タイ国運輸省鉄道局

タイ国
バンコク首都圏都市鉄道新マスタープラン（M-MAP2）策定能力向上プロジェクト

プロジェクト業務完了報告書

2024 年 8 月

独立行政法人
国際協力機構（JICA）

株式会社アルメック
社会システム株式会社
株式会社オリエンタルコンサルタンツグローバル
東京地下鉄株式会社

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M-MAP2 in Photos

	
第 1 回 JCC	第 1 回 JCC
	
第 2 回 M-MAP2 プラットフォーム (オンライン参加者)	第 4 回 M-MAP2 プラットフォーム
	
第 1 回　需要予測 WG	第 3 回　需要予測 WG (オンライン参加者)
	
第 3 回 Public Hearing	第 1 回 Knowledge Transfer

	
交通調査の視察	DRT との内部打ち合わせ
	
イェローラインの現地視察	鉄道事業スキームに関する協議
	
第 1 回本邦研修 (高輪ゲートウェイ駅)	第 1 回本邦研修 (虎ノ門駅)
	
第 2 回本邦研修 (東京メトロ研修センター)	第 2 回本邦研修 (評価会)

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2: Final PDM and PO
3: M-MAP2 Final Report, Summary and Continued Discussion on Demand Forecast
4: Railway Passenger and the COVID-19 Pandemic in Bangkok
5: Introduction of Transport Demand Forecast
6: Demand Forecast Modeling in the Tokyo Metropolitan Region
7: Directions and Suggestions for Developing of Mass Transit Network
8: Scenario Setting in Railway Development MP in Tokyo Metropolitan Region
9: Railway Fare System in Japan
10: Express Operation and Through Services
11: Business Segment Diversification for Financially Robust Mass Rapid Transit
12: Proposed Multi-purpose Development in Bangkok Metropolitan Region
13: Developing a Business Schemes for Privately-operated Rail Services
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略語表

ABM	アクティビティー・ベース・モデル（Activity-Based Model）
AGT	自動案内軌条式旅客輸送システム、新交通システム（Automated Guideway Transit）
ARL	エアポート・レール・リンク（Airport Rail Link）
BEM	バンコク高速道路メトロ（MRTの運行主体） (Bangkok Expressway and Metro Public Company Limited)
BMA	バンコク都庁 (Bangkok Metropolitan Administration)
BMR	バンコク都市圏（Bangkok Metropolitan Region）
BOT	建設-運営-譲渡 (Build Operate Transfer)
BTO	建設-譲渡-運営 (Build Transfer Operate)
BRT	バス高速輸送システム (Bus Rapid Transit)
BTSC	バンコク大衆輸送システム社（BTSの運行主体） (Bangkok Mass Transit System Public Company Limited)
BTDS	OTPが2022年に実施したバンコク都市圏交通実態調査、及び総合交通需要予測プロジェクト （Bangkok Travel Demand Survey）
COVID-19	新型コロナウイルス感染症 (Coronavirus Disease2019)
C/P,	相手国実施機関 (Counterpart)
CTPP No. 18	Council of Transport Policy Plan No. 18 (2000 Tokyo Metropolitan Area Urban Railway Masterplan)
CTPP No. 198	Council of Transport Policy Plan No. 198 (2016 Tokyo Metropolitan Area Urban Railway Masterplan)
DIW	工業事業局（Department of Industrial Works）
DLT	陸上運輸局 (Department of Land Transport)
DPT	公共事業都市農村計画局 (Department of Public Works and Town & Country Planning)
DRT	鉄道局 (Department of Rail Transport)
e-BUM	TDS、BTDSで用いたバンコク都市圏総合交通需要予測モデル （extended Bangkok Urban Model）
EMV	クレジットカードやデビットカードに埋め込まれたEMV決算基準 （Europay, Mastercard, and Visa）
GIS	地理情報システム (Geographical Information System)
GRDP	地域内総生産 (Gross Regional Domestic Product)
HIS	家庭訪問調査 (Household Interview Survey)
JCC	合同調整委員会 (Joint Coordinating Committee)
JET	JICA専門家チーム (JICA Expert Team)
JICA	独立行政法人国際協力機構（Japan International Cooperation Agency）
JV	共同企業体 (Joint Venture)
LOS	サービス水準（Level of Service）
LRT	軽量高速輸送機関 (Light Rail Transit)
MaaS	モビリティ・アズ・ア・サービス (Mobility as a Service)
M-MAP	バンコク首都圏都市鉄道マスタープラン（2010年策定バンコク都市鉄道MP） (Mass Rapid Transit Master Plan in Bangkok Metropolitan Region)
M-MAP2	バンコク首都圏都市鉄道新マスタープラン
M-MAP2 Blueprint	バンコク首都圏都市鉄道マスタープラン改定（M-MAP2）に係る情報収集・確認調査 （Data Collection Survey on The Development of Blueprint for The Second Mass Rapid Transit Master Plan (M-MAP2)）
MOF	財務省 (Ministry of Finance)
MOI	内務省 (Ministry of Interior)
MOT	運輸省 (Ministry of Transport)
MP	マスタープラン (Master Plan)

MRTA	タイ高速度交通公社 (Mass Rapid Transit Authority of Thailand)
NESDC	国家経済社会開発庁（National Economic and Social Development Council）
NSO	統計局（National Statistics Office）
OD	起終点 (Origin-Destination)
OTP	交通政策・計画局 (The Office of Transport and Traffic, Policy and Planning)
PDM	プロジェクトデザインマトリックス (Project Design Matrix)
PDMO	公的債務管理局 (Public Debt Management Office)
PO	活動計画表 (Plan of Operation)
PPHPD	方向別時間当たり旅客数（単位：人）（Passenger per Hour per Direction）
PPP	官民連携 (Public-Private Partnership)
PT	パーソントリップ調査（Person Trip Survey）
R/D, RD	討議議事録 (Record of Discussion)
RP	顕示選好（Revealed Preference）
SEPO	国営企業政策局 (State Enterprise Policy Office)
SP	選好意識（Stated Preference）
SRT	タイ国有鉄道 (State Railway of Thailand)
SRTET	タイ国有鉄道電鉄 （ARLの運営主体）(SRT Electrified Train Company Limited)
TAZ	交通分析ゾーン（Traffic Analysis Zone）
TDM	交通需要管理 (Transportation Demand Management)
TDS	OTPが2017年に実施したバンコク都市圏交通実態調査、及び総合交通需要予測プロジェクト（Travel Demand Survey）
TICA	タイ国際協力機構 (Thailand International Cooperation Agency)
VOT	時間価値（Value of Time）
WG	ワーキンググループ (Working Group)

1. プロジェクトの概要

1.1 プロジェクトの背景

バンコク首都圏の都市鉄道マスタープランは、1990 年代以降、数次に渡り見直されてきた。しかし、政権交代、事業実施段階での計画見直し、入札方法変更等により、計画に沿った整備は十分に進展しなかった。かかる状況を踏まえ、2010 年にタイ政府によりバンコク首都圏鉄道マスタープラン（Mass Rapid Transit Master Plan in Bangkok Metropolitan Region。以下「M-MAP」）が策定され、現在実施・計画されているバンコク首都圏の各種都市鉄道事業の基礎となっている。

近年、M-MAP に基づく主要路線の整備には一定の目途がついたと考えられる一方で、タイ政府は、M-MAP には需要予測の精度、駅・ルートや他交通モードとの連結性、都市鉄道と都市整備計画の統合促進等の課題があると考えており、これら課題への対応策を検討しつつ、新規路線計画を含む将来を見据えた新たなマスタープラン（以下「M-MAP2」）を策定する計画を持っている。

この状況の下、JICA はタイ運輸省の協力要請を受けて、2017 年 9 月から、M-MAP2 に係る「骨太の方針（以下、Blueprint）」の策定、及び現行の需要予測モデル改訂に向けた課題抽出等を行うため、情報収集・確認調査（以下「基礎調査」）を実施した。その結果、2019 年 1 月に策定した M-MAP2 の Blueprint は the Commission for the Management of Land Traffic により承認され、今後の計画策定はタイ政府が責任を持ち主体的に実施していくことが確認された。また、2019 年 4 月には、政策立案から監督まで鉄道行政全般を所掌する新部局として、タイ運輸省に鉄道局（Department of Rail Transport、以下 DRT）が設立され、今後の M-MAP2 策定も DRT が実施機関として取り組むことが確認された。

DRT は、基礎調査で課題を整理した鉄道需要予測モデルの作成と M-MAP2 詳細計画の策定に取り組むが、モデル分析や計画策定に係る経験が未だ不足している状況を踏まえると、質の高い計画とするためには、DRT の鉄道マスタープラン策定プロセスを通じた支援による能力強化、DRT が今後主催を担う各種ワーキンググループ（以下、WG）への参加等、日本側からの継続した支援が求められていた。

また、鉄道需要予測モデル作成に向けた交通調査等の実施にあたっては、ポストコロナ社会における公共交通の在り方や行動変容等についても合わせて検討する必要があり、日本側有識者の知見やアドバイスの提供も強く求められていた。

1.2 プロジェクトの全体概要

本プロジェクトの目的は、2021 年 3 月 1 日に署名された Record of Discussion (RD)に基づいた活動を実施することにより、以下に示す期待される成果を発現し、プロジェクト目標を達成することである。

- プロジェクト名：バンコク首都圏都市鉄道新マスタープラン(M-MAP2)策定能力向上プロジェクト

- 上位目標:バンコク首都圏における持続可能で総合的な交通ネットワークの整備が図られる。
- プロジェクト目標:タイ政府、DRT の将来の鉄道マスタープランの策定能力が向上する。
- 期待される成果 1:新たな鉄道需要予測モデルが作成される。
- 期待される成果 2:M-MAP2 詳細計画の策定が行われ、タイ政府による承認プロセスに諮られる。
- 期待される成果 3:M-MAP2 の具体的な実現に向けた取り組みが推進される。

本プロジェクトは 2 段階方式を採用しており、プロジェクト開始後の DRT との議論を踏まえ、2022 年 5 月の第1回 JCC において各成果の活動内容を下表のとおり更新している。

表 1.2.1 期待される成果及び活動の概要

期待される成果	活動の概要
【成果 1】新たな鉄道需要予測モデルが作成される。	1-1. 既存のマスタープランのレビューを行う。(タイ側) 1-2. M-MAP2「骨太の方針(Blueprint)」及び基礎調査で示された課題のレビューを行う。(タイ側) 1-3. 鉄道需要予測モデル改訂に向けた計画を立てる。(タイ側) 1-4. 1-3.に対する助言を行うとともに、コロナウイルスが公共交通に与えた影響の分析及びポストコロナ後の社会を踏まえた公共交通の在り方の検討を行う。(JICA) 1-5. 既存の交通調査結果のレビューや、OTP が別途実施する Household Interview Survey の結果を確認し、交通需要データを整理する。(タイ側) 1-6. 必要な交通調査の実施手法や調査票について助言を行う。(JICA) 1-7. 1-5.の結果を踏まえ、鉄道需要予測に必要な交通調査を実施する。(タイ側) 1-8. タイ側が取り纏めた交通需要データに対するレビューや助言を行う。(JICA) 1-9. 追加的に必要な交通調査を実施する。(JICA) 1-10. 現況と将来の社会経済フレームワークを設定する。(タイ側) 1-11. 1-10.に対する助言を行う。(JICA) 1-12. 需要予測の前提条件の見直しと現況 OD 表の再現を行う。(タイ側) 1-13. 1-8.に対する助言を行う。(JICA) 1-14. 最新需要予測手法のレビューを行い、新たな鉄道需要予測モデルを作成する。(タイ側) 1-15. タイ側が作成した鉄道需要予測モデルのレビュー及び助言を行う。(JICA)

【成果 2】M-MAP2 詳細計画の策定が行われ、タイ政府による承認プロセスに諮られる。	2-1. 都市開発、都市交通等の現状やトレンド分析と、主要課題の特定を行う。(タイ側) 2-2. 2-1.に対する助言を行う。(JICA) 2-3. 特定された課題の分析と改善案を検討する。(タイ側) 2-4. 2-3.に対する助言を行う。(JICA) 2-5. M-MAP2 Blueprint の主要政策手段について助言を行う。(JICA) 2-6. 鉄道整備政策手段を作成する(タイ側) 2-7. 2-6.に対する助言を行う。(JICA) 2-8. 活動 1 で作成された需要予測に基づき新たな路線計画を策定する。(タイ側) 2-9. 2-8.に対するレビュー及び助言を行う。(JICA) 2-10. 鉄道整備政策手段について、需要予測結果と一連の評価指標に基づき評価を行う。(タイ側) 2-11. 2-10.に対するレビュー及び助言を行う。(JICA) 2-12. 各路線につき運賃収入以外の収入最大化を図る財務手法についての検討も実施する。(JICA) 2-13. 各路線についての開発計画や政策を策定する。(タイ側) 2-14. 2-13.に対するレビュー及び助言を行う。(JICA) 2-15. M-MAP2 の承認プロセスに諮る。(タイ側)
【成果 3】M-MAP2 の具体的な実現に向けた取り組みが推進される。	3-1. M-MAP2 の策定に関してセミナー開催などの広報活動を行う。(タイ側、JICA) 3-2. 政策立案に向けた政府機関、鉄道事業者、有識者等の対話のための M-MAP2 プラットフォームを構築する。(タイ側、JICA) 3-3. 都市鉄道計画並びに M-MAP2 の実現に向けた取り組みについて議論する M-MAP2 プラットフォームを開催する。(タイ側、JICA)

注:下線は 2022 年 5 月の第1回 JCC で追加・修正された項目

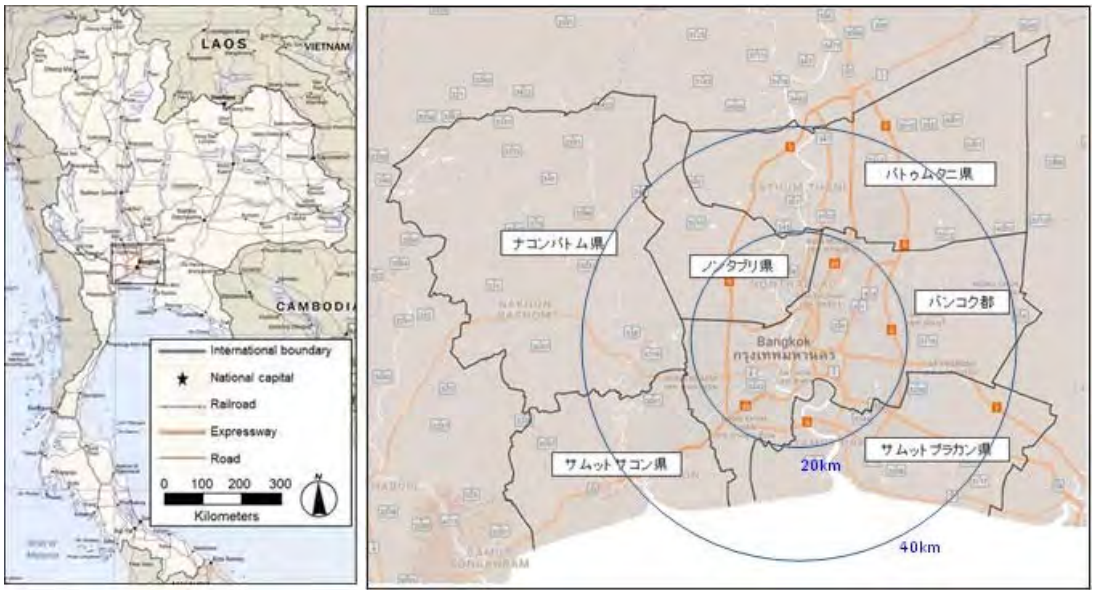
対象地域: バンコク首都圏(バンコク都と隣接 5 県(ナコンパトム、ノンタブリー、パトムタニ、サムットプラカン、サムットサコン)から成る首都圏域、都心から半径 40km 圏内を想定する)とする(図 1.2.1 参照)。

実施機関: タイ運輸省鉄道局(DRT)

関連機関 タイ運輸省交通政策・計画局(OTP)、タイ高速鉄道公社(MRTA)、タイ国鉄(SRT)

受益者: (1)直接受益者:DRT、(2)間接受益者:バンコク首都圏の住民(約 1,560 万人)

実施期間: 2021 年 10 月 17 日～2024 年 10 月 16 日(36 カ月間)



出典：JET により加工・作成

図 1.2.1 プロジェクト対象地域

1.3 プロジェクトの実施体制

プロジェクトの実施体制を図 1.3.1、プロジェクトメンバーを表 1.3.1、表 1.3.2、表 1.3.3 に示す。本プロジェクトでは、DRT 及びタイ側のコンサルタントと連携して事業を実施する。

本プロジェクト開始後、DRT の Deputy Director General (Project Manager)を議長とする鉄道需要予測 WG が立ち上がっている。

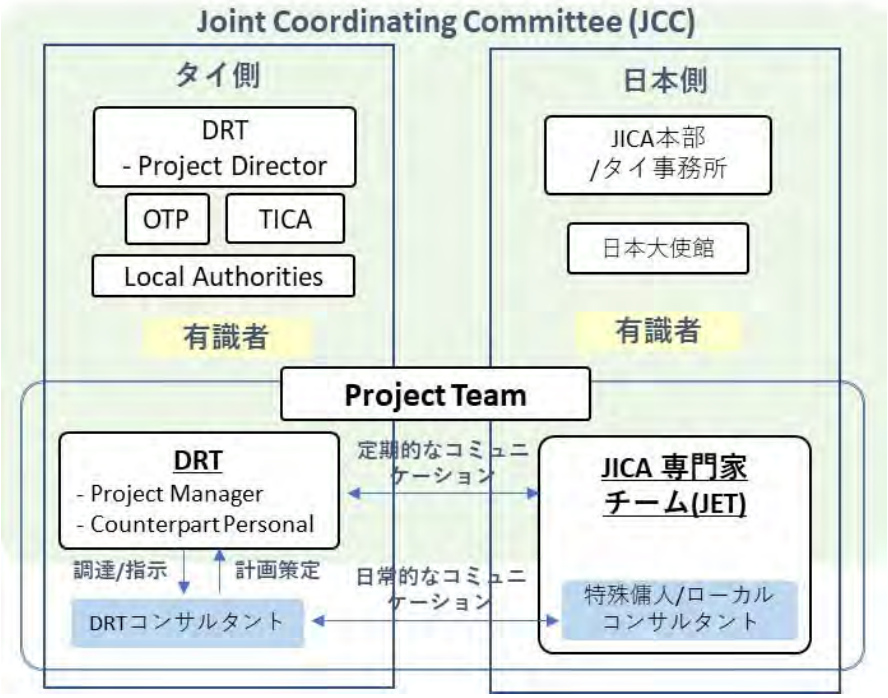


図 1.3.1 プロジェクト実施体制

表 1.3.1 JCC メンバー

役職	所属機関・組織
Project Director	Director General, DRT
Deputy Project Director	Deputy Director General, DRT
Project Manager	Director of Strategy and Planning Division, DRT
Counterpart Personnel	To be assigned from DRT
Committee Members from Thai Side	1) OTP, DPT, TICA 2) BMA (TTD, CPD) 3) Thai Academia (Dr. Suwat Waneesubut, Mr. Jumroon Tangpaisankit, Asst. Prof. Dr. Varameth Viciensan, Asst. Prof. Dr. Sittha Jensirisak, Dr. Sumet Ongkittikul) 4) SRT, MRTA, SRT-ET
Committee Members from Japanese Side	Representative of JICA Thai Office Japanese Experts

注：OTP: The Office of Transport and Traffic, Policy and Planning, DPT: Department of Public Works and Town & Country Planning, TICA: Thailand International Cooperation Agency, BMA: Bangkok Metropolitan Administration, TTD: Traffic and Transport Department, CPD: City Planning Department

表 1.3.2 JICA 専門家チーム（JET）メンバー

	氏名	所属	担当
1	増島（ますじま） 哲二（てつじ）	アルメック	業務主任者／都市交通計画1
2	小森（こもり） 賢（まさる）	社会システム	副業務主任者／都市交通計画2
3	金子（かねこ） 素子（もとこ）	アルメック	都市計画
4	巌（わたび） 眞裕（まさひろ）	東京地下鉄	鉄道事業運営
5	萩原（はぎわら） 崇之（たかゆき）	オリエンタルコンサル タンツグローバル	都市鉄道計画 1
6	村上（むらかみ） 太一（たいち）/ SRIMAHACHOTA（シリマハショタ） Teeranai（ティラナイ）	オリエンタルコンサル タンツグローバル	都市鉄道計画 2
7.	高木（たかき） 通雅（みちまさ）	アルメック	路面公共交通
8.	早崎（はやさき） 詩生（しお）	社会システム	交通需要予測評価
9.	加藤（かとう） 義彦（よしひこ）	アルメック	経済財務分析
10.	TANSAWAT（タンサワット） Tithiwach（ティティワッチ）	アルメック	都市交通計画補助／環境社会配慮／広報
11.	WETWITOO（ウェットウィトゥー） Jetpan（シャードパン）	社会システム	交通需要予測評価補助／研修計画

表 1.3.3 DRT のカウンターパートメンバー

部署	氏名（愛称）/役職	備考	2021 年 11 月のリスト	2023 年 8 月のリスト
A. Counterpart staff who **are fully involved in the discussion with JET** and DRT Consultant				
Strategy and Planning Division	Mr. Ruengdej Mangkorndejsakul *(A)* Director, Strategy and Planning Division	Project Manager	O	O
	1. Mr. Natthaporn Buaphut *(Noom)* Head of Strategy and Development Plan		O	O
	2. Mr. Pakhin Thananarong (Jui) Transport Technical Officer	Main coordinator (until 2023)	O	-
	3. Mr. Komkitti Angkatawiwat *(Bank)* Plan and Policy Analysis	Main coordinator (from 2023)	-	O

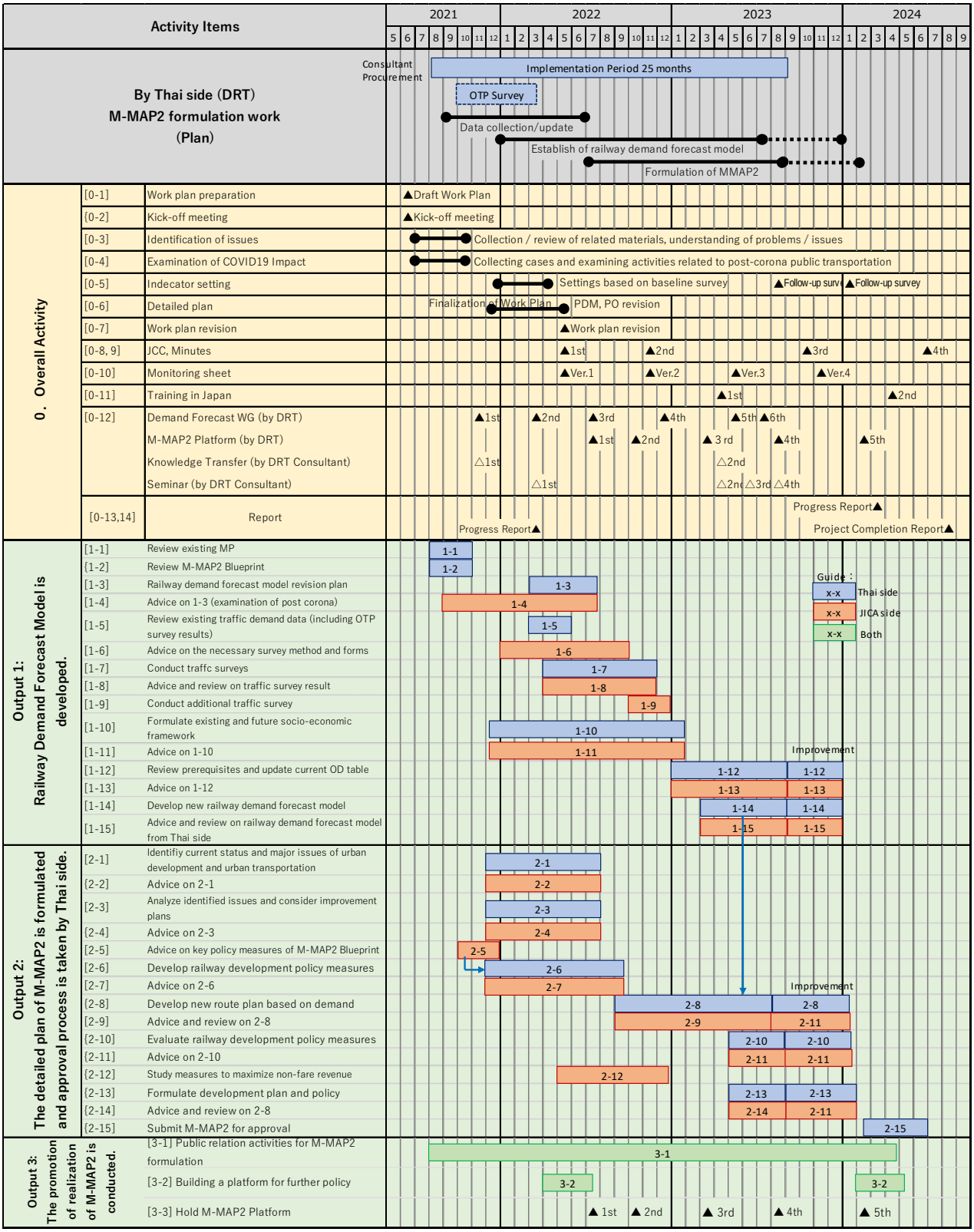
	4. Mr. Kittipid Onika *(Toon)* Plan and Policy Analysis		O	O
1. Strategy and Planning Division	1. Mr. Tossaporn Royvan *(Tod)* Head of Investing Plan and Budgeting		O	O
	2. Mr. Pana Supatitipong *(Nueng)* Head of International Cooperation		O	O
	3. Ms. Panita Chamchod *(Cake)* Head of Monitoring and Evaluation		-	O
	4. Ms. Banjawan Kunviroteluck *(Bird)* Transport Technical Officer		-	O
	5. Mr. Ratanon Karnjanapak *(View)* Transport Technical Officer		O	O
	6. Mr. Sorrawit Saisorn *(Nuk)* Transport Technical Officer		-	O
	7. Ms. Phitsuda Winyayen Transport Technical Officer		O	-
B. Counterpart staff **expected to improve understanding** on M-MAP2 and railway development policy through monthly meeting, Demand Forecast Working Group, and other important meeting/training. (All of the staff in the Strategy and Planning Division and some staff in other division)				
2. Rail Transport Regulation Division	1. Mr. Phusit Chairitthipong *(Tong)* Head of Services and Environment Group		O	O
	2. Ms. Duangchai Wongrak *(Duang)* Head of Rail Business Supervising Group		O	O
	3 .Mr. Wattanit Suwannarat *(Ne)* Chief of Rail Transport Business Regulation Group		O	O
	4. Mr. Kittisak Rumpirujipong *(Arm)* Mechanical Engineer		-	O
	5. Ms. Kamolrat Namueangrak *(Gambua)* Plan and Policy Analysis		O	O
	6. Mr. Narin Jaturapisanukul Civil Engineer		O	-
	7. Mr. Sarayut Sintoorahut Civil Engineer		O	-
3. Safety and Maintenance Standards Division	1. Mr. Suphalerk Soodyodprasert *(Art)* Head of Infrastructure standard		O	O
	2. Mr. Pannaphat Somwang *(Ball)* Electrical Engineer		O	O
	3. Mr. Pongsatorn Sirijanpen *(Gun)* Electrical Engineer		-	O
	4. Ms. Phanthira Thanasophon *(Ploy)* Civil Engineer		O	O
4. Legal Affairs Division	1. Mr. Pramote Suwankaew *(Chai)* Head of Law Development Group		O	O

1.4 プロジェクトの実施フロー

本プロジェクトの最新の全体フレームワークと概略工程を図 1.4.1 に示す。

プロジェクトの開始時点においては、DRT による M-MAP2 策定業務の期間は、18 か月であったが、交通調査や需要予測モデル構築において有識者の助言に対する対応に時間を要したため、7 か月を延長して 2023 年 9 月までとした。この時点で成果としての最終報告書が提出された。

一方、第 3 章（成果 1 の活動）及び第 4 章（成果 2 の活動）で示すとおり、需要予測モデルの更なる改善や分析等を行うため、2024 年 1 月まで活動を継続して実施して計画を更新した。



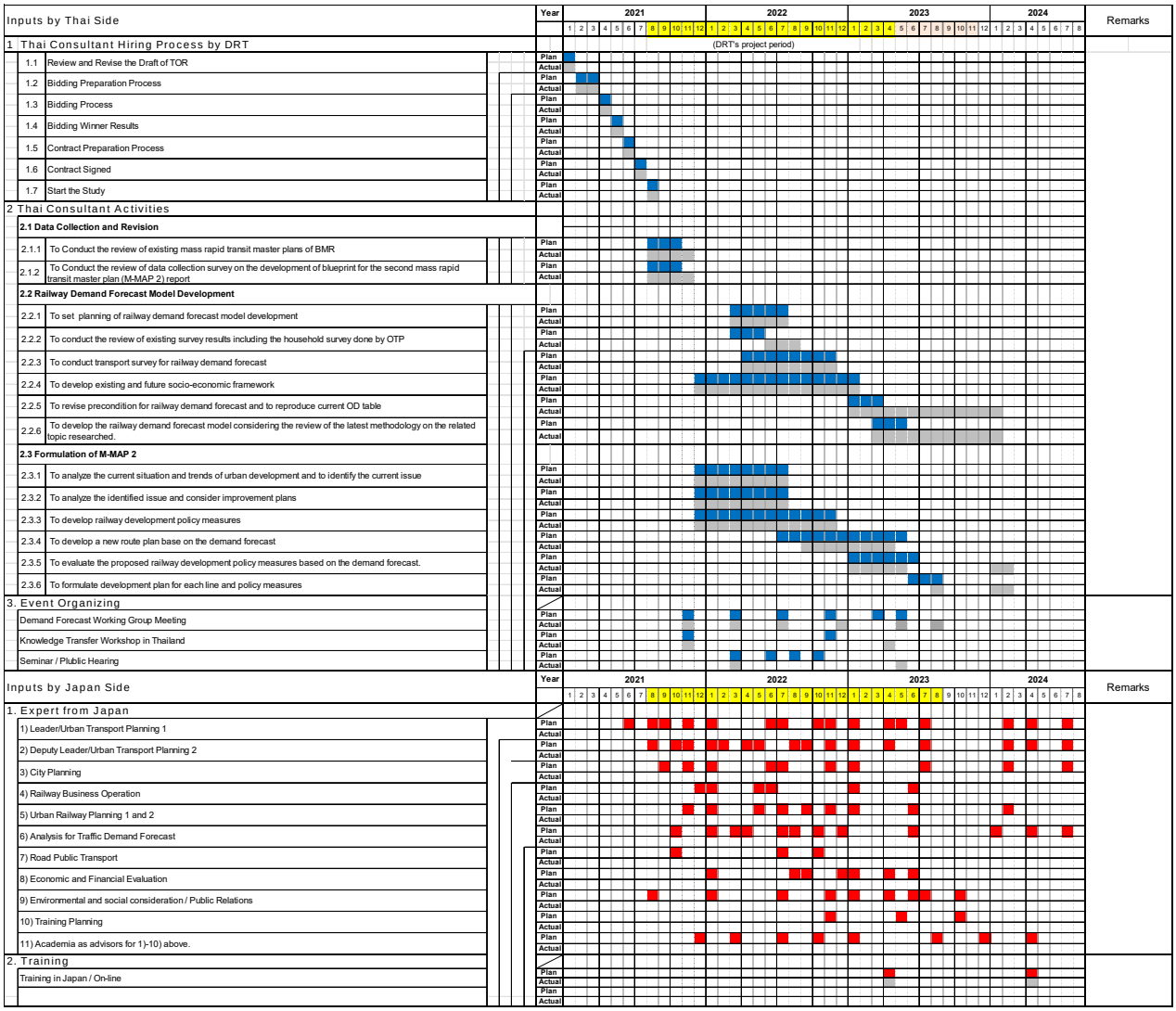
出典：JET 作成

図 1.4.1 プロジェクトの全体フレームワークと概略工程

2. プロジェクト実施内容

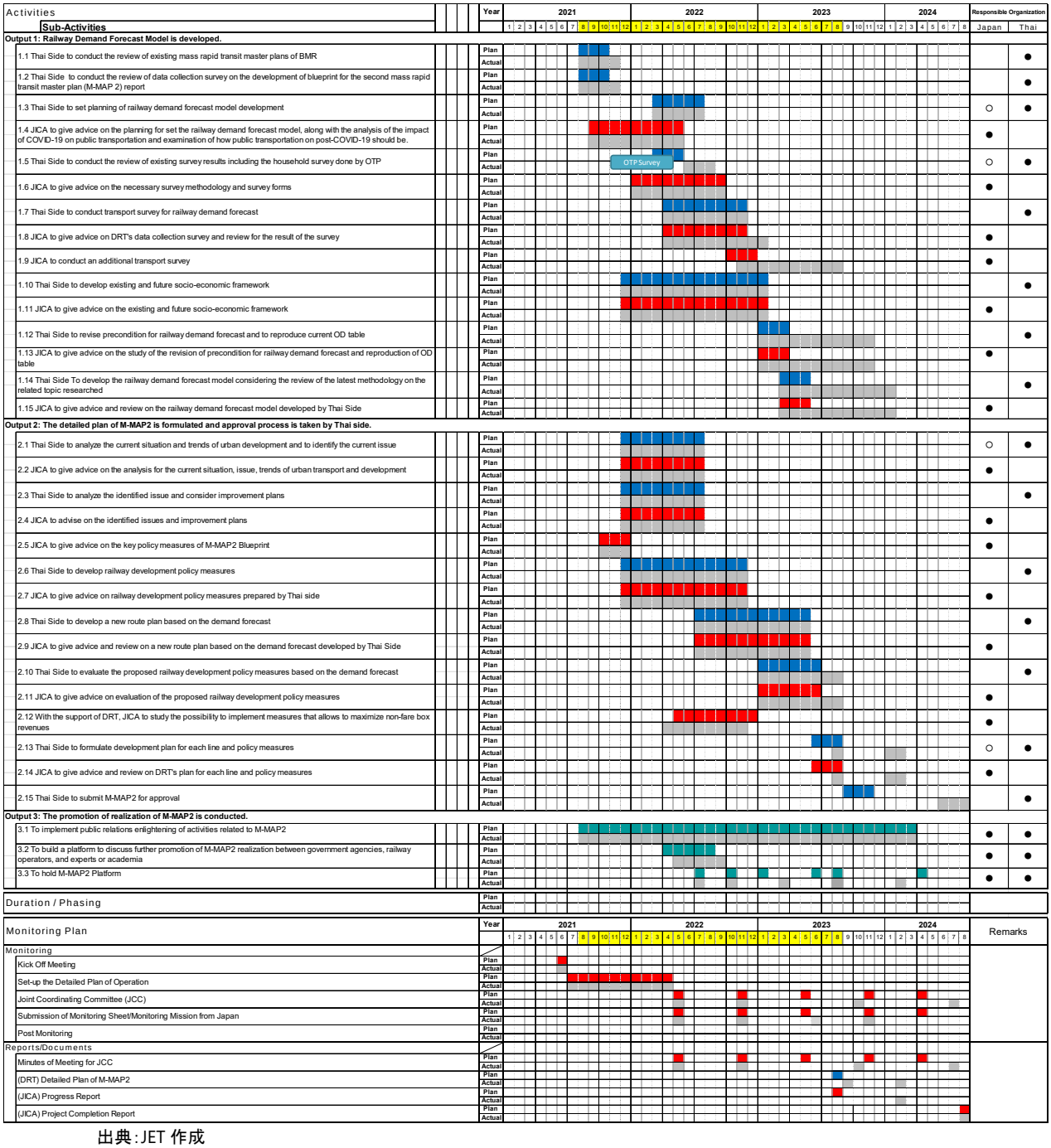
2.1 活動内容

本プロジェクトは、タイ側の活動として、DRT と DRT コンサルタントによる M-MAP2 の計画策定作業が実施され、日本側からは、その計画策定作業に対する技術的アドバイスを行うことが想定されていた。そのため、作業計画（PO: Plan of Operation）についても、タイ側のインプット（input by Thai side）として、1. コンサルタントの調達プロセスと、2. DRT コンサルタントによる作業（Thai Consultant Activities）、3.各種イベントの開催（Event Organizing）を明記することとした。これらタイ側のインプットと日本側のインプット（Input by Japan side）に基づいて、PDM で記載された各種活動を実施するものとして、PO を作成した。



出典：JET 作成

図 2.1.1 作業計画と実績（タイ側インプットと日本側インプット）



出典：JET 作成

図 2.1.2 作業計画と実績（Activities と Monitoring Plan）

2.2 プロジェクトの投入

2.2.1 日本側の投入

専門家チームの要員計画・実績表を下表に示す。1.3 に記したように、合計 9 分野 11 人の専門家が日本側より配置された。分野は、都市交通計画、都市計画、鉄道事業運営、都市鉄道計画、路面公共交通、交通需要予測評価、経済財務分析、都市交通計画補助/環境社会配慮広報、交通需要予測評価補助/研修計画である。

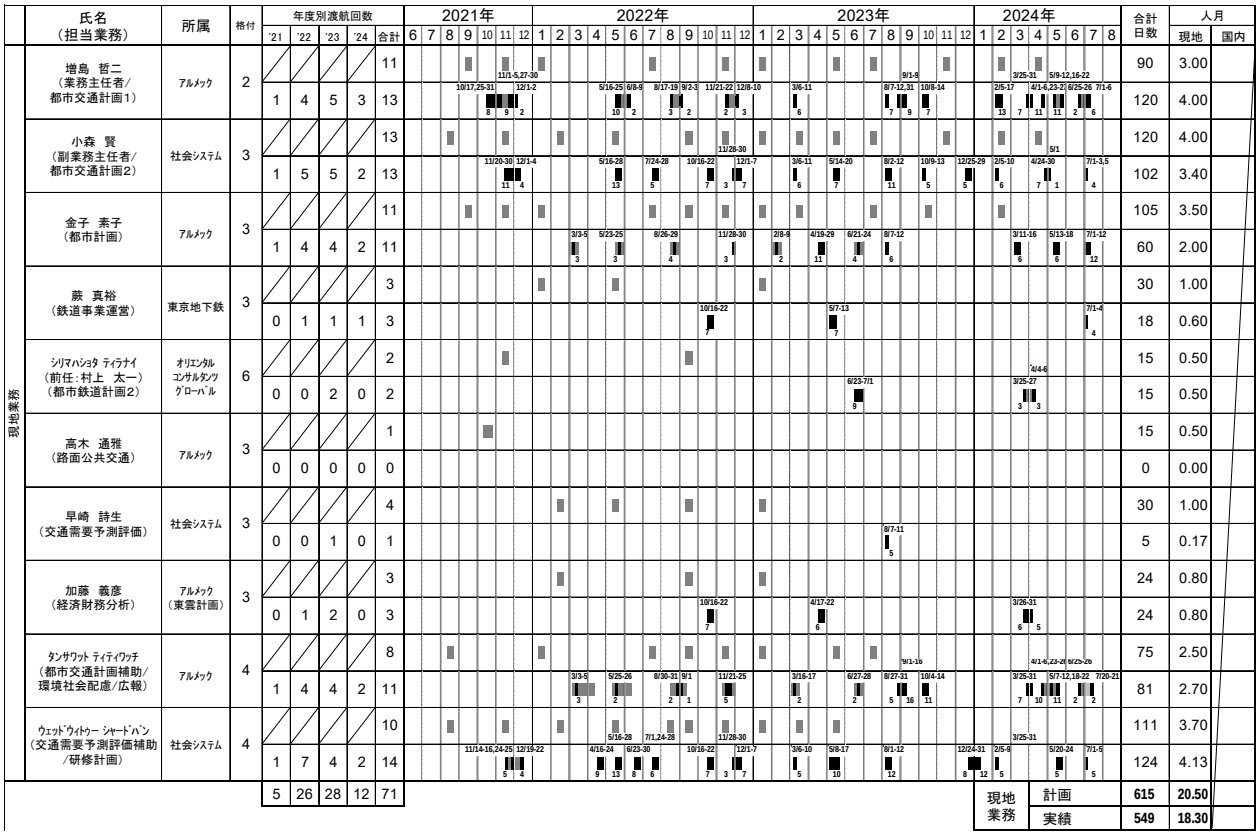


図 2.2.1 人月表（現地作業）

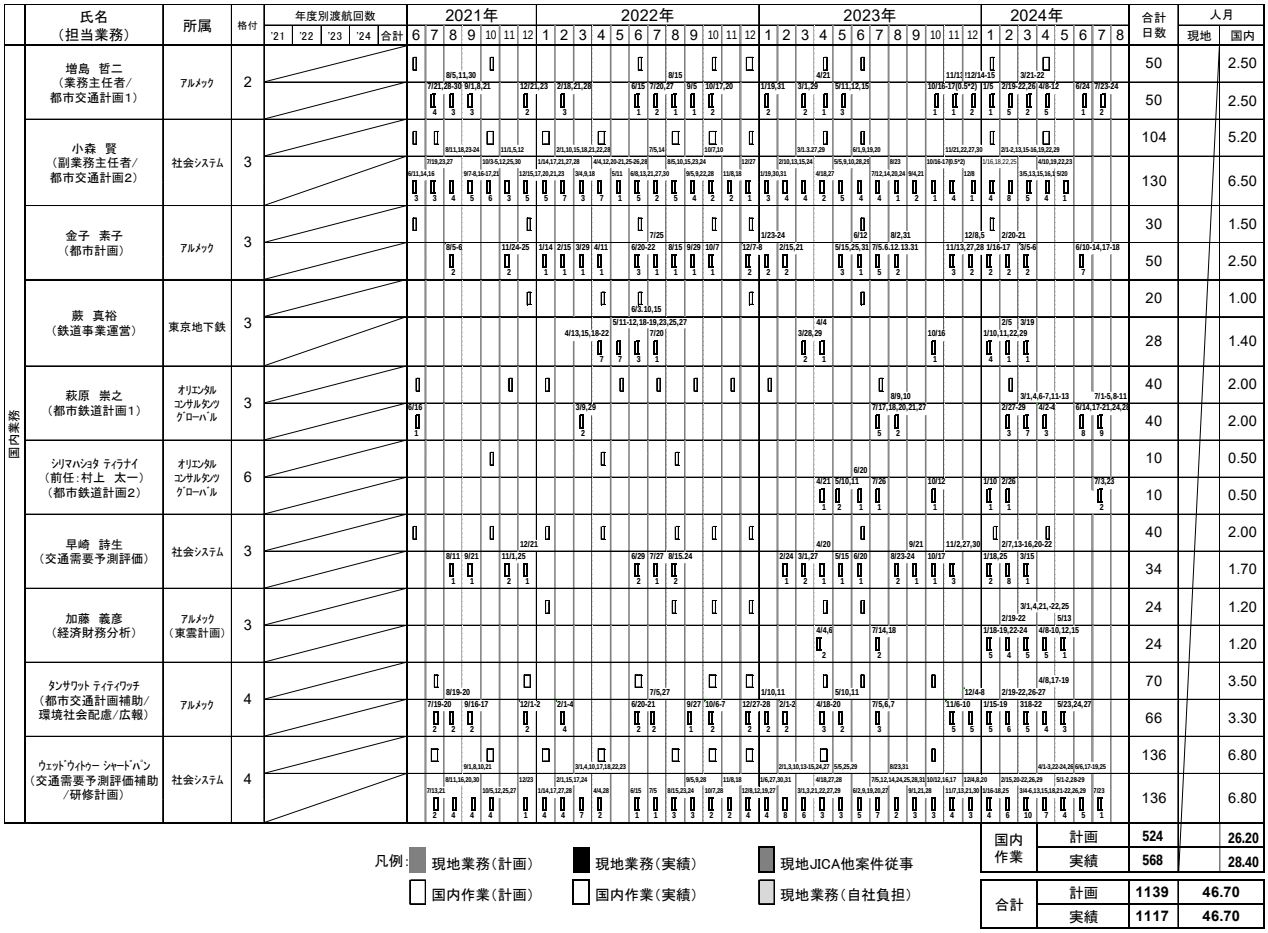


図 2.2.2 人月表(国内作業)

2.2.2 タイ側の投入

1) カウンターパートの任命

プロジェクト開始後、タイ側のカウンターパートが、DRT から表 1.3.3 に示す通り任命された。

主要カウンターパート: 日常的な JET との議論を行い、プロジェクトに主体的に取り組むメンバーとして、Strategy and Planning Division の Director を筆頭に、4 名のカウンターパートが任命された。このうち、1 名は、退職に伴い交代したが、その他の 3 名は、プロジェクト開始当時からプロジェクトに携わっている。

その他のカウンターパート: M-MAP2 の計画策定と鉄道政策の議論を理解し、後述する需要予測 WG や月例協議等への参加をするカウンターパートメンバーとして、Strategy and Planning Division、Rail Transport Regulation Division、Safety and Maintenance Standards Division、Legal Affairs Division から、合計 16 名が任命された。

2) DRTコンサルタントの調達

前述のように、本プロジェクトは、M-MAP2 の計画策定はタイ側が主体となって行い、その計画策定に必要な技術的アドバイスを日本側が行うことが想定されていた。DRT は、計画策定業務をコンサルタントに発注することとし、2021 年 8 月にコンサルタントとの契約を締結した。当初は、2023 年 1 月までに契約を完了する予定であったが、コロナの影響により、調査の実施に遅れが生じたため、2023 年 9 月まで契約期間を延長することとなった。

3) オフィススペースの提供

プロジェクト開始と同時に、DRT オフィス内に、プロジェクトのための執務スペースが確保され、wifi 等、執務に必要な環境が提供された。

2.3 プロジェクト全体にかかる活動

本プロジェクトにおけるタイ側との協議体制について、DRT や JICA と協議の上、以下のように整理した。このうち、JCC と需要予測 WG と月例協議の開催状況は、次項以下である。M-MAP2 プラットフォームの詳細は、成果 3 の一部として、5 章に記す。

表 2.3.1 プロジェクトにおける協議体制

会議/イベント	目的・役割	タイ側参加者	日本側参加者		
			JICA 本部 / タイ事務所	JET	有識者
Joint Coordinating Committee (JCC)	プロジェクト進捗状況と成果の確認、PDM/PO 変更の承認	DRT, OTP, DPT, DIC, BMA (TTD, CPD), SRT, MRTA, SRTET, academic experts	参加	参加	議題に応じて参加
M-MAP2 Platform [1)]	鉄道整備課題、計画、政策全般に関する協議	DRT, NESDC, MOT-OPS, OTP, PDMO, SEPO, DPT, DLT, MRTA, SRT, BMA-TTD/CPD/PWD, PAOs, BEM, BTSC, SRTET, BMTA, AERA1, RTDA, Academia	参加	参加	アドバイザーとして参加
Demand Forecast Working Group	需要予測に関する技術的事項の確認 需要予測作業の進捗の確認	DRT, OTP, DRT コンサルタント、有識者	参加	参加	アドバイザーとして参加
Monthly Meeting	定期的な DRT と JET の協議	DRT (DRT Consultant)	オブザーバー参加	参加	必要に応じて参加
Learning Session	特定計画課題に関する講義と討議	DRT (DRT Consultant)	オブザーバー参加	講師	必要に応じて参加
Public Hearing	Public hearing (DRT コンサルタントのタスクとして実施)	DRT DRT Consultant	オブザーバー参加	オブザーバー参加	-
Knowledge Transfer Seminar	Knowledge transfer for DRT (DRT コンサルタントのタスクとして実施)	DRT DRT Consultant	オブザーバー参加	オブザーバー参加	-

1) 第 1 回 JCC 会議で合意され、DRT によって設立（詳細は 6 章に記載）

2.3.1 JCC の開催

本プロジェクトでは JCC を年 2 回開催することを想定した。JCC を活用し、プロジェクトの進捗状況と課題、JCC 開催時点までに得られた成果について関係機関に広く共有し、必要に応じて課題への対応策を検討する。JCC での検討の結果、PDM 及び PO の改定が必要とされた場合は改定を行う。プロジェクト基本計画に関する事項を変更する場合は、変更 R/D（案）を作成し、適宜 JICA と確認して進める。プロジェクトの進捗や成果、懸念事項やその要因・対策、外部要因の分析調整及び関係者への共有を目的に 6 カ月毎にモニタリングシートを作成・更新する。

JCC の開催リストを以下に記す。

表 2.3.2 JCC 開催記録

	Date	Major Discussion	Number of Participants	
			Thai side	Japan side
1st JCC	26 May 2022	Matters Arising ・ Notification on Appointment of the Counterpart Members ・ Overall Project Framework ・ Progress of M-MAP2 Planning and Demand Forecasting Matters to be Confirmed ・ Overall Project Framework ・ Implementation Organizational Structure of MMAP2 TA Project ・ Means of Discussion/Coordination - Establishment of MMAP2 Platform	DRT 13 Other Organizations of JCC 13 Academia 4 Consultant -	JICA 3 JET 9 Academia 1
2nd JCC	29 November 2022	Matters Arising ・ Activities Update of M-MAP2 TA Project ・ Progress of the M-MAP2 Formulation - Progress of demand forecasting and traffic surveys - Progress of railway development policy and route planning Matters to be Confirmed ・ Updated Project Schedule ・ Framework of demand forecasting and traffic surveys ・ Direction of railway development policy and route planning	DRT 14 Other Organizations of JCC 17 Academia 5 Consultant 5	JICA 5 JET 7 Academia -
3rd JCC	12 October 2023	・ Activities Update of M-MAP2 Technical Cooperation Project ・ Progress of the M-MAP2 Formulation ・ Issues and updating steps of demand forecasting models ・ Proposed railway development policy and route planning ・ Updated Project Schedule ・ Summary of Discussions and Next Steps	DRT 10 Other Organizations of JCC 18 Academia 5 Consultant 5	JICA 4 JET 7 Academia – Other Participants 1
4th JCC	3 July 2024	・ Outline of M-MAP2 ・ Approval process of M-MAP2 ・ Activity summary of the JICA's Technical cooperation project ・ Conclusion and recommendations ・ Expectation from JICA	DRT 10 Other Organizations of JCC 12 Academia 1 Consultant 6	JICA 6 JET 10 Academia – Other Participants 1

2.3.2 需要予測 WG の構築

本プロジェクト開始後、M-MAP2 策定に向けた需要予測 WG の立ち上げについて DRT と協議を行った。特に、Blueprint 作成時から重要視してきた、アカデミアの参加について、その選定に

ついてアドバイスを行った。鉄道需要予測 WG は、DRT の Deputy Director General を Chairman とし、以下のメンバーから構成されている。

- Deputy-Director of Department of Rail Transport Chairman of WG
- Representative of Office of Transport and Traffic Policy and Planning
- Representative of The State Railway of Thailand
- Representative of Mass Rapid Transit Authority of Thailand
- Representative of S.R.T. Electrified Train Co., Ltd
- Dr. Suwat Waneesubut
- Mr. Jumroon Tangpaisankit
- Asst. Prof. Dr. Varameth Viciensan
- Asst. Prof. Dr. Sittha Jensirisak
- Dr. Sumet Ongkittikul
- Asst. Prof. Dr. Sutthipong Meeyai
- Director of the Strategy and Planning Division, DRT
- Head of Strategy and Development Plan Group, Strategy and Planning Division, DRT
- Staff of Strategy and Development Plan Group, Strategy and Planning Division, DRT

日本側有識者については、M-MAP2 Blueprint 作成時に携わって頂いた方を中心に、以下の 5 名の方に携わって頂くこととした。

- 森地　茂　　政策研究大学院大学　客員教授、名誉教授
- 内山　久雄　　東京理科大学　名誉教授
- 福田　敦　　日本大学　教授
- 伊東　誠　　一般財団法人運輸総合研究所　特任研究員
- 日比野　直彦　　政策研究大学院大学　教授

プロジェクト開始以降、DRT 及び DRT コンサルタントが主催した計 6 回の需要予測 WG を開催した（詳細は成果 1 に記載）。全てのイベントは、オンサイトとオンラインの併用で開催し、JET は現地、あるいはオンライン、日本側有識者はオンラインでの参加となった。

2.3.3 Learning Session の開催

Learning session は、特定鉄道整備政策に関するテーマごとに、開催した。

表 2.3.3 Learning Session 開催記録

	Date	Major Discussion	Participants	
			Thai side	Japan side
First Learning Session	20 October 2022	• Japanese Railway Fares: Summary • Urban Railway Investment Scheme: Bangkok • Open Discussion • Railway Financing Scheme and Investment for Network Optimization	DRT 4 Relevant Organization 41	JET 7
Second Learning Session	19 April 2023	• Supplemental Explanations on Japan's Through Operations	DRT 4	JET 4
Third Learning Session	21 April 2023	• Business Scheme Proposal for a New Line Development in Bangkok Metropolitan Region • Q&A	DRT 10	JET 8
Fourth Learning Session	12 May 2023	• Railway fare system in Japan • Q&A	DRT 6	JET 7

2.3.4 DRT との月例協議の実施

本プロジェクト開始後、主要カウンターパートである DRT の Strategy and Planning Division と、JET による月例会議を開催することを合意し、2021 年 9 月から会議を開催している。月例協議では、プロジェクト全体の進捗確認、DRT コンサルタントの作業確認、課題整理と対策案の協議を行うこととしている。これまで実施したプロジェクトチーム会議の概要を表 2.3.4 に示す。

表 2.3.4 プロジェクトチーム会議一覧

回	年月日	議題
第 1 回	2021 年 9 月 8 日	• メンバー紹介（DRT、DRT コンサルタント、JET） • インセプションレポート（DRT コンサルタント）
第 2 回	2021 年 10 月 12 日	• キックオフ会合以降の進捗確認 • 鉄道需要予測モデルと交通調査（DRT コンサルタント） • モデル構造や交通調査の確認
第 3 回	2021 年 11 月 12 日	• Blueprint の再確認 • 東京圏における需要予測手法の説明 • DRT コンサルタントの進捗の確認
第 4 回	2021 年 12 月 23 日	• DRT コンサルタントの進捗状況の確認 • M-MAP2 プラットフォームの早期設立の必要性 • 今後のスケジュールの確認 • OTP プロジェクト（BTDS）の進捗状況把握
第 5 回	2022 年 1 月 28 日	• 第 2 回 WG に向けた作業の進捗の確認 • 東京圏におけるシナリオ設定事例の紹介 • M-MAP2 プラットフォームでの議題想定
第 6 回	2022 年 2 月 18 日	• 人口推計手法及び需要予測関連の進捗確認
第 7 回	2022 年 3 月 22 日	• 都市鉄道ネットワーク整備への方向性と提案 • OTP Survey の進捗

		• Progress Report
第 8 回	2022 年 4 月 20 日	• 日本の鉄道料金システム • Progress Report
第 9 回	2022 年 6 月 15 日	• 料金設定 • M-MAP2 政策策定：政策課題、人口設定作業の進捗 • 需要予測モデルと交通調査
第 10 回	2022 年 7 月 20 日	• 鉄道事業への補助金 • BTDS データ分析 • M-MAP2 策定：人口設定作業の進捗、需要予測モデルと交通調査、M-MAP2 政策
第 11 回	2022 年 8 月 23 日	• M-MAP2 策定：人口設定作業の進捗、需要予測モデルと交通調査、M-MAP2 政策 • M-MAP2 課税政策
第 12 回	2022 年 9 月 28 日	• 相互直通運転と急行運転 • M-MAP2 策定：交通パイロット調査結果、M-MAP2 路線提案
第 13 回	2022 年 11 月 8 日	• M-MAP2 政策策定 • Activity-Based Model - モバイルデータと紙調査の結果 - モデル構築の進捗 • 4 段階推計法（メインモデル） - 人口推計と予測 - 交通調査のまとめ
第 14 回	2022 年 12 月 27 日	• 人口推計・予測方法 • 需要予測モデル構造 • 路線評価方法 • 鉄道事業ビジネス
第 15 回	2023 年 1 月 31 日	• 人口推計・予測方法 • 需要予測モデル構造 • M-Map2 政策：路線評価方法 • 鉄道事業ビジネス
第 16 回	2023 年 3 月 29 日	• 人口推計・予測方法 • 需要予測モデル構造 • M-Map2 政策：路線評価方法 • 鉄道事業ビジネス
第 17 回	2023 年 6 月 20 日	• Activity-Based Model (ABM)：モデル構造と推計結果 • 人口推計・予測方法 • 需要予測モデルのキャリブレーション

2.4 本邦研修の実施

各年度 1 回、各回 10 名、3 年間で合計 3 回の本邦研修を想定していたが、COVID-19 感染症拡大に伴う、日本の水際対策が継続していることを考え、2 回に統合して各回 15 名の研修を行うこととした。以下に、各研修の目的、実施期間、参加メンバー、研修内容を示す。

2.4.1 第 1 回本邦研修

研修期間

（準高級 1 名）2023 年 4 月 9 日～14 日　5 泊 6 日

（一般 14 名）2023 年 4 月 3 日～14 日　11 泊 12 日

研修員

タイ運輸省鉄道局（Department of Rail Transport, DRT）

№	名前・役職	№	名前・役職
1	Dr.Pichet Kunadhamraks Director General	9	Ms. Phitsuda Winyayen Transport Technical Officer
2	Mr.Ruengdej Mangkorndejsakul Director, Strategy and Planning Division	10	Ms. Benjawan Kunviroteluck Transport Technical Officer
3	Dr. Natthaporn Buaphut Head of Strategy and Development Plan	11	Ms.Duangchai Wongrak Head of Rail Business Supervising Group
4	Mr. Pakhin Thananarong Transport Technical Officer	12	Mr. Wattanit Suwannarat Head of Rail Transport Business Regulation
5	Mr. Phusit Chairitthipong Head of Monitoring and Evaluation	13	Mr. Suphalerk Soodyodprasert Head of Infrastructure standard
6	Ms. Kamolrat Namueangrak Head of Financial Structure Analysis	14	Mr.Pannaphat Somwang Electrical Engineer
7	Mr. Pana Supatitipong Head of International Cooperation	15	Mr. Pramote Suwankaew Head of Law Development
8	Mr. Tossaporn Royvan Head of Investing Plan and Budgeting		

研修の目的と達成すべき目標

(1) 我が国における鉄道ネットワークとその運用状況、技術を学び、各鉄道プロジェクトの役割と必要の理解を深める。

(2) 東京圏の都市鉄道マスタープラン策定の体制と取り組みについて、日本有識者の講義を通じて知見を深め、バンコク都における新たな都市鉄道マスタープラン策定に活用する。

研修内容と講義・見学先

(1) 都市鉄道マスタープラン策定：森地先生、福田先生、伊東様、岩倉先生

(2) 都市鉄道の種類とその役割：東西線～東葉高速線、グリーン車、江ノ電、湘南モノレール

(3) 沿線開発：高輪ゲートウェイ駅開発、虎ノ門ヒルズ駅開発、東葉高速線沿線開発

(4) 車両の新技術：宇都宮 LRT、烏山線

表 2.4.1 第 1 回本邦研修の日程表

日程（2023 年）			講師・見学先	研修テーマ	宿泊先	移動
1	4 月 3 日(月)	移動（バンコク→東京）			JICA 東京	―
2	4 月 4 日(火)	午前	JICA 東京センター、JICA 専門家チーム	オリエンテーション、自己紹介	JICA 東京	―
		午後	芝浦工業大学 岩倉成志教授	東京鉄道マスタープランにおける需要予測の役割		
3	4 月 5 日(水)	午前	JR 東日本	高輪ゲートウェイ駅開発	JICA 東京	公共交通機関
		午後	JICA 専門家チーム	すみだリバーウォーク		
4	4 月 6 日(木)	午前	東京メトロ 蕨真裕氏	東京メトロの歴史	JICA 東京	公共交通機関
		午後	東京メトロ 蕨真裕氏	虎ノ門ヒルズ駅開発		
5	4 月 7 日(金)	午前	東京メトロ 蕨真裕氏	直通運転、快速・特急列車	JICA 東京	公共交通機関
		午後	八千代市、UR	東葉高速線沿線開発		公共交通機関
			日本大学 福田敦教授	バンコク都市鉄道計画の今後の方針		
6	4 月 8 日(土)		休日（現地視察）		JICA 東京	
7	4 月 9 日(日)		休日（現地視察）		JICA 東京	
8	4 月 10 日(月)	午前	運輸総合研究所 伊東誠氏	東京都市圏の鉄道のマスタープラン	JICA 東京	―
		午後	政策研究大学院大学 森地茂教授	アジア国の都市鉄道整備を着実に進めるための都市鉄道計画		
9	4 月 11 日(火)	午前	宇都宮ライトレール	宇都宮 LRT	JICA 東京	貸切バス、公共交通機関
		午後	JR 東日本	烏山線の蓄電池電車		
10	4 月 12 日(水)	午前	JICA 専門家チーム	グリーン車	JICA 東京	公共交通機関
		午後	JICA 専門家チーム	江ノ電、湘南モノレール		
11	4 月 13 日(木)	午前	国土交通省鉄道局	DRT が掲げる「ミッション」に関連した日本鉄道局のご経験の共有	JICA 東京	―
			DRT	タイ鉄道整備プロジェクトの紹介		
		午後	DRT	研修のまとめ、意見交換、閉会式		
12	4 月 14 日(金)	移動（東京➡バンコク）				―

研修コースに対する所見

(1) 講義

当研修の目的に合致した講義を行ってもらうために、受け入れ先との事前やり取りを密に行い内容のすり合わせを行ったことで、最適な講義内容を計画することができたと言える。これまで M-MAP2 の調査の中で議論した内容を基に、特に都市鉄道マスタープランの策定については、東京圏の都市鉄道マスタープランの策定に関わる日本有識者の実経験を共有してもらい、適切な講義内容を計画してもらうことができた。講義は研修員の関心事と合致しており、妥当性は高かったと言える。ただし、講義での質疑応答の時間が短すぎたという意見が研修員からあった。

(2) 視察・見学

講義と同様に、当研修の目的に合致した視察・見学を行ってもらうために、受け入れ先との事前

やり取りを密に行い内容のすり合わせを行ったことで、最適な視察・見学先を計画することができたと言える。フィーダー路線、直通運転、快速運行等これまで M-MAP2 調査の中で議論した内容を基本に、加えて蓄電池電車や懸垂式モノレールなど DRT より特定な要望を含めて、適切な講義内容を計画してもらうことができた。視察・見学は研修員の関心事と合致しており、妥当性は高かったと言える。ただし、講義と同様に、視察・見学での質疑応答の時間が短すぎたという意見が研修員からあった。

(3) 研修期間・構成

講義に関しては、東京圏の鉄道マスタープランに携わった有識者、実務者の講義を受けられたとともに、今後、バンコクでも課題となる、TOD、直通運転、快速運転、グリーン車、モノレール等の現地視察が行えて、研修期間としては、十分な期間であったと言える。また、講義ばかりにならないよう現地視察と組み合わせるような日程を組み、研修員が退屈しないようにした。さらに、現地視察においては研修員の理解が深まるように、事前説明を行うようにして、効果的な現地視察が行うことができた。

2.4.2 第 2 回本邦研修

研修期間

（一般 15 名）2024 年 4 月 8 日～19 日　11 泊 12 日

研修員

タイ運輸省鉄道局（Department of Rail Transport, DRT）

№	Name, Position	№	Name, Position
1	Mr. Chanin Thanda Director of Legal Affairs Division	2	Ms. Kwansiree Chuangwilai Legal officer, Legal Affairs Division
3	Ms. Watsamon Kaewduangdee Legal officer, Legal Affairs Division	4	Mr. Kittisak Rumpirujipong Mechanical Engineering, Rail Transport Regulation Division
5	Ms. Krittiya Sukmankhong Transport technical officer, Rail Transport Regulation Division	6	Ms. Phanthira Thanasophon Civil Engineer, Rail Transport Regulation Division
7	Ms. Sopida Amnuaysilp Electrical Engineer, Safety and Maintenance Standards Division	8	Mr. Phalakorn Kladjaroen Electrical Engineer, Safety and Maintenance Standards Division
9	Ms. Panita Chamchod Plan and Policy Analyst, Strategy and Planning Division	10	Mr. Komkitti Angkatawiwat Plan and Policy Analyst, Strategy and Planning Division
11	Ms. Kanokkanchana Dumkhum Plan and Policy Analyst, Strategy and Planning Division/ Secretary of Dir. General	12	Mr. Ratanon Karnjanapark Transport Technical Officer, Strategy and Planning Division
13	Ms. Narisa Thongnum Transport Technical Officer, Strategy and Planning Division	14	Mr. Sorrawit Saisorn Transport Technical Officer, Strategy and Planning Division
15	Ms. Arpapun Srisura Transport Technical Officer, Strategy and Planning Division		

研修の目的と達成すべき目標

(1) 我が国における鉄道ネットワークとその運用状況、技術を学び、各鉄道プロジェクトの役割と必要の理解を深める。

(2) 鉄道計画策定とその関連計画について、日本有識者の講義を通じて知見を深め、タイにおける今後の鉄道計画策定に活用する。

研修内容と講義・見学先

(1) 鉄道計画：森地先生、清水氏、大野氏、古橋氏、加藤氏

(2) 都市鉄道と都市開発：加藤先生、小樽市、新青森駅

(3) 鉄道従業員の研修：JR 貨物、東京メトロ

(4) ライトレール（AGT 及び路面電車）：日暮里舎人ライナー、伊奈線、都電荒川線、函館市電、札幌市営地下鉄、札幌市電

表 2.4.2 第 2 回本邦研修の日程表

日程（2024 年）			講師・見学先	研修テーマ	宿泊先	移動
1	4 月 8 日(月)	来日（バンコク→東京）			JICA 東京	―
2	4 月 9 日(火)	午前	JICA 東京センター	オリエンテーション	JICA 東京	―
		午後	JICA 専門家チーム	自己紹介		
			東京大学 加藤浩徳教授	東京圏における都市鉄道マスタープランの策定、沿線開発		
3	4 月 10 日(水)	午前	日本貨物鉄道 中央研修センター	貨物鉄道の研修センター	JICA 東京	貸切バス
		午後	JICA 専門家チーム 日暮里舎人ライナー	日暮里舎人ライナーの視察 （日本のAGT）		公共交通機関
			JICA 専門家チーム 都電荒川線	都電荒川線の視察 （日本の路面電車）		
4	4 月 11 日(木)	午前	国道交通省　鉄道局 古橋隆昭氏	鉄道駅バリアフリー化の推進に向けた新たな料金制度	JICA 東京	―
			鉄道総合技術研究所 大野央人氏	鉄道駅構内及び鉄道車両におけるバリアフリー		
		午後	東雲計画株式会社 加藤義彦氏	鉄道事業スキーム		
5	4 月 12 日(金)	午前	東京メトロ 総合研修訓練センター	都市鉄道の研修センター	JICA 東京	貸切バス
		午後	鉄道運輸機構 清水健志氏	鉄道運輸機構と整備新幹線の紹介		
6	4 月 13 日(土)	休日（現地視察）			JICA 東京	―
7	4 月 14 日(日)					
8	4 月 15 日(月)	午前	政策研究大学院大学 森地茂教授	「今後の東京圏を支える鉄道のあり方に関する調査研究」の紹介	JICA 東京	公共交通機関
		午後	JICA 専門家チーム 伊奈線	伊奈線の視察 （日本のAGT）		
			JICA 専門家チーム 鉄道博物館	鉄道博物館の見学		
9	4 月 16 日(火)	午前	JICA 本部、専門家チーム 新青森駅	新青森駅周辺の開発	函館（ホテル）	公共交通機関
		午後	JICA 専門家チーム 函館市電	函館市電の視察 （地方都市における公共交通）		
10	4 月 17 日(水)	午前	移動		札幌（ホテル）	公共交通機関
		午後	JICA 専門家チーム 札幌市営地下鉄	札幌市営地下鉄の視察 （地方都市における公共交通）		
			JICA 専門家チーム 札幌市電	札幌市電の視察 （地方都市における公共交通）		

日程（2024 年）			講師・見学先	研修テーマ	宿泊先	移動
11	4 月 18 日(木)	午前	小樽市 松山和弘氏	小樽駅、新小樽駅の駅周辺まちづくり計画	札幌（ホテル）	貸切バス
		午後	JICA 本部、専門家チーム	閉会式		
12	4 月 19 日(金)	帰国（札幌→バンコク）			ー	ー

研修コースに対する所見

(1) 講義

当研修の目的に合致した講義を行ってもらうために、受け入れ先との事前のやり取りを密に行い、内容のすり合わせを行ったことで、最適な講義内容を計画することができたと言える。これまで M-MAP2 の調査の中で議論した内容を基に、特に都市鉄道マスタープランの策定や鉄道事業スキーム等については、東京圏の都市鉄道マスタープランの策定に関わる日本有識者の実経験を共有してもらい、適切な講義内容を計画してもらうことができ、妥当性は高かったと言える。また、タイ鉄道局長から別途、依頼された高速鉄道の建設技術の講義は、研修員の関心事と合致しており、今後、タイでの高速鉄道の導入が期待される。ただし、第 1 回本邦研修と同様に、講義に対する研修員の関心が高く、質疑応答の時間が短すぎたという意見が研修員からあった。

(2) 視察・見学

講義と同様に、当研修の目的に合致した視察・見学を行ってもらうために、受け入れ先との事前のやり取りを密に行い、内容のすり合わせを行ったことで、最適な視察・見学先を計画することができたと言える。特に M-MAP2 で計画している路線の中にライトレールとして指定した路線があるため、日暮里舎人ライナー及び伊奈線の日本式 AGT を体験したことは有益であった。また、バンコクで運営している Yellow Line 及び Pink Line はモノレールであるが、運行トラブルや車輪、クランプ装置の落下の事故の発生が続いているため、M-MAP2 で計画している今後のライトレールでは AGT の活用が期待される。また、タイ鉄道局長から要望があった鉄道運転手の訓練や地方都市でどのように都市鉄道を接続させて、高速鉄道の新駅を結節点とするのかについては、研修員の関心事と合致しており、妥当性は高かったと言える。ただし、講義と同様に、視察・見学での質疑応答の時間が短すぎたという意見が研修員からあった。

(3) 研修期間

講義に関しては、都市鉄道マスタープランに携わった有識者、実務者の講義を受けられたとともに、今後、タイの鉄道において課題となる、鉄道運転手の教育、高齢化社会に向けた鉄道施設のバリアフリー化、高速鉄道の関連計画、フィーダー路線となる中量軌道交通システム等の講義・現地視察が行えて、研修期間としては、十分な期間であったと言える。また、講義ばかりにならないよう、講師の日程を参考にし、一日の中に講義と現地視察を組み合わせるようなプログラムを調整し、研修員が退屈しないようにした。さらに、現地視察においては研修員の理解が深まるように、Line アプリで事前説明資料の配布を行うようにしたことで、効果的な現地視察が行うことができた。

3. 【成果 1:新たな鉄道需要予測モデルが作成される】に関する活動

3.1 概要

【成果 1:新たな鉄道需要予測モデルが作成される】に関する活動については、DRT コンサルタントとの不定期での会議、月例協議で進捗の確認の実施してきた。また、必要に応じて、有識者との打合せを設け、有識者のアドバイスをもらいながら進めてきた。さらに、需要予測 WG を計 6 回開催し、DRT、日本人有識者、タイ有識者等を含めて議論を行い、新たな鉄道需要予測モデルの構築を行ってきた。以下に、各需要予測 WG で議題を以下に示す。

なお、第 2 回まで森地先生、内山先生、福田先生、伊東様、日比野先生の 5 人体制であったが、機動性を重視して、第3回以降は、福田先生、伊東様、日比野先生の 3 人体制とした。

表 3.1.1 各需要予測 WG での議題

回	日時	議題	参加者	
			タイ側	日本側
第 1 回	2021 年 11 月 25 日	・需要予測 WG の目的 ・バンコクの都市鉄道整備の概要 ・M-MAP2 における交通調査・需要予測モデルの方針 ・日本側・タイ側学識経験者からアドバイス（予測モデルについて考慮すべき事項、自家用車の Captive 層の扱い方、等）	DRT 6 Academia 4 Consultant 6 Other Participants (MRTA) 2	JICA 3 JET 8 Academia 5
第 2 回	2022 年 4 月 4 日	・バンコクでのコロナ影響による鉄道利用変化 ・第 1 回需要予測 WG の指摘と対応 ・人口設定と予測の進捗状況 ・需要予測モデルと交通調査の進捗状況	DRT 7 Academia 5 Consultant 10 Other Participants (OTP, MRTA, SRTET) 7	JICA 4 JET 10 Academia 5
第 3 回	2022 年 7 月 27 日	・第 2 回需要予測 WG の指摘と対応 ・人口設定と予測 ・需要予測モデルと交通調査 ・アクティビティベースモデルと交通調査	DRT 17 Academia 3 Consultant 9 Other Participants (OTP, MRTA, SRTET) 7	JICA 4 JET 9 Academia 3
第 4 回	2022 年 12 月 6 日	・第 3 回需要予測 WG の指摘と対応 ・人口設定と予測 ・需要予測モデルと交通調査 ・アクティビティベースモデルと交通調査	DRT 6 Academia 5 Consultant 8 Other Participants (OTP, MRTA) 3	JICA 1 JET 8 Academia 3
第 5 回	2023 年 5 月 15 日	・人口設定と予測 ・交通ハブアクセス OD 調査結果の報告 ・幹線アクセス交通調査と需要予測モデル	DRT 4 Academia 3 Consultant 7 Other Participants (OTP, MRTA) 3	JICA 4 JET 9 Academia 3
第 6 回	2023 年 8 月 4 日	・アクティビティベースモデル ・人口設定・予測と需要予測	DRT 5 Academia 4 Consultant 5 Other Participants (MRTA, SRTET) 3	JICA 2 JET 8 Academia 3

出典:JET

3.2 活動内容

3.2.1 鉄道需要予測モデル改定に向けた助言

鉄道需要予測モデル改定に向けた DRT 及び DRT コンサルタントの方針を確認した上で、以下の助言を行った。

- 交通調査を実施する前に、どの様な政策目標を評価するモデルを構築するのか検討を行う必要があること
- M-MAP2 blueprint で既に、既存のモデルの改善点を整理しているので、それを確認する必要があること
- モデルに関しては、既に実用化されている東京圏で用いた予測手法に倣ってモデルを構築すること。(添付資料 6 参照)
- また、コロナ中での交通調査、特に BTDS 調査に関しては、何らかの補正を検討する必要があること。

なお、COVID-19 が公共交通に与えた影響について、COVID-19 蔓延中の鉄道乗客者数の変化と、バンコク首都圏で適用された COVID-19 への対応策との関係性について分析を行った（Appendix-4 参照）。

その結果、東京圏と同様のモデルの構造、説明変数を有するモデルを構築することとした。

3.2.2 交通調査手法や調査票への助言

DRT 及び DRT コンサルタントに対して、交通調査を実施するにあたり、以下の助言を行った。

- 交通調査を実施する前に、どの様な政策を評価するモデルを構築するか検討した上で、モデル構築に必要な質問を設ける必要があること
- 交通調査を実施する前に、既存の OTP が実施した PT 調査である TDS、BTDS の調査が活用できないか確認を行う必要があること
- 発生集中交通量、分布交通量は既存の TDS、BTDS の調査を活用すること

上記の助言を踏まえ、DRT 及び DRT コンサルタントは、交通機関分担モデル構築のための交通調査、鉄道経路配分モデルのための交通調査、さらに幹線アクセス交通モデル構築のための調査を実施することとした。なお、PT 調査でとらえられない既存の幹線鉄道駅、バスターミナル、空港への交通量（以下、幹線アクセス交通量と呼ぶ）の調査は、DRT の予算が足りず、実施できないことがわかったため、JICA の予算で実施することとした。なお JICA の予算で実施した調査は、3.2.4 に記載した。

なお、モデルの構築は、通常、RP データのみ、SP データのみ、RP と SP データを組み合わせた 3 つの方法があり、日比野先生からは RP データのみでモデル構築をした方が良いとの助言を頂いたが、十分なサンプル数が得られない可能性もあったので、SP 調査を交通調査に含めることとした。

なお必要サンプル数、調査票に関しては、確認を行うとともに、以下の助言等を行った。

- 必要なサンプル数の計算式を教えた。

- 日本で行った SP 調査の調査票の事例を示した。

上記の助言を基に、DRT 及び DRT コンサルタントは、以下の調査を実施した。

表 3.2.1 DRT 発注交通調査の概要

調査名	概要	RP･SP 調査の有無	有効取得サンプル
交通機関選択調査	普段、どこからどこへ、どの交通機関を選択しているか、また仮想の状況下で、LOS が変化した場合、どの交通機関を選択するか調査した。	RP+SP	8,328
鉄道経路選択調査	普段、普段、どこからどこへ、どの鉄道経路を選択しているか、また仮想の状況下で、LOS が変化した場合、どの鉄道経路を選択するか調査した。	RP+SP	4,988
駅アクセス調査	普段、どこからどこへ、どの交通機関で駅にアクセスしているか調査	RP のみ	5,925
モデル構築のための幹線アクセス調査	どこから、どの交通手段でターミナルにアクセスしているか調査	RP+SP	2,057

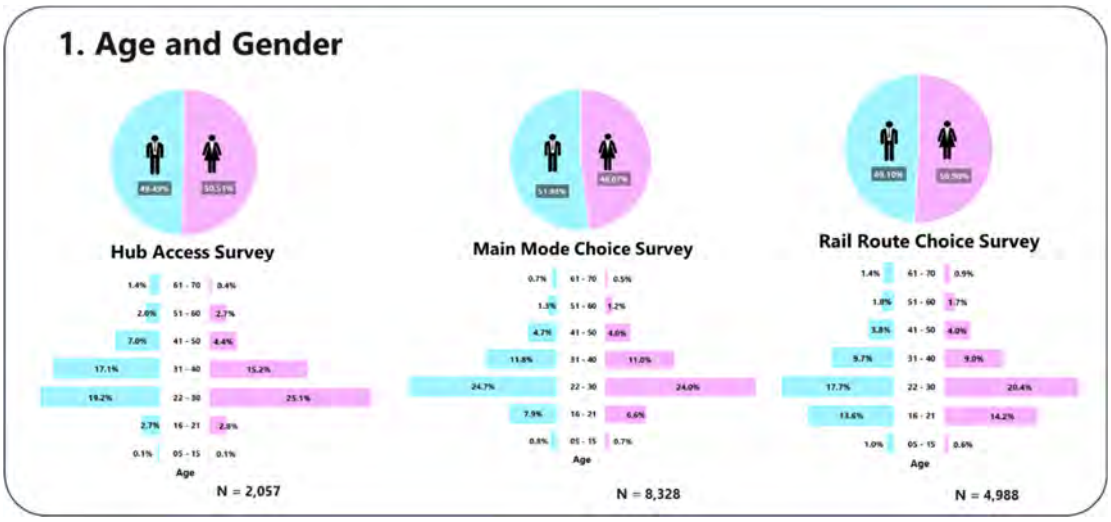
出典：JET

3.2.3 交通調査結果のレビュー

交通調査結果をレビューし、DRT 及び DRT コンサルタントに以下の助言を行った。

- いきなりモデル構築を行うのではなく、モデル構築の基礎資料となる交通調査の集計行うこと
- ジェンダー主流化を勘案して、ジェンダー別に充分にサンプルがとれているか確認を行うこと
- OD 交通量は、希望線図（ゾーン間を直線で結び、かつ直線の太さでそのゾーン間の交通量の大小を示した線）を用いるとわかりやすいこと。

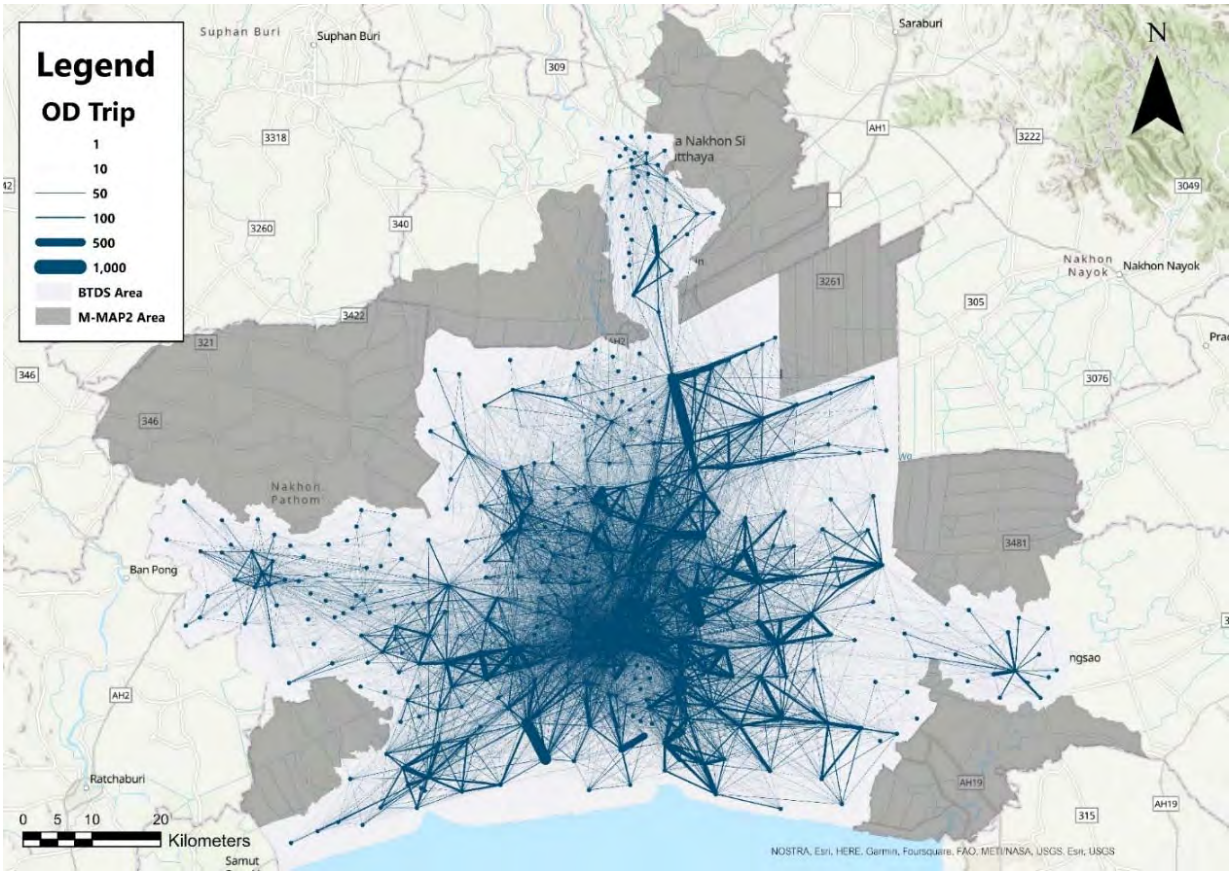
以下に、交通調査結果の一例を示す。



出典：DRT コンサルタント資料

図 3.2.1 年齢階層男女別サンプル数

OD 交通量に関しては、バンコク中心部、各地域から近隣地域への移動が多いことがわかり、明らかにおかしなトリップがないことを確認し、データに大きな間違いがないことを把握した。



出典：DRT コンサルタント資料

図 3.2.2 BTDS 調査における希望線図

3.2.4 追加交通調査の実施

DRT と DRT コンサルタント側の実施する調査を確認したところ、PT 調査でとらえられない幹線アクセス交通量の調査が抜けていたが、DRT の予算が足りず、実施できないことがわかったため、JICA 側の予算で実施することした。

以下にその概要を示す。

表 3.2.2 幹線アクセス OD 交通量調査の概要

実施調査会社	EI Consultant Co., Ltd.
契約金額	1,690,600 バーツ（税込）
契約期間	2022 年 11 月 28 日から 10 週間（契約延長あり）
調査期間	2023 年 1 月 23 日から 5 月 19 日まで
調査内容	幹線交通アクセスモデルの OD 交通量を推計するため、空港、幹線鉄道駅、バスターミナルのアクセス交通量（発着地別トリップ数）を把握
調査場所	Suvarnabhumi International Airport, Don Mueang International Airport, Bangkok Bus Terminal (North), Bangkok Bus Terminal (South), Bangkok Bus Terminal (East), Bang Sue Grand Station

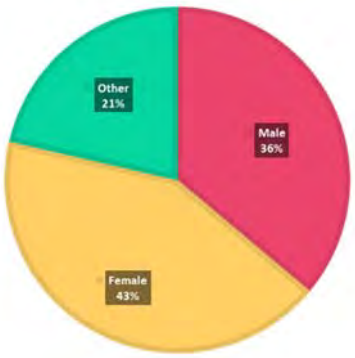
出典：JET

表 3.2.3 幹線アクセス OD 交通量調査の調査場所、調査機関、サンプル数

調査場所	調査期間	サンプル数
Suvarnabhumi International Airport	23 January 2023 - 26 January 2023	18,010
Don Mueang International Airport	22 February 2023, 18 May 2023 - 19 May 2023	11,408
Bangkok Bus Terminal (North)	1 February 2023 - 3 February 2023, 5 February 2023	9,707
Bangkok Bus Terminal (South)	14 February 2023 - 15 February 2023	4,111
Bangkok Bus Terminal (East)	9 February 2023 - 10 February 2023	3,608
Bang Sue Grand Station	6 March 2023 - 7 March 2023	915
Total		**47,759**

出典：JET

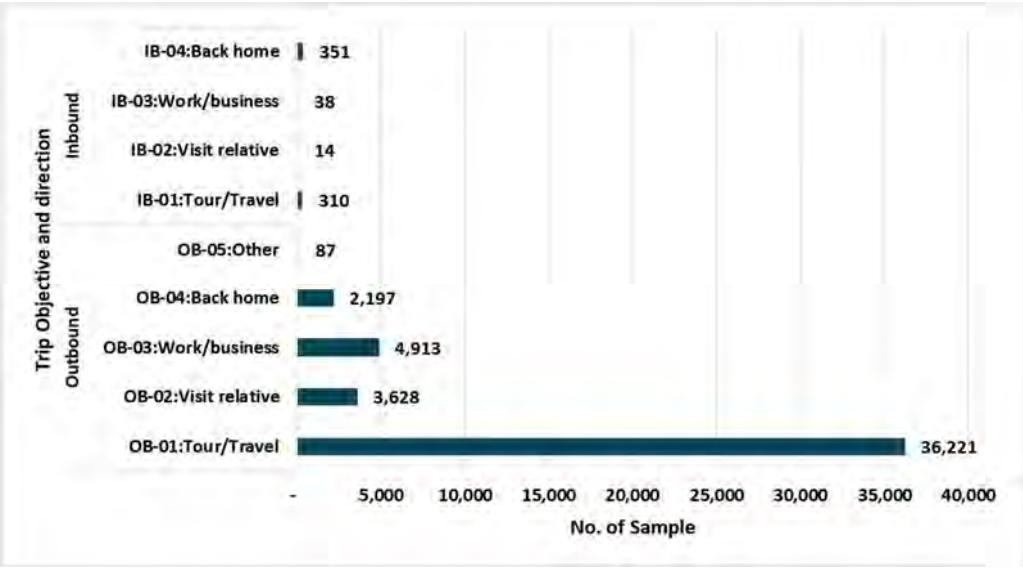
また、以下に調査結果の概要を示す。男女比をみると、男性は 36%、女性は 43%とそれぞれの割合は均等になっている。



出典：DRT コンサルタント

図 3.2.3 性別の割合

移動目的別のサンプルをみると、旅行目的のサンプルが多い。



出典：DRT コンサルタント

図 3.2.4 移動目的のサンプル数

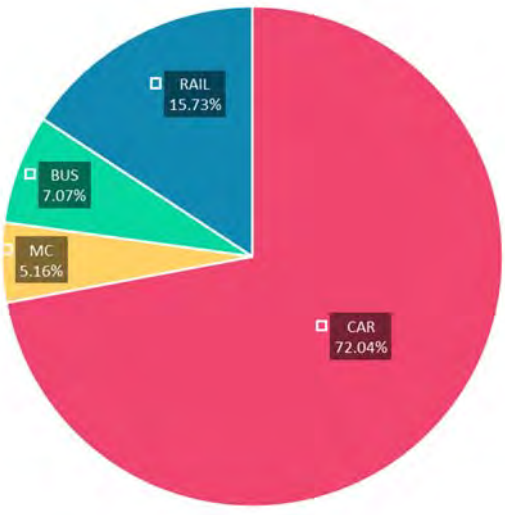
Suvarnabhumi 空港アクセス交通量をみるとバンコク中心部への移動が多いことがわかる。



出典：DRT コンサルタント

図 3.2.5 Suvarnabhumi 空港アクセス交通量の希望路線図

Suvarnabhumi 空港アクセス交通機関の分担をみると、車が最も多く、その割合も最も多いことがわかる。



出典：DRT コンサルタント

図 3.2.6 Suvarnabhumi 空港アクセス交通機関の分担

DRT コンサルタントは、この調査結果を用いて、幹線交通アクセスへの OD 交通量の推計を行った。

3.2.5 現況と将来の社会経済フレームワークの設定に対する助言

交通需要予測を行う上で必要となる社会経済フレームワークとして、現況と、将来の推計年次での、交通ゾーン(TAZ) 単位の居住人口と、昼間セクター別就業者人口、昼間生徒数が必要となるが、調査対象地域での利用可能な統計データが不十分であることから、これらを最大限活用した上で、推計することが求められていた。DRT コンサルタントは、社会経済フレームワーク設定の経験がなかったことから、利用可能なデータの確認から、適切な推計手法の検討を含め、社会経済フレームの設定に関するアドバイスを行った。

1) 必要なデータセットの確認

交通需要予測へのインプットとして、必要となる社会経済データの確認を行った。日本の事例と異なり、就業者人口と学生人口については、昼間データのみとし、夜間の従業者、学生人口は推計しないことを確認した。

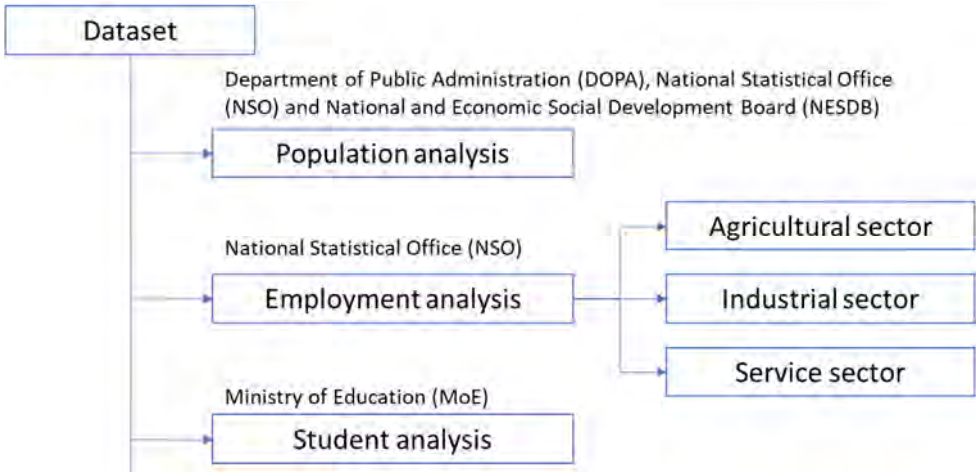


図 3.2.7 社会経済フレームワーク概要

2) 利用可能な既存データの収集と確認

タイでは、人口についてもセンサスと登録人口に乖離があり、雇用統計は県レベルでしか存在しないなどの状況を鑑み、社会経済データを推計する上で利用可能なデータを幅広く収集した。特に、Zone 単位での推計が課題となることから、土地利用や建物利用等の GIS データ、都市開発事業の詳細情報等の確認も行った。

表 3.2.4 利用可能な既存データ

Dataset		Data Source	Levels			
			Province	Amphoe	Tambon	TAZ
Population data	Number of registered populations	● Department of Public Administration (DOPA) ● National Economic and Social Development Board (NESDC)	**X**	**X**	**X**	
	Number of non-registered populations	● National Economic and Social Development Board (NESDC)	**X**			
	Number of population (100 m.x100 m. Gridded Population)	● www.worldpop.org				**X**
	Population projection data	● National Economic and Social Development Council (NESDC)	**X**			

Dataset		Data Source	Levels			
			Province	Amphoe	Tambon	TAZ
Household data	Number of households	● Department of Public Administration (DOPA)	**X**	**X**	**X**	
	Population census	● National Statistic Office	**X**			
Education data	Number of students	● Ministry of Education	**X**	**X**	**X**	**X**
	Number of univsesity students	● Ministry of Higher Education, Science, Research and Innovation (MHESI)				**X**
Employment data	Employment data by Sector	● National Statistic Office	**X**			
	Employment in industrial sector	● Department of Industrial Works (DIW)	**X**			**X**
	Land use areas in 3 employment sectors	● Land Development Department (LDD)				**X**
	Employment projection data	● Bangkok Metropolitan Region Plan (BMR Plan) by Department of Public Works and Town & Country Planning (DPT)	**X**			
Household income data	Average household income (Year 2019)	● National Statistic Office	**X**			

出典：DRT コンサルタント資料より JET 作成

3) 現況居住人口の推計

タイの人口統計には、統計局によるセンサスと内務省が管理する登録人口が存在するが、地方に登録をしたまま都市部に住み続ける人が多いことから、センサス人口と登録人口には大きな乖離があり、バンコク都ではそれぞれの数値に約 2 割の差がある。さらに、センサス人口についても、非登録人口が含まれていないため、実人口とは乖離があると言われている。また、TAZ レベルでの人口を推計の基本となる統計データは存在しないため、World Pop が衛星データをもとに推計している 100m 四方のグリッド人口を活用し配分を行った。

現況居住人口の推計方法を、図 3.2.8 に記す。

- 県レベルの居住人口：非登録人口が含まれている NESDC の統計を、県レベルの基本データとして活用する。
- District、Sub-District レベルの居住人口：NESDC のデータは県レベル人口を、上述の登録人口の、District、Sub-District 単位の割合に応じて配分。
- TAZ の居住人口：Sub-District 人口を、World Pop が推計した人口の TAZ 単位の割合に応じて配分。

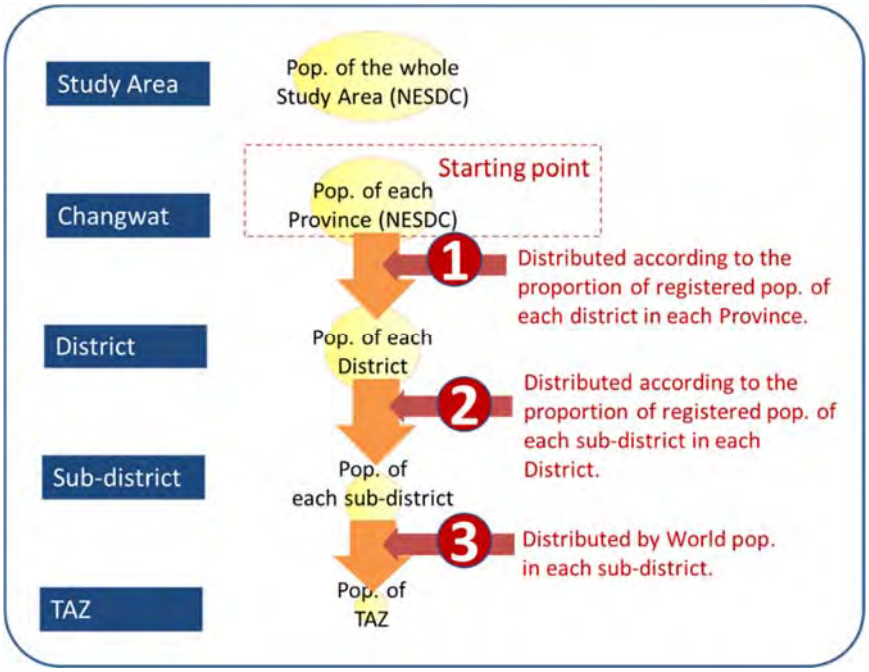


図 3.2.8 現況居住人口の推計方法

表 3.2.5 県別人口・人口密度・人口増加率

Study Area	NESDC Population (People)			Population Ratio			Population Density			Annual Growth Rate (%)	
	2010	2015	2019	2010	2015	2019	2010	2015	2019	10-15	15-19
Bangkok	7,691,376	8,107,418	8,318,381	53.22%	52.00%	50.94%	4,896	5,160	5,295	1.06%	0.64%
Samut Prakarn	1,736,914	1,918,361	2,075,369	12.02%	12.31%	12.71%	1,830	2,021	2,187	2.01%	1.99%
Nonthaburi	1,304,042	1,463,953	1,583,587	9.02%	9.39%	9.70%	2,045	2,296	2,483	2.34%	1.98%
Pathumthani	1,244,635	1,423,739	1,545,064	8.61%	9.13%	9.46%	820	938	1,018	2.73%	2.07%
Pra Nakorn Sri Ayuthaya (対象 TAZ のみ)	541,240	560,121	574,968	3.75%	3.59%	3.52%	368	381	391	0.69%	0.66%
Chacheongsao (対象 TAZ のみ)	382,302	414,088	434,256	2.65%	2.66%	2.66%	282	306	320	1.61%	1.20%
Nakorn Pathom	904,219	975,820	1,028,113	6.26%	6.26%	6.30%	426	459	484	1.54%	1.31%
Samut Sakorn	647,285	726,312	770,253	4.48%	4.66%	4.72%	760	853	904	2.33%	1.48%
TOTAL	14,452,013	15,589,811	16,329,992	100%	100%	100%	1,379	1,488	1,559	1.53%	1.17%

出典：DRT コンサルタント

4) 将来居住人口予測

将来人口の推計は、交通需要予測にとって、非常に重要なデータとなるため、信頼できるデータと、論理的な推計方法が求められる。日本の事例等を参考に、タイ国で利用可能なデータを最大限活用した上で、以下のような推計を行うこととした。

- 県単位の将来人口値：将来人口予測値としては、NESDC の人口予測を活用する。過去の予測と、現状の人口を比較し、NESDC の予測精度の精査も行った。
- ゾーン別の人口配置：2010 年～2019 年のゾーン別の増減傾向を基本とし、その傾向が将来も続くと仮定した場合の人口分布と、新たに想定される人口増加について、以下の 2 つの要素を考慮することとする。

  (1) 新規都市開発：大規模な都市開発は、既存の人口分布の傾向に大きな影響を与える

ため、別途考慮する。プロジェクトの住宅エリア面積、想定人口、想定開業時期を収集し、プロジェクトの計画人口の 70%の人口が居住すると想定し、その 60%が開業後の第一段階で、残りが第二段階で入ると想定した。

(2) 鉄道駅周辺への人口集積:都市鉄道の駅周辺は、人口がより集中し増加率が高くなる傾向にある。この増加率は、その地区の人口密度によって異なると想定し 2015 年の人口密度と 2015-2019 年人口増加率の傾向について、駅周辺とそれ以外の地区で比較分析を行い、その傾向を用いた上で、駅がある地区への増加率を推計した。

(3) 都市計画規制による追加的な人口増加:鉄道駅がない地区において、都市計画において緑地地域と特定されている地区については、人口増加が抑制されるとした。

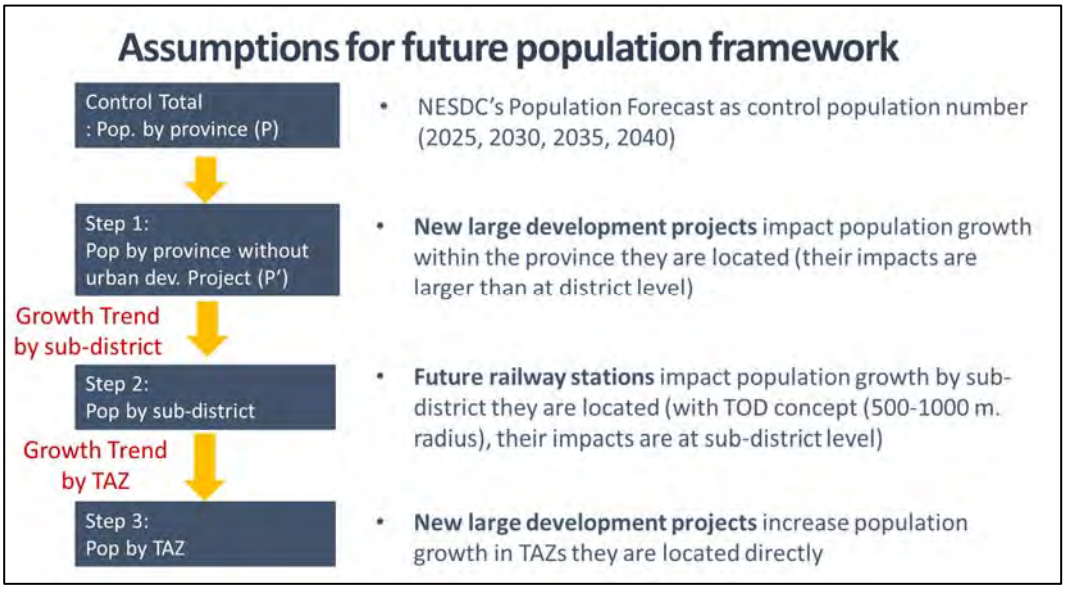


図 3.2.9 将来人口予測作業における仮定

5) 現況就業者数の推計

就業者数については、交通需要予測に必要となる TAZ ごとの農業、工業、サービスセクターの昼間就業者数について、日本の事例等を参考に、タイ国で利用可能なデータを最大限活用した上で推計方法の検討を行った。特に、雇用統計は県レベルでしか存在しないことから TAZ ごとの分布については、土地利用や建物利用等のデータを活用することとした。

表 3.2.6 現況就業者数推定のためのデータリスト

Available Data	Level	Source	Remarks
Employment by Sector (registered & non-registered) (2011, 2015 & 2019)	Province	National Statistical Office (NSO)	Statistic data used as control number for 3 employment sectors
Building Uses (Bangkok) (2015)	TAZ	Department of City Planning and Urban Development, BMA (CPUD)	GIS based data with x,y coordinates
Land Uses (Bangkok & Vicinities) (varies 2015-2021)	TAZ	Land Development Department (LDD)	GIS based data with x,y coordinates
Industrial Employment (registered only) (2015 & 2019)	TAZ	Department of Industrial Works (DIW)	Statistic data and GIS based with x,y coordinates

- **県別の就業者数**：NSO の統計値の雇用セクターの分類の修正を行い設定した。具体的には、Transportation とStorage セクターは、NSO の分類上サービスセクターであったが、工業セクターに変更し、Construction とWholesale は、NSO の統計上は工業セクターに分類されていたが、サービスセクターに変更した。

- TAZ ごとの就業者の分布

  (1) 農業セクター：県レベルの NSO 統計値を、農地の面積割合に応じて、各 TAZ に配分する。

  (2) 工業セクター：NSO と DIW がある。NSO は、登録、非登録事業者 が含まれている一方で、DIW は登録された事業者のみを対象とするが、場所情報も含まれている。そのため、DIW のデータについては、このまま活用し、非登録事業者の就業者数については、農業セクターの就業者数同様に、土地利用データの工業用地の面積の割合に応じて配分した。これらの二つのデータをもとに、TAZ ごとの就業者数を推計した。

  (3) サービスセクター：サービスセクターの土地・建物で就労する就業者と、それ以外の用途の中で就労する就業者を分類し、前者については、バンコクは建物面積ごとに、それ以外は土地面積ごとに配分し、後者は、人口に応じた配置になると想定し、TAZ の人口ごとに配分を行った。

6) 将来就業者数予測

将来就業者数については、利用可能なデータが非常に限られている中で、以下のようなステップで将来予測を行った。

- 県別・セクター別就業者総数

BMR：DPT が作成した BMR 地域計画でバンコク都と周辺 5 県の就業者数が 2037 年まで予測されている。一方で、2019 年の時点で、NSO の統計値との乖離がある事から、BMR の予測値から成長率を計算し、NSO の現況統計に、この成長率を合わせることで、2037 年までの就業者数を推計し、さらに 2032-3027 年の予測傾向から 2040 年値を推計した。

Phra Nakorn Sri Ayuthaya and Chacheongsao：この 2 県については、将来予測値が存在しないため、NESDC の人口予測の成長率を、就業者の成長率に当てはめ、将来就業者数の予測を行った。



出典：DRT コンサルタント

図 3.2.10 県別セクター別将来雇用者数フレームワーク

- TAZ ごとの就業者数（農業・工業セクター）：現況就業者数の増加傾向を元に、県別の将来就業者数を TAZ 単位に分布した。
- サービスセクター：サービスセクターの就業者数の予測は、以下を考慮し推計行った。
  (1) 新規都市開発の誘発需要：大規模な都市開発プロジェクトが生み出す就業者数を、床面積から推計を行った。
  (2) 現況の増加傾向：現況就業者数の増加傾向（2015-2019）を用い、各 Sub-district ごとの就業者数を推計した。
  (3) 現況の TAZ ごとの分布状況：上述で求めた各 Sub-district 内の就業者数を、現況サービスセクター就業者数の TAZ ごとの分布に比例配分し、TAZ ごとの就業者数を推計した。

7) 現況学生数の推計

現況学生数の分布は、通学目的の交通需要を予測する上で、重要なファクターとなる。タイの学生数に関する統計は、以下の 2 つがある。

- National Education Information System (NEIS)：幼稚園、小学校、中学校、高校の学生数の統計
- Ministry of Higher Education, Science, Research and Innovation (MHESRI)：college と university level の学生数統計

これらの 2 つの統計値は、学校の位置と紐づけられているが、2015 年時点のデータのみ利用可能である。そのため、以下のステップで現況学生数を推計した。

- 学校の位置は、2015 年と同じとする。
- 学生数の増減割合は、TAZ ごとの人口増減割合と同じとし、各地区の学生増減を TAZ ごとに分配。

8) 将来学生数予測

将来学生数については、NESDC の将来人口予測値と、現況学校統計を用いて、以下のような推計を行った。

- 学生総数：現況の就学率（学生数/5～24 歳の人口、2015）が、将来も継続すると想定し、将来の 5 歳～24 歳の人口から学生総数を推計。
- TAZ ごとの学生数：学校の分布は現況をベースとし、増減分については、各 TAZ の人口増減と比例して配分する。

3.2.6 需要予測の前提条件の見直しへの助言

1) 現況のLOSの設定の確認

需要予測において、重要になるのは、入力データとなる交通量とサービス水準（以下 LOS と呼ぶ）になる。LOS の設定については、以下の助言を行った。

- 鉄道、バス、自動車の LOS をどのように設定しているのか明確にすること

- それぞれの LOS の設定が実感と合うか経路を図示して確認を行うこと。なお、google の経路探索結果も確認して傍証すること

その結果、鉄道とバスの速度に関しては、既存路線の速度を参考に設定を行い、道路の速度は、GPS データに基づいて設定を行った。

すべての OD 間の LOS を確認することは、作業に膨大な時間を有するため、DRT コンサルタントが、主要な OD 間について、LOS の確認を行い、LOS が実感に合わなかった自動車に関しては、GPS データに基づいて、特に CBD エリアでの速度設定を再調整した。以下に、LOS の確認の例を示す。

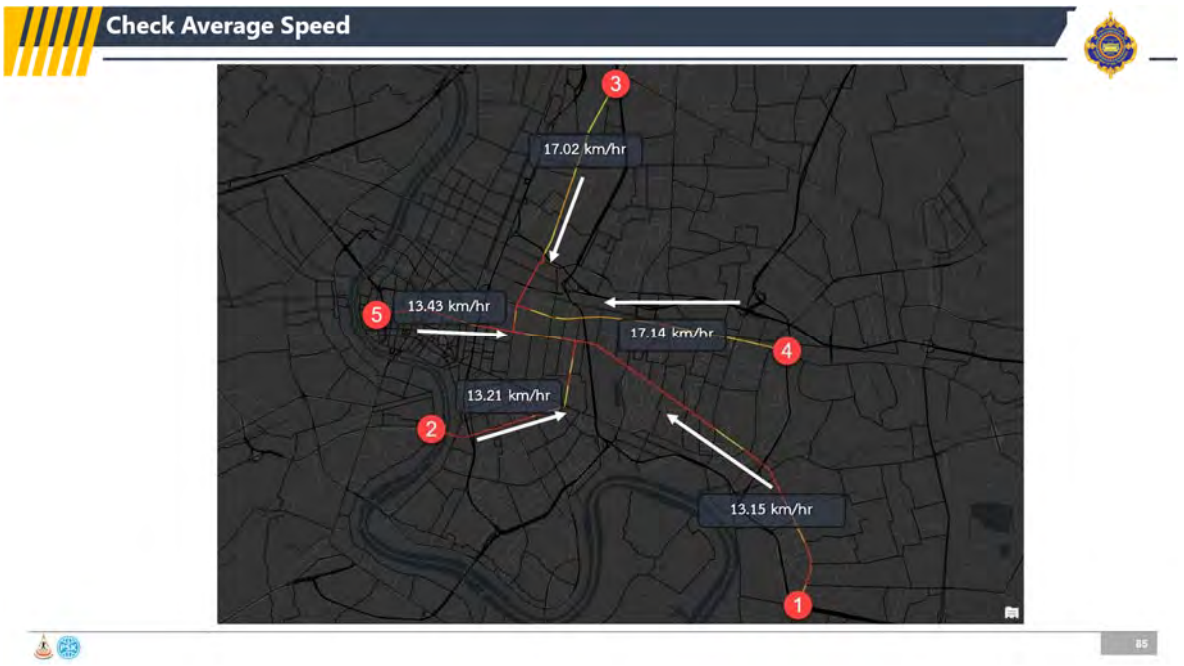


図 3.2.11 道路速度設定の確認

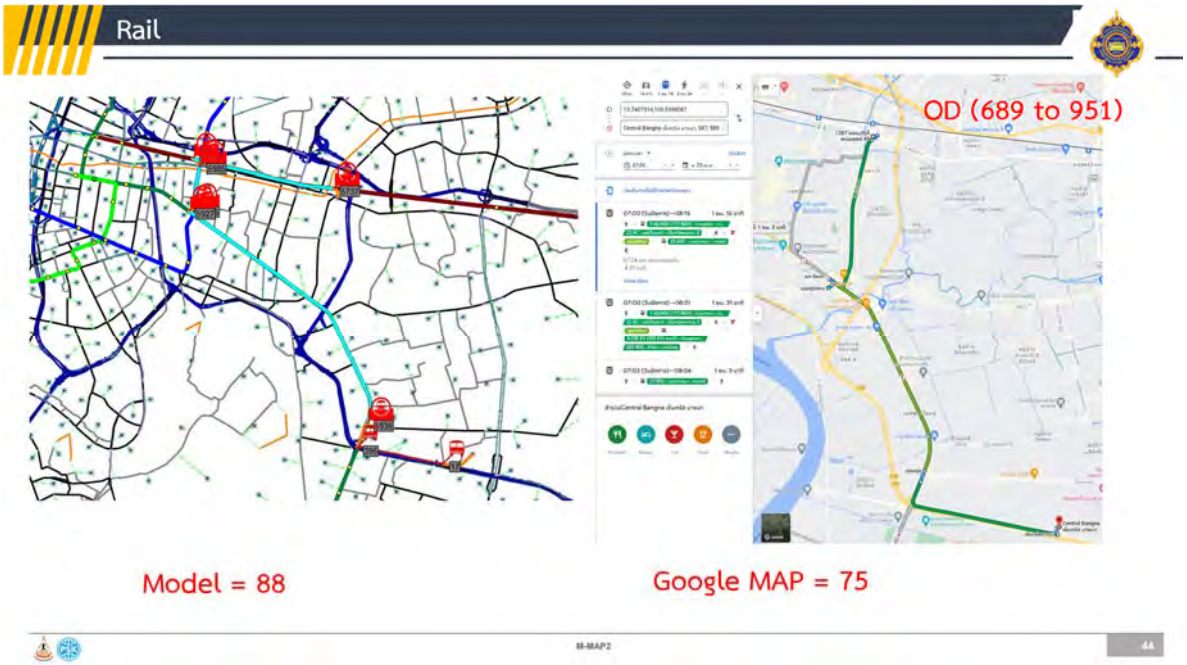


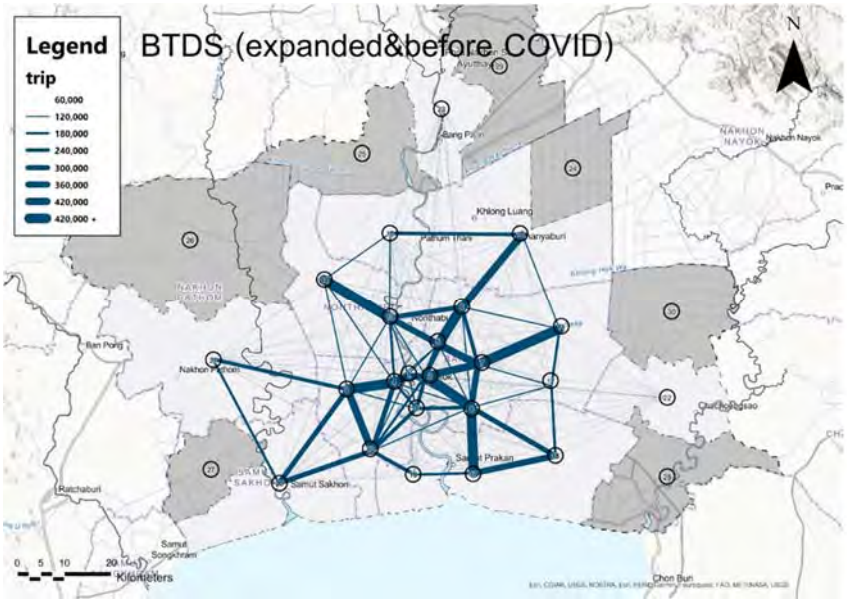
図 3.2.12 鉄道所要時間の確認

2) 現況OD表の作成

現況の OD 表の作成方法としては、交通調査結果から得られた現在のトリップパターンを用いる現在パターン法とグラビティモデルの 2 つの方法があるが、以下の助言を行った。

