose of visit, place of destination, origin)
- Limousine bus survey (Number of passenger, bus departure time)

Objective

- Analysis of users' characteristics by region
- Users' expected airport access time and reliability level
- Utilization of airport access by time period (i.e. condition of morning rush hour train)
- Model construction