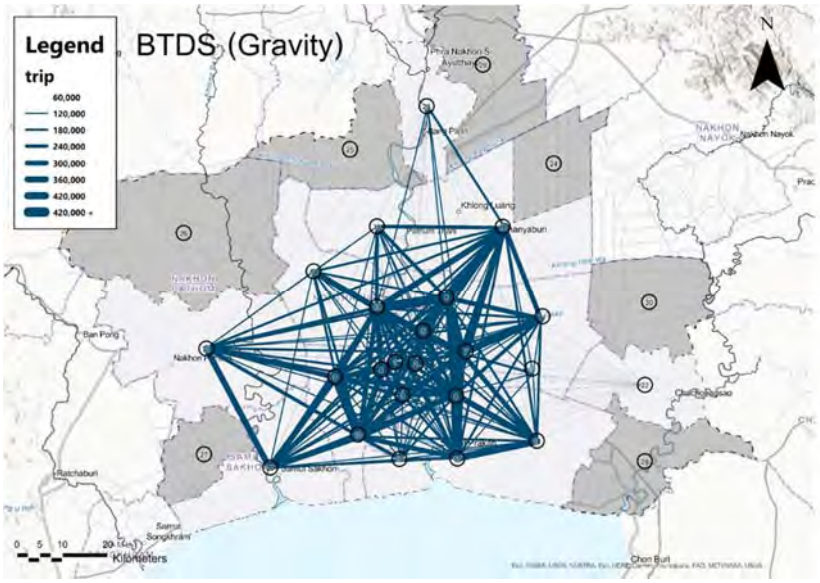
- グラビティモデルでは、全く交通量ない OD 間にも、計算上交通量が発生してしまうことから、現況パターンを用いた方がよい

上記の助言のもと、DRT コンサルタントは、現在パターン法とグラビティモデルの両方で、計算を行い、最終的に現在パターン法を用いることとした。



Trip purpose	Trip/day
Home to work	9,662,765
Home to School	1,106,402
Home to private	8,191,082
Non home-based to private	982,212
Work-Business	771,432
Work to Home	9,030,681
School to Home	1,115,059
Private to Home	9,443,530
Total	40,303,163

図 3.2.13 現在パターン法の希望線図（ゾーン内々交通量を省略）



Trip purpose	Trip/day
Home to work	10,321,312
Home to School	1,187,251
Home to private	8,751,308
Non home-based to private	1,052,393
Work-Business	831,391
Work to Home	9,713,588
School to Home	1,197,408
Private to Home	9,852,191
Total	42,906,842

図 3.2.14 グラビティ法の希望線図（ゾーン内々交通量を省略）

3.2.7 タイ側が作成した鉄道需要予測モデルのレビューと助言

1) 予測モデル

発生集中交通量に関しては、原単位の確認を行い、その原単位が極端な値でないことを確認した。また、分布交通量に関しては、現在パターン法を用いるため、モデルの構築は行っていない。さらに、機関選択モデル、経路選択モデルに関しては、統計的に有意であるか、また、時間価値、パラメータの大きさの確認を行い、東京圏と事例と比較して、妥当なものであることを確認した。

以下に、機関分担モデルでの通勤目的のパラメータ及び時間価値のバンコクと東京圏の比較を示す。

M-MAP2 の交通機関選択調査の実施期間の平均為替レート(2022 年 9 月 6 日～11 月 18 日)を 3.885 円/バーツと仮定すると、交通政策審議会答申第 198 号における通勤目的の時間価値 (VOT)は、39.3/3.885=10.116 バーツ/分となる。一方、M-MAP2 の時間価値をみると、3.39 バーツ/分であり、約 3 倍となる。東京の物価がバンコクの約 2～3 倍であることを考慮すると、M-MAP2 の VOT の推定は妥当である。

車両保有の有無、短距離トリップダミー、駅へのアクセスなどの他のパラメータも東京圏のモデルと同様のスケールであった。鉄道経路選択モデルにおける時間価値での VOT の比較でも同様の傾向が見られる。

表 3.2.7 機関分担モデルの通勤目的のパラメータ推計結果の比較

		東京 198 号答申		バンコク M-MAP2	
		Estimate	t-stat	Estimate	t-stat
定数項	バイク			0.074	0.193
	バス	-0.773	-7.65	1.44	3.188
	鉄道	2.82	21.8	4.219	14.721
乗車時間(分)		-0.0482	-18.2	-0.063	-3.919
σ(乗車時間)				0.03	2.602
費用(198 号:円、M-MAP2 バーツ)		-0.00123	-10.4	-0.018	-4.071
車保有	自動車	1.13	7.23	3.825	13.305
	バイク			2.372	9.835
都心ダミー	自動車	-1.72	-21.3		
短距離ダミー	自動車	0.665	6.13	1.494	4.537
	バイク			3.597	10.599
駅アクセス	鉄道	0.446	33.6	0.802	6.541
サンプル数		9,763		2,549	
時間価値(円／分)		**39.3**			
時間価値(バーツ／分)		**10.12**		**3.39**	

注意:198 号答申のパラメータは「非高齢」の値、M-MAP2 のパラメータ年齢層がない。

出典：JET

2) 各段階別の予測結果の確認

- 発生集中量モデルについては、目的別の発生・集中量原単位の確認を行った。通勤目的の発生源単位は、1を超えていたが、これはダブルワークの要因の一つであった。

Trip purpose	Production (Origin)		Attraction (Destination)	
	Population Index	Trip Rate	Population Index	Trip Rate
Home to work	The number of populations from 15 years and above, who is employed	1.071	Employment	1.011
Home to school	The number of populations between 5- and 21-year-old	0.880	The number of student seat	0.812
Home to private unemployed	The number of populations between 22- and 60-year-old, who is unemployed	0.771	Employment in service sector	0.042
Home to private WFH	The number of populations between 22- and 60-year-old, who work from home (WFH)	0.908	Employment in service sector	0.179
Home to private elder	The number of populations greater than 60-year-old	0.122	Employment in service sector	0.031
Non home-based to private	Employment	0.037	Employment in service sector	0.061
Work-business	Employment	0.047	Employment	0.047
Work to home	Employment	0.996	The number of populations from 15 years and above, who is employed	1.055
School to home	The number of student seat	0.728	The number of populations between 5- and 21-year-old	0.789
Private to home unemployed	Employment in service sector	0.050	The number of populations between 22- and 60-year-old, who is unemployed	0.929
Private to home WFH	Employment in service sector	0.203	The number of populations between 22- and 60-year-old, who work from home (WFH)	1.029
Private to home elder	Employment in service sector	0.030	The number of populations greater than 60-year-old	0.119

図 3.2.15　目的別の発生・集中量原単位

- 分布交通量モデルについては、隣接する地域、都心への交通量が多く、変な地域間で交通量がないことを確認した。

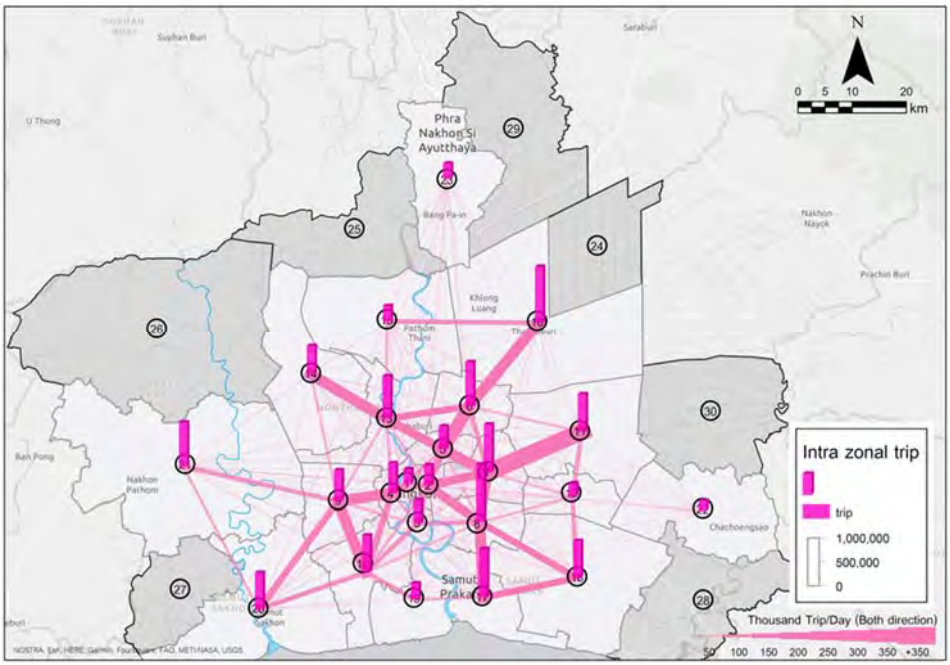


図 3.2.16　分布交通量の希望線図

- 機関分担モデルについては、モデルで推計した県別交通機関の割合を TDS, BTDS 調査での実績との比較を行い、大きな乖離がないことを確認した。

Province	Mode Share			
	CAR	MC	BUS	RAIL
Bangkok				
TDS_Y17	47.01%	20.76%	30.40%	1.83%
BTDS_Y22	51.08%	33.50%	11.50%	3.92%
Model_Y19	47.71%	27.85%	20.52%	3.91%
Chachoengsao				
TDS_Y17	42.06%	47.43%	10.12%	0.38%
BTDS_Y22	51.37%	40.06%	8.57%	0.00%
Model_Y19	50.73%	29.21%	20.03%	0.03%
Nakhon Pathom				
TDS_Y17	32.82%	56.48%	10.64%	0.06%
BTDS_Y22	53.04%	42.56%	4.34%	0.06%
Model_Y19	50.27%	28.84%	20.81%	0.08%
Nonthaburi				
TDS_Y17	46.30%	28.86%	24.51%	0.33%
BTDS_Y22	58.19%	34.01%	7.01%	0.79%
Model_Y19	49.46%	28.22%	21.46%	0.86%
Pathum Thani				
TDS_Y17	40.29%	39.97%	19.67%	0.07%
BTDS_Y22	57.31%	35.27%	7.12%	0.29%
Model_Y19	50.76%	28.59%	20.45%	0.20%
Phra Nakhon Si Ayutthaya				
TDS_Y17	34.59%	50.18%	14.72%	0.52%
BTDS_Y22	46.85%	46.20%	6.93%	0.02%
Model_Y19	50.65%	29.01%	20.21%	0.13%
Samut Prakan				
TDS_Y17	39.27%	31.61%	28.48%	0.64%
BTDS_Y22	51.03%	38.02%	9.74%	1.22%
Model_Y19	50.06%	26.88%	19.99%	3.07%
Samut Sakhon				
TDS_Y17	30.31%	55.11%	14.48%	0.10%
BTDS_Y22	56.52%	36.91%	6.35%	0.22%
Model_Y19	50.13%	28.37%	21.38%	0.12%

図 3.2.17　県別交通機関利用割合の比較

- 経路配分モデルについて路線別、断面別の鉄道利用者数の現況再現を行い、実績と再現地に大きな乖離がないことを確認した。なお、現況再現の具体的な方法は次の項目に記載した

Daily Line Loaded	Direction PP16 to PP01					Direction PP01 to PP16				
	Model	Obs.	Diff			Model	Obs.	Diff		
PP16 : Tao Poon	23,725	25,426	-1,701	-7%		0	0	0	0%	
PP15 : Bang Son	23,038	23,959	-921	-4%		21,775	23,016	-1,241	-5%	
PP14 : Wong Sawang	22,428	22,436	-8	0%		21,355	22,035	-680	-3%	
PP13 : Yaek Tiwanon	20,603	20,773	-170	-1%		21,406	21,410	-4	0%	
PP12 : Ministry of Public Health	18,350	18,570	-220	-1%		19,764	19,880	-116	-1%	
PP11 : Nonthaburi Civic Center	16,438	16,561	-123	-1%		17,441	17,608	-167	-1%	
PP10 : Bang Krasor	14,996	15,118	-122	-1%		16,115	16,193	-78	0%	
PP09 : Yaek Nonthaburi 1	13,373	13,491	-118	-1%		14,762	14,839	-77	-1%	
PP08 : Phra Nang Klao Bridge	12,630	12,735	-105	-1%		12,967	13,041	-74	-1%	
PP07 : Sai Ma	11,845	11,906	-61	-1%		12,344	12,447	-103	-1%	
PP06 : Bang Rak Noi Tha It	10,441	10,446	-5	0%		11,255	11,291	-36	0%	
PP05 : Bang Rak Yai	10,044	10,080	-36	0%		9,856	9,859	-3	0%	
PP04 : Bang Phlu	8,892	8,931	-39	0%		9,278	9,299	-21	0%	
PP03 : Sam Yaek Bang Yai	8,345	8,416	-71	-1%		8,243	8,267	-24	0%	
PP02 : Talad Bang Yai	2,853	2,837	16	1%		7,532	7,577	-45	-1%	
PP01 : Khlong Bang Phai	0	0	0	0%		4,207	4,178	29	1%	
			MAPE	1%				MAPE	1%	

図 3.2.18　Purple Line 現況再現の結果

3) 断面交通量による鉄道利用者の現況再現結果

将来の予測を精緻に行うためには、各路線の断面交通量の再現ができているモデルである必要がある。そのため、現況再現について、以下の助言を行った。

- 鉄道の現況再現を確認するためには、鉄道の駅間 OD 表もしくは断面交通量の実績値が必要であること
- 再現性を向上させるために、駅へのアクセスリンクの見直しが必要であること
- 乗降人員の大きい駅での再現を向上させることで、断面交通量の再現性が向上すること

上記の助言を基に、DRT コンサルタントは、事業者別の駅間 OD 表を入手し、現況再現及び再現性の向上に努めたが、抜本的な改善ができず、その理由として、現況鉄道 OD 表に問題あることがわかった。そのため、日本の有識者とも議論を重ね、現況駅間 OD 表を以下の方法で作成し、その OD 表を基に、経路配分の予測を行った。

作業①:鉄道事業者別の駅間 OD 表から全鉄道事業者駅間 OD 表するため、既存の交通調査結果を用いて、事業者間の乗り換え旅客数の推計を行う。

作業②:全鉄道事業者駅間 OD 表から現況地域間鉄道 OD 表を作成する

作業③:②の現況地域間鉄道 OD 表を基に鉄道経路配分を行う。

上記の作業を行った結果、現況再現性は、大幅に向上した。

4) 将来予測の補正方法

伊東様、日比野先生と協議を行い、将来の鉄道地域間 OD 表は、今回作成した現況鉄道地域間 OD 表と現況再現結果となる現況鉄道地域間 OD 表の差分で補正することとし、率での補正は、過大な補正になる場合があるため用いないこととした。需要予測に関する助言の詳細は、添付資料 3 を参照する。

参考：M-MAP2 でのアクティビティベースモデルの検討

BMR では、配偶者や子供の送迎トリップ等複雑な行動パターンが多いため、2015 年ごろからアクティビティベースモデルの検討が始められ、TDS でパイロットスタディとしてモデル開発が行われた。このような中、M-MAP2 Blueprint でもアカデミアからアクティビティベースモデルの検討の重要性が指摘されたこともあり、M-MAP2 でアクティビティベースモデルをパイロットスタディとして実施することになった。M-MAP2 のアクティビティベースモデルは DRT コンサルタントが独自に開発するもので、JET の助言の対象外であるため、モデルに関する内容は省略し、モバイルデータの活用と課題を中心に示す。

1. アクティビティベースモデルの検討対象地域

Thailand Cultural Center 駅、Rama 9 駅、Phetchaburi 駅の周辺

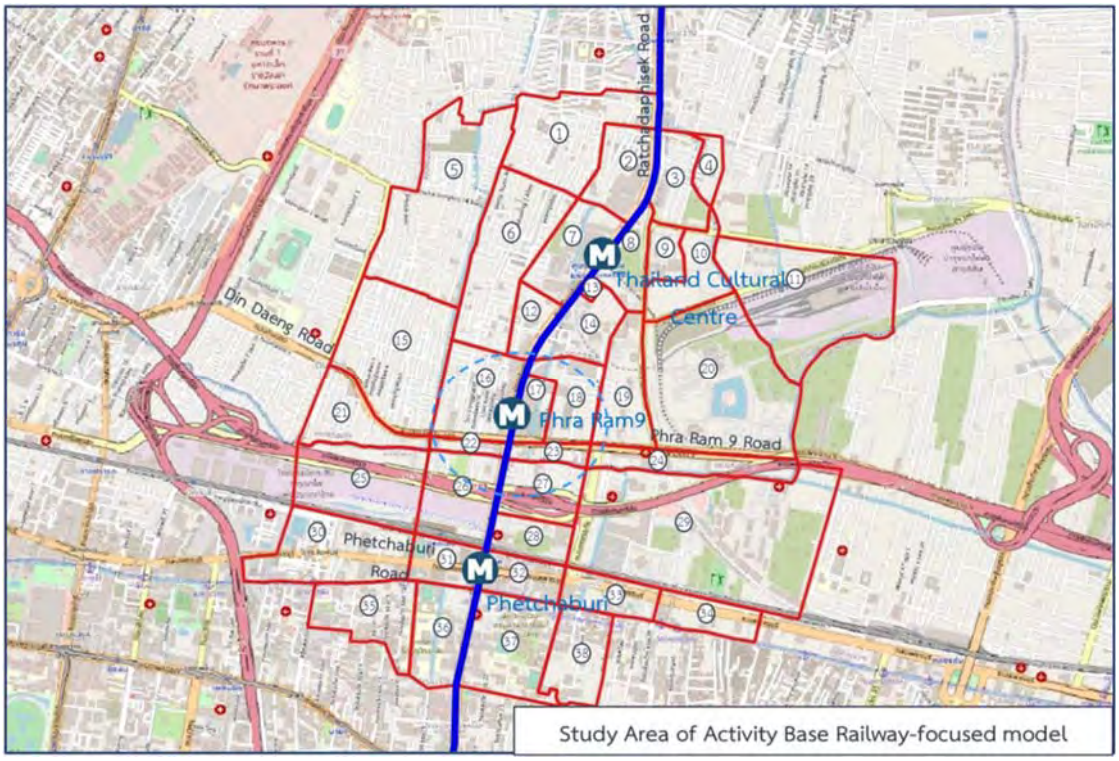


図 A アクティビティベースモデルの対象地域

2. モバイルデータの取得

アクティビティベースモデルの検討において、HIS のデータでは不十分なため、モバイルデータを活用するとともに、追加アンケート調査（Travel Diary）を実施した。アンケート調査は個人と行動の属性を詳細に取得できるが、予算の制約で 925 サンプルのみの取得となっている。一方、活用したモバイルデータは携帯電話基地局データで、通信会社の TRUE から購入し、2,500 件、7 日間分を取得した。COVID-19 の影響を排除するため、2019 年 12 月時点のデータを購入した。携帯電話基地局データの特徴は以下に示す。

- アンケート調査よりサンプル数が多い
- 時間ごとに 7 日間分の行動が把握できる
- 滞在地（住宅、職場）情報がある（通信会社の推計値）
- 移動目的、交通手段の情報がない

Unique_n	probability	LAT	LON	first_par_datetime	province_th	district_th	sub_district_th	duration	last_par_datetim	subs_type	monthly_payment	gender	age_grp	location2
Uq1	1	13.78112	100.5775	1/12/2019 0:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	1440	2/12/2019 0:00	POST	3.Pay_200to599	female	19-25	home
Uq1	1	13.78112	100.5775	2/12/2019 2:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	360	2/12/2019 8:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.035878181	13.76228	100.5688	2/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	2/12/2019 8:00	POST	3.Pay_200to599	female	19-25	work
Uq1	1	13.76228	100.5688	2/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	540	2/12/2019 18:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.003824092	13.78112	100.5775	2/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	2/12/2019 19:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.072657744	13.77789	100.5774	2/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	2/12/2019 19:00	POST	3.Pay_200to599	female	19-25	
Uq1	1	13.78112	100.5775	2/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	660	3/12/2019 7:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.058342624	13.76228	100.5688	3/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	3/12/2019 8:00	POST	3.Pay_200to599	female	19-25	work
Uq1	1	13.76191	100.5682	3/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	600	3/12/2019 19:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.277149709	13.78112	100.5775	3/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	3/12/2019 20:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.004841549	13.78112	100.5775	4/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 8:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.381956649	13.76191	100.5682	4/12/2019 9:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 9:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.13877551	13.75874	100.5651	4/12/2019 10:00	กรุงเทพมหานคร	ดินแดง	ดินแดง	0	4/12/2019 10:00	POST	3.Pay_200to599	female	19-25	
Uq1	0.428571429	13.76225	100.5682	4/12/2019 10:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 10:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.325868504	13.75772	100.5648	4/12/2019 11:00	กรุงเทพมหานคร	ดินแดง	ดินแดง	0	4/12/2019 11:00	POST	3.Pay_200to599	female	19-25	
Uq1	0.999260355	13.75661	100.5667	4/12/2019 12:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	60	4/12/2019 13:00	POST	3.Pay_200to599	female	19-25	stop
Uq1	0.761406844	13.76225	100.5682	4/12/2019 14:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	240	4/12/2019 18:00	POST	3.Pay_200to599	female	19-25	work
Uq1	0.006334581	13.78112	100.5775	4/12/2019 19:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	4/12/2019 19:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.978661494	13.78112	100.5775	4/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	300	5/12/2019 1:00	POST	3.Pay_200to599	female	19-25	home
Uq1	1	13.78112	100.5775	5/12/2019 1:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	300	5/12/2019 6:00	POST	3.Pay_200to599	female	19-25	home
Uq1	1	13.78112	100.5775	5/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	240	5/12/2019 12:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.004610656	13.78112	100.5775	5/12/2019 13:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	5/12/2019 13:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.689140811	13.81618	100.5606	5/12/2019 14:00	กรุงเทพมหานคร	จตุจักร	จตุจักร	120	5/12/2019 16:00	POST	3.Pay_200to599	female	19-25	stop
Uq1	1	13.78112	100.5775	5/12/2019 20:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	600	6/12/2019 6:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.5432	13.78112	100.5775	6/12/2019 7:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	0	6/12/2019 7:00	POST	3.Pay_200to599	female	19-25	home
Uq1	0.746196958	13.76191	100.5682	6/12/2019 8:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	120	6/12/2019 10:00	POST	3.Pay_200to599	female	19-25	work
Uq1	1	13.76228	100.5688	6/12/2019 14:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	180	6/12/2019 17:00	POST	3.Pay_200to599	female	19-25	work
Uq1	1	13.78112	100.5775	6/12/2019 18:00	กรุงเทพมหานคร	ห้วยขวาง	ห้วยขวาง	1020	7/12/2019 11:00	POST	3.Pay_200to599	female	19-25	home

図 B 携帯電話基地局データ（例）

3. モバイルデータの活用と課題

DRT コンサルタントより、アクティビティベースモデルで用いた携帯電話基地局データの課題を以下に示す。

課題 1：滞在地（住宅、職場）には欠損がある。
課題 2：基地局の範囲以上の詳細な滞在位置を把握できない。
課題 3：同じ時間帯でも複数の滞在地（複数の基地局）が記録されている。
課題 4：タイでは、規制の関係で、携帯電話の登録者は 18 歳以上である必要がある。#

携帯電話の基地局データを使った場合、先に示した課題 1 と 2 より、交通手段や移動目的等を推測することが困難であった。課題 3 によって現況より移動回数が多い結果となった。また、課題 4 より、通学関連トリップチェインのパラメータ推計が困難であった。

上記の課題があるため、DRT コンサルタントは、アクティビティベースモデルのパラメータ推計をアンケート調査データより実施した。携帯電話基地局データはモデルで推計した移動距離、住宅滞在時間、出社時間・帰宅時間の結果検証のみを活用した。



図 C 基地局範囲のボロノイ図

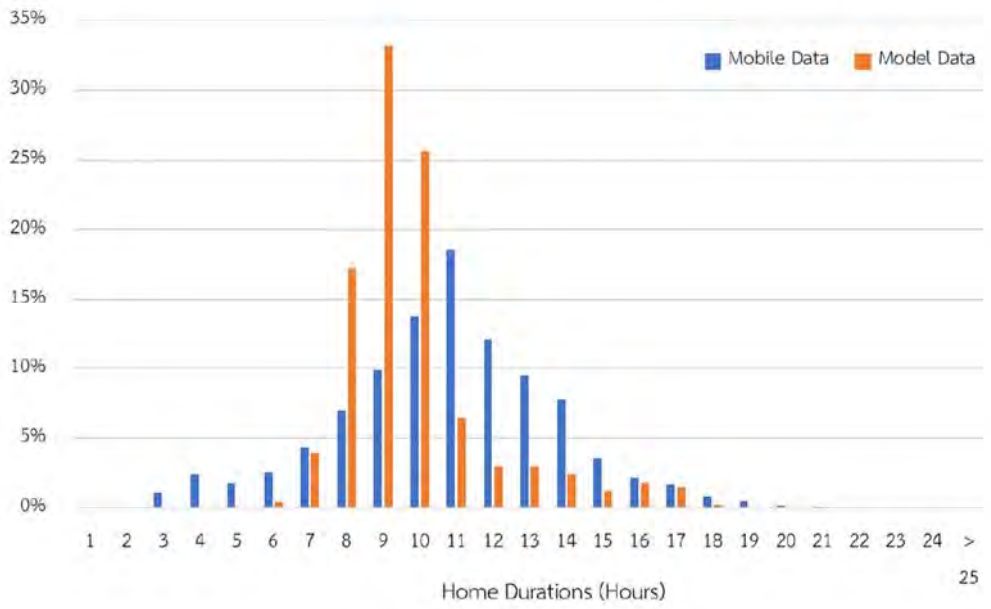


図 D 携帯電話基地局データとモデル推計値による住宅滞在期間の比較

4. 【成果 2:M-MAP2 詳細計画が策定され、タイ政府の承認プロセスに諮られる】に関する活動

4.1 概要

【成果 2:M-MAP2 詳細計画が策定され、タイ政府の承認プロセスに諮られる】に関する活動についても、DRT コンサルタントとの不定期での会議、月例協議で進捗の確認を実施してきた。M-MAP2 プラットフォームを設立し、日本人有識者、タイ有識者、鉄道事業者等の関係機関等を含めて議論を行い、新たな鉄道計画の策定を行ってきた。以下に、M-MAP2 プラットフォームで議題を以下に示す。なお、プラットフォームの目的や詳細については、次章に記す。

表 4.1.1 各 M-MAP2 プラットフォームでの議題

回	日時	議題
第 1 回	2022 年 7 月 5 日	・M-MAP2 プラットフォームの役割 ・M-MAP2 の政策方針
第 2 回	2022 年 10 月 17 日	・M-MAP2 プラットフォームのスケジュール ・評価対象路線
第 3 回	2023 年 3 月 7 日	・路線優先度の設定方法 ・M-MAP1 での計画路線のレビュー
第 4 回	2023 年 8 月 10 日	・鉄道運賃調査検討状況の紹介 ・路線優先度設定と M-MAP2 ネットワーク案
第 5 回	2024 年 2 月 7 日	・M-MAP2 路線の優先投資結果 (ベースラインシナリオ/輸送力増強シナリオ(増便、車両)) ・特急運転の提案

4.2 活動内容

4.2.1 都市開発、都市交通等の現状やトレンド分析や主要課題の特定への助言

都市開発、都市交通等の現状やトレンド分析や主要課題の特定を行うにあたり、以下の助言を行った。

- 月例協議において、M-MAP2 Blueprint では、現況の鉄道の混雑、将来の鉄道の輸送力の不足、鉄道不便地域の存在、都市構造への対応、空港アクセスの代替ルートの欠如を課題として設定をしたこと。
- また、課題は、定量的なデータに基づいたものが望ましいこと。

これの助言を受け、DRT 及び DRT コンサルタントは、主要課題として、以下を整理した。

表 4.2.1 DRT 及び DRT コンサルタントによる主要課題

人口に関する問題	都市交通に関する問題	公共交通システムに関する問題
• BMA における人口の増加 • 高齢化社会 • 都市の拡大 • 生活費	• 車の急激な増加 • 道路混雑 • 公共交通機関の利用 • 空港利用の増加	• 鉄道の混雑 • 公共交通ネットワークのカバーエリアの不足 • 踏切 • 鉄道駅での乗換え • 駅へのアクセス • 運賃の一貫性

4.2.2 特定された課題の分析と改善案の検討への助言

特定された課題の分析と改善案の検討を行うにあたり、以下の助言を行った。

- 月例協議において、東京首都圏の鉄道マスタープラン（運輸政策審議会答申第 18 号）では、以下の 5 の政策目標の設定と評価指標していること。

表 4.2.2 運輸政策審議会答申第 18 号における政策目標とのその評価指標

政策目標	指標
1. 鉄道の混雑緩和	• 最大混雑区間の混雑率 • 混雑率 150%以上の混雑長
2. 速達性の向上	• 時間短縮（全体） • 時間短縮(主要区間)
3. 都市構造・機能の再編整備等への対応	• 全体のアクセス・イグレス時間 • 乗換時間／乗換回数(副都心から中心部) • 乗換時間／乗換回数(業務核都市か中心駅)
4. 空港、新幹線等へのアクセス機能の強化	• 乗換時間／乗換回数（全体） • 乗換時間／乗換回数（主要拠点から）
5. 交通サービスのバリアフリー化、シームレス化等の推進	• 乗換回数（全体） • 乗換回数（主要区間）

4.2.3 M-MAP2 Blueprint の主要政策手段についての助言

DRT コンサルタントが、M-MAP2 Blueprint の内容について、十分に理解していなかったため、以下のとおり紹介を行った。

・M-MAP2 Blueprint の概要を作成し、M-MAP2 Blueprint で検討した内容を月例会議で紹介した。概要では、提案した M-MAP2 Blueprint の全体のフレームワーク、主要な政策目標、政策目標別の主要政策手段を紹介した。

この助言を受け、DRT 及び DRT コンサルタントは、M-MAP2 Blueprint の理解を深めた。

4.2.4 鉄道整備政策手段についての助言

現況のバンコク首都圏の課題に基づき、東京首都圏の鉄道マスタープランの政策目標及び評価指標、M-MAP2 Blueprint での提案内容を勘案して、DRT 及び DRT コンサルタントは、政策目標及び評価指標を以下のように設定した。

表 4.2.3 政策目標とのその評価指標

政策目標	指標
1. 鉄道の車内混雑緩和	• 鉄道の混雑率 • 交通機関別利用割合
2. 鉄道ネットワークへの接続可能性の向上	• 鉄道沿線から 800m 圏内の人口
3. バンコク及びその近隣をカバーする鉄道輸送の増加	• 鉄道輸送システムによる移動の時間短縮と費用の節減 • 鉄道で乗換がないトリップ数
4. 運賃水準の適正化・公平化（良心的で公平）	• 各地域の鉄道旅客による移動費用
5. 他の交通機関との効率的な乗り継ぎ（インターモーダル）	• 鉄道に接続されている公共バスおよびバンの路線数と、公共バスおよびバンの総路線数との比率 • 鉄道に接続されているボート乗り場数とボート乗り

	場総数との比率 • 駐車場のある駅の数と全駅数の比率 • 鉄道駅へのアクセス時間、例えば、都市部の駅では 15 分以内、郊外の駅では 30 分以内 • 都市部および郊外の駅がカバーするエリア内の利用頻度の高い歩行者施設の割合

4.2.5 需要予測に基づき新たな路線計画策定への助言

まず、東京圏での整備対象路線の分類（A_1、A_2、B）の仕方について 2023 年 5 月 9 日のセミナーにおいて、以下の通り助言を行った。

A：目標年次までに整備を推進すべき路線

A_1：目標年次までに開業することが適当である路線

A_2：少なくとも開業年次までに整備を着手することが適当な路線

B：沿線の開発プロジェクトの進捗状況、輸送需要動向、投資能力等を踏まえつつ整備の必要性、整備方策等について検討すべき路線

この助言を受けて、DRT 及び DRT コンサルタントは、東京圏の事例に、フィーダー路線を追加し路線の分類を以下のように設定した。

A: 必要不可欠のルート

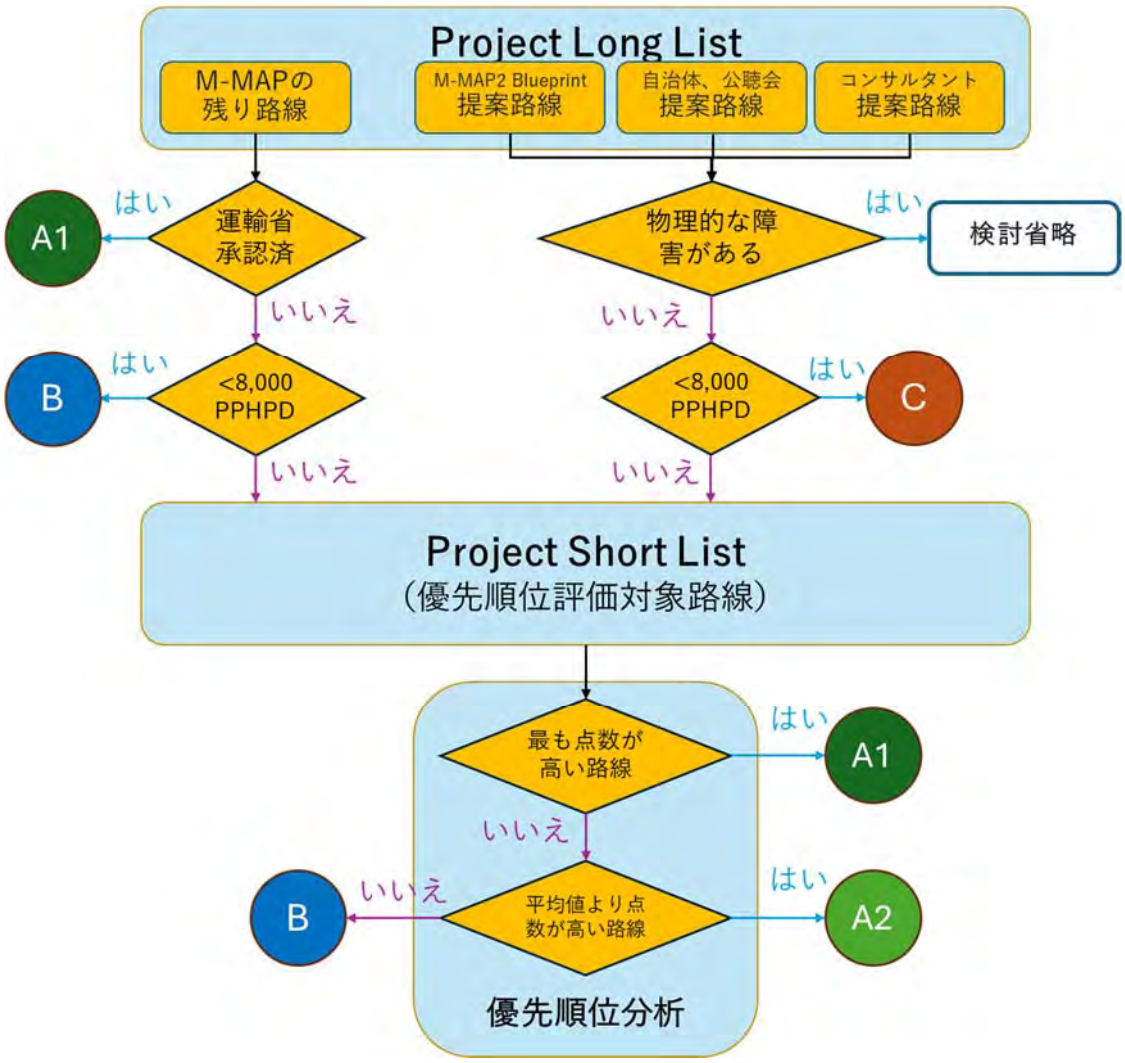
A1: 必要不可欠であり、すぐに実行可能

A2: 必要不可欠だが準備が必要（2029 年までに実施）

B: 可能性のあるルート：2029 年にプロジェクト実現可能性を再検討

C: トラムや電気バスなどの鉄道より輸送容量の低いフィーダーシステムとして実施

次に、路線の優先順位設定方法がわかりやすくなるように、その選定方法のフロー図に対して、助言を行った。この助言を受けて、DRT 及び DRT コンサルタントは、路線選定及び整備優先順位の設定方法を以下のようにした。



出典：DRT コンサルタント資料より、JET 作成

図 4.2.1 路線の優先順位設定方法のフロー

優先順位設定方法は東京圏都市鉄道マスタープランで実施した方法と異なる方法を取った。分析基準を以下に解説する。

検討対象路線（Project Longlist）より、M-MAP 計画路線、M-MAP2 で挙げられた候補路線を 2 グループに分別し、それぞれにスクリーニングを行った。

- M-MAP 計画路線に関しては、12 の計画路線のうち、現在までに整備されていない路線・延伸区間を検討した。M-MAP 路線グループのスクリーニング基準は、MOT が既に承認した路線・延伸区間を A1 とし、次に 2040 年の需要予測結果を基づき、8,000PPHPD（1 方向 1 時間当たり 8,000 人）未満の路線を B とした。
- M-MAP2 の候補路線として、M-MAP2 Blueprint での提案路線、自治体の提案路線、公聴会でヒアリングした路線、及び DRT コンサルタントの提案路線がある。この候補路線のスクリーニング基準は、先ず、用地がない、あるいは土地収用が難しい路線は削除し、残り路線は M-MAP 計画路線の基準と同様に、8,000PPHPD 未満の路線を C とした。

路線候補を以下のように設定した。

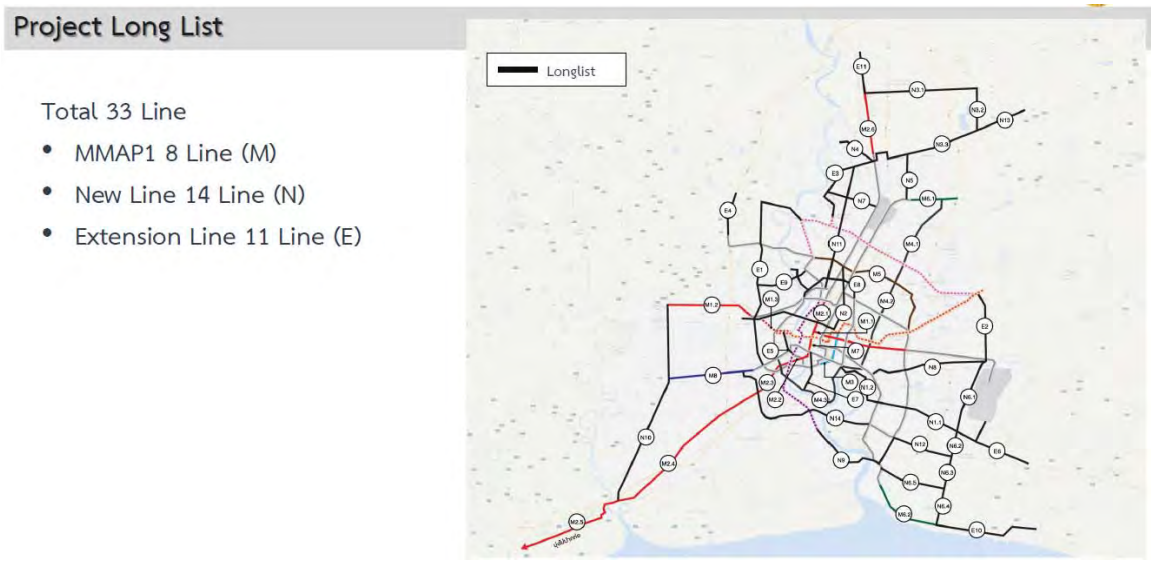


図 4.2.2 路線候補

M-MAP2 の路線候補は、スクリーニング後、優先順位評価対象路線（Project Shortlist）として優先順位分析を行った。

- 4.2.2 で紹介した運輸政策審議会答申第 18 号で用いた評価指標を参考し、4.2.4 では政策目標を評価できる優先順位の評価指標を作成した。
- DRT 職員、M-MAP2 プラットフォームに参加している関連組織の代表、タイアカデミアを対象に、以下の評価指標の重要性を調査し、評価指標のウエイトを決めた。

評価指標とウエイトを以下のように設定した。

Network Evaluation

Factor	Subfactor	Factor	Subfactor
Planning Policy 41 Point	Capacity • Modal Share (By Rail) (%) • In-vehicle (Rail) Congestion • Transfer Delay (By Rail) Coverage • Population within Coverage Area Connectivity • Average Travel Cost By Rail • Direct O-D Pairs per Total O-D Pairs Intermodal and Accessibility • PT Lines Accessible to Rail • High Quality Walk Link within Coverage Area • Access Time	Readiness 16 Point	Progress of Project
		Ease of Implementation 10 Point	• Right of Way • Utilities demolition • Traffic Impact
		Financial, Economic and Social Return 23 Point	• Economic Return (EIRR) • Financial Return (FIRR) • Social Return on Investment (SROI)
		Environment Impacts 10 Point	• Water sources surrounding the project • Sensitive areas • number of traffic intersections • Land and buildings to be expropriated

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図 4.2.3 整備優先順位の評価指標

評価指標とそのウエイトを基に、2040 年の各優先順位評価対象路線の総合指数を算出し、以下の基準より路線順位を決めた。

- A1：最も点数が高い路線
- A2：平均値より点数が高い路線

- B：平均値より点数が低い路線

そして、整備優先順位を以下のように設定した。

A1: Imperative and Ready to Proceed

"Immediately Implemented"

Line List
1) Red Line Rangsit – Thammasart (Commuter)
2) Red Line Taling Chan – Salaya (Commuter)
3) Red Line Taling Chan – Siriraj (Commuter)
4) Brown Line Khae Rai - Bueng Kum (LRT/Monorail/AGT)



図 4.2.4　M-MAP2 の整備優先順位 A1

A2: Imperative but Need Some Preparation

"Implemented by the year 2029"

Line List
1) Red Line (Bang Sue - Hua Lamphong) (Commuter)
2) Green Line (Silom) National Stadium – Yotse (Heavy Rail)
3) Green Line Bang Wa - Taling Chan (Heavy Rail)
4) Gold Line Klong San – Prachatipok (AGT)
5) Silver Line Bangna – Suvarnabhumi (LRT/Monorail/AGT)
6) Gray Line: Watcharaphon – Thonglor (LRT/Monorail/AGT)



図 4.2.5 M-MAP2 の整備優先順位 A2

Group B Potential Route

"Reconsidered project feasibility in 2029"

Line List
1) Cyan Line Sathon – Din Daeng (LRT/Monorail/AGT)
2) Green Line Khu Khot - Outer Ring Road (Heavy Rail)
3) Gray Line: Lam Luk Ka – Watcharaphon (LRT/Monorail/AGT)
4) Gray Line Phra Khanong - Tha Phra (LRT/Monorail/AGT)
5) Red Line Hua Lamphong - Wongwian Yai (Commuter)
6) Red Line Bang Bon – Mahachai – Paktho (Commuter)
7) Green Line Samutprakarn – Bangpu (Heavy Rail)
8) Blue Line Bangkhae – Phutthamonthon sai 4 (Heavy Rail)
9) Green Line Taling Chan – Rattanathibet (Heavy Rail)
10) Red Line Wongwian Yai - Bang Bon (Commuter)



図 4.2.6 M-MAP2 の整備優先順位 B

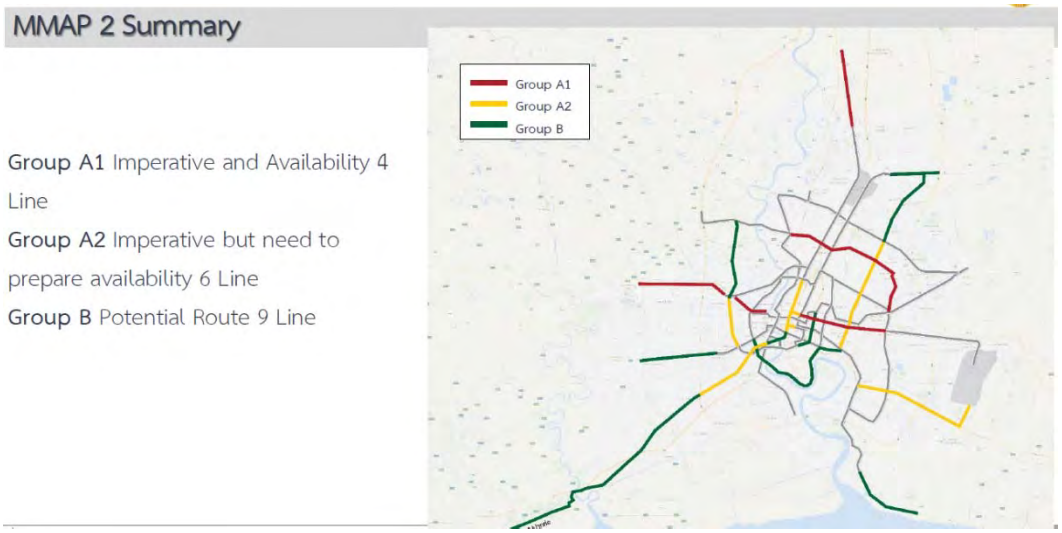


図 4.2.7 M-MAP2 の整備優先順位 A1, A2, B

4.2.6 各路線につき運賃収入以外の収入最大化を図る財務手法についての検討

1) 運賃収入以外の収入最大化の必要性

DRTから、都市鉄道事業者における運賃収入以外の収入を最大化することで、①鉄道事業の収益に充当することで運賃値上げを抑制する、さらには、②インフラ整備やネットワーク拡大に充当する可能性を模索したいとの要望があげられている。①の事例としては、本邦鉄道事業者の付帯収益の動向を、②の事例としては、本邦および海外における Land value capture（LVC）など地価上昇による便益を取り込む手法などを参考にすることを要望している。

これら要望に対応すべく、本技術協力プロジェクトの活動においては、それぞれ ①鉄道事業の付帯収益（以下、「付帯収益」という）、②事業領域の拡大による収益（以下、「拡大収益」という）に分けて、本邦および世界の代表的な事例を整理し、DRT 側に有益となる示唆を与えることに努めた。①の付帯収益では、本邦鉄道事業者において多様な付帯収益最大化の取り組みがなされていること、同時に利用者にとっての利便性も向上していることに勘案し、本邦の事例をとりあげた。他方、②については本邦においても過去には田園都市線、最近ではつくばエクスプレス整備手法が良い参考となるが、これら事例については既に説明済みであることから、海外を中心に（一部本邦もあり）鉄道事業者の事業領域拡大事例をとりあげた。

表 4.2.4 運賃収益以外の収益の分類

	鉄道事業「付帯収益」	事業領域拡大による「拡大収益」
定義	当該鉄道事業の施設を副次的に活用することにより可能となる事業から得られる収益。	当該鉄道事業の地理的な拡大や、同事業者もしくは同事業者と資本関係を有する事業者が実施する鉄道事業以外の事業。
事例	• 車内外広告収益 • 駅等施設における広告収益、エキナカ、高架下施設等の賃貸料収益	• 道路旅客・貨物輸送事業（バス、タクシー、宅配、トラック） • 卸売小売業（スーパー、コンビニ、旅行代理店、通販等） • 金融業（クレジットカード、保険等） • 電気ガス熱供給業 • 情報通信業、データ関連事業 • 不動産・物品賃貸業

		• 宿泊・飲食サービス業（ホテル、飲食店） • その他サービス業
会計上の扱い	会計上、鉄道事業の収益の一部として扱われる。	鉄道事業とは別の事業における収益として扱われる。
収入の享受者	(a)鉄道事業者が別事業として自ら実施するケース、(b)関連会社の事業として実施するケース、(c)資本関係を持たない他社が実施し、施設使用料等の収益を得る場合の、いずれの場合も含む。	(a)鉄道事業者が別の事業として自ら実施するケース、(b)関連会社の事業として実施するケースのいずれの場合も含む。
鉄道事業にもたらす効果	鉄道事業の収益構造の改善に寄与し、運賃収入の値上げ圧力を縮減する。	収益の改善が期待できない鉄道事業であっても、拡大収益をえることで、全体としては持続可能な収益を確保することが可能となる。
バンコクで想定される効果	MRTA が BEM に発注している鉄道事業とは別途、自らが保有する施設等を使った広告料や賃貸料などで収益を上げ、鉄道事業に必要な公的資金の軽減を図る。	MRTA が今後、高い収益が期待できない路線の整備・運営事業を調達するに際し、収益性の高い事業（政府保有地の開発など）への展開機会もあわせて提要することにより、公的資金充当の必要性をなくす、もしくは軽減する。

出典：JET

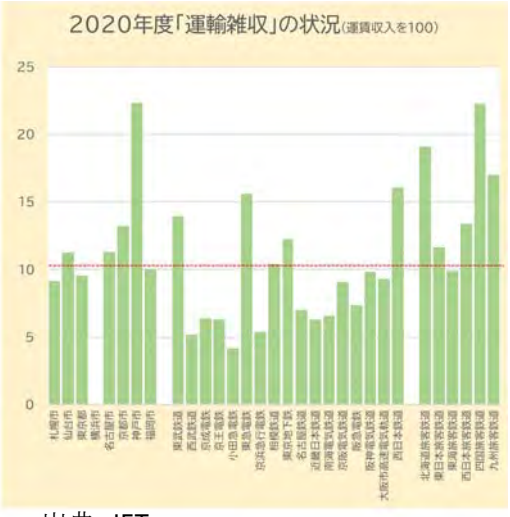
バンコク都市鉄道は路線ごとに PPP 調達で選定された事業者が運営しているが、いずれの路線の責任分担構造においても運営事業者が上表に示した①鉄道事業「付帯収益」を最大化して鉄道事業に必要とされる公的な財政支援を減らすインセンティブを持たせる仕組みにはなっていない。そのため、②事業領域拡大による「拡大収益」を増やす努力を事業者に促す仕組みの構築方法、ならびに拡大収益を積極的に追求している事業者の事例について DRT と協議を行った。DRT 側からは、鉄道事業は、本来は政府が実施するものを PPP 法に基づき事業内容を明確に規定して民間に任せている関係上、規定を超える事業展開は困難であり、そのためバンコクでは鉄道事業に携わる事業者に拡大収益の増加を期待することはできないとの制約が指摘された。この点については、財務省国営企業政策事務局（SEPO）とも協議を行った。

2) 本邦鉄道事業者の付帯収益の動向

DRT からの要望に応えるため、本邦鉄道事業者の附帯収益と鉄道運賃の概況、運輸政策審議会答申に示された乗継運賃割引制度等も含め、「本邦鉄道運賃」に関連する情報をタイ側関係者向けに共有した。

附帯収益は、駅構内で事業を営む構内営業者から得られる構内営業料、広告料や鉄道用地を貸し付けた際の土地建物高架下貸付料である。

この付帯収益は、「鉄道事業会計規則」において、「運輸雑収」として整理される。「鉄道統計年報（2020 年度）」をもとに公営、大手民鉄等、各社毎の鉄道運賃収入を 100 とすると「運賃雑収」の指数は、図 4.2.8 となる。



出典：JET

図 4.2.8 2020 年度運輸雑収の状況

東京地下鉄（帝都高速度交通営団）の「運賃雑収」の推移を見てみると図 4.2.9 となり、「運賃雑収」が、運賃値上げの抑制に寄与していたと考えられる。



出典：JET

図 4.2.9 東京地下鉄における運輸雑収の割合の推移

附帯収益の概要のポイントを以下に記載する。

(i) 本邦初となる地下高速鉄道、銀座線の開業時代（1927 年）から兼業による経営多角化が行われていた。浅草駅ビルを建設、地下食堂の開店、上野駅構内を利用した「地下鉄ストア」の開店等による兼業の展開により、附帯収益を鉄道事業収益に充当していた。

(ii) 駅構内や鉄道車両内への紙媒体広告による広告収入、駅売店設置による物品販売、鉄道線路の高架下施設及び有効活用できていない保有用地の活用策として、自動車の駐車料金収受、駅構内スペースの移設工事を伴う再編成による駅構内事業展開に至る。

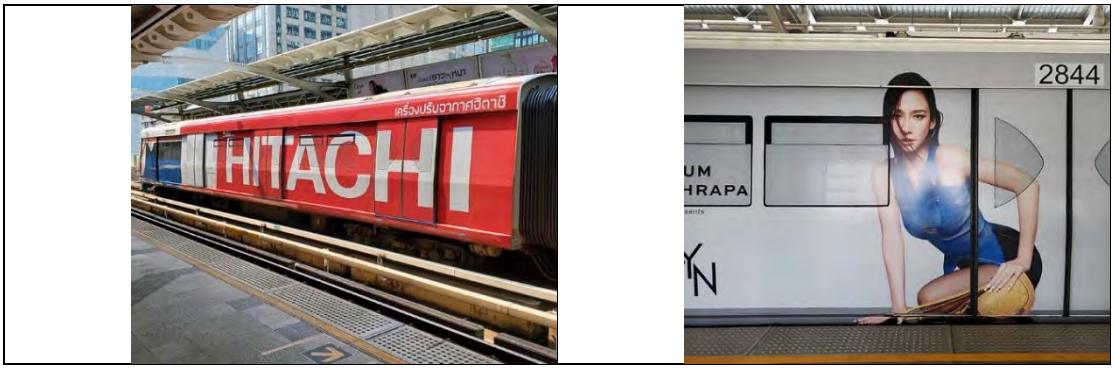
(iii) 利用者ニーズ等や社会環境変化に的確に対応することで、付帯収益を確保（運賃収入に対し 10%程度）しつつ、鉄道運賃値上げを抑制してきた経緯を紹介した。

DRT からは、鉄道施設に対する減価償却期間（年数）、将来の大規模改良工事の事業額の推移、鉄道運賃設定の考え方、運賃改定の仕組み等に関するものであった。なお、鉄道運賃については、月例会議や DRT 主催の Public Hearing、Learning Session の機会を活用し、東京都市圏の経験を取りまとめて発表を行った（添付資料 9 参照）。

3) バンコク都市鉄道における付帯収益の現状

バンコク都市鉄道事業においても、附帯収益として、駅構内や鉄道車両の活用事例が進んでいる。グリーラインでは、車両の窓ガラスを含め、側面全面が広告スペースである。駅で乗車待ちの利用者だけでなく、街なかの市民にも、訴求可能な動く広告となっている。車外景色も認識できるよう工夫された特殊加工したフィルムを車両の窓ガラスに貼付することで、ブラインドの役割もある。（図 4.2.10 参照）

なお、本邦では「良好な景観を形成し、若しくは風致を維持し、又は公衆に対する危害を防止すること」を目的とした『屋外広告物条例ガイドライン（1964 年）』により、広告物の面積、設置個所等細かく定められている。車両を活用した広告面積は、車両車体の面積の 30%以下と定められている。



出典：JET

図 4.2.10　グリーンラインの車体広告事例

グリーンラインでは、駅構内の広告も大型なものが多くあり、鉄道利用者への訴求力が高く、商品の認知向上等、広告主に対し、都市鉄道広告の媒体価値を高めている。これらの広告事業はグループ会社によって行われている。（下図 4.2.11 参照）



出典：JET

図 4.2.11　グリーンラインの駅構内広告事例

グリーンラインの主要駅では、改札コンコース階において、朝食・昼食の販売、雑貨販売、小店舗型等の施設がある。グリーンラインでは、改札内、改札外の双方に、商業施設が配置されている（下図 4.2.12 左）

ブルーラインやパープルラインでは、改札コンコース階の商業施設はないが、駅構内及び周辺商業施設との連絡通路を広範囲に有効活用し、本邦同様「エキナカ」、「駅チカ」による「駅スペース活用事業」（商業施設展開）が行われている。（下図右、Chatuchak Park 駅（BL13））。レッドラインでは、改札コンコース階の改札外において、小規模な売店が設置されている。



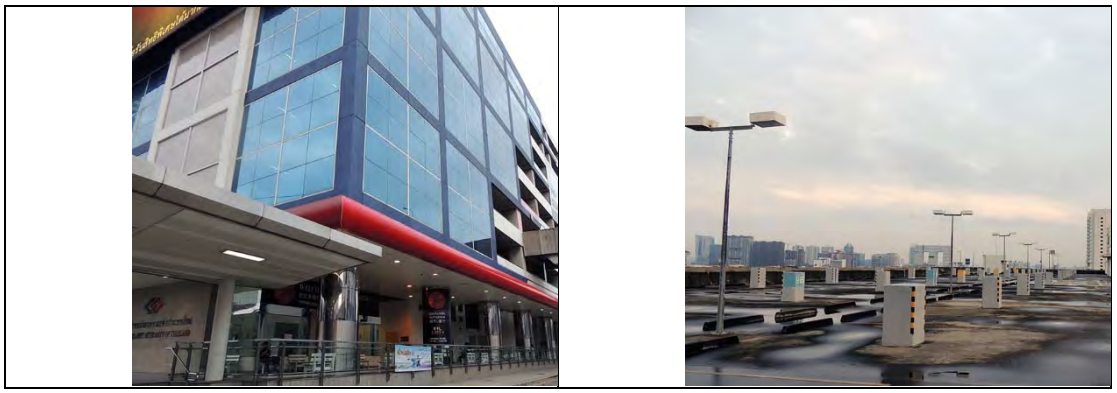
出典：JET

図 4.2.12　駅構内の商業施設事業例

以上のように、バンコク都の都市鉄道では、特にグリーンラインにおいて、附帯収益を得るため鉄道施設の活用が多数進んでいる。

4) 新たな付帯収益の展開策

バンコクの都市鉄道では、MRTA が事業主体となっている路線を中心に、パークアンドライン用の駐車ビルの整備が進んでいる。ブルーラインの Lat Phrao 駅（BL15）には、パークアンドライド用の駐車ビルがあり、多くの利用が見られた。イエローラインの開業（2023 年 7 月：営業運転開始）により、パークアンドライド（自家用車+駐車場利用）から「イエローライン乗車＋ブルーラインへ乗換」と転換が進めば本駐車ビルを全面的に商業利用ビルへ転用し、有効活用可能であると考える。（図 4.2.13 参照）



出典：JET

図 4.2.13 Lat Phrao 駅のパークアンドライド駐車場

5) 本邦鉄道事業者の新たな付帯収益の動向

また、DRT 及び DRT 関係者等へ本邦、鉄道事業者の取組事例等を参考とし、「新たな付帯収益の展開策」として下表をもとに共有した。バンコクの都市鉄道利用者等のニーズを的確に把握しつつ、検討することが重要であることも共有した。

表 4.2.5 運賃収入以外の収益の例

企業向け	鉄道利用者向け
「駅」 ・ 駅名（副駅名称）の命名権を販売 ・ 発車メロディー（乗降促進ブザー音）の権利を販売 「高架下」 ・ 野菜の水耕栽培工場の設置 ・ 騒音対策を実施し、業務及び居住等スペースを提供	「駅」 ・ コインロッカーの設置 ・ 荷物預かり、移送サービスの提供 ・ 自動販売機の設置 ・ 有料多機能トイレの設置 ・ 有料ベビー休憩室の設置 ・ シェアオフィスの設置 ・ 改札口の入場出場情報を活用した見守りサービスを提供 「高架下」 ・ 保育園の設置 ・ アウトドア体験施設の設置 ・ 鉄道博物館の設置

出典：JET

6) 鉄道事業の事業領域拡大による拡大収益最大化のための事例検討

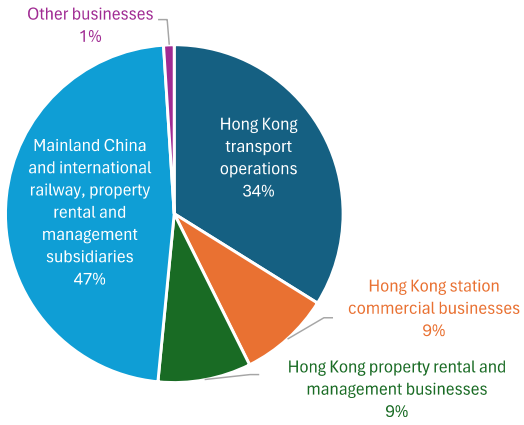
本邦の鉄道事業社が自動車事業、流通事業、不動産事業等に事業領域を拡大し、鉄道事業以

外の事業からも収益を得ており、これら拡大収益は鉄道事業からの収益を大幅に上回る事例もある。また海外の事例では、業態の多様化に加え、本来手掛けていた鉄道事業の地理的な（第三国への）展開による事業拡大を図る事例も少なくない。これらの事業領域拡大事例を分析し、バンコクの都市鉄道を運営する事業者についても事業拡大が実現し、運賃値上げ圧力の軽減や、インフラ整備促進に寄与することが期待できるシナリオ案を提示し、DRT 関係者とディスカションを、2024 年 3～4 月に実施した。

協議では、世界各地で鉄道事業の展開を進めている代表的な事業者をとりあげ、いずれの事業者も事業領域の拡大を図り、拡大収益増加をめざした企業グループ構造の構築を図っている様子を解説した（添付資料 11）。世界規模で鉄道事業に携わる代表的な事業者におけるこのような状況を踏まえ、バンコクにおいても事業者がそれぞれの鉄道路線の運営のみで事業採算を確保することを期待するのではなく、今後は、事業領域の多様化を促進する環境の構築と提供が必要となる旨を説明した。

Home market core business accounts for 34% only

Business segment	Revenue (HKD bill)
Hong Kong transport operations	9,342
Hong Kong station commercial businesses	2,415
Hong Kong property rental and management businesses	2,456
Mainland China and international railway, property rental and management subsidiaries	13,079
Other businesses	282
TOTAL	27,574



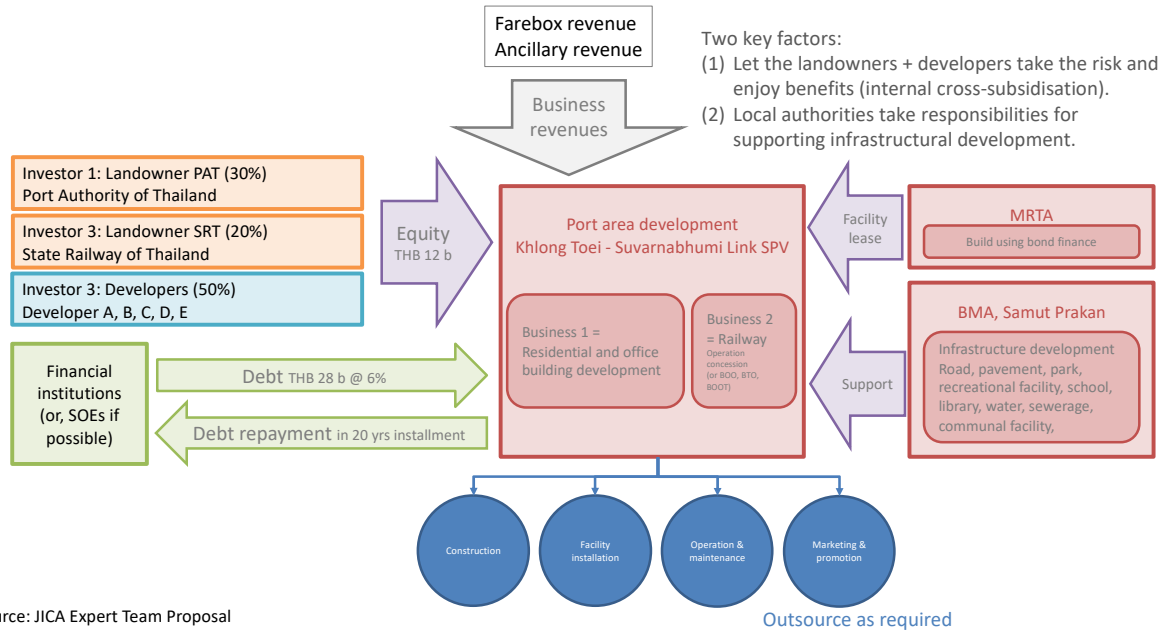
出典：香港 MTR 社 2023 年報より JET 作成

図 4.2.14　世界に展開する鉄道事業者の収益構造からみた事業領域拡大状況（香港 MTR 社の事例）

なお、鉄道事業者の事業領域拡大による、企業グループとしての収益の安定化の事例として最もわかりやすい事例は、日本の民鉄各社における事業領域多様化の事例であり、一例として東急グループの例もあわせて解説に加えている。

7)　新都市開発による開発利益を鉄道整備に活用する可能性に関する提案

都市鉄道路線の新規整備に際し、同都市鉄道事業単体では事業採算性が確保できなくとも、周辺地区における都市開発による不動産収入を含めると全体としては採算上も事業が成立することも考えられる。そこで 2023 年 4 月の現地活動においては、本邦における比較的最近の事例として、みなとみらい線と横浜みなとみらい 21 をとりあげ、都市鉄道整備が大規模再開発と一体的に進められたケースを紹介した（添付資料 12）。特に自治体、デベロパー、鉄道事業者それぞれが事業にどのように関与し、その背景にはどのような理由があったのか、結果的にどのようにして事業全体として成功したのかを解説した。



Source: JICA Expert Team Proposal

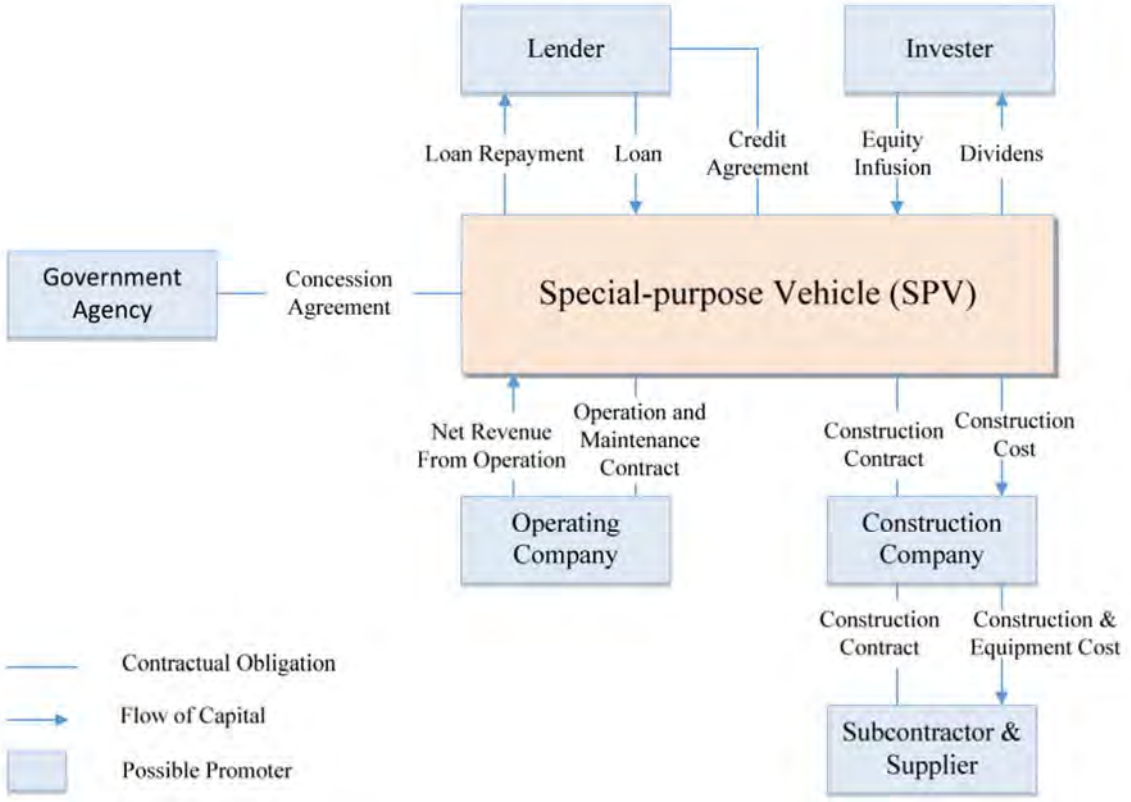
出典：JET

図 4.2.15　Khlong Toei - Suvarnabhumi Link (鉄道、地区一体開発モデル)

日本の事例をもとに、バンコクにおける類似事例実施の可能性として、Khlong Toei - Suvarnabhumi Link を近接するタイ港湾局が保有する遊休地の再開発とあわせて実施することを想定し、事業スキーム、関係機関の参加形態につき具体的な提案を行なった。これに対しタイ側からは鉄道事業と地区再開発事業を一体的に進めた事例はなく、実現は容易ではなさそうな点、現行の PPP 法で調達方法が定められている中、実施事業者の選定は非常に困難になることが予想される点などが指摘された。

DRT 側からの指摘を受け、例えば鉄道事業と地区開発事業を一体的に進める事業を現行 PPP 法に基づいて進めることがなぜ困難であるのか、どのような条件であれば可能となるのかを確認するため、2024 年 4 月に DRT 関係者の同席を得て PPP 法に基づく民間事業者調達を担当する財務省国営企業政策事務局（SEPO）との協議を行った。協議では鉄道事業と地区開発事業を一体的に進める事業の推進により期待される効果として財政負担軽減、公共交通指向型開発（TOD）の促進などをあげ、SEPO としての見解を聴取した。

その結果、SEPO としても PPP 法に基づく民間事業者調達を通じて一体的開発を推進することをむしろ推奨する姿勢であることが確認できた。その際の条件としては、官民共同で特殊目的会社（SPV）を設置する場合に公共セクター（省庁、国営企業、地方自治体等）からの出資が資本の過半であり、SPV 自体が国営企業の定義に該当すること、当該 SPV の業務所掌が国営企業として妥当なものであることが指摘された。



出典：SEPO

図 4.2.16　SEPO が規定する PPP スキーム構造

なお、上記提案とあわせて、タイ側からの要望に応じる形で、バンコク首都圏の都市交通における公的財政支援の負担軽減策や、本邦での一体的開発事例における自治体が果たしている役割（開発計画策定の面、財政支援の面）の大きさについても事例紹介を含めて議論を行った。

8)　不採算鉄道事業のPPP調達に係る財務手法と拡大収益活用

都市鉄道の新規整備に際し、低い採算性が見込まれる場合であっても極力公的な補助を回避するための手法についてタイ側から相談が寄せられていることを踏まえ、これまでも政策金融の活用、資金調達コスト最小化の工夫等について本邦の事例を紹介してきた。このような財務手法に関する議論に加え、2022 年 10 月の現地活動においては、タイの PPP 法に基づく事業者選定、調達方法を勘案した上で、事業の詳細パッケージ化の一体化それぞれの特徴を比較し、いずれの方法がどのような場合に適しているのかを、公的支援最小化の観点から説明した（添付資料 13）。その中では一体化調達による拡大収益内部化のメリットを強調ことに加え、官民の間での協調的関係の構築の必要性、また本邦鉄道における相互直通運転に際する事業者同士の協力関係と役割分担の重要性も紹介した。さらには、Land Value Capture (LVC) に類似した形で地区開発事業から得られる利益をインフラ整備に内部的に充当する可能性も言及した。

Scheme	Support for operation	Exit scenario for MOF
0. Open Access (on existing infrastructure)	None	N/A
1. PPP Net Cost BTO	None (MRG if applicable)	
2. PPP Gross Cost BTO	Revenue guarantee	Subsidy for revenue guarantee will gradually decrease with the operator's efforts.
3. Infra & rolling stock separation BTO	Revenue guarantee Rolling stock acquisition	
4. Public Corporation	Operation cost - farebox revenue	With the operator's efforts, operation will become profitable, to be privatised. => Sales profit + capital gain

出典：JET

図 4.2.17　スキーム別事業補助形態

タイ側からは、PPP 法に基づく調達方法の詳細については、財務当局マターであり、調達方法を鉄道行政側で検討することには限界がある旨の反応があった。加えて、鉄道行政と都市整備行政との連携が必要とされる点に関しても、タイ側としては高い関心を示しているものの、実践に向けては未だハードルは高いと認識している様子がうかがえた。

バンコクの都市鉄道に適用されてきた財政面での公的な支援は、これまでの事例としてはインフラ等の現物支給（上下分離の場合）、収益保証（PPP グロスコストの場合）が主なものである。タイに限らず多くの国における PPP 調達では、資金調達を民間側の分担と規定していることもあり、バンコクの都市鉄道整備においても、資金調達面で政府側が支援をしている事例はない。そこで、世界的に金利が上昇傾向にある中で、政策金融によるインフラ整備コスト抑制の必要性を強調し、日本では 1970 年代～2000 年頃にかけて財政投融資が重要な役割を果たしてきた旨、この財政投融資モデルはタイにおいても有効に機能する可能性がある旨をタイ側に説明した（添付資料 14）。

DRT 職員への説明に加え、2024 年 4 月には、タイ財務省公的債務管理局（PDMO）に対し、日本の財政投融資をモデルとしたインフラ整備促進基金創設の可能性に関しディスカッションを持つ機会を得た。会合では、日本における 2000 年頃までの財政投融資および政策金融全般に関する説明および、政策金融がインフラ整備には不可欠であった旨を説明し、タイにおける類似の仕組み創設を提言した。

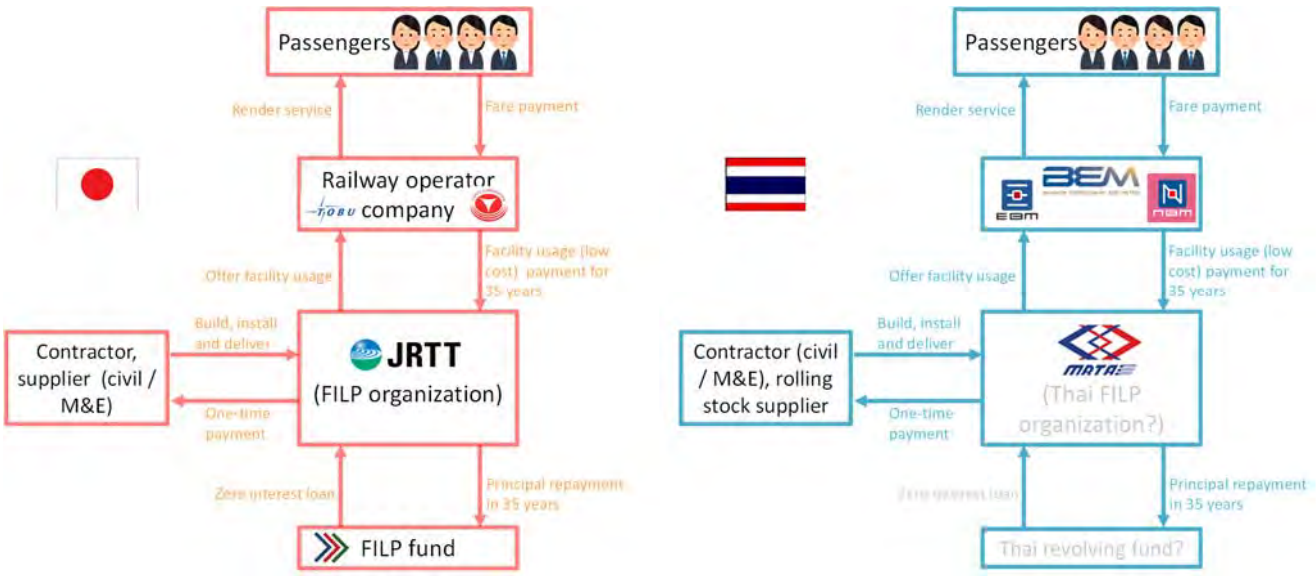
Thai Government has not addressed to relieving financing cost in PPP procurement.

	BTS (Green lines initial sections) Net cost BTO (civil) / BOT (M&E)	Net cost BOT MRTA (Blue initial section)	Net cost BTO MRTA (Pink, Yellow)	Gross cost BTO MRTA (Purple, Blue extension)	SOEs (Airport Rail Link, Red lines)
Land acquisition cost	ROW from gov't	Government	Government	Government	ROW from gov't
Financing cost	-	-	-	-	Not required
Infrastructure cost	-	Government	Government's fixed subsidy for the first 10 years	Gov't payback	Government
M&E cost	-	-		Government's remuneration	Government
Rolling stock cost	-	-			Government
O&M cost	-	-			Government

出典：JET

図 4.2.18　PPP 調達事業における資金調達コスト支援の必要性

このような提言に対し、PDMO としてはインフラ整備のための政策金融の原資を起債で調達することは可能としつつも、政府の保有資産活用如何を判断することは難しいとの見解であった。また、起債して調達した資金を政策金融に活用し、実質的に金利補填を行うことに対しては消極的な姿勢であった。DRT 職員からは、日本の鉄道・運輸機構（JRTT）が鉄道施設の保有、整備だけでなく財政投融資機関として金融面でも鉄道整備の促進に重要な役割を果たしている点を踏まえ、同様の仕組みが例えば MRTA などに備わることで日本の事例に類似した鉄道整備の実施を促進する仕組みが備わることが望ましい旨を PDMO 側に言及する場面もあった。このようなディスカションを踏まえ、DRT としても今後、都市鉄道整備促進のためのメカニズムのあり方について財務省とともに検討することに意欲を示していた。



出典：JET

図 4.2.19　鉄道整備促進の役割を担う財投機関を参考とした MRTA の政策金融機能案

4.2.7 各路線についての開発計画や政策策定への助言

路線計画以外でも鉄道整備の政策方針としてタイ側が将来検討すべき項目について、日本の事例を基に Learning Session として紹介した。以下にその内容を示す。

表 4.2.6 M-MAP2 の鉄道整備の政策方針

イベント名と日付	発表者	テーマ	概要
Monthly Meeting 2022 年 4 月 20 日 /6 月 15 日/7 月 20 日 Learning Session 2022 年 10 月 20 日 Seminar 2023 年 5 月 12 日	蕨真裕 Teeranai SRIMAHACHOTA	日本の鉄道料金システム （添付資料 9）	・日本の鉄道の運賃の概況と、東京での割引運賃や運賃外収入の事例、運輸政策審議会に示された運賃制度に関する記述を紹介した。 ・日本の鉄道料金システムについて、距離別や、事業開始年別にみた料金水準、鉄道料金種類、運賃の設定方法、許認可方法等、その歴史的な経緯とともに説明した。
Monthly Meeting 2022 年 9 月 28 日 Learning Session 2023 年 4 月 19 日 Seminar 2023 年 6 月 27 日	蕨真裕/ 加藤義彦/ WETWITOO Jetpan	急行運転 相互直通運転について Express Operation and Value-added Services (添付資料 10)	・東京都市圏における急行運転について、その必要性と運行方法について紹介をした。 ・東京首都圏の鉄道における、相互直通運転について、そのパターンと、事業項目ごとの鉄道事業者間の役割分担について、説明を行った（本邦研修への補足説明） ・鉄道事業における付加価値のあるサービスとして、グリーン車、拾得物サービス、ユニバーサルデザイン、観光列車について紹介した。
Learning Session 2023 年 4 月 21 日 SEPO 協議 2024 年 4 月 4 日	加藤義彦	鉄道事業の多角化/都市開発との一体化スキーム (添付資料 11、12)	・鉄道事業の多角化について、他国の鉄道事業者の事業領域の拡大、拡大収益増加の事例を紹介。 ・バンコク首都圏における、新規路線整備に対する事業スキームについて、日本の事例を踏まえながら、都市開発事業との連携の可能性と合わせて提案。
Learning Session 2022 年 10 月 20 日 PDMO 協議 2024 年 4 月 4 日	加藤義彦	鉄道事業に利用可能な財務手法 (添付資料 13,14)	・事業スキームの概況及び、資金支援となる投資、融資、補助金、投融資・補助金について整理を行った。また上下分離方式の特徴も整理。 ・採算性の低い都市鉄道事業への、政策金融の活用や資金調達コスト最小化の工夫等、日本の事例を紹介 ・タイの PPP 法に基づく事業者選定、調達方法を踏まえた上で、公的支援最初化の観点から、政策金融の可能性を提案。
Seminar 2023 年 5 月 11 日	増島哲二 Tithiwach Tansawat	バス交通 (添付資料 16)	・都市公共交通システムの一役を担うバス交通について、前半は東京都市圏でのバス交通の概要と役割について紹介し、後半はバンコク首都圏でのバス交通の現状と課題について議論した。

5. 【成果 3：M-MAP2 の具体的な実現に向けた取り組みが推進される】に関する活動

5.1 概要

バンコク首都圏（BMR）の M-MAP2 の関連政策を推進し、議論するために、DRT、JET、その他の関連機関と緊密に連携して活動を行った。これらの活動の目的は、M-MAP2 を具体的なプロジェクトとして形成し、効果的に実施することである。具体的には、以下のような活動を含む。

- M-MAP2 の認知度を高める広報活動
- M-MAP2 プラットフォームの確立
- M-MAP2 プラットフォーム会議の開催

5.2 活動内容

5.2.1 M-MAP2 の認知度を高めるための広報活動

M-MAP2 プロジェクトに関連する実施中の活動について情報を公開し、一般に知らせることを目的に、DRT と DRT コンサルタントは日本側と協力してセミナーを開催した。これらのセッションは、プロジェクトの詳細を広め、さまざまな機関や一般の人々からフィードバックを収集するための場として機能した。さらに、JET からも、鉄道政策に関する日本の経験に関する発表を行った。

表 5.2.1 M-MAP2 の広報活動

アイテム	議題	参加政府組織・関係機関	JET プレゼンテーション
第 1 回 Knowledge Transfer Training			
2021-11-24	· 前回会議（タイ側 WG 会議）議事録の承認 · 需要予測ワーキンググループの目的と DRT、DRT コンサルタント、JET 間の過去の活動 · バンコクの都市鉄道開発の概要 · M-MAP2 の交通調査・需要予測モデル	DRT, DRT Consultant, Thai Academia, JICA Expert Team, State Enterprise Policy Office, DLT, SRTET, BMTA, EEC, BMA, Bureau of the Budget, DPT, Provincial Land Transport Office of Samut Sakhon, Provincial Land Transport Office of Samut Prakan, Provincial Land Transport Office of Nonthaburi	小森氏と WETWITOO 氏 [JET]は、「日本の鉄道旅客需要予測モデル」というテーマを発表した。
第 1 回 M-MAP2 公聴会 [3 日間]			
2022-03-01 2022-03-02 2022-03-03	· M-MAP2 プロジェクトの紹介 · 大量輸送鉄道システムの利用促進 · 鉄道需要予測策定ガイドライン · 大量輸送鉄道システムと都市開発 · M-MAP2 ネットワークの開発計画	DRT, DRT Consultant, JICA Expert Team, MOT, DLT, OTP, SRT, SRTET, MRTA, BMTA, TTD - BMA, EEC, NESDC, local authorities (Samut Prakan, Nonthaburi, Pathum Thani, Nakhon Pathom, Samut Sakon), Thai Association for Town Planning, BTS, BEM, Krungthep#Thanakom PCL., Mass Media, Public Sector	
第 2 回 Knowledge Transfer Training [2 日間]			
2023-04-24	· 公共交通機関の利用促進 · 鉄道輸送需要予測モデルの入力データの準備 · 鉄道輸送需要予測モデル第 2 次入力データの準備	DRT, DRT Consultant, JICA Expert Team, MOT, DLT, OTP, SRT, SRTET, MRTA, BMTA, TTD - BMA, NESDC, BTS, BEM, SEPO	
2023-04-25	· 公共交通機関の利用を促進するための法的措置、役割、規制 · バンコク首都圏における鉄道旅行需		

アイテム	議題	参加政府組織・関係機関	JET プレゼンテーション
	要予測モデルの開発 · パイロットスタディ: アクティビティベースモデル (ABM) を開発するためのガイドライン		
第 2 回 M-MAP2 公聴会 [3 日間]			
2023-05-09	· 日本の鉄道運賃政策 · M-MAP2 のプロジェクト策定と需要予測モデル · アクティビティベースモデルの開発 · 鉄道網整備計画 · 鉄道輸送の利用促進に関する法令	DRT, JET, DLT, OTP, CAAT, BMTA, BMA, AOT, SEPO, Thailand Post, EGAT, Team Consulting Engineering, Sahamit Group, BEM, Royal Military Academy, Nim See Seng Transport 1988, Department of Rural Roads, Marine Department	蕨氏と WETWITOO 氏 [JET]が「日本の鉄道運賃政策」というテーマで講演。
2023-05-10	· 都市鉄道ネットワークの整備の方向性と提案 · M-MAP2 のプロジェクト策定と需要予測モデル · アクティビティベースモデルの開発 · 鉄道網整備計画 · 鉄道輸送の利用促進に関する法令	DRT, JET, SRTET, RMUTT, Kasem Bundit University, Public Sector, Sahamit Group, Topthai, BTS, Thai Airways, LS Electric, District Office [Buengkum, Bangkolaem, Nongchok, Ratchathewi, Bang Sue, Klongtoei, Wattana, Bangkhuntien, Ratburana, Bangkapi, Phranakhon, Dusit, Laksi], Thonburi, Engineering Institute of Thailand, The State Railway Workers, BTSC, MU, BEM, AOT, LTFT, KT, SRTET, RMUTP, MRTA	小森氏と WETWITOO 氏 [JET] 都市鉄道ネットワーク整備の方向性と提案について発表。
2023-05-11	· 都市公共交通システムの一部としてのバス輸送 · M-MAP2 のプロジェクト策定と需要予測モデル · アクティビティベースのモデル開発鉄道網整備計画 · 鉄道輸送の利用促進に関する法令	DRT, JET, Public Sector, Sahamit Group, Richie Place 2002 PLC, Topthai, Santimitr Transport, Supalai PLC, SK Auto Service, DNS Engineering, Starlight, Myplus Group, Transport, EK- Textile, Thanasiri, King Power, BEM, SCG Prop2morrow, Nakhonchai Air, SCCC, Loxley, DRT Consultant	増島氏と TANSAWAT 氏 [JET] 都市交通におけるバス交通について発表を行った。
3rd M-MAP2 Public Hearing [3 days]			
2023-06-27	· 急行運転と付加価値のあるサービス · M-MAP2 のプロジェクト策定と鉄道旅行需要予測モデルの開発 · 公共交通機関の利用促進 · M-MAP 2 ネットワーク開発の計画 · エンジニアリング環境と一般参加	DRT, DRT Consultant, JICA Expert Team, MOT, DLT, OTP, SRT, SRTET, MRTA, BMTA, TTD - BMA, local authorities (Samut Prakan, Nonthaburi, Pathum Thani, Nakhon Pathom, Samut Sakon), BTS, BEM, Mass Media (Living Pop, Render Thailand), Public Sector	蕨氏と SRIMAHACHOTA 氏 [JET]は、急行運転と付加価値のあるサービスについて発表した。
2023-06-28	· M-MAP2 のプロジェクト策定と鉄道旅行需要予測モデルの開発 · 公共交通機関の利用促進 · M-MAP 2 ネットワーク開発の計画 · エンジニアリング環境と一般参加	DRT, DRT Consultant, JICA Expert Team, MOT, DLT, OTP, SRT, SRTET, MRTA, BMTA, local authorities (Samut Prakan, Nonthaburi, Pathum Thani, Nakhon Pathom, Samut Sakon), BTS, BEM, Public Sector, SCG, RMUTT	
2023-06-29	· M-MAP2 のプロジェクト策定と鉄道旅行需要予測モデルの開発 · 公共交通機関の利用促進 · M-MAP 2 ネットワーク開発の計画 · エンジニアリング環境と一般参加	DRT, DRT Consultant, MOT, DLT, OTP, SRT, SRTET, MRTA, BMTA, JICA Expert Team, Mass Media, Public Sector, SCG	

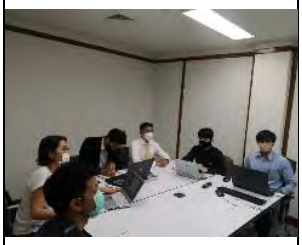
アイテム	議題	参加政府組織・関係機関	JET プレゼンテーション
4th M-MAP2 Public Hearing [3 days]			
2023-07-24	· 駅改修の必要性と駅構内シミュレーション · M-MAP2 ネットワーク開発 · M-MAP2 需要予測モデル開発アク · ティビティベースのモデル開発	DRT, DRT Consultant, MOT, DLT, OTP, SRT, SRTET, MRTA, BMTA, JICA Expert Team, Mass Media, ONEP, DOH, DRR, DOA, BEM, BMA, Civil Aviation, NESDC, SEPO, Port Authority of Thailand (PAT), Nakhon Pathom PAO, Samut Sakhon PAO, Samut Prakan PAO, Nonthaburi PAO	小森氏、蕨氏、WETWITOO 氏（JET）、花上氏（社会システム株式会社）が「駅改修の必要性と駅構内シミュレーション」というテーマで発表した。
2023-07-25	· 東南アジア・インドの都市鉄道プロジェクトにおける PPP 事例 · M-MAP2 ネットワーク開発 · M-MAP2 需要予測モデル開発 · アクティビティベースのモデル開発	DRT, DRT Consultant, JICA Expert Team, BMA District Office (50 Districts), BTS, Transport Co.,Ltd., Thai Airways, Chulalongkorm University, Thammasat University, Kasetsart University, KMUT, KMITL, RUTT, Rangsit University, Bangkok University, Dhurakij Pundit University	WETWITOO 氏（JET）は「東南アジアとインドの都市鉄道プロジェクトにおける PPP の事例というテーマで発表した。
2023-07-26	· 公共交通システムの代替案と解決策 · M-MAP2 ネットワーク開発 · M-MAP2 需要予測モデル開発 · アクティビティベースのモデル開発	DRT, DRT Consultant, JICA Expert Team, King Power International co., Ltd., Pruksa Real Estate PCL., Kitti Soonthorn Co., Ltd., SCG Logistic Management Co., Ltd., Public Sector, Nanthasan Co., Ltd., Moda Europa Co., Ltd., Unity Limited Partnership, CK Power Limited Partnership, Asian Seafood Co., Ltd., KMUTNB, Nakhon Thong Co., LTD., P Sky Co., Ltd., BAS Co., LTD., 168 Idea Engineering, A New Co., Ltd., Sri Vichai Co., Ltd., Rubi Railtec Asia Pacific, Swiss Advice Asia PTE. Ltd., Green Field Co., Ltd., Top Thai Co., Ltd., Siam City Cement PCL.	萩原氏と SRIMAHACHOTA 氏（JET）は「大量交通システムの代替案と解決策」というテーマで発表した。

Note:

AOT - Airports of Thailand PCL.
BEM - Bangkok Expressway and Metro PCL.
BMA - Bangkok Metropolitan Administration
BMTA - Bangkok Mass Transit Authority
BSCC - Siam City Cement
BTAJ - Bangkok Mass Transit System PCL.
BTSC - Bangkok Mass Transit System PCL.
CAAT - The Civil Aviation Authority of Thailand
DOA - Department of Airport
DOH - Department of Highway
DPT - Department of Public Works and Town & Country Planning
DRR - Department of Rural Road
DRT - Department of Rail Transport
EEC - Eastern Economic Corridor
EGAT - Electricity Generating Authority of Thailand
JET - JICA Expert Team
KMUTT - King Mongkut's University of Technology Thonburi
KMUTNB - King Mongkut's University of Technology North Bangkok
KMITL - King Mongkut's Institute of Technology Ladkrabang
LTFT - The Land Transport Federation of Thailand
MOT - Ministry of Transport
MU - Mahidol University
MRTA - Mass Rapid Transit Authority of Thailand
NESDC - Office of the National Economic and Social Development Council
ONEP - Office of Natural Resources and Environmental Policy and Planning
OTP - The Office of Transport and Traffic Policy and Planning
PAO - Provincial Administration Office
RMUTP - Rajamangala University of Technology Phra Nakhon
RMUTT - Rajamangala University of Technology Thanyaburi
RRUT - Rajamangala University of Technology Thanyaburi
SCC - The Siam Cement PCL.
SEPO - State Enterprise Policy Office
SRT - State Railway of Thailand
SRTET - SRT Electrified Train Company Limited
TTD-BMA - Traffic and Transportation Department - BMA

JICA ウェブサイトでプロジェクトの最新情報を公開し、プロジェクトの広報を行った。

表 5.2.2 JICA ウェブサイトのプロジェクトニュース

Volume.	Title	Main text	Photo
1 (Dec 2021)	第 1 回鉄道需要予測ワーキンググループを開催しました。	DRT は、バンコクの鉄道システムの需要予測を議論するために鉄道需要予測ワーキング グループを設立した。会議では、目的、M-MAP2 研究の進捗状況、有識者からの意見などが取り上げられました。 作業部会の設立を認め、交通調査後に第 2 回会合が予定されており、2022 年 2 月に予定されている。	
2 (Mar 2022)	DRT およびコンサルタント チームとの継続的なディスカッション	このプロジェクトは、DRT がバンコク向けの (M-MAP2) を策定するのを支援する。新型コロナウイルス感染症（COVID-19）の影響で当初はオンラインでの議論が行われたものの、2021 年 11 月に対面での会議が再開された。タイでは地区レベルの人口統計が限られているため、旅客需要の推計が課題に直面している。DRT コンサルタントは入手可能なデータに依存し、確認のための対面会議の効率性を重視しています。両チームは現場での活動を優先しており、技術サポートのためにバンコクへ行く予定だ。	
3 (Apr 2022)	第 2 回鉄道需要予測ワーキンググループを開催しました	2022 年 3 月 4 日、DRT の第 2 回需要予測ワーキング グループ会議では、M-MAP2 の進捗状況について議論された。有識者は需要モデルの交通行動や所得水準などの要素についてアドバイスを行った。 JICA の専門家は、鉄道乗客に対する新型コロナウイルス感染症の影響を強調し、交通調査の準備や鉄道政策評価のための需要予測モデルの指針を示した。	
4 (Aug 2024)	第一回合同調整委員会（JCC）が組織されました	2022 年 5 月 24 日に DRT で開催された第 1 回合同調整委員会（JCC）会議では、鉄道政策議論のための M-MAP2 プラットフォームの導入と需要予測ワーキンググループの設立に焦点が当てられ、承認されたプロジェクト計画と M-MAP2 プラットフォームの立ち上げが行われた。 これには、プロジェクトの開始時に DRT カウンターパートの理解を測るためのベースライン調査が含まれる。	
5 (Sep 2022)	最初の M-MAP2 プラットフォームが組織されました	2022 年 7 月 5 日、DRT で開催された最初の M-MAP2 プラットフォーム会議では、輸送能力、ネットワーク改善、複合輸送施設に焦点を当てたバンコクの鉄道開発の政策課題について議論され、政策の確立、需要予測モデルの作成、および計画の実施が検討された。	
6 (Nov 2022)	鉄道運輸省と JICA 専門家チームが共催した第 1 回学習会	2022 年 10 月 20 日、DRT と JICA 調査団は都市鉄道開発について議論するオンラインセッションを開催し、東京メトロの運賃、バンコクの投資計画、日本の鉄道の持続可能性などのテーマを取り上げ、さまざまな団体の代表者がタイの地方自治体の関与の可能性を模索した。	

7 (Nov 2022)	鉄道運輸省とJICA専門家チームが鉄道需要予測モデルの現地調査を視察	2022 年 10 月 21 日、DRT と JICA はチャラン 13 駅とバンコク旧南部バスターミナルで M-MAP2 現地調査を実施し、バンコクの都市鉄道マスタープランにおける鉄道需要予測モデルのためのデータを収集した。	
8 (Dec 2022)	第二回合同調整委員会（JCC）が組織されました	2022 年 11 月 30 日、第 2 回合同調整委員会（JCC）会議が DRT で開催され、M-MAP2 プロジェクトの進捗状況と変更点が議論された。 M-MAP2 の策定時期は新型コロナウイルス感染症の影響で 2023 年 8 月にずれ込んだ。 議論には、基本的な需要予測手法、継続的な交通調査、都市鉄道整備政策などが含まれた。 DRT 局長の Pichet 博士は、他の機関との協力を強調した。 この成果は、DRT と JET による交通調査結果の継続的な分析と鉄道需要予測の指針となる。	 
9 (Jul 2023)	日本初となる M-MAP2 研修プログラムを実施。	2023 年 4 月 3 日から 14 日まで、DRT のメンバー 15 名が JICA 東京国際センターで総合研修を受けました。 このプログラムでは、需要予測、都市開発、持続可能な鉄道プロジェクトに関する講義など、大量高速輸送マスタープランの作成に関する重要な側面を取り上げた。 視察には、JR 高輪ゲートウェイ、虎ノ門ヒルズ、東葉高速鉄道、宇都宮ライトレールトランジット、JR 東日本烏山線が含まれました。 ピチェ博士は閉会式で感謝の意を表し、持続可能な鉄道システムの将来の進歩に向けた日本とタイの協力強化を強調した。	 

5.2.2 M-MAP2 プラットフォームの設立

M-MAP2 プラットフォームは、政策議論のための共同プラットフォームとして機能するために、2021 年 8 月 19 日に DRT によって設立された。参加者には政府機関、鉄道事業者、専門家、学者が含まれており、バンコクの大量交通ネットワークの発展と地元および国際機関との調整のための政策提言に関する議論を行うことが想定されている。メンバー一覧は下表の通りである。

表 5.2.3 M-MAP2 プラットフォームメンバー一覧

	Components	Position		Components	Position
1	Director of Department of Rail Transport	Chairman	19	Representative of Traffic and Transportation Department, BMA	Member
2	Deputy Director of Department of Rail Transport	Vice Chairman	20	Representative of Department of City Planning, BMA	Member
3	Representative of Office of the National Economic and Social Development Council	Member	21	Representative of Department of Public Work, BMA	Member

4	Representative of Public Debt Management office	Member	22	Representative of Bangkok Expressway and Metro Public Company Limited	Member
5	Representative of State Enterprise Policy Office	Member	23	Representative of Bangkok Mass Transit System Public Company Limited	Member
6	Representative of Department of Public Works and Town & Country Planning	Member	24	Representative of Asia Era One Company Limited	Member
7	Representative of Samut Prakan PAO	Member	25	Representative of Rail Technology Development Agency	Member
8	Representative of Nonthaburi PAO	Member	26	Dr.Suwat Wanisubut	Member
9	Representative of Pathum thani PAO	Member	27	Mr.Chamroon Tangpaisalkij	Member
10	Representative of Nakhon Pathom PAO	Member	28	Assoc. Prof. Varameth Vichiensan	Member
11	Representative of Samut Sakhon PAO	Member	29	Asst. Prof.Sittha Jensirisak	Member
12	Representative of Office of the Permanent Secretary, Ministry of Transport	Member	30	Dr.Sumeth Ongkittikul	Member
13	Representative of Department of Land Transport	Member	31	Assoc. Prof. Dr. Saksith Chalermpong	Member
14	Representative of Office of Transport and Traffic, Policy and planning	Member	32	Director of Legal Affairs division, Department of Rail Transport	Member
15	Representative of the State Railway of Thailand	Member	33	Director of Rail Transport Regulation division, Department of Rail Transport	Member
16	Representative of Mass Rapid Transit Authority of Thailand	Member	34	Director of Strategy and Planning division Worker, Department of Rail Transport	Member
17	Representative of S.R.T. Electrified Train	Member	35	Head of Strategy and Development Plan Group, Strategy and Planning Division, Department of Rail Transport	Member and Secretary
18	Representative of Bangkok Mass Transit Authority	Member	36	Staff of Strategy and Development Plan Group, Strategy and Planning Division	Member and Secretary Assistant

5.2.3 M-MAP2 プラットフォーム会議の開催

M-MAP2 プラットフォームは、JICA の支援を受けて DRT の主催で 5 回開催され、以下の表に詳述するようにメンバー間のディスカッションが行われた。

表 5.2.4 M-MAP2 プラットフォーム会議一覧

アイテム	議題	参加機関	JET プレゼンテーション
第 1 回 M-MAP2 プラットフォーム			
2022-07-05	· 主要メンバー紹介 · M-MAP2 プラットフォームの役割 · M-MAP2 政策の方向性	DRT, DRT Consultant, M-MAP2 Platform members, Thai Academia, Japanese academia, JET	M-MAP2 プラットフォームの役割
第 2 回 M-MAP2 プラットフォーム			
2022-10-17	· 新規路線の検討 · 評価対象路線	DRT, DRT Consultant, M-MAP2 Platform members, Thai Academia, Japanese academia, JICA, JET	M-MAP2 プラットフォームのスケジュール
第 3 回 M-MAP2 プラットフォーム			
2023-03-07	· 前回会合のアドバイスへの対応 · ルート優先設定 · 都市鉄道事業スキームの見直しと M-MAP2 における考えられる影響	DRT, DRT Consultant, M-MAP2 Platform members, Thai Academia, Japanese academia, JICA, JET	前回の会議の概要について

第 4 回 M-MAP2 プラットフォーム			
2023-08-10	· 前回会合のアドバイスへの対応 · 鉄道運賃調査事業の紹介 · 経路優先度設定と M-MAP2 ネットワーク案（案）	DRT, DRT Consultant, M-MAP2 Platform members, Thai Academia, Japanese academia, JICA, JET	
第 5 回 M-MAP2 プラットフォーム			
2024-02-07	· 前回会合のアドバイスへの対応 · M-MAP2 路線の優先順位選定結果 · ベースラインシナリオ（最終レポートと同じ前提条件） · 容量増強シナリオ（増便、車両増） · 急行サービスの提案	DRT, DRT Consultant, M-MAP2 Platform members, Thai Academia, Japanese academia, JICA, JET	

各 M-MAP2 プラットフォームの協議内容の詳細は以下のとおりである。

第 1 回 M-MAP2 プラットフォーム: 主に議論された内容は、優先順位付け手法、経済、環境、社会的影響である。フィーダーシステムについては、乗客の需要に基づいた段階的なアプローチが検討され、鉄道ネットワークが十分普及した段階で、自家用車の使用を制限することを目的とした対策が議論された。また、歩道整備、バイクタクシーの統合、バス路線の調整などが、計画に考慮すべき重要な点とされた。さらに、都市の業務地区のパーク アンド ライド施設の最適化は、フィーダー システムをさらに有効に活用できる可能性がある。フィーダーシステム整備の適切な費用が重要な点であり、周辺土地利用との一体的な検討を慎重に組み込むことが強調された。M-MAP2 プラットフォームにおける連携には、県自治体(PAO)からの提案と鉄道運営主体からのルート提案路線を含めることとしており、M-MAP2 ネットワークの整備を進めていくために関係者間の協力の重要性が強調された。

第 2 回 M-MAP2 プラットフォーム: 主な議論内容としては、既存計画路線の完成を優先して、新たな路線の拡張を行うこと、混雑対策として財政的実現可能性を踏まえた段階的整備、インバウンド需要の詳細な分析、フィーダーシステムや車両規制政策の検討などが挙げられた。また、低密度住宅地向けのフィーダーレールなどの代替システムの検討、需要の大きい路線の容量増加、短期的で影響の大きい解決策の優先順位付けを提案した。主な重点分野には、PPP 契約、政府支援、運賃の公平性、人々の交通行動の変化、情報の更新などが含まれる。さらに、プラットフォームは、M-MAP1 の完成を優先し、EV バスなどの代替システムを検討することを強調した。

第 3 回 M-MAP2 プラットフォーム:計画の優先付け、経済、環境、社会的影響に関する議論が行われた。深刻な、既存路線の容量制約を認識した上で、運行可能乗客数の増加に向けてフィーダーシステムの導入を強調した。特に観光客や高齢化人口に対する包括的な需要分析に焦点が当てられ、過去の車両規制政策、駅のアクセシビリティ改善、低密度地域向けの代替システムの検討などが議論された。提案事項には、多様な優先順位付け方法として、過去の因子プロファイル法を使用した分析、NPV および B/C によるスクリーニングと、総合的な評価プロセス過去の土地利用を統合する提案が含まれていた。

第 4 回 M-MAP2 プラットフォーム: 本会議では、鉄道運賃検討プロジェクトの紹介、M-MAP2 鉄道ネットワーク案における路線の優先順位設定に関する発表が行われた。その後の議論には、日本とタイの有識者から、運賃調整、ファーストクラスシステム、調査技術、輸送力に関する懸念、

優先順位付けに関する基準の明確化などが取り上げられた。DRT からは、本プロジェクトにおける協働体制の重要性、ルートの優先順位付けの更新、関係者が参加する正式な M-MAP2 プラットフォームの必要性が強調された。

第 5 回 M-MAP2 プラットフォーム: 主な議論内容は、需要予測モデルの最新の結果報告、前回会議でのコメント、特に森地教授からのコメントへの回答であった。ACKCHAI 博士は、ベースラインシナリオ、容量増強シナリオ、および急行サービスの提案を含む、容量拡張に関する補足提案を提示した。その後の議論には、日本とタイの有識者からのコメントとして、ネットワーク分析、アクセシビリティ、モーダルシェアの計算、高速バスの運行評価などについて議論された。タイの有識者は、タイの鉄道システム開発におけるこの研究の有効性を強調した。閉会の挨拶では、今後の検討のための提言、最新の需要予測モデルの結果を運輸省と内閣の承認を得るための最終報告書に組み込む必要性が認められた。DRT の副局長は、急行運転サービスに取り組むことの緊急性と、当局に提出するマスタープランに専門家の意見を組み込むことが緊急であることを強調した。

6. プロジェクト評価

6.1 プロジェクト評価の目的

プロジェクトに対する評価を、以下の点に基づいて行った。

- 現行 PDM 及び PO に合わせて、プロジェクト活動の進捗、アウトプットの達成度、プロジェクト目標の達成見込み、実施プロセスを確認する。
- 妥当性、整合性、有効性、効率性、インパクト、持続性を基に、プロジェクトの評価を行う。
- 評価結果から、上位目標の達成に向けた課題について整理し、教訓及びプロジェクト活動に対する提言を抽出する。

6.2 プロジェクト評価手法

本評価は、以下の手順に沿って行った。

i. プロジェクトの目標「MP の策定能力の向上」と、成果 1「需要予測モデル構築」、成果 2「M-MAP2 の策定」、成果 3「M-MAP2 実現促進」の 3 つのアウトプットに関して、既存資料をレビューし、関係者へのインタビューを通じて、適切な評価指標と評価手段を設定する。

ii. アウトプット、プロジェクト目標の達成度及び上位目標の達成見込みを、PDM 上の評価指標に基づいて評価する。

iii. プロジェクトの実施プロセスとして、プロジェクト実施上の課題と工夫点を確認する。

iv. 評価 6 項目（妥当性、整合性、有効性、効率性、インパクト、持続性）による、プロジェクトの評価を実施する。

v. プロジェクト終了後の提言及びプロジェクト実施中の教訓を抽出する。

6.3 プロジェクト目標・成果の設定とその達成指標・評価手段の設定

PDM・PO の確定段階で、プロジェクトの上位目標、プロジェクト目標、期待される各成果を確認するとともに、それぞれの達成を評価する指標と、その評価手段について検討し、設定を行った。

表 6.3.1 プロジェクトの目標と評価指標

Narrative Summary	Objectively Verifiable Indicators	Means of Verification
Overall Goal: Sustainable and comprehensive transportation network in Bangkok Metropolitan Region is realized.	• 3 years after project completion, M-MAP2 is approved by the Commission for the Management of Land Traffic • M-MAP2 network is realized within the planned time frame	• Resolution of the Commission for the Management of Land Traffic
Project Purpose: Capability of Thai government and DRT to formulate future railway master plan is improved.	By the time of project completion • More than 4 officers in DRT are involved in regular discussion with JICA. • More than 19 officers in DRT improved their understanding on the planning steps of M-MAP2, railway policies, coordination mechanism for railway policies, and railway demand forecast model through training	• Meeting report • Baseline/ mid-term / at completion survey • M-MAP 2 Platform implementation report

	and regular meeting provided by JICA. • More than 7 staffs belonging to the organization related to urban transport (such as OTP, DPT, BMA-TTD, BMA-CPD, MRTA, SRT, SRTET) participate in M-MAP 2 Platform organized by DRT.	
Output 1: Railway Demand Forecast Model is developed.	1-1 Traffic surveys are conducted and database is developed. 1-2 Socio-economic framework is prepared. 1-3 Railway demand of each line is evaluated by railway demand forecast model.	• Demand Forecast Working Group (WG) meeting report • Relevant reports and meeting material explaining the result of traffic survey and demand forecast model, by DRT Consultant.
Output 2: The detailed plan of M-MAP2 is formulated and approval process is taken by Thai Side.	2-1 Railway policy measures are formulated. 2-2 M-MAP2 railway network plan is developed. 2-3 Prioritization for each line development is formulated. 2-4 M-MAP2 is submitted by Thai Side for approval	• M-MAP2 Platform meeting report • Relevant reports and meeting material explaining railway policy, railway network plan and development plan.
Output 3: The promotion of realization of M-MAP2 is conducted.	3-1 M-MAP2 output is publicized. 3-2 M-MAP2 Platform to discuss M-MAP2 realization between government agencies, railway operators, and experts or academia is organized. 3-3. Railway development policies are discussed in the M-MAP2 Platform.	• M-MAP2 Platform meeting report • M-MAP2 Public Hearing report • Knowledge transfer report

6.3.1 成果の達成度

本プロジェクトの PDM によると、各アウトプットの達成状況は、それぞれの主要な活動が行われたかどうかをもって、評価することとしている。プロジェクト活動の実施状況は、第 3 章～第 5 章に記載した通りであるが、各指標の達成状況は下記である。なお、評価指標は英文が正文であるため、和訳は参考として()付きで示す。

1) 成果1：新たな鉄道需要予測モデルが作成される (Railway Demand Forecast Model is developed)

Objectively Verifiable Indicators	Means of Verification
1-1 Traffic surveys are conducted and database is developed. 1-2 Socio-economic framework is prepared. 1-3 Railway demand of each line is evaluated by railway demand forecast model.	• Demand Forecast Working Group (WG) meeting report • Relevant reports and meeting material explaining the result of traffic survey and demand forecast model, by DRT Consultant.

1-1：Traffic surveys are conducted and database is developed.　3.2.2、3.2.3、3.2.4 に記載しているように、月例協議や需要予測 WG 会議において、交通調査手法や調査票の確認を行い、タイ側が実施した交通調査結果のレビューを行ったのちに、追加で補足すべき調査を確認した後、JICA 予算による調査の内容を確認し、実施した。

1-2：Socio-economic framework is prepared.　3.2.5 に記載しているように、月例協議、需要予測 WG 会議、個別協議を通じて、現況と将来（予測年次ごと）の TAZ ごとの夜間人口と、昼間就業者数、昼間学生数の推計方法を協議し、交通需要予測に必要な社会経済フレームワークを作成した。

1-3　：Railway demand of each line is evaluated by railway demand forecast model. 3.2.6、3.2.7 に記したように、需要予測の前提条件の見直し、需要予測モデル構築に向けた助言を行った。日常的な協議を通じて、進捗の確認を行い、月例協議での確認を行った上で、需要予測 WG 会議において、有識者の助言を受けて更新を行うプロセスを積み重ねた。需要予測 WG は、2021 年 11 月の第 1 回から、2023 年 8 月の第 6 回まで開催し、何度もやり取りを重ねながら、タイ側が検討する需要予測の見直し作業を行った。最終需要予測 WG 後も、積み残された課題に対応すべく、福田先生、伊東氏といった有識者の助言を頂きながら、2024 年 2 月に最終化した需要予測結果を公表するに至った。

2) 成果2：M-MAP2詳細計画が策定され、タイ政府の承認プロセスに諮られる

Objectively Verifiable Indicators	Means of Verification
2-1 Railway policy measures are formulated. 2-2 M-MAP2 railway network plan is developed. 2-3 Prioritization for each line development is formulated. 2-4 M-MAP2 is submitted by Thai Side for approval	• M-MAP2 Platform meeting report • Relevant reports and meeting material explaining railway policy, railway network plan and development plan.

2-1：Railway policy measures are formulated.　Appendix3 に記載されているように、M-MAP2 の鉄道政策として、以下の 5 つの政策が整理された。

Policy 1: To Alleviate Travel Congestion in the Rail System (Capacity)

Policy 2: Increase Rail Transportation to Cover Bangkok and its vicinities (Coverage)

Policy 3: To Increase the Potential of Rail Network Connection (Connectivity)

Policy 4: Improve Fare Patterns to be More Appropriate and Fairer (Affordable and Equitable)

Policy 5: To Connect with Other Forms of Transportation (Intermodal Efficiently)

2-2：M-MAP2 railway network plan is developed. Appemdix3 に記載されているように、現行 M-MAP に、候補路線を加えたロングリストを構築した。

2-3：Prioritization for each line development is formulated. Appemdix3 に記載されているように、上述の政策に基づいた評価指標を設定し、上述のロングリストに対して評価を行い、優先順位の高い路線を選定し、M-MAP2 ネットワークを構築した。これらの一連のプロセスを、M-MAP2 プラットフォームの議論を通じて、関係機関との合意形成を行った。

2-4：M-MAP2 is submitted by Thai Side for approval. 最終 M-MAP2 プラットフォーム会合後、DRT 内の検査を経た後、MOT に提出を行った。今後、MOT のコメントを受け、修正を行った後、Land Committee に提出される予定である。

3) 成果3：M-MAP2の具体的な実現に向けた取り組みが推進される

Objectively Verifiable Indicators	Means of Verification
3-1 M-MAP2 output is publicized. 3-2 M-MAP2 Platform to discuss M-MAP2 realization between government agencies, railway operators, and experts or academia is organized. 3-3 Railway development policies are discussed in the M-MAP2 Platform.	• M-MAP2 Platform meeting report • Relevant reports and meeting material explaining railway policy, railway network plan and development plan.

3-1: M-MAP2 output is publicized. 5.2.1 に記載したように、M-MAP2 の策定プロセスや、途中成果について、DRT 主催の計 4 回に及ぶ公聴会（Public Seminar）や、DRT のフェイスブックページ等のウェブサイト、及び、JICA のウェブサイトを通じて、広報を行った。

3-2 : M-MAP2 Platform to discuss M-MAP2 realization between government agencies, railway operators, and experts or academia is organized. 5.2.2 に記載しているように、プロジェクト開始後、M-MAP2 プラットフォームを設立した。構成メンバーについては、DRT と協議し選定を行った。

3-3. Railway development policies are discussed in the M-MAP2 Platform. 5.2.3 に記載したように、合計 5 回の M-MAP2 会議を行った。オンサイトとオンラオインのハイブリッドで開催し、有識者をはじめとする日本側の関係者も、全ての会合に参加した。

6.3.2 プロジェクト目標の達成度

本プロジェクトのプロジェクト目標と、その評価指標は、以下の 3 点である。

Project Purpose	Objectively Verifiable Indicators	Means of Verification
Capability of Thai government and DRT to formulate future railway master plan is improved	By the time of project completion • More than 4 officers in DRT are involved in regular discussion with JICA. • More than 19 officers in DRT improved their understanding on the planning steps of M-MAP2, railway policies, coordination mechanism for railway policies, and railway demand forecast model through training and regular meeting provided by JICA. • More than 7 staffs belonging to the organization related to urban transport (such as OTP, DPT, BMA-TTD, BMA-CPD, MRTA, SRT, SRTET) participate in M-MAP 2 Platform organized by DRT.	• Meeting report • Baseline/ mid-term / at completion survey • M-MAP 2 Platform implementation report

1) DRTのコアスタッフ4名以上との日常的な連携

DRT の CP のコアメンバーとして、Strategy and Planning Division の Director をはじめ、Strategy and Development Plan の Head と、Plan and Policy Analysis レベルの職員が 2 名、合計 4 名がアサインされた。この 4 名とは、日常的な連携を取り、進捗の報告と確認を行った。プロジェクトの途中で、Plan and Policy Analysis レベルの職員 1 名が、退職に伴い交代となったが、次のスタッフがすぐに配置されたため、特に大きな問題は発生せずに引き継ぐことができた。

2) DRTカウンターパート19名の理解向上

DRT のカウンターパート 20 名[1]の、M-MAP2 の計画ステップや鉄道政策、需要予測当に関する理解度については、プロジェクト開始時（2022 年 6 月～7 月）にベースライン調査を行い、2024 年 5 月に、終了時の確認調査を行った。なお、本プロジェクトの CP メンバー20 名のうち、6 名が、プロジェクトの途中で、退職や異動に伴い交代となったため、これら 6 名については、ベースライン調査を 2023 年 11 月に実施している。理解度の向上の確認については、当初からの CP メンバーと、プロジェクト途中から参加した CP メンバーで、別に整理を行った。

全体として、いずれにメンバーも理解度の向上が見られた。途中から参加したメンバーと、当初からのメンバーの比較からは、大きな違いは見られず、個々人の元々の基本的な知識レベルの差はあるものの、途中から参加したメンバーにおいても、一定の知識を得たことが分かる。途中から、プロジェクトの CP となったメンバーも、当初から DRT の職員であったことから、需要予測 WG や、Knowledge Transfer 会議に参加していたことが大きいと考えられる。一方で、カウンターパートの入れ替えがタイムリーに把握できなかったことから、途中から参加した CP メンバーに対するベースライン調査の実施が遅くなった。プロジェクトの CP については、定期的な確認を行い、新規職員や基礎知識の不足している CP に対しては、追加的なフォローが求められる。

表 6.3.2 部門別 DRT カウンターパート数

対象部局	当初からのメンバー	途中からのメンバー	合計
Strategy and Planning Division (Division 1)			
Core Members	3	1	4
Other Member	3	3	6
Rail Transprt Regulation Division (Division 2)	4	1	5
Safety and Maintenance Standards Division (Division 3)	3	1	4
Legal Affairs Division (Division 4)	1		1
合計	14 名	6 名	20 名

(1) Part 1: Overall M-MAP2 formulation

Part1 は、M-MAP2 策定プロセス全体について、計画策定準備、計画作成プロセス、求められる

[1] 1.3 に示すように、本プロジェクトのカウンターパートは、DRT の職員 20 名から構成される。このうち Ruendej 部長を除く 19 名の理解能力を評価対象として設定している。

計画内容について、理解度の確認を行った。

表 6.3.3 Part1 の質問と採点方法

Question	Scoring Method
1.1 Do you understand overall process for M-MAP2 formulation, including preparation, planning, measures for delivering the plan as below?	- Average of 5-point scale
1.2 Understanding about how to set the following planning conditions of M-MAP2?	
1.2.1 When is target year of M-MAP?	- Correct or not - % of persons answering correctly
1.2.2 Where is target area of M-MAP?	
1.2.3 Select the scope included in the M-MAP2 (multiple choice) 1. Development schedule of each line by section 2. Total number of passengers of each line in the target year 3. Number of passengers by station of each line 4. Share of public transport of the target year 5. Initial Environmental Examination of overall MRT system 6. Environmental impact Assessment of each line. 7. Cost estimation of each line by section 8. EIRR of each line	- Correct or not. - Score of each person= 0.25 point * the number of selected correct answers– 0.125 point * the number of in-correct answers - Average score
1.3 Do you understand how to prepare scope of work for M-MAP2 preparation?	- Average of 5-point scale

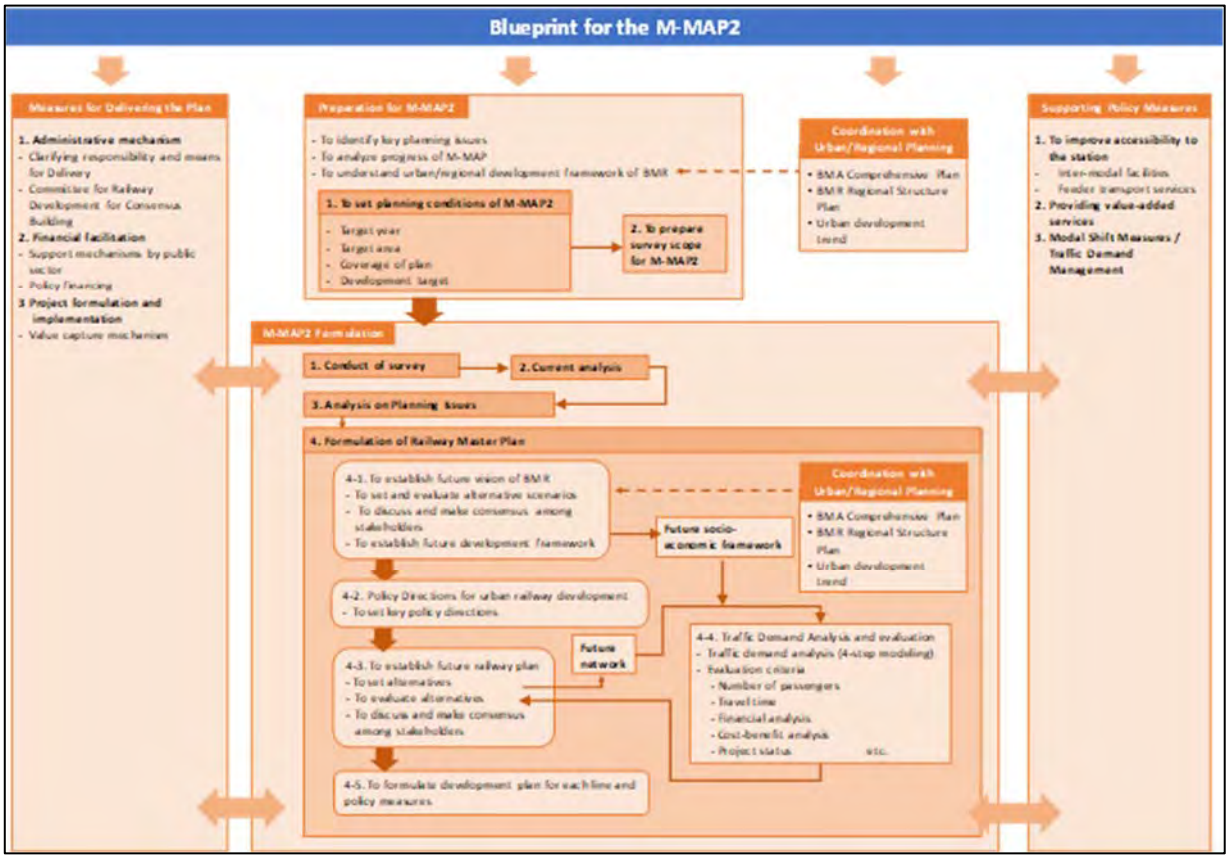
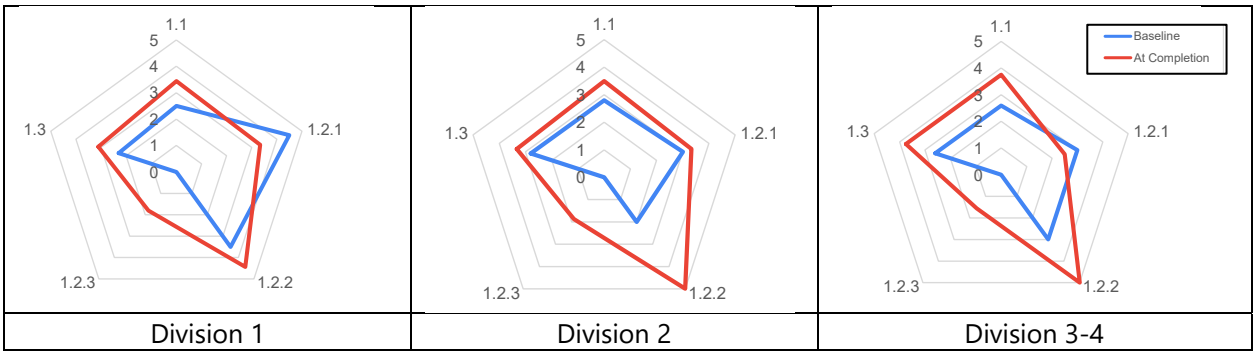


図 6.3.1 M-MAP2 作成プロセス(Q1.1)

ベースライン調査と完了時調査の比較から、M-MAP2 策定への理解度の改善がみられる。特

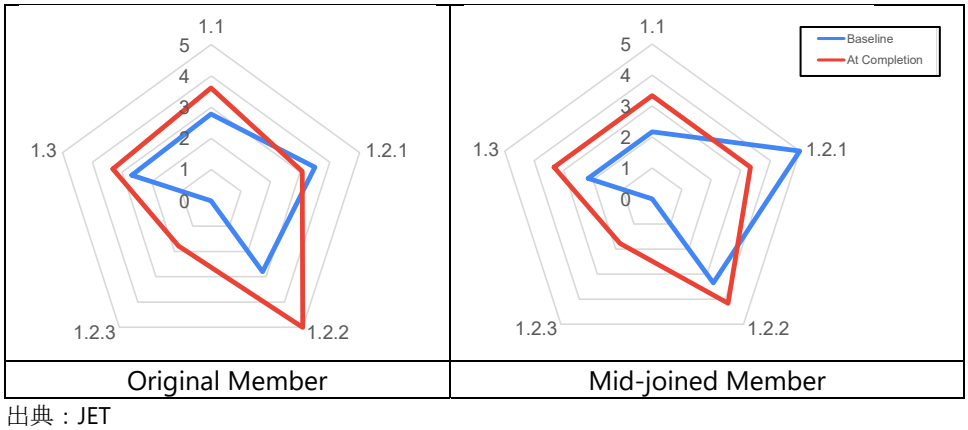
に(問 1.2.1)の目標年次と(問 1.2.2)の対象分野では、Division1 が最も理解度が高い。一方、Division 3 は、ベースライン時点では目標年次と対象範囲に関する理解度が最も低かったが、完了時調査時点では大幅な改善が見られた。Division 2 は、完了時調査ではすべての設問で理解度が向上しており、M-MAP2 の準備プロセスやスコープに対する理解度が向上していることがわかる。一方で、(問 1.2.3)の M-MAP2 に含まれるスコープについては、全メンバーの理解度が低く、路線ごとの計画段階でのスコープと、マスタープラン策定段階でのスコープの違いが十分理解できていないと思われる。



出典：JET

図 6.3.2 部署ごとの Part1 の回答結果(Base Line and At-Completion)

プロジェクト当初からのメンバーと途中から参加したメンバーを別に分析すると、当初からのメンバーは、M-MAP2 の対象エリアの把握(問 1.2.2)が 56.0%から 100%へと大きく理解度が向上し、全体のプロセス(問 1.1)は 2.78 から 3.62 に、スコープ作成(問 1.3)は 2.67 から 3.31 に理解度が向上した。途中からのメンバーも同様に、全体プロセスの理解(問 1.1)が 2.17 から 3.33 へと大きく向上し、対象領域の理解(問 1.2.2)も 67.0%から 83.3%へと向上した。



出典：JET

図 6.3.3 新旧メンバー別の Part1 回答結果(Base Line and At-Completion)

(2) **Part 2: Planning Procedures**

Part2 はベースライン調査、完了時調査で以下の計画策定ステップの理解度を確認した。

2.1 Review of existing relevant plans

2.2 Conduct of traffic survey

2.2.1 Prepare survey form

2.2.2 Analyze the result of traffic survey

2.3 Analysis on current situation and identification of key planning issues

2.4 Preparation of railway master plan

2.4.1 Establishment of future vision of BMR based on the review of relevant development plans

2.4.2 Formulation of future socio-economic framework (population, employment and student)

2.4.3 Set up of railway development policy measures

2.4.4 Development of railway demand forecast model

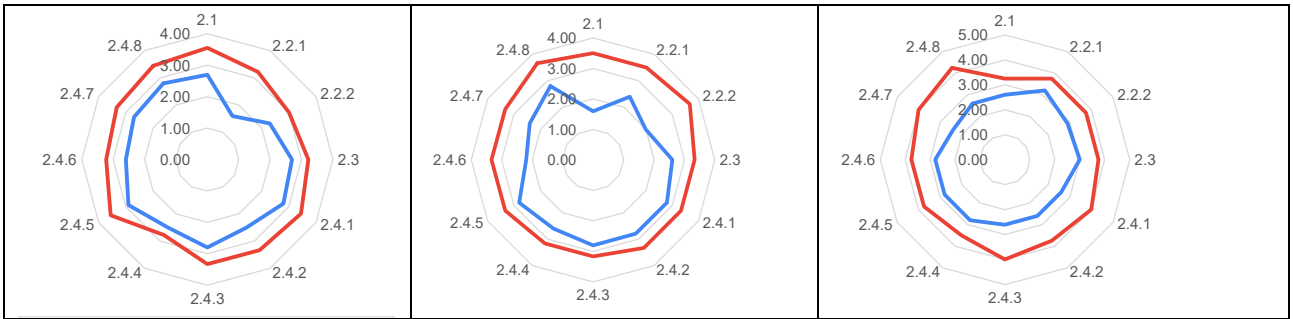
2.4.5 Preparation of future railway network

2.4.6 Evaluation of each route development (indicators to be evaluated)

2.4.7 Evaluation of railway development policy measures

2.4.8 Formulation of development plan of each railway line

5 段階評価の理解度を、Division 別、CP メンバータイプ別に平均点を整理した。ベースライン調査と完了時調査の比較から、20 名の CP メンバー全員がプランニングの手順について理解を深めたことがわかった。特に、Division2 の CP は、プランニング手順の理解度が最も高かった。特に、現状分析と重要な計画課題の特定が 2.60 から 3.33 に向上した。Division1 でも、特に調査票の作成において、1.60 から 3.22 へと大きく改善した。Division3-4 は、鉄道整備方針の設定で顕著な改善が見られた。

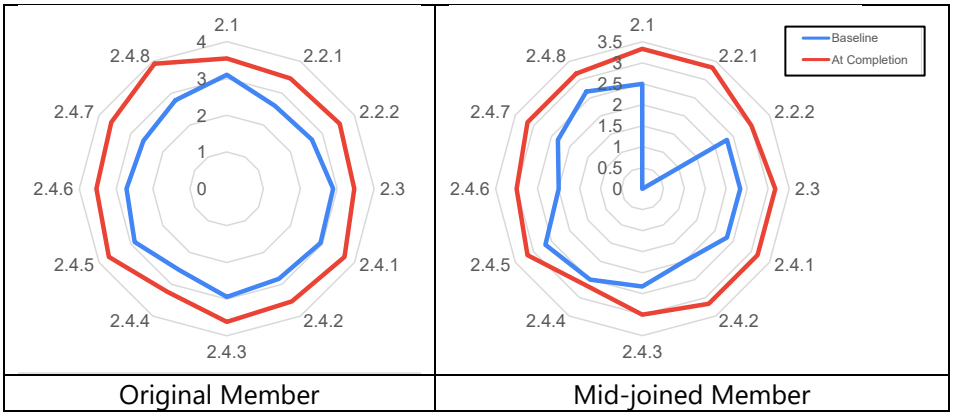


Division 1	Division 2	Division 3-4

出典：JET

図 6.3.4 部署ごとの Part2 回答結果(Base Line and At-Completion)

各鉄道路線の整備計画の策定については、当初からのメンバーが最も理解度が高く、2.78 から 3.92 に向上した。調査票の作成については、途中からのメンバーの理解度が最も高く、0 から 3.33 に向上した。現状分析や鉄道整備方針の策定については、両グループとも理解を深めている。

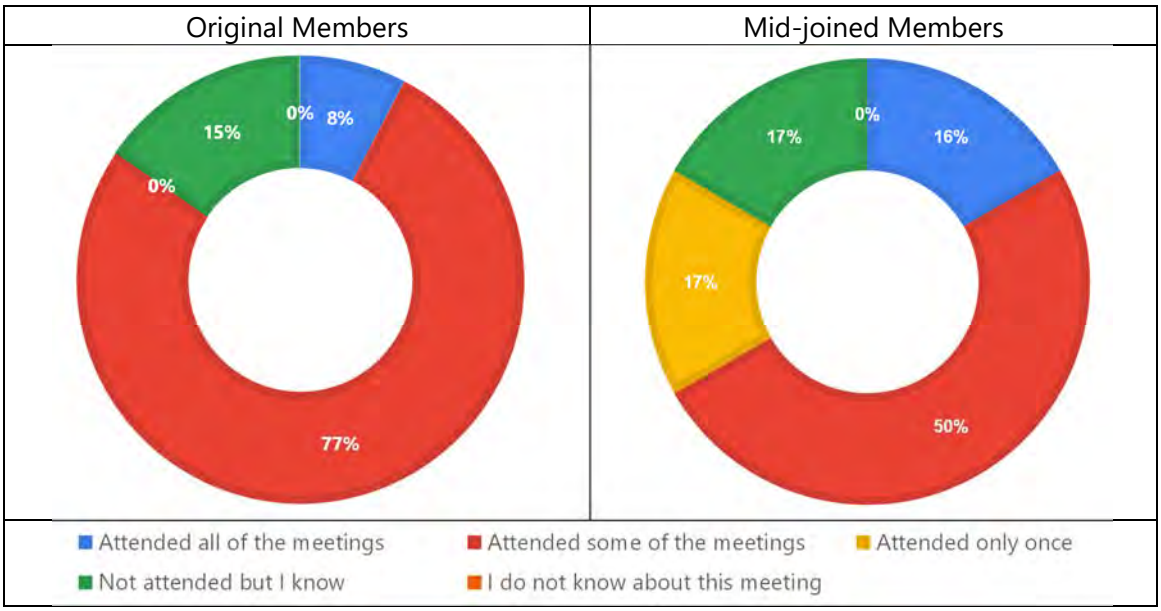


出典：JET

図 6.3.5 新旧メンバーごとの Part2 回答結果(Base Line and At-Completion)

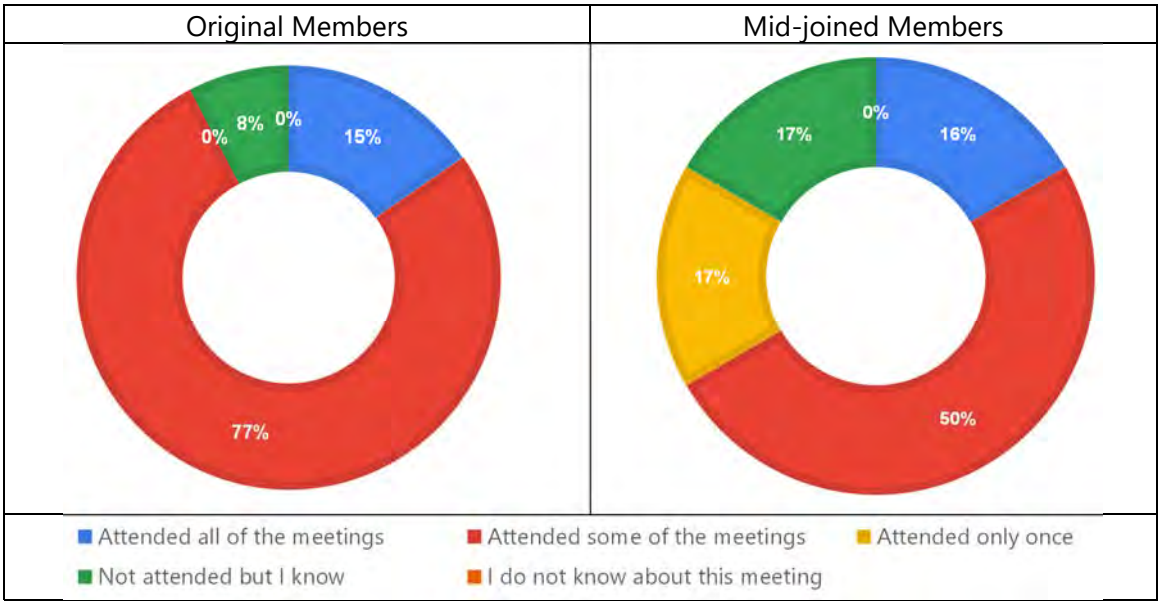
(3) Part 3: Demand Forecast Model

Part3 は、需要予測モデルの基本的な理解度を測定した。需要予測 WG と DRT コンサルタントが主催した Knowledge Transfer 会議は、CP メンバーにとって需要予測に関する理解を深める良い機会であった、その出席頻度も確認した。需要予測 WG と Knowledge Transfer 会議にすべて出席した CP はそれぞれ全体の 8%、15%であった。当初の CP メンバーの 77%が、需要予測 WG および Knowledge Transfer 会議の一部に出席した。



出典：JET

図 6.3.6 新旧メンバーごとの需要予測 WG 参加状況



出典：JET

図 6.3.7 新旧メンバーごとの Knowledge Transfer 参加状況

技術的な問題では、以下のような需要予測に関する基本的な知識を質問した。

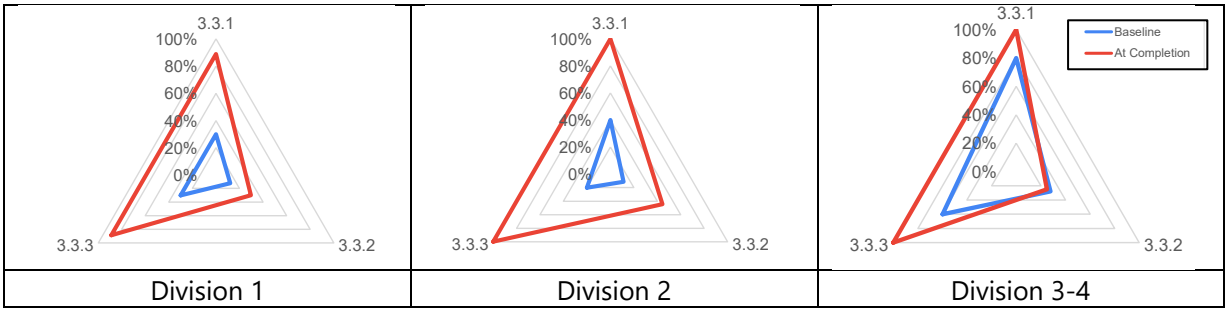
3.3. Please answer basic setting for demand forecast

3.3.1 What does LOS stand for?

3.3.2 Please answer three major factors to prescribe level of railway services

3.3.3 Please order below each demand forecast step from the beginning of 4 step model (1. Modal share, 2. Trip distribution, 3. Trip generation and attraction, 4. Route assignment)

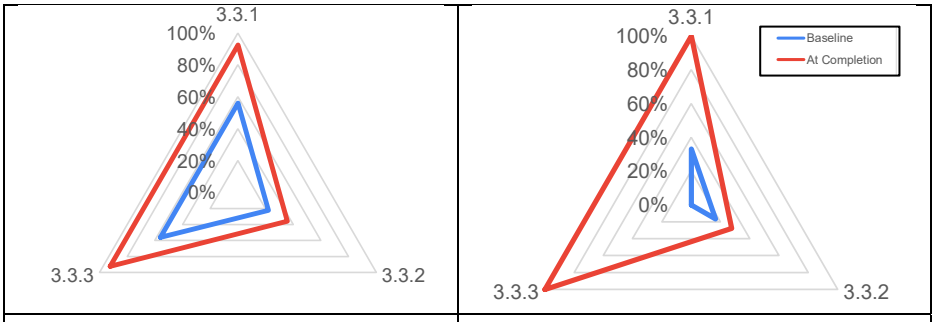
CPメンバーのほとんどが需要予測についての理解を深めた。Division2は、LOSの特定（問3.3.1）で最も高い理解度を示し、40.0%から 100.0%に改善した。また、Divison3-4 は、需要予測のステップ（問 3.4）の理解が特に改善されており、60.0%から 100.0%に増加した。Division1 は、LOSに関する理解度は低かったが、全般的に理解度が向上している。



出典：JET

図 6.3.8 部署ごとの Part3 回答結果(Base Line and At-Completion)

当初からのメンバーは、需要予測ステップの順序について、最も高い理解度を示し、56%から92.3%に改善した。両グループとも、プロジェクト終了までに理解度を大きく向上させた。



出典：JET

図 6.3.9 新旧メンバーごとの Part3 回答結果(Base Line and At-Completion)

(4) Part 4: Railway Development Policy

Part4 は、M-MAP2 で提案されている鉄道開発政策への理解の確認として、各政策を実現する実施施策について、自由回答での質問を行った。それぞれの Policy ごとに、どういった施策が回答されたかについて、円グラフで集計を行った。なお、Policy1 は例示したため、回答結果はない。

Policy 1: To Alleviate Travel Congestion in the Rail System (Capacity)

Policy 2: Increase Rail Transportation to Cover Bangkok and its vicinities (Coverage)

Policy 3: To Increase the Potential of Rail Network Connection (Connectivity)

Policy 4: Improve Fare Patterns to be More Appropriate and Fairer (Affordable and Equitable)

Policy 5: To Connect with Other Forms of Transportation (Intermodal) Efficiently

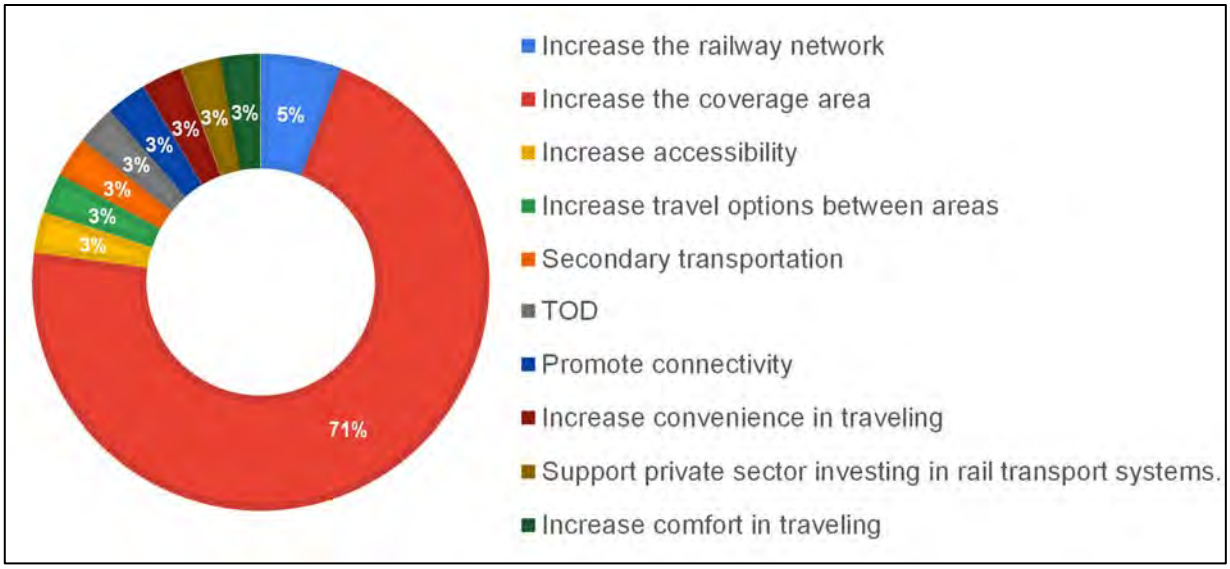


図 6.3.10 Part4 回答結果: Railway Development Policy 2

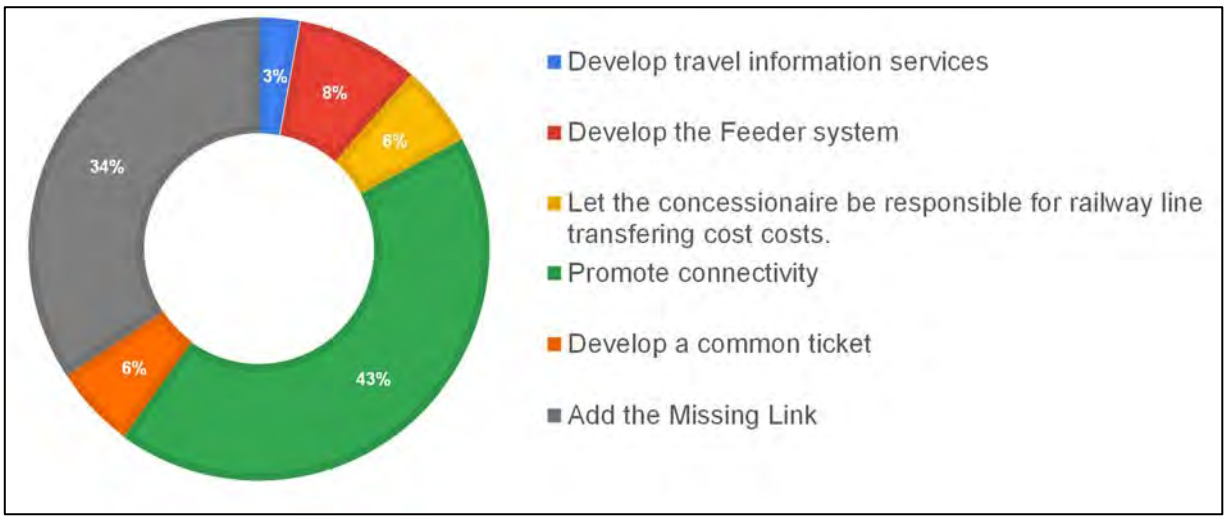


図 6.3.11　Part4 回答結果:　Railway development policy 3

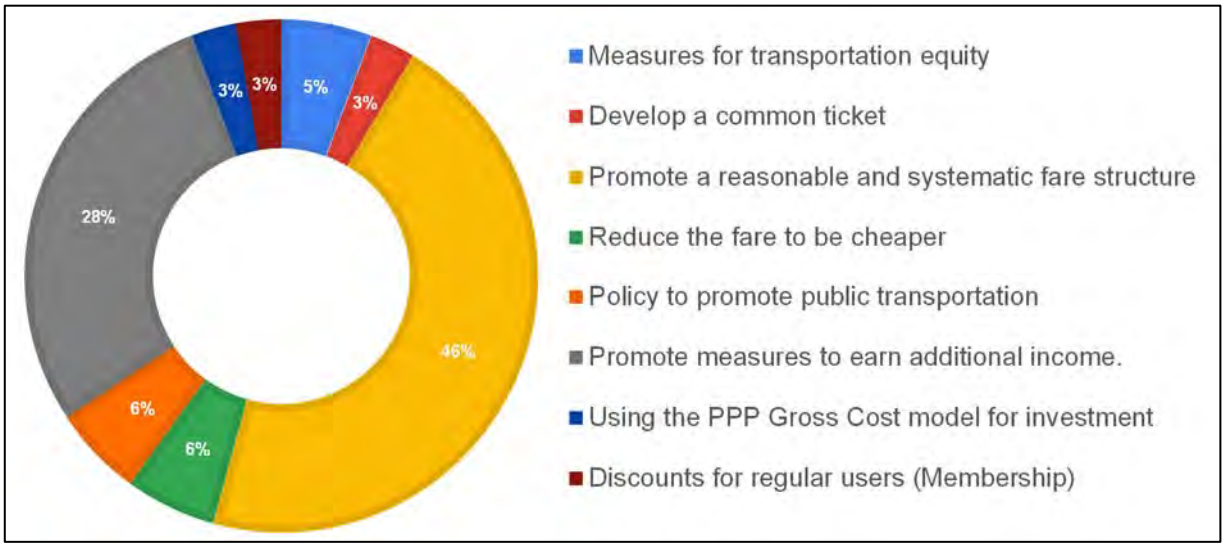
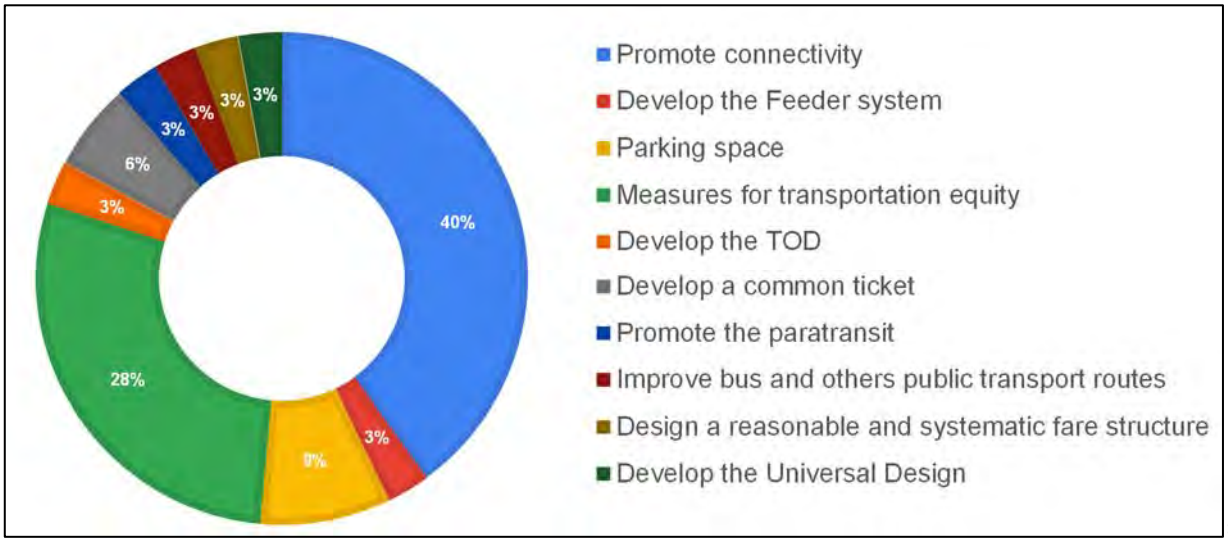


図 6.3.12　Part4 回答結果:　Railway development policy 4



#

図 6.3.13　Part4 回答結果:　Railway development policy 5

(5) **Part 5: Policy Implementation**

このパートでは、鉄道整備政策を議論する仕組みに焦点を当てた。M-MAP2 プラットフォームで議論すべき課題について、自由回答方式で質問した結果、以下のような回答が得られた。

鉄道開発スキーム

-スカイウォークなどの鉄道駅への接続のためのインフラへの助成措置。

- タイの状況に適した PPP 手法について。

- 鉄道サービスを提供する民間セクターの促進

- M-MAP2 マスタープランに沿ったプロジェクト実施の推進と参加。

鉄道開発と一体化した都市／地域開発

- 将来的に鉄道システムを発展させることができるような、土地収用やインフラ整備

- 地域とつながるネットワーク計画

鉄道ネットワーク計画

- M-MAP で当初提案され、M-MAP2 では提案されていない路線

鉄道技術的課題

- モノレールの安全性

- 将来の鉄道システムに適用可能な新技術とガイドラインの可能性

3) 交通関連機関から7名以上が、M-MAP2プラットフォーム会議に参加する

5 章に記載したように、本プロジェクト開始後、M-MAP2 プラットフォームを設立し、合計 5 回の会議を開催した。各会議への、交通関連機関からの参加者数を表 6.3.4 に記す。プロジェクトの目標として設定していた、交通関連機関から 7 名以上の担当者が参加することが、全ての会議において達成された。さらに、NESDC や、DPT、DLT、MRTA、BEM、BMTA、BTSC では、全 5 回の会合のうち、3 回以上同じ担当者が継続して参加しており、議論の継続性を確保することに繋がった。

表 6.3.4 M-MAP2 プラットフォームへの交通関連機関からの参加者数

	第 1 回	第 2 回	第 3 回	第 4 回	第 5 回
NESDC	1	2	-	3	4
PDMO	2	-	-	-	2
SEPO	2	2	-	-	1
DPT	1	1	1	1	-
OPS, MOT	-	1	1	2	-
DLT	1	1	1	2	1
OTP	1	-	-	2	5
SRT	1	1	-	-	-
MRTA	2	2	2	3	3
SRTET	-	-	-	2	2
BMTA	-	1	1	1	2
TTD, BMA	-	-	-	2	-
CPD, BMA	-	-	1	-	-
DPW, BMA	1	1	-	-	1
BEM	2	1	3	3	2
BTSC	2	-	1	1	2
Asia Era One	-	5	-	-	3
RTRDA	1	1	1	-	-
合計	17	19	12	22	28

BEM - Bangkok Expressway and Metro PCL.
BMA - Bangkok Metropolitan Administration
BMTA - Bangkok Mass Transit Authority
BTSC - Bangkok Mass Transit System PCL.
DPT - Department of Public Works and Town & Country Planning
MOT - Ministry of Transport
MRTA - Mass Rapid Transit Authority of Thailand
NESDC - Office of the National Economic and Social Development Council
OPS- Office of Permanent Secretary
OTP - The Office of Transport and Traffic Policy and Planning
PDMO- Public Debt Management Office
SEPO - State Enterprise Policy Office
SRT - State Railway of Thailand
SRTET - SRT Electrified Train Company Limited
CPD- City Planning Department
DPW- Department of Public Works
TTD- Traffic and Transportation Department - BMA

出典：JET

6.4 評価結果：評価 6 項目によるプロジェクトの評価

各評価項目について、以下の通り「高い」、「比較的高い」、「中程度」、「比較的低い」、「低い」の 5 段階で評価する。

6.4.1 妥当性（relevance）

本プロジェクトの妥当性は「高い」と判断される。

タイ国の開発政策・開発ニーズ：本件は、タイ国の首都、バンコク首都圏を対象とした都市鉄道マスタープランの策定を支援するものであった。バンコク首都圏は人口約 1,600 万人を擁し、自動車保有台数は 1,000 万台を超え、自動車に依存する交通システムが交通渋滞を深刻化させている。これに対し、高速道路や都市鉄道の整備が行われてきているが依然として激しい交通渋滞が発生し、円滑な人・物の流れを阻害し、大気汚染の原因ともなっている。これに対し M-MAP2 の策定と実施は、バンコク首都圏の多極分散を目指す地域計画や自動車からの転換を目指すモーダルシフト政策とも合致し、整合性が高い。

受益者層のニーズ：都市鉄道はだれでも利用できる公共交通であり、M-MAP2 の策定と実施は、すべての利用者、特に自動車を利用できない貧困層等の社会的弱者のニーズに合致している。

日本が協力する優位性：日本では、需要予測をベースとした科学的な評価アプローチやステークホルダーを取り込んだ鉄道計画の策定手法を採用している。M-MAP2 の策定支援においては、このノウハウや経験が活用でき、日本が協力する優位性が高い。

6.4.2 整合性（coherence）

本プロジェクトの整合性は「高い」と判断される。

日本の ODA 方針との整合性：日本のタイ国への開発協力方針における重点分野の一つに「持続的な経済の発展と成熟する社会への対応」がある。この中で、渋滞緩和等の都市機能の向上を含む持続可能な社会・経済の発展の基盤となる支援を行うと謳われており、都市鉄道整備の基盤となる M-MAP2 の策定支援はこれと合致する。

JICA の他事業との関連：バンコク首都圏では、JICA によるブルーライン、パープルライン、レッドライン等の整備に加えバンスーエリアの開発計画に対して有償・無償の協力を行っており、M-MAP2 の策定においてはこれらの整備を前提とした計画検討が行われており、関連性が高い。

6.4.3 有効性（effectiveness）

本プロジェクトの有効性は「比較的高い」と判断される。

計画策定の達成：本プロジェクトでは、M-MAP2 プラットフォームの実施を通じて、タイ側の中央・地方政府機関、都市鉄道運営・運行者、日タイの有識者のアドバイスを受けながら、計画策定を行ってきた。そのため、目標とした計画の達成度は高い。

計画の政府承認：日タイ有識者のアドバイスを反映させるため、交通調査の準備・実施、及び需要予測の精度向上に時間を要し、結果として計画策定の時期が当初より約 1 年ずれ込んだことから、承認手続き開始も当初予定期間より後ろ倒しとなった。この点は、プロジェクト期間の後半に計画実施に向けた議論のため余裕をもったスケジュールが確保されていたこと、M-MAP2 プラットフォームが早期に設立され議論がなされていたことから、有効性を損なうものではないと判

断した。

6.4.4 効率性（efficiency）

本プロジェクトの効率性は「中程度」と判断される。

DRT コンサルタントの実施スケジュール：本プロジェクトは、DRT が現地コンサルタントに計画策定業務を委託して実施している成果を適宜確認しながら、JET や日タイ有識者が第三者的にアドバイスを行うという構図であったため、DRT コンサルタントの作業スケジュールをコントロールする立場になく、交通調査・需要予測や計画策定の進捗確認やアドバイスを適時行うことが難しい場面があった。そのような状況でも DRT コンサルタントは本プロジェクトに最大限協力・対応をしたと評価する。

JET のアサインメント：上記のため、JET の現地アサインの時期が流動的になることも多く、計画していた 1 回の現地渡航を複数回に分割して実施する必要性が生じた。

6.4.5 インパクト（impact）

本プロジェクトのインパクトは「高い」と判断される。

都市鉄道整備の政策目標：今回の計画策定においては、5つの政策目標（Capacity, Coverage, Connectivity, Inter-modality, Accessibility）とその指標が設定されている。策定した M-MAP2 の実施により、多くの社会経済的便益が得られるものと推定される。

波及効果：政策目標以外の効果・影響としては、社会環境において、特にジェンダー、社会的弱者、人々の幸福などの側面でプラスの効果があり、大きなマイナスの側面は見当たらない。

6.4.6 持続性（sustainability）

本プロジェクトの持続性は「比較的高い」と判断される。

組織制度的持続性：本プロジェクトでは「有効性」で示した通り、計画の達成度は高いが、後述する課題・提言に示される通り、さらなる改善項目が示されている。これらに継続的に取り組むためには、DRT は本プロジェクトで設立した M-MAP2 プラットフォームの枠組みを継続する必要があり、これにより持続性が高まると考えられる。また DRT 職員のマスタープラン策定能力という面では、本プロジェクトの実施を通じて一定の向上が確認できたので、継続的にこれを維持・向上させるために関連の研修や内部での勉強会などの実施が必要であろう。

財政的持続性：策定した M-MAP2 で提案されたプロジェクトが着実に実施するための財務面の持続性に加え、次の計画策定に向けた交通調査の実施及び計画策定業務の費用が適時に確保される必要もある。M-MAP2 策定においても相応の予算が配賦されていることから、前広に準備して予算を確保することにより持続性が高まると考えられる。

技術的持続性：技術面では後述する課題と提言で示す項目を継続的に議論することが必要である。需要予測に関してはタイ有識者と、鉄道整備計画の策定に関しては，M-MAP2 プラットフォームで多岐にわたるステークホルダーと継続的に議論することにより持続性が担保されると考えられる。

7. 結論と提言

7.1 結論

プロジェクト目標や成果は達成され、プロジェクトの実施プロセスも適切であったと言える。また、6 項目（妥当性、整合性、有効性、効率性、インパクト、持続性）の観点から本プロジェクトを検証した結果、特に効率性の項で述べたような問題があったものの、プロジェクトの成果は高く評価される。以上より、本プロジェクトは、DRT、DRT コンサルタント及び JET の活動を通じ、M-MAP2 計画策定及びタイ政府、DRT の鉄道マスタープラン策定の能力向上に貢献したと言える。

7.2 提言

本業務の活動から得られた課題と教訓、及び、前節の評価結果から踏まえた課題を踏まえた提言を以下に記す。

7.2.1 鉄道需要予測に関する課題と提言

本業務の成果 1 では、鉄道利用者の現況再現性の高いモデルが構築できたが、今回の需要予測のプロセスやモデル構築においては、様々な気付きが得られており、以下に今後対応すべき点について提言を整理した。

1) 交通調査に関する課題と提言

- **コロナ禍の影響について:**コロナ禍で実施された PT 調査を用いており、補正を行ったものの、そのバイアスは完全に補正できていないことは、留意する必要がある。
- **通勤トリップの把握**:バンコク首都圏の交通特性の一つである、通勤途中の子供の送迎について、通勤の一つのトリップとして回答される傾向にあり、送迎トリップが十分に把握できていない可能性がる。調査の設計段階で、送迎が明記されるような工夫が必要である。
- **追加調査の実施及び平日休日別の予測**:観光客が多いバンコクでは、平日の PT 調査の実施のみならず、休日の PT 調査を実施することでより精度の高い予測ができる。
- **効率的な調査の実施**:今回 PT 調査は、OTP が実施した BTDS 調査結果を用いることとし、追加的に必要になる調査を DRT が実施したが、OTP の BTDS 調査実施から連携し、一部の調査を OTP と共同で実施することで、資金的にもより効率的な調査が実施できると期待される。

2) データの利用可能性

需要予測を行う上では、鉄道の乗客者数や、人口や雇用といった統計データの活用が不可欠となるが、統計データが存在しないことや、存在しても入手できなかったために、十分に利用できず、様々な仮定を用いた推計を行う必要があった。例えば、TAZ の産業別雇用者数を推計するため、日本では経済センサスデータより作成できるが、タイではデータがないため、土地・建物利用の現況等様々な官庁のデータより推計する必要であった。Sub-District 単位でのセンサスデータ、雇用データ、さらいは、駅間の乗客者数など、他の政府機関や、鉄道運営者から共有されることが期待される。

3) 発生集中モデル、分布モデルの作成

- **モバイルデータの活用**：今後、精度の高い発生集中・分布モデルを構築するために、携帯電話基地局データ等の更なる活用についても検討が求められる。
- **トリップ率**：将来のトリップ原単位については、その移動目的の原単位の指標が人口の場合は、GDP 成長率の 0.11 でトリップ原単位の伸び率を設定した。この仮定は TDS の仮定を基に決めたが、仮定の妥当性、及び 0.11 の弾力性については、更に詳細な議論が必要である。

4) 観光客の交通需要について

- 今回の需要予測モデルのベースとなっている BTDS 調査は、観光客への調査を行っておらず、観光目的の交通需要が把握できていなかった。本業務では、以下のように観光交通の需要予測を行ったが、今後改善すべき点は大きい。
- 観光客の移動は、(1) 出発地もしくは目的地が交通ターミナル（幹線鉄道駅、地域バスターミナル、空港）である移動と、(2) 観光を目的としたバンコク都市圏内の移動の 2 パターンがある。(1)は幹線アクセスモデル、(2)はメインモデル（都市内モデル）で予測を行った。
- (1)については、幹線アクセス OD 交通量調査の結果から、各交通ターミナルのアクセス OD 表を計算し、調査で把握した現地利用者と観光客の割合を基に、現地利用者と観光客アクセス OD 表を算出した。次に、幹線アクセス機関選択調査から、現地利用者と観光客のパラメータを別々に推計し、モード別交通量を算出した。将来予測は、交通ターミナルの将来利用者に基づき伸び率で交通量を予測した。但し、将来予測は、現在の現地利用者と観光客の割合をそのままで固定した。
- (2)については、BTDS でバンコク首都圏での観光目的の移動が把握できていないため、DRT コンサルタントが独自に主な駅で観光客の割合を調査し、モデルから予測した鉄道利用者に観光客数を追加している。
- (1)、(2)のいずれについても、将来、観光客の割合は増加する可能性が高いことから、現況の割合で固定する予測ではなく、将来の観光客の増加を見込んだ割合、もしくは現地利用者と観光客を別々に予測すること（マルチクラス分析）が望ましい。

5) 時間帯別の予測

- TDM 等の検討を行うには、時間帯別の予測が必要となるが、今回のモデルは 1 日の交通量のみしか予測ができない状態となっている。

6) 駅間ODデータの収集

- 今回の需要予測モデルでは、SRT、BTS、BEM の鉄道運営主体別の実績駅間 OD データに基づき現況再現を行った。鉄道運営主体別のデータでは鉄道運営主体間の乗り換え人数が把握できないため、精密が高い正確的な予測ができない状態となっている。
- 鉄道運営主体間の乗り換え人数を把握するため、EMV データ（クレジットカード決済データ、グリーンライン、ARL 以外の路線に決済可能）による駅間 OD データを用いることが望ましい。また、OTP が計画した公共交通の共通運賃制度が実施されれば、Central Clearing House（事業者間での支払いを管理する機関）が設立されるため、全公共交通機関 OD

データを活用できるようになることが期待される。

- また、現在、用いている鉄道運営主体別の実績駅間 OD データは鉄道運営主体が特定した一日（平日）であるが、学期、雨季等の季節変動を避けるため、1 年間の平均値を用いることが望ましい。

7.2.2 鉄道整備計画（M-MAP2）策定に関する課題

1) 路線優先順位付け

本プロジェクトで実施した M-MAP2 の路線評価プロセスは、DRT 及び DRT コンサルタントが作成した方法を基本としているが、以下のとおりいくつかの重要な問題が指摘されている。路線の優先順付けを行う上では、機能性と費用対効果を考慮し、建設が容易なルートよりも優先する必要がある。

- 今回の優先順位付けの方法(4.2.5 参照)では、最初の段階で、路線の便益を考えずに、用地の有無を含めて物理的な障害がある路線は、分析対象路線から削除している。土地収用費用、又は建設費用が高くても、整備効果が高い路線については、検討を行う必要がある。
- 路線の選定の基準として用いた 8,000 PPHPD という数値は、M-MAP 策定時の調査である TDS を参考にした基準であるとされているが、8,000 PPHPD の具体的な妥当性を深掘りする必要がある。また、同じ 8,000 PPHPD 未満の路線でも、何故、M-MAP 計画路線は B に評価され、M-MAP2 候補路線は C に評価されたのか、この区別に対する考え方と論理が必要である。
- 総合的な評価指数は、M-MAP2 プラットフォームに参加する専門家による点数付けに基づいて各指標に対する「重み」を算定し、評価指標ごとに重み係数をかけて加重平均で算出した。今回の評価プロセスでは、評価指標の算出方法を専門家に具体的に説明せず、指標リストから点数付けを行ったため、専門家の判断によって偏りが出る可能性がある。そのため、専門家の重みづけ評価の前に、評価指標の算出方法を確認しながら総合指数を算出することが必要となる。また、今回の、評価指標の算出方法は報告書に記載し、今後のマスタープランに参照にすべきである。
- 優先順位分析の段階で、なぜ最も評価点数が高い路線のみを A1 に評価したのか、なぜ平均値を A2 と B の評価基準としたのか、これらの基準の考え方と理論が必要である。

7.2.3 鉄道施策に関する課題

1) 鉄道事業スキーム

鉄道事業スキームは、持続可能な鉄道事業のためだけでなく、鉄道サービスの向上のためにも、重要な課題の一つである。本プロジェクトでは、PPP 事業スキームの課題そのものについては、十分議論を行っていないが、取り組むべき課題としては、下記がある。

- 現状の PPP 事業について、鉄道運営主体の財務状況を整理し、鉄道事業における PPP 制度の課題を、DRT、鉄道事業者、及び、SEPO 等財務省関係機関と共有する必要がある。
- 後述するような既存線の輸送力増強、急行線の導入等、新たな鉄道施策に対応するため

には、現状のコンセッション契約内で、あるいは、どういった変更が必要になるのか、検討が求められている。

- 鉄道事業によって生み出される周辺都市開発への便益を、鉄道事業に還元するためには、周辺都市開発と鉄道事業を一体化した PPP 事業スキームの検討が必要である。
- 他国事例を踏まえた上で、タイの将来事業スキームや調達システムの在り方の検討が求められている。

2) 運賃設定

運賃価格設定基準は、M-MAP2 セミナーや M-MAP2 プラットフォームで常に議論された主要な課題の一つであり、取り組むべきものは下記である。

- 定額運賃の導入については、需要が過剰となり鉄道内混雑が悪化することや、定額運賃というアプローチが鉄道事業に十分な収益を生み出すことができるかどうかを考慮する必要がある。
- 政府は、より手頃な価格でアクセスしやすいように、運賃を一律 20 バーツにすることを約束したが、これにより、潜在的な資金不足が生じる。政府は補助金を通じてこのギャップに対処する必要がある。
- 一部の路線のみに低廉価格が導入され、複数の運賃システムとなることは、その鉄道にアクセスでいる利用者のみが恩恵を受けることから、利用者の鉄道へのアクセシビリティに関連して、公平性に関する懸念を引き起こす可能性がある。鉄道料金への補助については、アフォーダブルな価格とアクセスしやすさのバランスを考慮した検討が重要となる。
- タイでは、運賃以外の収入については、法的根拠がないことからも、鉄道運営主体による運賃外収入を得るための対策が十分に講じられていない。運賃外収入を得るために広告スペースの活用などはみられるが、鉄道事業者による駅周辺開発はまだ十分行われていない。

3) 共通チケットシステム

共通チケットシステムは、M-MAP2 セミナーや M-MAP2 プラットフォーム内で議論されている課題である。各事業者の異なるチケットネットワーク間には互換性がないため、共通の発券システムを開発することは困難であり、以下のような課題があげられる。

- 鉄道チケットに関するデータ形式の連携に課題がある。共通チケットシステムに関連するデータプライバシーとセキュリティの問題が含まれる。
- 鉄道運営主体としては、発券システムと収益が懸念される。

スパイダーカードなどの共通チケットシステムの利用も検討されているが、まだ実現には至っていない。ただし、現在、支払いに EMV カードが、一部の鉄道事業者に導入されている。

4) 急行運転

路線延長距離が長い Green Line の Sukhumvit Line, Purple Line, Red Line などは、郊外部から都心部までの所要時間が長い。例えば、現在、Green Line の Sukhumvit Line 終点駅（クーコッド駅かケーハ駅）から中央駅（サイアム駅）までの所要時間は約 44 分であり、サービス水準を改善するため、急行運行の検討が必要である。急行運行の実施において、以下の点に留意する必要がある。

- 急行列車の停車駅、通過駅の設定
- 普通列車追い越しのための待避線の位置
- 急行運転に対する需要の確認
- 他路線への乗り換え利便性に配慮したダイヤ調整
- 高速運行のため車両の性能（動力、耐久性等）

5) 既存線の輸送力増強

既存線の輸送力増強は、M-MAP2 の Blueprint でも提示された喫緊の課題である。混雑している既存路線については、車両の増加や、運行本数の増加など、輸送力の増強を考える必要があり、その上で対応できない場合は、新規路線の検討を行う。通常、車両数や運行頻度の計画は FS で検討されるが、コンセッションに基づいて鉄道の運営を担っている鉄道運営主体にとっては、車両や運行頻度を増やすインセンティブがないため、Green Line や Blue Line に見られるように座席を撤去することで定員拡大が行われている。コンセッションのライセンスを供与する鉄道事業者と、鉄道運営主体は、既存線の容量を改善するための適切なインセンティブについて話し合う必要があり、理想的には、インセンティブが合意され、コンセッション契約に含まれることが推奨される。

6) 駅構内、乗り換え施設

総移動時間を短縮するためには、鉄道に乗車している時間だけでなく、駅での滞在時間も最小限に抑える必要がある。駅の出入り口、改札口、券売機、階段、エレベーター、エスカレーター、ホーム等の駅施設は、将来の需要予測結果に応じて設計する必要がある。さらに、複数の路線が接続する乗換駅では、乗り換え時間を最小限に抑えるように必要がある。Green Line のサイアム駅のような対面乗り換えが理想的な設計であり、次いで Blue Line と Purple Line が接続するタオプーン駅、Blue Line のタープラ駅などの 2 階建ての乗り換え等が望ましい。一方で、Purple line と Pink Line のノンタブリー県総合庁舎駅、Yellow Line と ARL の Hua Mak 駅のような長い乗換や、Green Line の Asok 駅と Blue Line の Sukhumvit 駅など、他方向の歩行者の移動と交差するような乗り換えは、極力避けるべきである。

7) 付加価値のある鉄道サービス

自家用車から公共交通への手段転換を図るためには、より付加価値のある鉄道サービスの提供が不可欠となる。具体的には、以下のような点を考慮すべきである。

- 運行頻度を上げるための信号改良
- グリーン車の導入
- 立体交差化による踏切の解消
- 顧客サービスの改善

8) アクセシビリティ

M-MAP2 の政策の一つである駅へのアクセシビリティに関しては、バスや周辺道路等、鉄道セクター外の対応が求められ、他機関との連携が必要となる。

- バス路線が駅へのアクセスを十分にサポートしておらず、鉄道駅に簡単にアクセスできるよ

うにルートを変更する必要がある。駅周辺のバス停など、乗換のための施設がない場合が多く、駅への歩行者ルートの確保が求められている。

- 駅からのフィーダーシステムが整備されていないため、郊外部での駅へのアクセスが容易ではない。例えば、駅によっては、駅まで直接アクセスできるルートがなく、バスを乗り換えたりバイクタクシーを利用したりする必要が生じる場合がある。
- 鉄道整備を担う DRT と、都市開発や歩道管理などを担う都市セクターの組織との連携は、駅へのアクセスにとって非常に重要となる。行政の縦割り傾向が強い中で、効果的な調整は依然として大きな課題として残っている。

9) 交通指向開発 (TOD)

- Comprehensive Plan（タイにおける都市空間計画）は鉄道路線の優先順位に影響を与える。将来の土地利用計画を比較し、現在建設中の路線も含め、さまざまな優先順位を検討する必要がある。
- 運賃以外の収入源を確保するには、周辺の都市開発事業者など、鉄道事業から便益を得る関係者を、鉄道事業の評価プロセスに含める必要がある。課題は、TOD を原則とした交通計画を、都市計画・土地利用計画と効果的に統合することである。

7.2.4 M-MAP2 プラットフォームにおける鉄道政策と施策に関する議論の継続について

成果 3 で構築された M-MAP2 プラットフォームは、鉄道整備に関わるすべての関係者が議論する唯一の、非常に重要な場である。DRT が、この M-MAP2 プラットフォームを継続的に開催していくことが期待される。将来的には下図に示すように制度化し、Technical Advisory Committee として制度化することを提案する。

2024 年 2 月に開催された第 5 回 M-MAP2 プラットフォームにて、既存路線の混雑率の確認、急行に関する基礎的検討が行われたが、7.2.3 に記載している M-MAP2 の実現に向けた、様々な鉄道施策に対する継続的な議論が必要である。

今後の M-MAP2 プラットフォームでの検討内容は、都市鉄道の政策課題に応じて選定されることが期待されるが、当面の課題を下記に示す。

1) 今後の事業スキームの在り方の検討

- これまでの鉄道事業における PPP プロジェクトの課題抽出
- タイでの鉄道事業以外での先進的な PPP 事例の整理
- 今後の事業スキームの在り方及び調達方法等の検討

2) 施設の改良及び路線建設

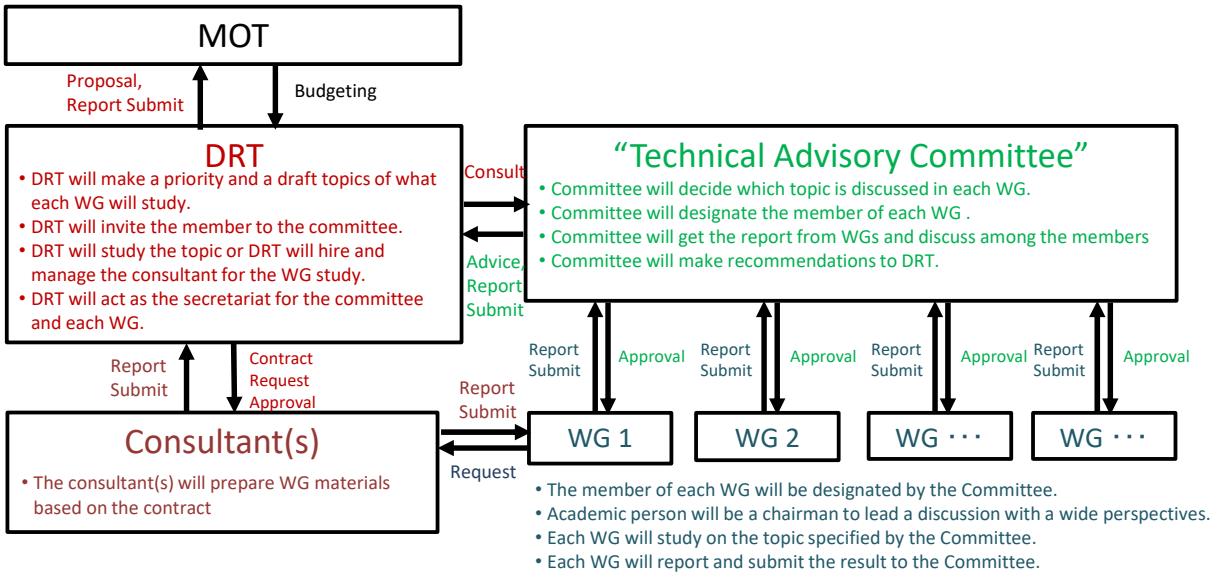
- 駅構内及びスカイウォークの混雑解消のための駅等の改良の検討
- 急行運転の検討
- 運行本数増強のための信号改良等の検討
- 鉄道の高架化（踏切の撤去）の検討
- 新規路線の詳細計画の検討

3) TOD＆公共交通利用促進の検討

- 駅へのアクセス及び駅前広場の在り方の検討
- 駅周辺開発の方策の検討
- 新規路線と並行するバス等の公共交通のネットワークの再編方針の検討
- 公共交通利用促進策（モビリティマネジメント）の検討及び実施
- バリアフリー施設の促進（例：バリアフリー施設の設置状況の把握と社会実験、案内用図記号（ピクトグラム）や案内標識の在り方の検討）

4) 運賃政策

- 20 バーツ均一運賃政策に関する補助金、収支採算性、運賃価格弾力性等の導入
- 他交通モード、都市間鉄道との MaaS 連携



出典：JET

図 7.2.1 提案する Technical Advisory Committee の構成

Appendices

Appendix 1: Minutes of Meetings of JCC

Appendix 2: Final PDM and PO

Appendix 3: M-MAP2 Final Report, Summary and Continued Discussion on Demand Forecast

Appendix 4: Railway Passenger and the COVID-19 Pandemic in Bangkok

Appendix 5: Introduction of Transport Demand Forecast

Appendix 6: Demand Forecast Modeling in the Tokyo Metropolitan Region

Appendix 7: Directions and Suggestions for Developing of Mass Transit Network

Appendix 8: Scenario Setting in Railway Development MP in Tokyo Metropolitan Region

Appendix 9: Railway Fare System in Japan

Appendix 10: Express Operation and Through Services

Appendix 11: Business Segment Diversification for Financially Robust Mass Rapid Transit

Appendix 12: Proposed Multi-purpose Development in Bangkok Metropolitan Region

Appendix 13: Developing a Business Schemes for Privately-operated Rail Services

Appendix 14: Infrastructure Financing Facility (Revolving Fund) for Mass Rapid Transit Development

Appendix 15: Developing a Business Schemes for Privately-operated Rail Services

Appendix 16: Bus Transportation as a part of Urban Public Transportation System

Appendix-1

Minutes of Meeting
Joint Coordinating Committee (JCC)

MINUTES OF MEETING

THE FIRST JOINT COORDINATING COMMITTEE (JCC) MEETING

FOR

THE PROJECT FOR ENHANCING CAPACITY FOR FORMULATION OF THE SECOND MASS RAPID TRANSIT MASTER PLAN IN BANGKOK METROPOLITAN REGION (M-MAP2)

In accordance with the Record of Discussions (R/D) signed on 1st March 2021 and subsequent assignment of the JICA Expert Team, the First meeting of the Joint Coordinating Committee (hereinafter referred to as "JCC") was held at the Department of Rail Transport (hereinafter referred to as "DRT") on 24th May 2022 to update the progress and to set the detailed plan of the Project for Enhancing Capacity for Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2) (hereinafter referred to as "the Project). The representatives from DRT, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the JICA Expert Team (hereinafter referred to as "JET"), and the other JCC members attended the meeting (refer to Annex 1).

Both sides agreed on the minutes of the meeting as summarized below, with documents submitted for the meeting annexed herewith.

1. Organizational Structure of Implementation of M-MAP2 TA Project

(1) Overall structure and means of discussion/coordination

JCC is established in order to facilitate the inter-agency coordination and confirm the progress and outputs of the Project. JCC meeting will be held twice a year and chaired by DRT. The monitoring sheet will be prepared and submitted to the JCC to monitor the progress of the Project twice a year.

In addition to JCC, various means of discussion and coordination such as M-MAP2 Platform, Demand Forecast Working Group, monthly project team meeting, public hearing and knowledge transfer seminar are organized and those contents and members are defined.

(2) Establishment of M-MAP2 Platform

The Demand Forecast Working Group has been established by DRT in September 2021 and the M-MAP2 Platform is requested to be established in earlier timing in order to coordinate with the Demand Forecast Working Group and to start the discussion on the railway development issues, policy and plans during the plan formulation of M-MAP2, rather than after the formulation.

JCC members have confirmed the necessity of early establishment of M-MAP2 Platform and suggested to discuss specific issues on the process of M-MAP2 formulation with participation and coordination of other related agencies.

(3) Assignment of DRT's counterpart staff

DRT has assigned the counterpart staff for the Project as follows (refer to Annex 2):

A) Counterpart staff who are fully involved in the discussion with JET and DRT Consultant

B) Counterpart staff expected to improve understanding on M-MAP2 and railway development policy through monthly meeting, Demand Forecast Working Group, and other important meeting/training.

(4) Participation of other organizations

- Participating and discussing in the major meetings such as JCC and M-MAP2 Platform.
- Sharing information of future plans, e.g. road and public transport network plan, future land use plan, service improvement and financing scheme, etc.

2. The detailed plan of the Project (Revised PDM and PO)

JCC members accepted the first version of the monitoring sheet. The summary of the Project monitoring (June 2021 – May 2022) is as per Annex 3.

(1) Revised Project Design Matrix (PDM) and Plan of Operation (PO)

The revised PDM is as per Annex 4 which is *Monitoring Sheet I Ver.1* and the revised PO is as per Annex 5 which is *Monitoring Sheet II Ver.1*. The PDM and PO will be used as a management tool of the Project, and it will be finalized once at the time of signing of the amendment of the Record of Discussions (R/D).

JCC members has confirmed the main contents of the revised PDM:

- Target year: to be discussed and set in the M-MAP2 Platform.
- Overall goal and project purpose: objectively verifiable indicators, means of verification, important assumptions are specified and determined.
- Expected outputs: objectively verifiable indicators, means of verification, important assumptions are specified and determined for each output.
- Detailed activities: necessary activities identified during finalization of work plans are added as the tasks of Thai Side and JICA.

As for PO, overall project schedule has been prepared based on the ongoing contract between DRT and DRT Consultant. The influence of COVID-19 may affect to the extension of project schedule.

(2) Revised Work Plan and Progress

The revised Work Plan is described in the form of the presentation material as per Annex 6. Progress of the M-MAP2 planning and demand forecasting works is updated by DRT as per Annex 7.

3. Other Points

(1) R/D Amendment: Based on the First JCC meeting, Minutes of Meeting (M/M) for R/D Amendment needs to be prepared. Once it is drafted, JICA will share DRT to review. Then both parties will proceed the internal approval for signing on the M/M for R/D Amendment.

(2) Japan Study Tour: Since the influence of COVID-19 is still remaining this year, the JCC members agreed to consider both possibilities to implement in Japan and replace to on-line training.

Annex 1: List of Attendance
Annex 2: List of DRT's Counterpart Staff
Annex 3: Monitoring Sheet Summary, Ver.1
Annex 4: Monitoring Sheet I (Project Design Matrix) Ver.1
Annex 5: Monitoring Sheet II (Plan of Operation) Ver.1
Annex 6: Presentation Material (DRT)
Annex 7: Presentation Material (JET)

24th May 2022
Bangkok, Thailand

Dr. Pichet KUNADHAMRAKS

Deputy Chairman of JCC
Deputy Director-General,
Department of Rail Transport

Mr. ONO Tomohiro
Director
Team 3, Transportation Group,
Infrastructure Management Department,
Japan International Cooperation Agency

Dr. MASUJIMA Tetsuji

Leader of JICA Expert Team

Annex 1

Project for Enhancing Capacity of Formulation of The Second Mass Rapid Transit Master Plan
In Bangkok Metropolitan Region (M-Map2)

List of Participants of 1st JCC Meeting
Tuesday 24th May 2022

Manangkasila Room, Na Talang Building, DRT
Online via Zoom

Organization	Name / Position
DRT	Dr. Pichet Kunadhamraks, Deputy Director General Mr. Ruengdej Mangkorndejsakul, Director, Strategy and Planning Division Mr. Phakhin Thonnarong, Transport Technical Officer Mr. Kittipitch Onika, Plan and Policy Analyst Ms. Pensri Luangaramsri, Plan and Policy Analyst, Professional Level, Rail Transport Regulation Division Mr. Tanyasak Noknoi, Rail Transport Regulation Division Mr. Sarayut Sintoorahut, Rail Transport Regulation Division Mr. Tossaporn Royvan, Plan and Policy Analyst, Strategy and Planning Division Mr. Pramote Suwankaew, Legal Affairs Division Ms. Kamolrat Namueangrak, Strategy and Planning Division Ms. Phitsuda Winyayen, Strategy and Planning Division Mr. Homare KOMATA, JICA Expert at DRT Mr. Pakpong Pattraphong, DRT Inhouse
JCC members	Mr.Roengsak Tongsom, Director from Office of Transport and Traffic Policy and Planning (OTP) Mr. Nakarin Plangpongpan, Director of Transport and Public Utilities Section 1 subdivision, Town and Country Planning Engineering Bureau, Department of Public Works and Town Planning (DPT) Mr. Sittiporn Somkidsan, Director of Transport System Office, Traffic and Transportation Department, BMA Mr. Surachet Mueangman, City Planner Senior Professional Level, City Planning and Urban Development Department, BMA Mr.Junlatep Chitasombat, Superintending Engineer, Track Rehabilitation Center, State Railway of Thailand (SRT) Ms. Nalinporn Chairat, Director of Accounting Division, Mass Rapid Transit Authority of Thailand (MRTA) Mrs. Arunee Hiam, Director Development Promotion and Coordination Division, TICA Mr. Saharat Atichetpredeeting, Acting Project Department Manager, S.R.T. Electrified Train Dr. Suwat Wanisubut Mr.Chamroon Tangpaisalkij Asst. Prof.Sittha Jensirisak Dr.Sumeth Ongkittikul

Japan Academia	Prof. Atsushi FUKUDA, Nihon University
JICA	Mr. Tomohiro ONO, JICA HQ Mr. Shintaro OGIWARA, JICA HQ Ms. Katharine Maneetapodi, Senior Program Officer, JICA Thailand
Other Participants	Mr. Ayuwat Chitprasert, Chief of Transportation network and Connection, Bureau of Transport and Traffic System Development, OTP Mr. Ekapon, OTP Ms. Orawan, S.R.T. Electrified Train Ms. Sorada Saowalakaksorn, MRTA
JET	Dr. Tetsuji MASUJIMA, Team Leader Mr. Masaru KOMORI, Deputy Team Leader Ms. Motoko KANEKO, Urban Planning Mr. Masahiro WARABI, Railway Business Management Mr. Takayuki Hagiwara, Urban Railway Planning Dr. Tithiwach Tansawat, Urban Transportation Planning Assistance /Environmental and Social Considerations / PR Dr. Jay Wetwitoo, Traffic Demand Forecast Evaluation Assistance / Training Planning Mr. Jehan Chuduang, Research Assistant Ms. Paweena Akrapranwat, Secretary

MINUTES OF MEETING

THE SECOND JOINT COORDINATING COMMITTEE (JCC) MEETING

FOR

PROJECT FOR ENHANCING CAPCITY of FORMULATION OF THE SECOND MASS RAPID TRANSIT MASTER PLAN IN BANGKOK METROPOLITAN REGION (M-MAP2)

The second meeting of the Joint Coordinating Committee (hereinafter referred to as "JCC") was held at the Department of Rail Transport (hereinafter referred to as "DRT") on 30th November 2022 to update the progress and schedule of "Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)" (hereinafter referred to as "the Project). The representatives from DRT, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the JICA Expert Team (hereinafter referred to as "JET"), and the other JCC members attended the meeting (refer to Annex 1).

Both sides agreed on the minutes of the meeting as summarized below, with documents submitted for the meeting annexed herewith.

1. Confirmation of Key Progress on Technical Matters in Formulating M-MAP2

JCC members confirmed the key progress on some technical matters in formulating M-MAP2 as follows:

(1) Railway Demand Forecasting Models and Traffic Surveys

Basic demand forecasting methods and models, and design of necessary traffic surveys have been deeply discussed and confirmed through the number of monthly meetings and the Demand Forecast WG meetings.

Then, the number of traffic surveys have been already implemented, and the database is now being developed. The supplemental traffic survey supported by JICA was commenced in November 2022 and the results will be processed and incorporated to the database. The results and outputs will be further shared and discussed in the next project stages.

(2) Urban Railway Development Vision and Policies

Basic urban railway development vision and policies have been determined through the discussion in the number of monthly meetings and the M-MAP2 Platforms. The urban railway route planning will be continuously discussed and evaluated by demand forecast analysis in the next project stages.

2. The detailed plan of the Project (Updated PO)

JCC members accepted the second version of the monitoring sheet. The summary of the Project monitoring (June 2022 – November 2022) is as per Annex 2.

(1) Project Design Matrix (PDM) and Plan of Operation (PO)

Since the PDM and PO were revised in the last Project Monitoring Sheet Ver.1, the PDM has no change as per Annex 3 which is *Monitoring Sheet I Ver.2*. On the other hand, the PO was updated in accordance with the change of timing of formulating the M-MAP2from January 2023 to August 2023, due to the influence of COVID-19, as per Annex 4 which is *Monitoring Sheet II Ver.2*.

(2) Updated work Progress

The update of the activity of M-MAP2 Technical Cooperation Project was reported by JET in the form of the presentation material as per Annex 5. Progress of the M-MAP2 planning and demand forecasting works were updated by DRT as per Annex 6.

3. Other Points

(1) Training in Japan: The first of two training in Japan is planned to implement in April 2023. The contents, participants, timing will be further considered in coordination between DRT and JICA.

Annex 1: List of Attendance
Annex 2: Monitoring Sheet Summary, Ver.2
Annex 3: Monitoring Sheet I (Project Design Matrix) Ver.2
Annex 4: Monitoring Sheet II (Plan of Operation) Ver.2
Annex 5: Presentation Material (JET)
Annex 6: Presentation Material (DRT)

30th November 2022
Bangkok, Thailand

Dr. Pichet KUNADHAMRAKS

Chairman of JCC
Director General,
Department of Rail Transport

Mr. Ryoichi KAWABE

Senior Representative of Thailand Office
Japan International Cooperation Agency

Dr. Tetsuji MASUJIMA

Leader of JICA Expert Team

Project for Enhancing Capacity of Formulation of The Second Mass Rapid Transit Master Plan
In Bangkok Metropolitan Region (M-Map2)

List of Participants of 2nd JCC Meeting
Wednesday 30th November 2022

Manangkasila Room, Na Talang Building, DRT
Online via Zoom

Organization	Name / Position
DRT	Dr. Pichet Kunadhamraks, Director General Mr. Ruengdej Mangkorndejsakul, Director, Strategy and Planning Division Dr. Natthaporn Buaphut, Head of Strategy and Planning Division Mr. Pana Supatitipong, Head of International Cooperation, Strategy and Planning Division Ms. Duangchai Wongrak, Head of Rail Business Supervising Group, Rail Transport Regulation Division Ms. Kamolrat Namueangrak, Head of Financial Structure Analysis, Strategy and Planning Division Mr. Phakhin Thananarong, Transport Technical Officer, Strategy and Planning Division Mr. Kittipitch Onika, Plan and Policy Analyst, Strategy and Planning Division Ms. Benjawan Kunviroteluck, Transport Technical Officer, Strategy and Planning Division Ms. Phanthira Thanasophon, Civil Engineer, Safety Maintenance Standards Division Mr. Phaopong Chareansuk, Civil Engineer, Civil Engineer, Safety Maintenance Standards Division Mr. Wattanit Suwannarat, Chief of Rail Transport Business Regulation Group, Rail Transport Regulation Division Mr. Pannaphat Somwang, Electrical Engineer, Safety Maintenance Standards Division Mr. Homare KOMATA, JICA Expert at DRT
JCC members	Ms. Supapan Diapiriyakit, Diplomatic Service Officer Senior Professional Level, TICA Mr. Silpeera Nakchamratsri, Development Cooperation Officer Practitioner Level, TICA Mr. Ayuwat Jitprasert, Chief of Transport Network and Connectivity Group, Transport and Traffic Development Division, OTP Mr. Ekapon Akarapanitkorn, Civil Engineer, Professional Level, OTP Mr. Nares Intarakumhang Na Rachasima, Plan and Policy Analyst Practitioner Level, OTP Ms. Thitisuda Nualsri, Plan and Policy Analyst Practitioner Level, OTP Ms. Isaraporn Boonin, Plan and Policy Analyst Practitioner Level, OTP

	Mr. Sittiporn Somkidsan, Director Traffic and Transportation Department, BMA Mr. Thanwit Thanyapornjoranon, Chief of Rail System Management Group, TTD, BMA Mr. Tharatorn Kanchanakorn, Senior Engineer, TTD, BMA Mr. Surachet Mueangman, Chief of Layout and Preparing the City Comprehensive Plan, City Planning and Urban Development Department, BMA Mr. Julatep Chitasombat, Superintending Engineer, Track Rehabilitation Center, SRT Dr. Atchara Limmonthon, Chief of Project Study Subdivision, MRTA Ms. Orapan Phuengpat, Engineer 6, MRTA Mrs. Wiyadarat Satiratat, Manager Policy Planning and Risk Management section, SRTET Ms. Kritsayaporn Suannisit, Manager Policy Planning and Risk Management Department, SRTET Ms. Orawan Chansri, Policy Planning and Risk Management Officer, SRTET Mr. Nattawut Maarjlert, SRTET Dr. Suwat Waneesubut Mr. Chamroon Tangpaisankij, President of Thailand Walking and Cycling Institute Foundation Asst. Prof. Dr. Sittha Jensirisak, Ubon Ratchathani University Asst. Prof. Dr. Varameth Vichiensan, Kasetsart University Dr. Sumet Ongkittikul, TDRI
JICA	Mr. Ryoichi KAWABE, Senior Representative, JICA TH Mr. Shintaro OGIWARA, Deputy Assistant Director, JICA HQ Mr. Kenichiro KOIWA, Representative, JICA Thailand Mr. Miu NAKAZONO, JICA HQ Ms. Katharine Maneethapodi, Senior Program Officer, JICA TH
DRT Consultant	Dr. Pongsak Suriyavanagul, Project Manager Dr. Isaradatta Rasmidatta, Project Manager Assistant Dr. Ackchai Sirikijpanichkul, Transport and Traffic Planning Specialist Mr. Jongsalit Jongudomkarn, Transport and Traffic Planning assistant Mr. Pakpong Pattraphong, DRT Inhouse staff
JET	Dr. Tetsuji MASUJIMA, Team Leader Mr. Masaru KOMORI, Deputy Team Leader Ms. Motoko KANEKO, Urban Planning Dr. Tithiwach Tansawat, Urban Transportation Planning Assistance /Environmental and Social Considerations / PR Dr. Jay Wetwitoo, Traffic Demand Forecast Evaluation Assistance / Training Planning Mr. Jehan Chuduang, Research Assistant Ms. Paweena Akrapranwat, Secretary

MINUTES OF MEETING

THE THIRD JOINT COORDINATING COMMITTEE (JCC) MEETING

FOR

PROJECT FOR ENHANCING CAPCITY OF FORMULATION OF THE SECOND MASS RAPID TRANSIT MASTER PLAN IN BANGKOK METROPOLITAN REGION (M-MAP2)

The third meeting of the Joint Coordinating Committee (hereinafter referred to as "JCC") was held at the Department of Rail Transport (hereinafter referred to as "DRT") on 12th October 2023 to update the progress and schedule of "Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)" (hereinafter referred to as "the Project"). The representatives from DRT, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the JICA Expert Team (hereinafter referred to as "JET"), and the other JCC members attended the meeting (refer to Annex 1).

Both sides agreed on the minutes of the meeting as summarized below, with documents submitted for the meeting annexed herewith.

1. Confirmation of Key Progress in Formulating M-MAP2

JCC members confirmed the key project progress on some technical matters in formulating M-MAP2 as follows:

(1) Railway Demand Forecast Modeling

The models and database have been provisionally developed. However, it was suggested by the Demand Forecast Working Group, the re-producibility of the current traffic situation by the model are to be further improved. Therefore, the following activities are being implemented with advice from Japanese academia:

- Review of accessibility to stations by zone such as time and service availability.
- Re-estimation of modal split model and railway route choice model based on the above-mentioned review.

Any other improvement issues will be included in the M-MAP2 document as the future tasks in formulating next mass rapid transit master plan.

(2) Proposed Railway Development Policy and Route Planning

Future railway route network has been provisionally evaluated and investment priory was examined. However, it was suggested by the M-MAP2 Platform, the following items shall be further considered:

- Capacity expansion for the existing lines (green and blue)
- Express operation (suitable for long-distance commuter lines)

The plan will be further evaluated through the evaluation criteria qualitatively and quantitatively using the updated demand forecast models.

(3) M-MAP2 Platform

The M-MAP2 Platform has been established ahead of schedule and already held 4 meetings. The Platform meeting shall be continuously held for the finalization of the plan and preparation for its implementation. It was suggested by Japanese side, the platform is expected to be the base for the "Committee for Railway Development".

2. Activity schedule towards the completion of the Project

JCC members have confirmed the broad schedule of the following major project activities towards the completion of the Project in June 2024:

- Improvement of the demand forecast model and database (by December 2023)
- Update of the M-MAP2 planning and evaluation (by January 2024)
- Hold the 5th M-MAP2 Platform (January 2024)
- Start the M-MAP2 approval process (after February 2024)
- Conduct of the 2nd Study Tour in Japan (April 2024)
- Hold the 4th JCC meeting (April-May 2024)
- Submission of the Project Completion Report (June 2024)

Annex 1: List of Attendance
Annex 2: Presentation Material (JET)
Annex 3: Presentation Material (DRT)

12th October 2023
Bangkok, Thailand

Dr. Pichet KUNADHAMRAKS

Chairman of JCC
Director General,
Department of Rail Transport

Mr. Ryoichi KAWABE

Senior Representative of Thailand Office
Japan International Cooperation Agency

Dr. Tetsuji MASUJIMA

Leader of JICA Expert Team

MINUTES OF MEETING

THE FOURTH JOINT COORDINATING COMMITTEE (JCC) MEETING

FOR

PROJECT FOR ENHANCING CAPCITY OF FORMULATION OF THE SECOND MASS RAPID TRANSIT MASTER PLAN IN BANGKOK METROPOLITAN REGION (M-MAP2)

The fourth meeting of the Joint Coordinating Committee (hereinafter referred to as "JCC") was held at the Department of Rail Transport (hereinafter referred to as "DRT") on 3rd July 2024 to confirm the final outputs of the "Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)" (hereinafter referred to as "the Project"). The representatives from DRT, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the JICA Expert Team (hereinafter referred to as "JET"), and the other JCC members attended the meeting (refer to Annex 1).

Both sides agreed on the minutes of the meeting as summarized below, with documents submitted for the meeting annexed herewith.

1. At this final JCC meeting, DRT shared an outline of the formulated M-MAP2 and the ongoing approval process as the latest update. JET also shared a summary of the overall activities implemented in the 3-years JICA's technical cooperation project and the results of its evaluation and recommendations. In conclusion, the project purpose and outputs were achieved, and evaluated that the project contributed to the development of the M-MAP2 through the activities of DRT, DRT consultants, and JET. (refer to Annex 2 and Annex 3)

2. As future issues related to demand forecasting (Output 1), the need for improvement was identified in the following areas: improvement of traffic survey methods, utilization of big data, forecasting weekend OD data and peak/off-peak hourly OD data, considering tourist flow, collection of accurate station-to-station OD data, and utilized for calibration of railway trip zone-OD, etc.

3. As future issues related to planning (Output 2), it was identified that improvements are needed in the evaluation method of route priority and consideration of express operations for future planning.

4. As future issues related to efforts to realize the plan (Output 3), it was identified that there is a need to continue discussions on important policy issues such as railway development schemes, fare policy, value-added railway services, TOD promotion, station access improvement, and modal shift, etc. It was also agreed that these issues will continue to be discussed using the organizational structure based on the M-MAP2 platform, likely called "Technical Advisory Committee".

5. The concept of further collaboration after M-MAP2 suggested by JICA to support DRT and the proposed "Technical Advisory Committee" for the discussion on the railway-related policy and issues was accepted by DRT. JICA and DRT confirmed to discuss closely on the further collaboration.

Annex 1: List of Attendance
Annex 2: Presentation Material (DRT)
Annex 3: Presentation Material (JET)

3rd July 2024
Bangkok, Thailand

Athibhu Chitranukroh.

Mr. Athibhu CHITRANUKROH

Deputy Chairman of JCC
Deputy Director General,
Department of Rail Transport

Mr. Ryoichi KAWABE

Senior Representative of Thailand Office
Japan International Cooperation Agency

Dr. Tetsuji MASUJIMA

Leader of JICA Expert Team

Annex 1

Project for Enhancing Capacity of Formulation of The Second Mass Rapid Transit Master Plan
In Bangkok Metropolitan Region (M-Map2)

List of Participants of 4th JCC Meeting
Wednesday 3rd July 2024
Manangkasila Room, Na Talang Building, DRT
Online via Zoom

Organization	Name / Position
DRT	Mr. Athibhu Chitranukroh, Deputy Director General Mr. Ruengdej Mangkorndejsakul, Director, Strategy and Planning Division Dr. Natthaporn Buaphut, Head of Strategy and Planning Division Mr. Pana Supatitipong, Head of International Cooperation Mr. Kittipid Onika, Plan and Policy Analysis, Strategy and Planning Division Mr. Wasin Boontongto, Transport Technical Officer, Strategy and Planning Division Mr. Sorrawit Saisorn, Transport Technical Officer, Strategy and Planning Division Mr. Mr. Pakpong Pattraphong, Transport Technical Officer Mr.Nadtaphon Timsawaddikun Transport Technical Officer Mr. Takaaki Furuhashi, JICA Expert at DRT
JCC members	Mr. Nakarin Plangpongpan, Survey and Mapping Expert, DPT Mr. Tharathorn Kanchanakorn, Civil Engineer, Professional Level, TTD, BMA Mr. Surachet Mueangman, Chief of Layout and Preparing the City Comprehensive Plan, City Planning and Urban Development Department, BMA Mr. Chaiwat Sangkapak,Director Transport and Traffic Development Division, OTP Mr. Ekapon Akarapanitkorn, Civil Engineer, Professional Level, OTP Mr. Julatep Chitasombat, Superintending Engineer, Track Rehabilitation Center, SRT Dr. Atchara Limmonthon, Chief of Project Study Subdivision, MRTA Ms. Orapan Phuengpat, Engineer 6, MRTA Ms. Ornanong Chaengpongpan, Director Strategic and Planning Department, SRTET Ms. Kritsayaporn Suannisit, Manager Policy Planning and Risk Management Department, SRTET Ms. Orawan Chansri, Policy Planning and Risk Management Officer, SRTET Ms. Kodchakorn Woratharakul, SRTET Asst. Prof. Dr. Varameth Vichiensan, Kasetsart University
JICA	Mr. Ryoichi KAWABE, Senior Representative, JICA TH Mr. Makoto TOYAMA, Senior Engineering Officer, JICA HQ Ms. Yuko HIROTA, Program Officer, JICA TH

	Mr. Kohei SATO Mr. Tomohiro SHIMIZU Ms. Katharine Maneethapodi, Senior Program Officer, JICA TH
Embassy of Japan	Mr. Tsuyoshi YAMAKAWA, First Secretary (Transport, Tourism), Embassy of Japan
DRT Consultant	Assoc. Prof. Dr. Pongsak Suriyavanagul, Project manager Assoc. Prof. Dr. Ackchai Sirikijpanichkul, Transport and Traffic Planning Specialist Dr. Peerapol Sittivijan, Transport and Traffic Modeling Specialist 2 Dr. Isaradatta Rasmidatta, Project Manager Assistant Mr. Jongsalit Jongudomkarn, Transport and Traffic Planning assistant Mr. Chatchawan Simalorit
JET	Dr. Tetsuji MASUJIMA, Team Leader Mr. Masaru KOMORI, Deputy Team Leader Mr. Takayuki HAGIWARA, Urban Railway Planning Ms. Motoko KANEKO, City Planning Mr. Masahiro WARABI, Railway Business Operation Dr. Tithiwach Tansawat, Urban Transportation Planning Assistance /Environmental and Social Considerations / PR Dr. Jay Wetwitoo, Traffic Demand Forecast Evaluation Assistance / Training Planning Dr. Teeranai Srimahachota Mr. Jehan Chuduang, Research Assistant Ms. Paweena Akrapranwat, Secretary

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Summary of Project Activities and Recommendations

The 4th JCC

3rd July 2024

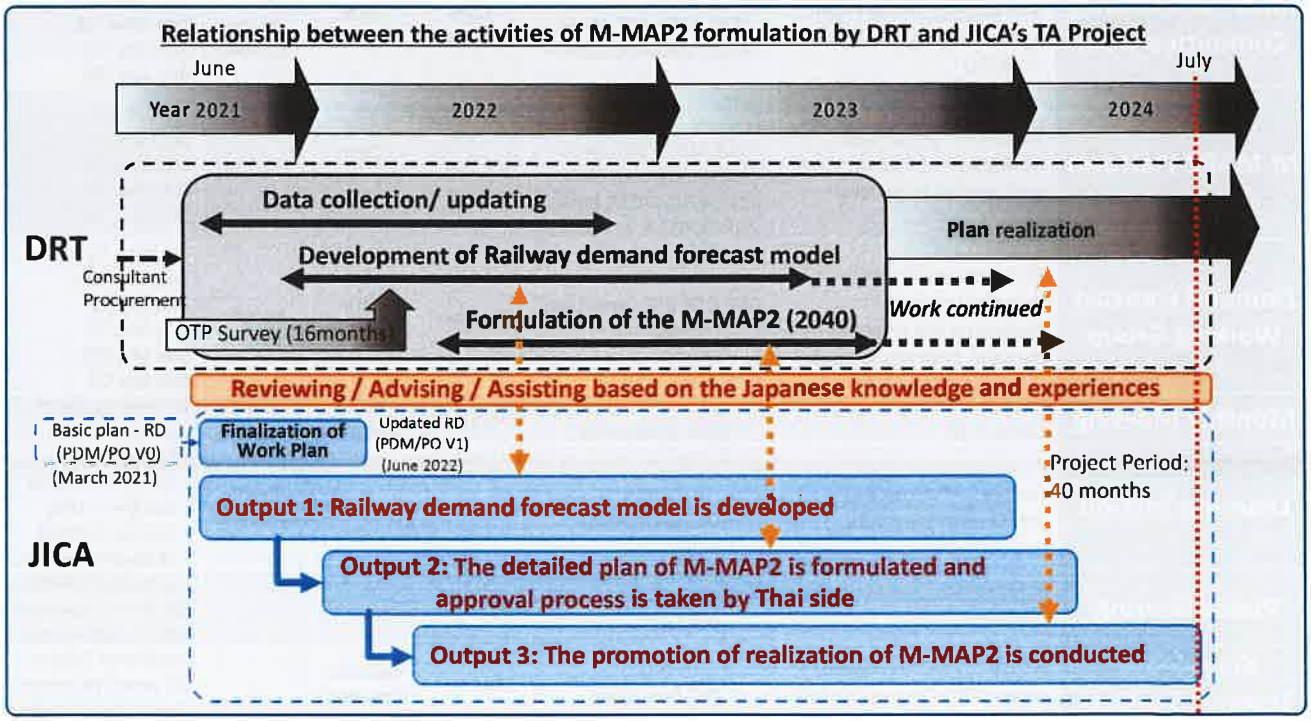
JICA Expert Team

(ALMEC / CRP / OCG / Tokyo Metro)

Project Implementation Framework

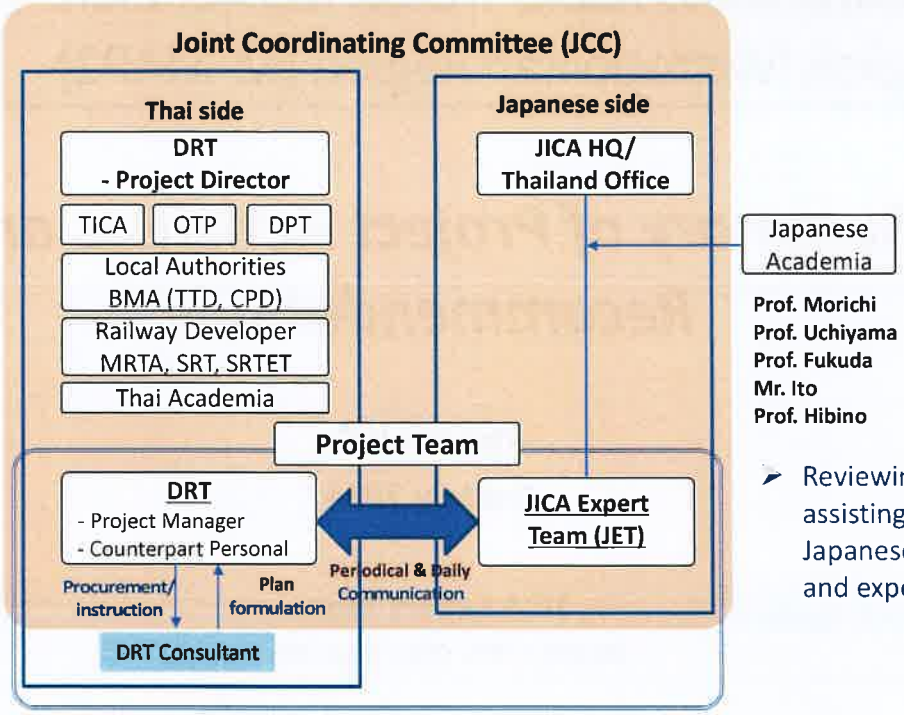
Overall Goal: Sustainable and comprehensive transportation network in Bangkok Metropolitan Region is realized.

Project Purpose: Capability of Thai Government and DRT to formulate future railway master plan is improved



Project Implementation Organization

Composition of JCC for M-MAP2



- Reviewing, advising, assisting based on the Japanese knowledge and experiences

Project Activities and Achievements

Means of Discussion / Coordination

Meeting / Event	Contents	Thai Organization	Japanese Participant			Achievements (as of Oct. 2023)
			JICA HQ/ Thai	JET	Academic Experts	
Joint Coordinating Committee (JCC)	Confirmation of progress and outputs of the Project, agreement on changes in PDM/PO	DRT, OTP, DPT, DIC, BMA (TTD, CPD), SRT, MRTA, SRTET, academic experts	Core Member	Core Member	(depend on the content)	Kick-off: June '21 1st: May '22 2nd: Nov. '22 3rd: Oct. '23 4th: July '24
M-MAP2 Platform	Discussion on railway development issues, plans, and policies in general	DRT, NESDC, MOT-OPS, OTP, PDMO, SEPO, DPT, DLT, MRTA, SRT, BMA-TTD/CPD/PWD, PAOs, BEM, BTSC, SRTET, BMTA, AERA1, RTDA, Academia	Member	Core Member	Advisor	1st: July '22 2nd: Oct. '22 3rd: Mar. '23 4th: Aug. '23 5th: Feb. '24
Demand Forecast Working Group	Technical confirmation of demand forecast. Reviewing the progress of demand forecasting work	DRT, OTP, DRT consultant, academia	Member	Core Member	Advisor	1st: Nov. '21 2nd: Mar. '22 3rd: Jul. '22 4th: Dec. '22 5th: May '23 6th: July '23
Monthly Meeting	Regular consultation between DRT and JET	DRT (DRT Consultant)	Observer	Core Member	Join if necessary	17 meetings were organized.
Learning Session	Lecture and discuss the specific planning issues	DRT (DRT Consultant)	Observer	Lecturer	Join if necessary	• Socio-economy • Demand Forecast • Rail fare setting • Rail dev. Scheme • Through operation, etc.
Public Hearing	Public hearing within DRT's Consultant's task	DRT DRT Consultant	Observer	Observer	-	Conducted 4 times. JET joined to present the Japan's experiences
Knowledge Transfer Seminar	Knowledge transfer for DRT within DRT's Consultant's task	DRT DRT Consultant	Observer	Lecturer, if needed	-	Conducted 2 times. JET joined to present the Japan's experiences

Project Activities



1st Demand Forecast WG Meeting adviced by Japanese Academia



2nd Demand Forecast WG Meeting



Knowledge Transfer Training



Monthly Meeting



Internal Meeting with DRT



Meeting on Population topic with DRT and DRT consultant

Project Activities



1st M-MAP2 Platform



3rd Demand Forecast Working Group



2nd M-MAP2 Platform



Learning Session by JET & DRT



inspect field surveys for the Railway
Demand Forecast Model



4th Demand Forecast Working Group

Project Activities



3rd M-MAP2 Platform



5th Demand Forecast Working Group



6th Demand Forecast Working Group



4th M-MAP2 Platform



3rd JCC



5th M-MAP2 Platform

1st Study Tour in Japan (April 2023)













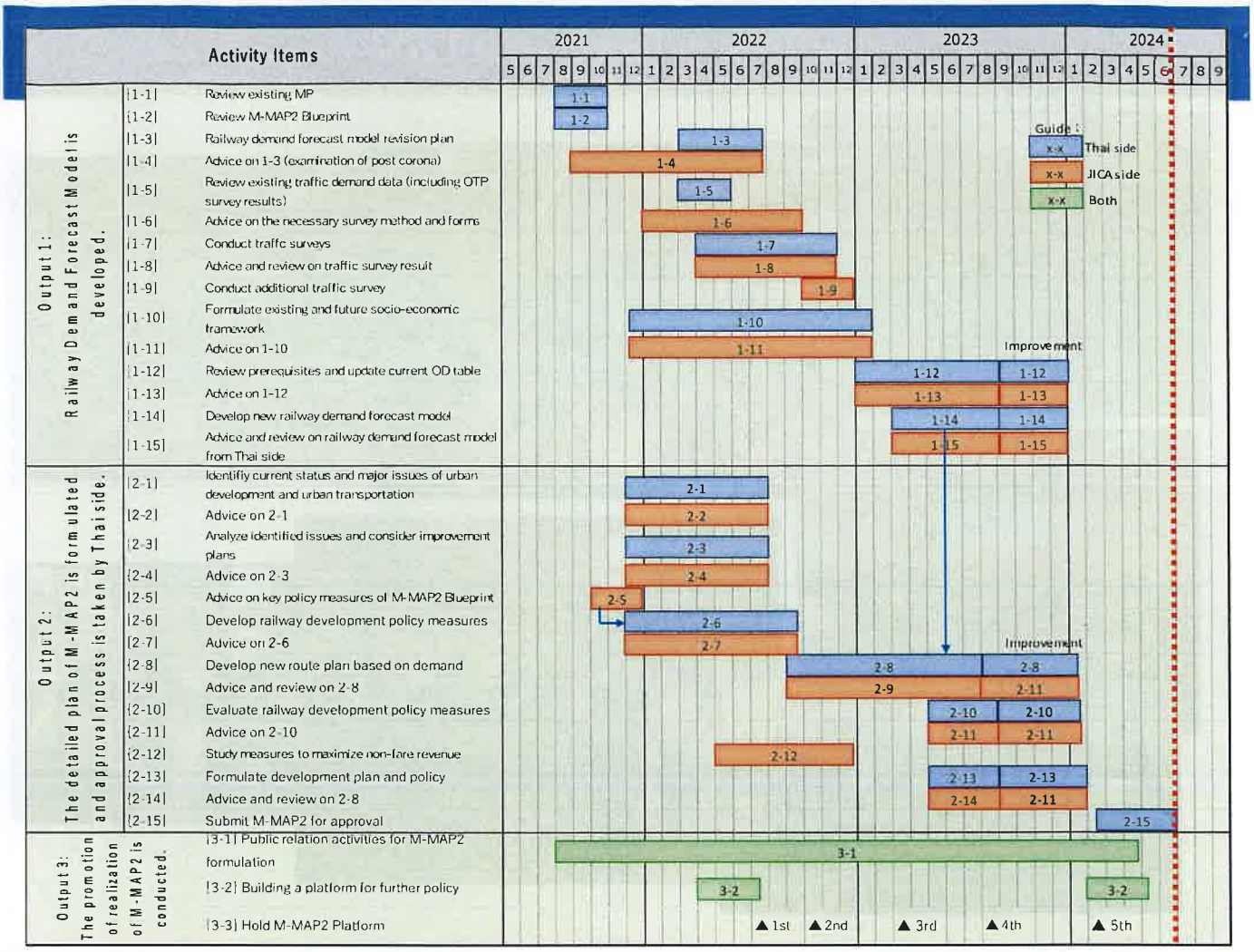


2nd Study Tour in Japan (April 2024)



Project Implementation Schedule (updated)

Activity Items			2021												2022												2023												2024								
			5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
By Thai side (DRT) M-MAP2 formulation work (Plan)			Consultant Procurement								Implementation Period 25 months																																								
											OTP Survey																																										
											Data collection/update																																										
															Establish of railway demand forecast model																																								
															Formulation of MMAP2																																								
0. Overall Activity	[0-1]	Work plan preparation	▲Draft Work Plan																																														
	[0-2]	Kick-off meeting	▲Kick-off meeting																																														
	[0-3]	Identification of issues	Collection / review of related materials, understanding of problems / issues																																														
	[0-4]	Examination of COVID19 Impact	Collecting cases and examining activities related to post-corona public transportation																																														
	[0-5]	Indecator setting	Settings based on baseline survey																												▲Follow-up surv										▲Follow-up survey								
	[0-6]	Detailed plan	Finalization of Work Plan												PDM, PO revision																																		
	[0-7]	Work plan revision	▲Work plan revision																																														
	[0-8, 9]	JCC, Minutes	▲1st												▲2nd																▲3rd																		4th
	[0-10]	Monitoring sheet	▲Ver.1												▲Ver.2												▲Ver.3												▲Ver.4								
	[0-11]	Training in Japan																									▲1st																▲2nd							
	[0-12]	Demand Forecast WG (by DRT)									▲1st				▲2nd				▲3rd				▲4th				▲5th	▲6th																				
		M-MAP2 Platform (by DRT)																	▲1st				▲2nd				▲3rd				▲4th						▲5th										
		Knowledge Transfer (by DRT Consultant)									1st																2nd																						
		Seminar (by DRT Consultant)													1st												2nd	3rd	4th																				
	[0-13,14]	Report									Progress Report▲																																						Progress Report▲				Project Completion Report▲				



Output1: Railway demand forecast model is developed

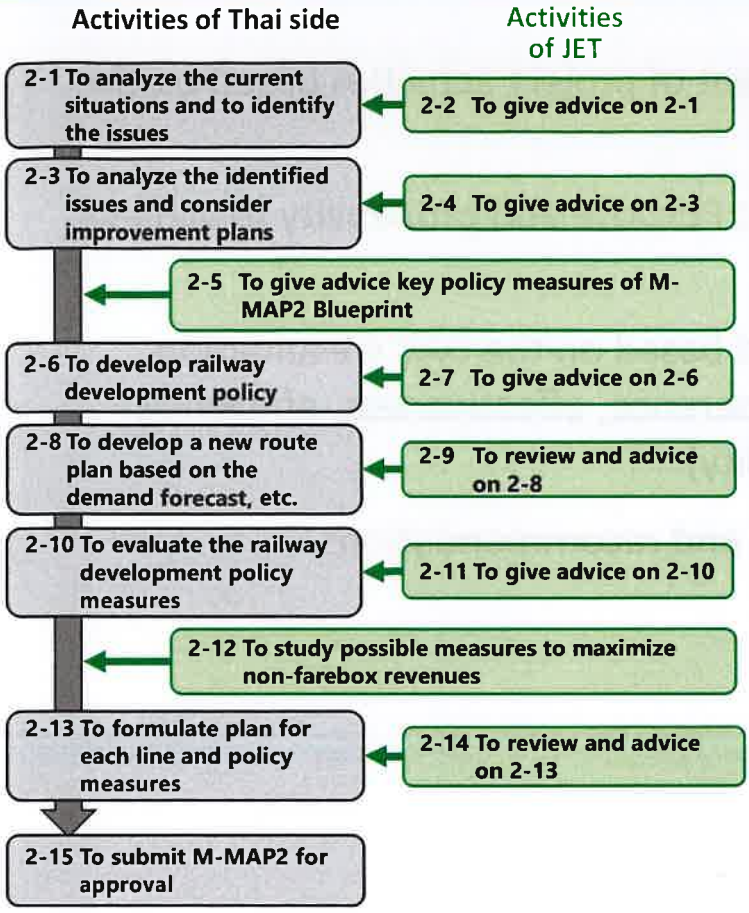
Activities of Thai side | **Activities of JET**

- **1-1 Review of the existing master plans of BMR**
- **1-2 Review of M–MAP2 Blueprint**
- **1-3 To set planning of demand forecast model development** ← **1-4 To give advice on 1-3**
- **1-5 To review the existing survey results incl. HIS data from OTP**
- ← **1-6 To give advice on the survey method and forms**
- **1-7 To conduct traffic surveys based on the result of 1-5** ← **1-8 To give advice and review the survey data**
- ← **1-9 To conduct an additional traffic survey**
- **1-10 To develop socio-economic framework** ← **1-11 To give advice on socio-economic framework**
- **1-12 To revise preconditions and reproduce current OD tables** ← **1-13 To give advice on 1-12**
- **1-14 To develop updated railway demand forecast model** ← **1-15 To give advice and review on 1-14**

RESULTS

- Railway demand forecast models and database were provisionally developed at the time of 6th WG meeting in August 2023.
- By January 2024, the re-producibility of the current traffic situation by the model was further improved through the following activities with advice from Japanese academia.
  - Review of accessibility to stations by zone such as time and service availability.
  - Additional railway trips from tourists traveling within CBD.
  - Calibration of base year station-to-station OD considering passenger transfer between operators.
  - Estimation of railway trip zone-OD based on station-to-station OD.

Output 2: The detailed plan of M-MAP2 is formulated and approval process is taken by Thai side

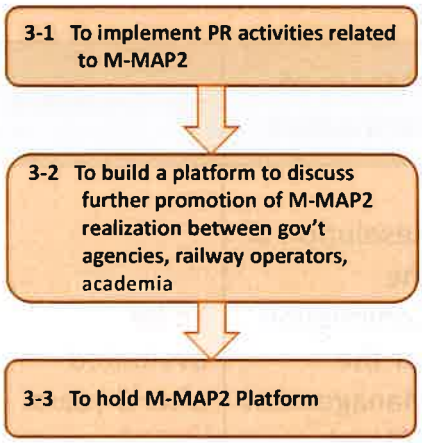


RESULTS

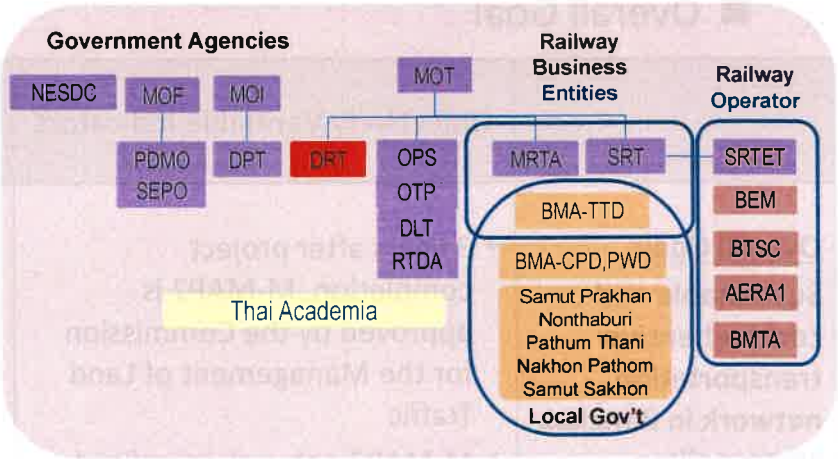
- Future railway route network was provisionally evaluated and investment priory was examined at the time of 4th M-MAP2 Platform meeting in August 2023.
- The following items shall be further considered as suggested by Thai/Japanese academia.
  - Capacity expansion for the existing lines (green and blue)
  - Express operation and business-class train cars (suitable for long-distance commuter lines)
- The plan was further evaluated through the evaluation criteria partly using the updated demand forecast models and finalized by February 2024.
- DRT is now preparing for the submission for its official approval.

Output 3: The promotion of realization of M-MAP2 is conducted

Cooperation of DRT and JET



M-MAP2 Platform



RESULTS

- The M-MAP2 Platform was established ahead of schedule.
- The M-MAP2 Platform meetings have been held 5 times to discuss the railway development policies and various planning issues.
- The M-MAP2 Platform is expected to be institutionalized as "Technical Advisory Committee" for continuous discussion of policies and planning issues.

Project Evaluation

- To evaluate achievement of project activities based on the PDM and PO.
- To evaluate the Project Purpose and probability to achieve the Overall Goal.
- To evaluate the Project based on the DAC 6 evaluation criteria (relevance, coherence, effectiveness, efficiency, impact and sustainability)
- To get lessons learned and recommendations.

Project Evaluation

- Overall Goal

	Objectively Verifiable Indicators	Means of Verification	Achievement
Overall Goal: Sustainable and comprehensive transportation network in Bangkok Metropolitan Region is realized.	• 3 years after project completion, M-MAP2 is approved by the Commission for the Management of Land Traffic • M-MAP2 network is realized within the planned time frame	• Resolution of the Commission for the Management of Land Traffic	To be evaluated after 3 years.

Project Evaluation

■ Project Purpose: Evaluation Framework

	Objectively Verifiable Indicators	Means of Verification	Achievement
Project Purpose: Capability of Thai government and DRT to formulate future railway master plan is improved.	By the time of project completion • More than 4 officers in DRT are involved in regular discussion with JICA.	Meeting report	• 4 CP members have been regularly assigned.
	• More than 20 officers in DRT improved understanding on planning steps of M-MAP2, railway policies, coordination mechanism for railway policies, and railway demand forecast model through training and regular meeting provided by JICA.	Baseline/mid-term/at completion survey	• All of CP members improved their understanding on M-MAP2 preparation in general (see next slide)
	• More than 7 staffs belonging to the organization related to urban transport (OTP, DPT, BMA(TTD, CPD), MRTA, SRT, SRTET) participate in M-MAP 2 Platform organized by DRT.	M-MAP 2 Platform implementation report	• In average 20 staff from transport-related organizations attended the M-MAP2 Platform meeting

Project Evaluation

■ Survey to measure the Understanding on M-MAP2 formulation

- ➢ Base line survey in 2021 and at-completion survey in 2024.
- ➢ Google-form questionnaire survey
- ➢ Target: 20 counterpart members of DRT (14 original members and 6 mid-joined members)

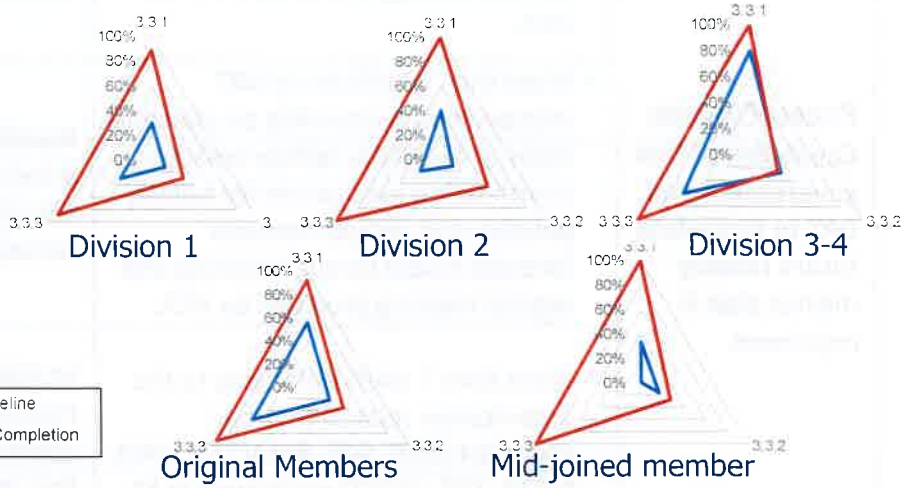
Item	Contents of Questionnaire
Part 1	Rational of M-MAP2 Formulation
Part 2	Planning Procedures
Part 3	Demand Forecast Model
Part 4	Railway Development Policy
Part 5	Mechanism to realize the policy

Project Evaluation

- Survey to measure the Understanding on M-MAP2 formulation
  - Evaluated by Division and by type of member (original and mid-joined members)

Ex. Result of Part 3: Basic Demand Forecast Model

3.3.1 What does LOS stand for?
3.3.2 Please answer three major factors to prescribe level of railway services
3.3.3 Please order below each demand forecast step from the beginning of 4 step model



All of CP members improved their understanding on M-MAP2 formulation in general.

Project Evaluation

- DAC 6 Evaluation Criteria

Criteria	Rating	Evaluation Aspects
Relevance	High	➢ Country's development policy and needs ➢ Beneficiary's need ➢ Advantages of Japan's cooperation
Coherence	High	➢ Consistency with Japan's ODA policy ➢ Linkage with other JICA projects
Effectiveness	Relatively High	➢ Achievement level of plan formulation ➢ Government approval of the plan
Efficiency	Medium	➢ Work schedule by DRT consultant ➢ JET's assignment in BKK
Impact	High	➢ Policy goals for urban railway development ➢ Social ripple effects
Sustainability	Relatively High	➢ Organizational and institutional sustainability ➢ Financial sustainability ➢ Technical sustainability

Conclusion and Recommendations

■ Conclusion:

The project purpose and expected outputs were fully achieved, and the project implementation process was appropriate.

The project as a whole was highly evaluated by DAC 6 evaluation criteria, though there were some issues as pointed out in the "efficiency" section.

In conclusion, the project contributed to the development of the M-MAP2 plan through the activities of DRT, DRT consultants, and JET including Japanese-Thai academics.

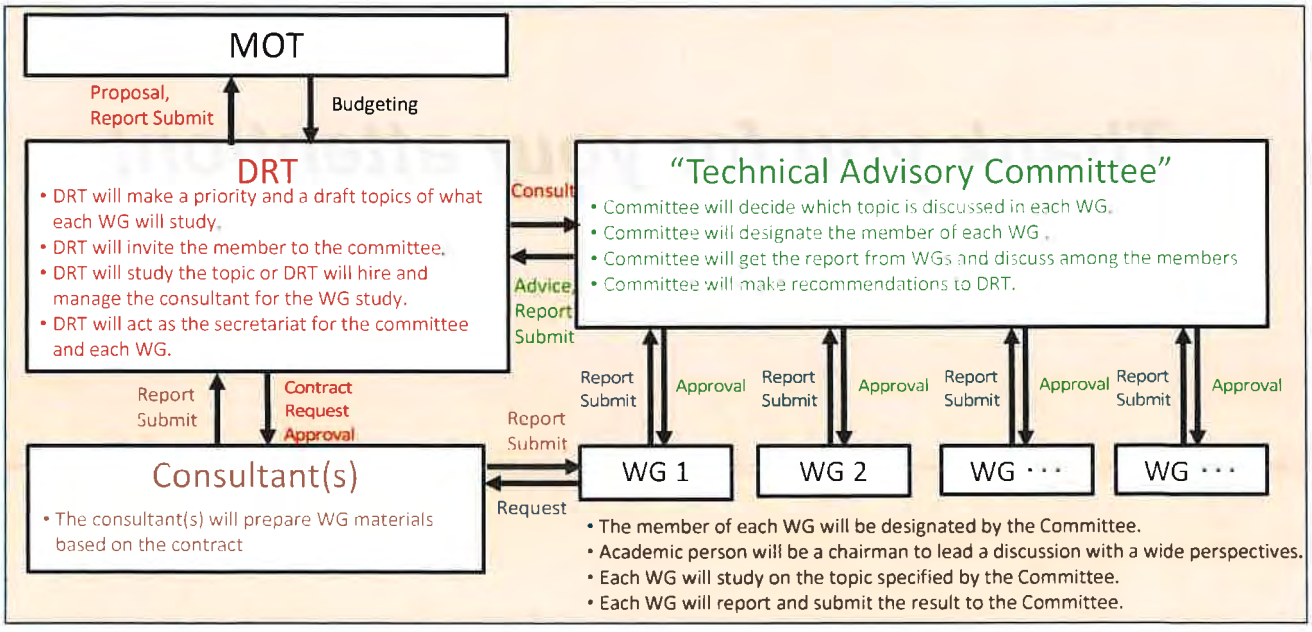
■ Recommendations:

Output 1: Demand Forecast	Output 2: Plan Formulation	Output 3: Policy and Planning Issues
The following issues are to be further improved and considered in the future demand forecast: ➢ To improve traffic survey methods ➢ To coordinate with OTP for traffic surveys ➢ To utilize bigdata ➢ To forecast weekend OD data, peak/off-peak hour OD data ➢ To consider tourist flow ➢ To collect accurate station-to-station OD data, and utilized for calibration of railway trip zone-OD	The following issues are to be further improved and considered in the next plan formulation (next planning will start in 2030 for target year of 2050): ➢ To improve evaluation method to determine the railway route priority ➢ To consider express operations, etc.	The following issues are to be further discussed and considered among the stakeholders in the form of proposed "Technical Advisory Committee" (M-MAP2 Platform is to be institutionalized): ➢ To improve railway business scheme ➢ To discuss fare policy including common ticketing system ➢ To provide value-added railway services ➢ To promote TOD ➢ To improve accessibility to railway stations and promote modal shift

Recommendations

■ Proposed Structure of "Technical Advisory Committee"

It is proposed the existing "M-MAP2 Platform" is to be institutionalized as "Technical Advisory Committee" by composing major stakeholders and several Working Group depending on the policy issues.



■ Expected schedule of the Committee:

2024 Q4 Establishment of the Committee. Designation of the topics and WG composition

2025 Q1 1st kick-off meeting

Final Steps

- Project Completion Report
  - 5 July: Submission of draft version to DRT and JICA
  - 19 July: Deadline for comments
  - 23 August: Submission final version (hard/soft copy) to JICA (then deliver to DRT later)

Thank you for your attention!

Department of Rail Transport

The Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

The Final Joint Coordinating Committee (JCC)

Wednesday, 3 July 2024 at 14:00 PM. (TST)
At the 2nd floor meeting room, Na Thalang Building, Department of Rail Transport
or Zoom Cloud Meeting Program

2.1 M-MAP2 Formulation

2.1.1 Plan Outline

a) Demand Forecast Model

b) Route Investment Priority Result

2.1.2 Approval Process

2.1 M-MAP2 Formulation

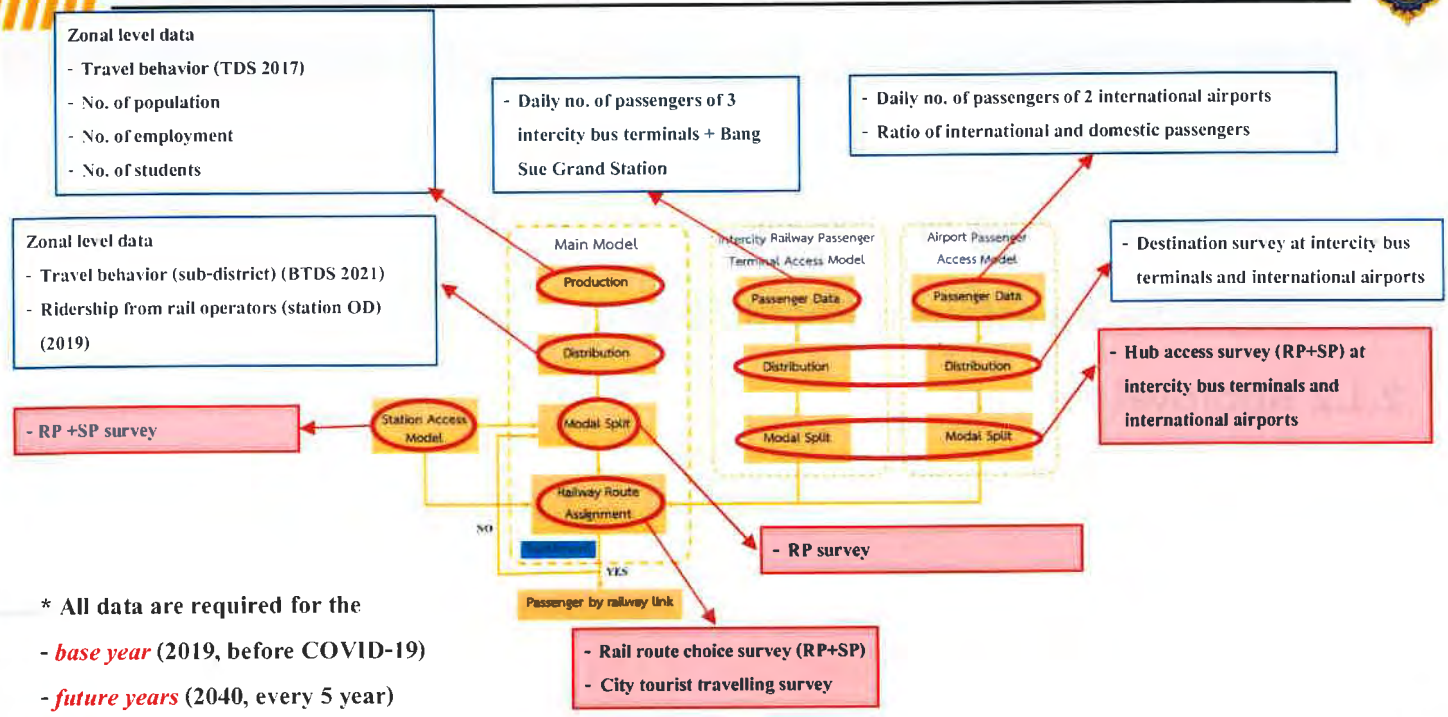
2.1.1 Plan Outline

a) Demand Forecast Model

b) Route Investment Priority Result

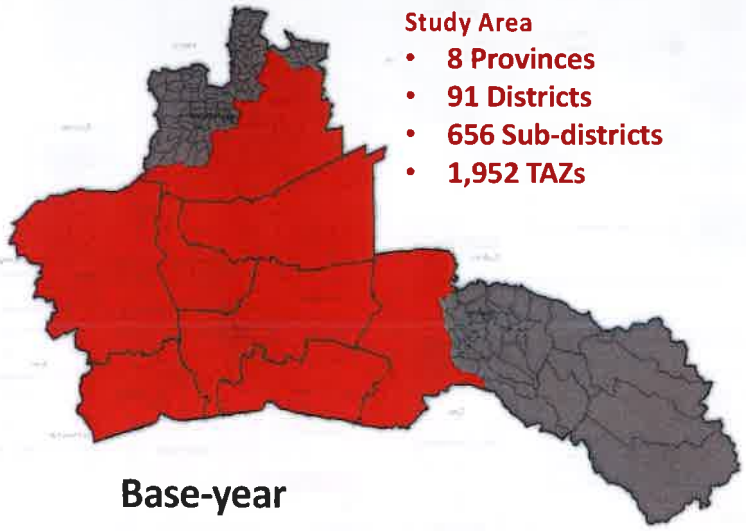
2.1.2 Approval Process

Data Requirement for the Development of Rail Demand Model



* All data are required for the

- *base year* (2019, before COVID-19)
- *future years* (2040, every 5 year)



Study Area

- **8 Provinces**
- **91 Districts**
- **656 Sub-districts**
- **1,952 TAZs**

	Province	No. of Districts	No. of Sub-districts	No. of TAZs
1	Bangkok	50	180	1,004
2	Samuth Prakarn	6	50	172
3	Nonthaburi	6	52	203
4	Pathumthani	7	60	188
5	Nakhorn Prathom	7	106	191
6	Samuth Sakorn	3	40	86
7	Phra Nakorn Sri Ayuthaya	8	110/209	69
8	Chacheongsao	4	58/93	39
	TOTAL	91	656	1,952

Base-year

- **Population**
- **Student**
- **Employment**

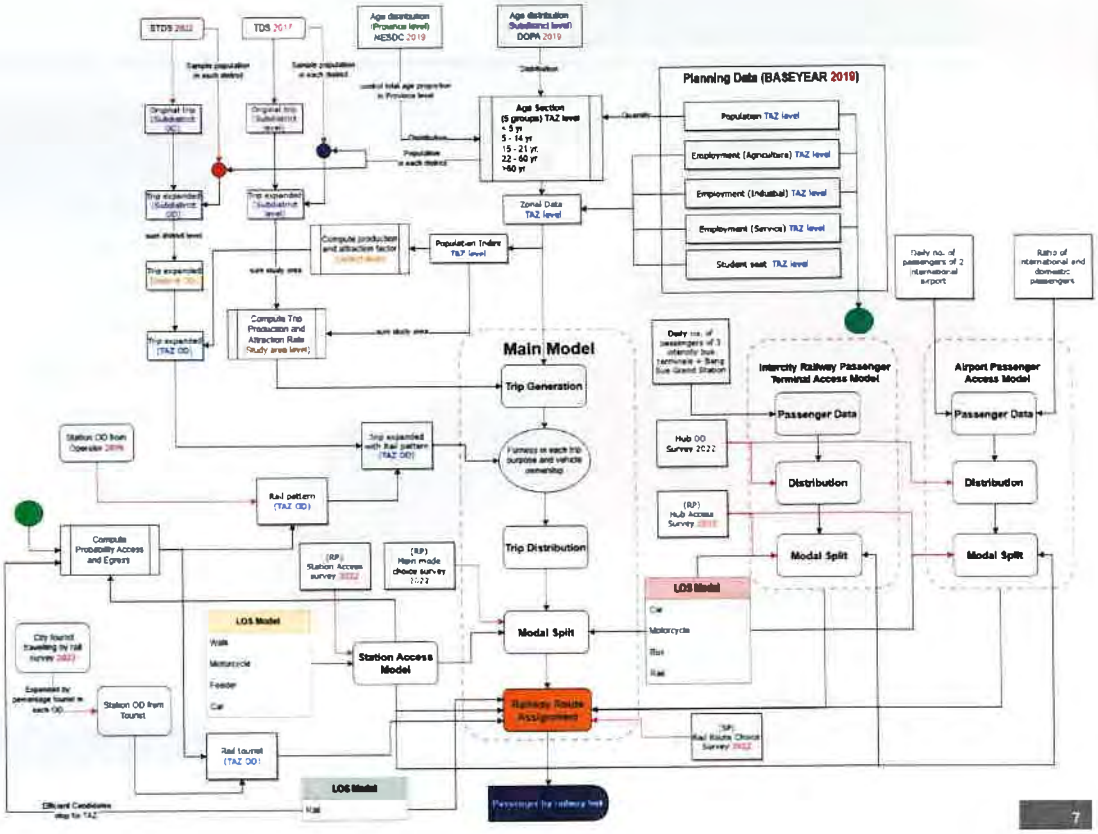
Future Forecast

- **Population**
- **Employment**
- **Student**

Available Data	Level	Source	Remarks
Population Forecast by Age Group (2010-2040)	Province	NESDC	• Use as control number /control growth rate
- Student age group (5-24yrs)			• Use for student forecast
- Working age group (25-59 yrs)			• Use for Ayuthaya & Chacheongsao employment forecast
- All age group			• Use for population forecast
Employment by Sector (2017-2037) BMR plan (BKK & Vicinities)	Province	DPT	• Use as control growth rate • Can only be applied for BKK and 5 surrounding provinces except Ayuthaya & Chacheongsao

Flow Chart

Base Year (2019) Model



Station Access Model

		BMR Model	
		Parameter	t-stat
	Access Mode		
ASC	WALK/BIKE		
	BIKE		
	MC	-2.266	-34.879
	FEEDER/BUS	-4.101	-35.381
	CAR	-2.802	-25.420
Travel time	WALK/BIKE	-0.091	-29.547
	Motorized	-0.032	-5.419
Sigma Travel time	WALK/BIKE	0.000	0.000
	Motorized	0.000	0.000
Travel cost	Motorized	-0.020	-7.937
Elevation Difference	WALK/BIKE		
LN(Frequency)	BUS		
Number of obs.		10,094	
Rho^2		0.4346	
Start Log Likelihood		-13473	
Final Log Likelihood		-7912	
AIC		15841	
BIC		15898	
Travel time VOT	Non-motorized	*4.5*	
	Motorized	*1.6*	
		(baht/min)	

Hub Access Model

		Thai		Foreigner	
	Mode	Estimate	t-stat	Estimate	t-stat
ASC	CAR				
	MC	-2.090	-7.559		
	BUS	-0.345	-1.534	-2.582	-4.801
	RAIL	0.839	3.398	-3.554	-7.631
Travel time	ALL	-0.056	-5.493	-0.072	-4.376
Sigma_Travel time	ALL	0.045	5.310	0.037	3.624
Travel cost	ALL	-0.013	-3.744	-0.007	-2.184
Vehicle Ownership	CAR	1.864	11.155		
	MC	0.646	2.625		
CBD Dummy	CAR				
Short Trip Dummy	CAR				
	MC	1.901	7.514		
Station Access	RAIL	0.844	8.719		
Number of obs.		1,161		610	
Rho^2		0.437		0.634	
Start Log Likelihood		-1638.540		-796.91	
Final Log Likelihood		-860.38		-232.84	
AIC		1740.77		475.67	
BIC		1791.34		497.74	
Travel time VOT		*4.39*		*9.95*	
		(baht/min)			

Rail Route Assignment

Variables		All purpose			
		parameter	t-stat	sigma	t-stat
Station Access (log-sum)		1.766	3.284	-	-
Waiting time (min)		-0.245	-5.043	0.129	3.304
In-vehicle time (min)		-0.211	-3.067	0.117	4.652
Horizontal transfer time (min)		-0.363	-3.021	0.104	3.055
Vertical transfer time (min)		-0.470	-6.015	0.139	7.038
Congestion		-0.018	-5.150	0.053	4.249
Fare (baht)		-0.070	-14.273	-	-
Number of obs.		12,456			
Rho^2		0.3273			
AIC		3,496.81			
BIC		3,593.40			
Final Log Likelihood		-1,880.5			
VOT (baht/min)	Waiting	3.50			
	In-vehicle time	3.01			
	Horizontal time	5.18			
	Vertical time	6.71			

Mixed Logit model

*Note: Random coefficient of time and Congestion assume Normal distribution

*Estimate from SP

Line Level and Section Validation

Lines	Year 2019 (Person-Trip/Day)			Year 2023 (Person-Trip/Day)		
	Model	Data from Operators**	%diff	Model	Data from Operators***	%diff
Airport Rail Link	77,536	79,160	-2.05%	83,077	77,723	6.89%
Purple Line	60,205	59,762	0.74%	75,829	75,829	-0.53%
Green Line*	772,689	795,898	-2.92%	906,401	924,828	-1.99%
- Sukhumvit	*631,179*	*664,667*	-5.04%	775,891	No data	-
- Silom	*301,367*	*305,719*	-1.42%	251,335		
Blue Line	335,268	311,198	7.73%	526,901	525,455	0.28%
Red Line*	Do not operate			29,628	27,715	6.90%
- North-South				23,835	No data	-
- East-West				8,760		
Golden Line				8,176	8,285	-1.32%
Yellow Line				74,176	43,381****	70.99%

Remark: * Passenger of Green line is counted as the same system, e.g., passenger transfer between Sukhumvit and Silom line is 1 person-trip.

** The data on April to July 2019, which is before the COVID-19 pandemic.

*** The data from DRT on 25 August 2023.

**** The Yellow line has just operated less than a year, so it is during the ramp-up period, generally about 40-60 percent of the forecasting figure (29,670-44,506 Person-Trip/Day).

Rail route Assignment Result

Line	Name	Model	Observed	Passenger/day Model	Passenger/day Observed	% diff	Average trip length (km) Model	Average trip length (km) Observed	% diff	Transit distance
ARL	Suvarnabhumi to Phaya Thai	41,861	40,944							
ARL	Phaya Thai to Suvarnabhumi	39,119	38,216	80,980	79,160	2.3%	16.55	16.95	-2.4%	28.45
Purple	Tao Poon to Khlong Bang Phai	29,322	31,083							
Purple	Khlong Bang Phai to Tao Poon	27,420	28,678	56,742	59,761	-5.1%	10.60	10.22	3.7%	20.97
Green Sukhumvit	Kheha to Mo Chit	330,601	336,759							
Green Sukhumvit	Mo Chit to Kheha	321,412	327,908	652,014	664,667	-1.9%	6.48	6.48	0.1%	33.04
Green Silom	National Stadium to Bang Wa	150,914	150,182							
Green Silom	Bang Wa to National Stadium	156,745	155,537	307,659	305,719	0.6%	5.50	5.61	-2.0%	13.11
Blue	Hua Lamphong to Tao Poon	158,666	153,643							
Blue	Tao Poon to Hua Lamphong	162,238	157,696	320,904	311,339	3.1%	6.19	6.17	0.3%	21.16
				1,418,299	1,420,646					

Daily Line Loaded	Direction A1 to A8 Model	Obs.	Diff		Direction A8 to A1 Model	Obs.	Diff	
A1 : Suvarnabhumi	13,264	13,296	-32	0%	0	0	0	0%
A2 : Lat Krabang	23,119	23,210	-91	0%	10,560	10,579	-19	0%
A3 : Ban Thap Chang	26,585	26,677	-92	0%	20,514	20,602	-88	0%
A4 : Hua Mak	31,407	31,323	84	0%	23,852	23,943	-91	0%
A5 : Ramkhamhaeng	33,951	33,781	170	1%	28,512	28,427	85	0%
A6 : Makkasan	22,252	22,574	-322	-1%	31,320	31,189	131	0%
A7 : Ratchaprarop	18,124	18,379	-255	-1%	20,994	21,307	-313	-1%
A8 : Phaya Thai	0	0	0	0%	17,284	17,525	-241	-1%
			MAPE	1%			MAPE	1%

Daily Line Loaded	Direction PP01 to PP16				Direction PP16 to PP01			
	Model	Obs.	Diff		Model	Obs.	Diff	
PP01 : Khlong Bang Phai	4,216	4,178	38	1%	0	0	0	0%
PP02 : Talad Bang Yai	7,561	7,577	-16	0%	2,868	2,837	31	1%
PP03 : Sam Yaek Bang Yai	8,250	8,267	-17	0%	8,388	8,416	-28	0%
PP04 : Bang Phlu	9,278	9,299	-21	0%	8,902	8,931	-29	0%
PP05 : Bang Rak Yai	9,853	9,859	-6	0%	10,046	10,080	-34	0%
PP06 : Bang Rak Noi Tha It	11,279	11,291	-12	0%	10,438	10,446	-8	0%
PP07 : Sai Ma	12,429	12,447	-18	0%	11,891	11,906	-15	0%
PP08 : Phra Nang Klao Bridge	13,027	13,041	-14	0%	12,713	12,735	-22	0%
PP09 : Yaek Nonthaburi 1	14,823	14,839	-16	0%	13,474	13,491	-17	0%
PP10 : Bang Krasor	16,186	16,193	-7	0%	15,098	15,118	-20	0%
PP11 : Nonthaburi Civic Center	17,594	17,608	-14	0%	16,544	16,561	-17	0%
PP12 : Ministry of Public Health	19,866	19,880	-14	0%	18,542	18,570	-28	0%
PP13 : Yaek Tiwanon	21,400	21,410	-10	0%	20,746	20,773	-27	0%
PP14 : Wong Sawang	21,920	22,035	-115	-1%	22,413	22,436	-23	0%
PP15 : Bang Son	22,660	23,016	-356	-2%	23,769	23,959	-190	-1%
PP16 : Tao Poon	0	0	0	0%	24,862	25,426	-564	-2%
			MAPE	0%			MAPE	0%

Daily Line Loaded	Direction BL28 to BL10				Direction BL10 to BL28			
	Model	Obs.	Diff		Model	Obs.	Diff	
BL28 : Hua Lamphong	14,087	13,592	495	4%	0	0	0	0%
BL27 : Sam Yan	21,324	20,768	556	3%	13,944	13,501	443	3%
BL26 : Si Lom	36,093	36,468	-375	-1%	21,455	20,944	511	2%
BL25 : Lumphini	43,385	43,586	-201	0%	35,572	35,799	-227	-1%
BL24 : Khlong Toei	44,826	44,834	-8	0%	43,577	43,565	12	0%
BL23 : Queen Sirikit National C	50,362	50,180	182	0%	44,770	44,534	236	1%
BL22 : Sukhumvit	74,295	72,404	1,891	3%	50,900	50,470	430	1%
BL21 : Phetchaburi	78,591	77,593	998	1%	76,670	74,842	1,828	2%
BL20 : Phra Ram 9	72,828	71,835	993	1%	80,074	79,102	972	1%
BL19 : Thailand Cultural Centre	65,791	65,036	755	1%	75,499	74,502	997	1%
BL18 : Huai Khwang	55,277	54,890	387	1%	69,521	68,760	761	1%
BL17 : Sutthisan	48,493	48,749	-256	-1%	59,081	58,661	420	1%
BL16 : Ratchadaphisek	46,379	46,866	-487	-1%	51,650	51,832	-182	0%
BL15 : Lat Phrao	38,580	39,710	-1,130	-3%	47,836	48,235	-399	-1%
BL14 : Phahon Yothin	31,379	33,206	-1,827	-6%	42,192	43,233	-1,041	-2%
BL13 : Chatuchak Park	29,733	29,671	62	0%	35,977	38,451	-2,474	-6%
BL12 : Kamphaeng Phet	28,508	28,429	79	0%	29,641	29,809	-168	-1%
BL11 : Bang Sue	25,350	25,375	-25	0%	28,118	28,088	30	0%
BL10 : Tao Poon	0	0	0	0%	25,055	25,083	-28	0%
			MAPE	1%			MAPE	1%

Daily Line Loaded	Direction E23 to N8				Direction N8 to E23			
	Model	Obs.	Diff		Model	Obs.	Diff	
E23 : Kheha	4,611	4,619	-8	0%	0	0	0	0%
E22 : Sai Luat	5,608	5,614	-6	0%	4,205	4,211	-6	0%
E21 : Phraek Sa	9,114	9,106	8	0%	4,924	4,928	-4	0%
E20 : Srinagarindra	10,606	10,580	26	0%	8,504	8,492	12	0%
E19 : Pak Nam	12,698	12,688	10	0%	9,558	9,524	34	0%
E18 : Royal Thai Naval Academy	13,989	13,998	-9	0%	11,759	11,743	16	0%
E17 : Chang Erawan	15,647	15,665	-18	0%	12,953	12,956	-3	0%
E16 : Pu Chao	17,003	17,037	-34	0%	14,384	14,396	-12	0%
E15 : Samrong	26,496	26,467	29	0%	15,536	15,564	-28	0%
E14 : Bearing	41,022	40,990	32	0%	24,690	24,668	22	0%
E13 : Bang Na	51,889	51,883	6	0%	36,939	36,915	24	0%
E12 : Udom Suk	71,322	71,362	-40	0%	42,711	42,693	18	0%
E11 : Punnawithi	79,925	79,969	-44	0%	60,487	60,527	-40	0%
E10 : Bang Chak	85,660	85,712	-52	0%	69,121	69,164	-43	0%
E9 : On Nut	106,265	106,491	-226	0%	73,272	73,336	-64	0%
E8 : Phra Khanong	115,366	115,637	-271	0%	94,574	94,805	-231	0%
E7 : Ekkamai	124,684	124,974	-290	0%	103,385	103,667	-282	0%
E6 : Thong Lo	133,048	133,367	-319	0%	115,009	115,277	-268	0%
E5 : Phrom Phong	140,263	140,887	-624	0%	123,211	123,474	-263	0%
E4 : Asok	137,239	139,312	-2,073	-1%	133,044	133,587	-543	0%
E3 : Nana	136,763	139,089	-2,326	-2%	130,331	132,118	-1,787	-1%
E2 : Phloen Chit	137,436	140,666	-3,230	-2%	132,049	134,139	-2,090	-2%
E1 : Chit Lom	128,123	133,301	-5,178	-4%	133,592	136,557	-3,025	-2%
CEN : Siam	119,087	120,737	-1,650	-1%	127,590	133,047	-5,457	-4%
N1 : Ratchathewi	113,698	115,498	-1,800	-2%	121,360	122,842	-1,482	-1%
N2 : Phaya Thai	101,989	103,780	-1,791	-2%	115,942	117,721	-1,779	-2%
N3 : Victory Monument	70,957	71,869	-912	-1%	103,281	104,931	-1,650	-2%
N4 : Sanam Pao	68,152	69,135	-983	-1%	76,835	77,800	-965	-1%
N5 : Ari	56,419	57,576	-1,157	-2%	73,361	74,391	-1,030	-1%
N6 : Sena Ruam	56,419	57,576	-1,157	-2%	60,696	61,964	-1,268	-2%
N7 : Saphan Khwai	47,757	49,042	-1,285	-3%	60,696	61,964	-1,268	-2%
N8 : Mo Chit	0	0	0	0%	52,419	54,002	-1,583	-3%
			MAPE	1%			MAPE	1%

Daily Line Loaded	Direction W1 to S12				Direction S12 to W1			
	Model	Obs.	Diff		Model	Obs.	Diff	
W1 : National Stadium	16,748	16,629	119	1%	0	0	0	0%
CEN : Siam	97,123	100,081	-2,958	-3%	16,016	15,685	331	2%
S1 : Ratchadamri	99,319	100,411	-1,092	-1%	97,982	101,239	-3,257	-3%
S2 : Sala Daeng	98,653	99,767	-1,114	-1%	101,275	102,131	-856	-1%
S3 : Chong Nonsi	85,201	85,482	-281	0%	100,705	101,743	-1,038	-1%
S4 : Saint Louis	85,201	85,482	-281	0%	89,285	89,632	-347	0%
S5 : Surasak	78,199	78,409	-210	0%	89,285	89,632	-347	0%
S6 : Saphan Taksin	65,567	65,677	-110	0%	81,828	82,075	-247	0%
S7 : Krung Thon Buri	54,632	54,716	-84	0%	70,043	70,227	-184	0%
S8 : Wongwian Yai	43,579	43,590	-11	0%	62,044	62,228	-184	0%
S9 : Pho Nimit	41,322	41,330	-8	0%	49,226	49,275	-49	0%
S10 : Talat Phlu	33,670	33,715	-45	0%	45,907	45,958	-51	0%
S11 : Wutthakat	24,257	24,240	17	0%	38,724	38,796	-72	0%
S12 : Bang Wa	0	0	0	0%	28,641	28,606	35	0%
			MAPE	1%			MAPE	1%

2.1 M-MAP2 Formulation

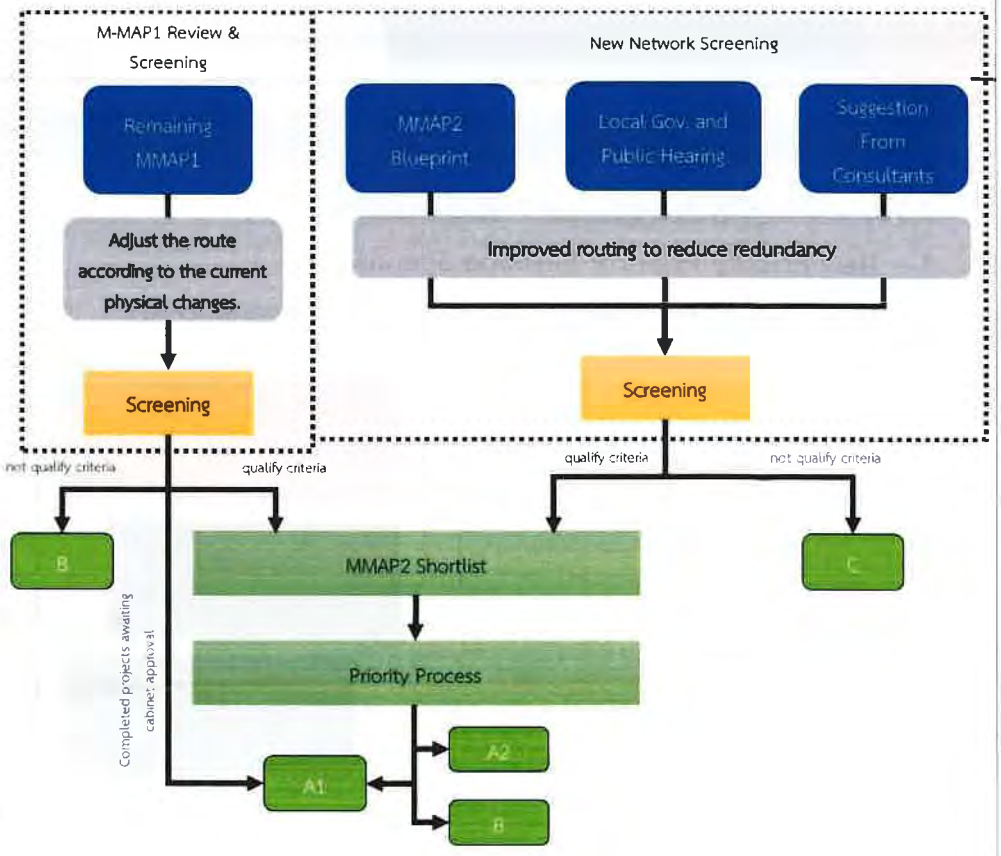
2.1.1 Plan Outline

a) Demand Forecast Model

b) Route Investment Priority Result

2.1.2 Approval Process

Priority Process



Priority

- Group A: Imperative Route
- A1: Imperative and Ready to Proceed
- A2: Imperative but Need Some Preparation
- Group B Potential Route
- Group C Feeder Route

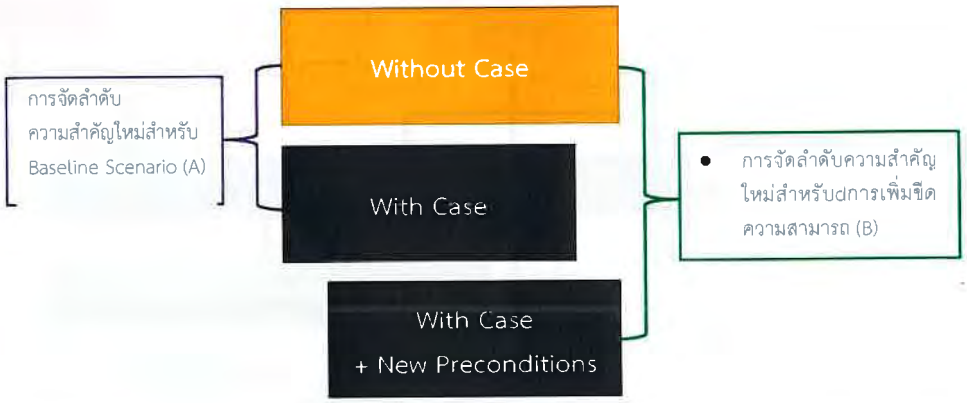
Priority Group

- Group A: Imperative Route
  - A1: Imperative and Ready to Proceed (Immediately Implemented)
  - A2: Imperative but Need Some Preparation (Implemented by the year 2029)
- Group B Potential Route
  - Reconsidered project feasibility in 2029
- Group C Feeder Route
  - Implemented as a Feeder system such as Bimodal Tram, Electric Buses

Network Evaluation

2 Scenario (Analyze from new revised model)

- New Priority Plan for Baseline Scenario (A)
- New Priority Plan for Enhanced Capacity Scenario (B)



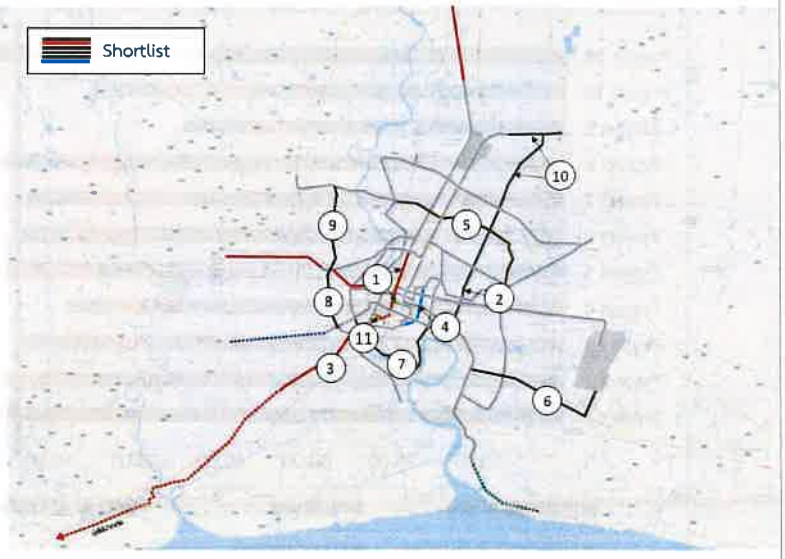
Network Evaluation

Factor	Subfactor	Factor	Subfactor
Planning Policy 41 Point	**Capacity** • Modal Share (By Rail) (%) • In-vehicle (Rail) Congestion • Transfer Delay (By Rail) **Coverage** • Population within Coverage Area **Connectivity** • Average Travel Cost By Rail • Direct O-D Pairs per Total O-D Pairs **Intermodal and Accessibility** • PT Lines Accessible to Rail • High Quality Walk Link within Coverage Area • Access Time	Readiness 16 Point	Progress of Project
		Ease of Implementation 10 Point	• Right of Way • Utilities demolition • Traffic Impact
		Financial, Economic and Social Return 23 Point	• Economic Return (EIRR) • Financial Return (FIRR) • Social Return on Investment (SROI)
		Environment Impacts 10 Point	• Water sources surrounding the project • Sensitive areas • number of traffic intersections • Land and buildings to be expropriated

Network Evaluation

Summary of routes that are prioritized (M-MAP2 Shortlist)

- **Project 1:** Red Line (Bang Sue - Hua Lamphong) and Green Line (Silom) National Stadium – Yotse
- **Project 2:** Gray Line: Watcharaphon – Thonglor
- **Project 3:** Red Line Wongwian Yai - Bang Bon
- **Project 4:** Cyan Line Sathon – Din Daeng
- **Project 5:** Brown Line Khae Rai - Bueng Kum
- **Project 6:** Silver Line Bangna – Suvarnabhumi
- **Project 7:** Gray Line Phra Khanong - Tha Phra
- **Project 8:** Green Line Bang Wa - Taling Chan
- **Project 9:** Green Line Taling Chan – Rattanathibet
- **Project 10:** Green Line Khu Khot - Outer Ring Road and Gray Line: Lam Luk Ka – Watcharaphon
- **Project 11:** Gold Line Klong San - Prachatipok



Source: Consultant

New Capacity Assumption for Enhanced Capacity Scenario (A)

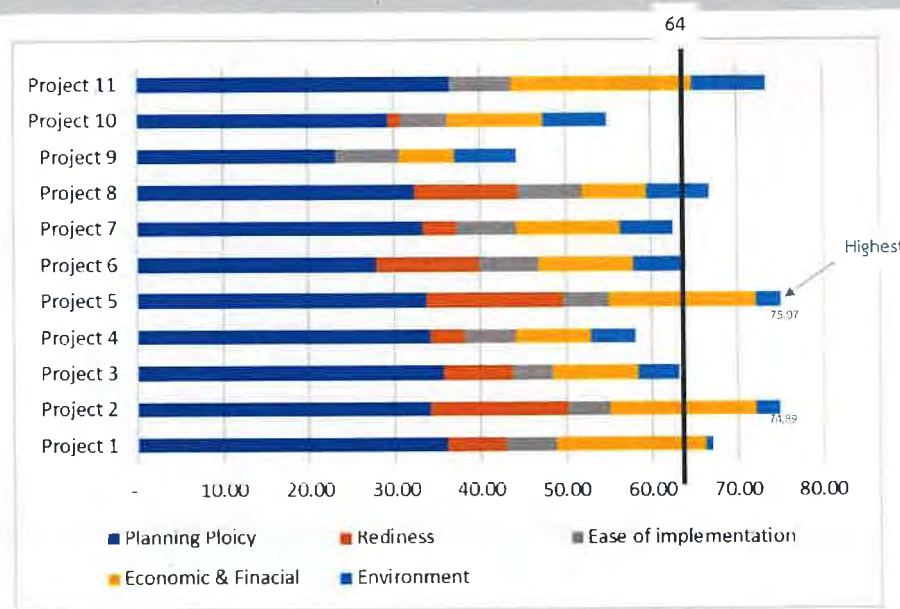
Routes with excess capacity

(Congestion Rate >150%)

- Airport Rail Link
- Green Line Sukhumvit
- Green Line Silom
- Blue Line
- Orange Line
- Pink Line
- Grey Line
- Cyan Line

LINE	Section	Frequency	Headway (mins.)	pax/car	no. of car	pax/train	Capacity (pax/h/dir)	Max Congestion Ratio
Red North-South	Bang Sue - Rangsit	6	10	193	6	1158	6,948	52
	Bang Sue - Hua Lamphong (P01)	6	10	193	6	1158	6,948	145
	Wongwain Yai - Bang Bon (P03)	6	10	193	6	1158	6,948	35
Red East-West	Bang Sue - Taling Chan	6	10	193	4	772	4,632	17
ARL	Phaya Thai - Suvarnabhumi	6	10	193	4	772	4,632	209
Green Sukhumvit	Khukhot - Kheha	15	4	193	4	772	11,580	276
	Khukhot - Outer Ring Road (P10)	15	4	193	4	772	11,580	70
Green Silom	National Stadium - Bang Wa	15	4	193	4	772	11,580	151
	National Stadium - Yotse (P01)	15	4	193	4	772	11,580	146
	Bang Wa - Taling Chan (P08)	15	4	193	4	772	11,580	44
	Taling Chan - Rattanathibet (P09)	15	4	193	4	772	11,580	40
Gold	Khlong San - Krung Thonburi	6	10	107	2	214	1,284	137
	Klong San - Prachatipok (P11)	6	10	107	2	214	1,284	97
Blue	Tha Phra - Lak Song	15	4	193	3	579	8,685	186
Purple	Khong Bang Phai - Tao Poon	10	6	193	3	579	5,790	132
	Tao Poon - Kru Nai	10	6	193	3	579	5,790	50
Orange	Bang Khun Non - Yeak Rom Klao	10	6	193	3	579	5,790	206
Yellow	Lat Phrao - Samrong	10	6	112	4	448	4,480	78
Pink	Nonthaburi Civic Center - Min Buri	10	6	112	4	448	4,480	227
	Sirat - Muang Thong Thani Lake	10	6	112	4	448	4,480	11
Grey	Watchaphon - Thonglor (P02)	10	6	112	4	448	4,480	177
	Phra Khanong - Tha Phra (P07)	10	6	112	4	448	4,480	45
	LamLukKa - Watcharaphon (P10)	10	6	112	4	448	4,480	62
Cyan	Sathon - Din Daeng (P04)	10	6	112	4	448	4,480	163
Silver	Bangna - Suvarnabhumi (P06)	10	6	112	4	448	4,480	37
Brown	Khae Rai - Bueng Kum (P05)	10	6	112	4	448	4,480	88

Prioritization results: Baseline Scenario (A)



Separate A and B

By Average Score (64)

* The Red Line Projects Rangsit - Thammasat, Taling Chan - Salaya and Taling Chan - Sirirat are pending cabinet approval, therefore automatically classified in A1

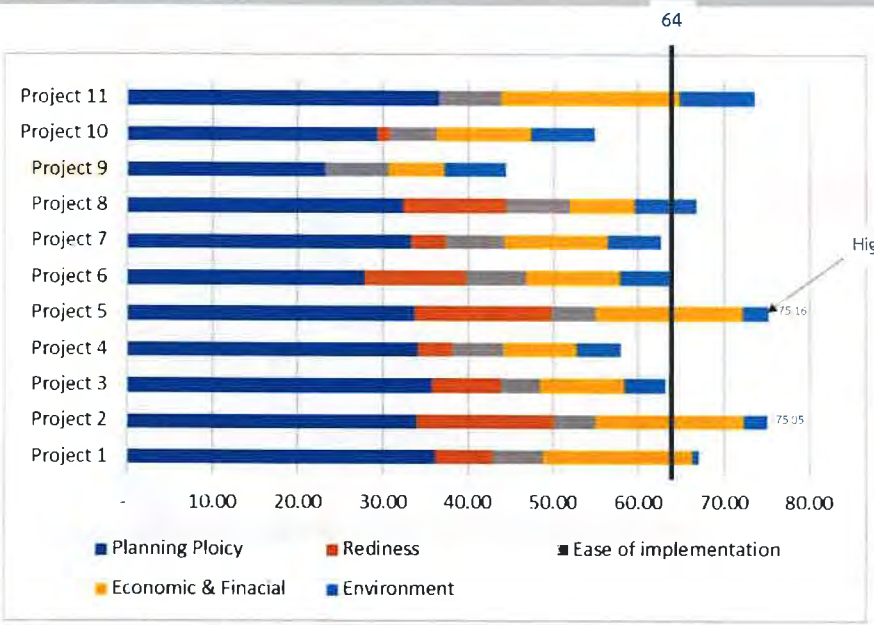
New Capacity Assumption for Enhanced Capacity Scenario (B)

Enhanced Capacity in

- Airport Rail Link
- Green Line Sukhumvit
- Green Line Silom
- Blue Line
- Orange Line
- Pink Line
- Grey Line
- Cyan Line

LINE	Section	Frequency	Headway (mins.)	pax/car	no. of car	pax/train	Capacity (pax/h/dir)	Max Congestion Rate
Red North-South	Bang Sue - Rangsit	6	10	193	6	1158	6,948	52
	Bang Sue - Hua Lamphong (P01)	*6*	*10*	*193*	*6*	*1158*	*6,948*	145
	Wongwian Yai - Bang Bon (P03)	*6*	*10*	*193*	*6*	*1158*	*6,948*	35
Red East-West	Bang Sue - Taling Chan	6	10	193	4	772	4,632	17
ARL	Phaya Thai - Suvarnabhumi	10	6	193	4	772	7,720	135
Green Sukhumvit	Khukhot - Kheha	24	2.5	193	6	1158	27,792	117
	Khukhot - Outer Ring Road (P10)	*24*	*2.5*	*193*	*6*	*1158*	*27,792*	70
Green Silom	National Stadium - Bang Wa	20	3	193	4	772	15,440	111
	National Stadium - Yotse (P01)	*20*	*3*	*193*	*4*	*772*	*15,440*	110
	Bang Wa - Taling Chan (P08)	*20*	*3*	*193*	*4*	*772*	*15,440*	33
	Taling Chan - Rattanathibet (P09)	*15*	*4*	*193*	*4*	*772*	*11,580*	40
Gold	Khlong San - Krung Thonburi	6	10	107	2	214	1,284	137
	Klong San - Prachatipok (P11)	*6*	*10*	*107*	*2*	*214*	*1,284*	37
Blue	Tha Phra - Lak Song	20	3	193	3	579	11,580	140
Purple	Khong Bang Phai - Tao Poon	10	6	193	3	579	5,790	152
	Tao Poon - Kru Nai	10	6	193	3	579	5,790	50
Orange	Bang Khun Non - Yeak Rom Klao	15	4	193	3	579	8,685	142
Yellow	Lat Phrao - Samrong	10	6	112	4	448	4,480	78
Pink	Nonthaburi Civic Center - Min Buri	20	3	112	4	448	8,960	118
	Sirat - Muang Thong Thani Lake	10	6	112	4	448	4,480	11
Grey	*Watchaphon - Thanglor (P02)*	*12*	*5*	*112*	*4*	*448*	*5,376*	147
	Phra Khanong - Tha Phra (P07)	*10*	*6*	*112*	*4*	*448*	*4,480*	45
	LamLukKa - Watcharaphon (P10)	*10*	*6*	*112*	*4*	*448*	*4,480*	62
Cyan	*Sathon – Din Daeng (P04)*	*12*	*5*	*112*	*4*	*448*	*5,376*	139
Silver	*Bangna – Suvarnabhumi (P06)*	*10*	*6*	*112*	*4*	*448*	*4,480*	37
Brown	*Khae Rai - Bueng Kum (P05)*	*10*	*6*	*112*	*4*	*448*	*4,480*	88

Prioritization results: Enhanced Capacity Scenario (B)



Separate A and B

By Average Score (64)

* The Red Line Projects Bangsue - Thammasat, Taling Chan - Salaya and Taling Chan - Sirirat are pending cabinet approval, therefore automatically classified in A1

Prioritization Summary

The scores in the two scenario are slightly different, but this does not make the prioritization results different.

Route		A1	A2	B
Red Line (N-S)	1.1 Rangsit – Thammasart	/		
	1.2 Bang Sue - Hua Lamphong		/	
	1.3 Hua Lamphong - Wongwian Yai			/
	1.4 Wongwian Yai – Bang Bon			/
	1.5 Bang Bon – Mahachai – Paktho			/
Red Line (E-W)	2.1 Taling Chan – Salaya	/		
	2.2 Taling Chan – Siriraj	/		
Green Line (Sukhumvit)	3.1 Samutprakarn – Bangpu			/
	3.2 Kukot – Outer Ring Road			/
Green Line (Silom)	4.1 National Stadium – Yotse		/	
	4.2 Bang Wa - Taling Chan		/	
	4.3 Taling Chan – Rattanathibet			/
Blue Line	5 Bangkhae – Phutthamonthon sai 4			/
Grey Line	6.1 Lam Luk Ka - Watcharaphon			/
	6.2 Watcharaphon – Thonglor		/	
	6.3 Phra Khanong - Tha Phra			/
Cyan Line Sathon – Din Daeng				/
Brown Line Khae Rai - Bueng Kum		/		
Silver Line Bangna – Suvarnabhumi			/	
Gold Line Klong San - Prachatipok			/	

M-MAP 2 Summary

A1: Imperative and Ready to Proceed

"Immediately Implemented"

Line List
1) Red Line Rangsit – Thammasart (Commuter)
2) Red Line Taling Chan – Salaya (Commuter)
3) Red Line Taling Chan – Siriraj (Commuter)
4) Brown Line Khae Rai - Bueng Kum (LRT/Monorail/AGT)

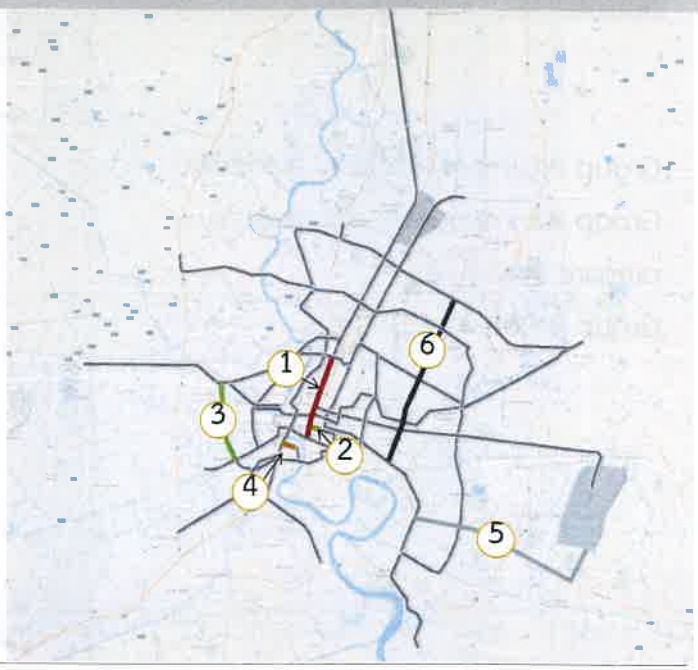


M-MAP 2 Summary

A2: Imperative but Need Some Preparation

"Implemented by the year 2029"

Line List
1) Red Line (Bang Sue - Hua Lamphong) (Commuter)
2) Green Line (Silom) National Stadium – Yotse (Heavy Rail)
3) Green Line Bang Wa - Taling Chan (Heavy Rail)
4) Gold Line Klong San – Prachatipok (AGT)
5) Silver Line Bangna – Suvarnabhumi (LRT/Monorail/AGT)
6) Gray Line: Watcharaphon – Thonglor (LRT/Monorail/AGT)



M-MAP 2 Summary

Group B Potential Route

"Reconsidered project feasibility in 2029"

Line List
1) Cyan Line Sathon – Din Daeng (LRT/Monorail/AGT)
2) Green Line Khu Khot - Outer Ring Road (Heavy Rail)
3) Gray Line: Lam Luk Ka – Watcharaphon (LRT/Monorail/AGT)
4) Gray Line Phra Khanong - Tha Phra (LRT/Monorail/AGT)
5) Red Line Hua Lamphong - Wongwian Yai (Commuter)
6) Red Line Bang Bon – Mahachai – Paktho (Commuter)
7) Green Line Samutprakarn – Bangpu (Heavy Rail)
8) Blue Line Bangkhae – Phutthamonthon sai 4 (Heavy Rail)
9) Green Line Taling Chan – Rattanathibet (Heavy Rail)
10) Red Line Wongwian Yai - Bang Bon (Commuter)

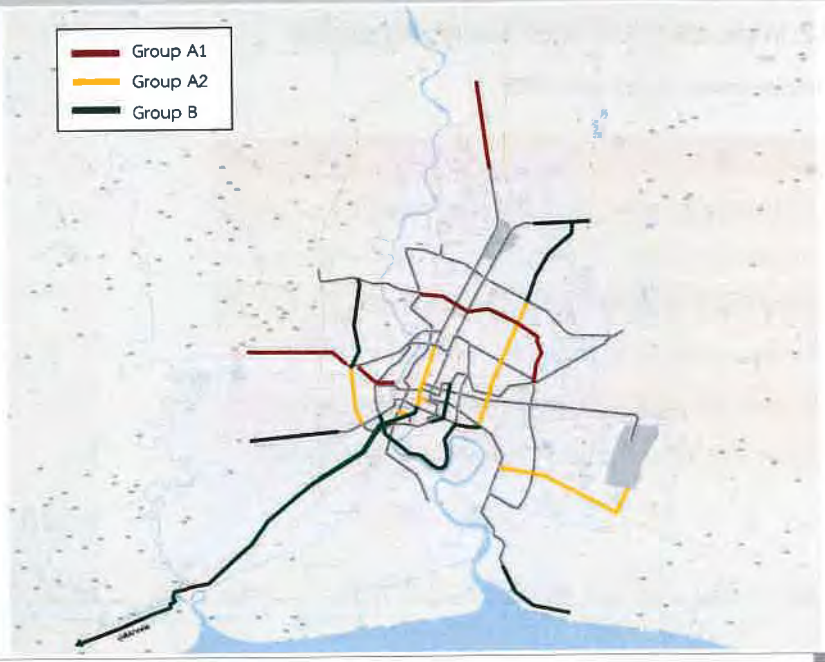


M-MAP 2 Summary

Group A1 Imperative and Availability

Group A2 Imperative but need to prepare availability

Group B Potential Route



2.1 M-MAP2 Formulation

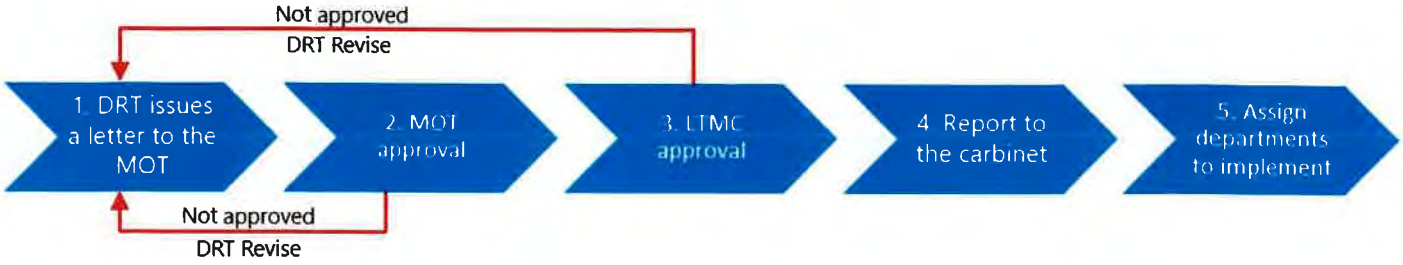
2.1.1 Plan Outline

a) Demand Forecast Model

b) Route Investment Priority Result

2.1.2 Approval Process

Approval Process



The process of proposing the project to the Cabinet

The steps in proposing the project are as follows:

- DRT issues a letter to the MOT through the deputy secretary-general and secretary-general.
- To obtain the MOT approval.
  - If approved, the MOT will assign DRT to further propose to the Land Traffic Management Committee (LTMC) and assign relevant departments to receive the study results and implement.
  - If not approved, the consultant must revise according to the comments of the committee
- DRT proposed to the LTMC.
  - If approved, proceed to report the masterplan to the cabinet
  - If not approved, the consultant must revise according to the comments of the committee
- Report M-MAP2 masterplan to the cabinet.
- Assign relevant departments to receive the study results and implement

** The consideration of the LTMC will only be considered at meetings. Annually, there are 2 meetings per year but in some years, there may be no meetings. However, the M-MAP2 project will not be considered in this 2024 fiscal year due to the inspection process not being approved. Once ready, DRT needs to contact OTP, which OTP is the secretariat of the LTMC, and ask when the committee will have a meeting.

Appendix-2

Final Project Design Matrix (PDM)
and
Project Operation (PO)

Project Monitoring Sheet I

Project Design Matrix

Project Title: Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)
Project Implementing Agency: Department of Rail Transport (DRT)
Target Group: Officers in charge of railway planning in DRT
Period of Project: June 2021 - June 2024 (36 months)
Project Site: Bangkok Metropolitan Region (BMR)

Version 4.0
Date: November 2023

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal: Sustainable and comprehensive transportation network in Bangkok Metropolitan Region is realized.	• 3 years after project completion, M-MAP2 is approved by the Commission for the Management of Land Traffic • M-MAP2 network is realized within the planned time frame	• Resolution of the Commission for the Management of Land Traffic		•	•
Project Purpose: Capability of Thai government and DRT to formulate future railway master plan is improved.	By the time of project completion • More than 4 officers in DRT are involved in regular discussion with JICA. • More than 19 officers in DRT improved their understanding on the planning steps of M-MAP2, railway policies, coordination mechanism for railway policies, and railway demand forecast model through training and regular meeting provided by JICA. • More than 7 staffs belonging to the organization related to urban transport (such as OTP, DPT, BMA-TTD, BMA-CPD, MRTA, SRT, SRTET) participate in M-MAP 2 Platform organized by DRT.	• Meeting report • Baseline/ mid-term / at completion survey • M-MAP 2 Platform implementation report	• The priority of this project of Thai government does not decrease.	• Capacity enhancement activities are being conducted through M-MAM2 Platform, Demand Forecast Working Group, learning sessions, Study Tour in Japan, etc.	• One of core member of DRT CP has been replaced due to resignment
Output 1: Railway Demand Forecast Model is developed.	1-1 Traffic surveys are conducted and database is developed. 1-2 Socio-economic framework is prepared. 1-3 Railway demand of each line is evaluated by railway demand forecast model.	• Demand Forecast Working Group (WG) meeting report • Relevant reports and meeting material explaining the result of traffic survey and demand forecast model, by DRT Consultant.	• Household Interview Survey and related surveys conducted by OTP will be provided on time. • The spreading of COVID-19 does not last longer. • Demand Forecast WG will be established by DRT. • M-MAP2 Platform will be established by DRT.	• Demand Forecast WG meeting has been organized 6 times.	•
Output 2: The detailed plan of M-MAP2 is formulated and approval process is taken by Thai Side.	2-1 Railway policy measures are formulated. 2-2 M-MAP2 railway network plan is developed. 2-3 Prioritization for each line development is formulated. 2-4 M-MAP2 is submitted by Thai Side for approval	• M-MAP2 Platform meeting report • Relevant reports and meeting material explaining railway policy, railway network plan and development plan.		• M-MAP2 Platform meeting has been organized 4 times	•
Output 3: The promotion of realization of M-MAP2 is conducted.	3-1 M-MAP2 output is publicized. 3-2 M-MAP2 Platform to discuss M-MAP2 realization between government agencies, railway operators, and experts or academia is organized. 3-3. Railway development policies are discussed in the M-MAP2 Platform.	• M-MAP2 Platform meeting report • M-MAP2 Public Hearing report • Knowledge transfer report		• M-MAP2 Platform has been established. • DRT conducted public hearing (4 times) and knowledge transfer seminar (2 times)	•

Activities	Inputs	Important Assumption
Activities for Output 1: 1-1 Thai Side to conduct the review of existing mass rapid transit master plans of BMR. 1-2 Thai Side to conduct the review of data collection survey on the development of blueprint for the second mass rapid transit master plan (M-MAP 2) report. 1-3 Thai Side to set planning of railway demand forecast model development. 1-4 JICA to give advice on the planning for set the railway demand forecast model, along with the analysis of the impact of COVID-19 on public transportation and examination of how public transportation on post-COVID-19 should be. 1-5 Thai Side to conduct the review of existing survey results including the household survey done by OTP. 1-6 JICA to give advice on the necessary survey methodology and survey forms. 1-7 Thai Side to do traffic surveys for railway demand forecast 1-8 JICA to give advice on DRT's data collection survey and review for the result of the survey. 1-9 JICA to conduct an additional traffic survey. 1-10 Thai Side to develop existing and future socio-economic framework. 1-11 JICA to give advice on the existing and future socio-economic framework. 1-12 Thai Side to revise precondition for railway demand forecast and to reproduce current OD table. 1-13 JICA to give advice on the study of the revision of precondition for railway demand forecast and reproduction of OD table. 1-14 Thai Side to develop the railway demand forecast model considering the review of the latest methodology on the related topic researched. 1-15 JICA to give advice and review on the railway demand forecast model developed by Thai Side.	**The Japanese Side** 1.Dispatch of expert team 1) Leader/Urban Transport Planning 1 2) Deputy Leader/Urban Transport Planning 2 3) City Planning 4) Railway Business Operation 5) Urban Railway Planning 1 and 2 6) Road Public Transport 7) Traffic Demand Forecast Evaluation 8) Economic and Financial Evaluation 9) Environmental and social consideration / Public Relations 10) Training Planning 11) Academia as advisors for 1)-10) above. 2.Counterpart training in Japan 3.Participation in Demand Forecast WG and M-MAP2 Platform 4.Equipment（if any） 5.Support for seminars or workshops	
Activities for Output 2: 2-1 Thai Side to analyze the current situation and trends of urban and transport development and to identify the current issue. 2-2 JICA to give advice on the analysis for the current situation, issue, trends of urban transport and development. 2-3 Thai Side to analyze the identified issue and consider improvement plans. 2-4 JICA to give advice on the identified issues and improvement plans. ~~study.~~ 2-5 JICA to give advice on the key policy measures of M-MAP2 Blueprint. 2-6 Thai Side to develop railway development policy measures. 2-7 JICA to give advice on railway development policy measures prepared by Thai Side. 2-8 Thai Side to develop a new route plan based on the demand forecast and related performance index. 2-9 JICA to give advice and review on a new route plan based on the demand forecast developed by Thai Side. 2-10 Thai Side to evaluate the proposed railway development policy measures based on the demand forecast and related performance index. 2-11 JICA to give advice on evaluation of the proposed railway development policy measures. 2-12 With the support of Thai Side, JICA to study the possibility to implement measures that allows to maximize non-fare box revenues. 2-13 Thai Side to formulate development plan for each line and policy measures. 2-14 JICA to give advice and review on the plan for each line and policy measures. 2-15 Thai Side to submit M-MAP2 for approval.	**The Thailand Side** 1.Assign counterpart personnel 2.Consultants 3.Advisory from Academia 4.Provision of office space 5.Events organizing 1) Demand Forecast WG 2) Monthly Meeting 3) Knowledge Transfer Seminar / Public Hearing 4) M-MAP2 Platform 6.Provision for available data	**Preconditions**
Activities for Output 3 3-1 To implement public relations enlightening of activities related to M-MAP2. 3-2 To build a platform to discuss further promotion of M-MAP2 realization between government agencies, railway operators, and experts or academia. 3-3 To hold for M-MAP2 Platform.		**Issues and Countermeasures**

Annex 5

Plan of Operation

Version Final
Dated 07, 2024
Monitoring

Project Title: Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2) Project

Inputs by Thai Side	Year	2021	2022	2023	2024	Remarks	Issue	Solution
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8			
1 Thai Consultant Hiring Process by DRT		(DRT's project period)						
1.1 Review and Revise the Draft of TOR	Plan							
	Actual							
1.2 Bidding Preparation Process	Plan							
	Actual							
1.3 Bidding Process	Plan							
	Actual							
1.4 Bidding Winner Results	Plan							
	Actual							
1.5 Contract Preparation Process	Plan							
	Actual							
1.6 Contract Signed	Plan							
	Actual							
1.7 Start the Study	Plan							
	Actual							
2 Thai Consultant Activities								
2.1 Data Collection and Revision								
2.1.1 To Conduct the review of existing mass rapid transit master plans of BMR	Plan							
	Actual							
2.1.2 To Conduct the review of data collection survey on the development of blueprint for the second mass rapid trar master plan (M-MAP 2) report	Plan							
	Actual							
2.2 Railway Demand Forecast Model Development								
2.2.1 To set planning of railway demand forecast model development	Plan							
	Actual							
2.2.2 To conduct the review of existing survey results including the household survey done by OTP	Plan							
	Actual							
2.2.3 To conduct transport survey for railway demand forecast	Plan							
	Actual							
2.2.4 To develop existing and future socio-economic framework	Plan							
	Actual							
2.2.5 To revise precondition for railway demand forecast and to reproduce current OD table	Plan							
	Actual							
2.2.6 To develop the railway demand forecast model considering the review of the latest methodology on the related topic researched.	Plan							
	Actual							
2.3 Formulation of M-MAP 2								
2.3.1 To analyze the current situation and trends of urban development and to identify the current issue	Plan							
	Actual							
2.3.2 To analyze the identified issue and consider improvement plans	Plan							
	Actual							
2.3.3 To develop railway development policy measures	Plan							
	Actual							
2.3.4 To develop a new route plan base on the demand forecast	Plan							
	Actual							
2.3.5 To evaluate the proposed railway development policy measures based on the demand forecast.	Plan							
	Actual							
2.3.6 To formulate development plan for each line and policy measures	Plan							
	Actual							
3. Event Organizing								
Demand Forecast Working Group Meeting	Plan							
	Actual							
Knowledge Transfer Workshop in Thailand	Plan							
	Actual							
Seminar / Ptublic Hearing	Plan							
	Actual							

Inputs by Japan Side	Year	2021	2022	2023	2024	Remarks	Issue	Solution
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8			
1. Expert from Japan								
1) Leader/Urban Transport Planning 1	Plan							
	Actual							
2) Deputy Leader/Urban Transport Planning 2	Plan							
	Actual							
3) City Planning	Plan							
	Actual							
4) Railway Business Operation	Plan							
	Actual							
5) Urban Railway Planning 1 and 2	Plan							
	Actual							
6) Analysis for Traffic Demand Forecast	Plan							
	Actual							
7) Road Public Transport	Plan							
	Actual							
8) Economic and Financial Evaluation	Plan							
	Actual							
9) Environmental and social consideration / Public Relations	Plan							
	Actual							
10) Training Planning	Plan							
	Actual							
11) Academia as advisors for 1)-10) above.	Plan							
	Actual							
2. Training								
Training in Japan / On-line	Plan							
	Actual							
	Plan							
	Actual							

Activities / Sub-Activities	Year	2021	2022	2023	2024	Responsible Organization: Japan	Responsible Organization: Thai	Achievements	Issue & Countermeasures
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8				
Output 1: Railway Demand Forecast Model is developed.									
1.1 Thai Side to conduct the review of existing mass rapid transit master plans of BMR	Plan						●		
	Actual								
1.2 Thai Side to conduct the review of data collection survey on the development of blueprint for the second mass rapid transit master plan (M-MAP 2) report	Plan						●		
	Actual								
1.3 Thai Side to set planning of railway demand forecast model development	Plan					○	●		
	Actual								
1.4 JICA to give advice on the planning for set the railway demand forecast model, along with the analysis of the impact of COVID-19 on public transportation and examination of how public transportation on post-COVID-19 should be.	Plan					●			
	Actual								
1.5 Thai Side to conduct the review of existing survey results including the household survey done by OTP	Plan					○	●		
	Actual		OTP Survey						
1.6 JICA to give advice on the necessary survey methodology and survey forms	Plan					●			
	Actual								
1.7 Thai Side to conduct transport survey for railway demand forecast	Plan						●		
	Actual								
1.8 JICA to give advice on DRT's data collection survey and review for the result of the survey	Plan					●			
	Actual								
1.9 JICA to conduct an additional transport survey	Plan					●			
	Actual								
1.10 Thai Side to develop existing and future socio-economic framework	Plan						●		
	Actual								
1.11 JICA to give advice on the existing and future socio-economic framework	Plan					●			
	Actual								
1.12 Thai Side to revise precondition for railway demand forecast and to reproduce current OD table	Plan						●		
	Actual								
1.13 JICA to give advice on the study of the revision of precondition for railway demand forecast and reproduction of OD table	Plan					●			
	Actual								
1.14 Thai Side To develop the railway demand forecast model considering the review of the latest methodology on the related topic researched	Plan						●		
	Actual								
1.15 JICA to give advice and review on the railway demand forecast model developed by Thai Side	Plan					●			
	Actual								
Output 2: The detailed plan of M-MAP2 is formulated and approval process is taken by Thai side.									
2.1 Thai Side to analyze the current situation and trends of urban development and to identify the current issue	Plan					○	●		
	Actual								
2.2 JICA to give advice on the analysis for the current situation, issue, trends of urban transport and development	Plan					●			
	Actual								
2.3 Thai Side to analyze the identified issue and consider improvement plans	Plan						●		
	Actual								
2.4 JICA to advise on the identified issues and improvement plans	Plan					●			
	Actual								
2.5 JICA to give advice on the key policy measures of M-MAP2 Blueprint	Plan					●			
	Actual								
2.6 Thai Side to develop railway development policy measures	Plan						●		
	Actual								
2.7 JICA to give advice on railway development policy measures prepared by Thai side	Plan					●			
	Actual								
2.8 Thai Side to develop a new route plan based on the demand forecast	Plan						●		
	Actual								
2.9 JICA to give advice and review on a new route plan based on the demand forecast developed by Thai Side	Plan					●			
	Actual								
2.10 Thai Side to evaluate the proposed railway development policy measures based on the demand forecast	Plan						●		
	Actual								
2.11 JICA to give advice on evaluation of the proposed railway development policy measures	Plan					●			
	Actual								
2.12 With the support of DRT, JICA to study the possibility to implement measures that allows to maximize non-fare box revenues	Plan					●			
	Actual								
2.13 Thai Side to formulate development plan for each line and policy measures	Plan					○	●		
	Actual								
2.14 JICA to give advice and review on DRT's plan for each line and policy measures	Plan					●			
	Actual								
2.15 Thai Side to submit M-MAP2 for approval	Plan						●		
	Actual								
Output 3: The promotion of realization of M-MAP2 is conducted.									
3.1 To implement public relations enlightening of activities related to M-MAP2	Plan					●	●		
	Actual								
3.2 To build a platform to discuss further promotion of M-MAP2 realization between government agencies, railway operators, and experts or academia	Plan					●	●		
	Actual								
3.3 To hold M-MAP2 Platform	Plan					●	●		
	Actual								
Duration / Phasing	Plan								
	Actual								

Monitoring Plan	Year	2021	2022	2023	2024	Remarks	Issue	Solution
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8			
Monitoring								
Kick Off Meeting	Plan							
	Actual							
Set-up the Detailed Plan of Operation	Plan							
	Actual							
Joint Coordinating Committee (JCC)	Plan							
	Actual							
Submission of Monitoring Sheet/Monitoring Mission from Japan	Plan							
	Actual							
Post Monitoring	Plan							
	Actual							
Reports/Documents								
Minutes of Meeting for JCC	Plan							
	Actual							
(DRT) Detailed Plan of M-MAP2	Plan							
	Actual							
(JICA) Progress Report	Plan							
	Actual							
(JICA) Project Completion Report	Plan							
	Actual							

Appendix-3

M-MAP2 Final Report, Summary and Continued Discussion on Demand Forecast

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ABBREVIATIONS

BEM	Bangkok Expressway and Metro Public Company Limited
BMA	Bangkok Metropolitan Administration
BOT	Build Operate Transfer
BTO	Build Transfer Operate
BRT	Bus Rapid Transit
BTSC	Bangkok Mass Transit System Public Company Limited
COVID-19	Coronavirus Disease2019
CTPP	Council of Transport Policy Plan
C/P,	Counterpart
DLT	Department of Land Transport
DPT	Department of Public Works and Town & Country Planning
DRT	Department of Rail Transport
GIS	Geographical Information System
GRDP	Gross Regional Domestic Product
HIS	Household Interview Survey
JCC	Joint Coordinating Committee
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
JV	Joint Venture
LRT	Light Rail Transit
MaaS	Mobility as a Service
M-MAP	Mass Rapid Transit Master Plan in Bangkok Metropolitan Region
M-MAP2	Mass Rapid Transit Master Plan in Bangkok Metropolitan Region 2
MOF	Ministry of Finance
MOI	Ministry of Interior
MOT	Ministry of Transport
MP	Master Plan
MRTA	Mass Rapid Transit Authority of Thailand
OD	Origin-Destination
OTP	The Office of Transport and Traffic, Policy and Planning
PDM	Project Design Matrix
PDMO	Public Debt Management Office
PO	Plan of Operation
PPP	Public-Private Partnership
SEPO	State Enterprise Policy Office
R/D, RD	Record of Discussion
SRT	State Railway of Thailand
SRTET	SRT Electrified Train Company Limited
TDM	Transportation Demand Management
TICA	Thailand International Cooperation Agency
WBS	Work Breakdown Structure
WEI	Wider Economic Impact
WG	Working Group

1. BACKGROUND

1.1 Review of Existing Transportation Masterplan in Thailand

The development of Thailand's rail mass transit system, initiated in 1972 to address Bangkok's traffic congestion, faced a prolonged and challenging path. Collaborating with Germany, the Thai government explored mass rapid transit solutions, culminating in the Lavalin project in 1979. However, construction didn't commence until 1990 due to delays.

Subsequent initiatives, such as the Hopewell Project, launched in 1990, encountered setbacks and economic crises, leading to its cancellation in 1998. The establishment of the Mass Rapid Transit Authority of Thailand (MRTA) in 1992 marked renewed commitment, followed by the approval of a mass transit master plan in 1994.

Despite economic hurdles during the 1997 Asian financial crisis, progress continued, leading to the Urban Rail Transportation Master Plan (URMAP) in 2000, which outlined a substantial rail network expansion over two decades. Political volatility in the early 2000s affected project continuity, yet the Bangkok Mass Transit Master Plan (BMT) was approved in 2004.

By 2008, the mass rapid transit network expanded to cover suburban areas with nine routes totaling 311 kilometers. In 2010, the Ministry of Transport introduced the Mass Rapid Transit Master Plan for Bangkok Metropolitan Region (M-MAP), envisioning a 20-year plan with 12 routes spanning 509 kilometers.

International collaboration, particularly with Japan, refined planning strategies through initiatives like the M-MAP2 Blueprint. By 2019, the Cabinet acknowledged the results, introducing five additional network routes to enhance Bangkok's rail mass transit system.

Despite challenges such as economic crises and political instability, the persistent government commitment and international collaboration demonstrate efforts to address traffic congestion and improve public transportation infrastructure in Bangkok and its surrounding areas.

The projects and plans for the development of major rail mass transit systems in the past are detailed as follows.

1.2 Review of M-MAP Plan and M-MAP2 Blueprint

1.2.1 M-MAP Plan

The M-MAP master plan for Thailand's rail mass transit system adopts a Trunk and Feeder format, with suburban mass rapid transit and mass rapid transit (MRT) as the main systems for high-traffic routes. These connect business centers to residential areas, while secondary systems like Light Rail Transit (LRT) and Bus Rapid Transit (BRT) serve lower-volume areas, reducing costs while enhancing connectivity.

The network pattern follows a radial and circumferential layout, reflecting Bangkok's development as a monocentric city with suburban centers. Radial routes transport passengers from suburbs to city centers, while ring routes facilitate inner-city travel, reducing congestion with more docking stations. Two transportation hubs, Phaholyothin Center and Makkasan Center, serve as connection points between mass transit systems.

The government aims to alleviate traffic congestion with 12 mass transit lines covering 509 km and 312 stations in Bangkok and its surroundings. The plan, emphasizing a "Radial and Circumferential Pattern," aligns with Bangkok's development guidelines, promoting easier travel, reduced commute times, and positive economic and environmental impacts.

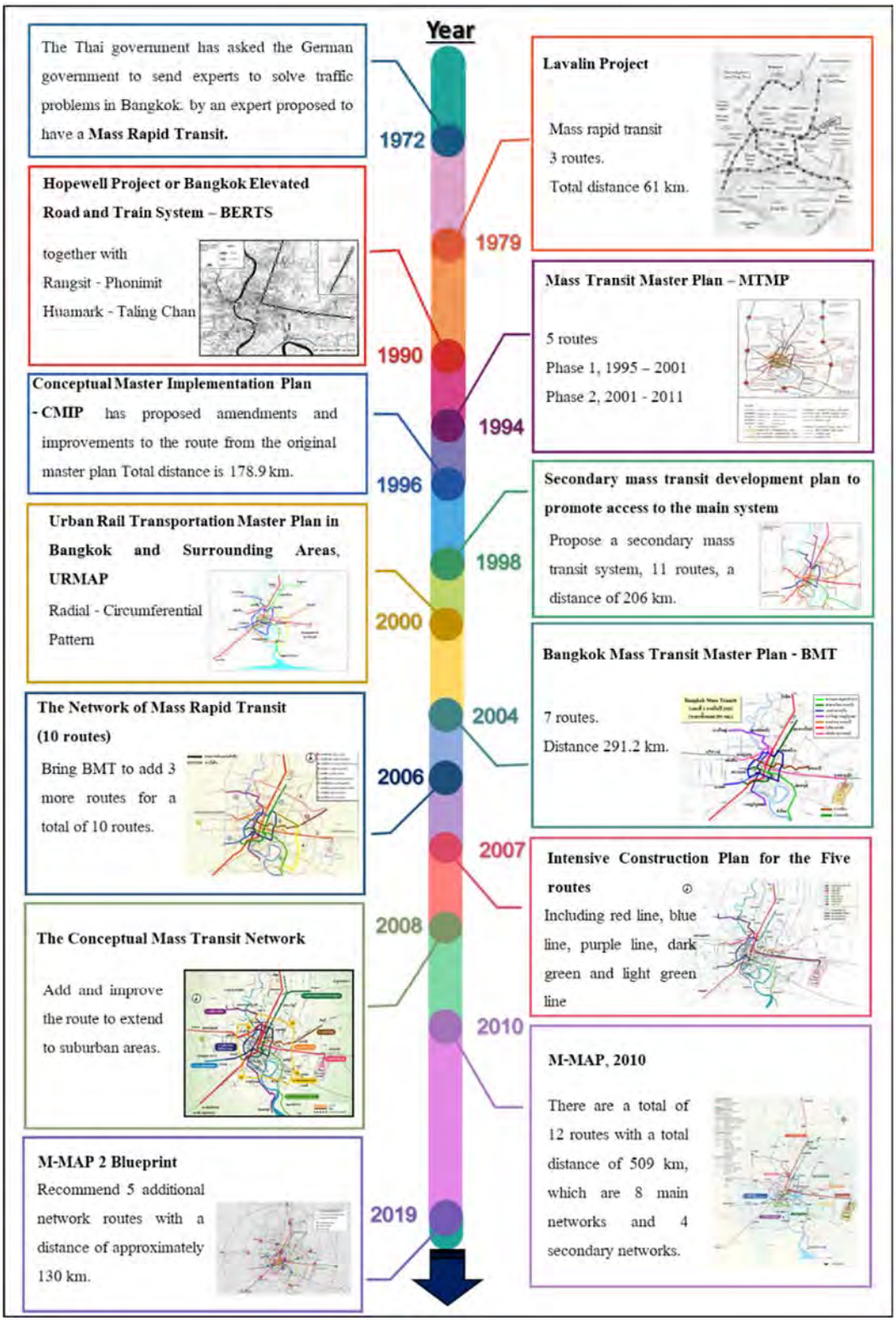


Figure 1-1 The development plan of the rail mass transit system in Thailand

Source: Consultant, 2021

1.2.2 M-MAP2 Blueprint

Office of Transport and Traffic Policy and Planning (OTP) collaborated with Japan International Cooperation Agency (JICA) to study the M-MAP2 Blueprint, aiming to enhance public transport efficiency and reduce car dependency in Bangkok. The study was divided into 3 parts:

- Part 1 assessed economic and social factors to suggest new rail routes beyond the original M-MAP projects.
- Part 2 focused on improving the Travel Demand Forecasting Model using data from the Travel Demand Survey and enhancing the movement of goods database.
- Part 3 outlined implementation guidelines and prioritized developing secondary routes to support city expansion and feed passengers to main routes. It included plans for seven routes in Bangkok, four pilot routes outside the master plan, and preparations for eight additional train lines.

OTP also unveiled details of the draft Mass Transit System Master Plan Phase 2 (M-MAP2 Blueprint) in collaboration with JICA. The plan proposed five new train routes spanning 131 kilometers to connect areas lacking mass transit systems and major transit hubs, supporting urban development and connectivity to neighboring cities and provinces. The conceptual plan of M-MAP (2010 plan) and M-MAP2 Blueprint are shown in the Figure below.

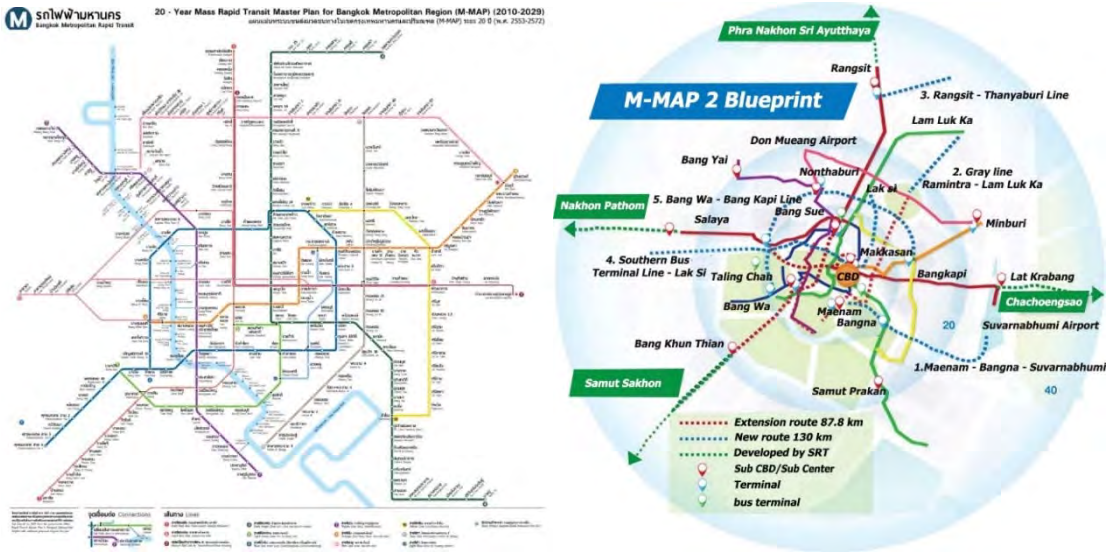


Figure 1-2 Conceptual plan of M-MAP and M-MAP2 Blueprint

Source: (Left) Edited from MRTA, (Right) Edited from OTP

2. DEVELOPMENT OF RAILWAY DEMAND FORECAST MODEL

2.1 Study, Review and Comparison of Transport and Traffic Models

2.1.1 Traffic and Transport Model in Thailand

1) The extended Bangkok Urban Model (eBUM)

The eBUM, developed by the OTP, underwent enhancements since 2011, integrating with the National Model of Transport and Traffic (NAM). Surveys from 2012-2013 improved data and calibration, enhancing accuracy for future traffic forecasting, aided by economic-social data from the 2010 census. Database utilized in M-MAP2 model such as road and public transit networks, nodes, links, and attributes were developed based on eBUM database, specifically eBUM from OTP's TDS project in 2018. The latest usage of eBUM was in OTP's BTDS project in 2023.

2) The model for forecasting the traffic volume of the Department of Rural Roads

The Department of Rural Roads employs a 4-step model approach, utilizing the Cube program's platform to forecast traffic volumes for rural road projects. This involves analyzing current traffic conditions, conducting surveys, and developing transport models to inform road design, assess traffic benefits, and mitigate environmental impacts, aligning with the department's infrastructure enhancement efforts.

3) The model for forecasting the traffic volume of the Department of Highways.

The Department of Highways develops Traffic and Transport Models to analyze current conditions and forecast future traffic based on economic, social, and development plans. The model results are validated against previous studies, aiding in road network improvement planning and traffic management strategies.

2.1.2 Rail Demand Forecast Model in Foreign Countries

1) Rail Demand Forecasting Models in Japan

The Rail Demand Forecasting Models in Tokyo, developed in 2016, assess the Tokyo Urban Rail Development Master Plan 2016 – 2030. Covering a 50-kilometer radius with 34 million people and 80-million-person trips/day, the model considers traveler age, urban regeneration laws' impact on land use patterns, demand from airports and high-speed railways, peak-hour crowding, and station access. These factors guide route and station selections, optimizing urban rail development planning in Tokyo.

2) Rail Demand Forecasting Models in the UK

The Passenger Demand Forecasting Handbook (PDFH) guides rail demand forecasting for the UK Department for Transport and Transport for London. It considers exogenous factors like GDP and endogenous factors like fares and service reliability, using historical data to determine their impact on rail demand.

3) Rail Demand Forecasting Models in China

The China Academy of Rails (CARs) developed the Modal Demand (MD) model to forecast passenger numbers for high-speed railway (HSR) systems. It identifies latent demand between areas based on travel utility, mode, and route choice, creating functions from current data. Future demand is estimated using actualization factors and future network data, enabling predictions for each OD pair and transport mode, notably for the Beijing-Shanghai high-speed train.

2.2 Impact of COVID-19 on the Public Transport and Post Corona

The COVID-19 pandemic profoundly impacted public transportation globally, including Thailand. Measures such as work-from-home policies, travel restrictions, and social distancing led to a significant decline in public transit ridership across land, water, and air transport modes. Thailand's public transport services were notably affected, with domestic flights plummeting by 98% and transportation between provinces reduced by 67% in April 2020.

2.2.1 Impact on Rail Mass Transit System

The COVID-19 pandemic led to a significant decline in rail mass transit ridership globally, resulting in reduced revenue and increased operational costs for safety measures, while strategies such as installing thermal cameras and ensuring social distancing within compartments are being implemented to mitigate the impact, alongside ongoing efforts to recover ridership levels and address long-term sustainability concerns, encapsulated by the 5 "R" concepts of Resilience, Return, Reimagination, Reform, and Research.

As the same as in Thailand, decreasing in ridership was reported in all types of rail mass transit system including State Railway of Thailand (SRT), Mass Rapid Transit Authority of Thailand (MRT), Airport Rail Link (ARL), and Bangkok Mass Transit System Skytrain (BTS) In early 2020. Ridership of the green lines dropped by 80% after the travel restriction as shown in the following figure. Although ridership slightly increased after that, it still could not reach the same level as before the pandemic.

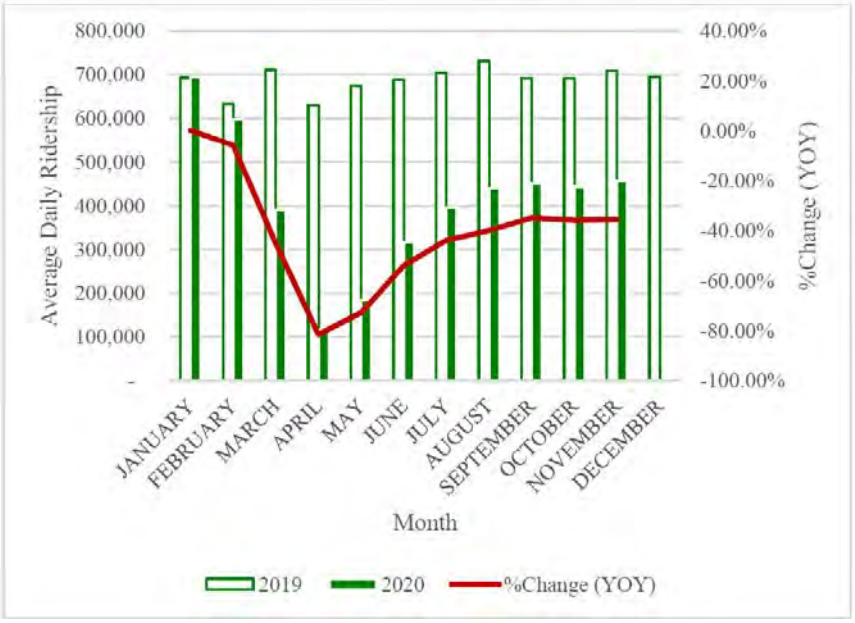


Figure 2-1 The COVID-19 impact on BTS green line ridership

Source: Siridhara, S. (2021). Sustainable urban transport index for Bangkok and impacts of COVID-19 on mobility

2.2.2 Significant Disruption from the COVID-19

The COVID-19 pandemic has accelerated disruption in various sectors, notably in the travel and transport industry. Public transit has suffered as people opt for private cars or alternative eco-friendly modes of transport. European cities have witnessed increased usage of electric vehicles, bikes, and scooters, while surveys indicate that a significant portion of the population is hesitant to return to public transit until they feel it is safe. To regain trust, transit agencies are implementing measures such as seat modifications, contactless features, and enhanced sanitation protocols. Moreover, promoting responsible and eco-friendly transportation options is becoming essential in post-pandemic travel planning, aligning with the growing demand for sustainable mobility solutions.

2.2.3 Solutions for Railways Sector during and in Aftermath of COVID-19 Pandemic

Guidance for the rail sector includes resilience strategies like addressing cash management challenges, creating detailed return plans, reimagining the "new normal," and reforming mobility policies. Additionally, research efforts are vital for innovative solutions in rail technologies, focusing on digitalization, automation, and cost reduction measures. These measures aim to ensure the rail sector's adaptability to future crises while maintaining competitiveness and sustainability in the post-pandemic era.

2.3 Traffic Demand Data Arrangement and Study of Existing Survey Results

The rail travel demand forecasting model aims to predict future passenger traffic, aiding in station classification and intermodal facility design, prioritizing rail development projects. The Extended Bangkok Urban Model (eBUM), developed under the Travel Demand Freight Movement Survey for National Transport Planning (TDS) by the OTP, covers Bangkok and neighboring areas, offering a sequential 4-step model for forecasting rail demand.

This section of the study aims to integrate data from various agencies as a precursor to the traffic and transport modeling studies for this study. The results of the Travel Demand Survey and the Home Interview Survey (HIS) were studied, collected, and reviewed, incorporating currently available data and considering its use as input data for model development from relevant agencies for further development in the future.

2.3.1 Study, Collect and Review Survey Results of Relevant Project Travel Data

A review of the past study projects of the OTP, from the Urban Transport Database and Model Development (UTDM) project in 1995 to the project to Travel Demand Freight Movement Survey for National Transport Planning (TDS, 2018), It was found that the data on travel demand were surveyed for 5 projects and another project that is being studied is Bangkok Travel Demand Survey: BTDS (2021) as shown in Table 1. The survey duration depends on the budget of each project. Additionally, in the 2019 M-MAP2 Blueprint project, JICA conducted the Destination-based Survey, a travel survey focused primarily on private car users and urban rail users.

Table 2-1 Past study projects of the OTP which surveyed travel demand

Project	Year	Study area (province)	TAZ	Census data (year)	HIS survey (household)
UTDM	1995	6	520	1990	7,879
TDMC II	2003	6	1,521	2000	19,899
TDMLII	2009	6	1,657	2000	3,018
TDL II	2013	8	1,771	2010	4,614
TDS	2018	8	1,885	2010	18,833
BTDS[1]	2023	8	1800*	2010	74,704

* Bangkok Travel Demand Survey : BTDS, OTP

* Data from Interim report, BTDS project : OTP, 2021

Source: Travel Demand Freight Movement Survey for National Transport Planning (TDS), OTP

1) Travel Demand Survey (TDS, 2018)

The survey data was analyzed, processed, and used to create models. The data obtained from the survey and analysis of travel needs include:

- Sample group characteristic, namely the distribution of survey data of the sample group, gender and age, work characteristics, Household size, income level and vehicle ownership.
- Travel characteristic, namely travel purpose, Travel mode, distance, travel time, travel speed, travel expenses, travel time and point of origin - destination in the travel of the sample group.

2) Destination based Survey (M-MAP2 Blueprint, 2019)

The Destination-Based Survey results in the M-MAP2 Blueprint project included a total of 2,760 samples. The main target groups were those who travel by using private car and urban rail users.

3) Bangkok Travel Demand Survey (BTDS, 2023)

As for the results of the survey in the BTDS (Bangkok Travel Demand Survey) project, OTP conducted a survey from November 2021 – March 2022, by surveying a total of 489 sub-districts in the Bangkok Metropolitan Region and a few districts in the provinces of Phra Nakhon Si Ayutthaya and Chachoengsao. A total of 74,704 households, 145,165 persons, and 241,232 trips were surveyed.

2.3.2 Study, Collect, and Review Data Necessary for Model Development

Necessary for model development from relevant agencies to consider the use of data as input data for model development that the information needed to develop the model is shown in the following table. Information has been collected from each agency for use in the development of the model.

Table 2-2 Necessary information from the relevant agency

List		Source
Population	Population and Housing Census	National Statistical Office
	civil registration	Department of Administrative Affairs
Number of Households	Population and Housing Census	National Statistical Office
	civil registration	Department of Administrative Affairs
Average household income	Household Income Distribution Report	National Statistical Office
Number of seats	school information	Ministry of Education
Number of employed	Number of people aged 15 years and over who are employed	National Statistical Office
Urban plan data	Land use and urban development	Department of City Planning and Urban Development, Department of Public Work and Town & Country Planning

Source: Consultant, 2022

2.4 Traffic Data Survey

This section conducts travel surveys to establish a baseline for the traffic model. Surveys include Access, Stated Preference, and OD surveys with a target of 7,000 samples, aligning with budget constraints. This project received cooperation from Japan International Cooperation Agency (JICA), which cooperates academically Record of Discussion (R/D) under the implementation of the project "Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2) Project" that provides academic advice during the implementation of the project.

2.4.1 Survey and Collect Travel Information

The travel survey and data collection surveys consist of the Access Survey, Stated Preference (SP) Survey, OD Survey, and the Activity Based Model Survey. The survey for this project focuses on rail travel data.

1) Procedures for Conducting Surveys

The operational procedures for the travel demand survey are shown in the Figure below.

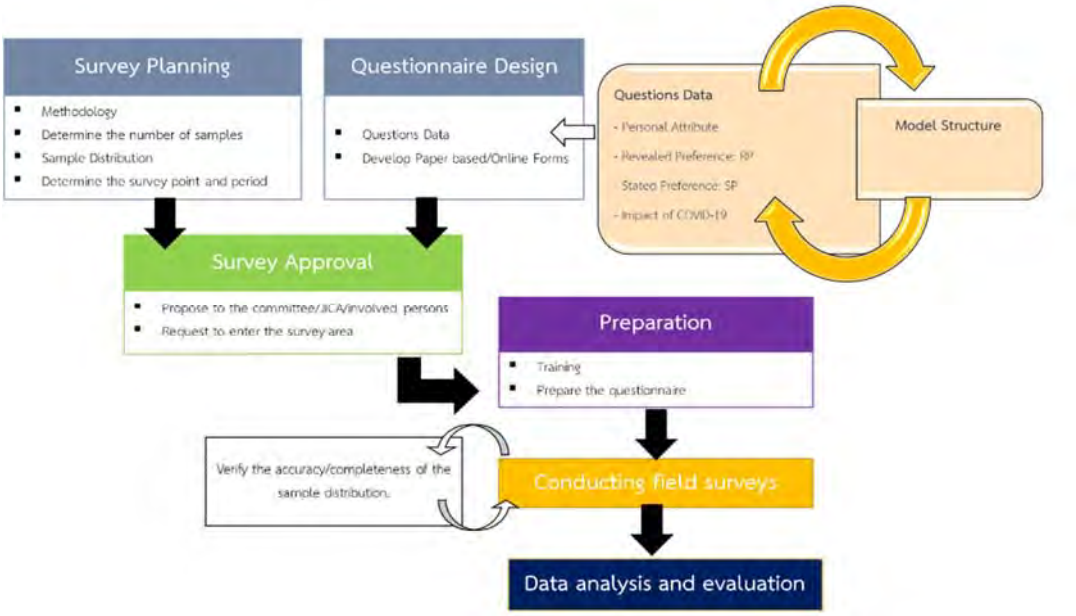


Table 2-3 Procedure for Conducting a Survey

2) Trevel Survey

The travel surveys in this study were divided into five categories. Four types of travel surveys were used for the development of Railway Demand Forecast Model and one type of travel survey for the development of another type of Railway Activity-Based Model. The Transport Hub OD survey was funded by JICA. The overview of the travel survey is shown below.

3) Survey Method

This study employs interviewer-conducted surveys using an online questionnaire accessed via tablets. Surveys were conducted on weekdays from 6:00 AM to 8:00 PM, spanning September 6 to November 18, 2022. Targeted samples include private car, motorcycle, and public transport users, with a focus on rail mass transit system users. Survey locations vary based on survey type and target group.

Table 2-4 The Overview of the Travel Survey

Travel Survey	Questionnaire	Part	Sample size
Travel survey for the development of a railway demand forecast model.			
1. Main Mode Choice Survey	Main Mode Choice Survey Questionnaire	Part 1: Respondent Characteristics Part 2: Service usage and attitudes about public transport Part 3: Travel behavior Part 4: Information about mode choice Part 5: Travel behaviors affected by COVID-19 and future travel behaviors Part 6: Importance factors affecting walking/cycling to the station	8,400
2. Hub Access Survey	Hub Access Survey Questionnaire	Part 1: Respondent Characteristics Part 2: Service usage and attitudes about public transport Part 3: Travel behavior Part 4: Information about mode choice Part 5: Travel behaviors affected by COVID-19 and future travel behaviors Part 6: Importance factors affecting walking/cycling to the station	1,800
3. Rail Route Choice Survey (Include Station Access Survey)	Rail Route Choice Survey Questionnaire	Part 1: Respondent Characteristics Part 2: Service usage and attitudes about public transport Part 3: Travel behavior Part 4: Information about mode choice Part 5: Travel behaviors affected by COVID-19 and future travel behaviors Part 6: Importance factors affecting walking/cycling to the station	4,200
4. Hub OD Survey	Hub OD Survey Questionnaire	Part 1: Respondent Information Part 2: Travel Information Part 3: Interviewer Information	47,000
Travel survey for the development of a railway activity-based model.			
5. Travel Diary Survey	Travel Diary Survey	Part 1: Interviewer Information Part 2: Household Information Part 3: Travel information of household members Part 4: Transportation information is entered into Metro Blue Line	700
Total			62,100

2.4.2 Survey and Collect Travel Information

This section aims to acquire current vehicle and passenger traffic data for calibrating the traffic model. Two types of traffic surveys were conducted: mid-block classified counts (MB) and occupancy surveys, as detailed below.

1) Mid-Block Classified Counts (MB)

2) Occupancy Survey

3) Passenger Congestion Survey

This survey aims to determine the passenger congestion on the mass transit vehicle. The data are used to develop the rail route choice model and to improve the level of service of rail network. All existing mass transit routes are conducted by the surveyor on the vehicle records the data including arrival time and departure time for each station, and the congestion rate. The survey was conducted on 13-21 July 2023 at the AM pear period (7:30 - 9:30) of the working day.

35%	70%	100%	150%	180%	200%
All the seat are occupied and no standing passengers	All the seat are occupied and standing passengers	Capacity of a train car (All the seat are occupied and standing passengers with holding (elaxingly a bar in front of the seat).	Passengers' shoulders are hit together but they can read newspaper without problems	Passengers' bodies are hit but they can read newspaper.	Passengers' bodies are hit with pressure but they can read a magazine somehow
To be prepared	To be prepared				

Figure 2-2 Concept of congestion rate of Occupancy Survey: OCC

Source: M-MAP2 Blueprint (JICA, 2018)

The results showed that the congestion rate of inbound direction to CBD, i.e. blue line, green line, ARL are quite high. In particular, the blue line section between Phahonyothin and Si Lom shows the congestion rate 150% - 200%. The following figure shows the congestion rate for each route.



Figure 2-3 The Results of Passenger Congestion Survey on Existing Urban Rail during AM Peak

2.5 Model Development and Validation

This section establishes the framework for developing traffic models to analyze Bangkok's rail network. It addresses ridership, mode of transportation, congestion, transit network improvement policies, station access, and fare policies to inform urban transportation policies.

2.5.1 Structure of the M-MAP2 Model

The structure of the model is shown in the figure below consists of the following:

(I) Station access model, which estimates the accessibility of each rail station,

(II) Main model, which is comprised of (1) trip generation model, (2) trip distribution model, (3) modal split model, (4) railway route assignment model,

(III) Intercity railway passenger terminal access model, and

(IV) Airport passenger access model.

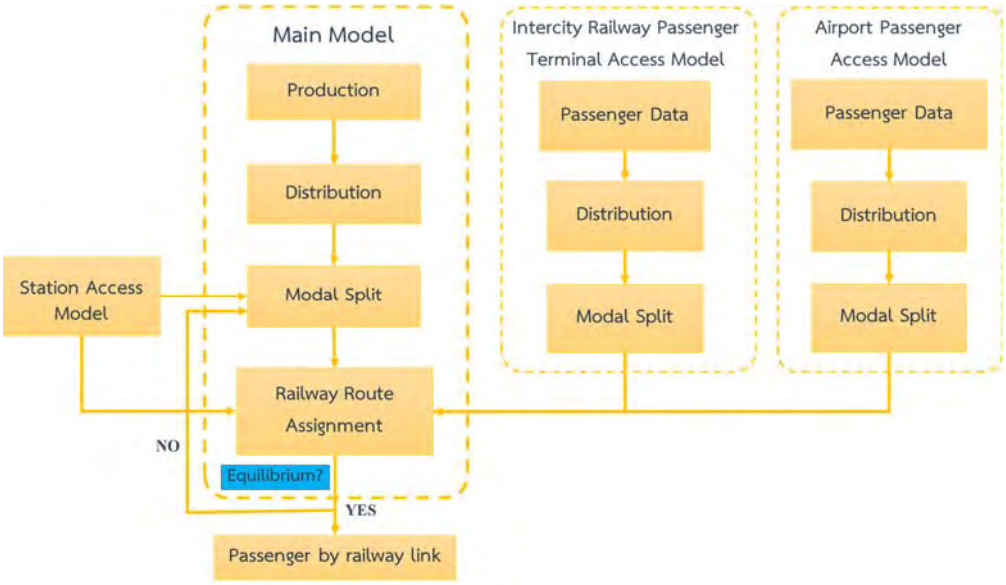


Figure 2-4 Model Structure

2.5.2 Determination of the Study Area

The rail transport network covers an area of Bangkok and its vicinity consisting of Bangkok, Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Sakhon, Samut Prakan, and some areas of Phra Nakhon Si Ayutthaya and Chachoengsao, which potentially covers some extensions of the future railway network.

2.5.3 Traffic Analysis Zone (TAZ)

The railway demand forecast model has divided the study area into traffic analysis zone (TAZ) as shown in Figure 8. The study area consists of 1,970 TAZs: internal 1,952 TAZs, and external 18 TAZs. The area is close to the existing and future urban rail network are split into smaller TAZ compared to the other areas.

1) The TAZ is split according to administrative boundary i.e., a sub-district, and/or a district, because it is simple to determine the planning data.

2) The TAZ is determined by considering a station access, in which one TAZ can access only one urban rail station. Except for, the TAZ that is transfer station may consist of more than one station.

3) The area is divided into the TAZ by the infrastructure boundaries e.g., road, railway, and geographical boundaries e.g., river, canal, etc.

4) The land use of each TAZ should be homogeneous, because it will be easy to compute the socio-economic data.

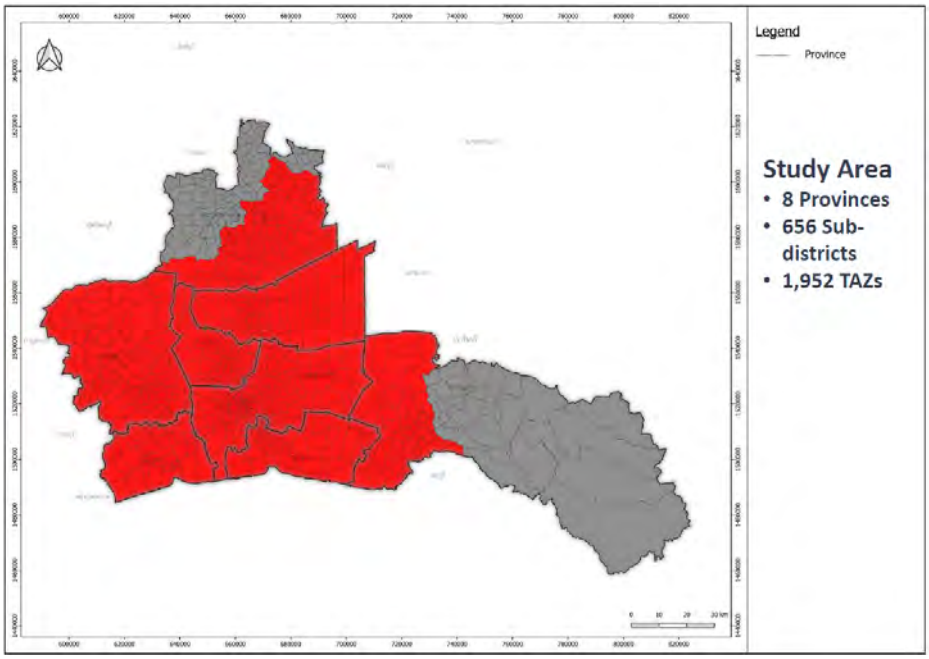


Figure 2-5 Traffic Analysis Zone (TAZ)

2.5.4 Transport Network Development

The transport network for the model includes current and future road and public transport networks, organized using nodes and links. Nodes signify entry/exit points or changes in the following figure, while links represent transport infrastructure connecting nodes. Centroids denote trip origins/destinations within subareas, with data on distance, road type, and traffic attributes.

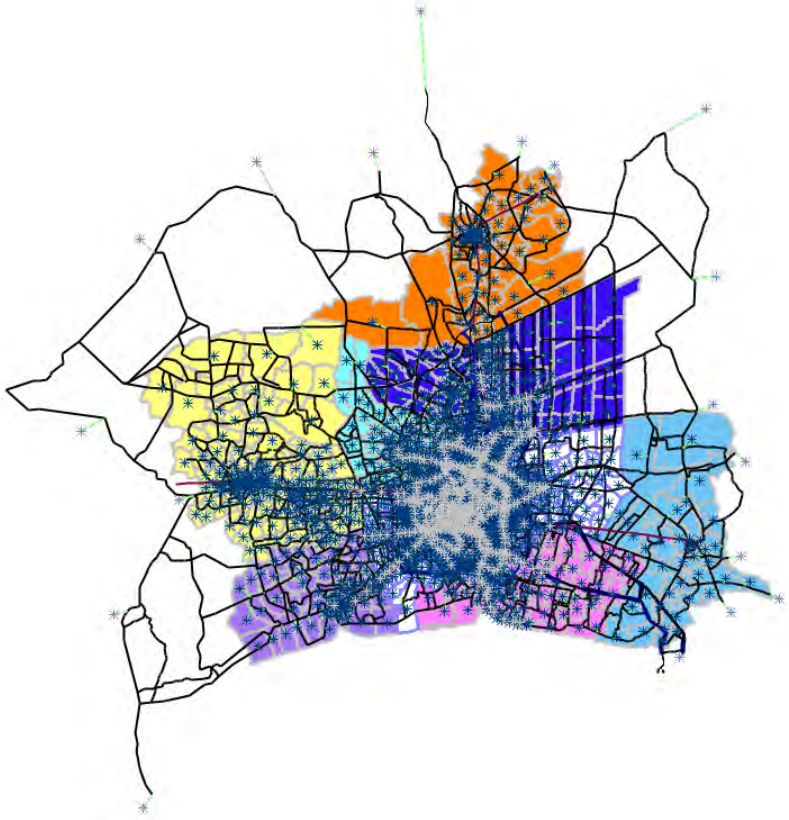


Figure 2-6 Overview of the Transport Network within the Study Area

2.5.5 Trip Generation and Trip Distribution Model Development

The trip generation model, the inaugural step in the 4-step sequence, computes traffic flow entering and exiting each Traffic Analysis Zone (TAZ), yielding trip production and attraction metrics. Unlike traditional definitions, trip production in this study signifies the origin of trips from each TAZ, while trip attraction denotes their destination.

This model comprises two sub-models, employing the trip rate method to calculate 12 distinct travel purposes, encompassing various trip types such as home-to-work, home-to-school, and non-home-based trips. Following this, the trip distribution model utilizes trip production data as input to analyze travel distribution among TAZs, constituting the second step in the 4-step model. It employs the gravity model, given the anticipated development of multiple TAZs alongside future rail network expansion. This approach ensures a comprehensive understanding of travel dynamics, essential for informing effective transportation planning and policy decisions in Bangkok and its vicinity.

2.5.6 Modal Split Model Development

Modal split model structure, in the following figure, computes the main mode share among (1) car and taxi, (2) motorcycle and motorcycle taxi, (3) bus, ferry, songthaew, public van, etc., and (4) rail. The non-motorized trip was not included in the model, because the survey data (from the BTDS project) asked for trip lengths greater than 500 meters, which most trips were motorized trips. The mixed logit model was used to compute the share among the main modes.

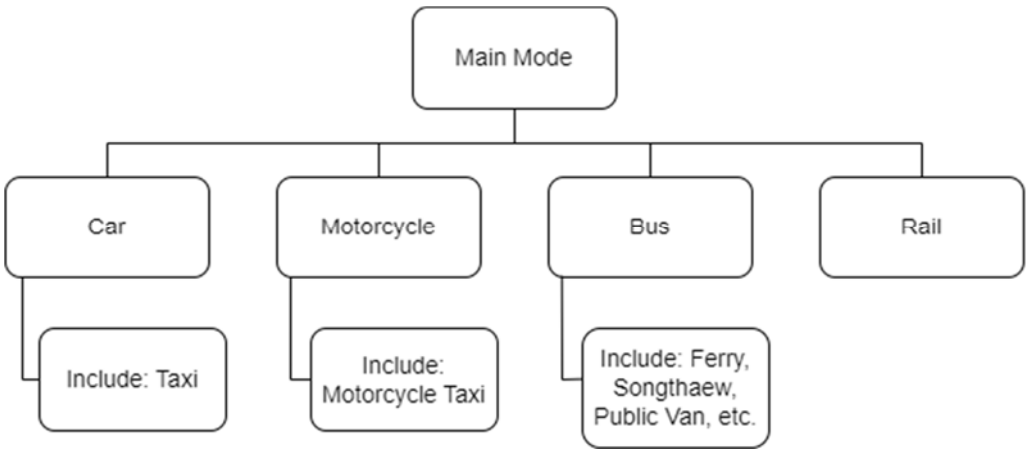


Figure 2-7 Modal Split Model Structure

Modal split analysis often employs binary or multinomial logit models due to their advantages, including easy application, strong theoretical foundation, and availability of software packages. However, multinomial logit models assume Gumbel-distributed error terms that are independent across alternatives and observations, leading to the independent of irrelevant alternatives (IIA) problem and biased estimations. The mixed logit model addresses this limitation by allowing for random parameters and can be applied to stated preference data where respondents answer in multiple scenarios. This model variation enhances the flexibility and accuracy of modal split analysis, accommodating real-world complexities more effectively.

2.5.7 Station Access Model Development

The station access model was developed by the mixed logit model to avoid the IIA problem as well as the modal split model. The station access model was used to evaluate the accessibility from a centroid of TAZ to an urban rail station and vice versa by (1) walk, (2) motorcycle or motorcycle taxi) (3) feeder e.g., bus, songthaew, etc., and (4) passenger car or taxi.

Several variables to be analyzed in the station access model are as follows:

Table 2-5 Variables - Station Access Model

Variables	Details
ASC	Alternative specific constant for each mode. Car as reference.
Non-Motorized Travel Time (Minute)	(Walk only) Walk: walking time between origin or destination to station.
Motorized Travel Time (Minute)	(Motorcycle/Motorcycle taxi, feeder, car) Motorcycle/Motorcycle taxi: travel time and waiting time between origin or destination to station. Feeder: travel time and waiting time between origin or destination to station, access/egress time to station included. Car: travel time between origin or destination to station, parking time included.
Travel Cost (Baht)	Total cost spent between origin or destination to station.

2.5.8 Railway Route Choice Model Development

The railway route choice model was developed by the mixed logit model to avoid the IIA problem as well as the modal split model and the station access model. The station access model was used to assign the passenger into the urban rail network.

Several variables to be analyzed in the railway route choice model are as follows:

Table 2-6 Variables - Railway Route Choice Model

Variables	Details
Fare (Baht)	Total route fare from origin station to destination station.
Boarding Time (Minute)	Total boarding time from origin station to destination station.
Transfer Time, Horizontally (Minute)	Time spent on walking horizontally while transferring the train.
Transfer Time, Vertically (Minute)	Time spent on moving vertically (elevator, escalator, etc.) while transferring the train.
Waiting Time (Minute)	Total time waiting for train boarding, including the first ride. Assume as a half of headway.
Station Access	Log-sum of the utility of every mode calculated railway station access model.
Congestion Index	Calculated from travel time and congestion rate, see below.

2.5.9 Transport Hub Access Model Development

The transport hub access model computes passenger flows between hubs and other TAZs, comprising two sub-models: intercity railway terminal and airport access models. Using a sequential 4-step approach: (1) Trip generation estimates trips based on previous studies like airport plans and high-speed trains. (2) Trip distribution expands OD matrices from hub survey data using the Furness method. (3) Modal split employs a mixed logit model, considering Thai and foreign passenger differences. (4) Railway route choice combines hub trip matrices with main model data and computes route choices. Several variables to be analyzed in the modal split model are as follows:

Table 2-7 Variables – Transport Hub Access Model

Variables	Details
ASC	Alternative specific constant for each mode. Car as reference.
Travel Time (Minute)	Rail: boarding time + transfer time + waiting time. Bus and other public transport: boarding time + waiting time + access/egress time. Car and motorcycle: driving time + parking time.
Travel Cost (Baht)	Rail: rail fare. Bus and other public transport: bus and other public transports fare. Car: VOC (fuel, maintenance) + toll fee + parking fee. Motorcycle: VOC (fuel, maintenance) + parking fee.
Short Trip Dummy	(Car and Motorcycle) 1 for OD with distance less than 5 km. 0 otherwise.
Station Access	(Rail alternative specific only) The log-sum of utility of access and egress modes.

2.5.10 Calibration and Validation of the Model

Model calibration involves parameter estimation to ensure accuracy, while validation tests results against external data. In the sequential 4-step model, each sub-model is calibrated for accuracy, then validated for efficiency in analyzing travel behavior.

1) Calibration and Validation of the Model by Mode Share

Travel patterns in Bangkok were collected to analyze mode share, and utilized for model calibration and validation against survey data. Validation focused on mode choice, with a detailed examination by province. Additionally, mode share by access and egress at various distance levels was investigated, revealing a correlation: increased access/egress leads to reduced rail share, and vice versa.

2) Calibration and Validation of the Model by Ridership of Existing Rails

The developed model underwent calibration and validation using passenger data from the existing rail network, including the Green Line, Blue Line, Purple Line, Red Line, and Airport Rail Link. Validation criteria stipulated a maximum 10% difference between model-predicted and survey-derived passenger numbers. Emphasis was placed on validating the main modal split model and the railway route choice model.

3) Validation of Travel Time in the Model

Travel time validation from various origins to destinations ensures a maximum 15% difference between model-predicted and observed data. For instance, Suvarnabhumi airport's travel time to different TAZs is represented via contour maps. Figures depict urban rail travel times with access and egress by car, motorcycle, feeder services (e.g., bus, shuttle bus, songthaew), and walking. Validation involves comparing model-predicted travel times with Google Maps data. If disparities exceed thresholds, network speed and travel time adjustments are made until the criteria are met.

2.6 Development of the Activity-Based Travel Demand Model for Rail System

In railway network planning, advanced travel demand modeling techniques like Activity-Based Models and MATSim offer comprehensive insights into travel behavior and network performance.

2.6.1 Activity-Based Travel Demand Model

In the Railway Network Master Plan project's Phase 2 (M-MAP2), there was a proposal for enhancing and developing the railway travel demand model, introducing the concept of an activity-based railway system. This approach aimed to address limitations observed in traditional 4-step travel demand models, particularly regarding trip chains, time-of-day considerations, and responses to changes in transportation service levels. Unlike conventional models, activity-based models like ABM simulate individuals' daily activities and travel patterns comprehensively. For instance, they consider scenarios like leaving accommodation, commuting to work, lunch breaks, and additional activities after returning home, providing a more nuanced understanding of travel behavior.

2.6.2 MATSim Model

In both traditional 4-step and activity-based models, the final step of traffic assignment is crucial for policy decisions and assessing infrastructure impacts. MATSim, a microsimulation travel modeling program, offers an alternative approach to traffic assignment, employing agent-based simulation and the Queue-Based Model analysis method. This program simulates population travel behaviors, allowing each agent to optimize its activity schedule based on factors like travel time and activity types. MATSim's iterative process involves steps such as importing demographic and activity schedule data, scoring activity schedules, replanning travel schedules, and analyzing simulation results, providing insights into travel efficiency and network performance.

2.6.3 The Study Area of Activity-based Railway-focused Model

The study area for the activity-based railway-focused model was chosen based on proximity to Transit Oriented Development (TOD) areas and a high prevalence of railway travel. Factors in selection included diverse land uses around stations, such as shopping centers and residences. MRT Rama 9 Station and nearby stations, including Phetchaburi and Thailand Cultural Centre, were selected due to their central location and diverse land uses. Rama 9 Station serves as a focal point with a mix of malls, hotels, offices, residences, hospitals, and government offices. The study area covered three metro stations and spanned five administrative districts (sub-districts): Din Daeng, Huai Khwang, Bang Kapi, Makkasan, and Khlong Toei Nuea. The following figure depicts the study area's boundary.

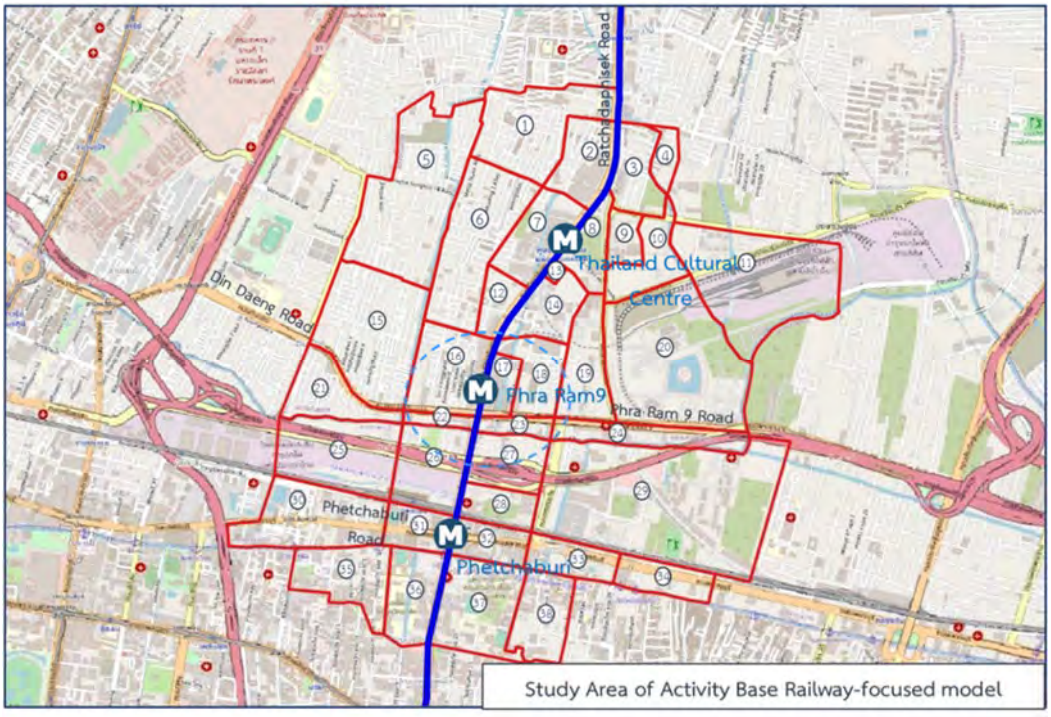


Table 2-8 Scope of the study area

2.6.4 Overview of Model Development Processes

The development process of the project's activity-based travel demand model with a rail system was divided into three main work groups: input data, data synthesis, and analysis and simulation of traveling activities. Input data, represented by the yellow box in the following figure, included primary and secondary data such as population demographics, infrastructure data, land use data, and historical public transport usage data. Survey data, including daily travel surveys and traffic count data, were also incorporated. Data synthesis, depicted by the grey box, involved population synthesis and the activity generator. Finally, the analysis and simulation segment, shown in the green box, utilized synthetic data to simulate activities and travel patterns within the study area.

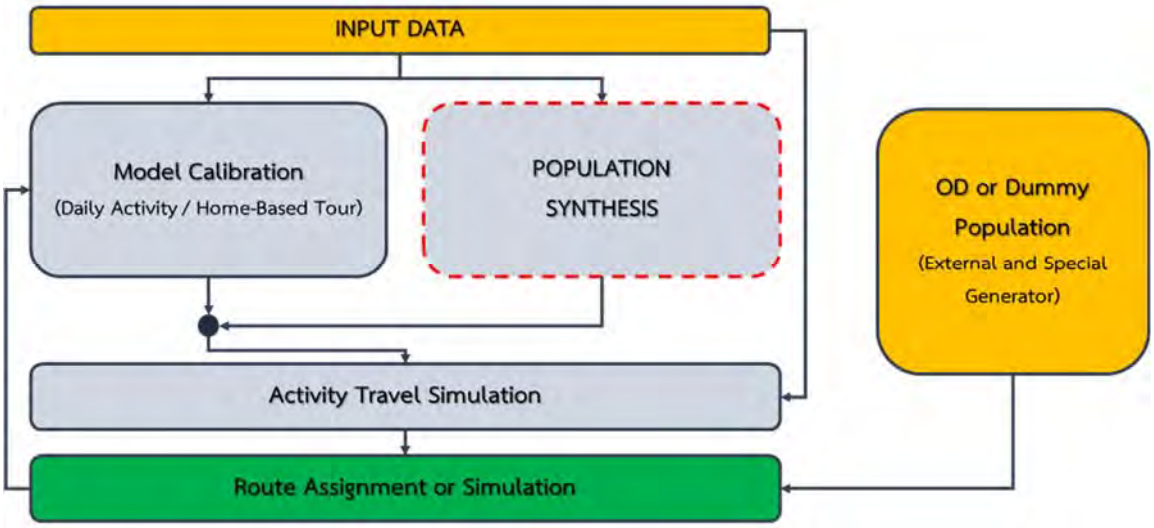


Figure 2-8 Overview of guidelines for developing an activity-based railway-focused model

3. DEVELOPMENT OF MASS TRANSIT NETWORK AND ENHANCEMENT STRATEGIES

3.1 Planning for the development of M-MAP2 network

The proposed routes in M-MAP2 master plan were divided into three groups: Group A includes necessary routes prioritized by the Department of Rail Transport, Group B consists of routes not immediately needed but kept for future review post-2029, and Group C comprises routes with inadequate demand but potentially serve as a feeder by electric buses or Bimodal Trams. The plan focuses on two scenarios: assessing M-MAP Master Plan routes for implementation necessity and considering proposed routes from various sources. Routes deemed unsuitable are reclassified into Group C. This approach ensures efficient allocation of resources and accommodates future transportation needs in Bangkok.

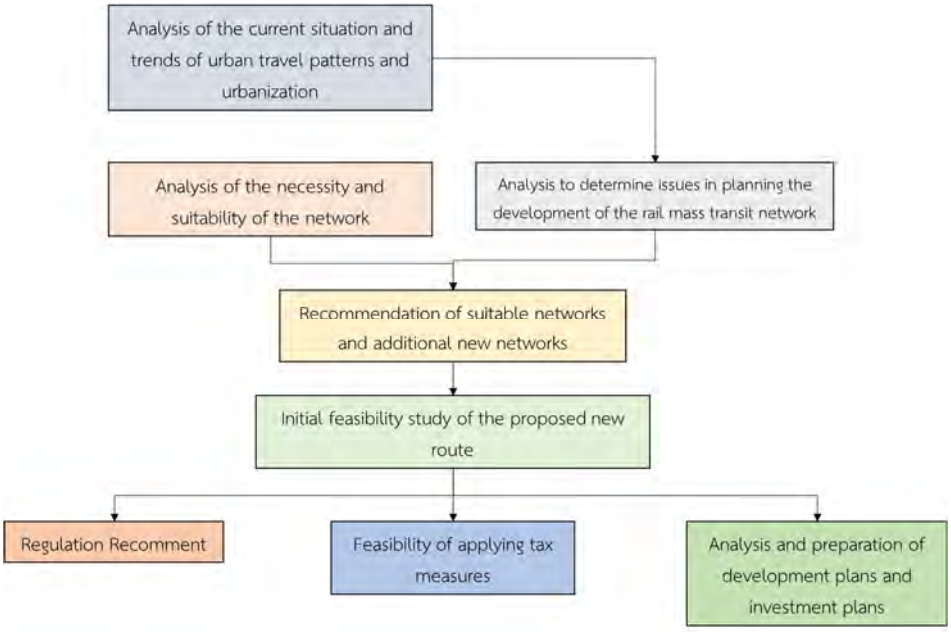


Figure 3-1 Operational guidelines in part 3

3.1.1 Railway Development Policies Direction

Based on the current state of rail transport in Bangkok and surrounding areas, policies can be crafted to address challenges, mitigate issues, or enhance initial development. These policies aim to offer solutions, alleviate problems, and bolster the advancement of rail infrastructure.

Policy 1: To Alleviate Travel Congestion in the Rail System (Capacity)

Rail congestion significantly hampers the popularity of rail transport. To tackle this, solutions focus on enhancing inter-area and intra-station travel capabilities. Improving inter-area travel, particularly on congested routes like the Blue Line from Chatuchak to Asok, is crucial. The lack of east-west connections worsens this issue, but future expansions like the Yellow Line are expected to help. Continuous analysis of travel density will be necessary to address future insufficiencies in the electric train network and add new lines as needed.

Enhancing intra-station travel involves setting standards for services, such as ticket purchase areas. The development policy includes indicators like Mode Share and Railway Congestion Ratio to assess rail usage and congestion levels. Capacity assessments consider factors such as passenger weight and system averages. These measures aim to optimize rail transport efficiency and enhance the overall travel experience in Bangkok and its surrounding areas.

Policy 2: Increase Rail Transportation to Cover Bangkok and its vicinities (Coverage)

The analysis of the rail transportation environment highlighted accessibility challenges for suburban populations due to dispersed settlement patterns, leading to higher travel costs and traffic congestion. Expanding the rail mass transit network is necessary to improve travel quality and reduce disparities. Development guidelines focus on increasing rail access within the urban area and planning for future growth.

Accessibility improvements involve assessing railway routes based on proximity to stations, focusing on areas within an 800-meter walkable radius. Additional lines will extend access beyond this range. Progress indicators include the number of people within 800 meters of a station with rail access, aiming to enhance an overall travel experience and reduce disparities.

Policy 3: To Increase the Potential of Rail Network Connection (Connectivity)

The past unpopularity of rail transport revealed the existing system's failure to meet travelers' needs, with congestion and poor connectivity as key issues. Policy guidelines focused on better-aligning routes to serve major cities in Bangkok and support future demands between sub-central business districts. Reducing missing links within the rail system was essential to enhance convenience and encourage usage. Proposed solutions included expanding networks in poorly connected areas. Development policy indicators, such as time and cost savings and the proportion of direct routes, aimed to improve travel efficiency and increase rail mass transit utilization, addressing congestion and connectivity issues.

Policy 4: Improve Fare Patterns to be More Appropriate and Fairer (Affordable and Equitable)

The travel costs constituted a significant portion of living expenses. This financial burden, coupled with economic constraints, led to a decrease in rail system users, hindering project viability. Moreover, disparate fare structures across systems and project owners resulted in inequality among commuters, with some facing higher fares for similar distances.

To address these issues, development guidelines focused on promoting a reasonable and uniform fare structure to enhance affordability and equity. Measures included adjusting fares to align with travelers' financial capabilities and implementing a common fare system while abolishing entry fees. Additionally, promoting supplementary income-generating avenues was crucial to offset potential revenue losses from fare reductions. Proposed measures encompassed windfall taxes, fund establishment, and income tax reductions.

Policy 5: To Connect with Other Forms of Transportation (Intermodal) Efficiently

With an aging population on the horizon and limited mass transit accessibility, travelers often resort to motorcycle taxis or taxis, which are less convenient than private cars. Consequently, rail mass transit usage remains below potential levels. Bangkok and its vicinity are planning various transport network developments, including water transport along canals, coordinated by OTP studies. Hence, rail route development must align and integrate with these plans.

The policy guidelines focused on enhancing travel connections, expanding rail access, and improving nearby bus stops. Ensuring equal travel opportunities for all involved establishing infrastructure standards with universal design principles and addressing needs within and around stations. Additionally, promoting semi-public transport systems like motorcycles, taxis, and non-motorized options further facilitated access.

The development policy indicators included the ratio of public bus and van lines connected to rail systems, berths connected to rail transport, and the utilization of station facilities. Entry/exit times to stations and the prevalence of pedestrian facilities were also monitored. These measures aimed to foster seamless travel integration, improve accessibility, and enhance the overall transit experience for all demographics.

Table 3-1 Indicators of network characteristics according to development issues

Policy No.	Policy	Indicators
1	To Alleviate Travel Congestion in the Rail System (Capacity)	• Mode Share • Railway Congestion Ratio
2	Increase Rail Transportation to Cover Bangkok and its vicinities (Coverage)	number of people who can access the rail transport system within 800 meters.
3	To Increase the Potential of Rail Network Connection (Connectivity)	• Time and cost savings in traveling by rail transport system • The proportion of Directiveness
4	Improve Fare Patterns to be More Appropriate and Fairer (Affordable and Equitable)	The cost of traveling by rail system of passengers in each area.
5	To Connect with Other Forms of Transportation (Intermodal) Efficiently	• The ratio between the number of lines of public buses and vans connected to the rail system and the total number of lines of public buses and vans. • The ratio between the number of berths connected to the rail transport system and the total number of berths. • The ratio between the number of parked and parked stations and the total number of stations. • Entry/exit times (passenger hours by entry/exit mode) to train stations, e.g. within 15 and 30 minutes, for urban and suburban stations respectively. • The ratio of high-use pedestrian facilities within the area covered by urban and suburban stations.

3.1.2 Long list

The acquired corridor is integrated with the existing corridor network outlined in the MMAP Plan, MMAP 2 Blueprint, and other local government and consultant-provided networks. The details are shown in Table 3-2 and Figure 3-2.

Table 3-2 Long List

Route	M-MAP2 Blueprint	Local Gov	Policy1	Policy2	Policy3	Public Hearing
M-MAP Routes						
M1 Red Line (E-W) M1.1 Bang Sue - Phayathai - Huamak M1.2 Taling Chan – Salaya M1.3 Taling Chan – Siriraj	M-MAP					
M2 Red Line (N-S) M2.1 Bang Sue - Hua Lamphong M2.2 Hua Lamphong - Wongwian Yai M2.3 Wongwian Yai – Bang Bon M2.4 Bang Bon – Mahachai M2.5 Bang Bon –Paktho M 2.6 Rangsit – Thammasart						
M3 Cyan Line (Sathon – Din Daeng)						
M4 Grey Line (Lumlukka - Tha Phra) M4.1 Lumlukka – Watcharapon M4.2 Watcharapon – Thong Lor M4.3 Phra Khanong - Tha Phra						
M 5 Brown Line (Khae Rai - Bueng Kum)						
M 6 Green Line (Suvhumvit) M6.1 Ku Kot – Outer Ring Road M6.2 Samutrprakarn – Bangpu						
M7 Green Line (Silom) National Stadium – Yotse						
M8 Blue Line Bangkhae – Phutthamonthon 4						
New Routes						
N1 Silver Line Mae Nam - Bangna – Suvarnabhumi N1.1 Bangna – Suvarnabhumi N1.2 Mae Nam - Bangna	/ /					
N2 Boromarajonani - Din Daeng - Laksi Line	/			/		
N3 Rangsit – Thanyaburi - Khlong 6 – Thammasart Line N3.1 Khlong 6 – Thammasart N3.2 Thanyaburi – Khlong 6 N3.3 Rangsit – Thanyaburi	/ / /	/ / /				
N4 Rangsit – Pathum Thani Line		/			/	
N5 Khlong 3 – Ku Kot Line		/		/		/
N6 Suvarnabhumi – Phraeksa - Sukhumvit Line N6.1 Suvarnabhumi – BangnaTrat N6.2 Bangna Trat – Thepharak N6.3 Thepharak – Phraeksa N6.4 Phraeksa - Tamru N6.5 Phraeksa - Sukhumvit		/ / / /	/ / / /	/ / / /		/ /
N7 Don Muang – Sri Saman Line				/		
N8 Phra Khanong – King Kaew Line				/	/	
N9 Thepharak – Rat Burana Line			/			
N10 Salaya – Mahachai Line					/	
N11 Bang Sue – Pathum Thani Line				/		
N12 Srinakarin - Bang Bo Line						/

Route	M-MAP2 Blueprint	Local Gov	Policy1	Policy2	Policy3	Public Hearing
N13 Khlong 6 – Ongkharak Line						/
N14 Bang Khae – Samrong Line						/
Extensions						
E1 Green Line (Silom) Bang Wa –Rattanathibet - Pak Kret Line	/	/			/	
E2 Pink Line Minburi – Lat Krabang Line			/	/		
E3 Pink Line Muang Thong - Pathum Thani Line					/	
E4 Purple Line Bang Yai – Bang Bua Thong Line				/	/	
E5 Golden Line (Khlong San-Siriraj) Line				/		
E6 Silver Line Suvarnabhumi- Bang Bo Line					/	
E7 Red Line Bang Sue – Rama 3 Line				/		
E8 Yellow Line Lat Phrao – Ratchayothin - Bang Aor – Tha Nam Non Line				/		/
E9 Brown Linw Khae Rai – Ratchaphruek Line	/					
E10 Green Line Bang Pu – Chakri Naruebodindra Line						/
E11 Red Line Thammasart – Navanakorn Line						/

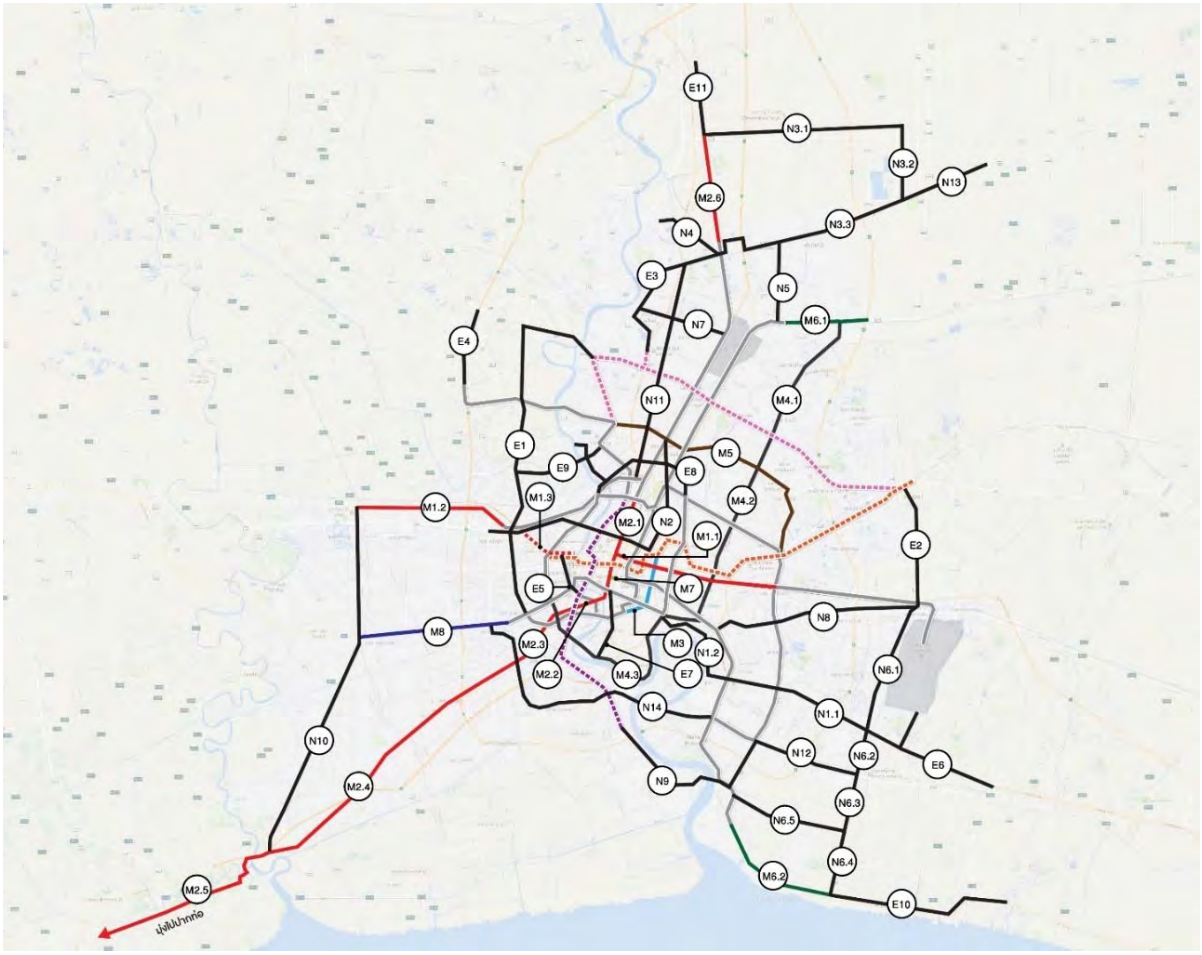


Figure 3-2 Network of Long List

3.1.3 Route Screening

From Table 3-2, the Long List was refined into a Short List using screening criteria outlined in Figure 3-3. The route screening was separated into 2 criteria.

Screening of M-MAP

Two key issues were considered:

- Red Line: Hua Lamphong – Wong Wian Yai Section faced challenges due to intersecting routes and land expropriation.
- Routes like Red Line: Bang Bon - Mahachai, Green Line: Samut Prakan – Bang Pu, and Blue Line Section Bang Khae – Phutthamonthon Sai 4 did not meet passenger volume criteria for 2029.
- They were classified under Group B for reconsideration post-2029.

New Route Screening

Two key issues were considered:

- Routes such as Phra Khanong – King Kaew Line and Yellow Line: Lat Phrao – Ratchayothin – Bang O faced physical challenges.
- Silver Line: Bangna – Suvarnabhumi and Green Line: Bang Wa – Rattanathibet met passenger volume criteria. Other routes were categorized under Group C as feeder routes.

The routes meeting the criteria were prioritized, resulting in 10 projects grouped as shown in the figure below.

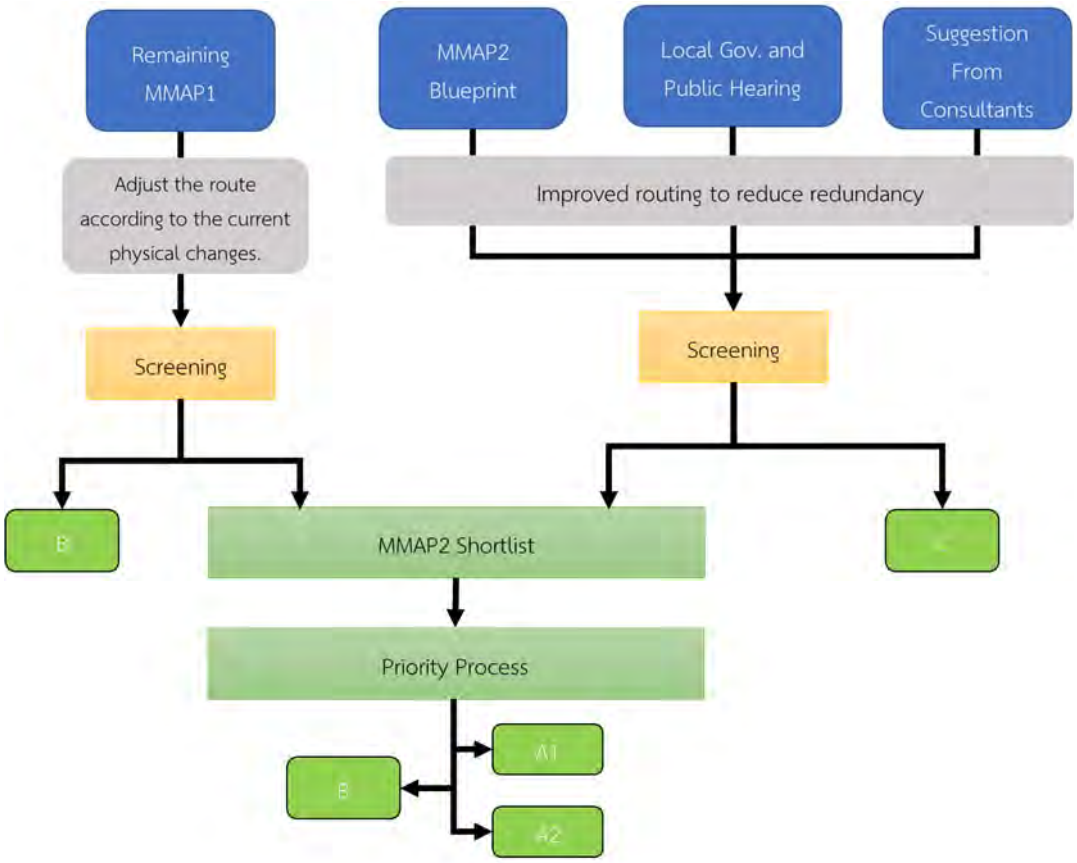


Figure 3-3 Route Screening

3.2 Analysis and prioritization and preparation of development plans and investment plans

3.2.1 Prioritization guidelines

Guidelines for Multi-criteria Decision Analysis (MCDA) integrate Multi-attribute Utility Theory (MAUT), Outranking, and Multi Actor Multi Criteria Analysis (MAMCA). The process begins with identifying options and criteria, defining objectives, and measuring impacts, ensuring all calculations meet Threshold Constraints. Factor values and weights are calculated to evaluate and compare alternatives. For project prioritization, key considerations include:

- Widely referenced factors in educational works.
- Quantitative or qualitative comparability.
- No significant correlation with other factors.
- Alignment with the study's objectives for forecasting rail travel demand and developing Bangkok's rail mass transit networks (Phase 2).

The factors that were used to prioritize the project and the score analysis guideline are shown in Table 3-3.

Table 3-3 Project Priority Factors

Factors to consider	Analysis factors
Planning Policy	Weighted Score of Measures: • Capacity • Coverage • Connectivity • Intermodal and Accessibility
Readiness	The current project status: • Agreed in principle. • Under preliminary design. • passed the environmental impact assessment, etc.
Ease of Implementation	Difficulties in implementing the project include: • There is a wide enough passageway. • To expropriate additional land. • Demolition of utilities, etc.
Financial, Economic, and Social Return	The indicators: • Economic Internal Rate of Return - EIRR • Financial Internal Rate of Return - EIRR • Social Return on Investment - SROI
Environment Impacts	Environmental impacts within 100 meters of the project route: • Number of surface water source intersections • Number of Sensitive Areas • number of intersections • The amount of land and buildings to be expropriated.

3.2.2 Priority Process

The prioritization study was divided importance into three levels:

- **Group A: Imperative Route**
  - A1: Imperative and ready to proceed (immediate implementation)
  - A2: Imperative but requires some preparation (implementation by 2029)
- **Group B: Potential Route**
  - B: Reconsider project feasibility in 2029
- **Group C: Feeder Route**

Of 13 projects that met screening requirements, the Red Line projects (Rangsit – Thammasart, Taling Chan - Salaya, and Taling Chan - Siriraj) are awaiting cabinet approval and should be categorized as A1. Thus, 10 projects are prioritized.

- **Project 1**: Red Line Bang Sue - Hua Lamphong - Phayathai - Hua Mak and Green Line (Silom) National Stadium – Yotse
- **Project 2**: Gray Line: Watcharaphon – Thonglor
- **Project 3**: Red Line Wongwian Yai - Bang Bon
- **Project 4**: Cyan Line Sathon – Din Daeng
- **Project 5**: Brown Line Khae Rai - Bueng Kum
- **Project 6**: Silver Line Bangna – Suvarnabhumi
- **Project 7**: Gray Line Phra Khanong - Tha Phra
- **Project 8:** Green Line Bang Wa - Taling Chan
- **Project 9**: Green Line Taling Chan – Rattanathibet
- **Project 10**: Green Line Khu Khot - Outer Ring Road and Gray Line: Lam Luk Ka - Watcharaphon

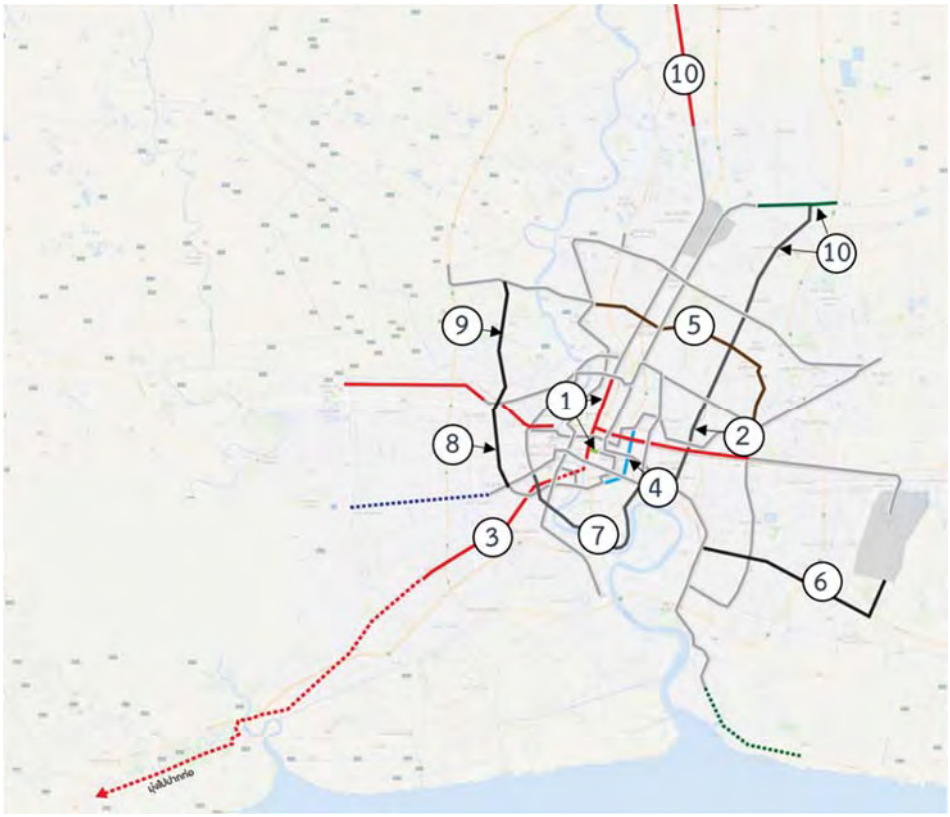


Figure 3-4 Short list of 10 projects

3.2.3 Prioritization results

The results of prioritizing each factor were compiled. It can be summarized as Table 3-4, which will prioritize as follows:

- As Group A1 already includes three projects, the Red Line (N-S), Rangsit - Thammasart, the Red Line (E-W), Taling Chan - Salaya and Taling Chan - Siriraj, and the Brown Line. Therefore, only the projectwith the highest score were selected to be included in the A1, with others considered for inclusion in other categories.

Table 3-4 Project Priority

Route		A1	A2	B
Red Line (N-S)	1.1 Rangsit – Thammasart	/		
	1.2 Bang Sue - Hua Lamphong		/	
	1.3 Hua Lamphong - Wongwian Yai			/
	1.4 Wongwian Yai – Bang Bon		/	
	1.5 Bang Bon – Mahachai – Paktho			/
Red Line (E-W)	2.1 Taling Chan – Salaya- Siriraj	/		
	2.2 Bang Sue - Phayathai - Huamak		/	
Green Line (Sukhumvit)	3.1 Samutrprakarn – Bangpu			/
	3.2 Kukot – Outer Ring Road		/	
Green Line (Silom)	4.1 National Stadium – Yotse		/	
	4.2 Bang Wa - Taling Chan		/	
	4.3 Taling Chan – Rattanathibet			/
Blue Line	5 Bangkhae – Phutthamonthon Sai 4)			/
Grey Line	6.1 Lam Luk Ka - Watcharaphon			/
	6.2 Watcharaphon – Thonglor		/	
	6.3 Phra Khanong - Tha Phra			/
Cyan Line Sathon – Din Daeng				**/**
Brown Line Khae Rai - Bueng Kum		**/**		
Silver Line Bangna – Suvarnabhumi			**/**	

* Please note that the prioritization result mentioned above is based on the result of DRT final report submitted on September 2023. Revision of the final plan after September 2023 will be covered in the appendix of this review summary report.

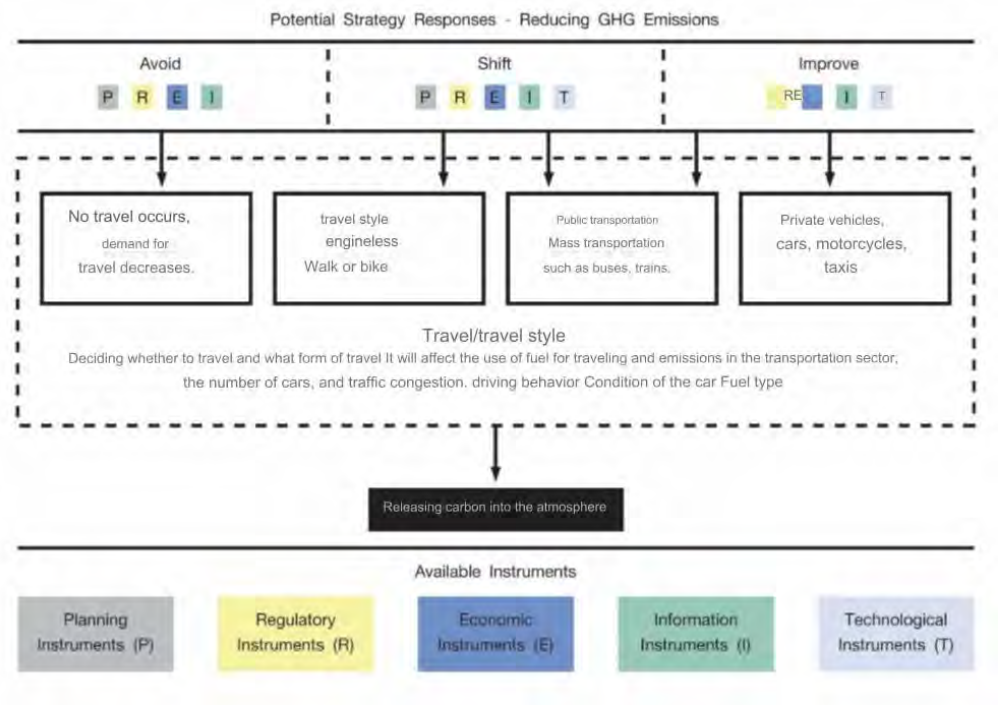
3.3 Recommendation of Measures and Enactment of Laws and Regulations to Promote the Use of Mass Transit Systems

3.3.1 Concepts for Proposing Measures, Laws, Rules and Regulations to Promote the Use of Mass Transit Systems

1) Concepts according to the National Greenhouse Gas Reduction Action Plan 2021-2030 in the Field of Transport

Since joining key international climate agreements, Thailand has committed to significant greenhouse gas (GHG) reduction targets, emphasizing the transport sector's role in these efforts. The country has established the National Greenhouse Gas Reduction Action Plan for 2021-2030, aiming to cut emissions by 20% or 111 million tons of CO2 equivalent by 2030. This plan categorizes projects by level, type, and criteria for GHG reduction across

various transport modes, including land, rail, waterways, and air. It also outlines five key guidelines for sustainable transport development: infrastructure planning, policy incentives, economic incentives, awareness cultivation, and technology use for emission reduction, aligning with the A-S-I principle for environmentally friendly logistics.



Source:National Greenhouse Gas Reduction Action Plan 2021-2030, Transport Branch, OTP.

Figure 3-5 Process leading to environmentally friendly transportation

2) Concept of supporting environmental conservation tax (Green Tax / Carbon Tax)

The National Greenhouse Gas Reduction Action Plan 2021-2030 highlights economic incentives as a key strategy, proposing income tax relief for taxpayers who contribute to greenhouse gas reduction by using public transport. This approach aligns with the Fiscal and Fiscal Discipline Act B.E. 2561, emphasizing tax collection and exemption fairness, equality, and non-discrimination, while fostering economic and social stability. The law requires a detailed assessment of revenue loss and expected benefits from tax incentives, ensuring that such measures support broader objectives like reducing pollution and traffic, thus contributing to overall economic, social, and environmental well-being.

3) Measures to alleviate personal income tax burden

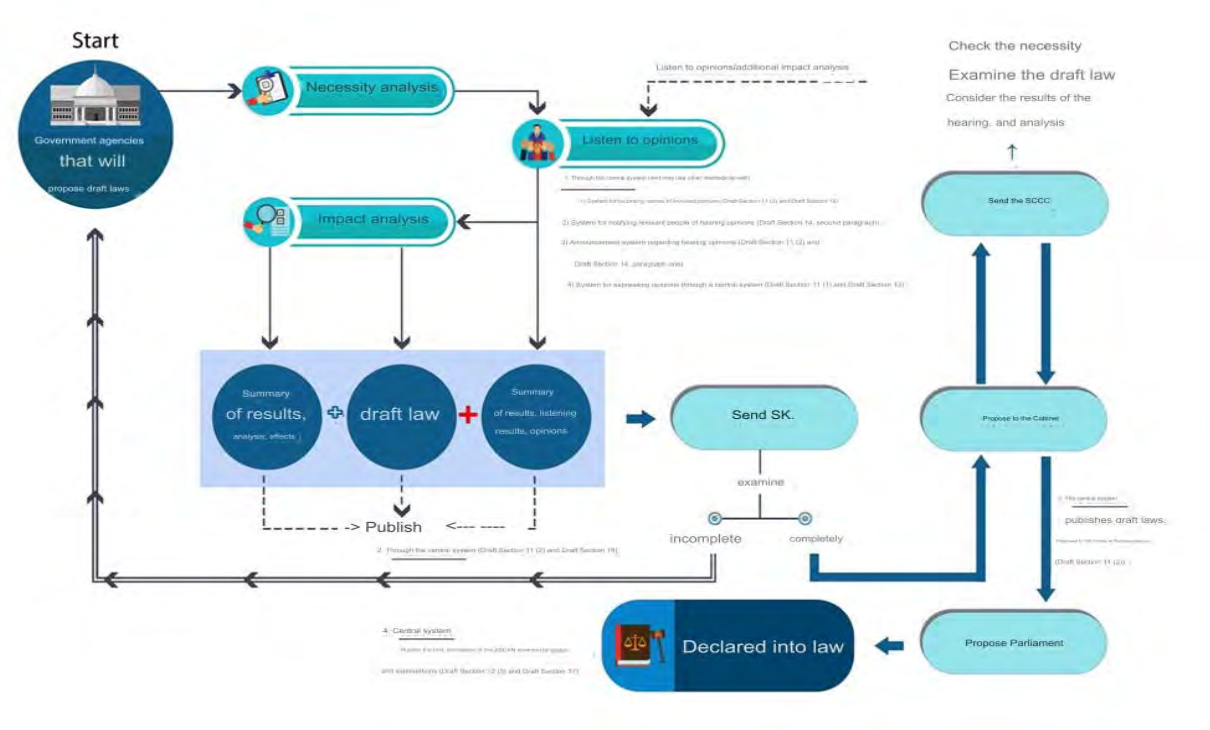
Individuals with assessable income above a certain threshold are obligated to pay tax, yet specific income types are exempt for various reasons, including economic, social, and political motives. This has led to the implementation of tax measures like deductions, exemptions, and credits to encourage certain taxpayer behaviors, provide indirect social welfare, and stimulate the economy. For instance, exemptions have been made for COVID-19 related income and for shareholders in merged or business-transferred commercial banks, aiming to mitigate double taxation and align taxpayer actions with societal goals.

4) Measures to reduce corporate tax

Juristic persons can benefit from tax deductions on various expenses, including depreciation of computers, equipment, and software; fees for supporting electronic tax systems; and employee-related expenses like wages for the elderly and training. Additionally, laws provide corporate tax reductions in specific cases or areas to stimulate economic growth, such as decrees to reduce revenue rates, promote investments in the Special Development Zone, and encourage the purchase of biodegradable products. These measures aim to address economic, social, and environmental issues, suggesting that similar incentives could promote mass transit use, thereby reducing traffic, pollution, and energy consumption while fostering urban prosperity.

5) Issuing or amending laws

Drafting legislation in Thailand involves adhering to key legal frameworks, including the nation's Constitution, the Act on Rules for Legal Draft and Evaluation of Legal Achievement, and the Act on the Facilitation of Government Permissions Consideration. This process necessitates the proposal of laws at various statutory levels and the drafting of ministerial regulations. To effectively implement measures supporting mass transit, it's essential to either amend existing laws or introduce new legislation, requiring coordinated efforts from consultants, legal action plans, and relevant agencies.



Source: Office of the Council of State

Figure 3-6 The process of proposing bills at the statutory level

3.3.2 Proposals for Measures to Promote the Use of Mass Transit Systems

1) Mass Transit Fare Subsidy Measure (Prompt Go: PG)

The project aims to reduce fare burdens and encourage train travel in Bangkok, contributing to rail system development, CO2 emission reduction, and travel expense savings. It introduces a scheme linking state welfare to a wallet application for fare payment, enhancing accessibility for those without smartphones. The Ministry of Finance and Transport, among others, will oversee this initiative, expected to shift transport modes from personal vehicles to trains, thus easing traffic, reducing environmental impact, and fostering economic benefits through increased public transport use.

The initiative proposes increasing monthly public transportation subsidies from 500 baht to 1,000 or 1,500 baht, aiming to boost mass transit use among state welfare recipients. This move is expected to reduce personal car use, decrease environmental pollution, and enhance the mass transit system's efficiency. Additionally, the government can leverage reduced emissions for carbon credits. Economic analyses predict benefits from reduced vehicle operation costs and travel time, highlighting the project's potential to alleviate overall economic burdens while promoting sustainable urban mobility.

Table 3-5 Benefits and Costs of Fare Subsidy Policies (summary)

Benefits and Costs	750 baht/month	1,000 baht/month	1,500 baht/month
Number of users	8,580 people / day	11,334 people / day	16,661 people / day
Expenses	70.79 million baht / month	93.50 million baht / month	137.45 million baht / month
Economic benefits			
- Reduced vehicle costs	41.24 million baht / month	55.82 million baht / month	79.28 million baht / month
- Reduced travel time	75.65 million baht / month	119.64 million baht / month	151.59 million baht / month
Including the benefits that the state: receives more than the costs	116.89 million baht/ month	175.46 million baht/ month	230.86 million baht/ month

Source: Consultant's Estimate

Table 3-6 Traffic and transportation analysis results before and after fare subsidies

Analysis results	No measures	Measure 750 baht/month	Measures 1,000 baht/month	Measures 1,500 baht/month
Number of users (person/day)	-	1,661	2,279	3,499
Volume (PCU-KM/day)	137,679,570	137,675,664.40	137,674,284.40	137,672,062.80
Volume (PCU-KM/day)	3,618,866	3,618,657.60	3,618,536.40	3,618,448.40

Source: Consultant's Estimate

Table 3-7 Benefits and Costs of Fare Subsidy Policies

Analysis results	Measure 750 baht/month	Measures 1,000 baht/month	Measures 1,500 baht/month
Cost (baht/year)	14,950,008	33,838,873	104,967,360
Mileage Saving (PCU-KM)	3,905.60	7,550.86	18,768.00
(PCU-HR) Travel time savings (PCU-HR)	208.40	470.86	1,044.00
VOC Saving (baht/year)	8,248,627	15,947,410	39,638,016
VOT Saving (baht/year)	10,498,969	23,721,279	52,595,604
ENV Saving (baht/year)	8,215,934	15,884,203	39,480,910
Carbon Credit (baht/year)	27,839	53,823	133,778
Total benefits (Baht/year)	26,991,369	55,606,715	131,848,308
Value (baht/year)	12,041,361	21,767,842	26,880,948

Source: Consultant's Estimate

2) Go Green with Rail: GGR

The project aims to encourage train travel and reduce car usage, advancing rail system development and lowering greenhouse gas emissions. It proposes fare top-ups via a Pre-Paid wallet for public transport, offering tax deductions for individuals and double expense claims for juristic persons. Implemented in phases, it targets natural and juristic persons in Bangkok, supported by multiple ministries and funded through taxes and government budgets. The initiative expects to increase train usage, enhance transport efficiency, and contribute to environmental and economic benefits, while requiring legislative adjustments and technology development to facilitate implementation and manage prepaid fares.

Table 3-8 Project Implementation Period – GGR Policy

Duration (year)	Action	Remarks
Year 1	Study relevant feasibility information such as the value of tax discounts. Using a common ticketing system Development of a wallet application to support the operation system make a draft law	Able to coordinate with relevant departments to acknowledge opinions and suggestions.
Year 2 to Year 3	- Coordinate with operators and related agencies, namely MRTA, SRT, Department of Land Transport (KOR), Bangkok Metropolitan Administration (Bangkok), including private sectors who are licensed to operate rail transport. to propose a plan and integrate according to the plan. - Propose relevant legislation	May allow the licensee to operate the rail transport business to contribute to the cost of preparing the area or others because they benefit from the implementation of such measures.
Year 4 onwards	- publicize the project let the public know and start service - Implement tax measures	

Source: Consultant's Proposal

Table 3-9 Comparison of the decrease in tax collection after income-based measures (1)

net income	Average tax collected (baht/person)		Reduce
	Before measures	After measures	
0-150,000 baht/year	no tax		
150,001-300,000 baht/year	3,750	3,250	500
300,001-500,000 baht/year	17,500	16,500	1,000
500,000-750,000 baht/year	46,250	44,750	1,500
750,001-1,000,000 baht/year	90,000	88,000	2,000
more than 1,000,000 baht/year	240,000	237,500	2,500

Source: Consultant's Estimate

Table 3-10 Comparison of the decrease in tax collection after income-based measures (1)

Net income	Number of participants	Reduced taxes	Amount
0-150,000 baht/year	no tax		
150,001-300,000 baht/year	823,797	500	411,898,500
300,001-500,000 baht/year	388,500	1,000	388,500,000
500,000-750,000 baht/year	124,420	1,500	186,630,000
750,001-1,000,000 baht/year	18,230	2,000	36,460,000
more than 1,000,000 baht/year	15,938	2,500	39,845,000
Total			1,063,333,500

Source: Consultant's Estimate

Table 3-11 Amount of Tax Reduction – GGR Policy

Result	No measures	Measures	Reduced proportion
Total travel distance (PCU-km.)	280,957,675	279,016,513	1,941,162.12
Total travel time (PCU-hr.)	8,378,734	8,279,240	99,493.66
Average speed (KPH)	33.532	33.701	- 0.17

Source: Consultant's Estimate

3) Go together measures (direct feeder measures to railway station during rush hour)

The "Go Together" measure aims to streamline Bangkok's public transportation by introducing dedicated shuttle services to transport passengers directly to main bus stations during peak hours, promoting rail transport use over personal cars. It seeks to reduce greenhouse gas emissions, PM 2.5 dust, and support the Thailand 4.0 policy through improved feeder systems, fare reduction, and common ticket policies. The project involves pre-paid fare top-ups, tax deductions for individuals and juristic persons, and is supported by various government agencies. The initiative is expected to ease travel, lower public fare costs, attract more users to mass transit, and indirectly benefit the economy and environment.

4) Facilities for passengers

For passenger convenience, transport hubs should offer seamless connectivity between train stations and buses, including facilities compliant with disability laws. Essential features include an adequate number of Kiss and Ride stops for easy drop-offs, a user-friendly app displaying comprehensive mass transit schedules to aid in travel planning, and life-saving

equipment like Automated External Defibrillators (AED) for emergencies. These facilities aim to enhance the overall travel experience, ensuring safety, accessibility, and efficient trip coordination.

5) The use of the Regulatory Sandbox mechanism

The "Go Together" measure integrates new technologies to enhance the mass transit system as part of Smart City development, emphasizing Smart Mobility. It aims to facilitate passenger services through innovations like the Internet of Things (IoT), improving public transport quality. However, legislative adaptation may lag behind technological advances, potentially slowing the implementation of IoT-supported Smart City initiatives. To address this, the Regulatory Sandbox is proposed, allowing testing of new ideas or innovations, like cashless payments, under government supervision without immediate legal constraints. This approach promotes innovation while reducing regulatory risks for entrepreneurs.

6) Measures of access to rail mass transit stations by walk or bicycle

The initiative to enhance Bangkok's rail mass transit system focuses on addressing underutilization by improving accessibility, convenience, and integrating sustainable transportation modes like walking and cycling. The project aims to make rail transit an attractive option by prioritizing factors such as travel time, reliability, affordability, and safety. Enhancements include better station access, promoting active transport for station entry and exit, and considering the physical and mental health benefits of walking and cycling. Collaboration with local government and development aligned with Transit-Oriented Development principles are crucial for success, aiming to reduce reliance on personal vehicles, improve public health, and support urban sustainability.

3.4 Assessing the Feasibility of Applying Tax Measures and the Drafting of Laws relating to the Use of Areas along the Mass Transit Routes

3.4.1 Tax Measures for Juristic Persons or Natural Persons who Own Land or Immovable Property

Local administrative organizations play a crucial role in collecting land and building taxes, utilizing these funds for local development. Proposed legal amendments aim to reduce taxes for lands used as free parking for electric train passengers, encouraging private sector participation and reducing project costs for entities like the State Railway of Thailand and the Mass Rapid Transit Authority of Thailand. Additionally, exploring Land Value Capture as a financial tool reflects the potential for leveraging land value increases from infrastructure development, indicating ongoing efforts to finance public transportation improvements efficiently.

3.4.2 Transit-Oriented Development: TOD

Transit-Oriented Development (TOD) around metro stations is crucial for urban development alongside public transport systems. TOD's success requires collaborative efforts from government, local organizations, and both private and public sectors. The Office of Transport and Traffic Policy (OTP) has drafted the TOD Thailand Master Plan for

sustainable urban growth, needing legal backing for swift implementation. A proposed Land Development Act aims to ensure budget allocation by government agencies and the establishment of a Development Promotion Fund to support infrastructure-related projects, emphasizing the significance of funding in achieving successful area development around infrastructure.

3.4.3 Conclusions and Recommendations for Drafting Measures, Draft Laws, Rules, Regulations and Tax Measures to Promote the Use of Mass Transit Systems

1) General measures

Countries like Australia and the UK implement various fare discounts and conveniences for rail passengers, such as the Opal card in Australia for seamless travel and fare discounts in the UK for children and specific groups. Thailand follows suit with discount programs across its transit lines, such as fare alliances with the Rabbit Card and special discounts for different user groups. These measures aim to enhance the attractiveness of public transit, making it a more viable and preferred option over personal vehicle use, thereby supporting sustainable urban mobility and the development of a more integrated public transport system.

2) Tax measures

Land Value Capture (LVC) is employed internationally to fund public utilities and urban development, leveraging the increased land value due to infrastructure projects. Models include tax-based or fee-based mechanisms like property taxes, special assessments, and tax increment financing, and development-based approaches such as land sales, leases, and urban redevelopment. Japan and South Korea exemplify this, with Japan using land readjustment for rail structures and South Korea financing new cities with infrastructure investments primarily funded by land taxes. The U.S. utilizes Tax Increment Financing, channeling real estate tax surpluses into infrastructure funding.

3) Space utilization measures (4 principles of TOD development)

In England, Transport for London (TFL) manages urban development and collaborates flexibly with the private sector for land development along rail lines, unlike the more rigid Thai government agencies. TFL's strategies include selling or leasing land to developers and entering joint ventures to enhance station areas. Additionally, TFL implements transport premium charges and congestion charges to manage city traffic and fund transport improvements.

4) Proposals for the implementation of measures

The consultant recommends a mix of policy and legal measures to enhance rail transport use and development around stations. Policies include fare support, environmental taxes, promotional activities, and improvements in service quality to attract more passengers. Legally, proposed changes to the Revenue Code and Land and Building Tax Act aim to facilitate tax benefits for individuals and juristic persons investing in green transport

initiatives and to support the development of Transit-Oriented Development (TOD) areas, enhancing local and state revenue while promoting sustainable urban growth.

3.5 Recommendations

3.5.1 Recommended Measures

The proposal includes establishing feeder systems from communities to railway stations, mandating real estate developers to provide transport services as part of their offerings, similar to public utilities. This approach would enhance railway network usage and convenience for residents, with commercial entities like department stores potentially offering shuttle services to increase patronage. Legal amendments are suggested to facilitate commercial activities around stations for revenue generation. Additionally, public awareness and educational campaigns on rail travel benefits, partnerships for promotional discounts, and comprehensive travel packages could further incentivize public transport use.

3.5.2 Additional Suggested Measures

The study analyzes three fare scenarios for Bangkok's rail transit: current fares, a 20-baht flat fare for state welfare cardholders, and a 20-baht fare for all passengers. A 20-baht fare for welfare cardholders would increase ridership but decrease revenue, offering modest travel benefits. Analysis conditions were assumed socio-economic variables at 2028 with the urban railway network at the end of 2023, plus currently under-construction lines (Pink line spur line, Orange line west and east, and Purple line southern extension) included. Implementing a 20-baht fare for all would significantly increase passengers and travel benefits but drastically reduce revenue, requiring substantial government subsidies. These findings suggest evaluating the balance between increased accessibility and financial sustainability for mass transit promotion.

Table 3-12 Fare Scenarios (Model Analysis)

scorecard	Case 1 (as if)	Case 2 (20B for low-income)		Case 3 (20B for all)	
		Analysis	difference	Analysis	difference
number of passengers (Person-trip/day)	1,522,056	1,562,876	40,820	1,713,547	191,491
revenue collected (baht/day)	49,522,614	45,594,578	-3,928,036	31,205,792	-18,316,822
total travel distance (PCU-Km./day)	27,598,582	27,581,595	-16,987	27,474,202	-124,380
total travel time (PCU-Hr./day)	1,020,403	1,018,197	-2,206	1,004,941	-15,462

Source: Consultant's Estimate

Table 3-13 Fare Scenarios (Model Analysis – Case 2 & 3)

Value	Case 2 (20B for low-income)	Case 3 (20B for all)
Subsidy amount (million baht/year)	1,296.25	6,044.55
Voc Saving (million baht/year)	37.00	270.90
Vot Saving (million baht/year)	110.65	775.57
Environmental Cost Saving (Million baht/year)	35.71	261.46
Tradable Carbon Credit Value (Million baht/year)	0.12	0.89
total benefits	183.48	1,308.82

Source: Consultant's Estimate

4. PROMOTING THE REALIZATION OF M-MAP2

4.1 The Project's Public Relations and Public Participation

The action plan for public relations and public participation procedures has been revised by the Consultant to ensure alignment with the project study on mass rapid transit in the Bangkok Metropolitan Region. Accurate information regarding the project's concepts and guidelines for reviews and improvements amid changing contexts has been provided by the Consultant to educate the public and foster public understanding. Opportunities for target groups to exchange information/opinions and make useful recommendations have been offered by the Consultant, aiming to make the Study more comprehensive, enhance public knowledge/understanding, and appropriately disseminate information to the media. Public participation and public-relations activities have been conducted in accordance with the Regulations of the Office of the Prime Minister on Public Hearing, B.E. 2548 (2005).

Activities for public participation, including seminars and focus groups, have been initiated by the consultants. The project has been introduced, and the progress of the study has been reported, while comments from related target groups, scholars, and experts have been gathered. The importance, benefits, and opportunities of the project have been acknowledged through seminars and focus groups conducted four and five times, respectively, adhering to the specified regulations. Details of activities are as follows.

1) Public relations for the 1st seminar invitation
2) Public relations summarizing the results of the 1st seminar.
3) Public relations for the 2nd seminar invitation
4) Public relations summarizing the results of the 2nd seminar.
5) Public relations for the 3rd seminar invitation
6) Public relations summarizing the results of the 3rd seminar.
7) Public relations for the 4th seminar invitation
8) Public relations summarizing the results of the 4th seminar.
9) Public relations summary of subgroups No. 1-5

4.1.1 Public Participation

1) 1st seminar

The 1st seminar, held from Tuesday, 1st, to Thursday, 3rd March 2022. The information disseminated covered project reasons, objectives, operators, locations, procedures, timelines, products, results, and potential effects. Target groups, including government, private sector, organizations, general public, and media, totaling 275 organizations, provided comments and suggestions for project improvement. The seminar occurred daily at Centara Grand at Central World Hotel, Bangkok.

The seminar addressed concerns and suggestions regarding Bangkok's rail system development, addressing issues like accurate passenger data, mobile phone usage for data assessment, challenges in private car usage, and the feasibility of a feeder system. Participants questioned data sources, integrated ticketing, COVID-19 considerations, and the model's capabilities. Conclusions emphasized the need for detailed data, operator cooperation, efficient public transport, and infrastructure development. Concerns included land readjustment consequences, GPS tracking for public buses, and application roles. The seminar highlighted the project's accuracy, applicability, and potential demographic impacts, stressing the importance of addressing urban planning challenges in Bangkok.

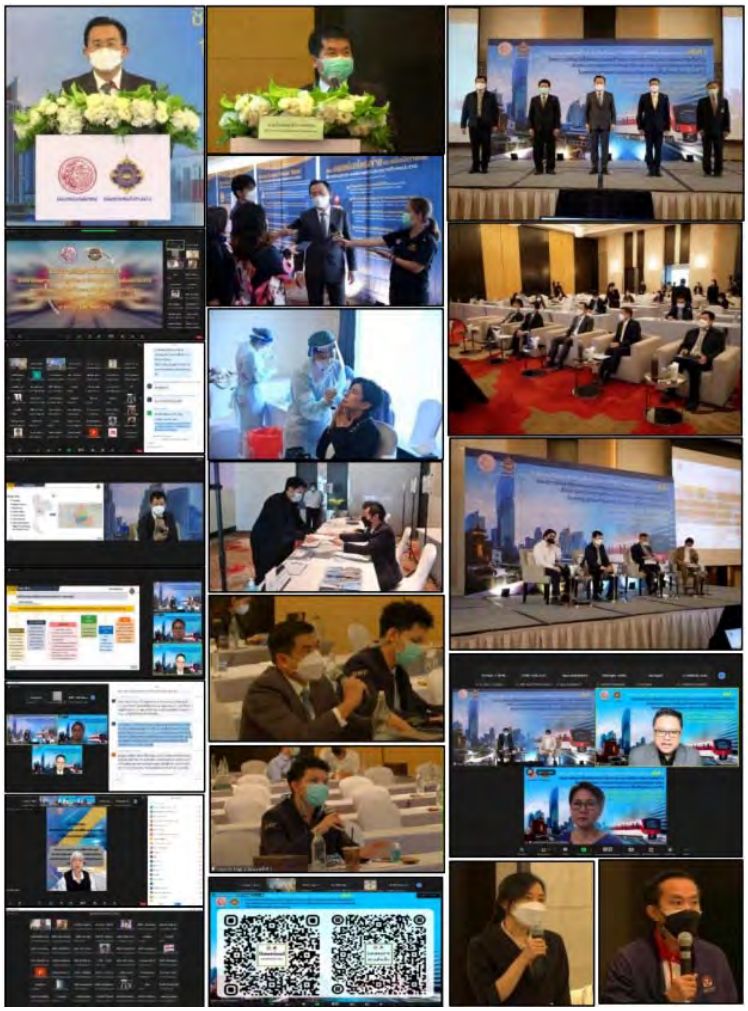


Figure 4-1 Photos of the 1st seminar

Source: Consultant, 2022

2) 2nd seminar

The 2nd seminar was held from May 9 to 11, 2023, covered project details such as objectives, operators, locations, and expenses. The Department of Rail Transport followed regulations, disseminating information on the Office of the Permanent Secretary's network system. Government, private sector, organizations, and media actively participated, offering suggestions for project enhancement. The seminar was held at Pullman Hotel, Grand Sukhumvit Bangkok.

The seminar addressed concerns regarding the fare structures, joint ventures, and passenger fare adjustments in rail system development. It reviewed Japan's rail-promoting policies and the project's next phase. The Department of Rail Transport's role in the master plan and an activity-oriented rail demand model was highlighted. Proposals included testing electric train operations and joint ventures, along with online comment boxes. The discussion emphasized effective public-private partnerships and advanced rail system management, drawing insights from Japan's success.



Figure 4-2 Photos of the 2nd seminar

Source: Consultant, 2023

3) 3rd seminar

The 3rd seminar, held from Tuesday, June 27 to 29, 2023, at the Renaissance Ratchaprasong Hotel, focused on the implementation of the M-MAP 2 project, rail travel demand forecasting models, and promoting the rail mass transit system. Planning for the M-MAP2 network and aspects like engineering, environment, and public participation were discussed. The seminar aimed to publicize and gather opinions.

The seminar addressed concerns and suggestions regarding the development of the rail system. Various proposals were made, including the analysis of the Blue Line's economic value, connections to the Southern Transit System, and extending electric train lines for redundancy. Recommendations emphasized comprehensive planning, efficient fare collection methods, and technology integration. The importance of coordinating with

relevant authorities, amending expropriation laws, and promoting online payment options was underscored. The overall focus was on addressing key issues and enhancing collaboration for a successful and efficient rail transportation system.



Figure 4-3 Photos of the 3rd seminar

Source: Consultant, 2023

4) 4th seminar

The 4th seminar, held from July 24 to 26, 2023, at Hotel Birk, Pratunam, Bangkok, focused on the M-MAP 2 project and rail travel demand models. It covered promoting rail transit, planning the M-MAP2 network, and addressing engineering, environmental, and public participation aspects. The seminar aimed to publicize information and gather opinions.

The seminar addressed concerns and suggestions regarding various aspects of rail system development. Topics included emergency management standards, the proposal to build Pantai Norasing BTS station for improved connectivity and tourism, and the urgency of developing the BTS line from Wongwian Yai to Mahachai. Participants inquired about the review of the Red Line Thani Rathaya presentation and proposed modifications to the Blue Line Sathorn-Din Daeng route. Other topics included the consideration of boat or bicycle transportation, reducing greenhouse gases, and extending the Purple Line to the Blue Line. The conclusion emphasized the importance of comprehensive planning for effective urban development and transportation.

4.2 The Project's Public Relations and Public Participation

4.2.1 Producing Media for PR and Public Participation Events

1) Posters

The 2,000 posters on A3-sized were produced for disseminating information about the Project, seminars, and focus-group meetings. These include the following posters: (1) Poster inviting public participation in events and activities (Seminar No. 1-4, Focus Group No. 1-5) (750 copies), (2) 1st issue of PR poster for the first educational event (30 copies), (3) 2nd issue of PR poster for the first seminar (250 copies), (4) 3rd set of posters for the 2nd set of 250 sheets (150 copies), (5) 4th set of posters for the 3rd seminar and public hearing (250 sheets), (6) 5th set of posters for the 4th seminar and public hearing (250 copies), and (7) 6th set of posters for the public relations group meeting and public hearings (250 copies). The number of posters totaling 2,000 copies.



Figure 4-4 Poster 2 PR poster for the first seminar

Source: Consultant, 2022

2) Pamphlets

The study, collection, and preparation of information for the creation and distribution of project publicity documents, in the form of pamphlets, were undertaken. The pamphlets, totaling 2,750 copies and presented on glossy 130 gsm A3-sized paper folded in half, encompassed four sets. These sets were dedicated to various seminars, including the (1) 1st issue published for the first seminar, totaling (250 copies), (2) 2nd issue published; consultants produced the second set for use in public relations seminars and public hearings for sub-groups No. 1-5 (1,500 sheets), (3) 3rd Issue published for the 3rd seminar (500 copies), and (4) Issue 4th, published for the 4th seminar (500 copies).



Figure 4-5 Pamphlet, Issue 4 published for the 4th seminar

Source: Consultant, 2022

3) Exhibition Boards

The production and distribution of exhibition boards for the Project were carried out by the consultants, aiming to provide informative displays at the registration point of the four specified seminars. Four sets of five boards were produced for use in different public relations seminars and public hearings. The conclusion highlighted the completion of the exhibition board production and dissemination, reinforcing the consultants' efforts in delivering informative visuals to enhance the seminar and hearing experiences. The exhibition board include: (1) Set 1 Consultants produced and disseminated the 1st set of exhibition boards for use in the 1st public relations seminar and public hearing (2) Set 2 Consultants prepare and disseminate the 2nd set of exhibition boards for use in the 2nd set of public relations seminars and public hearings (3) Set 3 Consultants prepare and disseminate the 3rd set of exhibition boards for use in the 3rd public relations seminar and public hearing (4) Set 4 Consultants prepare and disseminate the 4th set of exhibition boards to be used in the 4th public relations seminar and public hearing.



Figure 4-6 Exhibition boards for the 2nd set of public relations seminars and public hearings

Source: Consultant, 2023

4) Video presentations 7-120

The video presentation has been conducted by the consultants, who studied, collected, and prepared data to produce and disseminate four sets of videos for use in specific public relations seminars and public hearings, each video, described in English and has 3-5 minutes, the video presentation aimed to effectively communicate project data and study results. The comprehensive approach covered diverse aspects, ensuring a nuanced understanding of the project's intricacies and outcomes. The video presentation includes: (1) Video set 1 to be used as part of the 1st public relations seminar and public hearing, (2) Video set 2 to be used as part of the 2nd public relations seminar and public hearing, (3) Video set 3 to be used as part of the 3rd public relations seminar and public hearing, and (4) Video set 4 to be used as part of the 4th public relations seminar and public hearing.



Figure 4-7 Video set 2 to be used as part of the 2nd public relations seminar and public hearing

Source: Consultant, 2023

5) Infographic

The Information for the production and dissemination of project-related infographics was studied, collected, and prepared by the consultants. Four sets of infographics were created, each serving to publicize diverse aspects of the project on the website and fan page. The sets covered topics such as the introduction to M-MAP 2, a comparison of traffic models, the relocation of the train operation center, and the three types of travel data surveyed for model development. The infographics were designed to effectively convey information to a wide audience. The infographic includes: (1) Infographic Set 1 “Introduction to M-MAP 2”, (2) Infographic Set 2 “Traffic Model Comparison”, (3) Infographic Set 3, “Move the train operation center”, and (4) Infographic Set 4, “3 Types of Travel Data Surveyed for Model Development.



Figure 4-8 Infographic 3 "Move the train operation center

Source: Consultant, 2023

6) Work for Media Coverage

The communication and public relations strategies were devised by the consultants, encompassing both mainstream and online media channels. This involved managing media participation in four seminars, disseminating project information. The consultants coordinated with various news outlets, delivering seminar schedules and inviting media coverage. Across the seminars, media attendance varied, reaching 30 attendees during the third seminar. Press releases were meticulously prepared for each seminar, resulting in substantial coverage. The first seminar garnered attention from 14 news media outlets, comprising four print publications and 10 online platforms. The second seminar continued the trend with coverage from 11 news media, including four print publications and seven online sources. Comprehensive post-event summaries were crafted, outlining the outcomes of news dissemination.

In addition to media management, press releases were crafted for the first public relations seminar and public hearing, generating significant coverage. The first seminar, in particular, witnessed dissemination by 14 news media outlets, featuring four print publications and 10 online platforms. Subsequent seminars maintained robust coverage, with the second seminar engaging 11 news media outlets, including four print publications and seven online platforms. The consultants meticulously summarized the results of news dissemination, providing an insightful overview of the project's media outreach achievements.



Figure 4-9 Press release for the first public relations seminar and public hearing

Source: Consultant, 2022

7) Share information on Facebook fan pages

The establishment and management of the Facebook Fan Page titled "M-MAP: Master Plan for Mass Rapid Transit System Development" were undertaken by the consultants, serving as an additional promotional channel for the project. Over the period from September 1, 2021, to July 31, 2023, the fan page was actively supervised, providing essential news and information about the project. During this time, the fan page accumulated 1,531 likes, with 1,525 followers, reaching an audience of 64,240 individuals. The fan page disseminated 20 contents related to project information, and an additional 259 contents were shared, including information and press releases from various news agencies and related fan pages.



Figure 4-10 Content posted on M-MAP2 Facebook fan page

Source: Consultant, 2021

4.3 Educational Event

4.3.1 The First Educational Event

The 1st educational event, conducted on November 24, 2021, at Infinity Ballroom 2, Pullman Bangkok King Power, sought to educate and train officials from the Department of Rail Transport and relevant authorities on the development of mass transit for Phase 2 of the Bangkok Metropolitan Region. The program included presentations on topics, Japan's Rail passenger demand forecast models, models from foreign countries, Activity-Based Model (ABM-Railway-Focused Model), and mass rapid transit usage promotion. With a total of 142 participants, the event followed stakeholder engagement processes, fostering awareness, understanding, and gathering opinions throughout the Study for Development.

In the education session, the rail demand models session, insights from Tokyo's model were shared by Mr. Komori and Dr. Wetwitoo, emphasizing its evolution since 1972 and its impact on policy decisions. Dr. Peerapol highlighted the application of foreign rail-system development to Thailand, incorporating lessons from Japan, Britain, and China. Asst. Prof. Dr. Treerapot's presentation on the "Activity-Based Model" focused on accurate population travel forecasting through detailed analysis of daily activities. The "Promotion of Mass Rapid Transit Usage" session, led by a legal expert, covered measures from Australia and the UK, emphasizing fare discounts and land utilization strategies. Recommendations included establishing a central fund for transport, leveraging a Sovereign Wealth Fund model, and enacting tax laws to support rail development around stations.



Figure 4-11 The first educational event

Source: Consultant, 2021

4.3.2 The Second Educational Event

The 2nd educational event for the rail travel demand forecasting model in Bangkok, held on April 24-25, 2023, educated and trained Department of Rail Transport officials and relevant authorities. With 261 participants, the event covered topics, promoting rail mass transit usage, preparing input data for travel demand models, legal measures, and guidelines for an activity-based model (ABM). The event aimed to engage stakeholders, gather comments, and enhance awareness for the ongoing rail transport development project in Bangkok and its contiguous area during Phase 2.

In the presented content, various experts in the field of transportation and traffic modeling discussed significant measures and developments in the realm of urban mobility. The presenters included Asst. Prof. Dr. Suthipong Meeyai and Asst. Prof. Dr. Teeraphot Siripairoj. Asst. Prof. Dr. Suthipong Meeyai addressed the implementation of environmental conservation tax measures and other initiatives aimed at promoting the use of electric trains, resulting in substantial economic and environmental benefits. On the other hand, Asst. Prof. Dr. Teeraphot Siripairoj delved into the intricacies of activity-based travel demand modeling, utilizing data collection through surveys and mobile phone signals to understand daily travel patterns. The models developed were calibrated using actual survey data from three stations, providing valuable insights into passenger volume and activity positioning for improved urban planning.



Figure 4-12 The second educational event

Source: Consultant, 2023

4.3.3 The Third Educational Event

The 3rd educational event, conducted on July 20 and 21, 2023, aimed to educate officials about the development of the mass transit transport system in Bangkok Metropolitan Region Phase 2. Held at Suranaree University of Technology and Rajamangala University of Technology Isan in Nakhon Ratchasima province, the event covered topics such as the train system connecting Bangkok Apiwat Central Station, the Bangkok-Rangsit Railway System, and upcountry train travel. Courses related to rail systems from both universities were highlighted. Disseminated through electronic media via Zoom Cloud Meeting, the event trained participants in predictive model development for rail transport and travel demand forecasting.

The presentation covered the rail system in Bangkok and contiguous areas, highlighting vital connections like Bangkok Apiwat Central Station and the Bangkok-Rangsit Railway System. Emphasis was placed on the role of the rail network in addressing traffic and pollution issues in the growing city. Details about Bangkok Apiwat Central Station, its design, and connectivity were discussed. The Bangkok-Rangsit Railway System aimed to boost transportation efficiency and business competition. The presentation also touched on current and future developments, including long-distance trains, suburban rail projects, and expansions. Suranaree University of Technology's contribution to rail education, covering disciplines such as Transportation Engineering, was highlighted. Overall, the focus was on the evolving rail transport system's role in sustainable development and convenience in Bangkok.



Figure 4-13 The Third Educational Event

Source: Consultant, 2023

5. UPDATED ACTIVITIES AFTER THE SUBMISSION OF FINAL REPORT FROM DRT CONSULTANT

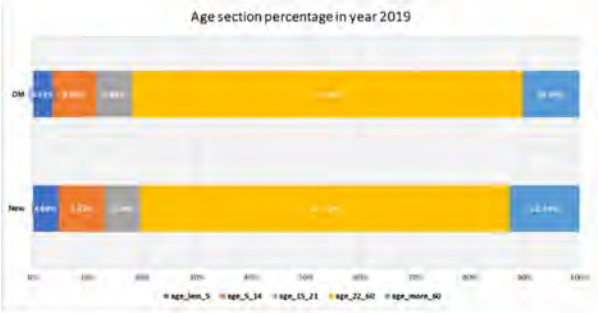
5.1 Background

DRT consultant submitted the Final Report (FR) in September 2023 and the Executive Summary (ES) in December 2023, which was previously discussed in Chapters 1 to 4 of this report. This appendix explains the update beyond the mentioned submission until the final M-MAP2 plan presented in the 5th M-MAP2 platform on February 7, 2024.

5.2 Demand Forecast Model Revision

5.2.1 Revision of Population Assumption

DRT consultant originally assumed non-registered populations estimated by NESDC to be a working population (22-60 years old). However, in the new estimates, DRT consultant assumed non-registered populations to be distributed according to DOPA database, the same as the registered population. With the new assumption, the working-age population was decreased, while the population in other strata was increased. Total population used for calculating trips also decreased as well since the population without trips (0-5 years old) increased. With the new assumption, the trip rates were recalculated as follows:



	Old*	New**
no. of employed (person)	10,382,780	9,934,810
no. of student (person)	2,387,309	2,432,112
no. of unemployed (person)	360,829	341,670
no. WFH (person)	1,315,811	1,245,667
no. elder (person)	1,306,470	1,610,627
Total population	15,753,198	15,564,887
Home to work	10,376,607	10,643,929
Home to school	2,386,333	2,139,324
Home to private_unemployed	275,639	263,566
Home to private_wfh	1,180,817	1,131,114
Home to private_elder	271,746	196,925
Total 12 Purposes	**29,611,605**	**29,446,300**

Figure 5-1 Population estimation result

Table 5-1 Trip rates estimation result

Trip purpose	Production (Origin)		Attraction (Destination)	
	Population Index	Trip Rate	Population Index	Trip Rate
Home to work	The number of populations from 15 years and above, who is employed	1.071	Employment	1.011
Home to school	The number of populations between 5- and 21-year-old	0.880	The number of student seat	0.812
Home to private unemployed	The number of populations between 22- and 60-year-old, who is unemployed	0.771	Employment in service sector	0.042
Home to private WFH	The number of populations between 22- and 60-year-old, who work from home (WFH)	0.908	Employment in service sector	0.179
Home to private elder	The number of populations greater than 60-year-old	0.122	Employment in service sector	0.031
Non home-based to private	Employment	0.037	Employment in service sector	0.061
Work-business	Employment	0.047	Employment	0.047
Work to home	Employment	0.996	The number of populations from 15 years and above, who is employed	1.055
School to home	The number of student seat	0.728	The number of populations between 5- and 21-year-old	0.789
Private to home unemployed	Employment in service sector	0.050	The number of populations between 22- and 60-year-old, who is unemployed	0.929
Private to home WFH	Employment in service sector	0.203	The number of populations between 22- and 60-year-old, who work from home (WFH)	1.029
Private to home elder	Employment in service sector	0.030	The number of populations greater than 60-year-old	0.119

5.2.2 Travel Time Checking and Calibration

As suggested by Japanese Academia, LOS of the link to make precise demand forecasts, especially travel time, should be checked and calibrated properly. For road travel time in the model network, DRT consultant utilized the link average speed from Taxi GPS data given by OTP with some adjustments for the model. Then, DRT performed a comparison of travel time with Google Maps to validate the model network. Travel time from both the model and Google Maps showed similar results.



Figure 5-2 Road link speed in the model network



Figure 5-3 Comparison of road speed with Google Maps (TAZ 257 to 801)

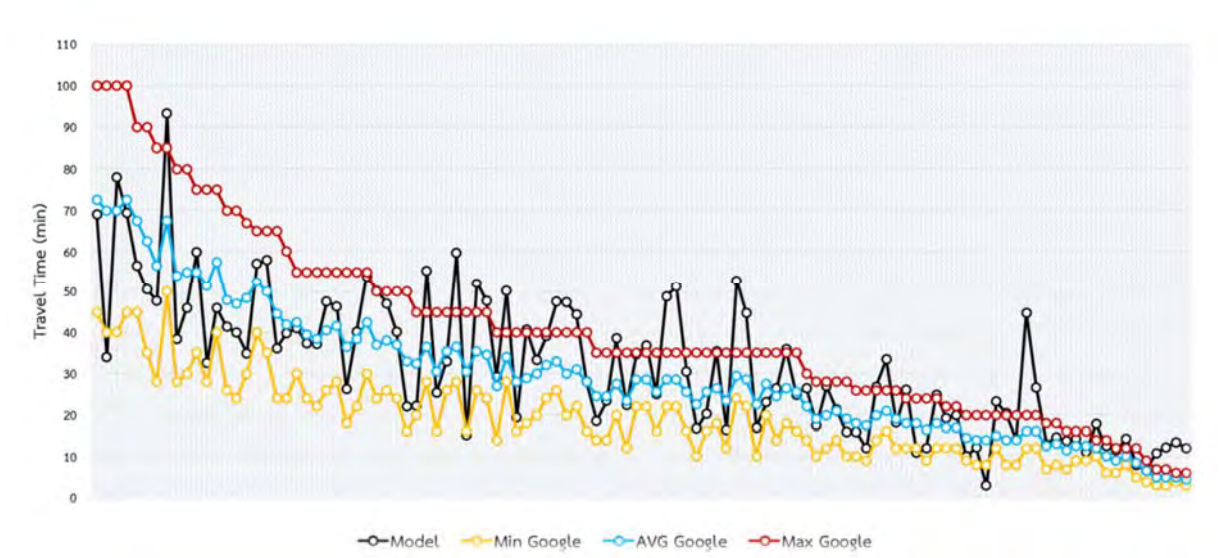


Figure 5-4 Comparison of road speed with Google Maps from selected observations

Note: X-axis indicates selected 100 OD pairs

Although bus and railway travel time in Bangkok provided by Google Maps are, by far, less accurate than the road speed, DRT consultant also performed the comparison of the travel time. The comparison of travel time computed by Google Maps and the model network data (developed based on OTP's network data and GTFS's LOS data) was conducted and the example is shown in the figure below. As a result, there were some differences in travel time, especially for buses in which the network during data extraction (September 2023) was under the reformation process and not reflected in M-MAP2 model (base year 2019). In this case, travel time (as well as routes) from Google Maps was not referenced as road travel time, and the travel time from the model network data was utilized for the demand forecast.



Figure 5-5 Comparison of bus speed with Google Maps (TAZ 257 to 801)

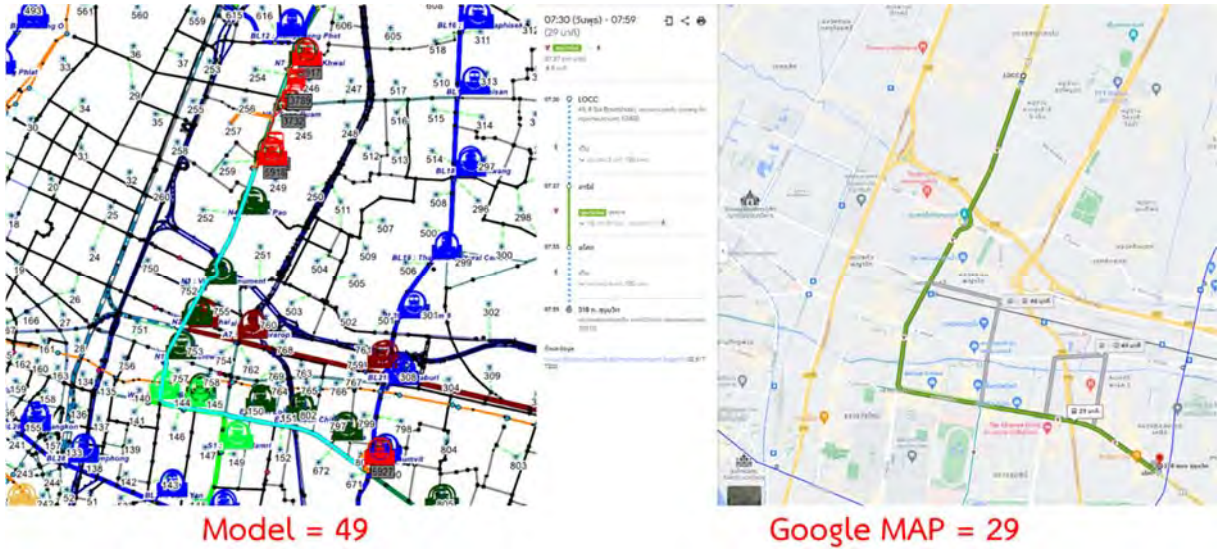


Figure 5-6 Comparison of railway speed with Google Maps (TAZ 257 to 801)

5.2.3 RP Survey Data Screening

As surveys conducted by DRT consultant were collected via tablets with Google API, coordinates of origin and destination can be recorded, and the travel time can be calculated automatically based on Google Maps. With travel time available from Google API, DRT consultant performed a data screening for Mode Choice model by excluding records choosing a car as their mode of travel with unrealistic road travel time response when compared to the range from Google API. Records with more than 60% difference in travel time were excluded from parameter estimation for Mode Choice model.

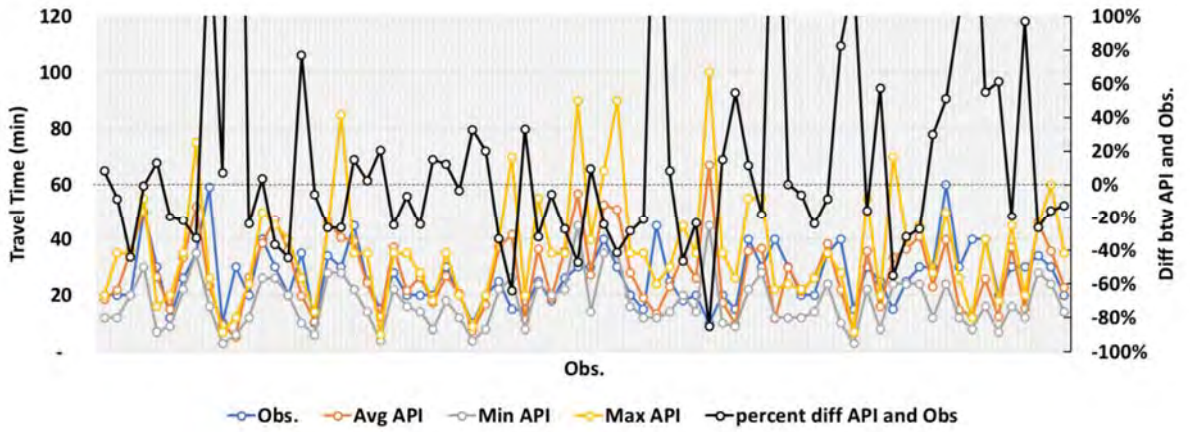


Figure 5-7 Comparison of road speed with Google API from selected observations

Note: X-axis indicates selected 100 OD pairs

Table 5-2 Example of screening records

id	main_mode	origin_taz	dest_taz	travel_time_Obs.	trave_time_API	diff_api_percent
MCS-0011	Car	798	801	5	10	-50%
MCS-0012	Car	1,518	801	50	47	7%
MCS-0013	Car	670	801	15	12	27%
MCS-0014	Car	1,518	800	50	47	7%
MCS-0015	Car	670	800	15	12	27%
MCS-0016	Car	798	800	5	10	-50%
MCS-0017	Car	1,699	491	30	67	-55%
MCS-0018	Car	488	491	15	11	35%
MCS-0019	Car	1,254	491	15	18	-15%
MCS-0020	Car	1,301	491	20	38	-48%
MCS-0021	Car	1,382	353	110	43	155%
MCS-0022	Car	30	494	25	13	86%
MCS-0023	Car	402	491	15	14	7%
MCS-0024	Car	353	23	10	11	-6%
MCS-0025	Car	896	491	30	58	-48%
MCS-0026	Car	1,206	353	20	29	-32%
MCS-0027	Car	403	495	15	14	7%
MCS-0028	Car	23	491	10	11	-6%
MCS-0029	Car	23	495	10	11	-6%
MCS-0030	Car	487	495	15	11	35%
MCS-0031	Car	1,703	1,246	30	67	-55%
MCS-0032	Car	1,206	488	20	29	-32%
MCS-0033	Car	1,201	487	20	29	-32%
MCS-0034	Car	896	1,246	30	58	-48%
MCS-0035	Car	1,382	491	110	43	155%
MCS-0091	Car	984	1,210	5	49	-90%
MCS-0092	Car	1,207	1,203	5	9	-42%
MCS-0093	Car	1,207	1,207	5	9	-42%
MCS-0094	Car	1,217	1,210	20	17	17%
MCS-0095	Car	1,204	1,210	5	7	-27%

5.2.4 Parameter Estimation Checking and Comparison with CTPP No. 198

JET compared parameter estimation between M-MAP2 and CTPP No. 198 estimates. Assuming the average exchange rate across the M-MAP2 Main Mode Choice Survey period (September 6 to November 18, 2022) of 3.885 yen per baht, the time value of time (VOT) for commuting purposes in the CTPP No. 198 model would be 39.3/3.885=10.116 baht/minute. On the other hand, the time value in the M-MAP2 model is 3.39 baht/minute, which is almost 3 times lower. Considering that the cost of living in Tokyo is about 2 to 3 times higher than in Bangkok, the VOT estimate in M-MAP2 is reasonable.

Table 5-3 Comparison of parameter estimation result in the Mode Choice Model

		CTPP No.198 (2016)		M-MAP2 (2023)	
		Estimate	t-stat	Estimate	t-stat
Alternative Specific Constants (Car as a reference alternative)	MC			0.074	0.193
	Bus	-0.773	-7.65	1.44	3.188
	Rail	2.82	21.8	4.219	14.721
Travel Time (min)		-0.0482	-18.2	-0.063	-3.919
SD Travel Time				0.03	2.602
Travel Cost (CTPP No.198:Yen, M-MAP2:Baht)		-0.00123	-10.4	-0.018	-4.071
Vehicle Ownership	Car	1.13	7.23	3.825	13.305
	MC			2.372	9.835
Central Business District Dummy	Car	-1.72	-21.3		
Short Distance Trip Dummy	Car	0.665	6.13	1.494	4.537
	MC			3.597	10.599
Station Accessibility Log-Sum-Exp	Rail	0.446	33.6	0.802	6.541
Sample Size		9,763		2,549	
Value of Time (Yen/min)		**39.3**			
Value of Time (Baht/min)		**10.12**		**3.39**	

Note:
1. Estimates from both masterplans were based on RP data
2. Estimates shown in the figure are for commuting trip purposes.
3. CTPP No. 198 estimates refer to the population group from 0-64 years old, while M-MAP2 estimates were pooled from all ages.
4. Travel Time in M-MAP2 model was assumed to be normally distributed. Hence, Standard Deviation (Sigma) Travel Time represents the normal distribution standard deviation, and VOT can be computed directly from the Travel Time estimate.

Estimates and value of time of Route Assignment model and Station Access model from M-MAP2 and CTPP No. 198 were in a similar range as well, suggesting no unrealistic estimates in M-MAP2.

Table 5-4 Comparison of parameter estimation result in the Station Access model

	CTPP No.198 (2016)		M-MAP2 (2023)			
	Estimate	t-stat	Parameter		SD	
			Estimate	t-stat	Estimate	t-stat
Waiting Time (min)	-0.145	-4.24	-0.245	-5.043	0.129	3.304
Boarding Time (min)	-0.151	-7.35	-0.211	-3.067	0.117	4.652
Horizontal Transfer Time (min)	-0.242	-6.54	-0.363	-3.021	0.104	3.055
Vertical Transfer Time (min)	-0.313	-4.77	-0.470	-6.015	0.139	7.038
In-Train Congestion	-0.0122	-2.50	-0.018	-5.150		
Fare (CTPP No.198:Yen, M-MAP2:Baht)	-0.00355	-3.89	-0.070	-14.273		
Station Accessibility Log-Sum-Exp	0.883	12.7	1.766	3.284		
Sample Size	1,000		12,456			
VOT Waiting (Baht/min)	**10.47**		**3.50**			
VOT Boarding (Baht/min)	**10.97**		**3.01**			
VOT Horizontal Transfer (Baht/min)	**17.58**		**5.18**			
VOT Vertical Transfer (Baht/min)	**22.67**		**6.71**			

Note:
1. CTPP No. 198 estimates were based on RP data, while M-MAP2 were based on SP data
2. CTPP No. 198 estimates refer to estimates for commuting trips from the population 0-64 years old, while M-MAP2 estimates were from SP data, resulting in pooled samples from all ages and trip purposes.
3. Travel Time in M-MAP2 model was assumed to be normally distributed. Hence, Sigma Travel Time represents the normal distribution standard deviation, and VOT can be computed directly from the Travel Time estimate.

Table 5-5 Comparison of parameter estimation result in the Station Access model

		CTPP No.198 (2016)		M-MAP2 (2023)	
		Estimate	t-stat	Estimate	t-stat
Alternative Specific Constants (Walk as a reference alternative)	MC	-3.02	-32.9	-2.266	-34.879
	Bus	-4.58	-17.9	-4.101	-35.381
	Car	-6.78	-33.6	-2.802	-25.420
Travel Time (min)	Walk, MC	-0.220	-26.7	-0.091	-29.547
	Bus, Car	-0.0911	-7.45	-0.032	-5.419
SD Travel Time	Walk, MC			0.000	0.000
	Bus, Car			0.000	0.000
Travel Cost (CTPP No.198:Yen, M-MAP2:Baht)		-0.00603	-9.62	-0.020	-7.937
Elevation Difference (m)	Walk, MC	-0.0107	-4.13		
Bus Frequency (ln frequency/hr)	Bus	0.287	6.22		
Sample Size		3,000		10,094	

Note:
1. Estimates from both masterplans were based on RP data
2. CTPP No. 198 estimates refer to estimates for commuting trips from the population 0-64 years old, while M-MAP2 estimates were from SP data, resulting in pooled samples from all ages and trip purposes.
3. CTPP No. 198 grouped bicycles with MC (as two-wheeler vehicles), however, M-MAP2 grouped bicycles with walking (as non-motorized vehicles).

Note that M-MAP2 also estimated transport hub access parameters although JET would like to omit the comparison due to significant differences in model structure. For instance, CTPP No. 198 estimated parameters by transport hub type (Airport international flights, Airport domestic flights, HSR stations), by trip purpose/nationality, and by travel direction (access/egress). For airports, ASC was specified by Haneda or Narita airport separately. However, M-MAP2 estimated parameters by pooling all transport hubs (Airports, Bus terminals, Intercity railway station) together without consideration of trip purpose or travel direction. CTPP No. 198 allowed Car, Bus, and Rail as access modes (personal cars and taxis separated in HSR station access) while M-MAP2 additionally allowed MC as an access mode for the locals.

Furthermore, CTPP No. 198 has specific parameters for Railway Route Assignment model by transport hub type, while M-MAP2 assigned all railway trips from main and sub-models in a single Railway Route Assignment model. Estimates from CTPP No. 198 and M-MAP2 are shown below.

Table 5-6 Parameter estimates from Mode Choice model for transport hub access (CTPP No. 198)

			Japanese - Business Trip		Japanese - Leisure Trip		Foreigner	
			Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
ASC (Rail as a reference alternative)	Haneda Airport	Bus	-1.25	-5.24	-1.49	-7.04	-2.96	-15.1
		Car	-1.81	-11.5	-1.27	-10.2	-1.23	-10.7
	Narita Airport	Bus	-0.489	-1.93	-1.06	-4.73	-2.06	-10.7
		Car	-1.57	-7.04	-1.05	-5.98	-0.913	-6.31
Travel Time (min)		Car, Bus	-0.0193	-8.07	-0.0157	-7.65	-0.0177	-9.70
Travel Cost (Yen)		Car, Bus	-0.000207	-4.44	-0.000253	-7.22	-0.000298	-10.0
Number of Transfers		Bus	-0.942	-8.58	-0.853	-8.18	-0.935	-9.86
Bus Frequency (ln no. of bus/hr)		Bus	0.312	5.80	0.252	5.15	0.811	16.5
Travel Time Reliability (min)		Car, Bus	-0.0460	-2.02	-0.0323	-1.60	-0.0665	-3.64
Transport Hub Accessibility Log-Sum-Exp		Rail	0.459	12.2	0.526	13.8	0.533	18.9
Sample Size			3,255		4,085		7,340	

Note:
1. Estimates were based on RP data.
2. Only estimates for Airport access/egress for international flights are shown.
3. Travel time reliability parameter is a standard deviation of road link travel time estimated from link congestion rate and link distance by road type. Please see CTPP No. 198 Demand Forecast Technical Report for detailed information.
4. Unlike the main model, transport hub access log-sum-exp was calculated based on the parameters in transport hub access's Railway Route Assignment model (as shown in the next table).

Table 5-7 Parameter estimates from Railway Route Assignment model for transport hub access (CTPP No. 198)

		Japanese - Business Trip		Japanese - Leisure Trip		Foreigner	
		Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Travel Time (min) (boarding time on a local train, transfer time, waiting time)	All sections except Keisei Skyliner, JR Narita Express	-0.0624	-15.7	-0.0498	-13.2	-0.0551	-23.9
Boarding Time (min)	Keisei Skyliner, JR Narita Express	-0.0132	-2.36	-0.00538	-1.10	-0.0124	-3.42
Travel Cost (Yen)		-0.000648	-3.67	-0.00106	-6.71	-0.000761	-7.03
Number of Transfers		-0.391	-7.00	-0.309	-5.86	-0.338	-8.91
Narita & Keisei Dummy	Route using Keisei Higashi-Narita Line	2.07	7.35	1.57	5.65	1.74	9.86
Narita & JR Dummy	Route using JR Airport Branch Line	2.43	6.28	1.74	4.58	2.01	8.40
Sample Size		1,975		2,011		3,986	

Note:
1. Estimates were based on RP data.
2. Only estimates for Airport access/egress for international flights are shown.
3. Alternatives were fixed by each airport. Haneda airport has two alternatives (Tokyo Monorail, Keikyu Airport Line). Narita airport has four alternatives (Keisei Skyliner, Keisei non-reserved seat train, JR Narita Express, JR non-reserved seat train). Hence, to calculate the utility of a route to/from Narita airport using both non-reserved (local) train and reserved seat train (Keisei Skyline or JR Narita Express), boarding time on non-reserved seat train and reserved seat train will be separately considered by first two parameters.

Table 5-8 Parameter estimates from Mode Choice model for transport hub access (M-MAP2)

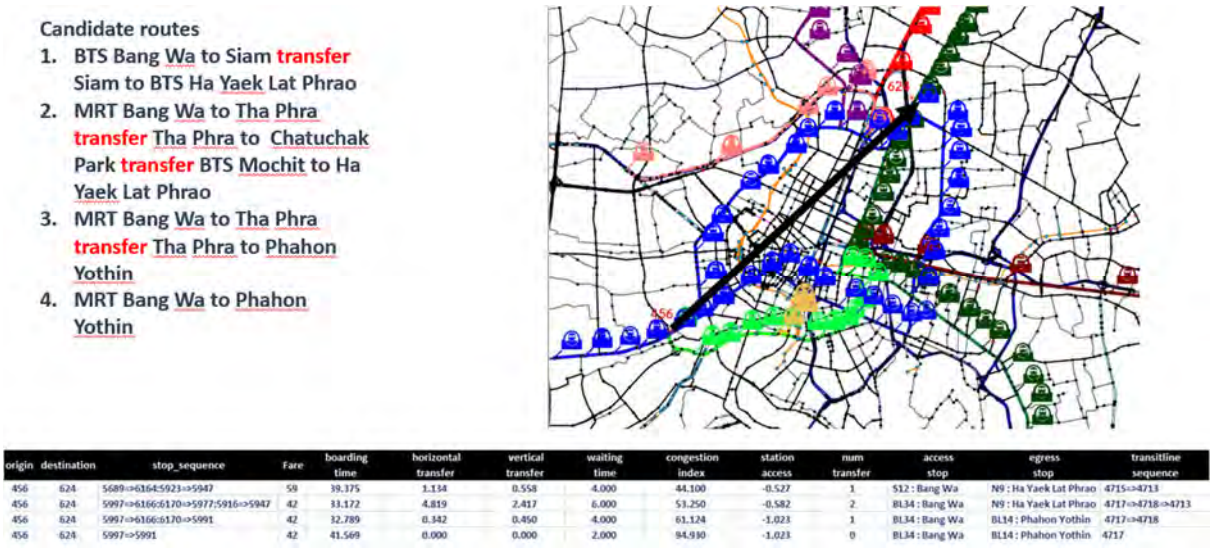
		Thai		Foreigner	
		Estimate	t-stat	Estimate	t-stat
Alternative Specific Constants (Car as a reference alternative)	MC	-1.928	-6.068		
	Bus	-0.115	-1.485	-6.507	-2.610
	Rail	0.763	2.327	-8.598	-2.672
Travel Time (min)		-0.073	-3.728	-0.149	-1.921
SD Travel Time		0.038	2.876	0.061	1.583
Travel Cost (Baht)		-0.016	-3.384	-0.018	-1.550
Vehicle Ownership	Car	2.097	8.381		
	MC	0.712	2.801		
Short Distance Trip Dummy	MC	1.816	6.778		
Station Accessibility Log-Sum-Exp	Rail	1.091	4.475		
Sample Size		1,161		610	

Note:

1. Estimates were based on RP data.
2. Estimates were pooled from all transport hubs (airports, bus terminals, Bang Sue station).
3. Foreigners were not allowed to use MC as an access mode.
4. Travel Time in M-MAP2 model was assumed to be normally distributed. Hence, Sigma Travel Time represents the normal distribution standard deviation, and VOT can be computed directly from the Travel Time estimate.
5. For detailed information, please refer to CTPP No. 198 Reports (in Japanese): https://www.mlit.go.jp/policy/shingikai/tetsudo01_sg_000261.html
6. M-MAP2 Final Report (in English, Thai): http://mmap2.drt.go.th/

5.2.5 Railway Route Choice Checking

DRT consultant conducted extensive auditing on the railway route choice algorithm to ensure logical selection of candidate routes for railway route distribution. This verification process involved confirming candidate routes generated by the demand forecast software (OmniTrans) and comparing them with routes selected by Google Maps. The majority of comparisons indicated similar route choices between Google Maps and the software, with exceptions noted for some ODs where one trip-end was outside Bangkok's build-up area, as depicted in the figure below.



origin	destination	stop_sequence	Fare	boarding time	horizontal transfer	vertical transfer	waiting time	congestion index	station access	num transfer	access stop	egress stop	transitline sequence
456	624	5689=>6164:5923=>5947	59	39.375	1.134	0.558	4.000	44.100	-0.527	1	S12 : Bang Wa	N9 : Ha Yaek Lat Phrao	4715=>4713
456	624	5997=>6166:6170=>5977:5916=>5947	42	33.172	4.819	2.417	6.000	53.250	-0.582	2	BL34 : Bang Wa	N9 : Ha Yaek Lat Phrao	4717=>4718=>4713
456	624	5997=>6166:6170=>5991	42	32.789	0.342	0.450	4.000	61.124	-1.023	1	BL34 : Bang Wa	BL14 : Phahon Yothin	4717=>4718
456	624	5997=>5991	42	41.569	0.000	0.000	2.000	94.930	-1.023	0	BL34 : Bang Wa	BL14 : Phahon Yothin	4717

Figure 5-8 Confirming candidate routes generated by software (TAZ 456 to 624)

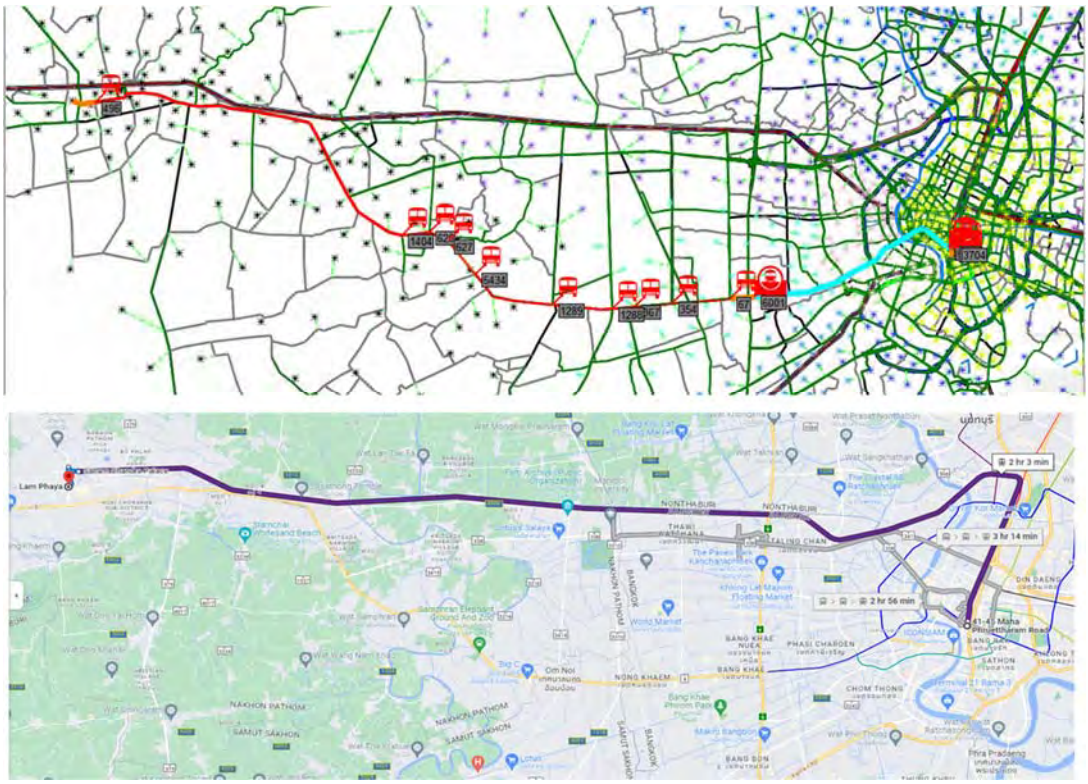


Figure 5-9 TAZ 52 to 1743, Confirming candidate routes generated by software (top) and Google Maps (bottom)

Note: Google Maps suggested using SRT suburban train, which is unrealistic and not to be considered in M-MAP2. M-MAP2 model suggested using a bus, then transferring the Blue line.

5.2.6 Reproduction and Railway OD Calibration

Before model calibration, reproduction results of railway passengers by section (station-to-station) were not promising. Overestimation was found in the suburban area, while underestimation was found in CBD. An example of a reproduction result before the calibration is shown below.

Next, discussions among DRT consultant, JET, and academia centered on addressing potential factors contributing to low reproducibility before calculations. It was noted that the absence of data on the movement of foreign tourists in OTP's travel survey (2022 BTDS) could lead to underestimation of trips, especially in CBD areas with significant tourist activity. In response, DRT consultant initiated a small-scale survey at major railway stations in Bangkok to gather data on the number of tourists and their destination stations. This information enabled DRT consultant to estimate station OD tables for tourists and incorporate these trip ODs into the original station OD dataset.

Next, DRT consultant pointed out that, estimated station OD from the survey data were not reliable as OTP's travel survey contains very low sample size for railway users (about 3%). The problem was more significant in small stations as there was no sample in some OD pairs. DRT also conducted their additional railway survey; however, the survey was conducted only in some selected stations so station OD table cannot be estimated based on this data. Since the most reliable railway passenger data that DRT has is station OD table obtained from railway operators (Two Green lines from BTSC, Blue and Purple lines from BEM, and ARL from SRTET), it was suggested converting station OD table to rail-TAZ OD table (OD table of rail user by TAZ) as shown in the figure below.

Table 5-9 Reproduction result of Green Sukhumvit line before the calibration

Daily Line Loaded	Direction E23 to N8			Direction N8 to E23		
	Model	Obs.	Diff	Model	Obs.	Diff
E23 : Kheha	5,271	4,619	14%	0	0	0%
E22 : Sai Luat	14,300	5,614	155%	4,877	4,211	16%
E21 : Phraek Sa	20,334	9,106	123%	12,418	4,928	152%
E20 : Srinagarindra	30,753	10,580	191%	17,966	8,492	112%
E19 : Pak Nam	51,722	12,688	308%	29,168	9,524	206%
E18 : Royal Thai Naval Academy	53,444	13,998	282%	42,619	11,743	263%
E17 : Chang Erawan	59,852	15,665	282%	44,272	12,956	242%
E16 : Pu Chao	60,071	17,037	253%	47,753	14,396	232%
E15 : Samrong	59,732	26,467	126%	46,523	15,564	199%
E14 : Bearing	62,844	40,990	53%	44,223	24,668	79%
E13 : Bang Na	59,210	51,883	14%	46,756	36,915	27%
E12 : Udom Suk	60,447	71,362	-15%	48,003	42,693	12%
E11 : Punnawithi	69,339	79,969	-13%	54,153	60,527	-11%
E10 : Bang Chak	79,028	85,712	-8%	64,994	69,164	-6%
E9 : On Nut	84,843	106,491	-20%	72,360	73,336	-1%
E8 : Phra Khanong	95,702	115,637	-17%	83,981	94,805	-11%
E7 : Ekkamai	104,645	124,974	-16%	109,149	103,667	5%
E6 : Thong Lo	106,262	133,367	-20%	106,961	115,277	-7%
E5 : Phrom Phong	104,874	140,887	-26%	110,652	123,474	-10%
E4 : Asok	82,066	139,312	-41%	110,156	133,587	-18%
E3 : Nana	77,582	139,089	-44%	85,741	132,118	-35%
E2 : Phloen Chit	78,490	140,666	-44%	81,679	134,139	-39%
E1 : Chit Lom	77,477	133,301	-42%	83,149	136,557	-39%
CEN : Siam	66,711	120,737	-45%	83,494	133,047	-37%
N1 : Ratchathewi	66,316	115,498	-43%	70,713	122,842	-42%
N2 : Phaya Thai	60,257	103,780	-42%	68,788	117,721	-42%
N3 : Victory Monument	45,102	71,869	-37%	58,455	104,931	-44%
N4 : Sanam Pao	39,256	69,135	-43%	42,970	77,800	-45%
N5 : Ari	36,605	57,576	-36%	42,561	74,391	-43%
N6 : Sena Ruam	36,605	57,576	-36%	32,978	61,964	-47%
N7 : Saphan Khwai	21,901	49,042	-55%	32,978	61,964	-47%
N8 : Mo Chit	0	0	0%	25,720	54,002	-52%
			MAPE 76%			MAPE 66%

Note: Base year is 2019, hence, north extensions opened after 2019 were not included in the validation process.

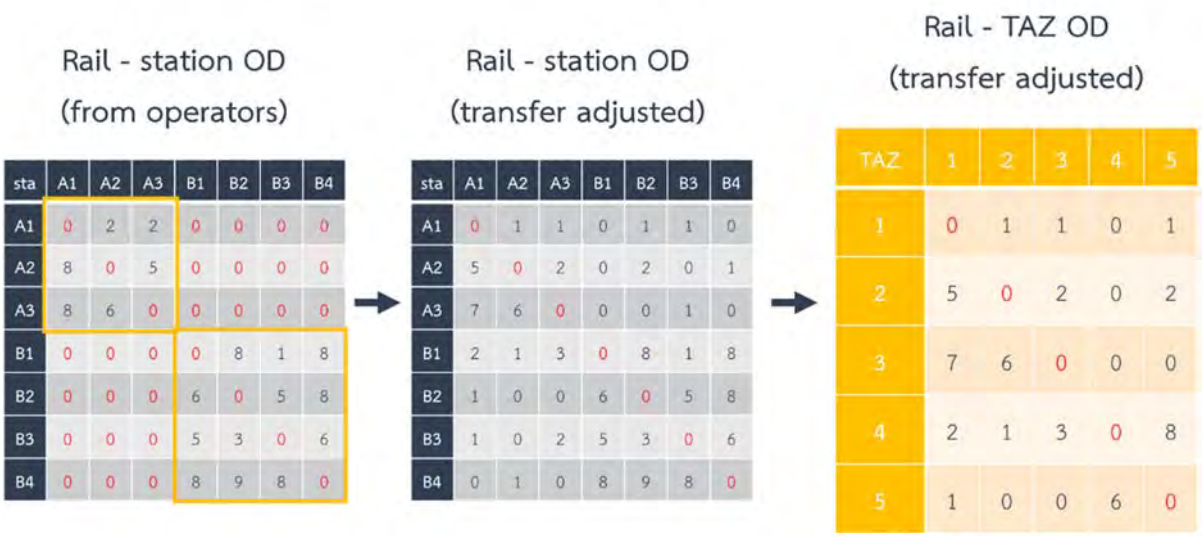


Figure 5-10 Example of backward conversion flow from station OD table to rail-TAZ OD table

However, it should be noted that as actual station OD tables are separately provided by operators, hence no trip OD between a pair of stations from different operators. To solve this problem, DRT consultant adjusted transfer passengers based on the data from their additional railway survey. The transfer ratio of each station was calculated from survey data, then, as there is no station with more than two lines connected, transfer passengers can be carried over 100% to the connected line.

Table 5-10 Transfer ratios in 10 stations (5 pairs)

NAME	transfer_pax	terminal_pax	tranfer + terminal	transfer_ratio
A6 : Makkasan	14	260	274	5.11%
A8 : Phaya Thai	41	80	121	33.88%
BL13 : Chatuchak Park	30	55	85	35.29%
BL21 : Phetchaburi	9	109	118	7.63%
BL22 : Sukhumvit	10	55	65	15.38%
BL26 : Si Lom	6	20	26	23.08%
E4 : Asok	10	399	409	2.44%
N2 : Phaya Thai	41	115	156	26.28%
N8 : Mo Chit	26	37	63	41.27%
S2 : Sala Daeng	4	157	161	2.48%
Average	191	1287	1478	**12.92%**

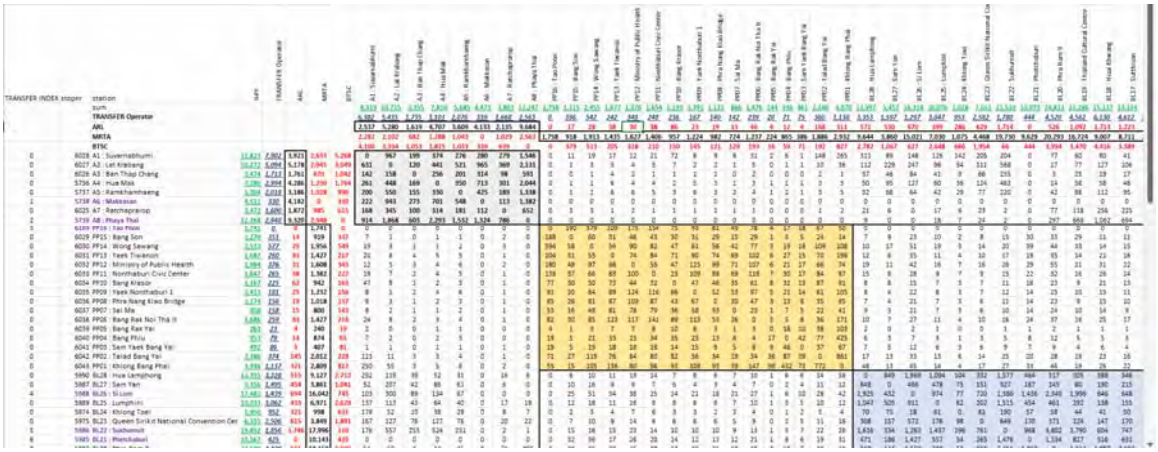


Figure 5-11 Adjusted station OD table

After that, the adjusted station OD table will be converted to rail-TAZ OD table based on the weighted indices of station access/egress log-sum-exp, number of population, and number of employments as shown in the procedure below.

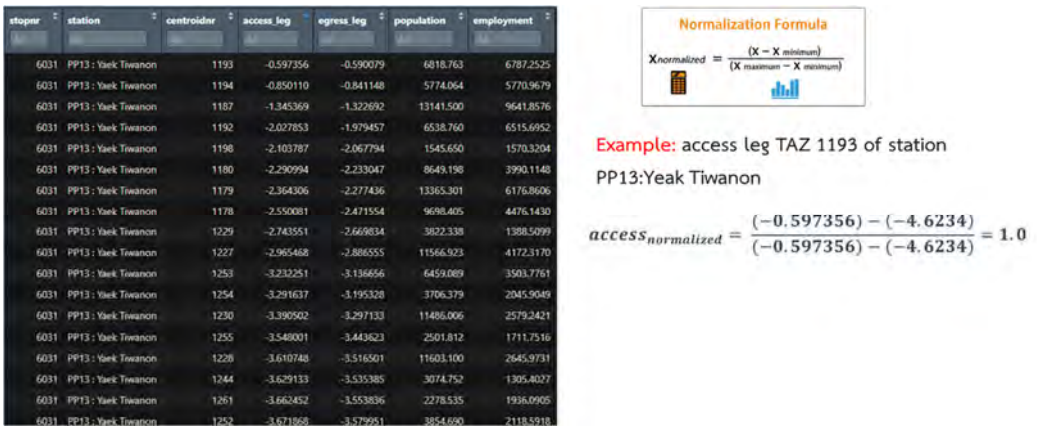


Figure 5-12 Calculation of normalization index of TAZ's access/egress, population and employment

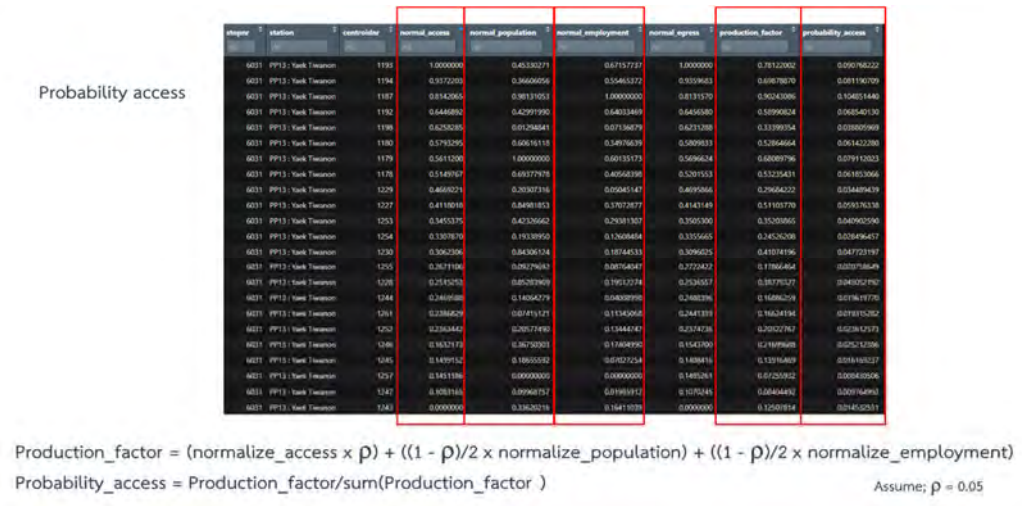


Figure 5-13 Calculation of probability of accessing each TAZ

Note: Probability of egressing from each TAZ was also calculated by the same method.

Table 5-11 Distribution of station OD trip to rail-TAZ OD trip

stopnra	stopnrb	trip	station_origin	centroidnr	production_factor	probability_access	station_dest	centroidnr	attraction_factor	probability_egress	trip_final
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	671	0.55	0.13	1.35
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	672	0.48	0.12	1.16
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	677	0.42	0.10	1.03
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	797	0.40	0.10	0.97
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	800	0.58	0.14	1.41
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	801	0.67	0.16	1.63
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	805	0.45	0.11	1.09
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	798	0.26	0.06	0.64
6031	5986	162	PP13 : Yaek Tiwanon	1178	0.53	0.06	BL22 : Sukhumvit	799	0.30	0.07	0.73
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	671	0.55	0.13	1.72
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	672	0.48	0.12	1.49
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	677	0.42	0.10	1.32
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	797	0.40	0.10	1.24
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	800	0.58	0.14	1.80
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	801	0.67	0.16	2.09
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	805	0.45	0.11	1.40
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	798	0.26	0.06	0.82
6031	5986	162	PP13 : Yaek Tiwanon	1179	0.68	0.08	BL22 : Sukhumvit	799	0.30	0.07	0.94
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	671	0.55	0.13	1.34
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	672	0.48	0.12	1.15
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	677	0.42	0.10	1.02
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	797	0.40	0.10	0.96
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	800	0.58	0.14	1.40
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	801	0.67	0.16	1.62
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	805	0.45	0.11	1.09
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	798	0.26	0.06	0.64
6031	5986	162	PP13 : Yaek Tiwanon	1180	0.53	0.06	BL22 : Sukhumvit	799	0.30	0.07	0.73
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	671	0.55	0.13	2.29
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	672	0.48	0.12	1.97
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	677	0.42	0.10	1.75
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	797	0.40	0.10	1.64
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	800	0.58	0.14	2.38
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	801	0.67	0.16	2.77
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	805	0.45	0.11	1.86
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	798	0.26	0.06	1.09
6031	5986	162	PP13 : Yaek Tiwanon	1187	0.90	0.10	BL22 : Sukhumvit	799	0.30	0.07	1.24
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	671	0.55	0.13	1.49
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	672	0.48	0.12	1.29
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	677	0.42	0.10	1.14
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	797	0.40	0.10	1.07
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	800	0.58	0.14	1.56
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	801	0.67	0.16	1.81
6031	5986	162	PP13 : Yaek Tiwanon	1192	0.59	0.07	BL22 : Sukhumvit	805	0.45	0.11	1.21

Zone OD trip = station OD trip x Probability_access x Probability_egress

Reproduction results were improved as shown in the example below.

Table 5-12 Reproduction result of Green Sukhumvit line after the calibration

Daily Line Loaded	Direction E23 to N8					Direction N8 to E23				
	Model	Obs.	Diff			Model	Obs.	Diff		
E23 : Kheha	4,616	4,619	-3	0%		0	0	0	0%	
E22 : Sai Luat	5,613	5,614	-1	0%		4,208	4,211	-3	0%	
E21 : Phraek Sa	9,122	9,106	16	0%		4,927	4,928	-1	0%	
E20 : Srinagarindra	10,618	10,580	38	0%		8,507	8,492	15	0%	
E19 : Pak Nam	12,709	12,688	21	0%		9,566	9,524	42	0%	
E18 : Royal Thai Naval Academy	13,990	13,998	-8	0%		11,768	11,743	25	0%	
E17 : Chang Erawan	15,639	15,665	-26	0%		12,952	12,956	-4	0%	
E16 : Pu Chao	16,990	17,037	-47	0%		14,374	14,396	-22	0%	
E15 : Samrong	26,544	26,467	77	0%		15,521	15,564	-43	0%	
E14 : Bearing	40,845	40,990	-145	0%		24,688	24,668	20	0%	
E13 : Bang Na	51,510	51,883	-373	-1%		36,739	36,915	-176	0%	
E12 : Udom Suk	71,257	71,362	-105	0%		42,296	42,693	-397	-1%	
E11 : Punnawithi	79,854	79,969	-115	0%		60,335	60,527	-192	0%	
E10 : Bang Chak	85,545	85,712	-167	0%		68,963	69,164	-201	0%	
E9 : On Nut	106,179	106,491	-312	0%		73,187	73,336	-149	0%	
E8 : Phra Khanong	115,243	115,637	-394	0%		94,451	94,805	-354	0%	
E7 : Ekkamai	123,536	124,974	-1,438	-1%		103,257	103,667	-410	0%	
E6 : Thong Lo	132,793	133,367	-574	0%		113,660	115,277	-1,617	-1%	
E5 : Phrom Phong	139,720	140,887	-1,167	-1%		122,874	123,474	-600	0%	
E4 : Asok	134,868	139,312	-4,444	-3%		132,371	133,587	-1,216	-1%	
E3 : Nana	134,218	139,089	-4,871	-4%		128,145	132,118	-3,973	-3%	
E2 : Phloen Chit	134,731	140,666	-5,935	-4%		129,667	134,139	-4,472	-3%	
E1 : Chit Lom	125,180	133,301	-8,121	-6%		131,039	136,557	-5,518	-4%	
CEN : Siam	118,257	120,737	-2,480	-2%		124,580	133,047	-8,467	-6%	
N1 : Ratchathewi	112,804	115,498	-2,694	-2%		120,783	122,842	-2,059	-2%	
N2 : Phaya Thai	101,169	103,780	-2,611	-3%		115,351	117,721	-2,370	-2%	
N3 : Victory Monument	70,169	71,869	-1,700	-2%		102,106	104,931	-2,825	-3%	
N4 : Sanam Pao	67,415	69,135	-1,720	-2%		75,798	77,800	-2,002	-3%	
N5 : Ari	55,712	57,576	-1,864	-3%		72,405	74,391	-1,986	-3%	
N6 : Sena Ruam	55,712	57,576	-1,864	-3%		59,766	61,964	-2,198	-4%	
N7 : Saphan Khwai	47,202	49,042	-1,840	-4%		59,766	61,964	-2,198	-4%	
N8 : Mo Chit	0	0	0	0%		51,754	54,002	-2,248	-4%	

Future railway passenger forecasts can be made by first calculating the difference between the converted rail-TAZ OD table and the rail-TAZ OD table estimated from the model in the base year. Next, this difference from the base year is added to the model-forecasted rail-TAZ OD table for the future year, resulting in the future station OD table.

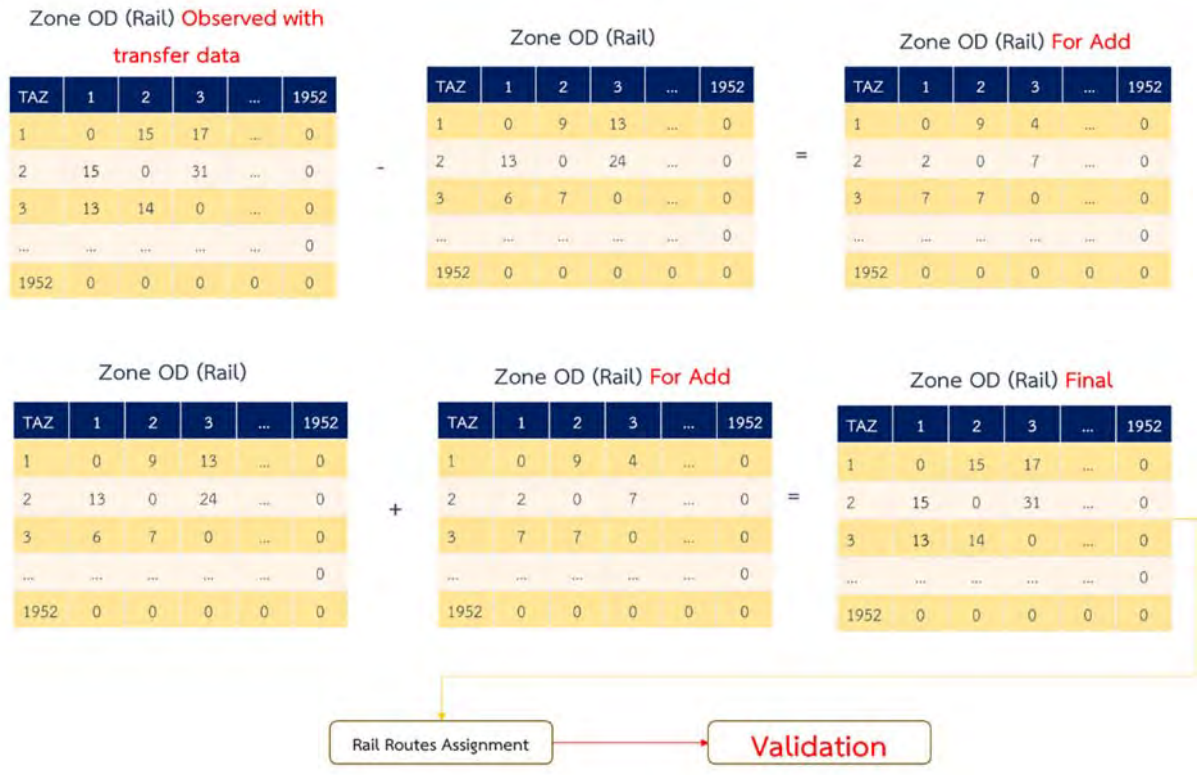


Figure 5-14 Procedure for future forecast (upper: base year, lower: future year)

5.2.7 New Capacity Assumption

As suggested by Japanese Academia, capacity improvement of the congested lines should be considered before new line investments. In response to the comment, capacity parameters of the plans with a congestion rate higher than 150% in the initial analysis will be enhanced to the maximum capacity and reanalyzed. Capacity enhancement was assumed through increasing service frequency and the number of cars per train. Based on this assumption, the new investment prioritization result (next section) was obtained.

Table 5-13 Capacity parameters and congestion rate in the initial analysis

Routes with excess capacity (Congestion Rate >150%)

- Airport Rail Link
- Green Line Sukhumvit
- Green Line Silom
- Blue Line
- Orange Line
- Pink Line
- Grey Line
- Cyan Line

LINE	Section	Frequency	Headway (mins.)	pax/car	no. of car	pax/train	Capacity (pax/h/dir)	Max Congestio
Red North-South	Bang Sue - Rangsit	6	10	193	6	1158	6,948	52
	Bang Sue - Hua Lamphong (P01)	*6*	*10*	*193*	*6*	*1158*	*6,948*	145
	Wongwain Yai - Bang Bon (P03)	*6*	*10*	*193*	*6*	*1158*	*6,948*	35
Red East-West	Bang Sue - Taling Chan	6	10	193	4	772	4,632	17
ARL	Phaya Thai - Suvarnabhumi	6	10	193	4	772	4,632	209
Green Sukhumvit	Khukhot - Kheha	15	4	193	4	772	11,580	276
	Khukhot - Outer Ring Road (P10)	*15*	*4*	*193*	*4*	*772*	*11,580*	70
Green Silom	National Stadium - Bang Wa	15	4	193	4	772	11,580	151
	National Stadium - Yotse (P01)	*15*	*4*	*193*	*4*	*772*	*11,580*	146
	Bang Wa - Taling Chan (P08)	*15*	*4*	*193*	*4*	*772*	*11,580*	44
	Taling Chan - Rattanathibet (P09)	*15*	*4*	*193*	*4*	*772*	*11,580*	40
Gold	Khlong San - Krung Thonburi	6	10	107	2	214	1,284	137
	Klong San - Prachatipok (P11)	*6*	*10*	*107*	*2*	*214*	*1,284*	87
Blue	Tha Phra - Lak Song	15	4	193	3	579	8,685	186
Purple	Khong Bang Phai - Tao Poon	10	6	193	3	579	5,790	132
	Tao Poon - Kru Nai	10	6	193	3	579	5,790	50
Orange	Bang Khun Non - Yeak Rom Klao	10	6	193	3	579	5,790	206
Yellow	Lat Phrao - Samrong	10	6	112	4	448	4,480	78
Pink	Nonthaburi Civic Center - Min Buri	10	6	112	4	448	4,480	227
	Sirat - Muang Thong Thani Lake	10	6	112	4	448	4,480	11
Gray	*Watchaphon - Thonglor (P02)*	*10*	*6*	*112*	*4*	*448*	*4,480*	177
	Phra Khanong - Tha Phra (P07)	*10*	*6*	*112*	*4*	*448*	*4,480*	45
	LamLukKa - Watcharaphon (P10)	*10*	*6*	*112*	*4*	*448*	*4,480*	62
Cyan	*Sathon – Din Daeng (P04)*	*10*	*6*	*112*	*4*	*448*	*4,480*	163
Silver	*Bangna – Suvarnabhumi (P06)*	*10*	*6*	*112*	*4*	*448*	*4,480*	37
Brown	*Khae Rai - Bueng Kum (P05)*	*10*	*6*	*112*	*4*	*448*	*4,480*	88

Table 5-14 Capacity parameters and congestion rate in the final analysis

Enhanced Capacity in

- Airport Rail Link
- Green Line Sukhumvit
- Green Line Silom
- Blue Line
- Orange Line
- Pink Line
- Grey Line
- Cyan Line

LINE	Section	Frequency	Headway (mins.)	pax/car	no. of car	pax/train	Capacity (pax/h/dir)	Max
Red North-South	Bang Sue - Rangsit	6	10	193	6	1158	6,948	52
	Bang Sue - Hua Lamphong (P01)	*6*	*10*	*193*	*6*	*1158*	*6,948*	145
	Wongwain Yai - Bang Bon (P03)	*6*	*10*	*193*	*6*	*1158*	*6,948*	35
Red East-West	Bang Sue - Taling Chan	6	10	193	4	772	4,632	17
ARL	Phaya Thai - Suvarnabhumi	10	6	193	4	772	7,720	135
Green Sukhumvit	Khukhot - Kheha	24	2.5	193	6	1158	27,792	117
	Khukhot - Outer Ring Road (P10)	*24*	*2.5*	*193*	*6*	*1158*	*27,792*	70
Green Silom	National Stadium - Bang Wa	20	3	193	4	772	15,440	111
	National Stadium - Yotse (P01)	*20*	*3*	*193*	*4*	*772*	*15,440*	110
	Bang Wa - Taling Chan (P08)	*20*	*3*	*193*	*4*	*772*	*15,440*	33
	Taling Chan - Rattanathibet (P09)	*15*	*4*	*193*	*4*	*772*	*11,580*	40
Gold	Khlong San - Krung Thonburi	6	10	107	2	214	1,284	137
	Klong San - Prachatipok (P11)	*6*	*10*	*107*	*2*	*214*	*1,284*	87
Blue	Tha Phra - Lak Song	20	3	193	3	579	11,580	140
Purple	Khong Bang Phai - Tao Poon	10	6	193	3	579	5,790	132
	Tao Poon - Kru Nai	10	6	193	3	579	5,790	50
Orange	Bang Khun Non - Yeak Rom Klao	15	4	193	3	579	8,685	142
Yellow	Lat Phrao - Samrong	10	6	112	4	448	4,480	78
Pink	Nonthaburi Civic Center - Min Buri	20	3	112	4	448	8,960	118
	Sirat - Muang Thong Thani Lake	10	6	112	4	448	4,480	11
Gray	*Watchaphon - Thonglor (P02)*	*12*	*5*	*112*	*4*	*448*	*5,376*	147
	Phra Khanong - Tha Phra (P07)	*10*	*6*	*112*	*4*	*448*	*4,480*	45
	LamLukKa - Watcharaphon (P10)	*10*	*6*	*112*	*4*	*448*	*4,480*	62
Cyan	*Sathon – Din Daeng (P04)*	*12*	*5*	*112*	*4*	*448*	*5,376*	139
Silver	*Bangna – Suvarnabhumi (P06)*	*10*	*6*	*112*	*4*	*448*	*4,480*	37
Brown	*Khae Rai - Bueng Kum (P05)*	*10*	*6*	*112*	*4*	*448*	*4,480*	88

5.3 Priority Process

5.3.1 Shortlist

After revising the demand forecasting model and re-evaluating the network, Project 11 was added to the new shortlist as follows:

- Project 1: Red Line Bang Sue – Hua Lamphong – Phayathai – Hua Mak and Green Line (Silom) National Stadium – Yotse
- Project 2: Gray Line: Watcharaphon – Thonglor
- Project 3: Red Line Wongwian Yai – Bang Bon
- Project 4: Cyan Line Sathon – Din Daeng
- Project 5: Brown Line Khae Rai – Bueng Kum
- Project 6: Silver Line Bangna – Suvarnabhumi
- Project 7: Gray Line Phra Khanong – Tha Phra
- Project 8: Green Line Bang Wa – Taling Chan
- Project 9: Green Line Taling Chan – Rattanathibet
- Project 10: Green Line Khu Khot – Outer Ring Road and Gray Line: Lam Luk Ka – Watcharaphon
- Project 11: Gold Line Klong San – Prachatipok

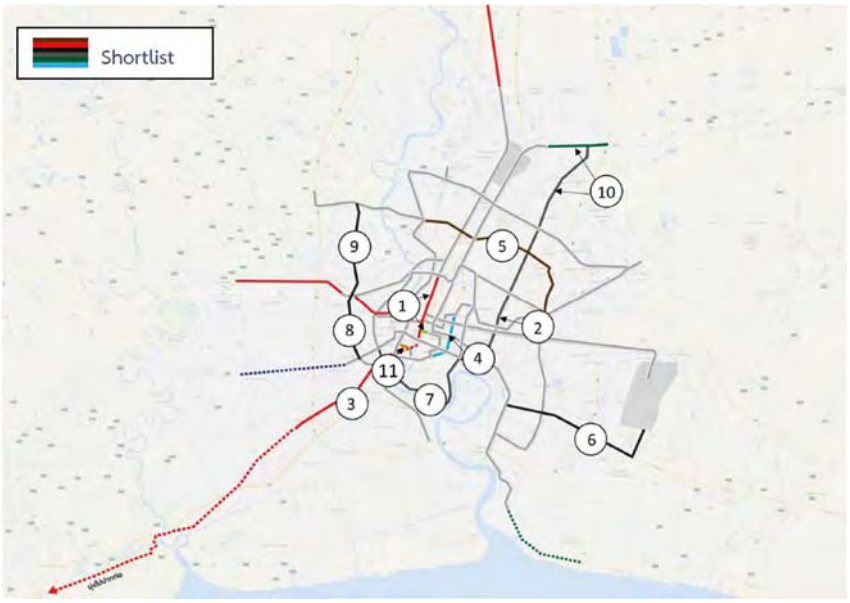


Figure 5-15 Eleven projects in Shortlist

5.3.2 Prioritization summary

Based on 11 projects in the shortlist, the prioritization process proceeds with the New Capacity Assumption for the Enhanced Capacity Scenario (B) using congestion rates of 150%. Changes are made as follows:

- Red Line (N-S) Wongwian Yai – Bang Bon (1.4 in the table below) was reevaluated from A2 to B
- Red Line (E-W) Phayathai – Huamak was excluded from the analysis due to overlapping with ARL.
- Gold Line Klong San – Prachatipok was included for the analysis and evaluated as category A2.

As a result, the project priorities are summarized into categories A1, A2, and B, as shown in the table below.

Table 5-15 Changes in Project Priority

Route		September 2023 (DRT Report)	February 2024 (Final Plan)
Dark Red Line (N-S)	1.1 Rangsit – Thammasart (North Ext.)	A1	A1
	1.2 Bang Sue – Hua Lamphong (Missing Link)	A2	A2
	1.3 Hua Lamphong - Wongwian Yai (South Ext. 1)	B	B
	1.4 Wongwian Yai – Bang Bon (South Ext. 2)	**A2**	**B**
	1.5 Bang Bon – Mahachai – Paktho (South Ext. 3)	B	B
Light Red Line (E-W)	2.1 Taling Chan – Salaya (West Ext.)	A1	A1
	2.2 Taling Chan – Siriraj (Thonburi Branch Ext.)	A1	A1
	Phaya Thai – Huamak (East Ext.)	**A2**	**Not Shortlisted**
Green Line (Sukhumvit)	3.1 Samutprakarn – Bangpu (South Ext.)	B	B
	3.2 Kukot – Outer Ring Road (North Ext.)	B	B
Green Line (Silom)	4.1 National Stadium – Yotse (Missing Link)	A2	A2
	4.2 Bang Wa - Taling Chan (West Ext. 1)	A2	A2
	4.3 Taling Chan – Rattanathibet (West Ext. 2)	B	B
Blue Line	5 Bangkhae – Phutthamonthon Sai 4 (West Ext.)	B	B
Grey Line	6.1 Lam Luk Ka - Watcharaphon (North Ext.)	B	B
	6.2 Watcharaphon – Thonglor (Center)	A2	A2
	6.3 Phra Khanong - Tha Phra (BRT Alignment)	B	B
Cyan Line	Sathon – Din Daeng	B	B
Brown Line	Khae Rai - Bueng Kum	A1	A1
Silver Line	Bangna – Suvarnabhumi	A2	A2
Gold Line	Klong San - Prachatipok	**Not Shortlisted**	**A2**

Based on the Project Priority, a development plan can be summarized as follows

A1: Imperative and ready to proceed

Projects which considered "Immediately Implemented"

① Red Line: Rangsit - Thammasart (Commuter)
② Red Line: Taling Chan - Salaya (Commuter)
③ Red Line: Taling Chan - Siriraj (Commuter)
④ Brown Line: Khae Rai - Bueng Kum (LRT/Monorail/AGT)



Figure 5-16 Development plan for A1 projects

A2: Imperative but need some preparation

Projects which will be implemented by the year 2029

① Red Line: (Bang Sue - Hua Lamphong) (Commuter)
② Green Line: (Silom) National Stadium - Yotse (Heavy Rail)
③ Green Line: Bang Wa - Taling Chan (Heavy Rail)
④ Gold Line: Klong San - Prachatipok (AGT)
⑤ Silver Line: Bangna - Suvarnabhumi (LRT/Monorail/AGT)
⑥ Gray Line: Watcharaphon - Thonglor (LRT/Monorail/AGT)

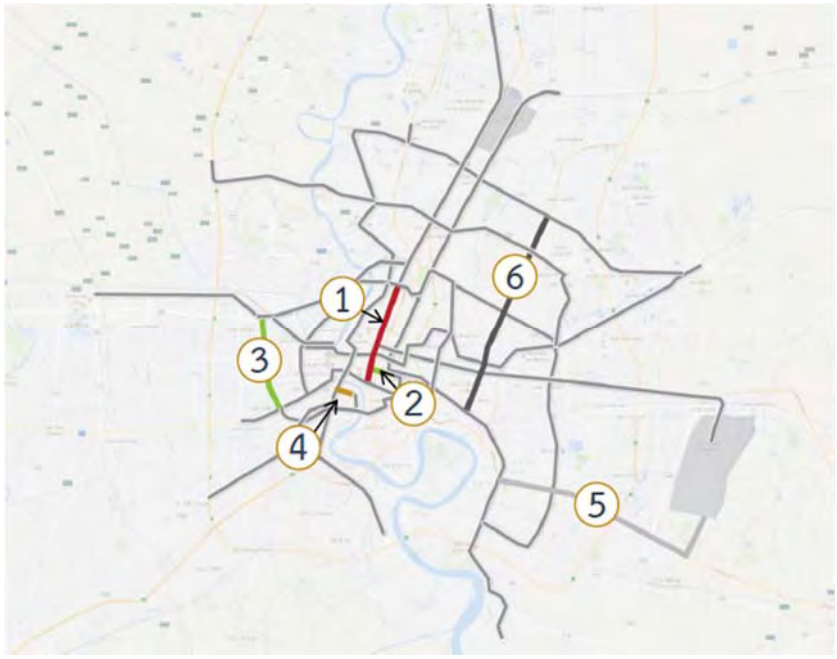


Figure 5-17 Development plan for A2 projects

B: Potential routes

Projects which will be considered for project feasibility in the year 2029

① Cyan Line: Sathon - Din Daeng (LRT/Monorail/AGT)
② Green Line: Khu Khot - Outer Ring Road (Heavy Rail)
③ Gray Line: Lam Luk Ka - Watcharaphon (LRT/Monorail/AGT)
④ Gray Line: Phra Khanong - Tha Phra (LRT/Monorail/AGT)
⑤ Red Line: Hua Lamphong - Wongwian Yai (Commuter)
⑥ Red Line: Bang Bon – Mahachai - Paktho (Commuter)
⑦ Green Line: Samutrprakarn - Bangpu (Heavy Rail)
⑧ Blue Line: Bangkhae - Phutthamonthon - Sai 4 (Heavy Rail)
⑨ Green Line: Taling Chan - Rattanathibet (Heavy Rail)
⑩ Red Line: Wongwian Yai - Bang Bon (Commuter)

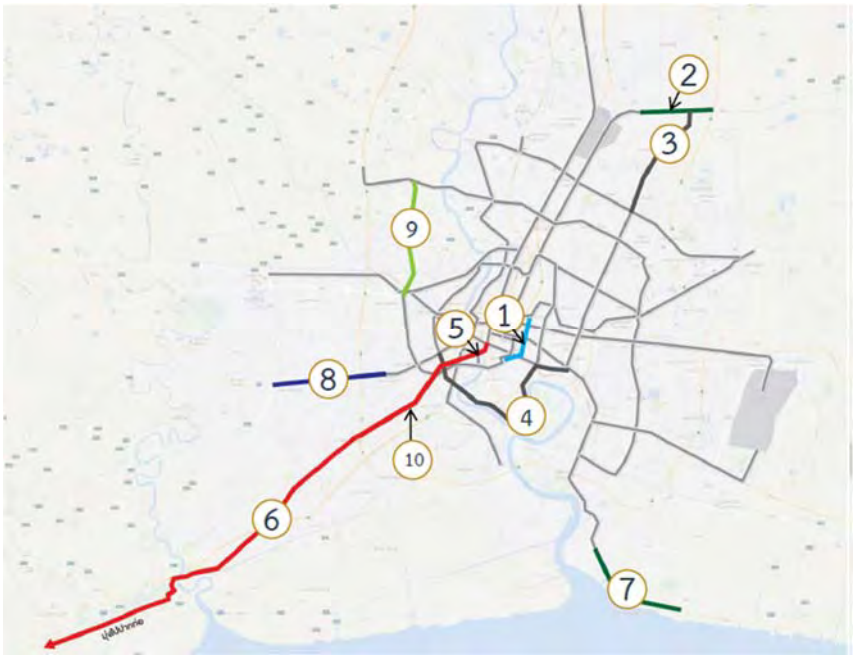


Figure 5-18 Development plan for B projects

5.4 Proposed express services

DRT consultants have proposed the express services for Airport Rail Link (ARL) and Red Line (N-S) based on the consideration of Origin and destination of each line and the physical possibility

5.4.1 Airport Rail Link (ARL)

The express train stops at Suvarnabhumi Airport (A1), Lat Krabang (A2), Makkasan (A6), and Phaya Thai (A8) terminal station as shown in the FIgure below.



Figure 5-19 Proposed express operation for ARL

5.4.2 Red Line (N-S)

The express train stops at Bang Sue (RN01), Lak Si (RN06), Don Mueang (R08), and Rangsit (R10) as shown in the Figure below.



Figure 5-20 Proposed express operation for Red Line (N-S)

5.5 Future Considerations for Railway Development from the 5th M-MAP2 Platform, 7th Feb. 2024

Based on the last (5th) M-MAP2 platform held on 7th Feb 2024, discussions and comments from the platform are summarized below for future consideration. Comments were received from:

- **Japanese Academia**: Prof. Shigeru MORICHI (GRIPS), Prof. Hisao UCHIYAMA (Tokyo University of Science), Mr. Makoto ITO (JTTRI), Prof. Atsushi FUKUDA (Nihon University), and Prof. Naohiko HIBINO (GRIPS)
- **Thai Academia**: Dr. Sittha Jaensirisak (Ubon University), Dr. Sumet Ongkittikul (TDRI), and Prof. Saksith Chalermpong (Chulalongkorn University)
- **Committee Members**: Mr. Keerati Kruachan (OTP) and Mr. Punnaluk Surassawadee (NESDC)

5.5.1 Recommendations from Japanese Academia

1) Priority Process and Congestion Analysis

The Japanese academics suggested analyzing the priority process for both the entire M-MAP2 network and individual projects. They emphasized the need to consider various aspects of congestion, including track congestion, headway analysis, and station capacity (platforms, escalators, ticket gates) through microsimulation. Additionally, they advised careful planning for underground stations and express train infrastructure to minimize passenger inconvenience.

2) Data Analysis

Inquiries were made about the analysis method, whether it was based on zones or 100-meter grids. Detailed explanations for the calculation methods and justifications behind the various indices presented, such as modal share, were requested. There were also questions about the feasibility of the 2.5-minute headway for the Sukhumvit Green Line, probing the underlying assumptions.

3) Network Design

Clarification was sought on the characteristics of each railway line, whether they functioned as circular feeders, monorails, or commuter trains. The focus on lines within a 20-kilometer radius was questioned, given the discussions on developing networks in broader areas like the CBD, sub-centers, and urban development zones. Additionally, inquiries were made about the existence and operational plans for an express railway.

4) Additional Considerations

Research findings were emphasized, suggesting that people prioritize time savings over congestion levels, which might be relevant to M-MAP2. A more in-depth analysis of station access and egress, considering factors like station plazas, was recommended, along with the continuous development of the model.

5.5.2 Recommendations from Thai Academia

Questions were raised about the importance of the Bang Sue-Hua Lamphong connection given the reduced ridership at Hua Lamphong station. There were inquiries about why some missing links from the Blueprint were not considered. Concerns were raised about the high elasticity value used for the Red Line.

Suggestions were made to incorporate additional factors like signal systems and vehicle design when assessing express train operations. The use of a scoring system for route prioritization was questioned, suggesting a need to carefully consider which indices are used to avoid double-counting.

5.5.3 Recommendations from Other Committee Members

Concerns were expressed about the impact of the 20 baht flat fare policy on the overall system. The importance of integrating the railway system with other modes of transportation like buses and feeder systems was emphasized. Suggestions were made for collaboration with relevant agencies for coordinated development and consideration of future urban development plans.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-4

Railway Passenger and the COVID-19 Pandemic in Bangkok

Outline

- **Background and Objective**
  - Various impact from COVID-19 to public transport can be perceived
    - Less travel, less demand
    - Level of service needs to be maintained to prevent the further virus spread
  - The impact from COVID-19 to public transport needs to be analyzed systematically
    - To maintain the public transport service during the pandemic
    - To make preparation for a new pandemic in the future

Source: JICA Expert Team, Project Kick-off Meeting, 16 June 2021

- **Methods**

  Data collection: Government Policies, DRT Policies, Number of COVID-19 cases, Number of people vaccinated.

  Data Analysis: Analyzed by analyzing the trend of the number of passengers compared to the COVID-19 outbreak situation and daily infection cases.

- **Conclusion**

  Factors affecting Number of rail passenger

Terms of the Government Gazette in an emergency situation (COVID-19) related to Railway System

No.	Published	Restriction policy (Affect travel)
1	March 25, 2020.	• Curfew from 10.00 p.m. - 04.00 a.m. for 14 days. • Close the risky place in Bangkok and surrounding areas. • Refrain/delay travel across provinces.
2	April 1, 2020.	• Curfew from 10.00 p.m. - 04.00 a.m. for 14 days.
5	May 1, 2020	• Curfew from 10.00 p.m. - 04.00 a.m. for 14 days. • Refrain/delay travel across provinces.
7	May 15, 2020	• Curfew from 11.00 p.m. - 04.00 a.m. for 14 days. • Open-air restaurants, food courts, canteens, places of entertainment. • Open department stores, shopping centers and community malls • Open Exercising, health care and recreational activities, fitness center.
9	May 29, 2020	• Curfew from 11.00 p.m. - 03.00 a.m. for 14 days.
11	June 30, 2020	• Prepare public transport to cope with increased travel due to the easing of measures. • Measures Relaxation by MOI
14	August 31, 2020	• Open all school educational institutions, universities, and tutoring schools • Open Sports fields or sport competition venues. • Public transportation open with full capacity.
15	December 25, 2020	• Forbidden people to enter area, place that is at risk of getting disease.
16	January 3, 2021	• Close buildings and premises of all types of schools and educational institutions located in COVID-19 zoning areas. • Refrain/delay travel across provinces. • Organizations (Public and Private) are asking to work from home
18	January 29, 2021	• Samut Sakhon be categorized as maximum and strict COVID-19 control. • Bangkok, Nonthaburi, Pathum Thani and Samut Prakan be categorized as maximum COVID-19 control.
20	April 16, 2021	• Refrain/delay travel across provinces. Especially maximum control areas.
22	April 29, 2021	• Organizations (Public and Private) are asking to work from home as much as possible.
25	June 26, 2021	• Set up a checkpoint to prevent travel across the red area. • Organizations are asking to work from home as much as possible.
27	July 10, 2021	• Curfew from 9.00 p.m. - 04.00 a.m. for 14 days. • Organizations are asking to work from home as much as possible.
28	July 18, 2021	• People in the dark red areas must refrain from traveling outside of their dwellings unnecessarily. • Curfew from 9.00 p.m. - 04.00 a.m. for 14 days. • Set up a "strong checkpoint" to prevent travel across the red area. • Limit the number of passengers on all types of public transport. In the Dark red area, 50% of the passenger capacity. • Organizations are asking to work from home as much as possible.
32	August 28, 2021	• Refrain/delay travel across provinces. Especially maximum control areas. • Limit the number of passengers on all types of public transport. In the Dark red area, 75% of the passenger capacity.
33	September 10, 2021.	• Curfew from 9.00 p.m. - 04.00 a.m. for 14 days to 30 September 2021.
34	September 19, 2021.	• Curfew from 10.00 p.m. - 04.00 a.m. for 14 days • All measures will continue to be in force until 15 October 2021.

Source: Ministry of Labor

Terms of the Government Gazette in an emergency situation (COVID-19) related to Railway System

No.	Published	Restriction policy (Affect travel)
35	October 15, 2021.	• Curfew from 11.00 p.m. - 03.00 a.m. for 14 days. • Restaurants, food courts, Open department stores, shopping centers and community malls service until 10.00 p.m. • Relax measures to limit the number of passengers.
36	October 21, 2021	• No curfew start on 31 October 2021
37	October 21, 2021	• Curfew from 11.00 p.m. - 03.00 a.m. for 14 days. • Maximum Control area (School, University, Library, Nursery) • Restaurants, food courts, Open department stores, shopping centers and community malls service until 10.00 p.m.
38	November 13, 2021	• Curfew from 11.00 p.m. - 03.00 a.m. • All measures from No.37 will continue to be in force.
39	November 30, 2021	• No curfew start on 30 November 2021 • All measures from No.38 will continue to be in force.
40	December 15, 2021	• Air-Restaurants, food courts, service until 01.00 a.m. • The venue of New Year's festival activities must comply with the COVID-19 screening measures.
41	January 1, 2021	• All measures from No.37 will continue to be in force. • Work from home

Source: Ministry of Labor

There are no further announcements from the government after this.

Department of Rail Transport restrictions policies (DRT Policies)

No.	Published	Restriction policy (Affect travel)
1	March 26, 2020	• Avoid touching other people while traveling • Social distancing at least 1 meter
2	April 7, 2020.	• All Train will start service at 4.00 a.m. and close at 9.30 p.m. • Social distancing at least 1 meter
4	May 15, 2020	• All Train will start service at 4.00 a.m. and close at 10.30 p.m. • Social distancing at least 1 meter
5	October 15, 2020	• BTS SkyTrain has made a Group Release at Chidlom Station to reduce the density of people. • Arrange a service with the highest frequency is on the Sukhumvit Line every 2.25 minutes and the Silom Line every 3.45 minutes • Social distancing at least 1 meter
6	December 21, 2020	• All Train will not park and pick up passenger at Samut Sakhon • All Train will not service during curfew between 10.00 p.m. to 05.00 a.m. • Social distancing at least 1 meter
8	January 14, 2021	• Refrain from operating trains with service routes in the most restricted area (Red area). • Added passenger screening officers. • Social distancing at least 1 meter
10	July 12, 2021	• All Train will start service at 4.00 a.m. and close at 9.00 p.m. • Limiting service of the train system across the strictest provincial area • Social distancing at least 1 meter
12	August 5, 2021	• Extension of enforcement measures No.10 from 10 July 2021 to 31 August 2021 • Reduce the service of the train system across the provincial that is defined as the highest and strict control area
13	September 30, 2021	• All Train will start service at 4.00 a.m. and close at 10.00 p.m. • Social distancing at least 1 meter

Source: Department of Rail Transport

Zone	Province (BMR)
Dark Red (Full Control area)	Bangkok, Nonthaburi, Pathumthani, Samut Prakan
Red (Control area)	Nakhon Pathom, Samut Sakhon
Yellow (Control area)	-

Source: Department of Disease Control of Thailand, 2020

Operators	Operation Time (No COVID-19)
ARL	06.00 a.m. – 12.00 a.m.
MRT	06.00 a.m. – 12.00 a.m.
BTS	06.00 a.m. – 12.00 a.m.

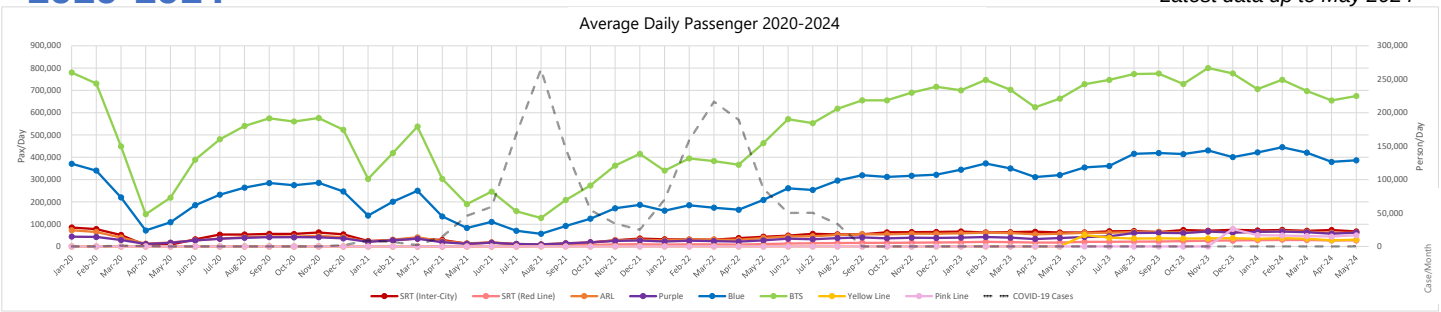
Source: ARL, MRT, and BTS, 2020

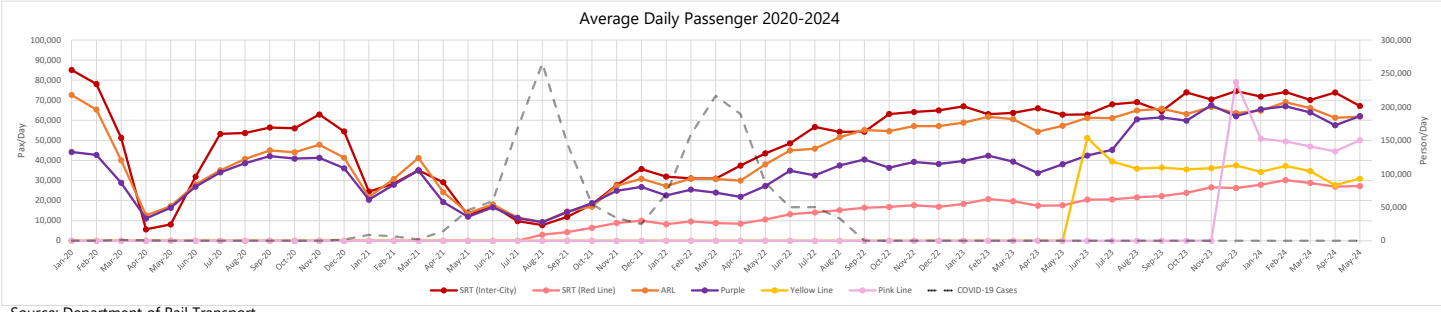
There are no further announcements from the DRT after this.

Average monthly passenger traffic in rail transport compared to the COVID-19 outbreak situation and number of COVID-19 cases during January 2020 to Dec 2022

2020-2024

Latest data up to May 2024

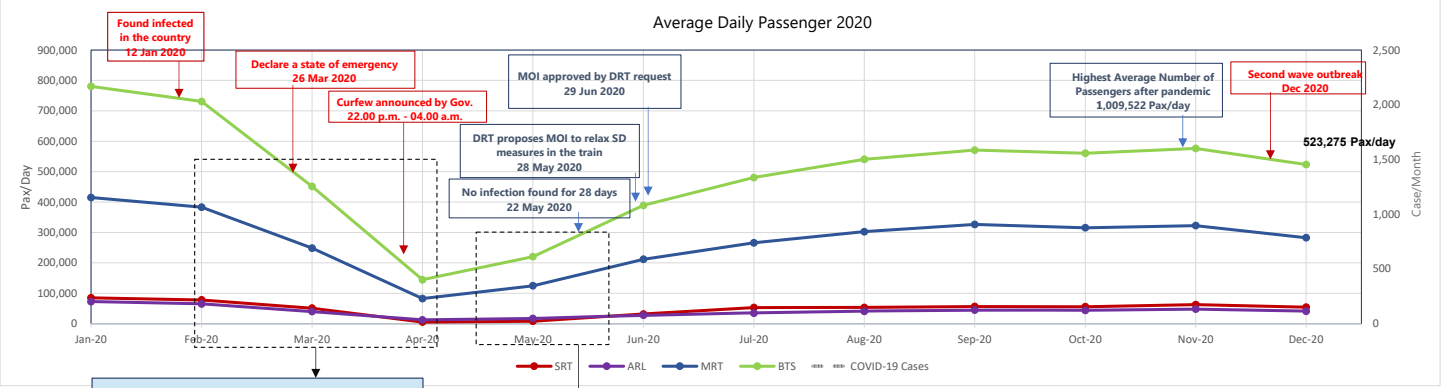




Source: Department of Rail Transport

Average monthly passenger traffic in rail transport compared to the COVID-19 outbreak situation and number of COVID-19 cases during 2020

2020



- (First Outbreak) Number of COVID cases getting higher
- Curfew 10 p.m. – 4.00 a.m. announced by Gov.
- Fear and Panic

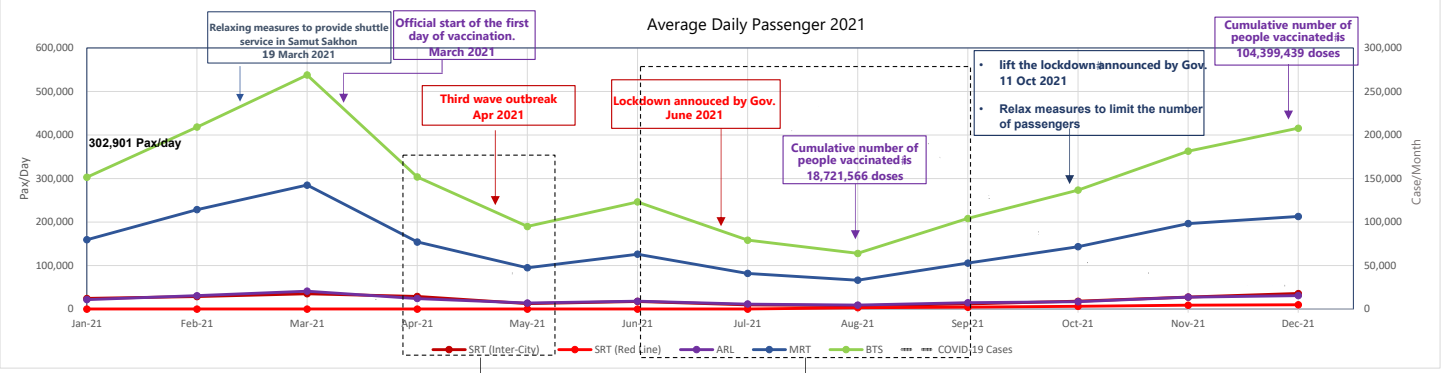
- Number of COVID cases getting lower.
- Measures Relaxation by Ministry of Interior (ˆ¿ˆ).

Source: Department of Rail Transport

Average monthly passenger traffic in rail transport compared to the COVID-19 outbreak situation and number of COVID-19 cases during 2021

2021

Different scale from 2020



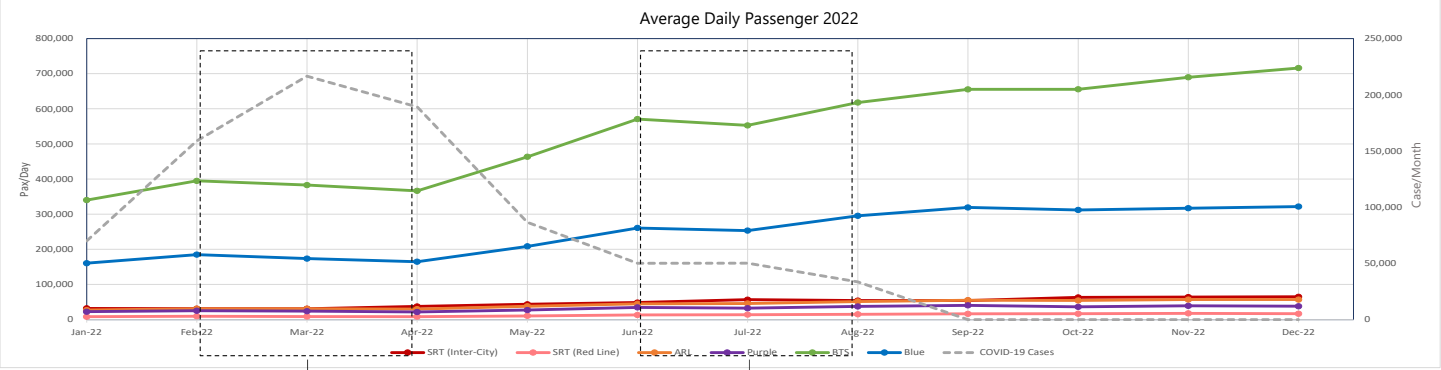
- Third wave outbreak
- Number of people infected getting higher
- The number of passengers are not decrease much due to people beginning to receive vaccines.

- Lockdown announced by Gov.
- Curfew 10.00 p.m. – 04.00 a.m. announced by Gov.
- Train operation time 04.00 a.m. – 9.00 p.m. announced by DRT
- Highest number of COVID cases

Source: Department of Rail Transport

Average monthly passenger traffic in rail transport compared to the COVID-19 outbreak situation and number of COVID-19 cases during 2022

2022



- Forth wave outbreak
- Number of people infected getting higher
- The number of passengers are not decrease much due to people beginning to receive vaccines.

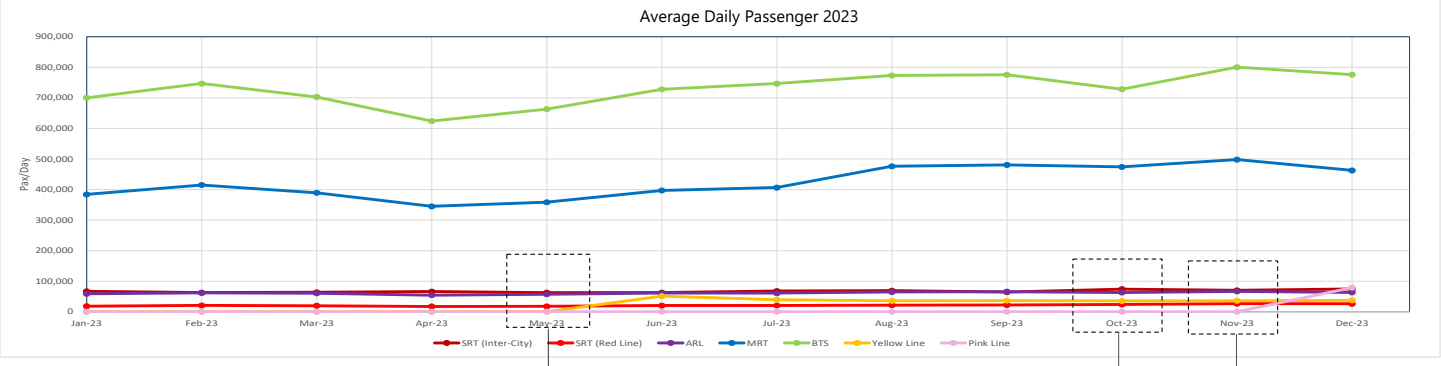
- Number of COVID cases getting lower until almost zero.
- Number of passenger of all systems are increasing in general.

Source: Department of Rail Transport

Average monthly passenger in rail transport

2023

Latest data up to May 2024



- Yellow Line started operation in May 2024

- Red Line and Purple Line started promotion 20 Baht flat fare

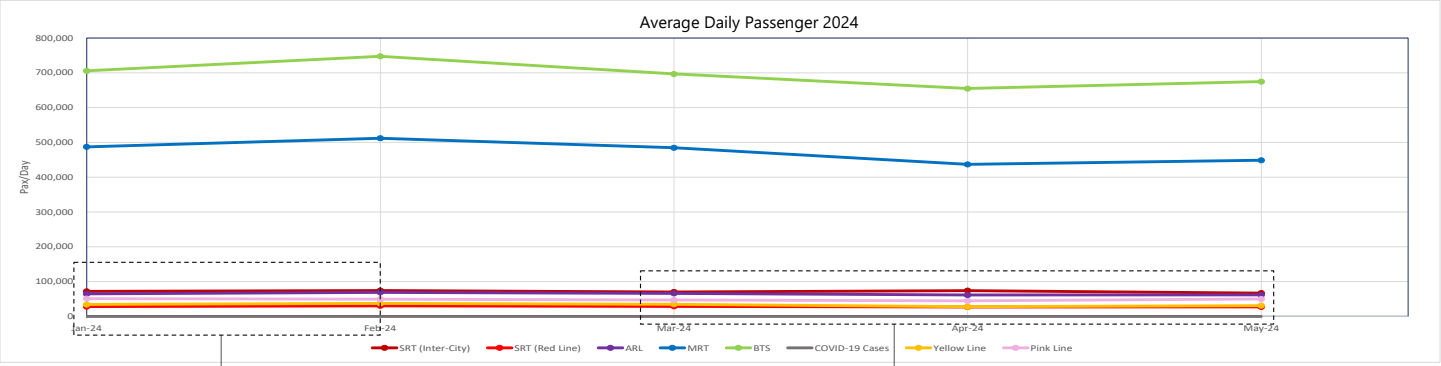
- Pink Line started operation in November 2024

Source: Department of Rail Transport

Average monthly passenger in rail transport

2024

Latest data up to May 2024



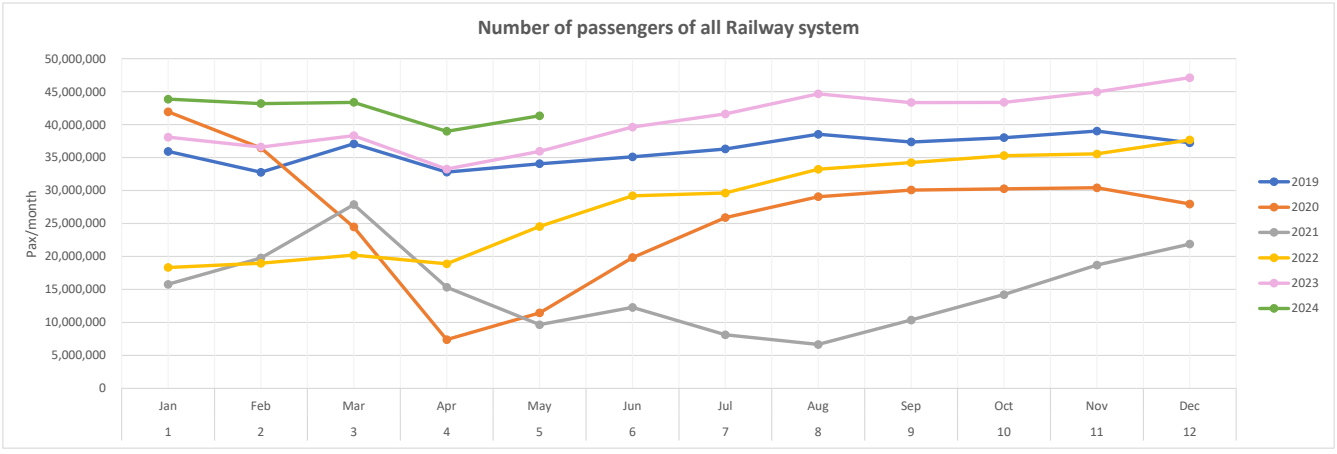
- Pink Line closed 7 stations from Nonthaburi civic center to Pak Kret Bypass station due to a power failure.
- Started shuttle operation from Nonthaburi civic center to Royal irrigation station

- Yellow Line stared shuttle operation from Kalantan station to Si Udom station due to an accident on conductor rail.
- The repair process expected to be completed around June.

Source: Department of Rail Transport

Average total monthly passenger in rail transport 2019-2024

Latest data up to May 2024



Source: JICA Expert Team

Number of Total passenger in 2019 (No Covid-19) compared with 2020, 2021, 2022, 2023, and 2024

Year/Month	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Total
2019	35,935,961	32,769,271	37,078,944	32,790,080	34,060,110	35,109,745	36,303,758	38,537,319	37,368,389	38,021,850	39,026,128	37,241,766	434,243,321
2020	41,947,594	36,460,619	24,463,994	7,369,879	11,437,623	19,824,922	25,887,193	29,063,053	30,071,811	30,263,647	30,417,040	27,952,550	315,159,925
2021	15,761,317	19,769,176	27,859,605	15,324,232	9,644,802	12,262,498	8,106,584	6,639,944	10,352,472	14,205,910	18,689,497	21,872,872	180,488,909
2022	18,317,457	18,959,787	20,197,942	18,878,067	24,533,283	29,203,093	29,619,424	33,232,242	34,239,887	35,296,065	35,552,750	37,669,736	335,699,733
2023	38,087,469	36,609,624	38,327,267	33,256,496	35,944,134	39,621,734	41,619,357	44,669,557	43,357,117	43,379,151	44,947,544	47,112,839	486,932,289
2024	43,861,500	43,197,439	43,381,797	38,977,424	41,340,158	-	-	-	-	-	-	-	210,758,318
%YoY 2019-2020	16.73%	11.26%	-34.02%	-77.52%	-66.42%	-43.53%	-28.69%	-24.58%	-19.53%	-20.40%	-22.06%	-24.94%	-27.42%
%YoY 2019-2021	-56.14%	-39.67%	-24.86%	-53.27%	-71.68%	-65.07%	-77.67%	-82.77%	-72.30%	-62.64%	-52.11%	-41.27%	-42.73%
%YoY 2019-2022	-49.03%	-42.14%	-45.53%	-42.43%	-27.97%	-16.82%	-18.41%	-13.77%	-8.37%	-7.17%	-8.90%	1.15%	-22.69%
%YoY 2019-2023	5.99%	11.72%	3.37%	1.42%	5.53%	12.85%	14.64%	15.91%	16.03%	14.09%	15.17%	26.51%	12.13%
%YoY 2019-2024	22.05%	31.82%	17.00%	18.87%	21.37%	-	-	-	-	-	-	-	-51.47%

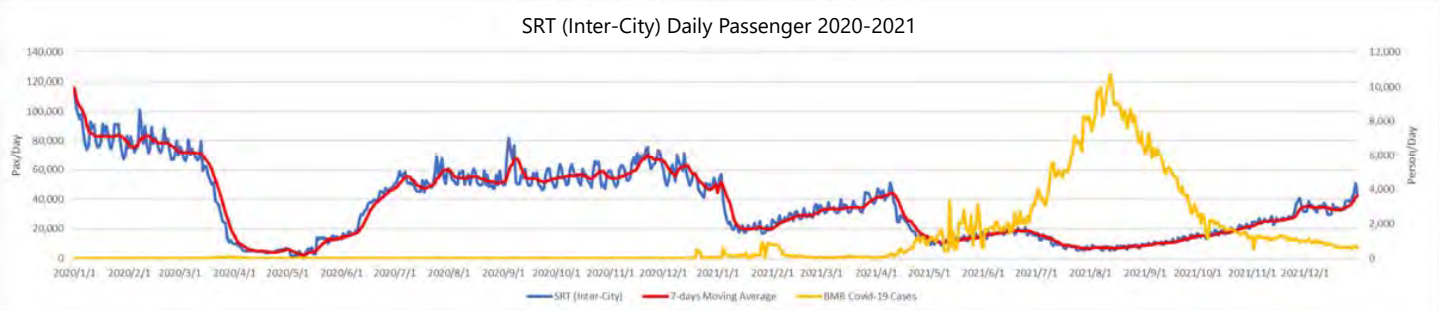
Source: JICA Expert Team

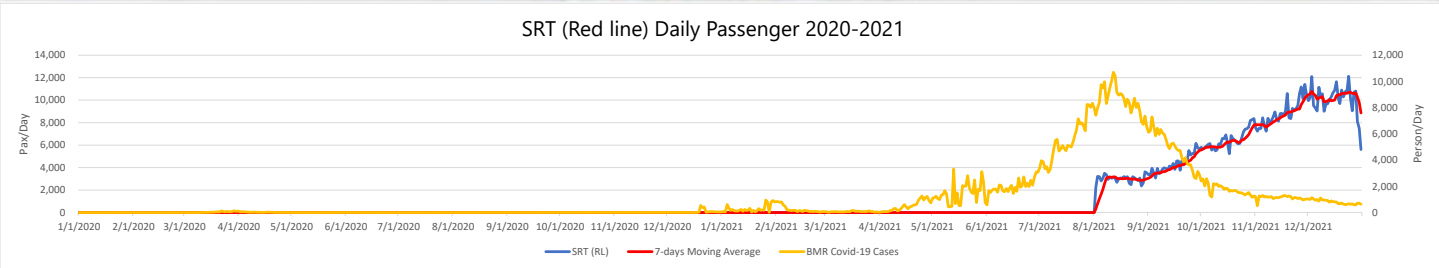
Conclusion

Factors	Result (Travel Demand)
Gov. and DRT policies • Curfew • Lockdown • Close and open area • Limit number of passenger • Work from home	Number of Passenger Decrease
Daily infection cases • High cases • Fear and Panic	
COVID-19 Vaccine • No COVID-19 Vaccine	
Gov. and DRT policies • Measures relaxation	Number of Passenger Increase
Daily infection cases • Low cases	
COVID-19 Vaccine • People got COVID-19 Vaccine	

Attachment 1

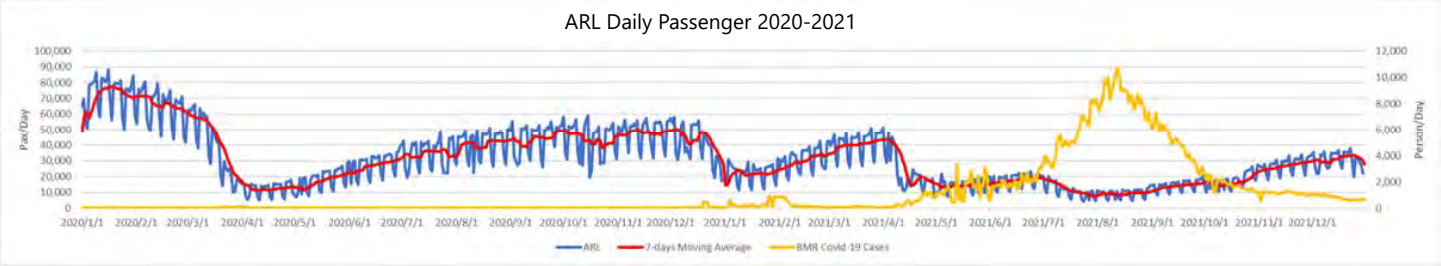
Appendix : Daily passengers traffic in rail transport compared to the number of COVID-19 cases

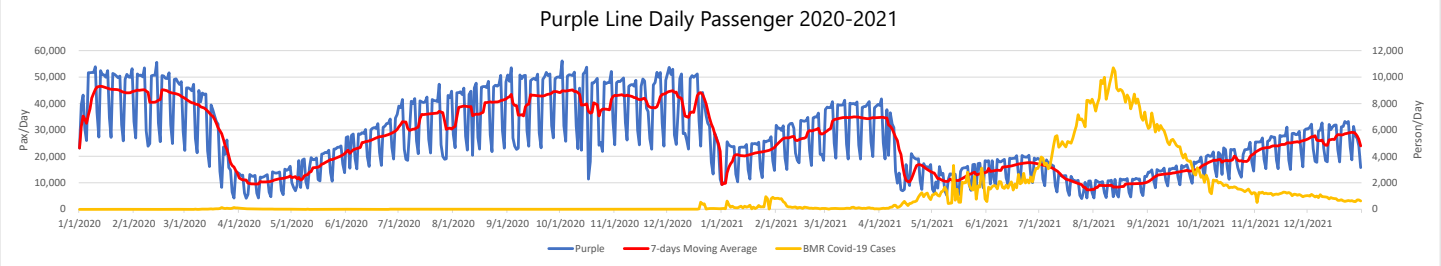




Source: JICA Expert Team

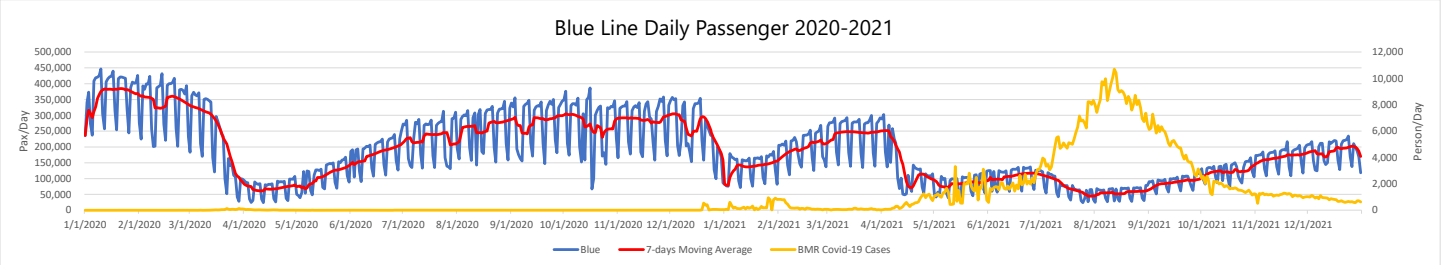
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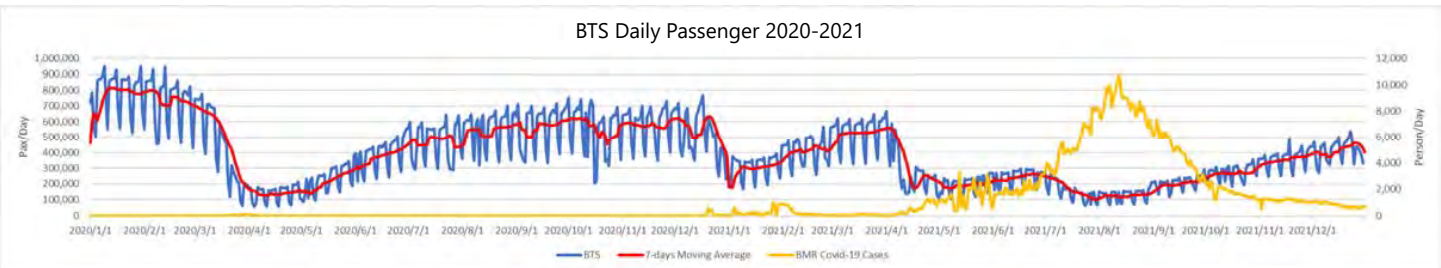




Source: JICA Expert Team

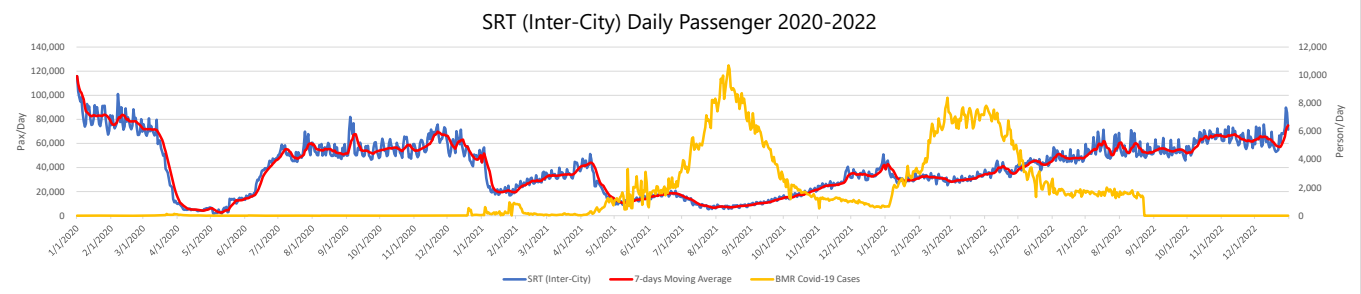
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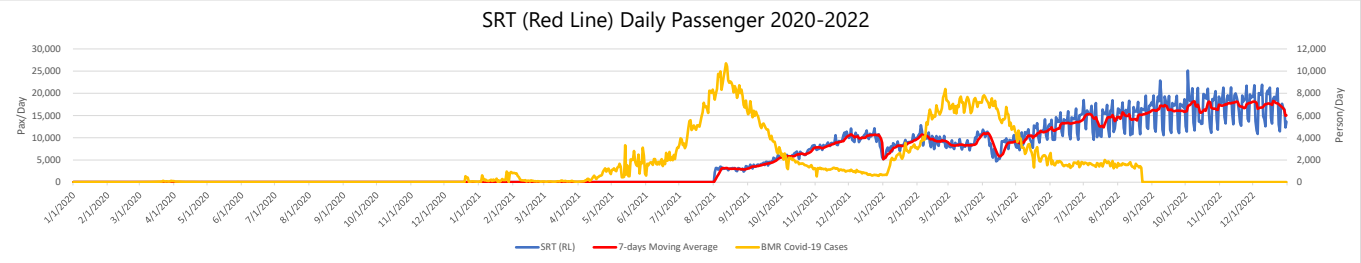




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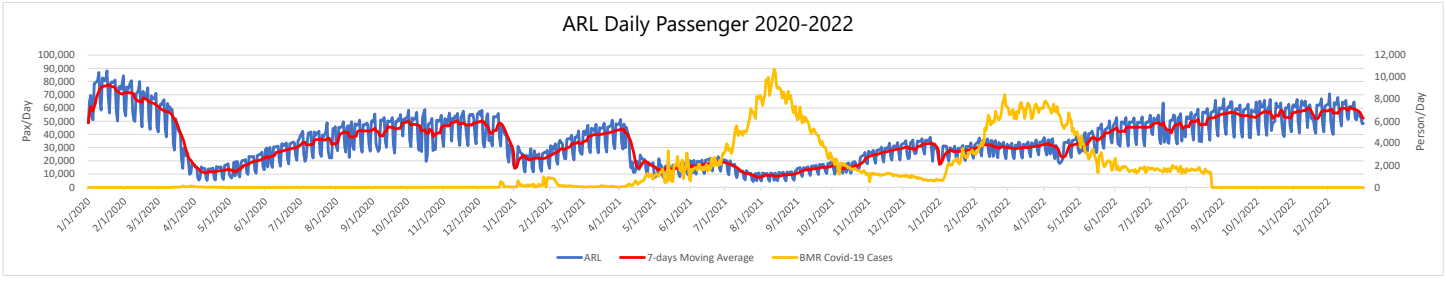
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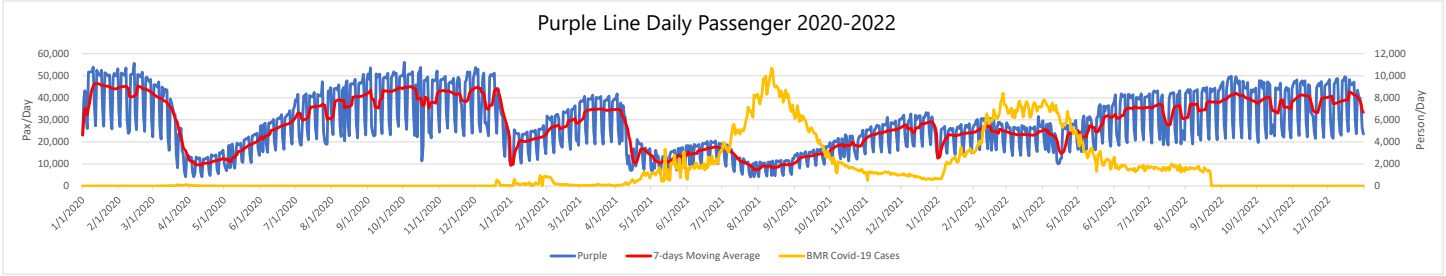




Source: JICA Expert Team

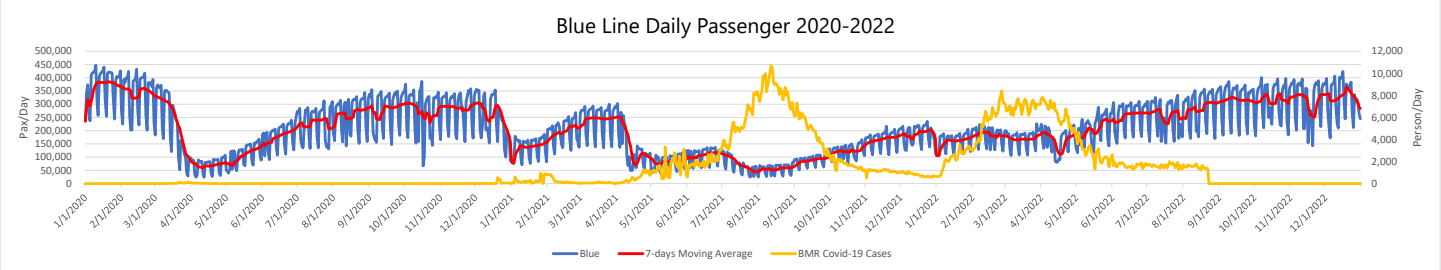
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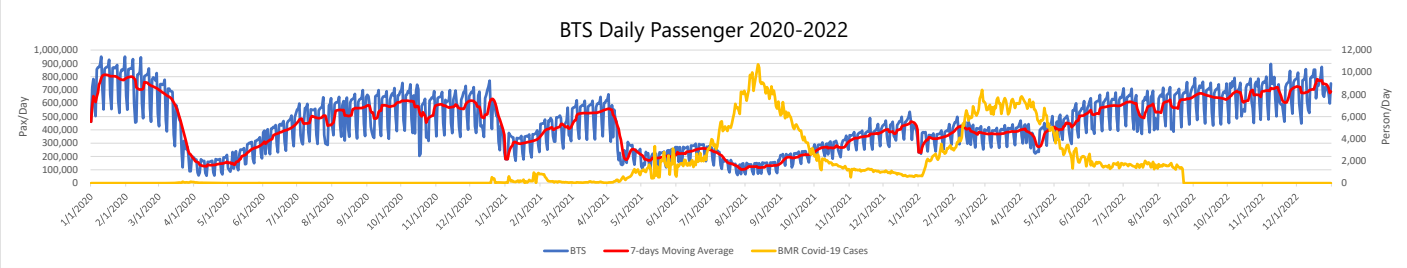




Source: JICA Expert Team

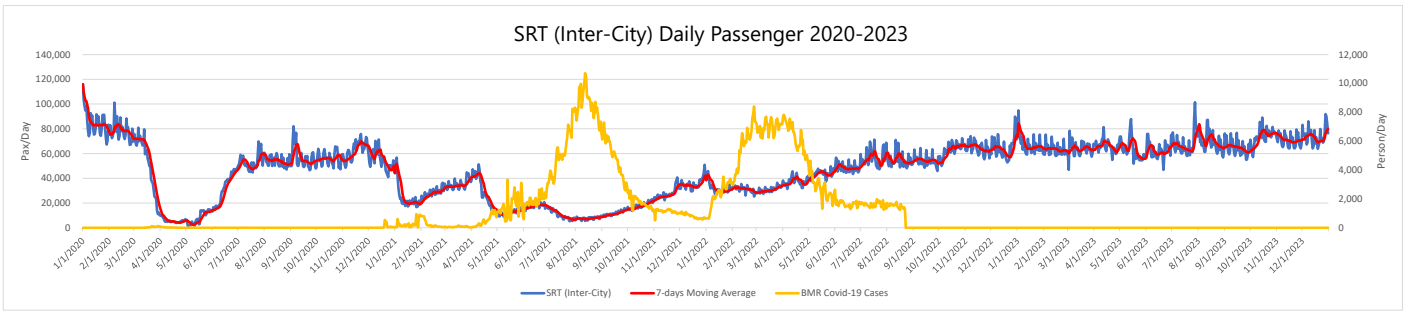
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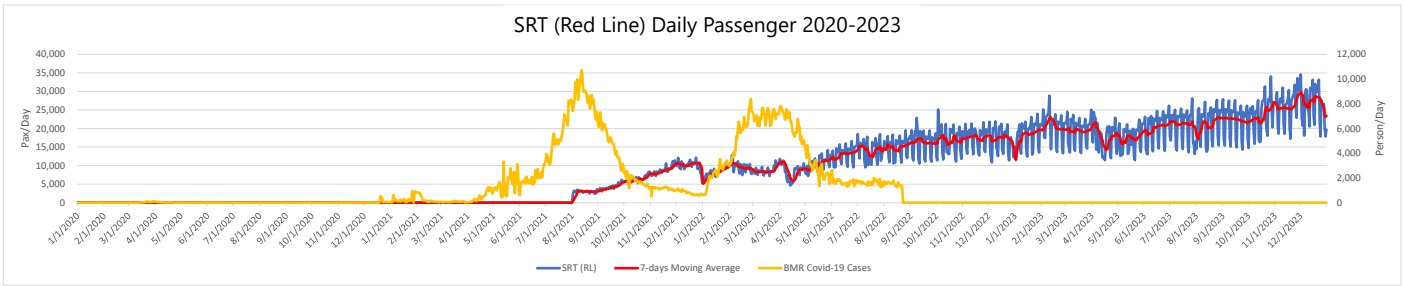




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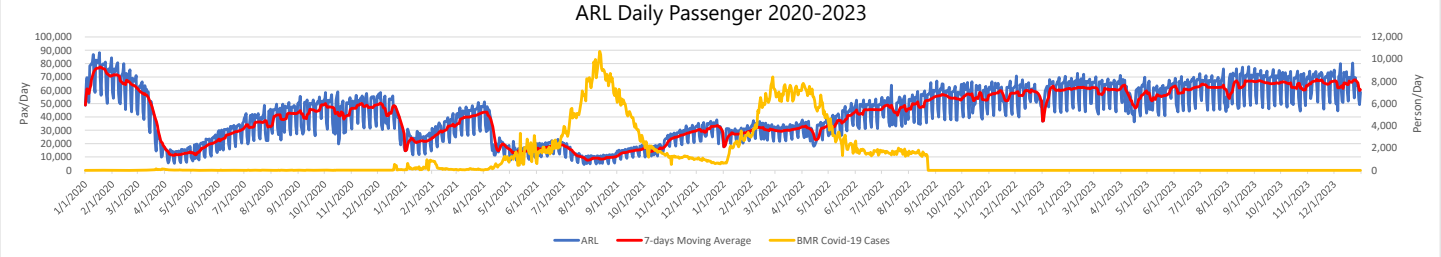
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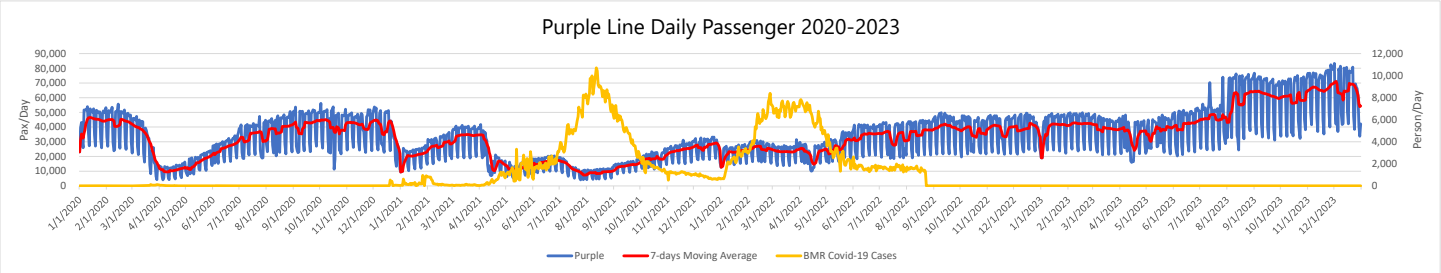




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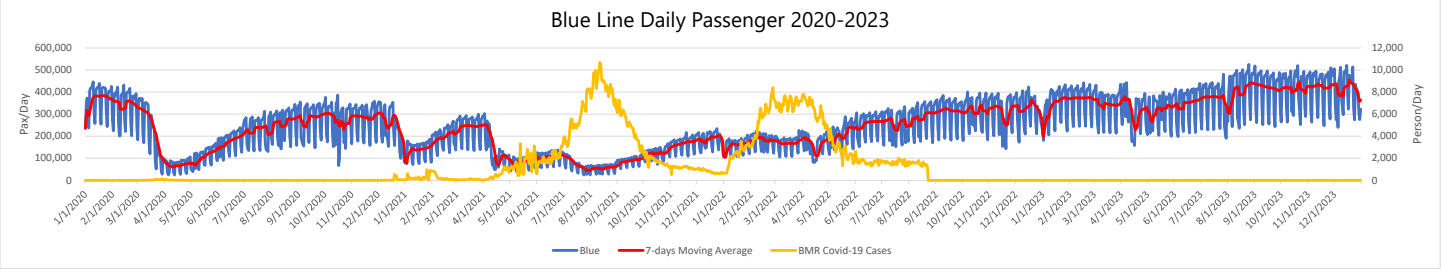
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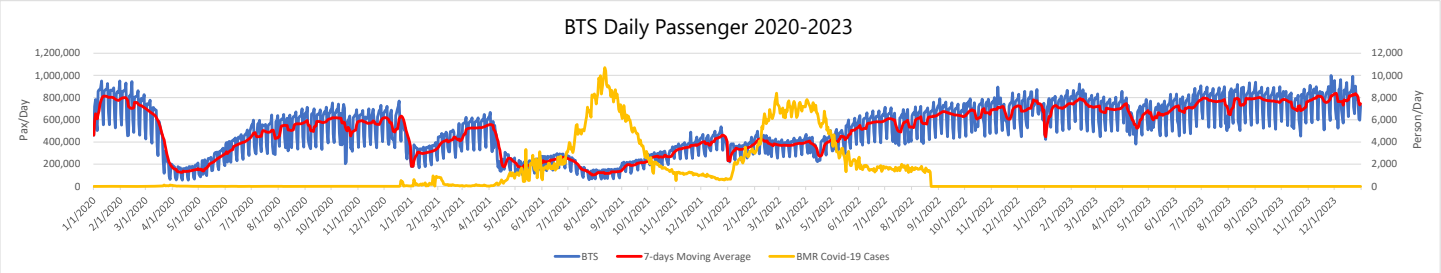




Source: JICA Expert Team

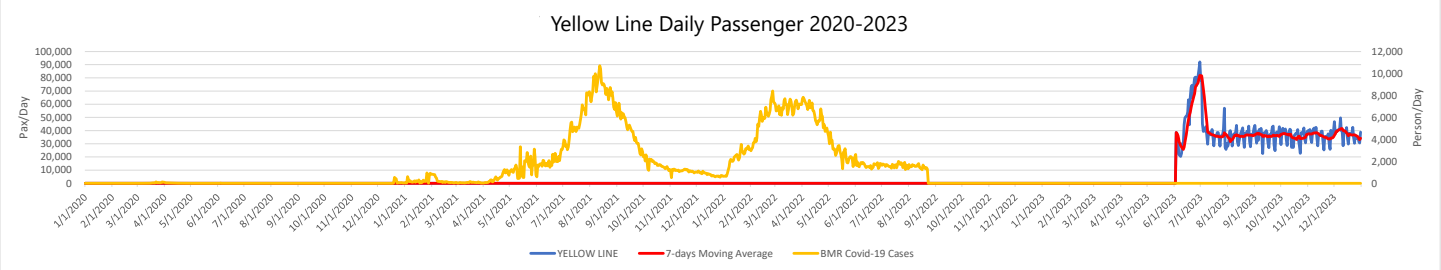
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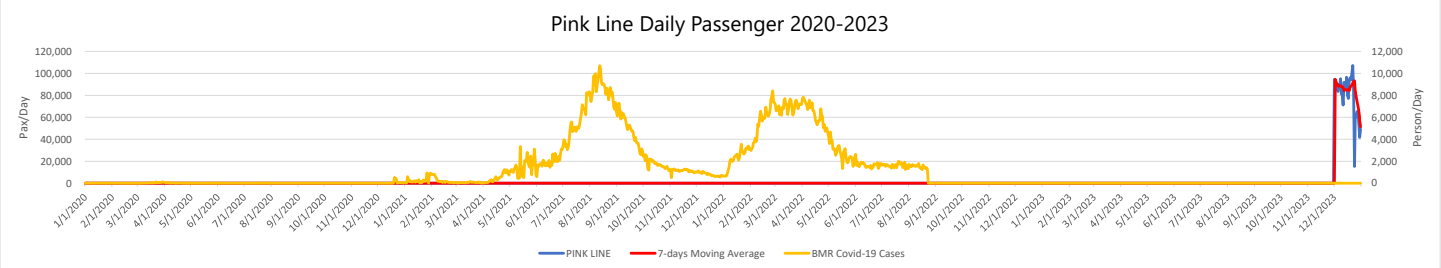




Source: JICA Expert Team

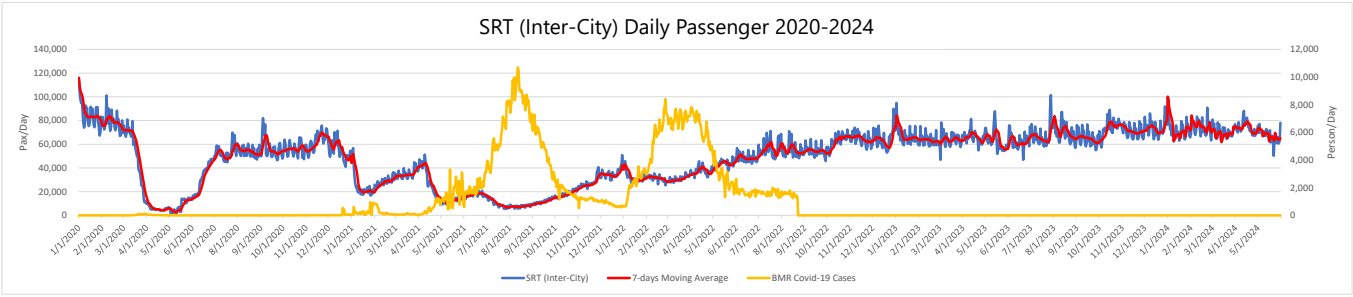
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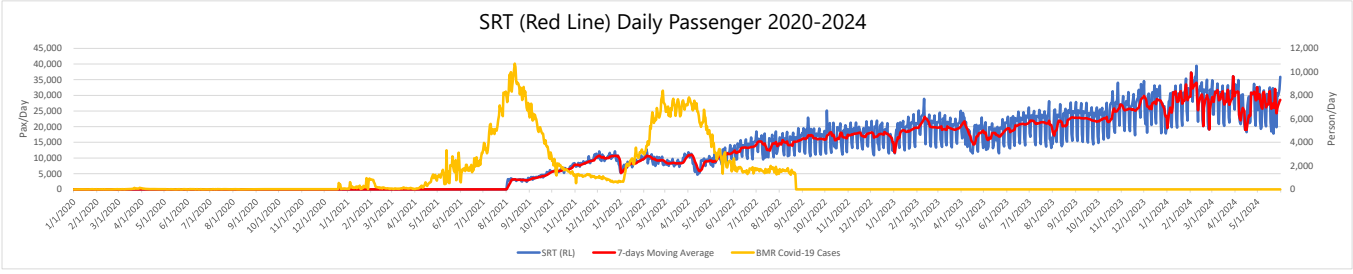




Source: JICA Expert Team

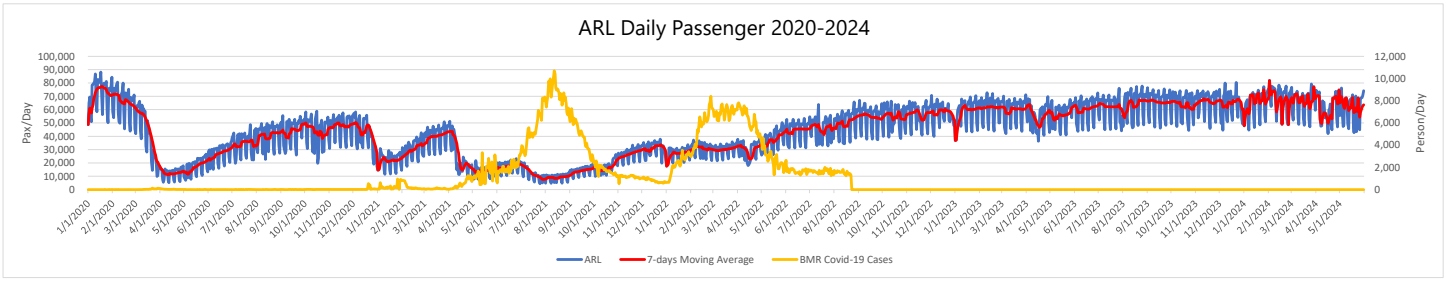
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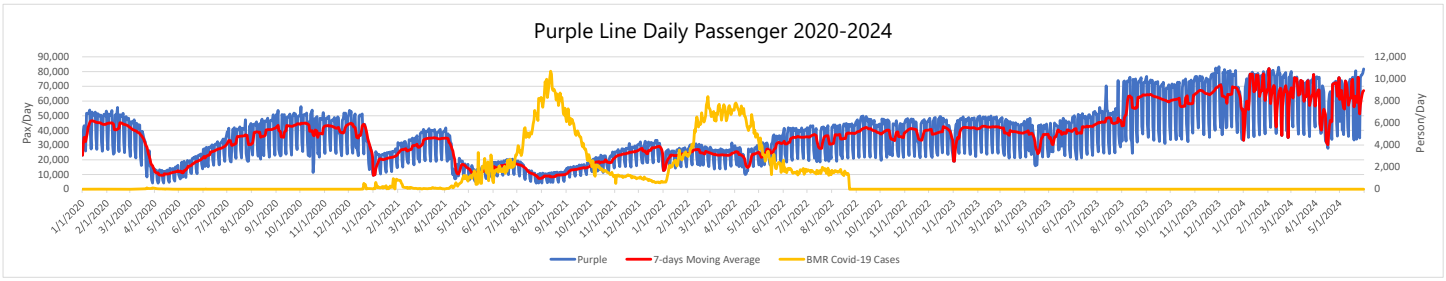




Source: JICA Expert Team

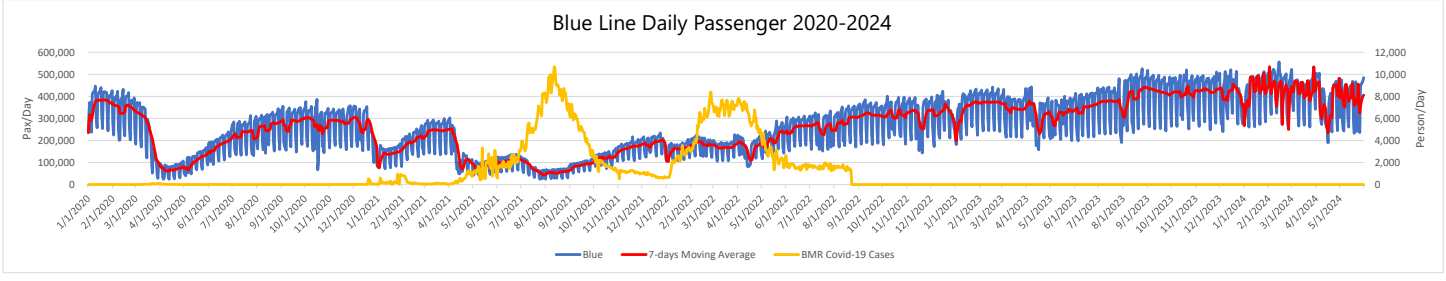
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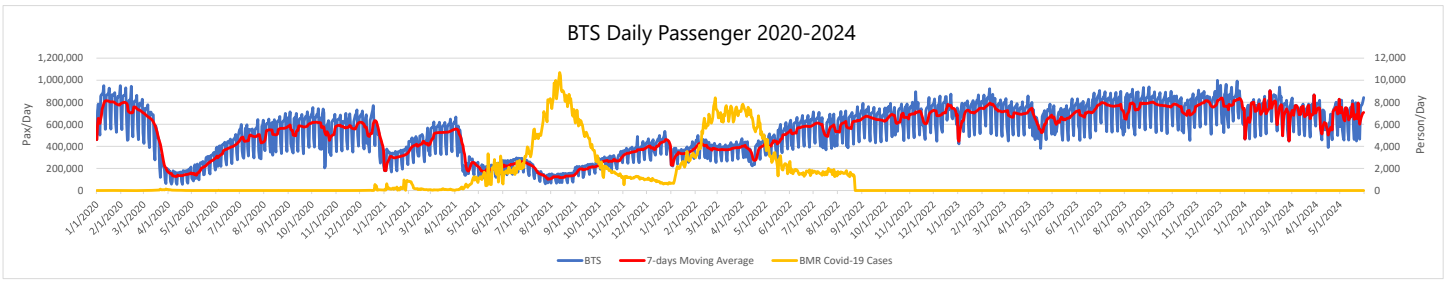




Source: JICA Expert Team

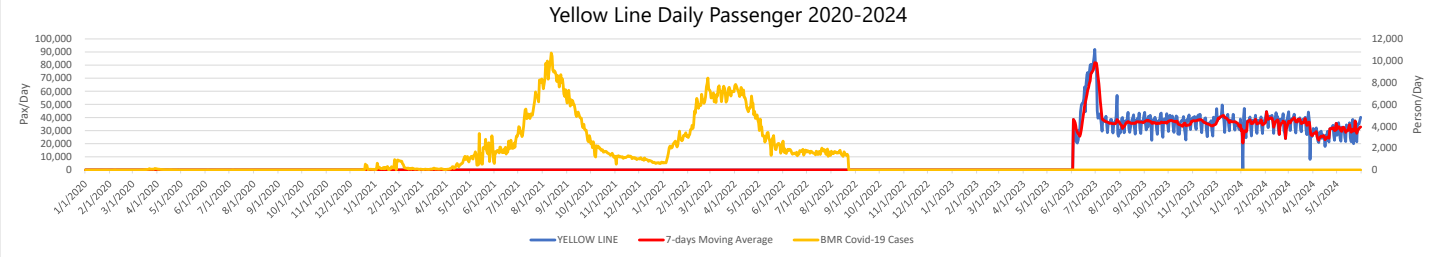
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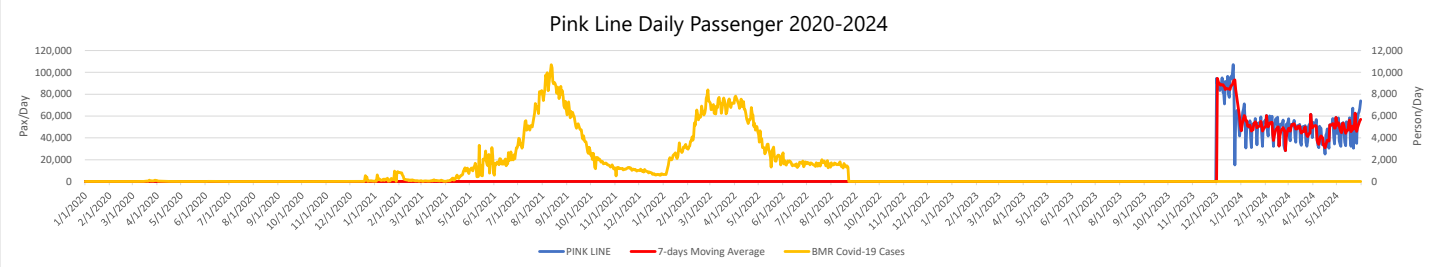




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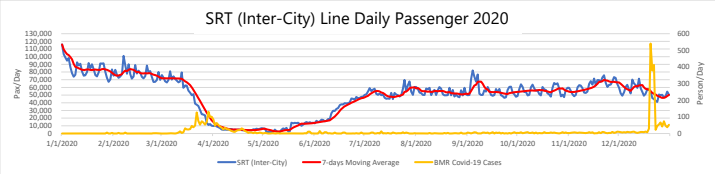


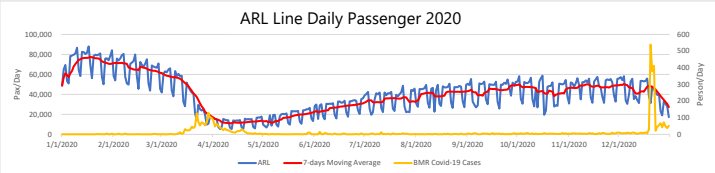
Source: JICA Expert Team

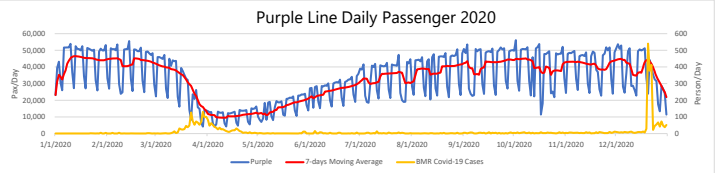
Attachment 2

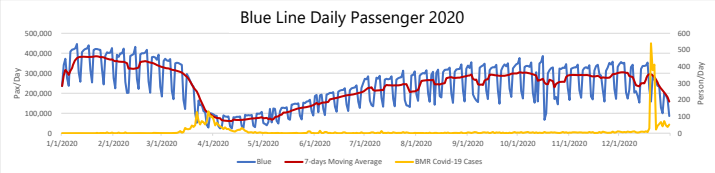
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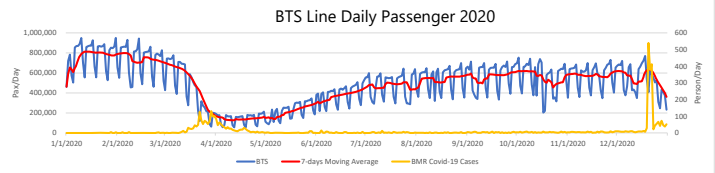
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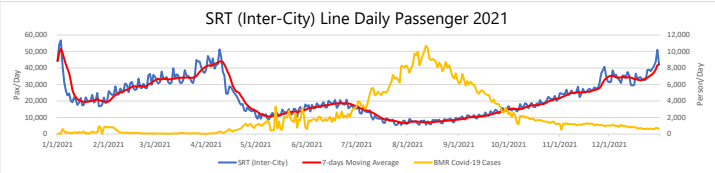


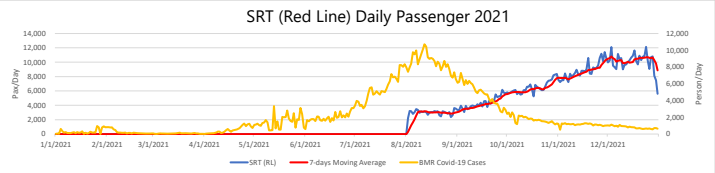


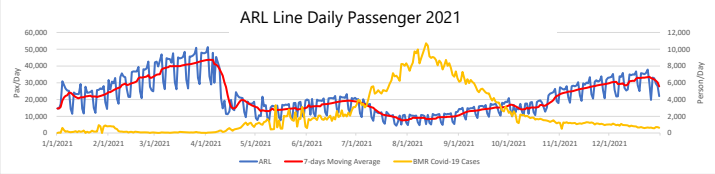
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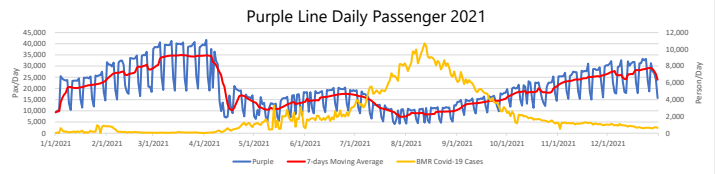
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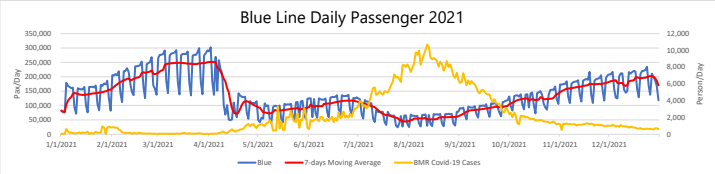
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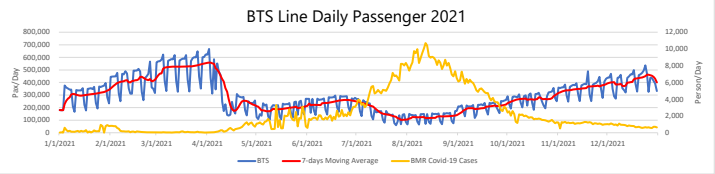








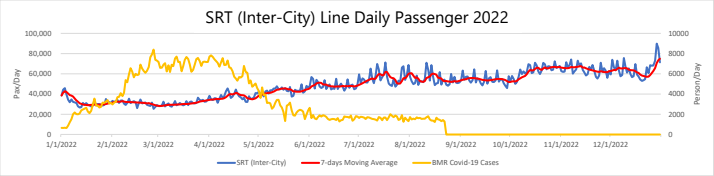


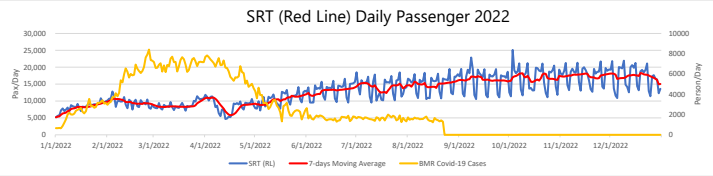


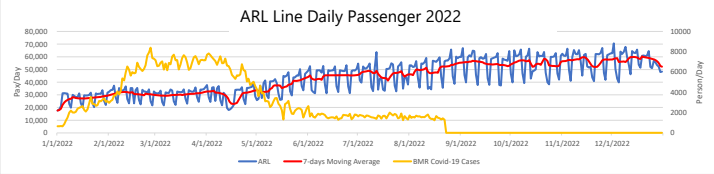
Source: JICA Expert Team

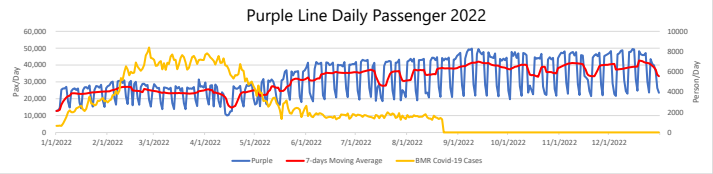
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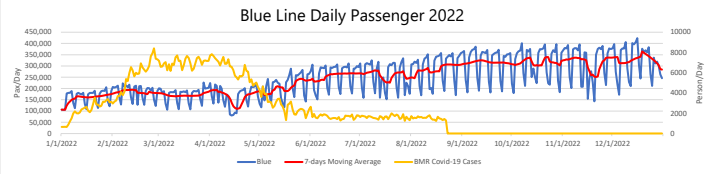
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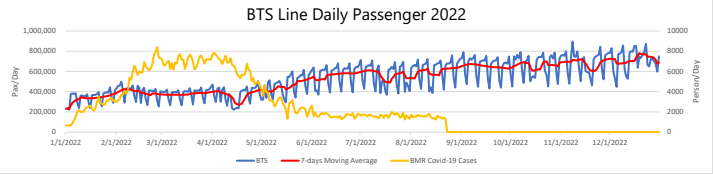








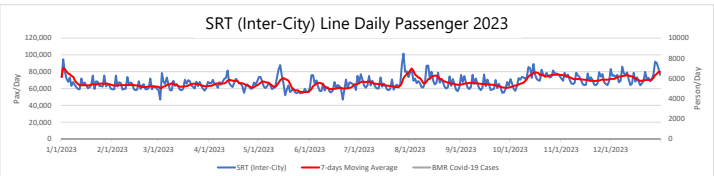


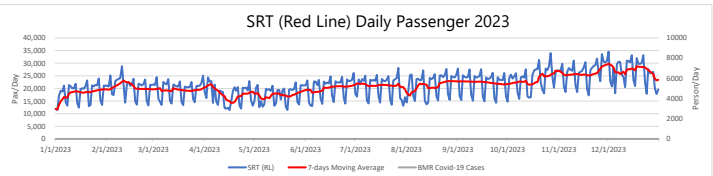


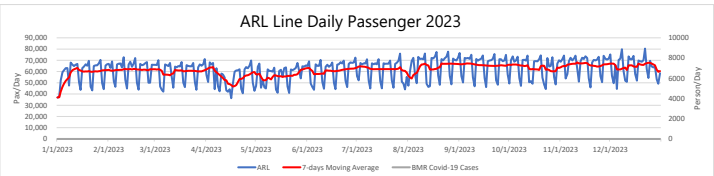
Source: JICA Expert Team

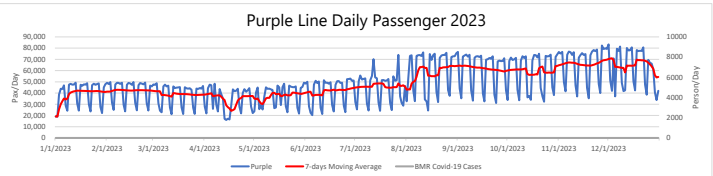
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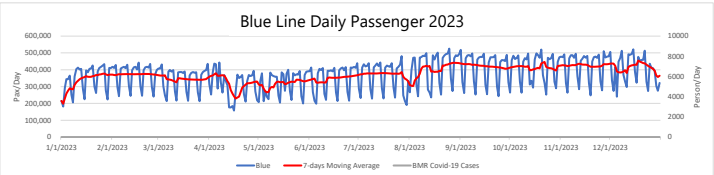
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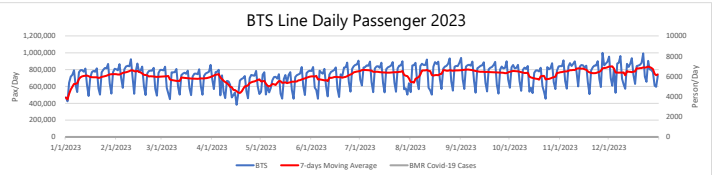








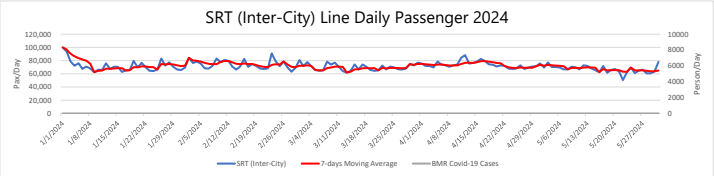


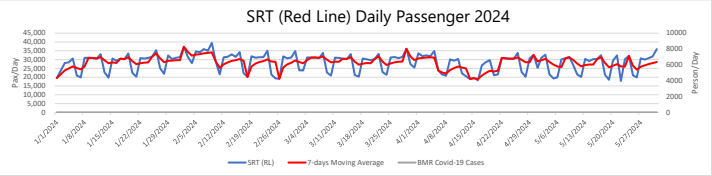


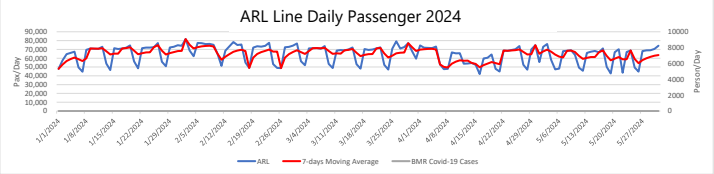
Source: JICA Expert Team

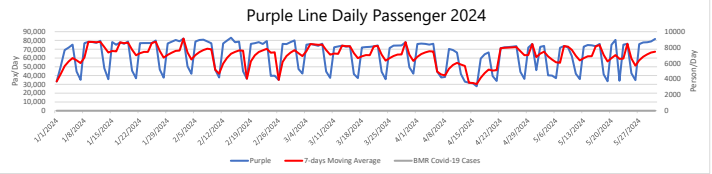
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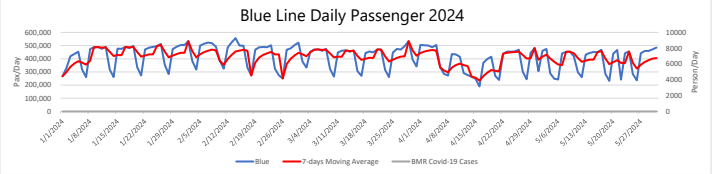
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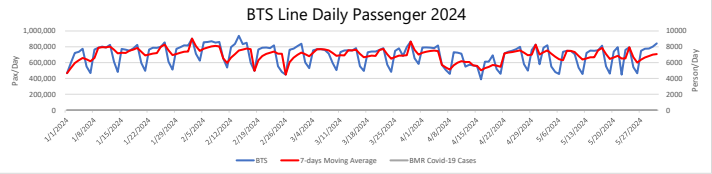








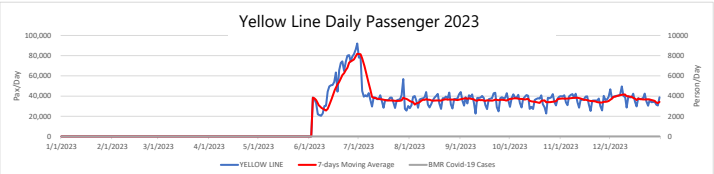


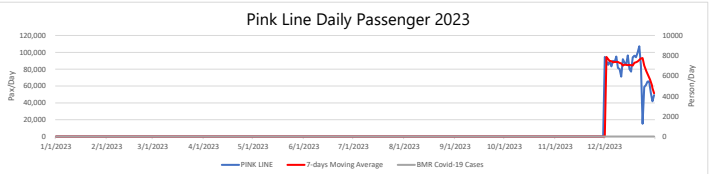


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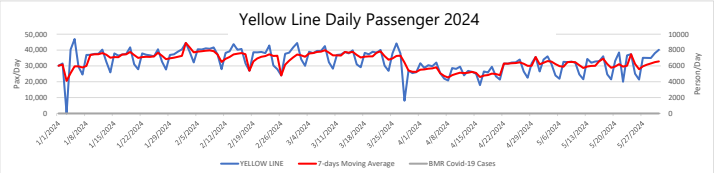
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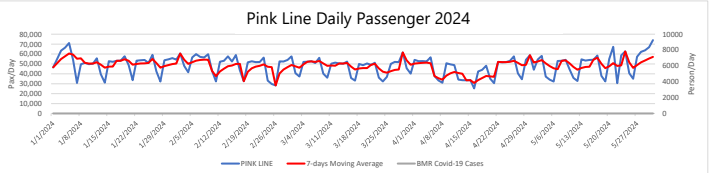
2023 (continue)





2024 (Continue)





Source: JICA Expert Team

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-5

- Introduction of Transport Demand Forecast –

Topics

1. Why do we need to forecast travel demand
2. How to forecast travel demand

1. Why do we need to forecast travel demand

1. Why do we forecast travel demand?

- What will happen if we don't forecast travel demand?
- How is the congestion below transport?



Blue Line in Bangkok,Thai



MRT in Manila, Philippines

Source: http://business.inquirer.net/133679/mrt-3-debt-gets-ratings-upgrade.



BRT in Jakarta, Indonesia

Source: http://commons.wikimedia.org/wiki/File:TransJakarta_Bundaran_HI.jpg



Automated Guideway Transit (AGT) in Aichi, Japan

Source: https://ja.wikipedia.org/wiki/%E6%A1%83%E8%8A%B1%E5%8F%B0%E6%96%B0%E4%BA%A4%E9%80%9A%E6%A1%83%E8%8A%B1%E5%8F%B0%E7%B7%9A#/media/File:Peachliner.jpg

1. Why do we forecast travel demand?

- Blue Line in Bangkok,Thai





1. Why do we forecast travel demand?

- MRT in Manila, Philippines



Source: http://autocar.com.ph/dotr-to-increase-number-of-operational-mrt-trains-by-april/



Line to the MRT 3
Source: http://insights.looloo.com/motorcycle-in-manila/

1. Why do we forecast travel demand?

- BRT in Jakarta, Indonesia



Source:
http://news.metrotvnews.com/read/2014/12/18/333760/naik-transjakarta-tanpa-macet-bakal-jadi-kenyataan



Source: http://www.thejakartapost.com/files/images/p03-b-1_13.jpg

1. Why do we forecast travel demand?

- AGT in Aichi, Japan
  - Abandoned in 2006 after 15-year operation, because of low passenger.
  - Bus is operating instead of AGT route now.





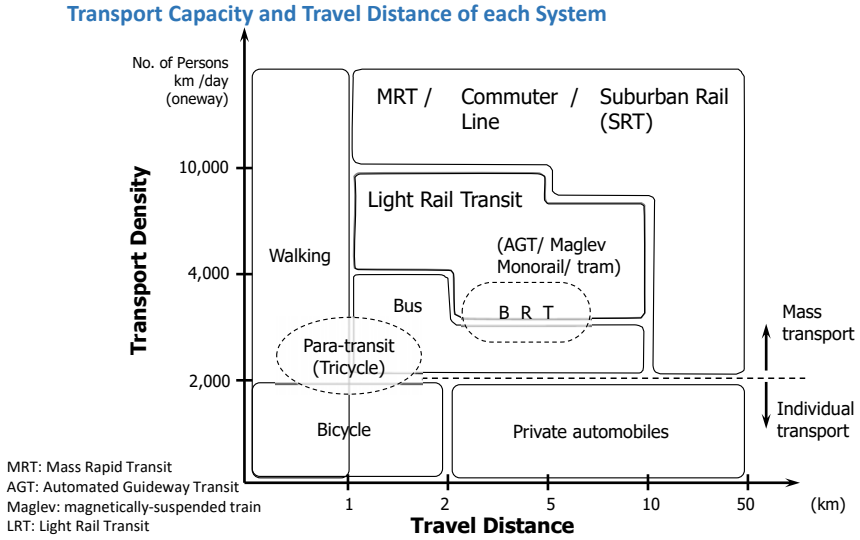
Source of Photos:
http://www.geocities.jp/chilokulo/toukadaihaisi.html

1. Why do we forecast travel demand?

■ How do we prevent these cases?

- Persuasive and accurate demand forecast is necessary
- Need to introduce appropriate system to meet expected traffic demands.

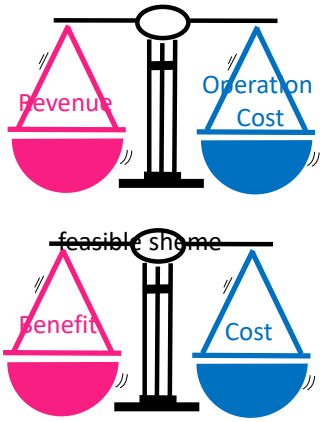
Transport Capacity and Travel Distance of each System



1. Why do we forecast travel demand?

Result of Demand forecast will be used below analysis

- Financial Analysis
- Cost-benefit analysis



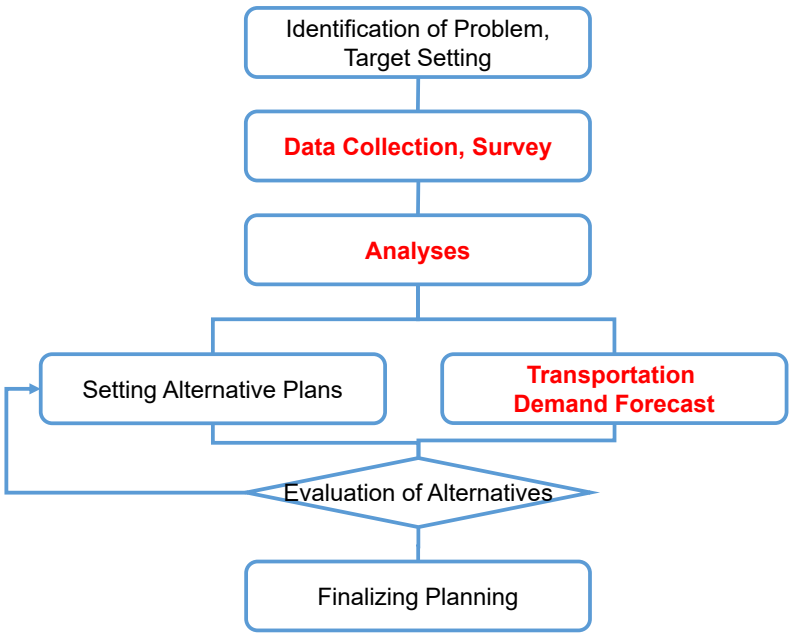
What will happen when revenue is lower than Operation cost?
Is it possible to continue the operation?

If we forecast future travel demand accurately
→We can select the proper mode
We select the feasible scheme

2. How to forecast travel demand

2. How to forecast travel demand

Planning Process



2. How to forecast travel demand

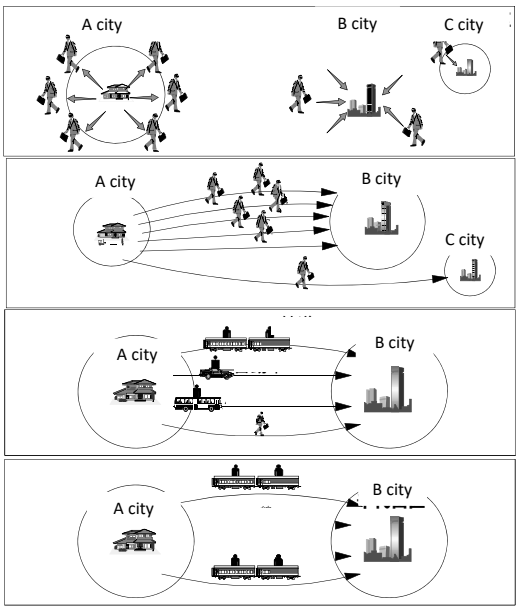
Flow of Four-Step Model

		Output
0	• Zoning, network data • Future Population	
1	• Trip Generation / Attraction	Number of trip from/to each zone
2	• Trip Distribution	Number of trip between each zone
3	• Modal Split	Number of trip between each zone by mode
4	• Assignment	Number of passenger / vehicle of each transport link (road / railway etc.)

2. How to forecast travel demand

Flow of Four-Step Model

1	• Trip Generation • / Attraction
2	• Trip Distribution
3	• Modal Split
4	• Assignment



2. How to forecast travel demand

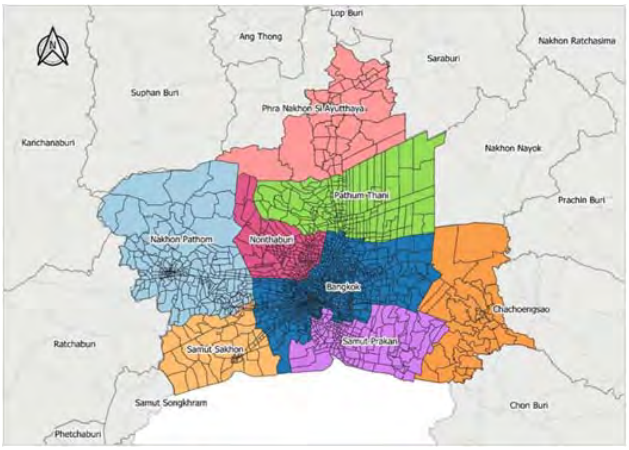
Zoning

What is Zoning

- Unit of area for demand forecasting

Point of zoning

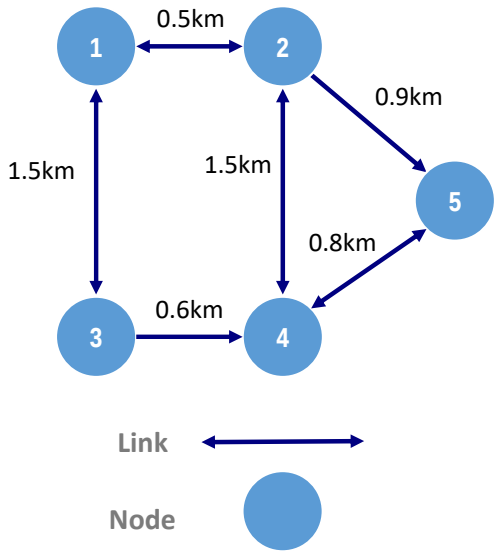
- Availability of Socio-economic Statistic
  → Administrative zones
- Balance of Demand Size
  → Small zone in center and large in suburbs
- Easy to Distinguish
- Budget constrain
- Computing time

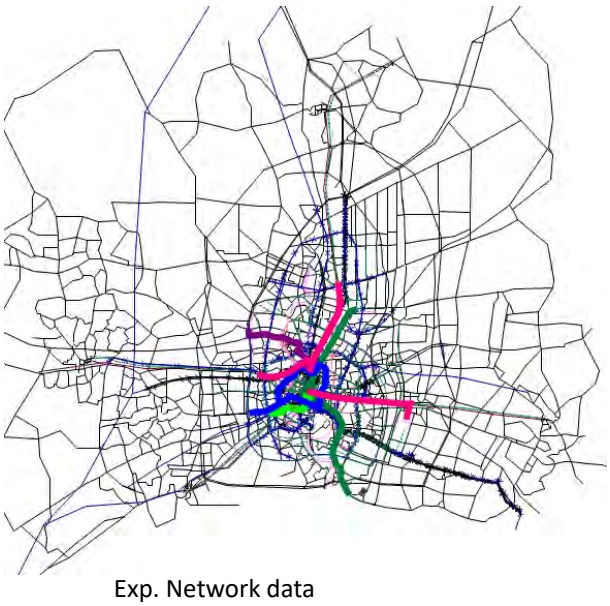


Barangay zone

2. How to forecast travel demand

Network Data





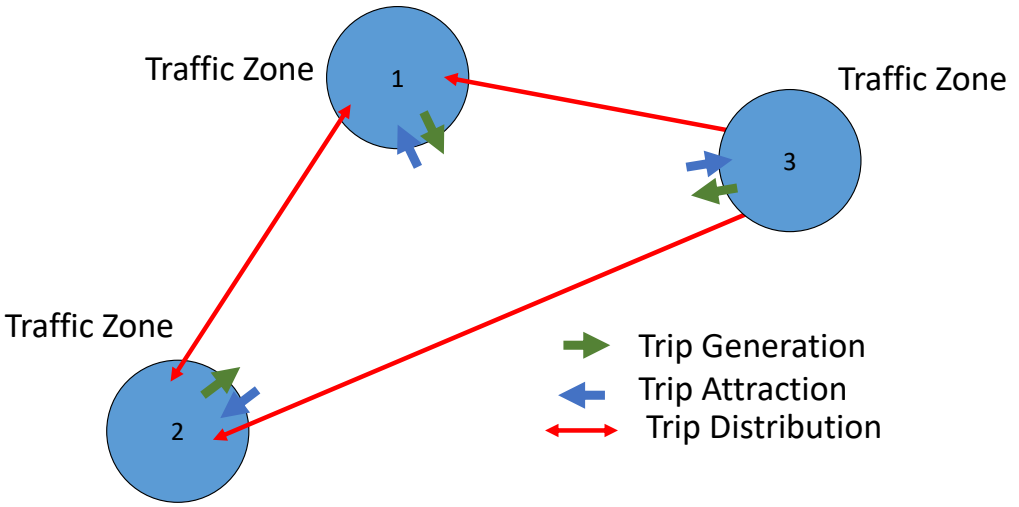
Exp. Network data

Distance, travel time and cost are calculating by network data

2. How to forecast travel demand

Four-step Model

- **Trip generation/attraction**
- **Trip distribution**



2. How to forecast travel demand

Trip Generation & Attraction

- Two methods in Generation and Attraction

☐ Trip Rate

First, calculate trip (generation, attraction) per person, or per 1m² floor area. Then apply this ratio to the forecasted population in the future to calculate the forecasted trip

〔Trip rate〕

$$\alpha = \frac{G_{現況}}{X_{現況}}$$

〔Future generation (or attraction) volume〕

$$G_{将来} = X_{将来} \times \alpha$$

α : Trip rate〔trip／person〕　G : volume〔trip〕
X : population in each zone〔person〕

・Calculation based on the current trip rate, so it is easy to resemble the current rate situation.
・Trip rate based on 2008 person-trip survey.

☐ Regression Analysis

Generation and Attraction volume will be estimated by various explanatory variables. Parameter will be estimated based on least square method.

〔Future generation (or attraction) volume〕

$$G_{将来} = \alpha + \beta \times X_{現況}$$

α、β : parameter　G: volume〔trip〕
X : population in each zone〔person〕

・By this method, it is possible to incorporate various indices in the model. However, it is difficult to resemble the result with the current situation.
・When analyze with regression model、if model r square is low, model capability to simulate the current situation will be reduce too.

2. How to forecast travel demand

Trip Distribution

- Three methods in Distribution

Current Pattern Method

Incorporate the growth rate and distribute each O-D by Frater Method

$$T_{ij} = t_{ij} \cdot \frac{G_i}{g_i} \cdot \frac{A_j}{a_j} \cdot \frac{1}{2} \left(\frac{g_i}{\sum_j t_{ij} \cdot A_j / a_j} + \frac{a_j}{\sum_i t_{ij} \cdot G_i / g_i} \right)$$

T_{ij} :Forecasted volume between zone i, j G :Forecasted generated volume in zone i

A_j :Forecasted attracted volume in zone j g :Current generated volume in zone i

t_{ij} :Current volume between zone i,j

a_j :Current attracted volumn in zone j

- Suitable for the area with less development, or with a few expected change in the future
- Not recommended for the area with a large change in the future

Function Model Method

- Gravity Model

Utilizing the Newton's law of gravity into the demand forecasting model by considering attraction-distribution as a mass, and the zone travel time as a decay parameter.

$$T_{ij} = \kappa \cdot G_i^{\alpha} \cdot A_j^{\beta} \cdot d_{ij}^{-\gamma}$$

G_i :Forecasted generated volume in zone i

d_{ij} :Travel time between zone i, j

T_{ij} :Forecasted volume between zone i, j

A_j :Forecasted attracted volume in zone j

$\alpha, \beta, \gamma, \kappa$:Parameter

- Suitable for the area with a large redevelopment plan

Similar Pattern Method

In the area with the large development is expected, the transport pattern will be completely changed. Therefore, this method consider this change based on the value from the nearby development.

Consider the travel pattern from the nearby developments

Match the similar development and apply the flow data. Then do iteration based on such flow data.

- Suitable for the area with a large scale land development.
- Because the pattern from nearby development is emulated, so there might a some distortion in trip between those area and area nearby

2. How to forecast travel demand

OD tables

Destination Zone

	1	2	3	.	.	j	.	.	n
1	40	22	32			t_{1j}			
2	23	53	16			t_{2j}			
3	31	19	66			t_{3j}			
.									
.									
i	t_{i1}	t_{i2}	t_{i3}			t_{ij}			
.									
.									
n									

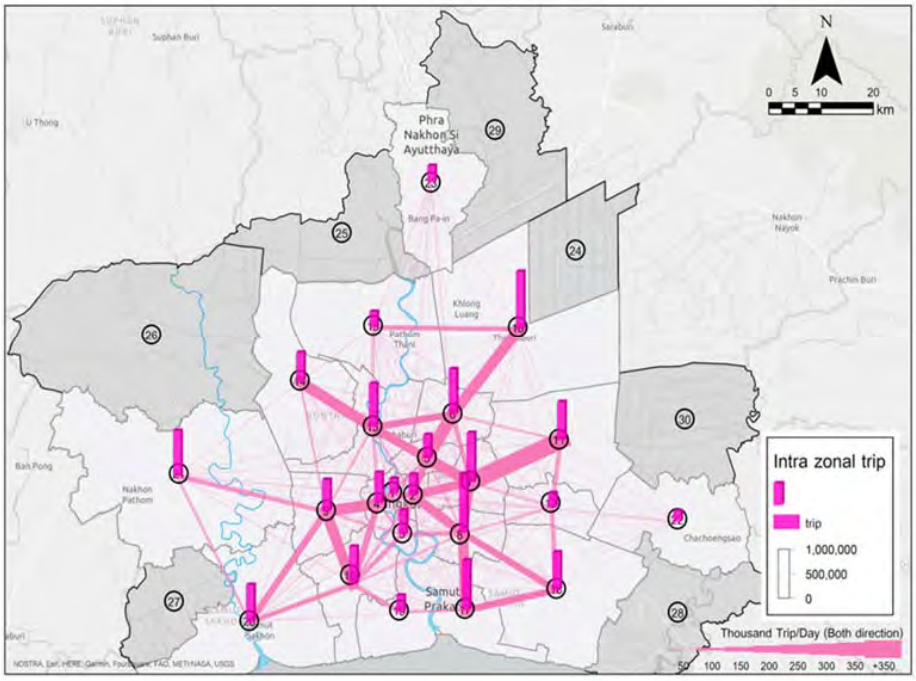
Origin Zone

Trip Generation

Trip Attraction

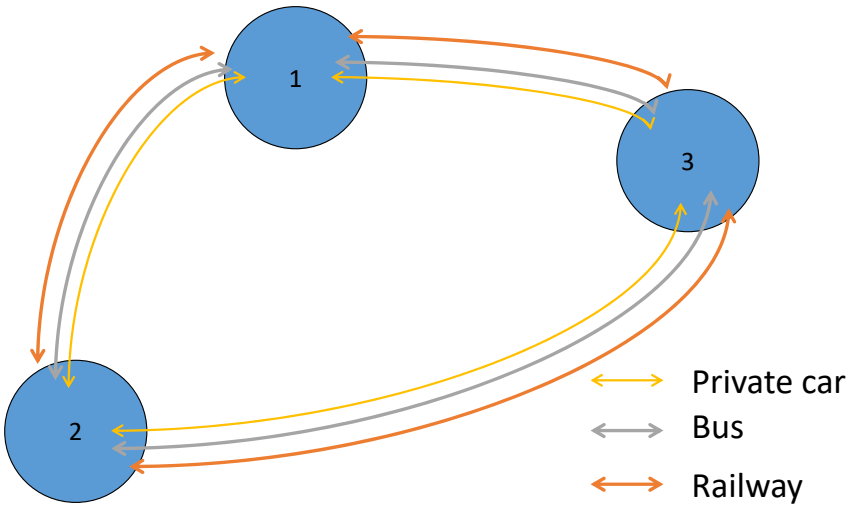
2. How to forecast travel demand

Example of trip distribution result by desire line



2. How to forecast travel demand

- Modal split



2. How to forecast travel demand

- Modal split

☐ Logit Model

In this model, utility probability distribution is based on Gumbel Distribution.

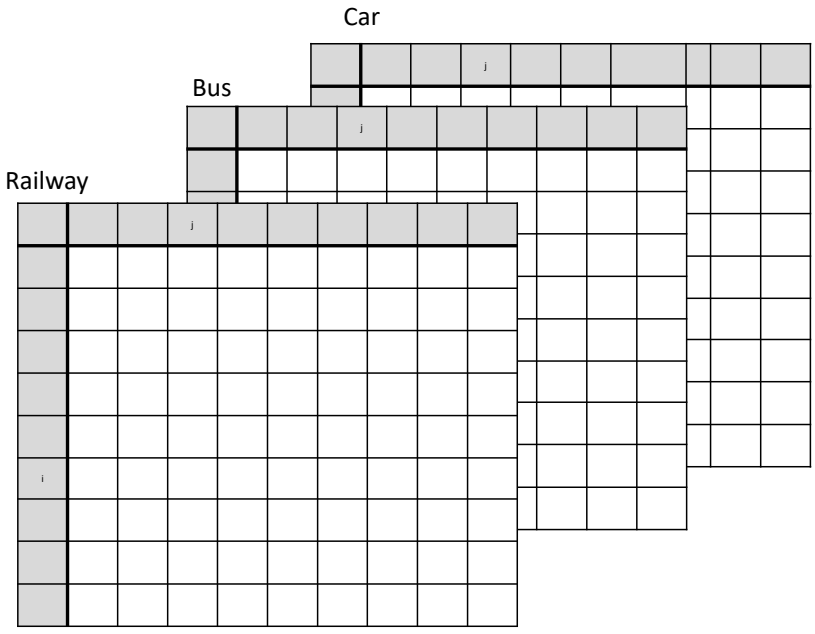
$$Pi = \frac{e^{Vi}}{e^{VR} + e^{VB} + e^{VC}}$$

$$Vi = \alpha_1 Ti + \alpha_2 C i + \alpha_3 D + \cdots$$

i : Mode（i＝R : rail、B : bus、C : car）　　Pi : Probability of selecting mode i
e=2.71828　　Vi : Utility when selecting mode i
Ti、Ci、D : explanatory variable of utility when selecting mode i
α : Utility estimation parameter

2. How to forecast travel demand

- OD tables by mode



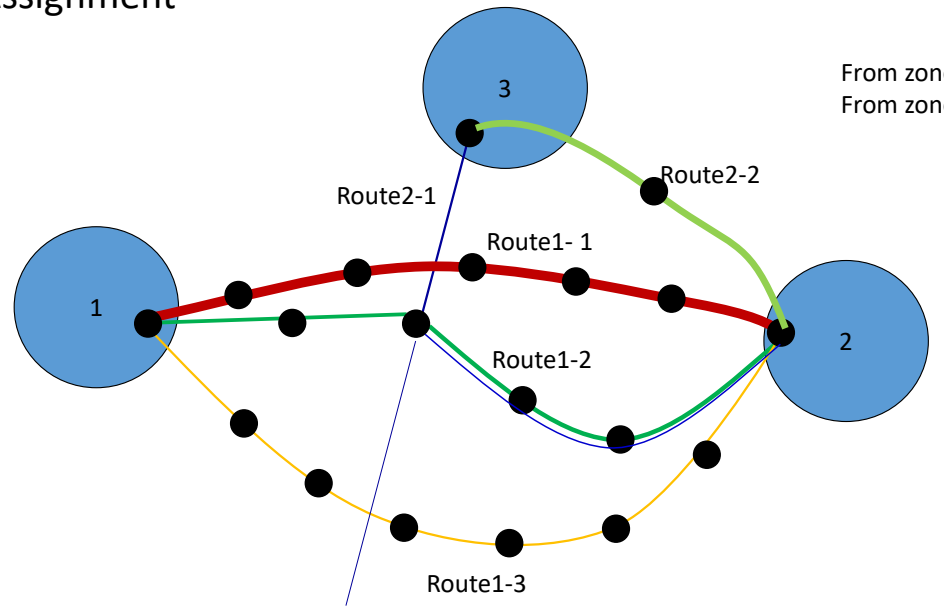
2. How to forecast travel demand

- Example of modal share result

Province	Mode Share			
	CAR	MC	BUS	RAIL
Bangkok				
TDS_Y17	47.01%	20.76%	30.40%	1.83%
BTDS_Y22	51.08%	33.50%	11.50%	3.92%
Model_Y19	47.71%	27.85%	20.52%	3.91%
Chachoengsao				
TDS_Y17	42.06%	47.43%	10.12%	0.38%
BTDS_Y22	51.37%	40.06%	8.57%	0.00%
Model_Y19	50.73%	29.21%	20.03%	0.03%
Nakhon Pathom				
TDS_Y17	32.82%	56.48%	10.64%	0.06%
BTDS_Y22	53.04%	42.56%	4.34%	0.06%
Model_Y19	50.27%	28.84%	20.81%	0.08%
Nonthaburi				
TDS_Y17	46.30%	28.86%	24.51%	0.33%
BTDS_Y22	58.19%	34.01%	7.01%	0.79%
Model_Y19	49.46%	28.22%	21.46%	0.86%

2. How to forecast travel demand

- Route Assignment



From zone 1 to 2,there are 3 routes
From zone 3 to 2 there are 2 routes

Logit model or probit model is used for the route assignment forecast for railway

2. How to forecast travel demand

- Assignment

Daily Line Loaded	Direction PP16 to PP01					Direction PP01 to PP16				
	Model	Obs.	Diff			Model	Obs.	Diff		
PP16 : Tao Poon	23,725	25,426	-1,701	-7%		0	0	0	0%	
PP15 : Bang Son	23,038	23,959	-921	-4%		21,775	23,016	-1,241	-5%	
PP14 : Wong Sawang	22,428	22,436	-8	0%		21,355	22,035	-680	-3%	
PP13 : Yaek Tiwanon	20,603	20,773	-170	-1%		21,406	21,410	-4	0%	
PP12 : Ministry of Public Health	18,350	18,570	-220	-1%		19,764	19,880	-116	-1%	
PP11 : Nonthaburi Civic Center	16,438	16,561	-123	-1%		17,441	17,608	-167	-1%	
PP10 : Bang Krasor	14,996	15,118	-122	-1%		16,115	16,193	-78	0%	
PP09 : Yaek Nonthaburi 1	13,373	13,491	-118	-1%		14,762	14,839	-77	-1%	
PP08 : Phra Nang Klao Bridge	12,630	12,735	-105	-1%		12,967	13,041	-74	-1%	
PP07 : Sai Ma	11,845	11,906	-61	-1%		12,344	12,447	-103	-1%	
PP06 : Bang Rak Noi Tha It	10,441	10,446	-5	0%		11,255	11,291	-36	0%	
PP05 : Bang Rak Yai	10,044	10,080	-36	0%		9,856	9,859	-3	0%	
PP04 : Bang Phlu	8,892	8,931	-39	0%		9,278	9,299	-21	0%	
PP03 : Sam Yaek Bang Yai	8,345	8,416	-71	-1%		8,243	8,267	-24	0%	
PP02 : Talad Bang Yai	2,853	2,837	16	1%		7,532	7,577	-45	-1%	
PP01 : Khlong Bang Phai	0	0	0	0%		4,207	4,178	29	1%	
			MAPE	1%				MAPE	1%	

Appendix-6:

Demand Forecast Modeling in the Tokyo Metropolitan Region

- Its development history and modeling structure-

General Information

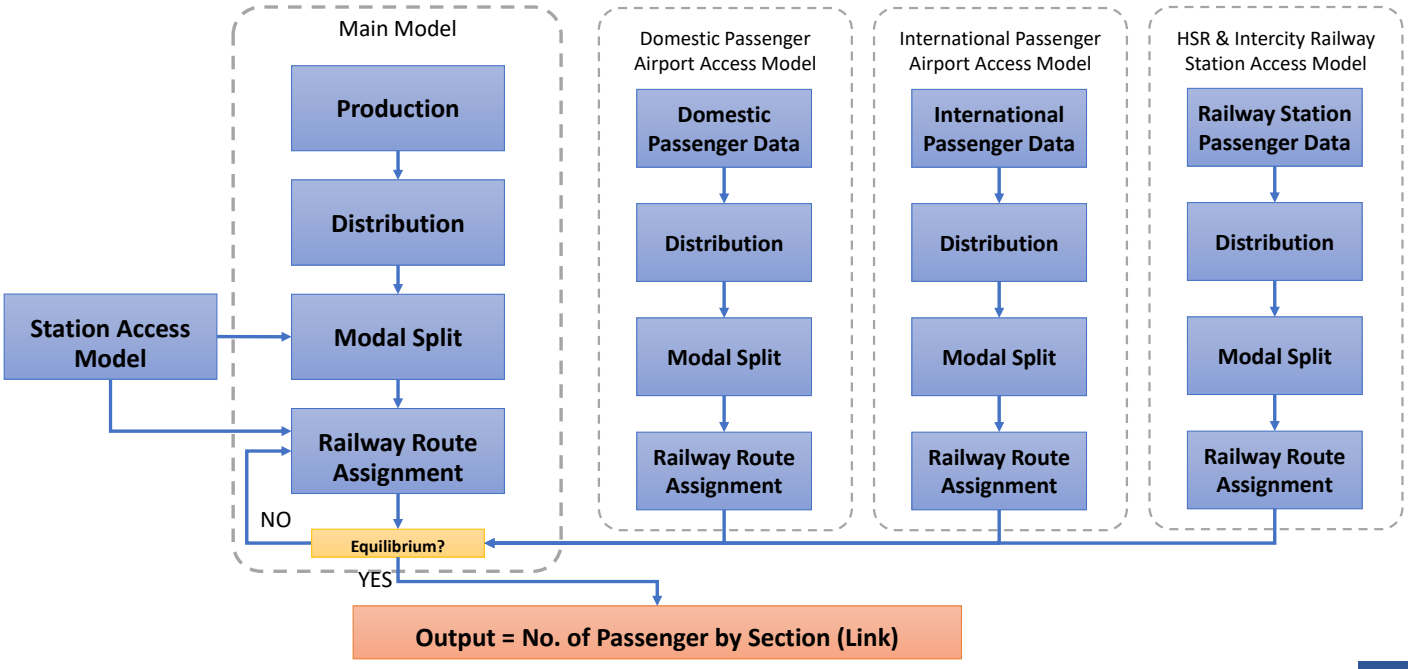
- Developed by CalibriMLIT
  - Secretariat: Railway Bureau and Kanto Regional Bureau (MLIT)
- Railway Master Plan Model for Tokyo Metropolitan Area
  - Tokyo, Kanagawa, Saitama, Chiba, and a part of Ibaraki Pref.
  - Study area approx. 50km radius from CBD
  - Population of 30 Million
- 4-Step Model
- Latest Model Developed in 2016
  - Which we will cover this model today



Development History

	Analysis	Features of Model
CUTP No.15 (1972) Target year 1985	Demand forecasting and other related analyses	・First introduction of 4-Step Model ・40 analysis zones
CTPP No.7 (1985) Target year 2000	Evaluation of the congestion rate in the most congested section	・Analysis of morning peak-hours by consider only working and schooling commuter ・Introduction of Disaggregate Travel Demand Model ・658 analysis zones
CTPP No.18 (2000) Target year 2015	・Congestion alleviation, time savings analysis ・Evaluation of railway service profitability ・Cost-effectiveness analysis (CEA) ・Service continuity	・Include daytime traffic analysis (not only peak hour) for profitability estimation ・Introduction of congestion parameter ・Introduction of Probit Model ・Introduction of Airport and HSR access model ・1,812 analysis zones
CTPP No.198 (2016) **Target year 2030**		・Increase the group of trip purpose ・Analysis by age groups due to the effect of population aging ・2,843 analysis zones

Demand Forecast Model in CTPP No.198: Overall Flow



Main Model: Structure



2,843 analysis zones + 64 external zones = 2,907 zones

Trip Purpose	
1) Home to Work	6) Work - Business
2) Home to School	7) Work to Home
3) Home to Private	8) School to Home
4) Non Home-Based Private	9) Private to Home
5) Home to Business	10) Business to Home

Time Period		
AM Peak (purpose 1-2)	Off Peak (purpose 3-6)	PM Peak (purpose 7-10)

Age Group (for Home to Work*)	
Production Model	Every 5 years, until 85+
Distribution Model	Female: 15-34, 35-64, 65-74, 75+ Male: -64, 65-74, 75+
Modal Split Model	-64, 65+
Route Assignment Model	

*For other trip purposes, see slide 6

Major Data Input
• 2010 National Census (for Production) • 2008 Person-Trip Survey (for Distribution and Modal Split) • 2010 Metropolitan Transport Census (for Route Assignment) • Other railway passenger statistics for reconstruction and calibration

Main Model: Production

Trip Rate Method

$$G_{ipa} = \alpha_{ipa} \cdot X_{ipa}$$

$$\alpha_{ipa} = \frac{g_{ipa}}{x_{ipa}}$$

Where
G_{ip}: **Future** trip generated from zone i for trip purpose p, age group a
X_{ip}: **Future** population index from zone i for trip purpose p, age group a
α_{ip}: Trip generation rate from zone i for trip purpose p, age group a
g_{ip}: **Current** trip generated from zone i for trip purpose p, age group a
x_{ip}: **Current** population index from zone i for trip purpose p, age group a

Same applies with attraction, but with different population index

Age Group by Trip Purpose

Trip Purpose (same as page 4)

	①通勤		②通学		③自宅発私事		④その他私事		⑤自宅発業務		⑥勤務先発業務		⑦勤務先からの帰宅		⑧通学先からの帰宅		⑨私事先からの帰宅		⑩業務先からの帰宅	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Production	5歳階層別	5歳階層別	5歳階層別	5歳階層別	15未満 15-64 65-74 75以上	15未満 15-34 35-64 65-74 75以上	15未満 15-64 65-74 75以上	15未満 15-34 35-64 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	15-34 35-64 65-74 75以上	15未満 15以上	15未満 15以上	15未満 15-64 65-74 75以上	15未満 15-34 35-64 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上
Distribution	65未満 65-74 75以上	15-34 35-64 65-74 75以上	15未満 15以上	15未満 15以上	15未満 15-64 65-74 75以上	15未満 15-34 35-64 65-74 75以上	15未満 15-64 65-74 75以上	15未満 15-34 35-64 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上	15-34 35-64 65-74 75以上	15未満 15以上	15未満 15以上	15未満 15-64 65-74 75以上	15未満 15-34 35-64 65-74 75以上	65未満 65-74 75以上	65未満 65-74 75以上
Modal Split	65未満 65以上		全年齢統合		65未満 65-74 75以上		65未満 65-74 75以上		65未満 65以上		65未満 65以上		65未満 65以上		全年齢統合		65未満 65-74 75以上		65未満 65以上	
Route Assignment	65未満 65以上		全年齢統合		65未満 65以上		65未満 65以上		65未満 65以上		65未満 65以上		65未満 65以上		全年齢統合		65未満 65以上		65未満 65以上	

Main Model: Production

Population Index and Trip Rate by Trip Purpose

Trip Purpose	Generation		Attraction	
	Population Index	Trip Rate	Population Index	Trip Rate
1) Home to Work	Number of workers	1.000	Number of employment	1.000
2) Home to School	Number of students	1.000	Number of school seats	1.000
3) Home to Private	Number of people who stay at home during the daytime*	0.716	Daytime population	0.265
4) Non Home-Based Private	Daytime population	0.237	Daytime population	0.237
5) Home to Business	Number of workers	0.075	Number of employment	0.075
6) Work - Business	Number of employment	0.194	Number of employment	0.194
7) Work to Home	Number of employment	0.465	Number of workers	0.466
8) School to Home	Number of school seats	0.713	Number of students	0.715
9) Private to Home	Daytime population	0.312	Nighttime population	0.312
10) Business to Home	Number of employment	0.076	Number of workers	0.076

*equals to = Nighttime pop. – No. of workers – No. of employment + No. of people WFH

Main Model: Distribution

Two steps in Distribution Model

1. **Gravity Model**
- Used as initial OD trip only on a specific on area, trip purpose, origin, or destination with expected land development

2. **Growth Rate Model**
- After distribute by Gravity Model on the specific ODs, apply growth rate for the rest based on future population data
- Most of the urban areas are already developed in TMA, so assume no large scale development between OD
- Finally, balance with Fratar Method until total generation = total attraction

Main Model: Distribution

Gravity Model

$$T_{ijpa} = (\kappa + \delta_0 \cdot d_0) \cdot G_{ipa}^{\alpha} \cdot A_{jpa}^{\beta} \cdot c_{ij}^{(\gamma + \delta_0 \cdot d_0 + \sum_k \delta_k \cdot d_k)}$$

Where

T_{ij}: **Future** no. of trip from zone i travel to zone j

A_j: **Future** Trip attracted to zone j

c_{ij}: Generalized cost of trip from zone i to j

δ_0, d_0: CBD, sub-CBD parameter and dummy

δ_k, d_k: k[th] distance parameter and dummy

$\alpha, \beta, \gamma, \kappa$: other gravity model parameters

Note: CBD, sub-CBD and distance dummy may be excluded from some trip purpose and age group models

Model Variables

Variables	Detail
Generation	Trip generated, calculated from Generation Model (10,000 person)
Attraction	Trip attracted, calculated from Attraction Model (10,000 person)
Generalized Cost	OD generalized cost calculated from Modal Split Model
<10 km Dummy	1 if road distance between OD is in dummy range, 0 otherwise
10-20 km Dummy	
20-30 km Dummy	
30-40 km Dummy	
40-50 km Dummy	
50-60 km Dummy	
CBD, sub-CBD Dummy	1 if O or D zones (or both) are defined as CBD or sub-CBD, 0 otherwise

Main Model: Distribution

Growth Rate Model

$$T_{ij} = t_{ij} \cdot \frac{G_i}{g_i} \cdot \frac{A_i}{a_i} \cdot \frac{1}{2}\left(\frac{g_i}{\sum_j t_{ij} \cdot \frac{A_j}{a_j}} + \frac{a_j}{\sum_i t_{ij} \cdot \frac{G_i}{g_i}}\right)$$

Where
t_{ij}: **Current** no. of trip from zone i travel to zone j
g_i: **Current** Trip generated from zone i
a_j: **Current** Trip attracted to zone j

	1	...	j	...	J	
1	T_{11}	...	...	...	T_{1J}	G_1
:	:	⋱			:	:
i	:		T_{ij}		:	:
:	:			⋱	:	:
J	T_{J1}	...	...	...	T_{JJ}	G_J
	A_1	...	...	...	A_J	$\sum_{i=1}^{J} G_i = \sum_{j=1}^{J} A_j$

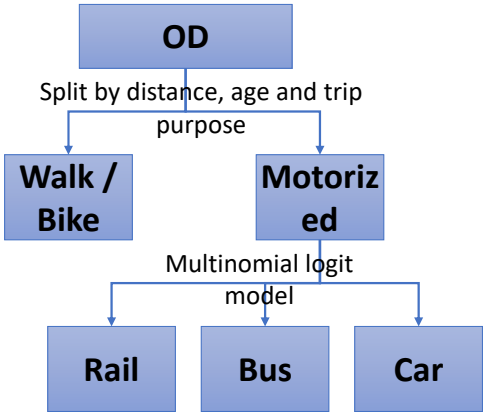
Note: use T_{ij} from Gravity Model if already specified by Gravity Model

Main Model: Modal Split

Two steps in Modal Split Model
(Nest structure, but not Nested Logit Model)

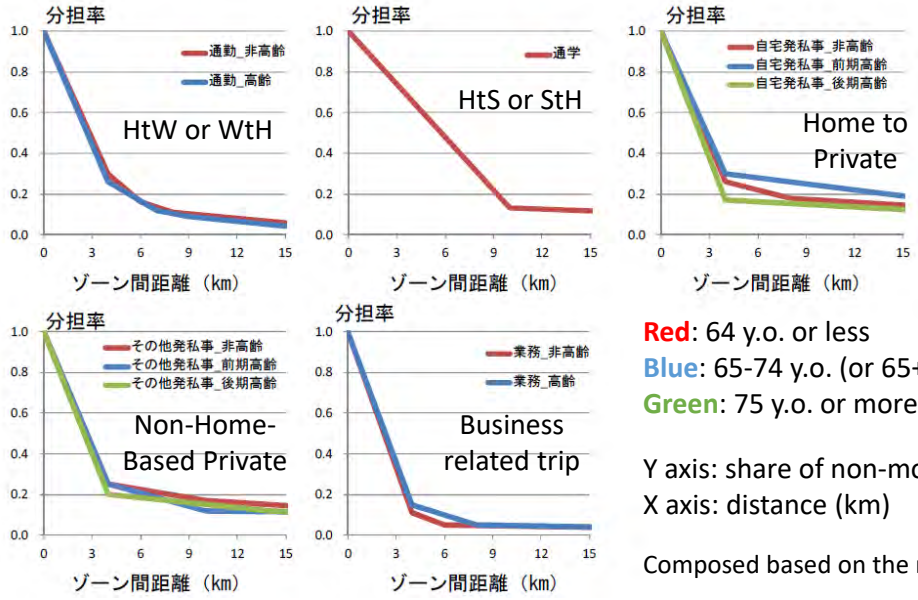
1. Motorized – Non-Motorized Split
- Fixed the non-motorized share (walk and bicycle) based on the distance, age and trip purpose

2. Motorized Modal Split
- Split motorized mode by rail, bus and car
- Multinomial Logit Model
- For rail choice, consider log sum of station access model as one of the variables



Main Model: Modal Split

Motorized – Non-Motorized Split



Red: 64 y.o. or less
Blue: 65-74 y.o. (or 65+ if there is no green line)
Green: 75 y.o. or more

Y axis: share of non-motorized mode
X axis: distance (km)

Composed based on the result of 2008 Person-Trip Survey

Main Model: Modal Split

Motorized Modal Split

$$P_i = \frac{exp(V_i)}{\sum_{i=1}^{n} exp(V_i)}$$

$$V_i = \sum_k (\theta_k \cdot X_{ik})$$

Where
P_i= Probability of selecting mode i
V_i= Utility of selecting mode i
n= Number of transport mode, here = 3 (rail, bus, car)
θ_k= kth utility parameter
X_{ik} = kth utility variable of mode i

Model Variables

Variables	Detail
Travel Cost (Yen)	RAIL: rail fare BUS: bus fare CAR: VOC (fuel, maintenance) + toll fee
Travel Time (Minute)	RAIL: boarding + transfer + waiting time BUS: boarding + waiting + access/egress to bus stop time CAR: driving + parking (both O&D) time
Vehicle Ownership (Veh/Person)	(CAR ONLY) Vehicle Ownership per capita (20-84 y.o.)
CBD Dummy	(CAR ONLY) 1 for destination zone in the municipality with car share less than 20%, 0 otherwise
Station Access	(RAIL ONLY) Log-sum of the utility of every mode calculated railway station access model, calculated as sum of log-sum of access and egress
Short Trip Dummy	(CAR ONLY) 1 for OD with distance less than 5km, 0 otherwise
ASC	Alternative specific constant for each mode. Bus as a reference.

Main Model: Modal Split

Estimates		Home to Work, Work to Home				HtS, StH	
		-64		65+		All age	
		parameter	t-value	parameter	t-value	parameter	t-value
Travel Cost (yen)	All	-0.00123	-10.4	-0.000940	-7.34	-0.00561	-13.1
Travel Time (min)	All	-0.0482	-18.2	-0.0389	-13.8	-0.0102	-2.13
Vehicle Ownership	CAR	1.13	7.23	2.45	12.9	0.972	3.35
CBD Dummy	CAR	-1.72	-21.3	-0.847	-8.57	-0.571	-2.05
Station Access	RAIL	0.446	33.6	0.504	24.0	0.148	4.93
Short Trip Dummy	CAR	0.665	6.13	0.530	4.33	2.18	6.87
ASC	BUS	-0.773	-7.65	0.248	1.98	4.28	14.0
	RAIL	2.82	21.8	2.73	17.0	4.80	14.8
Adjusted R^2		0.740		0.545		0.975	
Hit Ratio		90.3		79.9		93.8	
Travel Time VOT (yen/min)		39.3		41.3		1.81	
N		9,763		3,689		2,786	

Main Model: Railway Route Assignment

Multinomial Probit Model

$$P_m^{c-r} = \int_{\varepsilon_1=-\infty}^{\varepsilon_m+V_m^{c-r}-V_1^{c-r}} \cdots \int_{\varepsilon_m=-\infty}^{+\infty} \cdots \int_{\varepsilon_M=-\infty}^{\varepsilon_m+V_m^{c-r}-V_M^{c-r}} \phi(\varepsilon) d\varepsilon_M \cdots d\varepsilon_1$$

$$\phi(\varepsilon) = (2\pi)^{-\frac{M}{2}} |\Sigma|^{-\frac{1}{2}} \exp\left(-\frac{1}{2}\varepsilon\Sigma^{-1}\varepsilon^T\right)$$

$$\Sigma = \sigma^2 \begin{pmatrix} L_1 & L_{12} & \cdots & L_{1M} \\ L_{12} & L_2 & \cdots & L_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ L_{1M} & L_{2M} & \cdots & L_M \end{pmatrix} + \sigma_0^2 I$$

Covariance Matrix for distance

Covariance Matrix for other route characteristics

$$\eta = \frac{\sigma^-}{\sigma_0^2}$$

$$\Sigma = \sigma_0^2 \begin{pmatrix} \eta L_1 + 1 & \eta L_{12} & \cdots & \eta L_{1M} \\ \eta L_{12} & \eta L_2 + 1 & \cdots & \eta L_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ \eta L_{1M} & \eta L_{2M} & \cdots & \eta L_M + 1 \end{pmatrix}$$

$$V_m = \sum_k (\theta_k \cdot X_{mk})$$

Model Variables

Variables	Detail
Fare (Yen)	Total route fare from origin station to destination station
Boarding Time (Min)	Total boarding time from origin station to destination station
Transfer Time, Horizontally (Min)	Time spent on walking horizontally while transferring the train
Transfer Time, Vertically (Min)	Time spent on moving vertically (elevator, escalator, etc.) while transferring the train
Waiting Time (Min)	Total time waiting for train boarding, including the first ride. Assume as a half of headway.
Congestion Index	Calculated from travel time and congestion rate, see below
Station Access	Log-sum of the utility of every mode calculated railway station access model
Variance Ratio	Similarity of a certain route to other routes

Congestion Index

$$CI_m = \sum_j \left(B_{mj} \cdot \left(\frac{CR_{mj}}{100} \right)^2 \right)$$

Where
CI_m= Congestion index of route m
B_{mj}= Boarding Time of link j, route m
CR_{mj}= Congestion rate of link j, route m

Main Model: Railway Route Assignment

	Work				School		Private				Business	
	-64		65+		All Age		-64		65+		All Age	
	parameter	t-value	parameter	t-value	parameter	t-value	parameter	t-value	parameter	t-value	parameter	t-value
Fare	−0.00355	−3.89	−0.00325	−3.09	−0.00415	−3.94	−0.00365	−3.56	−0.00447	−2.84	−0.00314	−2.74
Boarding Time	−0.151	−7.35	−0.0974	−5.62	−0.0800	−5.40	−0.0912	−5.22	−0.102	−3.13	−0.136	−7.35
Horizontal Transfer	−0.242	−6.54	−0.139	−4.22	−0.133	−3.51	−0.205	−3.94	−0.183	−2.60	−0.140	−2.79
Vertical Transfer	−0.313	−4.77	−0.329	−4.91	−0.137	−2.02	−0.221	−2.87	−0.261	−2.10	−0.376	−4.25
Waiting Time	−0.145	−4.24	−0.112	−3.63	−0.0784	−3.37	−0.105	−3.67	−0.120	−2.52	−0.132	−4.07
Congestion Index	−0.0122	−2.50	−0.0335	−5.42	−0.0101	−1.88						
Station Access	0.883	12.7	0.991	10.6	0.908	12.6	0.752	11.4	0.975	4.98	0.888	12.2
Variance Ratio	0.128	2.88	0.022	1.16	0.019	1.08	0.033	1.15	0.253	1.36	0.035	1.32
Adjusted R^2	0.440		0.389		0.433		0.353		0.331		0.490	
Boarding VOT	42.6		30.0		19.3		25.0		22.7		43.2	
Horizon Transfer VOT	68.3		42.7		32.0		56.2		40.9		44.5	
Vertical Transfer VOT	88.1		101		33.1		60.5		58.4		120	
Waiting VOT	40.7		34.3		18.9		28.8		26.9		41.9	
N	1,000		500		500		500		500		500	

Station Access Model

Calculate the share of mode used for railway station access, from walk, bicycle, car, bus

$$P_i = \frac{exp(V_i)}{\sum_{i=1}^{n} exp(V_i)}$$

$$V_i = \sum_{k} (\theta_k \cdot X_{ik})$$

Where
P_i= Probability of selecting mode i
V_i= Utility of selecting mode i
n= Number of transport mode, here = 4 (walk, bicycle, car, bus)
θ_k= k^{th} utility parameter
X_{ik} = k^{th} utility variable of mode i

Model Variables

Variables	Detail
Non-Motorized Travel Time (Minute)	(WALK, BICYCLE ONLY) WALK: walking time between origin or destination to station BICYCLE: cycling time between origin or destination to station, parking time included
Motorized Travel Time (Minute)	(CAR, BUS ONLY) CAR: travel time between origin or destination to station, parking time included BUS: travel time between origin or destination to station, access/egress time to bus stop included
Travel Cost (Yen)	Total cost spent between origin or destination to station
Elevation Difference	(WALK, BICYCLE ONLY) Elevation difference between origin or destination to station. Reference from 50m mesh elevation data
LN(Frequency)	(BUS ONLY) Business, Private: Ln of frequency per day Work, School: Ln of peak hour frequency, calculated from frequency per day x 0.16
ASC	Alternative specific constant for each mode. CAR as a reference.

Transport Hub (Airport, HSR Station) Access Model

- Domestic Passenger Airport Access Model
- International Passenger Airport Access Model
- HSR & Intercity Railway Station Access Model

1. Production Model

- Technically, no production model. Use the passenger data from airport survey or intercity railway survey for generation and attraction

2. Distribution Model

- Apply only growth rate model for OD distribution

3. Modal Split Model

- Multinomial Logit Model, same as Main Model
- Some new variables, including
  - Reliability index (for airport and road)
  - Airport or station specific dummy

4. Route Assignment Model

- Multinomial Logit Model (not Probit)
- Variables are simplified version of the main model
  - No congestion index, no station access
  - Introduce some line specific dummies

Reliability Index

$$RI_i = \alpha \cdot CI_i + \beta_E D_{Ei} + \beta_F D_{Fi} + \beta_T D_{Ti} + \gamma$$

Where

RI_i= Reliability index of route i

CI_i= Congestion index of route i, defined by average travel time/free flow travel time

E= Expressway

F= Four lanes or more road

T= Two lanes road

D_i= Distance of each types of road in route i

α, β, γ= Estimated parameters

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M MAP2)

Appendix-7

Directions and Suggestions for Development of Mass Transit Network

Objectives and Contents

Objectives

- To review “M-MAP2 Blueprint”, formulated in 2019
- To review “Council of Transport Policy Plan (CTPP) No.18”, formulated in 2000
- To suggest implications & requirements for future mass transit network in Bangkok

Contents

1. **Recap : M-MAP2 Blueprint**
2. **Overview of CTPP No.18**
3. **Route Evaluation Criteria**

1. Recap : M-MAP2 Blueprint

1. Background and Objective

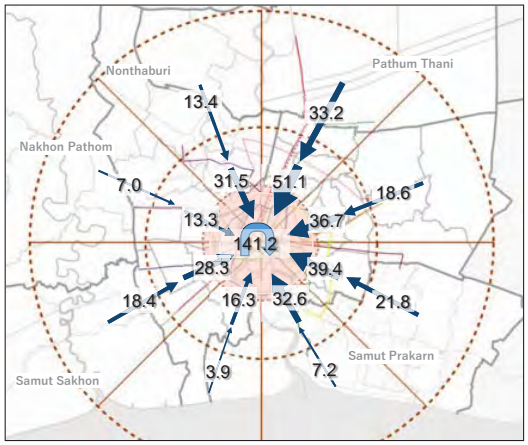
M-MAP2 Blueprint responded to the suggestions from academia, which must be inherited to the ongoing activities.

	Suggestions by Prof. Morichi	Assessment	Proposed Routes
A	Residential development at suburban blank areas (what intervals and which directions to explore?)	Demand and supply in radial direction	・Extension of Gray line ・New line in Pathum Thani (Rangsit – Thanyaburi) ・Improvement of SRT line
B	Provisions of circular routes (as the city grows, circular direction becomes vital.)	Demand and supply in circular direction	・New Northern Ring Line
C	Rectification of capacity shortage at congested routes (any routes to be rescued?)	Understanding of congestions at existing routes	・Expansion of transport capacity ・Gray line
D	Density of mass transit network (if covered by rail, how will the network become?)	Understanding of catchment areas in the city center	・Additional line in the City center
E	Links between sub-centers	Understanding of CBD and Sub CBD locations	・Pink line (Minburi - Nontaburi) ・Red line (Bang Khun Thian – Wong Wian Yai)
F	Provisions of feeder service and express service (hierarchy)	Provisions of hierarchical network	・SRT, Dark Red line, Light Red, Dark Green
	Other Considerations	**Assessment**	**Proposed Routes**
G	Access to airports	Airport locations and accessibility	・New Line linking City Center Bang Na – Suvarnabhumi Airport

A) Demand and supply in radial direction

■ Where Future Demand will be?

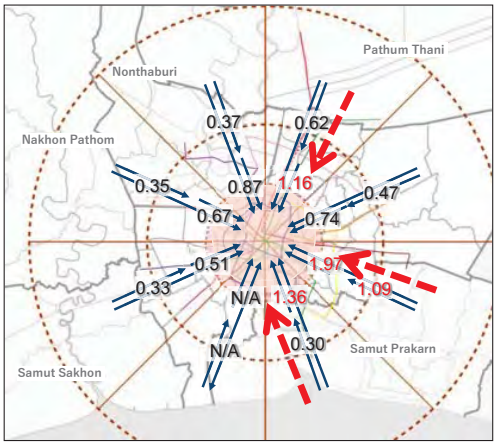
Transport Demand (000trips/hour) by Direction(2037)



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)



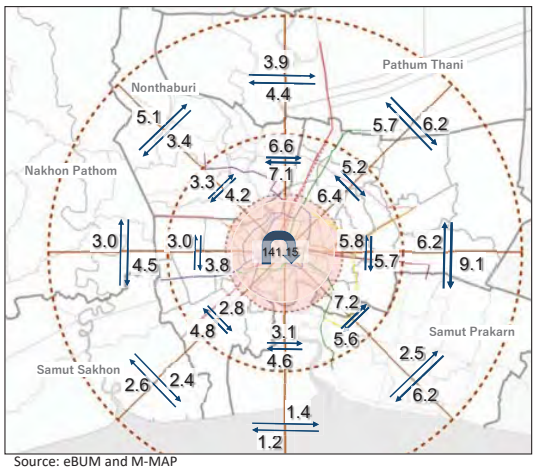
Note: Assuming completion of M-MAP Planned Route with the train design capacity

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

B) Demand and supply in circular direction

■ Where Future Demand will be? (circular direction)

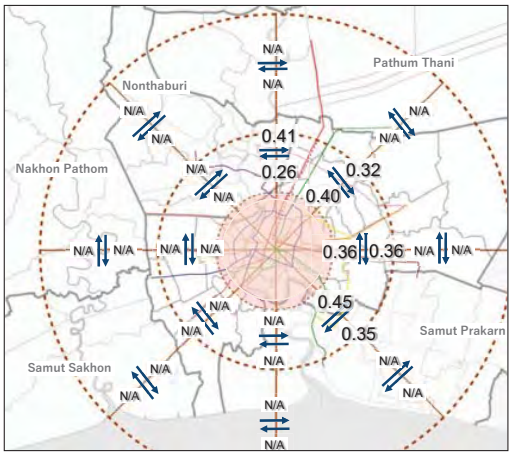
Transport Demand (000trips/hour) by Direction(2037)



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

C) Understanding of congestions at existing routes

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



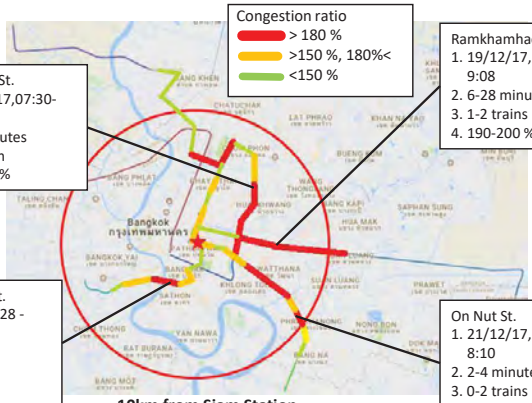
Tokyo's Target



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 %



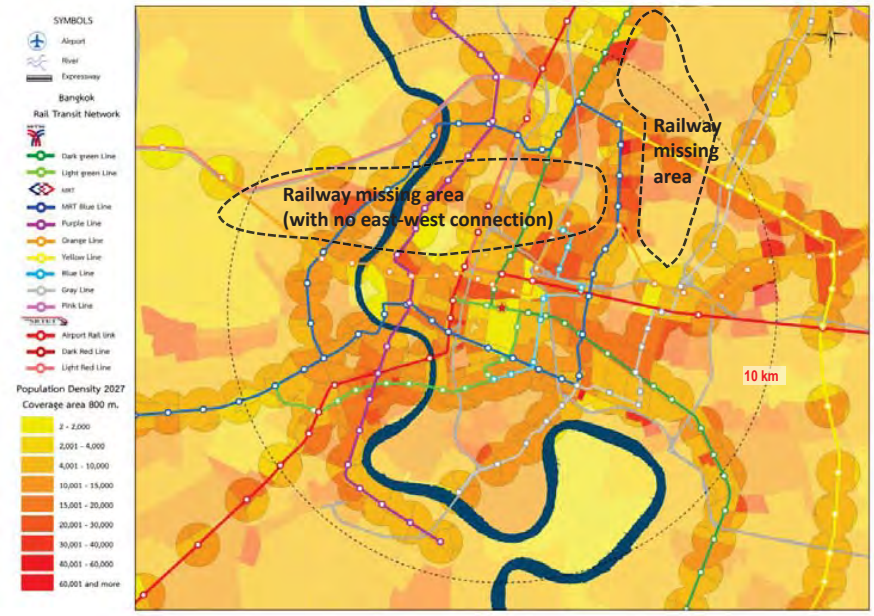
On Nut St.
1. 21/12/17, 07:20-8:10
2. 2-4 minutes
3. 0-2 trains
4. 170-200 %



*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)

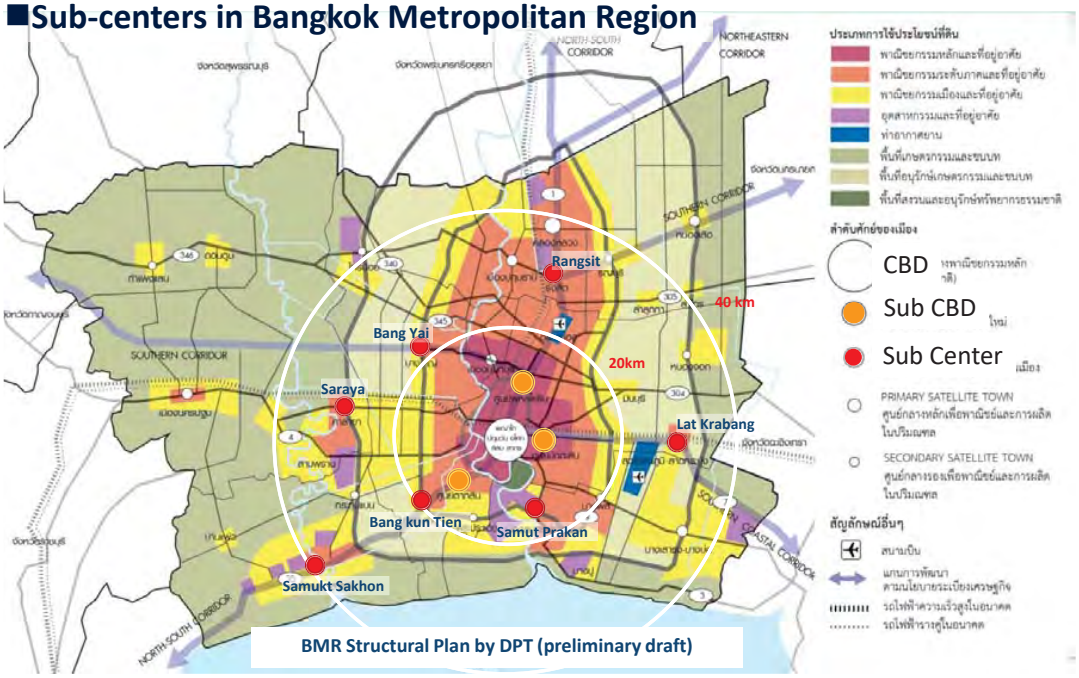
D) Understanding of catchment areas in the city center

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



E) Understanding of CBD and Sub CBD locations

■Sub-centers in Bangkok Metropolitan Region



BMR Structural Plan by DPT (preliminary draft)

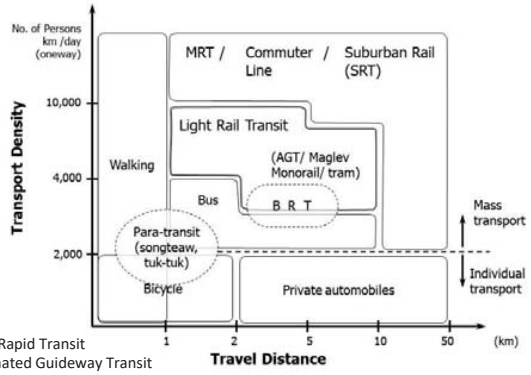
F) Provisions of hierarchical network

■Express operation will be

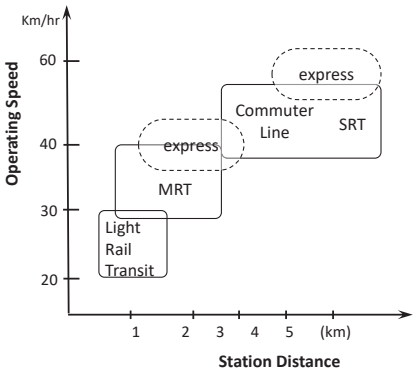
- ➢ Express operation for commuter lines (SRT, Dark Red, Light Red)
- ➢ Express operation for longer- MRTs (Dark Green)

■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

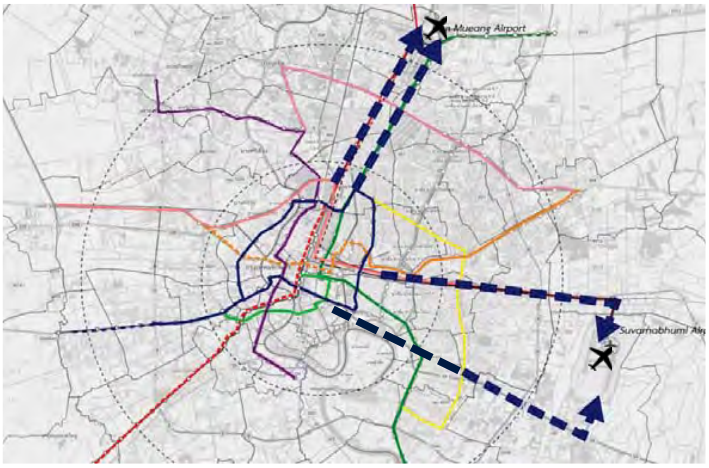


G) Airport locations and accessibility

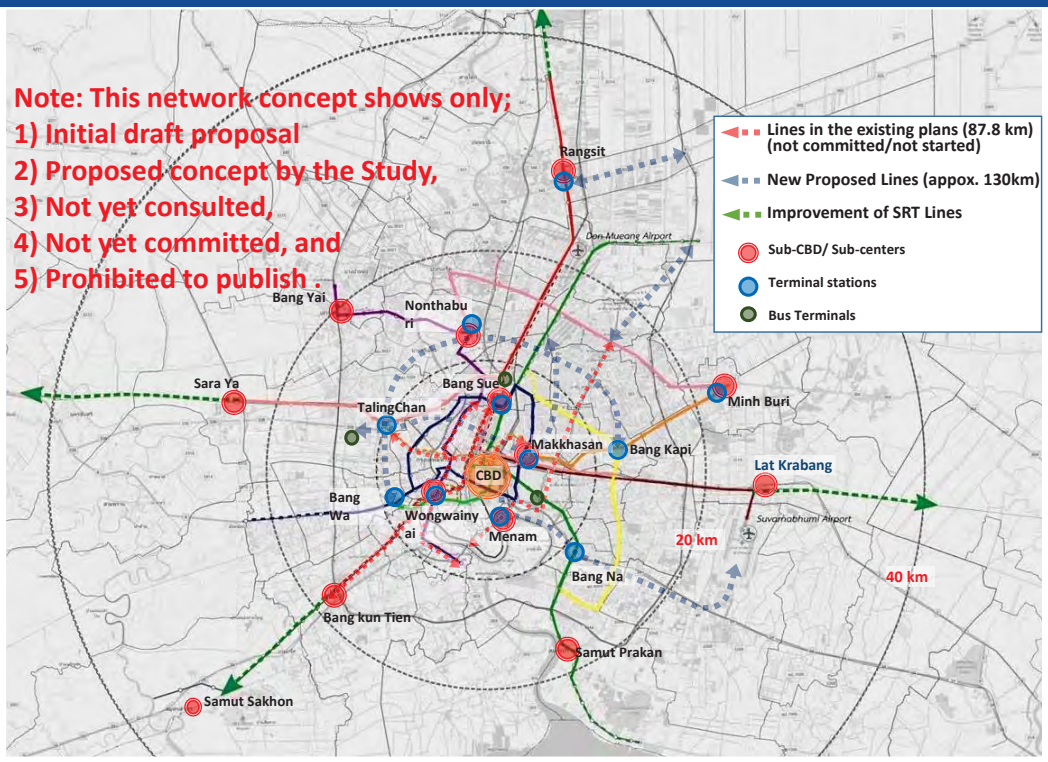
A) To develop alternative routes to access to International Airports

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

Alternative Mass Transit Route to Airports



Draft Proposal of Future Mass Transit Corridors for Policy Discussion Purpose Only



2. Overview of CTPP No.18

Why CTPP No.18?

- Timing of formulation (less than 25 years)
- Several lines were already developed.
- Impact of development can be verified.

Structure of the Committee

(1) What is CTPP No.18?

- In 1998, the **Transport Minister** requested **the Council** of Transport Policy to formulate the new railway master plan in Tokyo Metropolitan Area (TMA).
- **The Council** assigned the Regional Transport **Committee** to formulate the plan.
- **The Sub-Committees** were established to assist the Committee.

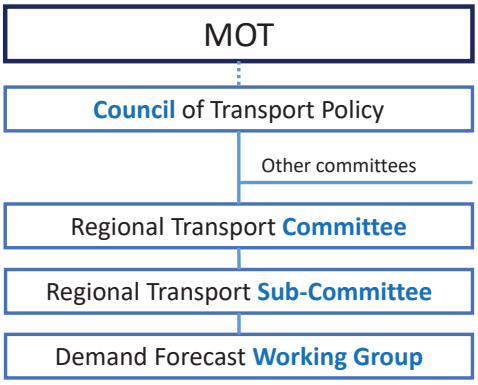
(2) Structure of the Committee

Two-layered structure:

Main-Committee and Sub-Committee

Separate WG to handle issues* on demand forecast

(* modeling structure, assumption, and verification)



Committee Members, Period and Frequency

(3) Committee Member

The Chairperson and the Members

- Academic experts

(as the chairperson and the members)

- Local governments
- Railway operators
- Railway industry groups
- Representative from users

The Secretariat

- MLIT

The Coordinator

- District Transport Bureau, MLIT

(4) Period & Frequency of Committee

Implementation Period

Preparation period

Approx. **3 years** (until Nov 1998)

(current situation, issues identification, interviews with stakeholders)

Planning period:

1 year and 2 months (from Nov 1998)

Frequency

27 committee and sub-committee meetings for the period of 1 year and 2 months

Plan Structure and 5 Policy Goals

1. **Preface**
2. **Current Condition and Future Prospects**

(Approx. 3 years of preparation)

3. **Fundamental consideration in railway planning**

i. In-train congestion alleviation
ii. Shortening travel time
iii. Restructuring urban structures and functions
iv. Airport/HSR station access improvement
v. Universal design and seamless service

- Made clear the policy objectives
- Clarified the role of each route
- Led to comprehensive and objective evaluation
- Identified development priority

4. **Development plan**

- Service enhancement in existing routes
- New routes, double-double track plans (653 km in total)
- The effect of congestion alleviation, accessibility improvement from the proposed lines

5. **Measures for realization**

- Executing/O&M bodies, financing scheme
- Support facilities for railway development
- Cooperation between railway and urban dev't
- User-friendliness, off-peak commuting strategy
- Management and financial stability

6. **Conclusion**

Key Characteristics

(1) Building a framework for better preparation, discussions & consensus building

Preparatory Works

- Before the advisory request from the minister, carried out **preparatory works for 3 years** on the review on current status, issues identification, and stakeholder coordination.
- **Identified the issue** to be discussed during the formulation of CTTP in advance.

Study framework with extensive discussions

- Made wider range of discussion with the committee **led by academic scholars**.
- Advisory based on the **academic perspective without sectionalism** from the gov't administration.

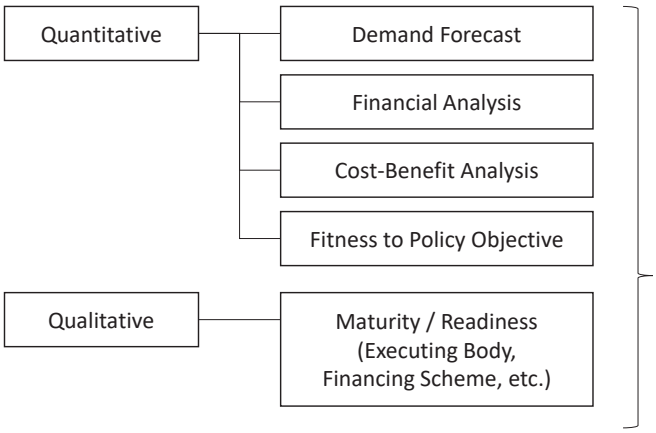
Friendly framework for consensus building

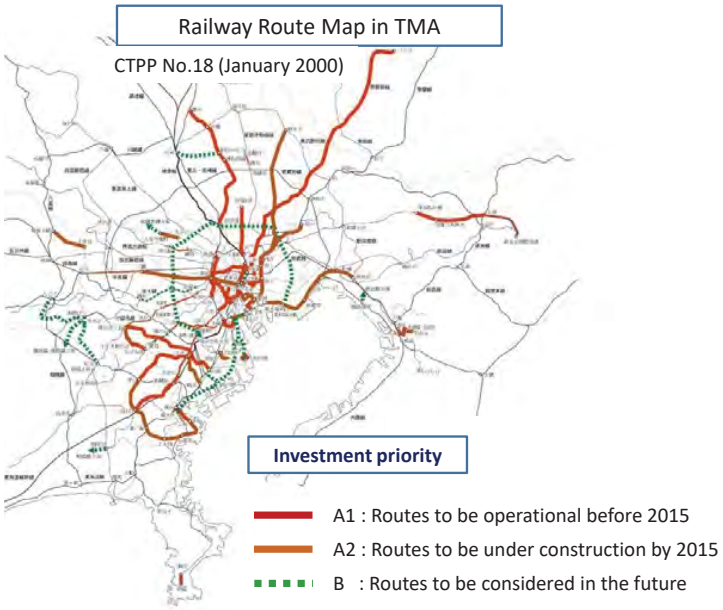
- Each stakeholder **reached their own consensus** within their organization **in advance**.
- Efficiently conducted the discussion in the committee meetings.
- Improved consensus building among stakeholders.

Key Characteristics

(2) Clarifying the role of each routes and priority of development

- Clarifying the role of each route
  - fitness to 5 policy objectives
- Comprehensive and objective evaluation for respective routes
- Criteria to determine the investment priority





Key Characteristics

(3) Envisaging actual implementation

- As part of key subjects, CTPP No.18 included;
  - Implementing structures (project execution and O&M entities), and;
  - Practical financing scheme for new lines and upgrading projects.
- CTPP No. 19 studied additional support facilities for railway development in the future.

(4) Both binding and flexible

A binding master plan

- In principle, develop only the routes in the master plan.
- Not recognized if they were not listed in the report, thereby **avoiding inefficient investment**.
- (otherwise, appearance of additional routes make changes in demand forecast of the network.)
- Taken over across the Governments with the planning period of 15 years

A flexible master plan

- Cancelled if the local gov't concluded the route to be unfeasible at further assessment.

Other Characteristics

(1) Assuring “continuity” and “sustainability” of railway development policy

- Plans to address urgent needs against the overwhelming shortage of traffic capacity
- Continued planning for **60 years** in response to the urban issues of each period
- Each Minister had **taken-over the plan** across the administrations, thereby railway development was carried out from a long-term perspective, ensuring **consistency** in the masterplan.

1956	CUTP #1	High demand from suburbs to city center
1960	CUTP #4	Problems from rapid motorization
1962	CUTP #6	Transport demand to CBD exceeding estimations due to high economic growth
1966	CUTP #9	Declining of night-time population growth in Tokyo Metropolis Population and industrial concentration in Yokohama, Kawasaki
1968	CUTP #10	Concentration and urban spread exceeding estimations
1972	CUTP #15	In-train decongestion during peak hours Longer commuting due to urban spread

1985	CTTP #7	Response to multipolar population increase Changes in urban structure, Globalization Business expansion in sub-centers
2000	CTTP #18	Returns of population to Tokyo CBD Continued urban spread Existence of heavily congested lines Insufficient access to airport & HSR station
2016	CTTP #198	Tokyo as a leading city in international competition Measures for Tokyo Olympics/Paralympics Countermeasure to natural disasters Fiscal condition problems

CUPT : Council of Urban Transport Plan

Other Characteristics

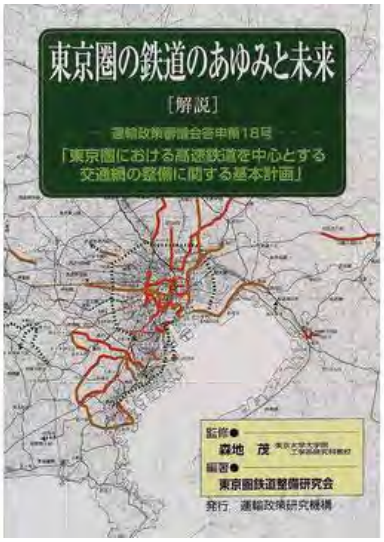
(2) Understanding users' needs and CEPA* to citizens and relevant parties

(*CEPA - **C**ommunication, **E**ducation and **P**ublic **A**wareness)

- **Public comments** – Considered 219 comments from the public.
- **Publication** - ‘History and future of railways in the TMA’

Thereby, answering the expectations of citizens;

- By clarifying the importance, necessity, effects and priorities
- In an easy-to-understand manner.



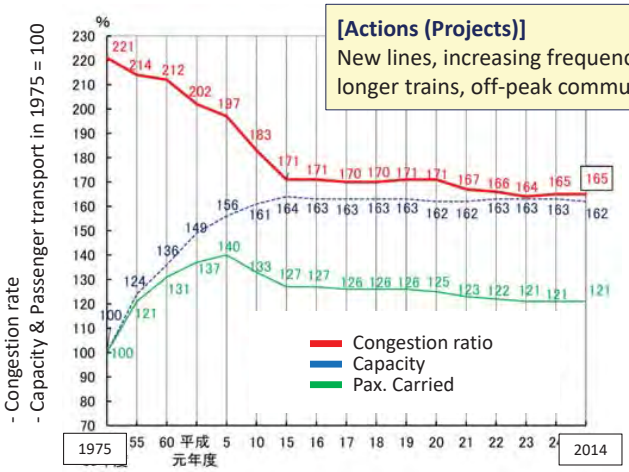
Other Characteristics

(3) Showing the role of planned routes on policy targets (using indicators to clarify national policy targets)

After setting policy targets, consider actions for realization.

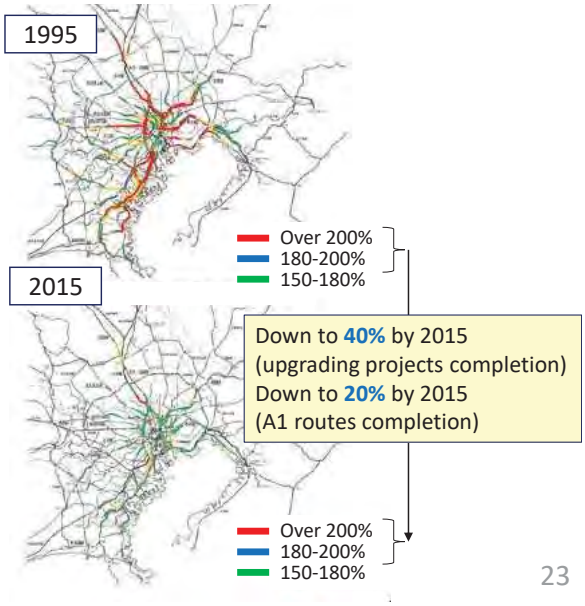
[Policy Goal]

Peak time congestion ratio : **183%** in 1998 to **150%** in 2015.



[Actions (Projects)]
New lines, increasing frequency, longer trains, off-peak commuting, etc.

Length of overcrowded sections



Down to **40%** by 2015
(upgrading projects completion)
Down to **20%** by 2015
(A1 routes completion)

Other Characteristics

(4) Building common awareness among administration, stakeholders & the public

Local governments to formulate their own plans and propose routes in council interviews.

Inviting **stakeholders (e.g. operators) from the master plan stage** for mindful coordination

Fukutoshin Line – history of coordination to realize the most extensive inter-operability

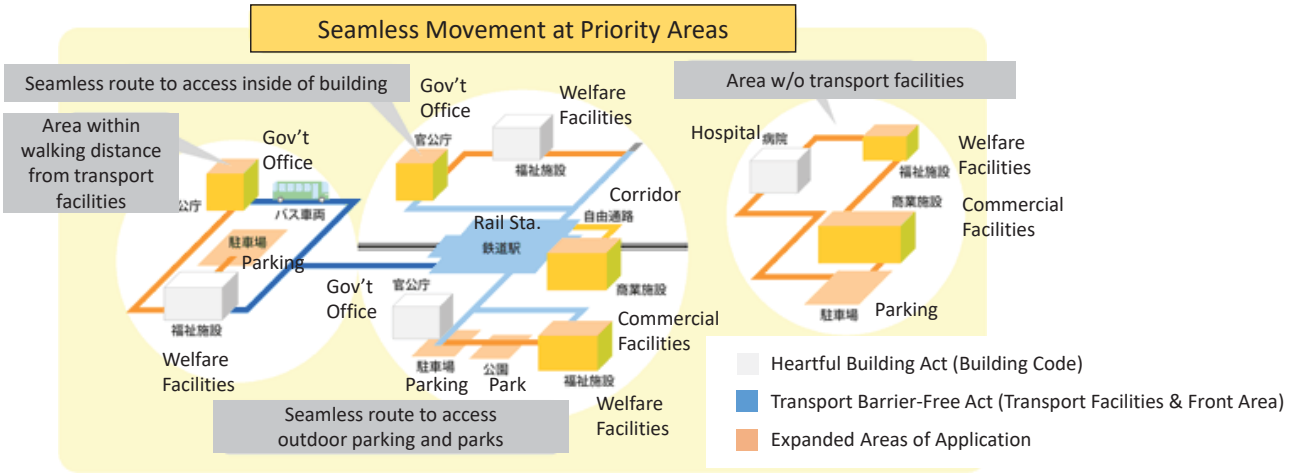
Timeline		Administrator	Stakeholders	Studies
1972	CUTP #15	MOT (now MLIT)	Tokyo Metropolitan Gov't Police Agency	First presented as "a route connecting suburbs via Tokyo"
2000	CTTP #18	MLIT	Academe, local gov'ts, operators, transport associations, public corps, economic groups, mass media, and consumer groups	Forming a trunk line connecting suburbs via Tokyo. **Inter-operability** across different operators **Demand forecast, financial analysis, and cost-effectiveness analysis of respective routes**
2000-2001	Railway Survey	MLIT	Academe, local gov'ts, operators	Assessment of inter-operability, corridor, demand, operations, facility, impacts, and other challenges
1999 2001	Business authorization Construction permit	MLIT (Regulator)	Tokyo Metro (Operator, applicant)	Profitability, CAPEX, funding, land and properties, budget, and schedule
2008 2013	Partial inter-operability Full inter-operability	MLIT (Regulator)	Tokyo Metro (Executing body)	

Other Characteristics

(5) Promoting barrier-free access

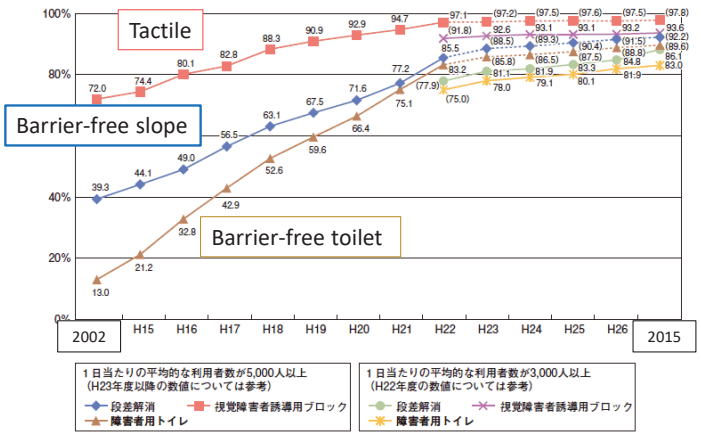
- The plan clearly defined the promotion of barrier-free railways.
- The promotion later progressed by the enforcement of the Law.

("Law for the Promotion of Seamless Transportation of the Elderly, Disabled, etc.", 2006)

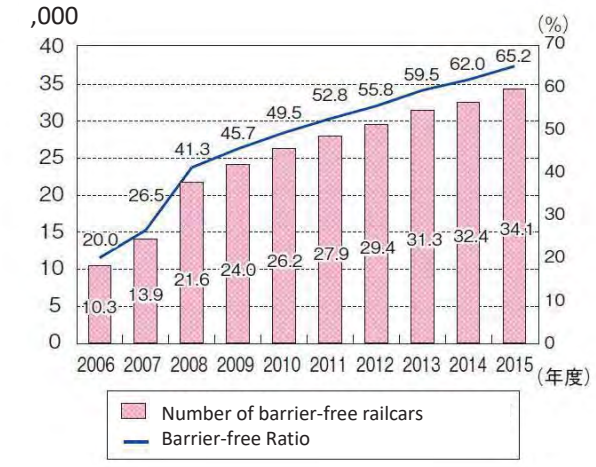


Other Characteristics

Station Facilities



Railcars



Other Characteristics

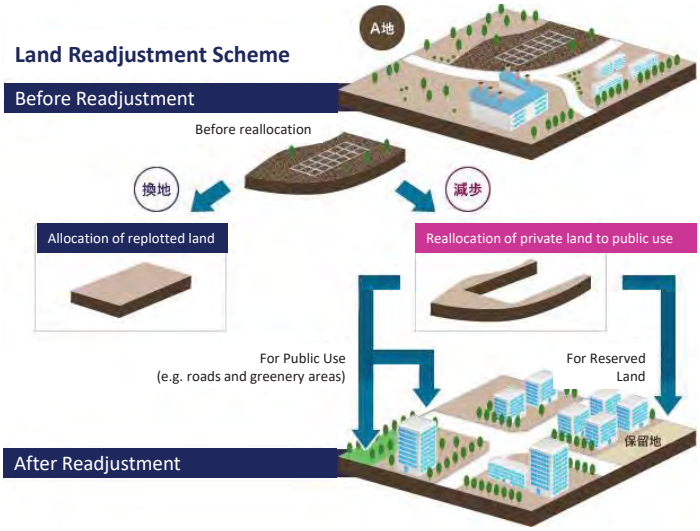
(6) Strengthened cooperation between railways and urban development

- Integration of urban development around stations and railway dev't was promoted with the Law.

("Law for Comprehensive Advancement of Housing Development and Railway Construction in Metropolitan Areas" for the corridor of Tsukuba Express)

Urban Dev't along Tsukuba Express Corridor





Summary of CTPP No.18

- As the implication to the next masterplan studies, it is suggested to **elaborate 5 Goals / Policy Objectives for railways** based on the review of current socio-economic and transport issues.
- Policy objectives (and priority of development) are designed based on the **extensive surveys and demand forecast**, where the role of academe should particularly be emphasized.

Key Characteristics of CTPP No.18

1. Building a study framework that enables preparation, discussions, and consensus building
2. **Clarifying the role of each routes and priority of development**
3. Envisaging actual implementation
4. Both binding and flexible

Other Characteristics of CTPP No.18

1. Assuring "continuity" and "sustainability" of railway development policy
2. Understanding users' needs and CEPA* to citizens and relevant parties
3. **Showing the role of planned routes on policy targets**
4. Building common awareness among administration, stakeholders & the public
5. Promoting barrier-free access
6. Strengthened cooperation between railways and urban development

3. Route Evaluation Criteria

Route Evaluation Criteria in Tokyo Metropolitan Area

1. Evaluation Flow

2. Evaluation Criteria

(1) Evaluation by Traffic Demand

(2) Evaluation by Socio-economic Impact (Accomplishment of Policy Goals)

(3) Evaluation by Cost-benefit Analysis

(4) Evaluation by Financial Analysis

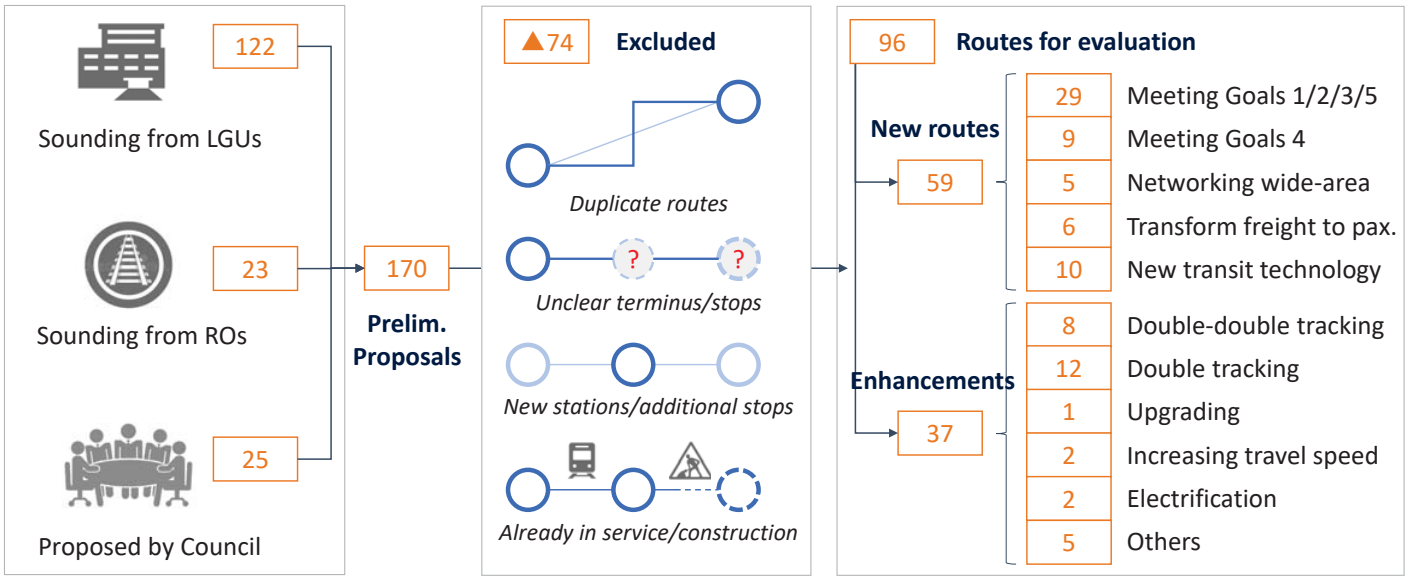
(5) Evaluation by Prospects of Implementing & Operating Bodies

3. Evaluation Result

4. Conclusion

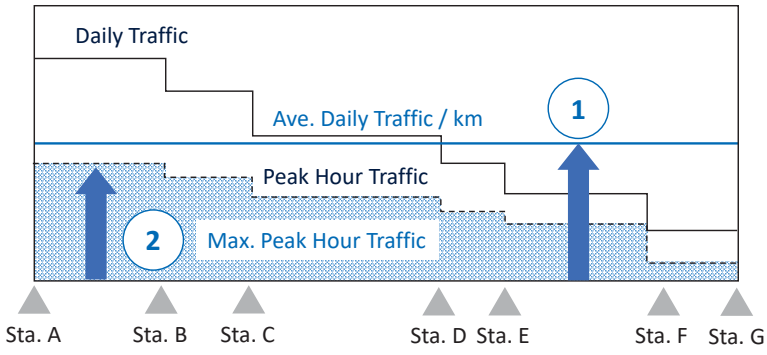
Evaluation Flow

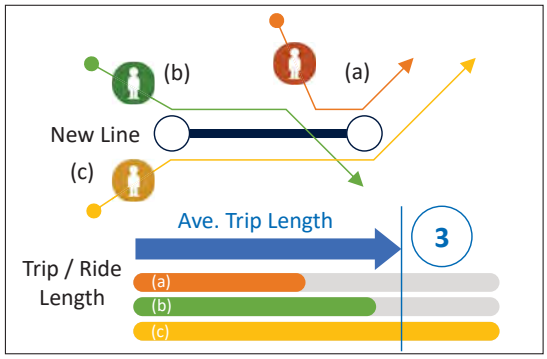
Proposals from LGUs/ROs/Council were evaluated, except those excluded in the screening process.



Evaluation by Traffic Demand

3 indicators were used to evaluate traffic demand; traffic density, max. peak hour traffic & ave. trip length.





1	**Traffic Density**	Indicator for Traffic Volume
2	**Max. Peak Hour Traffic**	Indicator for Required Transport Capacity
3	**Average Trip Distance**	Indicator for Passengers' Reach Length

Railway Network for demand forecast includes:

Existing lines
+ Lines being implemented
+ Target (single) line for evaluation
x [96 routes for evaluation]

Evaluation by Accomplishment of Policy Goals

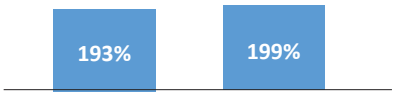
Various KPIs were designed to evaluate how respective route proposals meet the policy goals.

Goal	KPI	Objects	W/O PRJ	With PRJ
 **Goal 1** Alleviate in-train congestion	Congestion ratio	Most congested section	195%	172%
	Congestion length	Over-congested sections (Low / Med. / High)	L M H	L M H
 **Goal 2** Shorten travel time	Time saving (total)	Entire network	100%	-5,000H 99.95%
	Time saving (key sections)	Key sections	45 min	-10min 35 min
 **Goal 3** Reinforce urban structures & functions	Total access/egress time	To/from nearest station	100%	-5,000H 99.95%
	Total time /# of transfer	From sub-center to center From regional core to CBD	55 min 3	-15min 30 min 0
 **Goal 4** Improve access to airports & High Speed Rail stations	Total time /# of transfer	Whole passengers	100% 100	-1500H -5000T 88% 85
	Time /# of transfer	From key locations	65 min 2	-15min 52 min 1
 **Goal 5** Promote universal design & seamless service	Total number of transfer	Entire network	100%	-45,000T 99.7%
	Time /# of transfer	Key sections	38 min 1	-3min 35 min 0

Goal 1. Alleviate in-train congestion

In-train congestion can be evaluated with congestion ratio & length of over-congested sections.

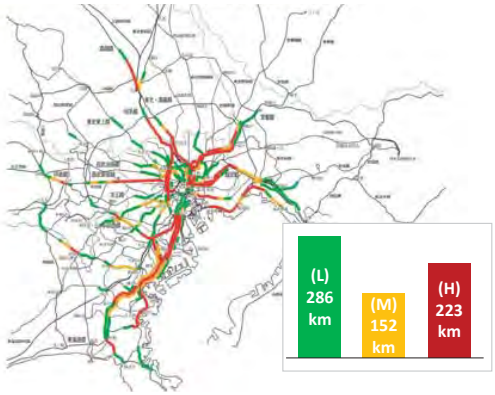
Congestion Ratio (AS-IS)



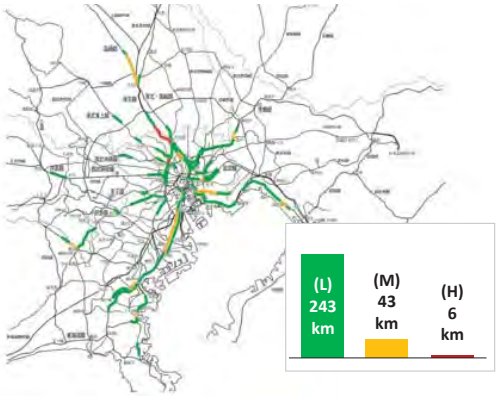
Congestion Ratio (TO-BE)



Length of over-congested sections (AS-IS)



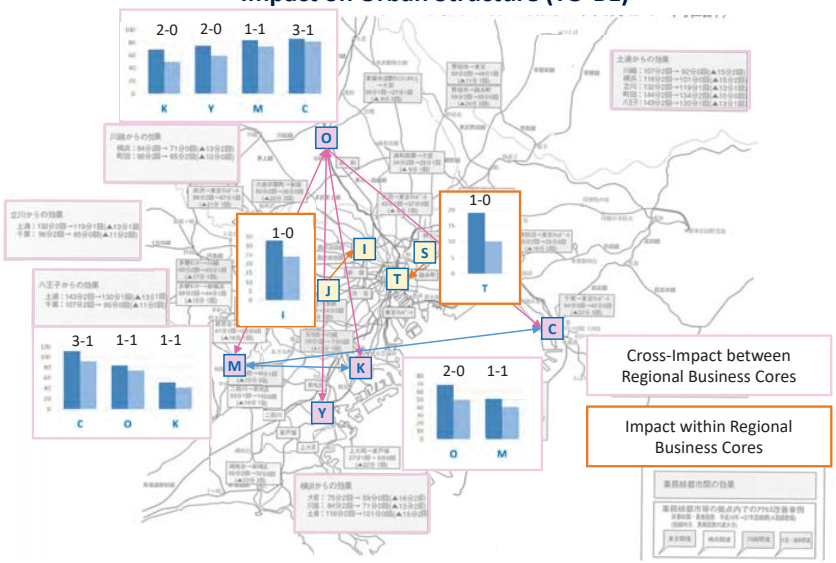
Length of over-congested sections (TO-BE)

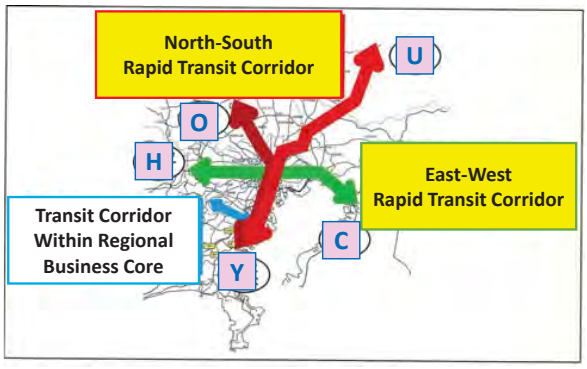


Goal 2. Shorten travel time / Goal 3. Reinforce urban structures & functions

Travel time & no. of transfer among CBDs / regional cores can describe strength of urban structures & functions. (In case of MM: Makati / Global City / Ortigas / Bay Area / Eastwood / Cubao /EDSA North)

Impact on Urban Structure (TO-BE)





Goal 5

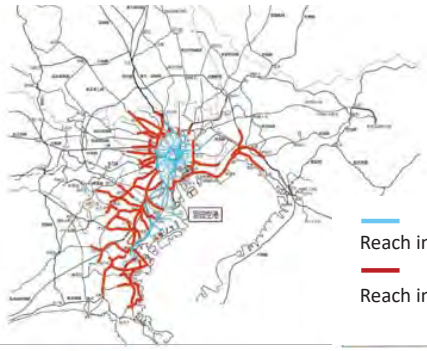
Promote universal design & seamless service

Change in number of transfers

Goal 4. Improve access to airports & High Speed Rail stations

Access time and no. of transfers to airports from key locations are good indicators for Bangkok.

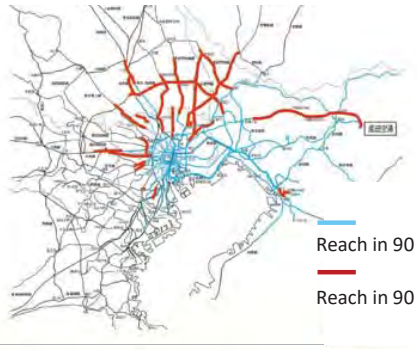
Access Improvement – Haneda Airport (AS-IS, TO-BE)



Reach in 60 min (AS-IS)

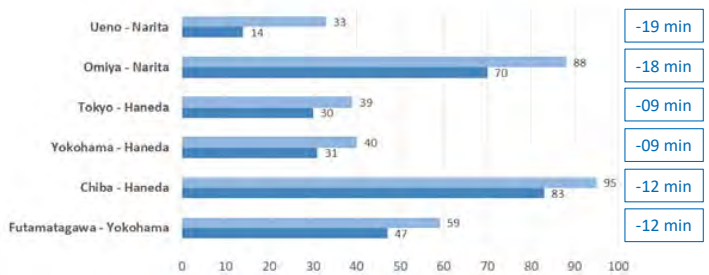
Reach in 60 min (TO-BE)

Access Improvement – Narita Airport (AS-IS, TO-BE)



Reach in 90 min (AS-IS)

Reach in 90 min (TO-BE)



0	0	Transfer
1	1	Transfer
1	0	Transfer
1	0	Transfer
1	1	Transfer
1	0	Transfer

Goal 5

Promote universal design & seamless service

Change in number of transfers

Evaluation by Cost-Benefit Analysis

Conventional cost-benefit analysis was used (with some difference in benefits compared to MP in BKK).

Benefit		Cost		Benefit	Cost
User Benefit	**Travel Time Saving** Monetary conversion of TTS in total *(JPY 47/min.; Rail Trip Time)* **Travel Cost Saving** Sum of TTS in total **Decongestion Benefit** Monetary conversion of decongestion *(200% 10 mins journey – equivalent to 180% 10 mins journey + JPY 44)*	CAPEX	**Capital Expenditure** Incl. civil infrastructure and E&M systems	**1) Cost-benefit B/C** **2) Net Present Value** **3) EIRR**	
Supplier Benefit (Operator)	**Benefit of rail operator** **Change in Benefit of other operators** in complementary or competitive relationship	Maintenance Cost	**Maintenance Cost** Including replacements & refurbishments		
Env. Benefit	**Monetary conversion of NOx / SOx reduction** *(NOx : JPY 2.92 mil./ton, SOx : JPY 2,300/ton)*				

** Rate as of CTPP #18*

Evaluation by Financial Analysis

Cost recovery ratio & subsidy ratio (rate of grant by the Gov't) were used to evaluate financial soundness.

Cost Recovery Ratio in Key Year

[CRR] = [Revenue] / [Operating Expense]

- CRR > 1 : Operating surplus

[Revenue] / [Operating Expense] =

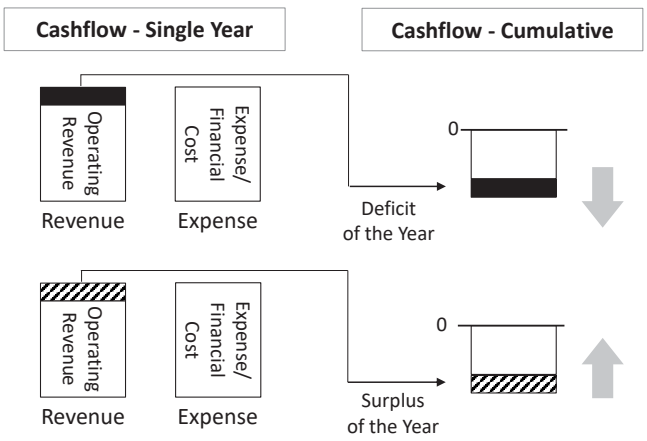
$$\frac{\text{(Fare Revenue + Non-fare Revenue)}}{\text{(Personnel Cost + Other Expenses + Taxes)}}$$

Ratio of Viability Gap (i.e. Subsidy Ratio)

[Rate of Viability Gap] =

[Grant from the Gov't] / [CAPEX (excluding RST)]

- [Grant] = amount to fill the viability gap
- [CAPEX] = base cost including financial cost excluding rolling stock cost



Evaluation by Prospects of Implementing & Operating Bodies

Even in the MP phase, project readiness is part of evaluation criteria to ensure feasibility.

- Institutional / Organizational Readiness
- Executing Capacity (including Financial)
- Engagement of the Local Government

▶

- Prospects of Implementing & Operating Body
- Concreteness / Maturity of Business Plan
- Willingness of the Local Government

Evaluation Result

Proposals were evaluated consistently with the said criteria, thereby ensuring accountability & objectivity.

Study Route	Route / Section	Length	Demand (Traffic Density)	Accomplishment of Policy Goals / Socio-Economic Impact							Financial Viability			Maturity of Project Formulation
				Decongestion	Seamless	Travel Time	Urban Structure	Access to HSR/Air	Relevance/ Impact to Other Lines	Benefit / Cost	Net Cashflow	Rate of Grant	Investment Cost	
1	A	3.6	319	○	△	△	△	○	xx	6.7	5.4	0%	628	Operating body
2	B	8.5	95						xx	1.0	2.4	80%	3,236	Willingness of LGU
3	C	11.4	91	△		○			xx	2.3	2.7	50%	2,282	Financing capacity
4	D	6.6	75	△		△	△		xx	3.0	1.7	80%	1,351	Etc.
5	E	12.3	111	○	○	△	△	△	xx	2.8	2.6	60%	8,363	
…96														

[○] [△] : See Reference

Evaluation Result

Selected routes were categorized to A1/A2/B, showing the areas of improvements except A1.

	New Routes	Enhancements
A Routes to be promoted by the target year		
A1 Routes to be operational by the target year (conditions satisfactory for implementation)	8	1
A2 Routes to be under construction by the target year (not fully satisfactory in terms of maturity, investment returns, etc.)	12	2
B Routes to be considered in the future (to review dev't along the corridor, traffic demand, investment capacity etc.)	11	2

Summary of Route Evaluation Criteria

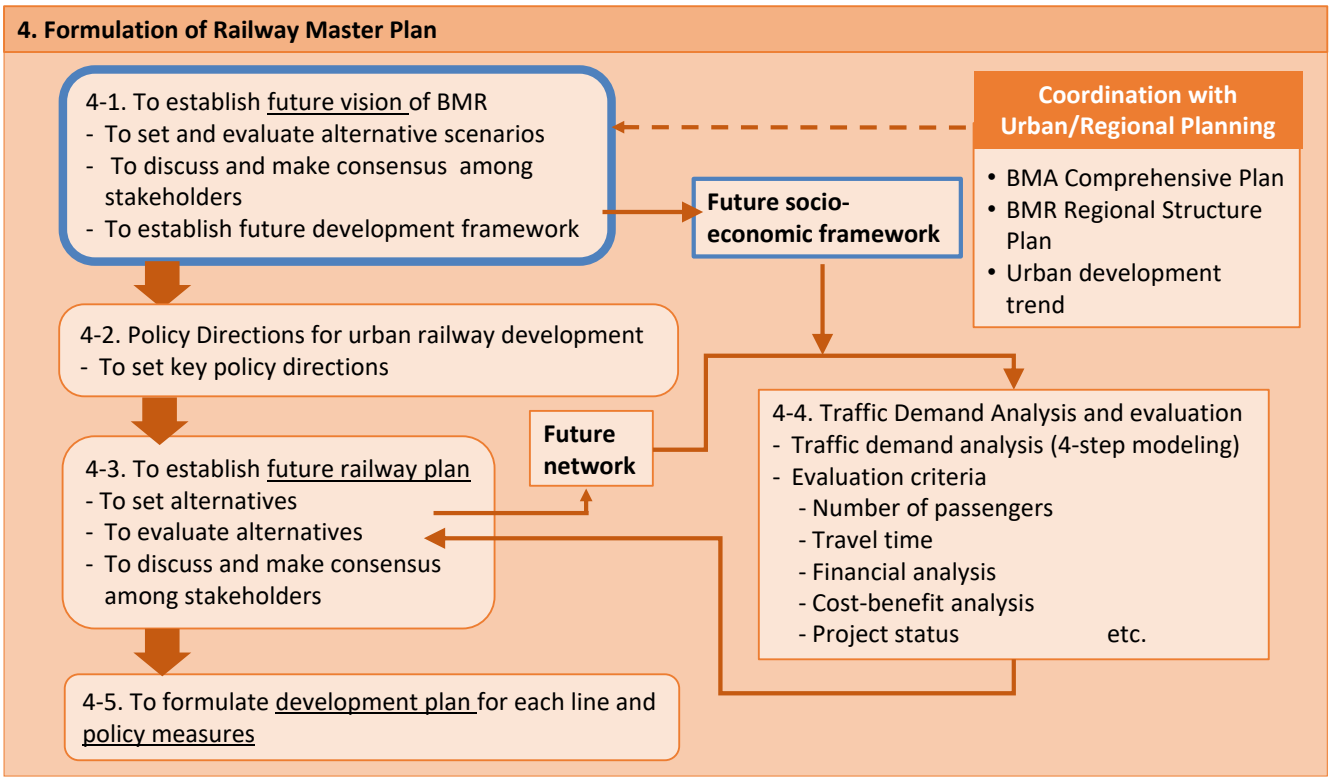
- **Varieties of KPIs** : were designed in the masterplan (CTPP #18) to evaluate how respective route proposals meet the policy goals, where some of the indicators may be useful for M-MAP2.
- **Accountability & Objectivity** : Proposals should evaluated consistently with the criteria to meet policy goals / objectives, thereby ensuring accountability & objectivity.
- **Priority setting with the areas of improvement** : Flexibility may be enhanced if the areas of improvements are explained for the routes with lower priority.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-8

Urban Development Direction ~ Scenario Setting in Railway Development Master Plan in the Tokyo Metropolitan (CTPP No.198)

1. Future Development Scenario Analysis in Railway Master Plan

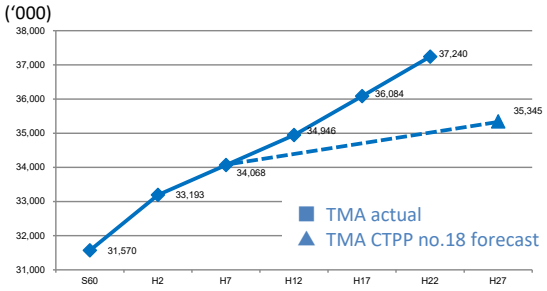


Process of Formulation of Railway Master Plan (Extract from M-MAP2 Blueprint Report)

1. Future Development Scenario Analysis in Railway Master Plan

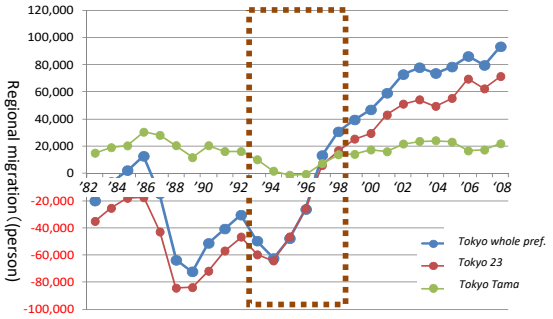
- Socio-economic framework is the first step of the railway master plan formulation, which will affect the result of demand forecast.
- Evaluation of the Railway Master Plan of TMR (CTPP No. 18, 2000) shows the error of railway demand forecast caused by underestimation of future population.

Comparison of actual TMA Population and Forecasted Population of CTPP NO.18



Comparison between forecasted and actual nighttime population

Rapid changes of migration trend, more people started to migrate into central Tokyo, was not reflected in the CTPP No. 18.



Transition in migration in Tokyo

CTPP: Council of Transport policy Plan

2. Factors to be considered in Future Development Scenario

(1) Changes of Urban/Regional Structure

- **Regional Development Plan/ Urban Development Plan**
- **Large-scale urban development project:** in suburban area, urban regeneration project
- **Large-scale regional infrastructure project:** inter-city high-speed railway, port, airport

(2) Changes of Lifestyle and society

- Depopulation phase
- Changes of lifestyle and society: Progressing aged society with low birthrate, increase of women's employment rate
- Continuous concentration into the Tokyo central area

(3) Global Environment

- Increase of foreign visitors (business, tourist, etc.)
- COVID-19 situation

(4) Disaster Management

- Disaster risk management
- Mitigation of climate change

2. Factors to be considered in Future Development Scenario

(1) Changes of Urban/Regional Structure

☐ Urban/Regional Development Plan

- **Tokyo Metropolitan Development Plan:** set metropolitan development direction from mono-centric metropolitan to deconcentrated polycentric metropolitan
- **National Grand Design 2050**
- Other national/regional development policy
- Provincial Development Plan



Deconcentrated Network Structure
(Future Regional Structure of Tokyo Metropolitan Region)

2. Factors to be considered in Future Development Scenario

(1) Changes of Urban/Regional Structure

☐ Large scale urban development project

- Committed urban residential development projects with more than 2,000 residential population
- Committed large-scale urban development projects with more than 2,000 employees or more than 50,000 m^2

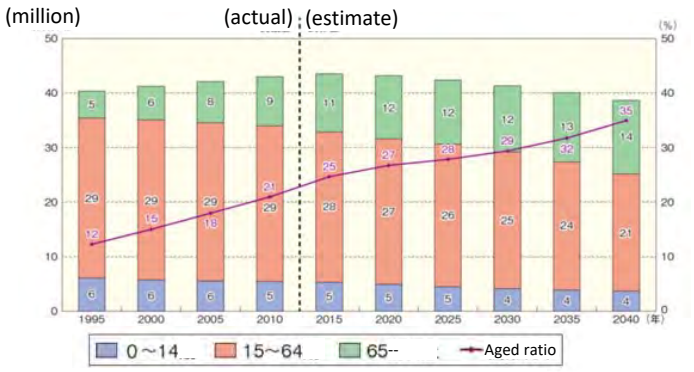
☐ Large-scale regional infrastructure project

- Airport: future expected passengers to/from airport
- High-speed Railway: future expected passengers at each station of High-speed Railway

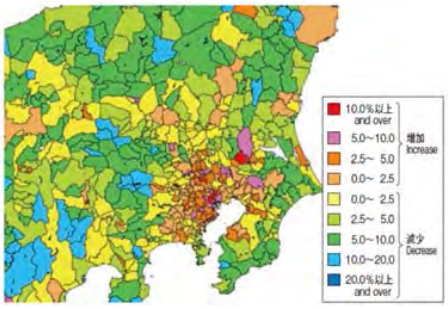
2. Factors to be considered in Future Development Scenario

(2) Changes of Lifestyle and Urban Society

- Future population trend
  - Total population of metropolitan area is expected to decrease.
    (forecast by The National Institute of Population and Security Research)
- Aged society and lower birthrate
  - Aged ratio will increase continuously.
    (forecast by The National Institute of Population and Security Research)
- Continuous concentration into the Tokyo central area.
  - Increase of workplace in Tokyo Central Area
  - Increase of residential population in Tokyo Central Area



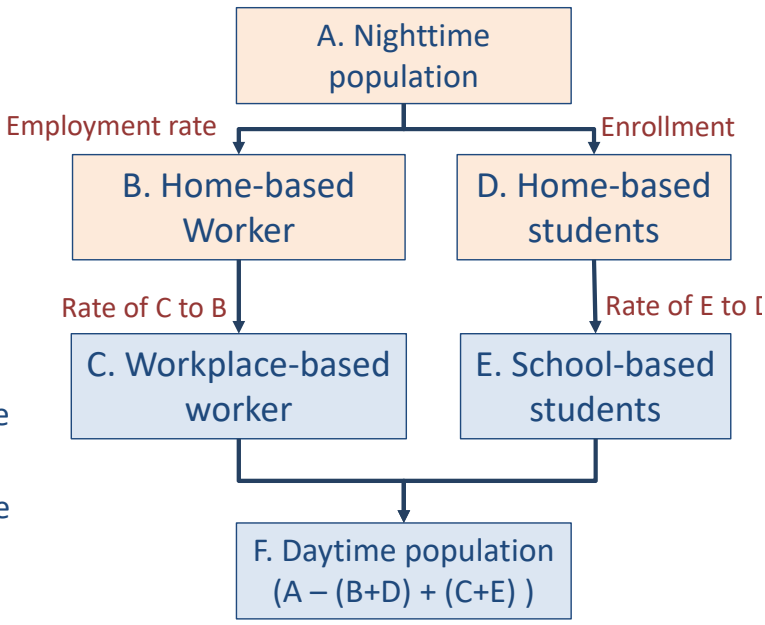
Source: Annual Report of Metropolitan Development, 2015



Source: Annual Report of Metropolitan Development, 2015

3. Socio-economic Framework in the CTPP No.198

(1) Flow of Estimation



(2) Types of Population to be estimated

A. Nighttime population
(home-based population)

B. Number of workers at residence
(home-based worker)

C. Number of workers at workplace
(workplace-based worker)

D. Number of students at residence
(home-based student)

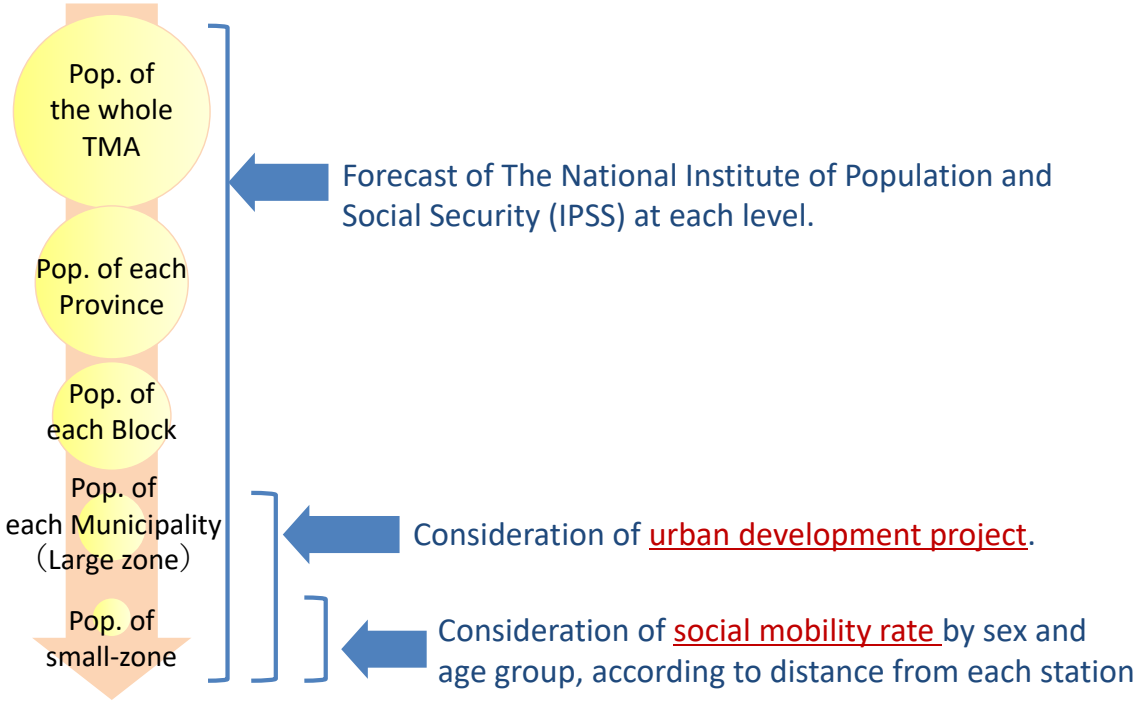
E. Number of students at school
(school-based student)

F. Daytime population
= nighttime population - (home-based worker + student) +
(workplace-based worker + school-based student)

3. Socio-economic Framework in the CTPP No.198

(3) Nighttime Population and those distribution

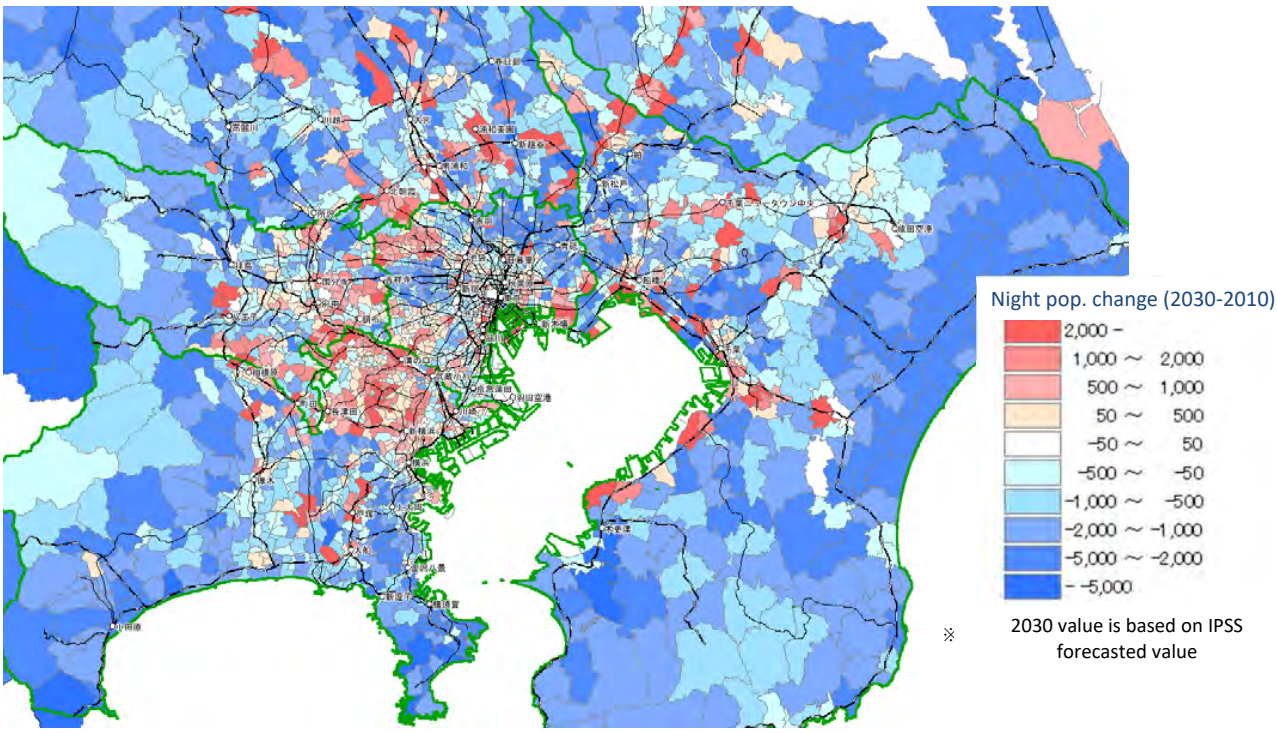
- Control-total for population is set at each level based on the future projection by the National Institute of Population and Social Security



3. Socio-economic Framework in the CTPP No.198

(3) Nighttime Population and those distribution

Population in TMA is decreasing in overall, but along the railway lines, population is increasing.



3. Socio-economic Framework in the CTPP No.198

(4) Workers at residence and those distribution

- The number of workers at residence is estimated with nighttime population + employment rate by gender and by age group

Home-based worker	=	Nighttime population	x	Employment Rate (by gender and age group)

- Three future cases are set for employment rate considering the following,
  (i) change of employment rate in the past several years
  (ii) considering the Government stimulus and unemployment measures
  (iii) considering the Government measures to promote employment of women and aged people.
  ➔ see next page.

- Non-commuting workers, who work at home, is estimated to decrease continuously.

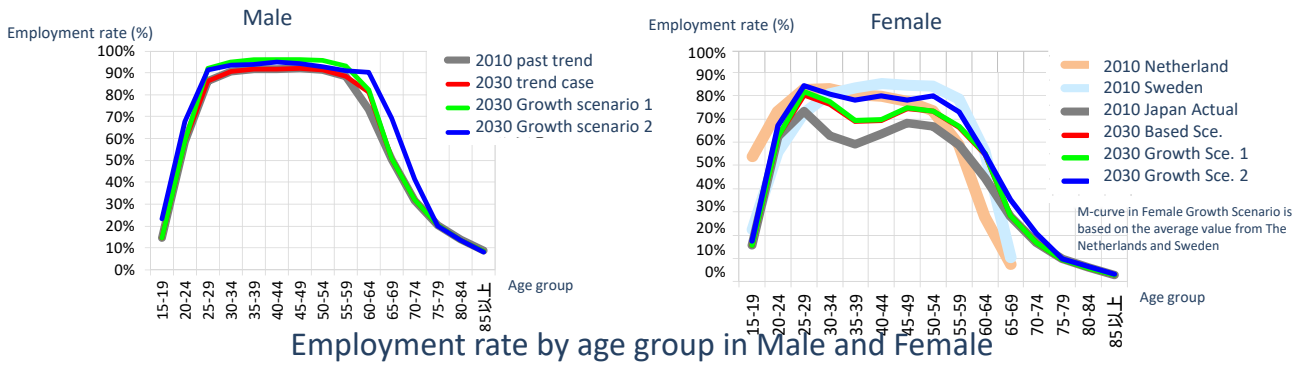
3. Socio-economic Framework in the CTPP No.198

(4) Workers at residence and those distribution

- Three future scenarios set for employment rate by age and gender

Scenario	Basic hypothesis	Male, Female (<25)	Male (25-59)	Female (25-59)	Male, Female (60-64)	Male, Female (>65)
Trend Scenario	Continue the recent trend	same	Declining trend stop	Increase at the current rate		same
Growth Scenario 1	Original scenario	same	Increase upto the past peak	Increase at more than current rate		same
Growth Scenario 2	Based on national assumption from IPSS	Increasing	Steadily increase	Increase more than current rate	Sharply increase	Sharply increase

➡ Trend Scenario was selected for the CTPP No.198.



Employment rate by age group in Male and Female

3. Socio-economic Framework in the CTPP No.198

(5) Workers at workplace and those distribution

- **The total number of workers at workplace:** estimated based on the ratio of workplace-based workers to home-based workers in TMR (α).

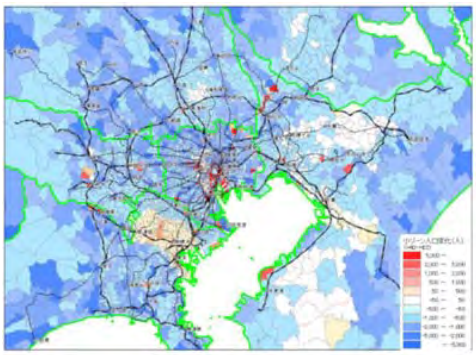
$$\text{Workplace-based worker} = \text{Home-based Worker} \times \alpha\left(\frac{\text{workplace-based worker}}{\text{home-based worker}}\right)$$

α: from National Census in 2010 (almost stable in the past several years.)

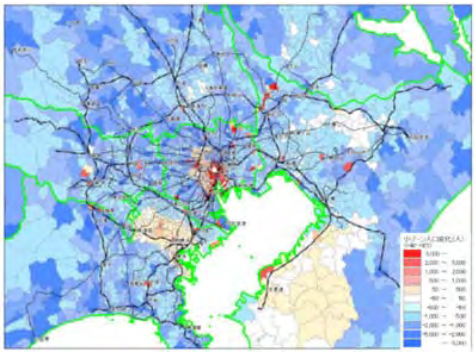
- **Provincial, block, city-level:**
  - Estimated by types of industry,
    (i) industries linked to the changes of nighttime population
    (ii) other industries
  - Two future cases are set as below;
    (Case A) assuming that concentration into the city center continues
    (Case B) assuming that concentration into the city center eases
  - Large-scale urban development projects is considered.

3. Socio-economic Framework in the CTPP No.198

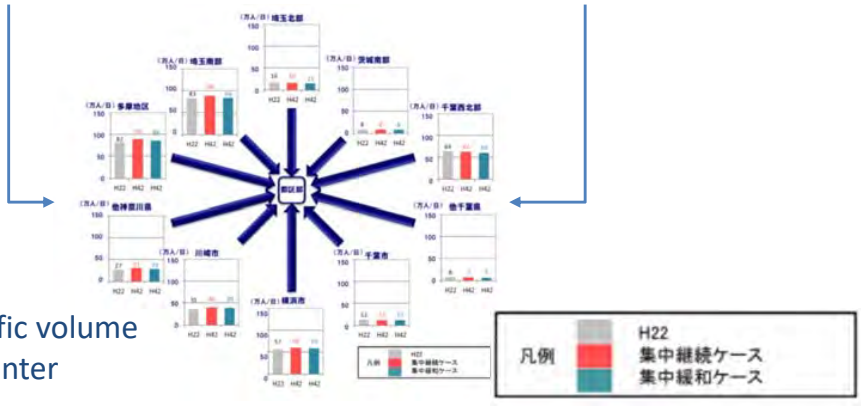
(5) Workers at workplace and its distribution



A: Concentration Continuity Case



B: Concentration Easing Case



Estimation of traffic volume into Tokyo City Center

3. Socio-economic Framework in the CTPP No.198

(6) Students at residence/school and those distribution

- **The number of students at residence :** estimated with nighttime population x enrollment rate (by municipality)

$$\text{Home-based students} = \text{Nighttime population} \times \text{Enrollment Rate}$$

Enrollment rate: from National Census in 2010
(almost stable in the past several years.)

- **The number of students at school:** estimated with the current rate of home-based students to the school-based students (β)

$$\text{School-based students} = \text{Home-based students} \times \beta\left(\frac{\text{school-based students}}{\text{home-based students}}\right)$$

β: National Census in 2010
(almost stable in the past several years.)

- **The number of university students at school:** estimated based on the current distribution of university students.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-9: Railway Fare System in Japan

Japanese Railway Fares
เรื่องค่าโดยสารรถไฟของญี่ปุ่น

1

Contents

1. Overview of Rail Fares in Japan
2. Tokyo Subway Fares
   (Discounts and non-fare box revenue)
3. Comparison of fares in major cities.
   Such as discount etc.

2

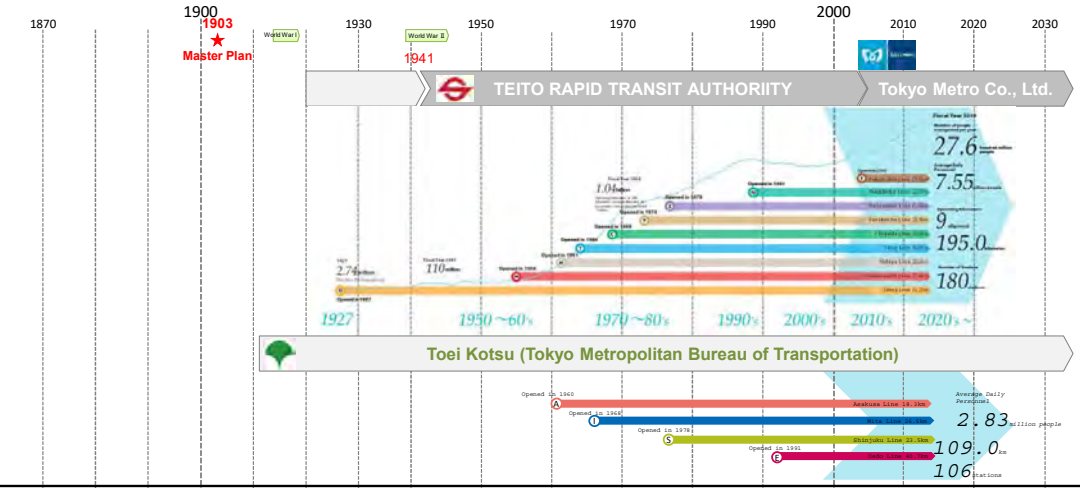
2

Key POINT

Ninety-five years have passed since the Ginza Subway Line began service.
The capital city of Tokyo has developed along with the development of the subway system.

・The construction of the subway was supported by the Land Adjustment Law promulgated in 1938, the use of FILP (Fiscal Investment and Loan Program) based on the Report of the Transport Policy Council in 1951, and the subsidy system for subway expressway construction established in 1962.

Average Daily Personnel
10.38 million people
304 km
286 stations



3

3

Summary of 13 routes

Route number	Route name	Km	Business Person		Through operation service
1	Asakusa Line	18.3			①Keihin Electric Express Railway Main Line / Airport Line / Kurihama Line / Zushi Line ②Keisei Electric Railway Oshiage Line / Main Line / Higashi Narita Line / Narita Airport Line ③Hokuso Railway Hokuso Line, ④Shibayama Railway Line
2	Hibiya Line	20.3			①Tobu Railway Isesaki Line / Nikko Line
3	Ginza Line	14.2			
4	Marunouchi Line	24.2+3.2			
5	Tozai Line	30.8			①East Japan Railway Chuo Main Line / Sobu Main Line ②Toyo Rapid Railway Toyo High Speed Line
6	Mita Line	24.2+2.3			①Tokyu Meguro Line/Toyoko Line
7	Namboku Line	21.3			①Tokyu Meguro Line / Toyoko Line ②Saitama Rapid Railway Saitama Rapid Railway Line
8	Yurakucho Line	28.3			①Tobu Railway Tojo Main Line ②Seibu Railway Seibu Yurakucho Line / Ikebukuro Line
9	Chiyoda Line	21.9+2.1			①East Japan Railway Company Joban Line ②Odakyu Electric Railway Odawara Line
10	Shinjuku Line	23.5			①Keio Electric Railway Keio New Line , Keio Line , Sagamihara Line , Takao Line
11	Hanzomon Line	16.8			①Tokyu Den -en-toshi Line ②Tobu Railway Isesaki Line / Nikko Line
12	Oedo Line	40.7			
13	Fukutoshin Line	11.9			①Tobu Railway Tojo Main Line ②Seibu Railway Seibu Yurakucho Line/Ikebukuro Line ③Tokyu Toyoko Line ④Yokohama High Speed Rail Minatomirai Line

304．0km

4

4

1. Overview of Rail Fares in Japan

2. Tokyo Subway Fares
(Discounts and non-fare box revenue)

3. Comparison of fares in major cities.
Such as discount etc.

5

5

1-1. There is a commuter pass system.

- Fares include "Regular" and "Passes".

Japanese Railway Fares

Passenger

freight

Regular
(Single Journey)

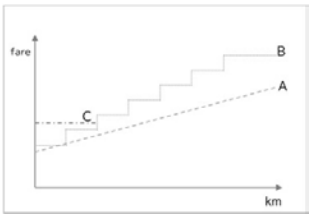
Coupon Type

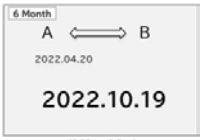
Discount Type

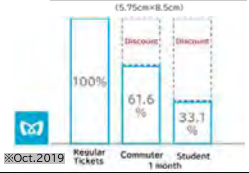
Passes

✓Commuter
✓Student

	Single Journey Discount	
1 Month		×60
3 Month	1 Month	×3×0.95
6 Month	1 Month	×6×0.9



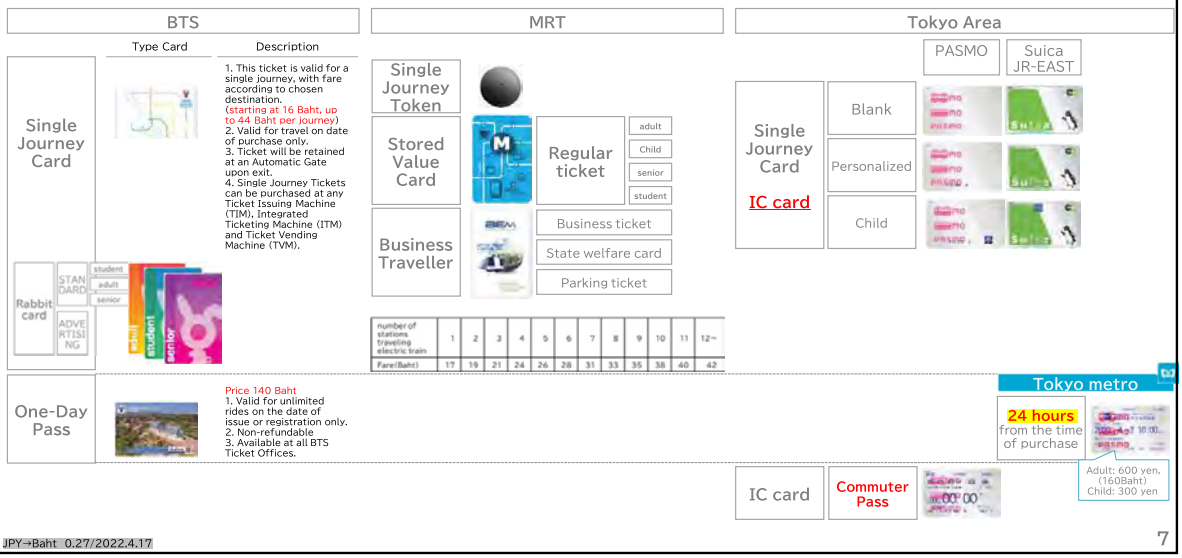




6

6

1-2. Ticket Info. (Bangkok,Tokyo)



7

1-3. Product list รายการสินค้า

	Regular Tickets ตั๋วธรรมดา	Coupon Tickets คูปอง	Economical Tickets ตั๋วส่วนลด	Passes บัตรโดยสารประเภทพาส
Face of the ticket หน้าตาของตั๋ว	 สำหรับผู้ใหญ่ エドモンソン券(縦3cm×横5.75cm)	 สำหรับผู้ใหญ่	 สำหรับลูกค้าที่มาเยี่ยมชมเมืองโตเกียว	 (縦5.75cm×横8.5cm)
Smart Card IC card type บัตร IC Mar.2007～				

Fares depend on the distance you will travel.
ค่าโดยสารจะขึ้นอยู่กับระยะทางที่คุณจะเดินทาง (JPY)

Distance (km)	1～6km	7～11km	12～19km	20～27km	28～40km
Standard Ticket	170	200	250	290	320
Smart Card	168	199	242	283	314

Percentage of Passenger Journeys	57.3% =1,586,054,340 /2,766,167,475 (2018)
Percentage of fare Revenue	44.0% =153,242,974,261 /348,509,579,644 (2018)

8

8

1-4. Coupon Tickets คูปอง

Tokyo Metro has three types of Coupon Tickets to meet passengers' needs. Coupon Tickets can be used at any Tokyo Metro station.
Restrictions apply on its usage and on the number of tickets you can obtain.
โตเกียวเมโทรมีคูปองทั้งหมด 3 ประเภทเพื่อตอบสนองความต้องการของผู้โดยสาร คูปองสามารถใช้ได้ทุกสถานีของรถไฟใต้ดินโตเกียวเมโทร ซึ่งคูปองแต่ละประเภทมีข้อจำกัดเรื่องการใช้งานและจำนวนคูปองที่คุณสามารถซื้อได้ต่างกัน





1995～



1995～

Types ประเภท	Ordinary Coupon Tickets คูปองธรรมดา	Off-peak Coupon Tickets คูปองสำหรับช่วงเวลาที่ไม่ใช่ชั่วโมงเร่งด่วน	Weekend/Holiday Discount Coupon Tickets คูปองส่วนลดวันหยุดสุดสัปดาห์และวันหยุดนักขัตฤกษ์
Number of Tickets จำนวนตั๋ว	Sold in packs of 11 tickets (Adult and Child fares available) จำหน่ายเป็นชุด ชุดละ 11 ใบ (มีทั้งสำหรับผู้ใหญ่และสำหรับเด็ก)	Sold in packs of 12 tickets (Adult fares only) จำหน่ายเป็นชุด ชุดละ 12 ใบ (มีเฉพาะสำหรับผู้ใหญ่เท่านั้น)	Sold in packs of 14 tickets (Adult fares only) จำหน่ายเป็นชุด ชุดละ 14 ใบ (มีเฉพาะสำหรับผู้ใหญ่เท่านั้น)
Restrictions ข้อจำกัด	No restrictions on the day or time of use ไม่มีข้อจำกัดสำหรับวันหรือเวลาในการใช้งาน	Can only be used Monday - Friday 10 a.m. to 4 p.m., Saturdays, Sundays and holidays as well as December 30 - 31 and January 2 - 3. สามารถใช้ได้เฉพาะวันจันทร์-ศุกร์ ตั้งแต่เวลา 10.00 น. ถึง 16.00 น. วันเสาร์, อาทิตย์ และวันหยุดนักขัตฤกษ์ รวมถึงวันที่ 30 - 31 ธันวาคม และวันที่ 2 - 3 มกราคม	Can only be used Saturdays, Sundays and holidays as well as December 30 - 31 and January 2 - 3. สามารถใช้ได้เฉพาะวันเสาร์, อาทิตย์ และวันหยุดนักขัตฤกษ์ รวมถึงวันที่ 30 - 31 ธันวาคม และวันที่ 2 - 3 มกราคม

9

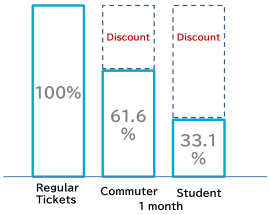
9

1-5. Passes บัตรโดยสารประเภทพาส

Student/Commuter Railway Pass

The Student/Commuter Railway Pass allows you to take unlimited rides between stations on the specified route. (Only the person registered on the card may use this pass.)""





Tokyo Metro All-line Pass

The Tokyo Metro All-line Pass allows you to take unlimited rides on all Tokyo Metro lines as long as the pass is valid. (A magnetic railway pass can be used by whoever possesses the card, while a PASMO card pass can only be used by the person registered on the card.)

1984～



Valid period อายุการใช้งาน	1 month 1 เดือน	3 months 3 เดือน	6 months 6 เดือน
Price ราคา	17,300 yen	49,310 yen	93,420 yen

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1－6. 1-Day Open Tickets. ตั๋วประเภท 1 วัน

These are great value tickets that can be used on Tokyo Metro and other lines in Tokyo.
24-hour tickets that can be used freely for 24 hours from the first use and 1-day open tickets that can be used freely from the first train until the last train on a specific date are also available.



ตั๋วเหล่านี้เป็นตั๋วราคาคุ้มค่าที่สามารถใช้ได้กับรถไฟโตเกียวเมโทรและรถไฟสายอื่นๆ ในโตเกียว
นอกจากนี้ ยังมีจำหน่ายตั๋ว 24 ชั่วโมงที่สามารถใช้ได้อย่างอิสระตลอด 24 ชั่วโมงนับจากการใช้งานครั้งแรก และตั๋วประเภท 1 วันที่สามารถใช้ได้อย่างอิสระตั้งแต่รถไฟขบวนแรกจนถึงขบวนสุดท้ายในวันที่ระบุ

	JR East				
Tokyo 1-Day Ticket	☑ (within the 23 wards)	✓	✓	1,600JPY (427Baht)	นี่เป็นตั๋วที่สามารถใช้ได้ 1 วันโดยสามารถใช้ได้ภายใน 1 เดือนนับจากวันที่ซื้อตามที่ลูกค้ากำหนด และสามารถใช้เดินทางบนรถไฟโตเกียวเมโทรทั้ง 9 สาย ตั้งแต่ขบวนแรกจนถึงขบวนสุดท้ายของวัน, รถไฟใต้ดิน Toei ทั้ง 4 สาย, รถราง Tokyo Sakura (Toden), รถบัส Toei (รวมถึงพื้นที่ Tama), Nippori-Toneri Liner ทุกโซน และรถไฟ JR ทั้งหมดภายในเขตโตเกียว
Common One-day Ticket for Tokyo Metro & Toei Subway		✓	☑	900JPY (240Baht)	สามารถขึ้นรถไฟของโตเกียวเมโทรและรถไฟ Toei ได้ทุกสายอย่างไม่จำกัดในระยะเวลา 1 วัน
Tokyo Metro 24-hour Ticket ตั๋วโตเกียวเมโทรประเภท 24 ชั่วโมง		✓		600JPY (160Baht)	ตั๋วนี้ให้คุณสามารถนั่งรถไฟได้อย่างอิสระเป็นเวลา 24 ชั่วโมงรวมถึงวันถัดไป* หลังจากเวลาที่ใช้ครั้งแรก

JPY→Baht 0.27/2022.4.17

11

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1. Overview of Rail Fares in Japan

2. Tokyo Subway Fares
   (Discounts and non-fare box revenue)

3. Comparison of fares in major cities.
   Such as discount etc.

12

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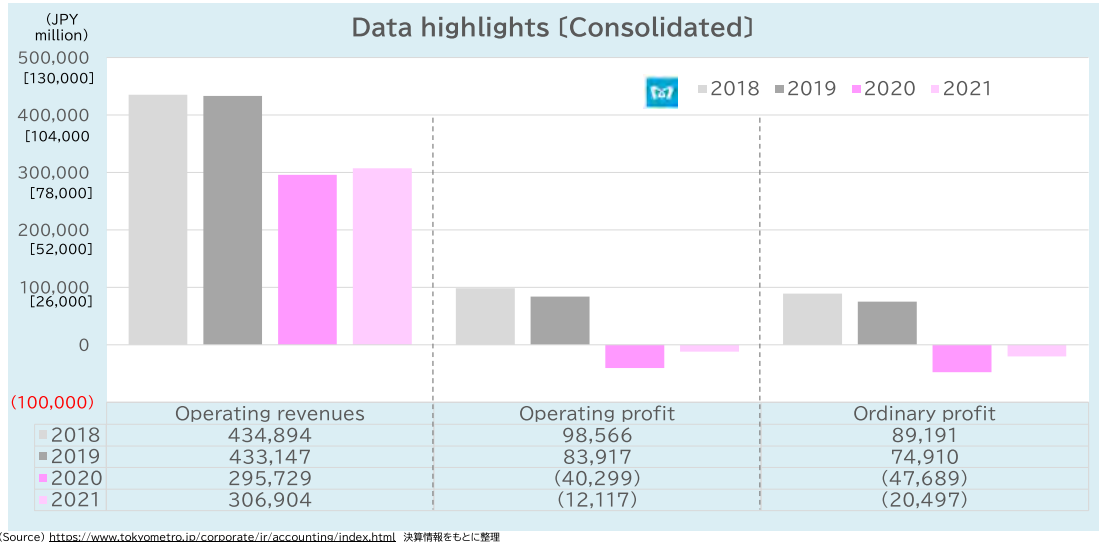
2-1. non-fare box revenue(Other Income)



13

[Reference] Consolidated income statement by COVID-19 (Tokyo Metro)

- Tokyo Metro's consolidated financial statements have been in the red for the second consecutive term.
  (In 2020, passenger transportation revenue will account for 75% of operating revenue.)



(Source) https://www.tokyometro.jp/corporate/ir/accounting/index.html 決算情報をもとに整理

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2-2. Ancillary business Outline of 15 Major Private Railways in Japan(2018)

15 major private passenger railways in Japan have harnessed the power of private business. many of which established their businesses in the first part of the 20th century. The private business methodologies utilized by the railway operators include engaging in multifaceted affiliated businesses such as buses and other transport businesses, real estate and other businesses related to housing along the railway lines. retail businesses. such as shopping centers. and tourism and leisure-related businesses. all while continuing to keep the railway business as their core enterprise.
Table summarizes major information for each of these 15 private railways in Japan.

(Source) KISS-RAIL 2.0(JARTS)

No	Company	Established Year	Service Area	Route KM (km)	Number of Pamnger (million)	Net passenger fare revenue	non-fare revenue	Railways	Others	Railway business sales		Revenue from operations (million)	Ancillary business ratio
YEAR				2018	2018	2018 a	2018 b	2018 c=a+b	2018 d	2018 e=c+d	f=c/e	2018 g	h=(g-e)/g
1	TOBU Railway	1897	Tokyo	463.3	926	148,846	15,101	163,947	67,960	231,907	70.7%	617,543	62.4%
2	SEIBU Holdings	1912	Tokyo	176.6	665	100,533	3,997	104,530	44,070	148,600	70.3%	565,939	73.7%
3	KEISEI Electric Railway	1909	Tokyo	152.3	292	65,564	3,855	69,419	15,955	85,374	81.3%	261,553	67.4%
4	KEIO Corporation	1910	Tokyo	84.7	677	82,259	3,920	86,179	42,622	128,801	66.9%	447,508	71.2%
5	ODAKYU Electric Railway	1923	Tokyo	120.5	766	119,526	3,838	123,364	50,537	173,901	70.9%	526,675	67.0%
6	TOKYU Corporation	1922	Tokyo	104.9	1,189	141,385	15,021	156,406	128,125	284,531	55.0%	1,157,440	75.4%
7	KEIKYU Corporation	1898	Tokyo	87.0	483	82,832	3,219	86,051	68,075	154,126	55.8%	339,268	54.6%
8	SOTETSU Holdinas	1917	Tokyo	35.9	233	31,575	1,915	33,490	0	33,490	100.0%	260,502	87.1%
9	NAGOYA Railroad	1910	Nagoya	444.2	393	90,135	4,750	94,885	14,930	109,815	86.4%	622,567	82.4%
10	KINTET SU Group Holdings	1910	Osaka	501.1	578	149,326	7,118	*156,444*	5,747	162,191	96.5%	1,236,905	86.9%
11	NANKAI Electric Railway	1884	Osaka	154.8	239	58,446	2,793	61,239	38,787	100,026	61.2%	227,424	56.0%
12	KEIHAN Holdings	1906	Osaka	91.1	295	52,055	3,790	55,845	3,167	59,012	94.6%	326,159	81.9%
13	HANKYU HANSHIN Holdings Hankyu	1907	Osaka	48.9	655	96,516	6,125	102,641	97,999	200,640	51.2%	791,427	64.8%
14	HANKYU HANSHIN Holdings Hanshin	1899	Osaka	143.6	245	34,055	2,633	36,688	41,645	78,333	46.8%	---	
15	NISHI-NIPPON Railroad	1908	Fukuoka	106.1	105	20,669	1,334	*22,003*	144,569	166,572	13.2%	396,835	58.0%
※	Tokyo Metro	2004 (1941)	Tokyo	195.1	2,766	348,510	34,862	383,372	16,057	399,429	96.0%	434,894	8.2%

(Source) KISS-RAIL 2.0(JARTS)を参考に大手民鉄の現況(2018年度)「日本民営鉄道協会」(https://www.mintetsu.or.jp/activity/databook/pdf/19databook_p02-05.pdf)、国土交通省発行、鉄道統計年報をもとに整理

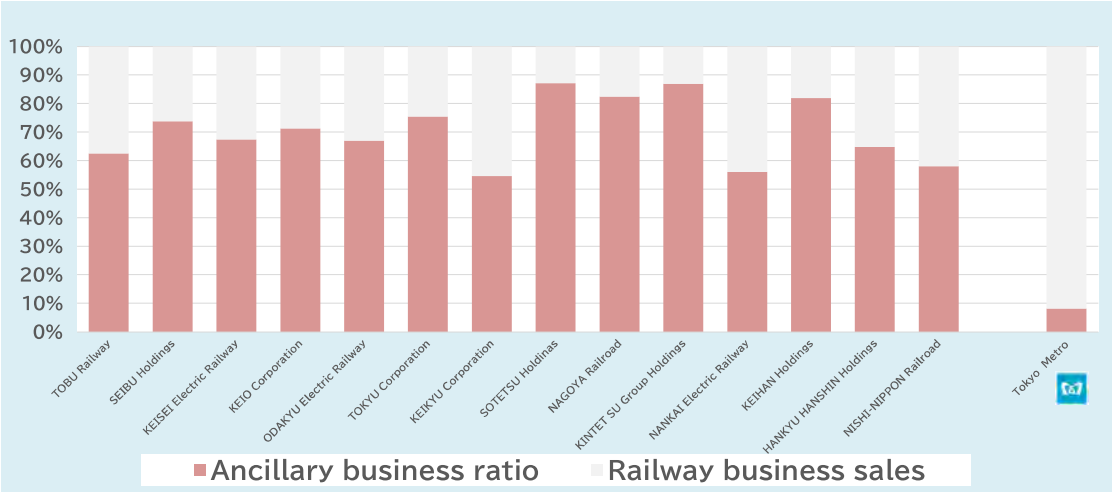
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15

[Reference] "Auxiliary business ratio" of 15 major Japanese railway companies (FY2018)

At present. some 70 to 90 percent of the revenue in these respective business groups comes from these diverse, affiliated businesses. Needless to say, they have put their energy into developing the areas along the railway lines and generating railway passengers by joining diverse.

(Source) KISS-RAIL 2.0(JARTS)

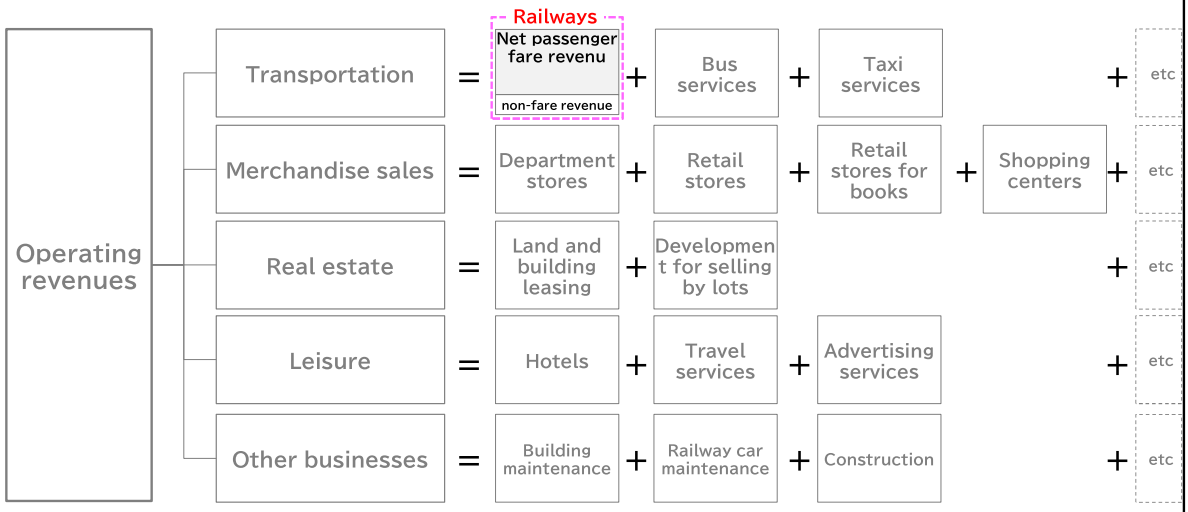


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[Reference] Breakdown of operating revenue (example)

- In order to understand the diversification of management in the railway business, we organized it based on sales and segment information in the consolidated financial statements.



(Source) https://www.keio.co.jp/company/stockholder/results_briefing/pdf/factbook2019.pdf, 京浜急行「決算短信2019」を参考に整理

17

17

[Reference] Consolidated Financial Results of Major Railroad Companies (FY2018-FY2021)

- **COVID-19** to cause 11 companies to lose money in FY2020.
- 11 companies were profitable in FY2021.

No	Company		Revenue from operations 2018	Operating income 2018	Ordinary income 2018	Revenue from operations 2019	Operating income 2019	Ordinary income 2019	Revenue from operations 2020	Operating income 2020	Ordinary income 2020	Revenue from operations 2021	Operating income 2021	Ordinary income 2021
1	TOBU Railway		617,543	67,295	62,972	653,874	62,653	58,414	496,326	-13,577	-9,892	506,023	24,732	27,406
2	SEIBU Holdings		565,939	73,332	65,415	554,590	56,823	48,770	337,061	-51,587	-58,785	396,856	-13,216	-17,440
3	KEISEI Electric Railway		261,553	31,608	50,720	274,796	28,320	41,705	207,761	-18,056	-32,165	207,761	-5,201	-3,191
4	KEIO Corporation		447,508	40,078	39,281	46,000	43,300	41,900	315,439	-20,866	-17,980	299,872	740	5,366
5	ODAKYU Electric Railway		526,675	52,089	49,687	534,132	41,103	38,299	385,978	-24,190	-31,223	358,753	6,152	4,699
6	TOKYU Corporation		1,157,440	81,971	81,907	1,164,243	68,760	70,925	935,927	-31,658	-26,824	879,112	31,544	34,998
7	KEIKYU Corporation		339,268	40,147	37,774	312,751	29,489	26,834	234,964	-18,420	-20,156	265,237	3,510	5,065
8	SOTETSU Holdinas		260,502	31,622	29,596	265,100	26,243	23,903	221,136	-3,148	-4,572	216,684	3,998	3,294
9	NAGOYA Railroad		622,567	49,455	51,599	622,916	47,363	49,288	481,645	-16,354	-8,146	490,919	2,932	13,135
10	KINTET SU Group Holdings		1,236,905	67,779	67,129	1,194,244	49,380	47,224	697,203	-62,115	-41,959	691,512	3,864	30,658
11	NANKAI Electric Railway		227,424	27,745	23,898	228,015	35,223	31,677	190,813	5,552	1,854	201,793	12,190	9,931
12	KEIHAN Holdings		326,159	33,715	32,108	317,103	31,123	29,886	253,419	-1,265	238	258,118	13,408	16,485
13	HANKYU HANSHIN Holdings	Hankyu	791,427	114,937	110,543	762,650	95,170	88,795	568,900	2,066	-7,623	746,217	39,212	38,450
14		Hanshin	---	---	---	---	---	---	---	---	---	---	---	---
15	NISHI-NIPPON Railroad		396,835	20,171	19,271	389,446	16,411	14,322	346,121	-9,501	-9,639	427,159	10,451	13,953
※	Tokyo Metro		434,894	98,566	89,191	433,147	83,917	74,910	295,729	-40,299	-47,689	306,904	-12,117	-20,497

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1. Overview of Rail Fares in Japan

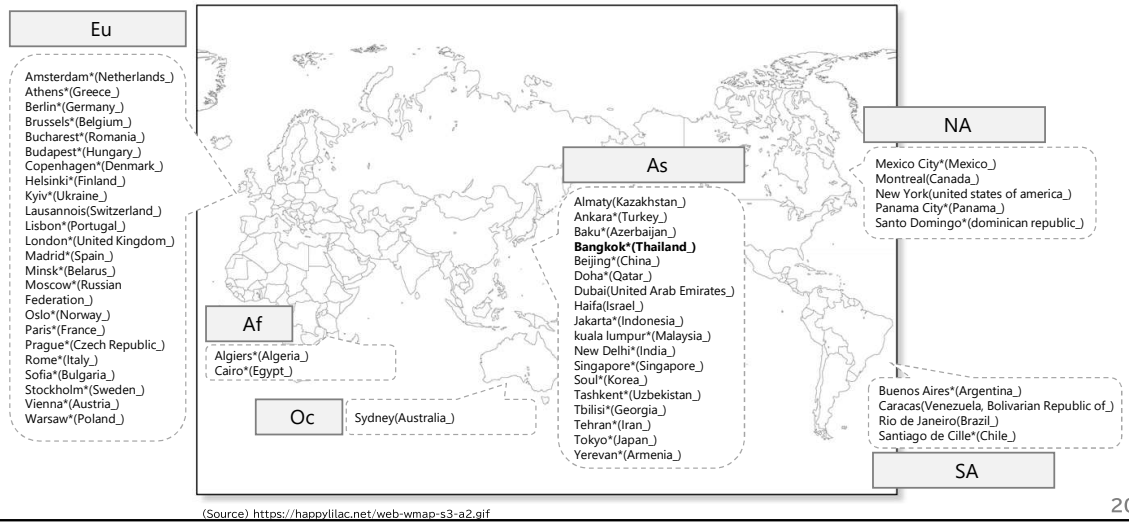
2. Tokyo Subway Fares
(Discounts and non-fare box revenue)

**3. Comparison of fares in major cities.
Such as discount etc.**

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3-1.Survey target city [Fare comparison]

- Survey of urban rail fares centered on the capitals of each country.
- สำรวจค่าโดยสารรถไฟในเขตเมืองที่มีศูนย์กลางในเมืองหลวงของแต่ละประเทศ

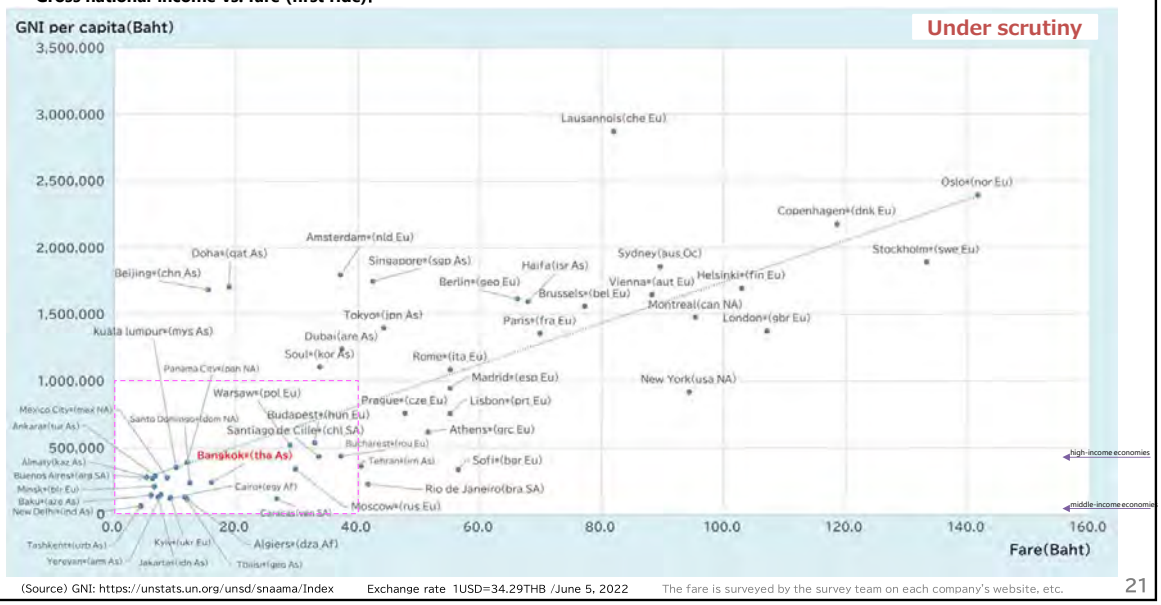


(Source) https://happylilac.net/web-wmap-s3-a2.gif

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3-2. GNI per capita(Gross National Income/2020 figures)[Fare comparison ①]

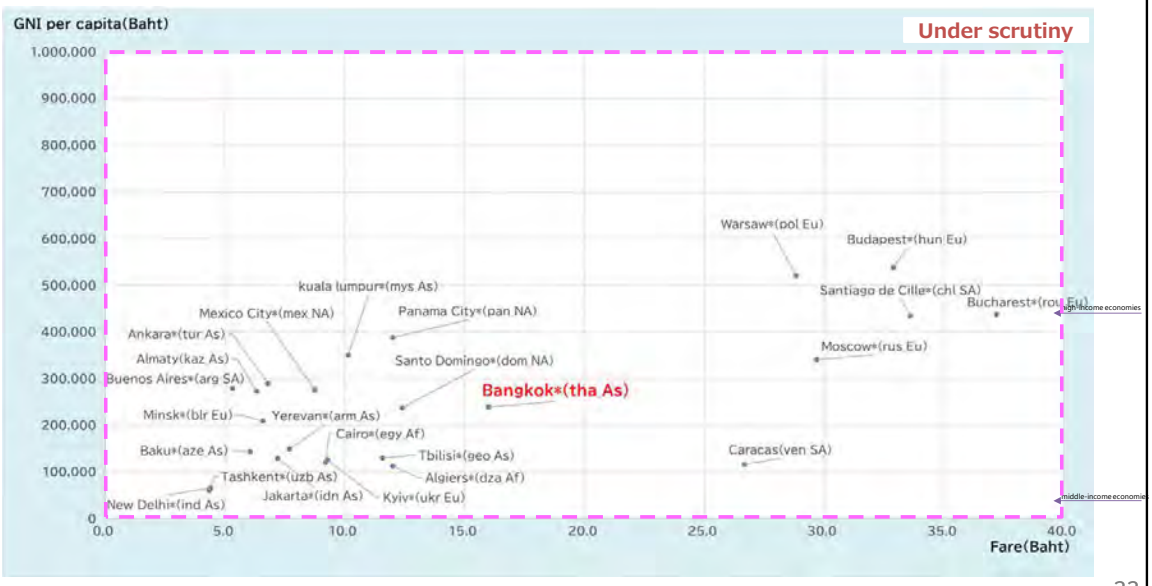
- **Gross national income vs. fare (first ride).**



(Source) GNI: https://unstats.un.org/unsd/snaama/Index Exchange rate 1USD=34.29THB /June 5, 2022 The fare is surveyed by the survey team on each company's website, etc. 21

21

3-2.GNI per capita （Gross National Income/2020 figures） [Fare comparison ①]

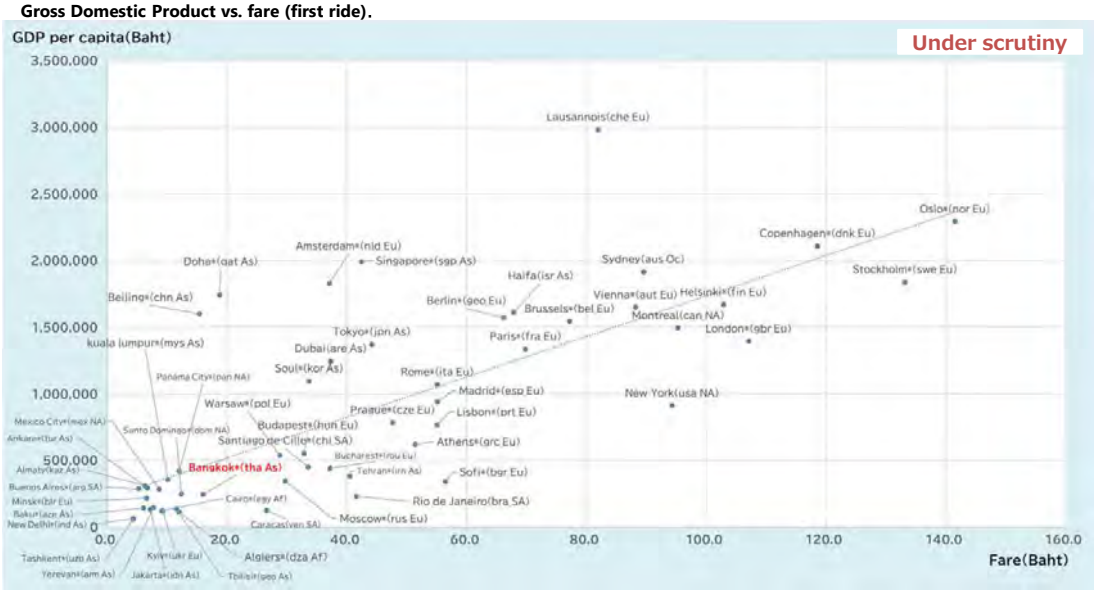


(Source) GNI: https://unstats.un.org/unsd/snaama/Index Exchange rate 1USD=34.29THB /June 5, 2022 The fare is surveyed by the survey team on each company's website, etc. 22

22

3-3. GDP per capita（Gross Domestic Product /2020 figures ） [Fare comparison ②]

- **Gross Domestic Product vs. fare (first ride).**



(Source) GDP: https://unstats.un.org/unsd/snaama/Index　Exchange rate 1USD=34.29THB /June 5, 2022　The fare is surveyed by the survey team on each company's website, etc.

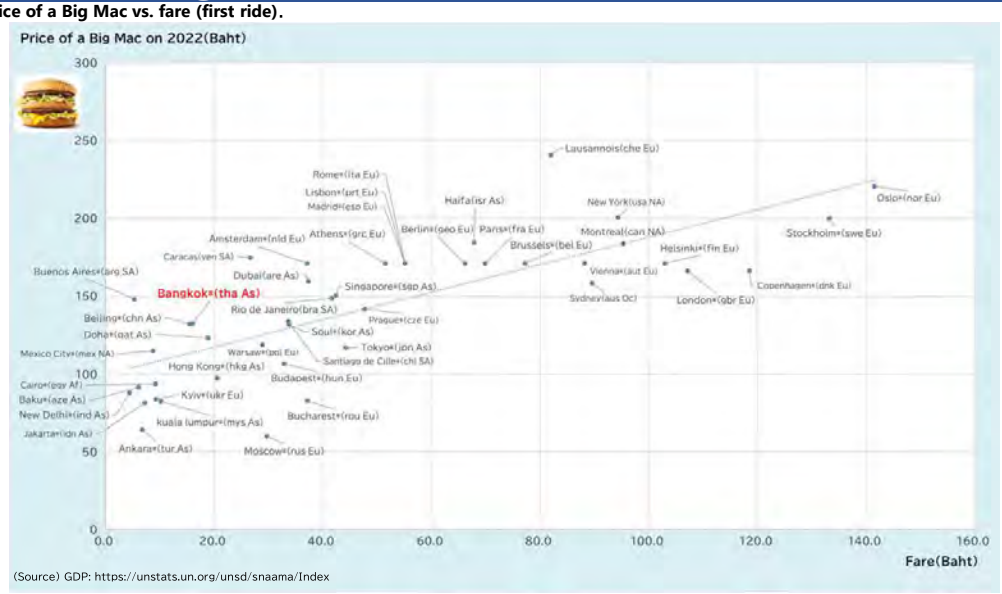
23

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3-4. Price of a Big Mac on 2022 [Fare comparison ③]

Under scrutiny

- **Price of a Big Mac vs. fare (first ride).**

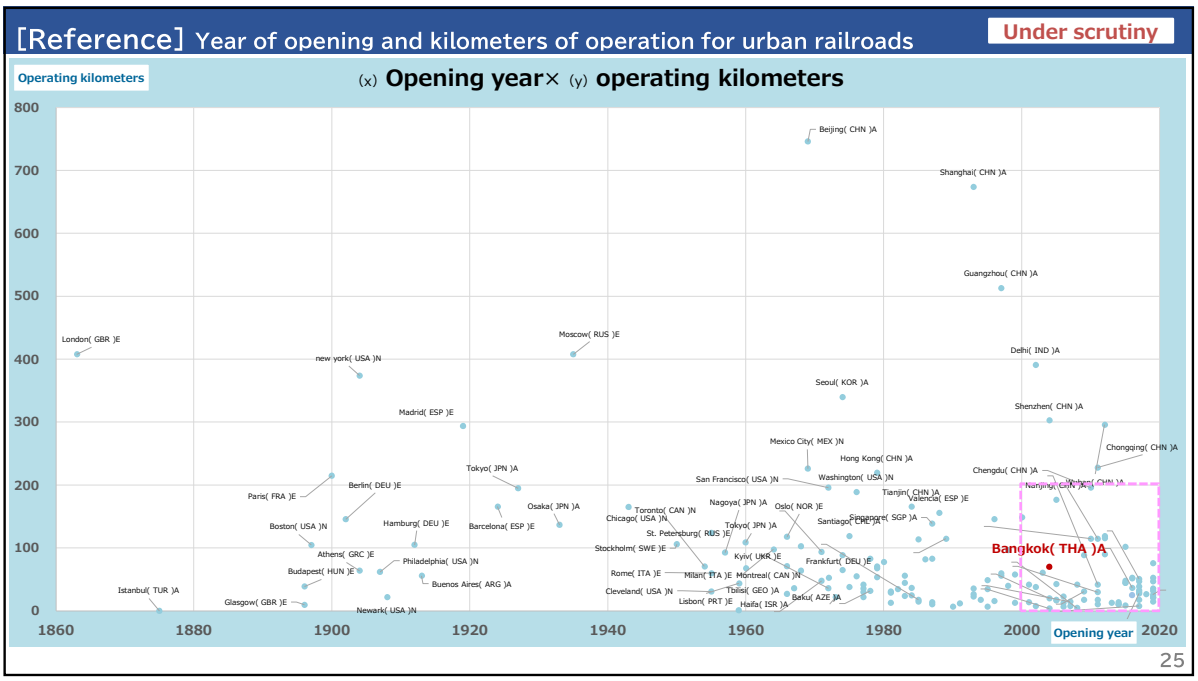


(Source) GDP: https://unstats.un.org/unsd/snaama/Index

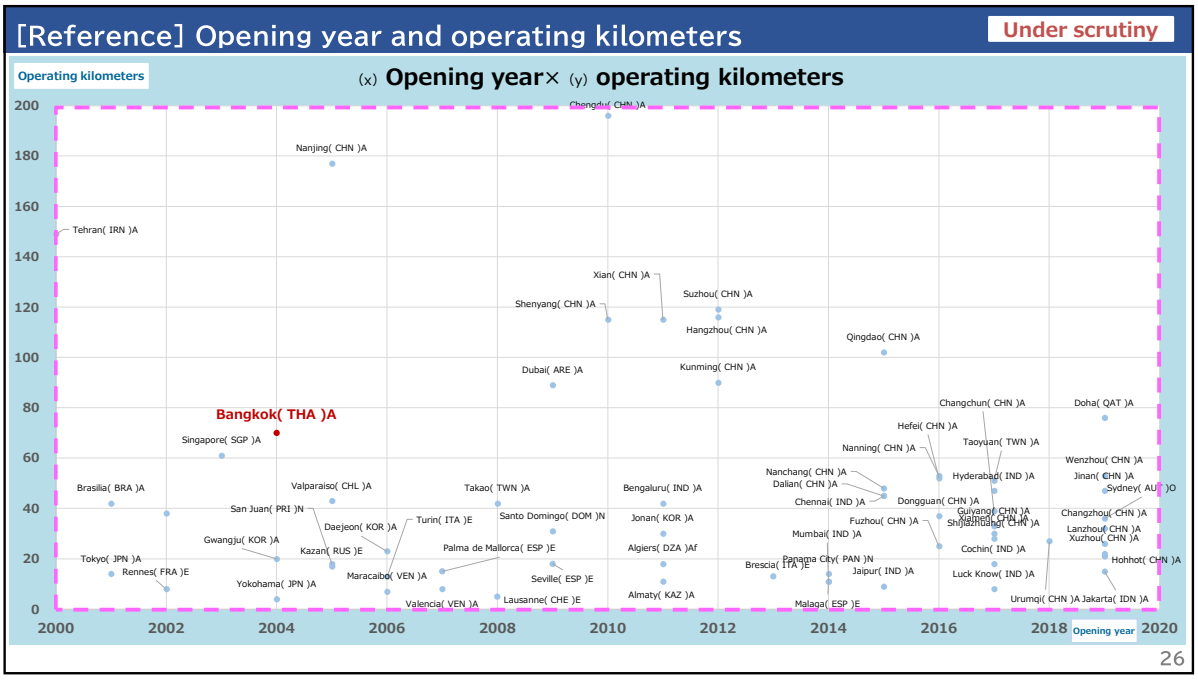
https://www.mcdonalds.co.jp/products/1210/　Exchange rate 1CAD=27.23THB /May 9, 2022　The fare is surveyed by the survey team on each company's website, etc.

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[Reference] Year of opening and kilometers of operation for urban railroads
Under scrutiny
Operating kilometers
(x) Opening year× (y) operating kilometers
800
700
600
500
400
300
200
100
0
1860
1880
1900
1920
1940
1960
1980
2000
2020
Opening year
Beijing(CHN)A
Shanghai(CHN)A
Guangzhou(CHN)A
Delhi(IND)A
Seoul(KOR)A
Shenzhen(CHN)A
Chongqing(CHN)A
Chengdu(CHN)A
Wuhan(CHN)A
Nanjing(CHN)A
Tianjin(CHN)A
Hong Kong(CHN)A
Mexico City(MEX)N
San Francisco(USA)N
Washington(USA)N
Valencia(ESP)E
Singapore(SGP)A
Santiago(CHL)A
Bangkok(THA)A
Moscow(RUS)E
London(GBR)E
new york(USA)N
Madrid(ESP)E
Tokyo(JPN)A
Paris(FRA)E
Berlin(DEU)E
Osaka(JPN)A
Barcelona(ESP)E
Boston(USA)N
Hamburg(DEU)E
Athens(GRC)E
Philadelphia(USA)N
Budapest(HUN)E
Buenos Aires(ARG)A
Istanbul(TUR)A
Glasgow(GBR)E
Newark(USA)N
Toronto(CAN)N
Chicago(USA)N
Nagoya(JPN)A
Oslo(NOR)E
St. Petersburg(RUS)E
Tokyo(JPN)A
Stockholm(SWE)E
Kyiv(UKR)E
Frankfurt(DEU)E
Rome(ITA)E
Milan(ITA)E
Montreal(CAN)N
Cleveland(USA)N
Tbilisi(GEO)A
Lisbon(PRT)E
Haifa(ISR)A
Baku(AZE)A
25

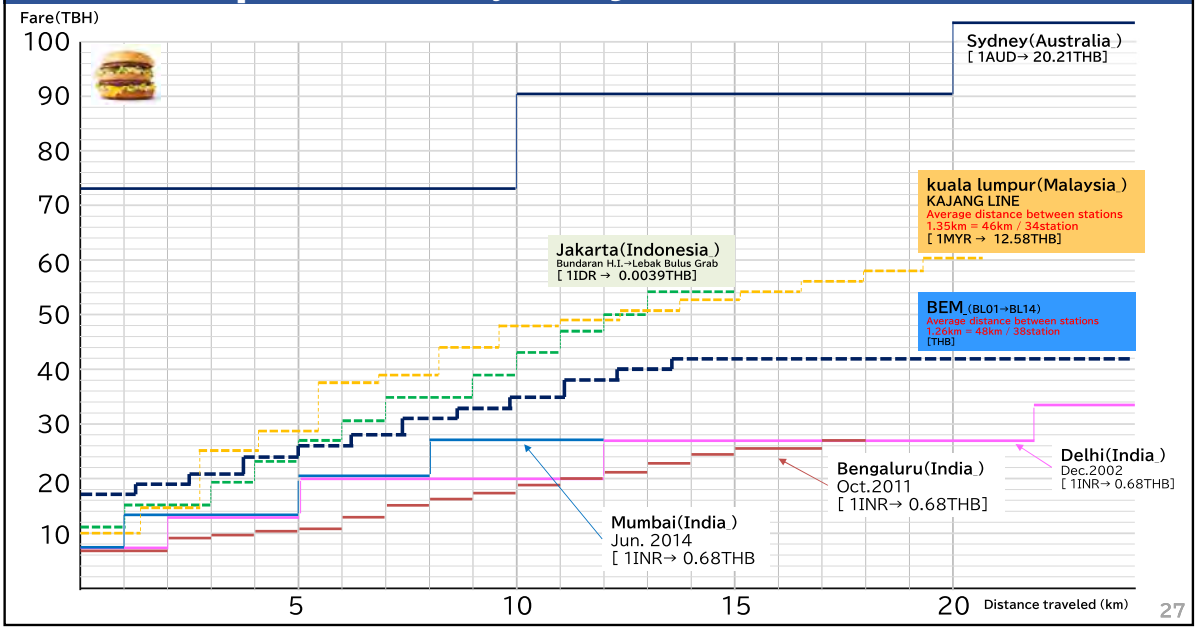
25


[Reference] Opening year and operating kilometers
Under scrutiny
Operating kilometers
(x) Opening year× (y) operating kilometers
200
180
160
140
120
100
80
60
40
20
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Opening year
Chengdu(CHN)A
Nanjing(CHN)A
Tehran(IRN)A
Xian(CHN)A
Suzhou(CHN)A
Shenyang(CHN)A
Hangzhou(CHN)A
Qingdao(CHN)A
Dubai(ARE)A
Kunming(CHN)A
Bangkok(THA)A
Singapore(SGP)A
Changchun(CHN)A
Doha(QAT)A
Hefei(CHN)A
Taoyuan(TWN)A
Nanning(CHN)A
Wenzhou(CHN)A
Jinan(CHN)A
Sydney(AUS)O
Nanchang(CHN)A
Dalian(CHN)A
Hyderabad(IND)A
Brasilia(BRA)A
Valparaiso(CHL)A
Takao(TWN)A
Bengaluru(IND)A
Chennai(IND)A
Dongguan(CHN)A
Changzhou(CHN)A
San Juan(PRI)N
Santo Domingo(DOM)N
Jonan(KOR)A
Fuzhou(CHN)A
Lanzhou(CHN)A
Daejeon(KOR)A
Turin(ITA)E
Mumbai(IND)A
Xuzhou(CHN)A
Gwangju(KOR)A
Palma de Mallorca(ESP)E
Algiers(DZA)Af
Cochin(IND)A
Tokyo(JPN)A
Kazan(RUS)E
Panama City(PAN)N
Hohhot(CHN)A
Rennes(FRA)E
Maracaibo(VEN)A
Seville(ESP)E
Brescia(ITA)E
Jaipur(IND)A
Luck Know(IND)A
Yokohama(JPN)A
Almaty(KAZ)A
Malaga(ESP)E
Urumqi(CHN)A
Jakarta(IDN)A
Valencia(VEN)A
Lausanne(CHE)E
26

26

3-5. Fare comparison - Fares by boarding distance (stairs) -

Under scrutiny



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3-6(2-7). INDEX 1km fare per person

- One figure that can be used to determine the status of a route is the amount of **1km fare per person**.

1km fare per person = Net passenger fare revenue received by metro (Fare Income) ÷ Passenger km

2018		Tokyo Metro										Total	Toei Subway				Total
		Ginza line Line 3	Marunouchi Line 4	Hibiya Line 2	Tozai Line 5	Chiyoda Line 9	Yurakucho Line 8	Hanzomon Line 11	Namboku Line 7	Fukutoshin Line 13			Asakusa Line Line 1	Mita Line 6	Shinjuku Line 10	Oedo Line 12	
Network Length - Operated, Kilometres		14.3	27.4	20.3	30.8	24.0	28.3	16.8	21.3	11.9	195.1		18.3	26.5	23.5	40.7	109.0
Number of Station served by line		19	28	21	23	20	24	14	19	11	179		20	27	21	38	106
Passenger Journeys (m)	a	419	503	451	536	475	423	393	211	215	2,766		279	246	289	357	1,030
Passenger km (millions)	b	1,482.1	2,491.8	2,398.3	4,710.1	3,378.7	3,114.4	2,027.9	1,302.0	1,281.8	22,187.1		1,470.4	1,634.0	2,004.2	2,084.8	7,193.3
Net passenger fare revenue received by metro(m) (Fare Income)	c	36,615	47,788	43,587	56,447	47,164	42,585	34,059	19,788	20,476	348,510		35,000	32,552	40,333	46,763	154,648
Average ride per person km	d=b/a	3.53	4.96	5.32	8.79	7.12	7.36	5.16	6.16	5.96	8.02		5.27	6.65	6.93	5.85	6.98
Average fare per person	e=c/a	87.3	95.0	96.6	105.4	99.3	100.6	86.6	93.6	95.1	126.0		125.4	132.6	139.5	131.1	150.2
1km fare per person (JPY)	f=c/b	24.70	19.18	18.17	11.98	13.96	13.67	16.80	15.20	15.97	15.71		23.80	19.92	20.12	22.43	21.50
[THB] 1JPY→0.26THB		6.4	5.0	4.7	3.1	3.6	3.6	4.4	4.0	4.2	4.1		6.2	5.2	5.2	5.8	5.6

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3-6. Such as discount

- There are various discount systems.
- We hope this will be helpful as a measure for M-MAP2.

Depends on the time zone
- ✓ Morning
- ✓ Daytime
- ✓ Night

By the number of days
- ✓ 1-day
- ✓ 2-day
- ✓ 3-day
- ✓ Weekly
- ✓ Monthly
- ✓ 4-month etc

Number of times
- ✓ 2 trips
- ✓ 10 trips

Common to other modes
- ✓ Bus
- ✓ LRT

Depends on the user
- ✓ Child
- ✓ Student
- ✓ Senior
- ✓ Traveler

By time
- ✓ 24H
- ✓ 48H
- ✓ 72H
- ✓ 96H
- ✓ 120H

Number of people and combinations
- ✓ family
- ✓ Young family

Other modes total
- ✓ Bus
- ✓ LRT

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The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix 10

Express Operation and Through Operations in Japan

What is "Express Operation"?

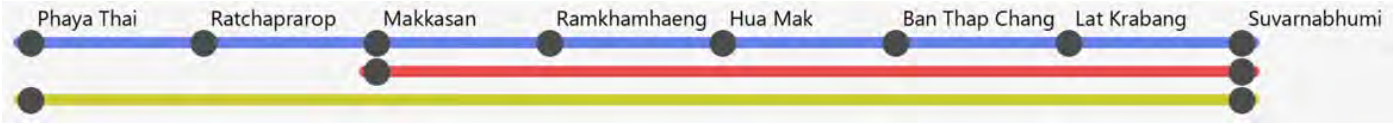
A rail service which stop **only in major stations**
This concept has been applied in SRT intercity trains for more than 100 years
Express Operation in ARL (suspended since September 2014)



City Line
Makkasan Express Line
Phaya Thai Express Train

Airport Rail Link
(before Sep 2014)







Express operation for long-distance commuting

Pros

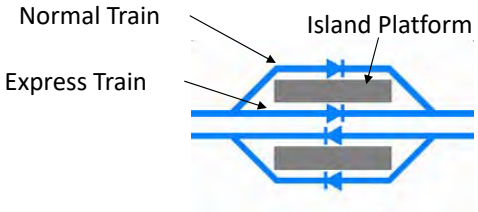
- Shorter travel time for long-distance trips
- Less congestion at stations near city center (distribution of demand)
- Increased attractiveness of line compared to competing modes
- Encourage real estate development near express train stops

Cons

- Lower accessibility for passing stations
- Concentration of passengers to certain trains
- Challenge in restoring normal operation after accidents

Addition of Siding at Stations

- Avoid express trains running slowly behind normal trains
- Passengers can transfer between express and normal trains

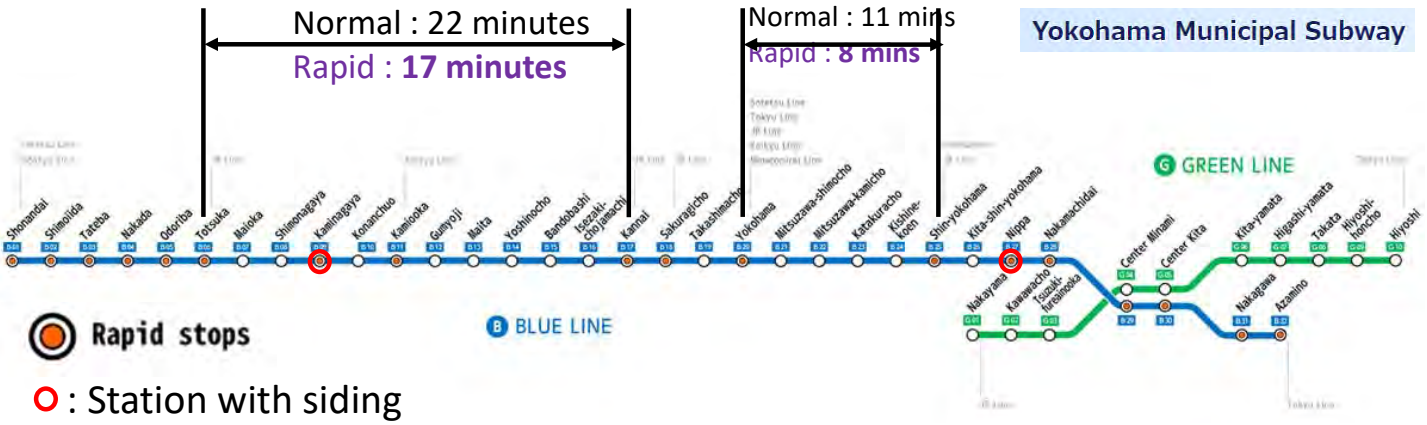


- In case of delays, sidings and railway crossover can be used to enable operation of partial section of line.

Benefits of Express Operation

Yokohama Municipal Subway

Shorter Travel Time



O : Station with siding

Benefits of Express Operation

Real Estate Development at Express Stops (shopping malls, etc.)

Shopping Mall at Minami-machida Grandberry Park Station



Station

History of Minami-Machida Grandberry Park
1976 : Station opens, express train does not stop
2000 : "Grandberry Mall" opens, express train stops during holiday season
2007 : Express train stops on weekend only
2019 : Redeveloped with the surrounding area and renamed as "Grandberry Park", express train stops everyday

Tokyu Den-en-toshi Line (Length 31.5km) DT



Minami-machida Grandberry Park Station
29.2 km, 36 min from Shibuya Station
(equivalent to Hua Lamphong – Rangsit)

Example of Express Operation : Metro

Wm|r#Vxezd|

Tokyo Metro Tozai Line

Length : 30.8 km



: Station with siding

City Center ⟷ Suburb

Case 1 : Express train only passes stations in suburb

Toei Shinjuku Line

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

10 7 Required traveling time

Length : 23.5 km



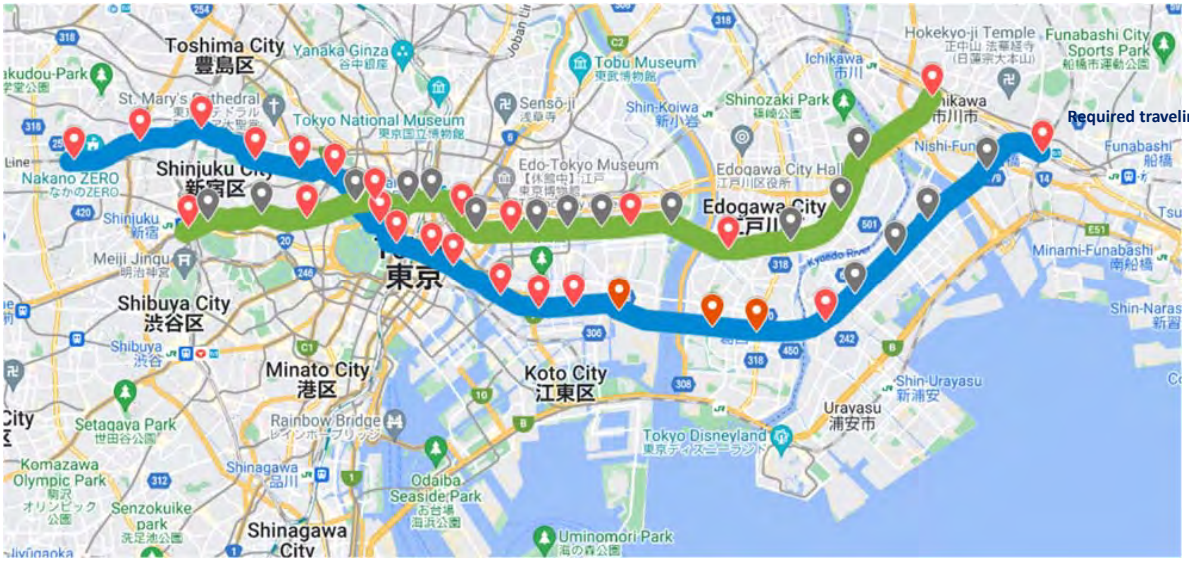
: Station with siding

City Center ⟷ Suburb

Case 2 :
Express train passes stations in both city center and suburb

Example of Express Operation : Metro

- Local stops
- Commuter Rapid stops
- Rapid stops

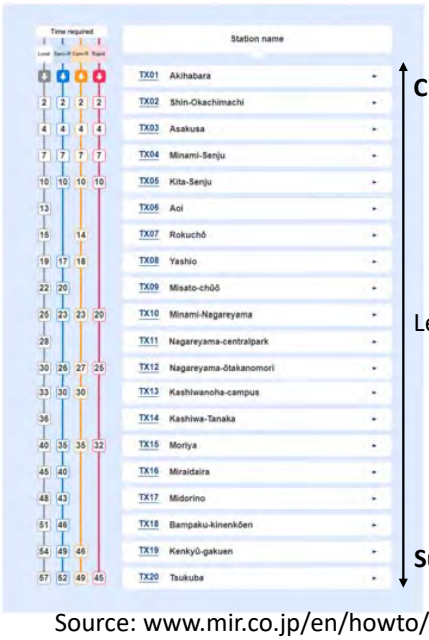


Required traveling time

Example of Express Operation : Suburban Railway

Wvxnedh{suhv

19 21 Required traveling time



City Center

Length : 58.3 km

Suburb

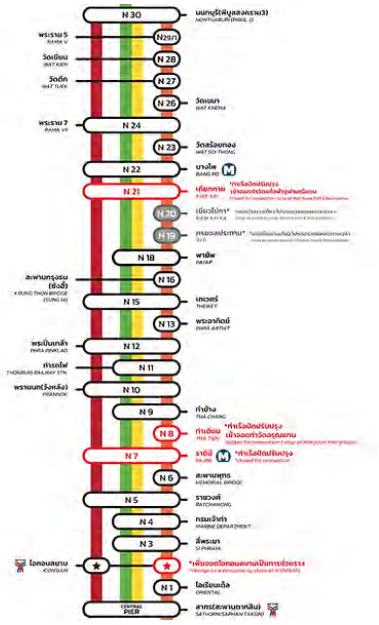


Source: www.mir.co.jp/en/howto/route_map

<

Express Operation: Bangkok?

Chao Phraya Express Boat

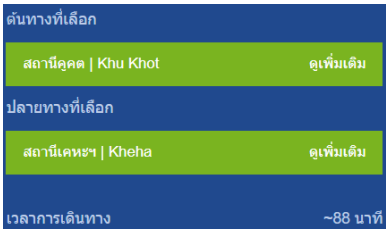


Example of Potential Express Operation in Sukhumvit Line (Length : 53.5km)



Normal Train

Express Train



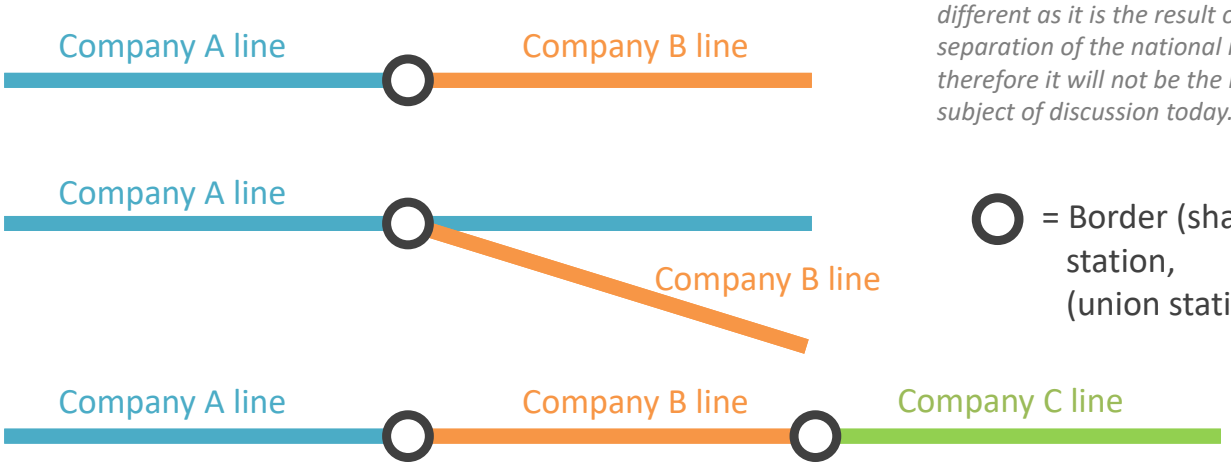
Current travel time between terminal stations = 88 minutes !!!
(from BTS website)

What is "Through Service"?

- A rail service running between **multiple lines, and/or multiple operators**
- In Tokyo, there are mainly two types:
  1. Multiple lines, one operator -> ***More preferable*** *from the viewpoint of the user*
  2. Multiple lines, multiple operators -> *We will focus on this today*
- Characteristics
  - Some trains run between multiple lines (typically express trains), while some trains run only on their line (usually local trains)
  - One rolling stock runs continuously on multiple lines, usually with multiple drivers

Through Operation

Through operation as the subject of discussion (many variations)



Please note that JR companies' through operation is fundamentally different as it is the result of the separation of the national network, therefore it will not be the main subject of discussion today.

= Border (shared) station, (union station)

Through Operation

Demarcation of roles, cost sharing (an example of reciprocal through operation)

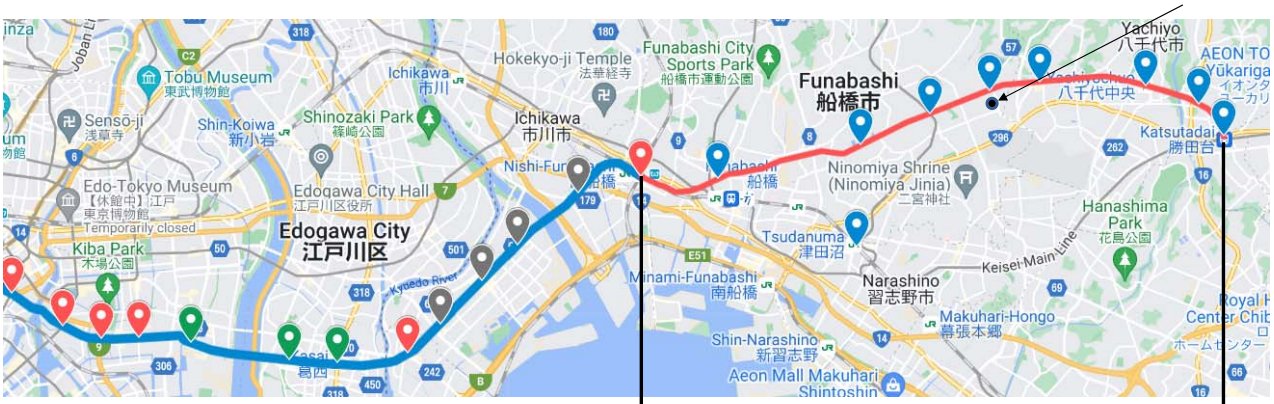
Operation	Arrangement	Cost sharing
Border station (facility, staff)	Entrusted to one company (to the major operator).	Cost is commonly shared based on the number of users.
Track and facilities	The one who owns maintains its track and facility*1	Not required
Rolling stock	Number of carriage x km travelled is reciprocally balanced.	Not required*2
Driver, guard	Operates only within the company boundary.*3	Not required
Train control room	Individually controlled for each company's section.	Not required*4
Fare collection & distribution	At station*5 / IC card operator. Fare table for each company.	Clearing house arrangement
Customer service	Responsible for the company's section (with coordination as manuals stipulate).	No cost sharing

Through Operation

There are many variations

Explanatory notes
*1 Owner and O&M entity may differ in the cases of vertical separation.
*2 Calculation & settlement is sometimes done in response to auditor's requirements. Even when carriage x km cost is calculated, the train usage cost is very minimal. Train quality (one-manned operation, energy efficient, etc.) does not normally count to train usage cost calculation (but with some exceptions in the past).
*3 Exceptions are there with Minatomirai21 Line (Yokohama), Skyliner, and others where train operation is entrusted to the major operator company.
*4 Sometimes control room staffs in the minor company are seconded from the major company.
*5 Fare collection and distribution includes commuter pass, ticket vending, excess fare collection, and IC card settlement.

Example: Toyo Rapid Railway Line



Distance: 30.8 km, **Stations**: 23

Passenger: 1.45 million pax/day (2017)

Operator/Owner: Tokyo Metro Co., Ltd.

Shareholders: Ministry of Finance 53.4%, Tokyo Metropolitan Government 46.6%

Distance: 16.2 km, **Stations**: 9

Passenger: 0.123 million pax/day (2021)

Operator/Owner: Toyo Rapid Railway Co., Ltd.

Shareholders: Chiba Prefecture 33.5%, Funabashi City 24.9%, Yachiyo City 22.1%, Tokyo Metro 12.6%, Keisei Electric Railway + Subsidiary 2.7%, Tobu Railway 0.7%, Mizuho Bank 0.4%

Example: Toyo Rapid Railway Line

Eastbound (to suburb)

From T 09 Otemachi

7	勝 02	勝 05	津 09	津 12	勝 15	勝 18	勝 22	勝 25	津 28	津 30	妙 33	津 36
	妙 39	勝 42	津 44	妙 47	勝 51	勝 53	津 56					
8	勝 00	妙 02	05	勝 08	妙 11	13	勝 16	勝 19	妙 21	八 24	26	勝 29
	妙 32	36	勝 40	43	46	勝 49	妙 51	東 54	勝 56	58		

Destination: Unmarked: For Nishi-funabashi 勝: For Toyo-katsutadai 八: For Yachiyo-midorigaoka 津: For Tsudanuma 妙: For Myoden 東: For Toyocho

Train Type: Red: Rapid Service

Only trains with 勝 or 八 run through *Toyo Rapid Railway*. Other trains run through *JR Sobu Line* (weekday peak-hour only) or terminate within *Tozai Line*.

Westbound (to CBD)

From TR 05 船橋日大前 Funabashi-Nichidaimae Sta.

[Weekday] Up Trains (For Nishi-Funabashi, Nakano)

5	M 01	09	29	M 42	M 51					
6	M 07	●M 19	● 27	● 32	M 40	44	● 49	53	●M 58	
7	● 05	M 09	● 15	● 20	● 25	● 30	34	M 41	● 47	52	57
8	02	M 07	14	● 19	●M 27	M 32	● 41	50	● 55		
9	▲M 05	M 09	▲ 16	▲ 28	▲ 40	▲ 55					

No Mark: For Nakano / M: For Mitaka / T: For Toyocho

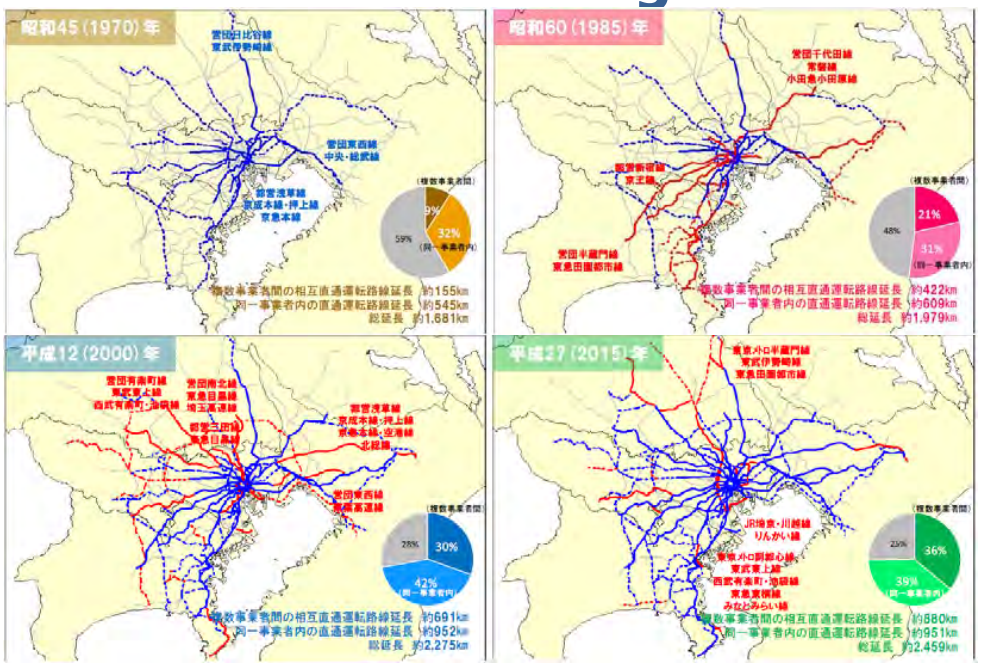
Red Number▲: Rapid (stops at all stations on the Toyo Rapid Line, Urayasu, Toyocho, and all stations after Toyocho)

Red Number●: Commuter rapid (stops at stops at all stations on the Toyo Rapid Line, Urayasu, and all stations after Urayasu)

Car No. 10 (front car) is women-only until Otemachi Sta. (Until 9am on Tozai Line)

Every train from *Toyo Rapid Railway* has through service to CBD via *Tozai Line.*

Timeline of Through Service in TMA



Existing Service
Multiple Operators

Existing Service
One Operator

New Service
Multiple Operators

New Service
One Operator

Source: MLIT

Through Service: Pros and Cons

Pros

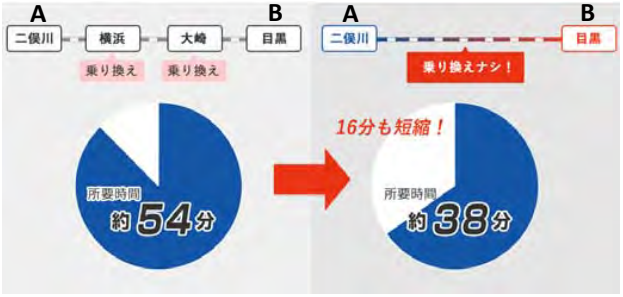
- Travel time + Transfer reduction
- Service can be provided by multiple operators

Cons

- Agreements between operators are needed (huge effort required)
- Additional investment is required to connect the tracks physically
- Usually creates more delay during rush hour
- May creates confusion to first-time user
- For multiple operators, fare tends to be higher (depending on the scheme)

Pros





To connect green line, yellow line and purple line, the blue and red missing links are invested

Travel time reduction from A to B = 16 minutes

Source: JRTT

No transfer = Less commuting time

3 companies operate together

Additional investment is required to connect the 3 lines

Additional Information



Source: JRTT



Source: JRTT

JRTT* issued **a Green Bond** to finance these missing links

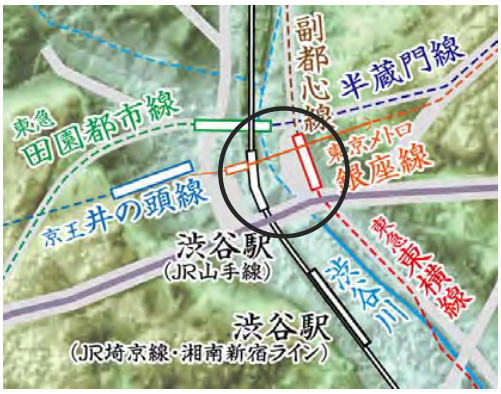
*similar to MRTA in Thailand, but invest in intercity rail and HSR too

Cons

Note: **Red** Line = Tokyu Toyoko Line, **Brown** Line = Tokyo Metro Fukutoshin Line
Blue Line = Keio Inokashira Line, **Orange** Line = Tokyo Metro Ginza Line



Dotted line = underground
Full line = ground or elevated



Shibuya station before 2012
The **red** line was on the ground level

Shibuya station during 2012 - 2020
The **red** line was moved underground for a through service with the **brown** line subway

Additional investment is required to connect the old and the new lines

Some lines cannot be connected because of the gauge difference

Cons

	Lines with Through Service												Standalone Lines							
	東急田園都市線				東京メトロ半蔵門線				東武伊勢崎線				東京メトロ銀座線				東京メトロ丸ノ内線			
	始発～10時		10時以降		始発～10時		10時以降		始発～10時		10時以降		始発～10時		10時以降		始発～10時		10時以降	
遅延時分	日数	割合	日数	割合	日数	割合	日数	割合	日数	割合	日数	割合	日数	割合	日数	割合	日数	割合	日数	割合
遅延なし	83	34%	37	15%	67	28%	28	12%	215	89%	216	90%	135	56%	143	59%	169	70%	122	51%
10分程度	106	44%	105	44%	95	39%	124	51%	7	3%	1	0%	100	41%	86	36%	62	26%	95	39%
15分程度	34	14%	61	25%	57	24%	54	22%	3	1%	1	0%	5	2%	8	3%	7	3%	12	5%
20分程度	10	4%	13	5%	8	3%	10	4%	9	4%	3	1%	1	0%	3	1%	2	1%	6	2%
25分程度	2	1%	4	2%	3	1%	4	2%	1	0%	3	1%	0	0%	0	0%	0	0%	3	1%
30分以上	6	2%	21	9%	11	5%	21	9%	6	2%	17	7%	0	0%	1	0%	1	0%	3	1%
遅延発生日数	158	66%	204	85%	174	72%	213	88%	26	11%	25	10%	106	44%	98	41%	72	30%	119	49%
調査日数	241	100%	241	100%	241	100%	241	100%	241	100%	241	100%	241	100%	241	100%	241	100%	241	100%
Average total delay	8.8分		14.1分		10.4分		13.6分		2.2分		4.1分		4.5分		4.6分		3.4分		6.0分	

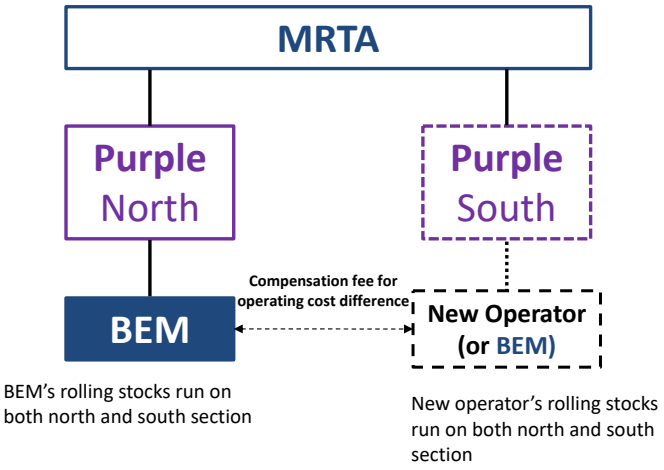
More delay caused by excessive dwell time in the suburban area

Source: MLIT

Possible Implication in Bangkok

Purple Line South Extension:

Operator does not have to be BEM
(albeit same operator is preferred)





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Through Operation

Conclusion

- Through operations in central Tokyo have appeared due to historical background that Metro/Toei were given duopoly in the CBD, not because of positive reasons.
- Through operations in the suburbs of the Tokyo Metropolitan Area are mostly due to the the existing operators' hesitance to extend the line to non-profitable sections.
- Integrity is always favoured. There are cases of through operation companies merging as single operator for a better integrity (Toyama LRT, Hokushin Kyuko, Chiba Kyuko, etc.).

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-11

Business Segment Diversification for Financially Robust Mass Rapid Transit

Contents

1. Business Segment Diversification for Non-farebox Revenue
2. How are the Internationally-renowned Operators Performing?
3. Case Study (1) - MTR
4. Case Study (2) - RATP
5. Case Study (3) - Japanese Private Railways
6. Findings and Implications

Business Segment Diversification for Financially Robust Mass Rapid Transit

1. Business Segment Diversification for Non-farebox Revenue

Non-farebox Revenue for Mass Rapid Transit Operators

Business Diversification for Non-farebox Generation

	1) Consumer business	2) Connecting transit service	3) Utility / data / communication services	4) Facility sharing business	5) Real estate business	6) Facility development & management	7) Loyalty marketing
Example	Goods & services in and out of station (vending, dining, data, IT, entertainment, tourism, health, education etc.)	Feeder bus, taxi and other mobility services	Energy, telecom, supply, disposal,	Advertising at station, in rolling stock, and on other facilities Offering event activity space	Station property renting	Residential, commercial, industrial facility development, renting, selling, and management	Franchising business activities under MRT brand
Goods & service beneficiary	fare-paying passengers, facility users, and public in general	fare-paying passengers and facility users	Dwellers in adjacent area (businesses & consumers) and public in general	Business entities (service industry)	Business entities (service industry)	Property owners and users	Business entities (service industry)
Implementation method	By establishing retail service affiliates Case: JR-Cross	By establishing transport service affiliates Case: Filéo (Keolis)	By establishing utility service affiliates Case: RATP Solutions Ville	By establishing advertising agency affiliates Case: Stellar (SMRT)	By establishing an affiliated real estate agency Case: MTR Properties rental & mgnt	By establishing an affiliated development company Case: MTR Properties development	Entrusted to a brand management Case: TfL contracting

Source: JICA Expert Team

Monetising Business Segment Diversification

Non-farebox revenue may be generated and captured by internalising the relevant (or fringe) business opportunities.

(1) Establishing designated business divisions or affiliated companies

(2) Contracting (franchising)

(Rail + Area Development Multi-purpose Project: Examples)



Shinagawa station redevelopment (2025-36) Floor area of 374,300 m2



Tsukuba station Azuma 20 area development (2023-2024) Floor area of 20,000 m2

Source: Development companies' website information



Hong Kong MTR offering residential, commercial and office properties along its railway lines (MTR West Rail Kam Sheung Road Station).

Source: The Standard, 14 Apr 2022

Business Segment Diversification for Financially Robust Mass Rapid Transit

2. How are the Internationally-renowned Operators Performing?

Identifying Public Transport Operators

World's top urban transport operators in figures (FY2022)

	MTA (New York)	TfL (London)	RATP Group
Ridership (annual)	1.1 billion	3.3 billion	5.8 billion (16 million x 365)
Revenue (annual)	USD 7 billion	GBP 5,804 million = USD 7.5 billion	EUR 6,076 million = USD 7 billion
Employee	70,000	25,000	71,000
Business segment and revenue share	(1) Passenger and toll 90% (2) Other 10%	(1) Fare (LU, Elizabeth Line, buses, rail) 73% (5) Road user charging 16% (6) Rents & commercial advertising 4% (7) Other 7%	(1) Transport operators 80% (2) Infrastructure management 17% (3) Safety and security 2% (4) Other services (urban services, digital services, engineering cooperation services, etc.) 1%
International presence	Unidentified	Commercial consulting and international operations	Operations in 15 countries

Source: Compiled from website information, annual reports, and financial statements

Identifying Public Transport Operators

World's top urban transport operators in figures (FY2022)

	JR East	MTR (Hong Kong)	Keolis (SNCF group)
Ridership (annual)	5.3 billion (14.6 million x 365)	1.1 billion	3.2 billion
Revenue (annual)	JPY 2,406 billion = USD 16 billion	HKD 47,812 million = USD 6.2 billion	EUR 6.7 billion = USD 7.4 billion
Employee	70,000	50,000	68,000
Business segment and revenue share	(1) Railway business 67% (2) Retail sales, restaurant 14% (3) Shopping center 16% operations and hotel operations (4) Others 3%	(1a) HK transport operations 28% (1b) HK station commercial 6% (2) HK property rental and management business 10% (3) Mainland China and international railway, property rental and management subsidiaries 55% (4) Other 1%	(1) Revenue 99% *(Metro, rail, tramway, parking, bicycles, buses & coaches, transport for people with reduced mobility, on-demand transport, autonomous mobility, river & maritime transport)* (2) Other income from operations 1%
International presence	India, Thailand, Indonesia, Singapore, Taiwan, UK, Vietnam, Philippines	12 railway services in 4 countries (Mainland China inc. Macau, UK, Sweden, Australia)	13 countries "generates half of its revenues from its international businesses."

Source: Compiled from website information, annual reports, and financial statements

Identifying Public Transport Operators

Other major urban transport operators (FY2022)

	DB Arriva	SMRT	Tokyo Metro
Ridership (annual)	1.5 billion	600 million (NSEWL+CCL) 226 million (bus)	2.2 billion (5.95 million x 365)
Revenue (annual)	EUR 4.2 billion = USD 4.6 billion	(SMRT Trains = SGD 813 million) (SMRT Buses = SGD 314 million)	JPY 345 billion = USD 2.3 billion
Employee	35,500	(9,300?)	9,700
Business segment and revenue share	(1) UK bus 23% (2) UK Trains 28% (3) Mainland Europe 48%	Public Transport Businesses (1a) SMRT Trains (1b) SMRT Buses Non-public Transport Businesses (2a) Strides (train OMS, mobility) (2b) Stellar Lifestyle (commercial business)	(1) Transportation 90% (2) Real estate 4% (3) Retail, advertising and IT 6%
International presence	10 European countries	France (STRIDES International operation of Grand Paris Express Network), (anticipated: Australia, Europe)	1 affiliated consultancy in Vietnam

Source: Compiled from website information, annual reports, and financial statements

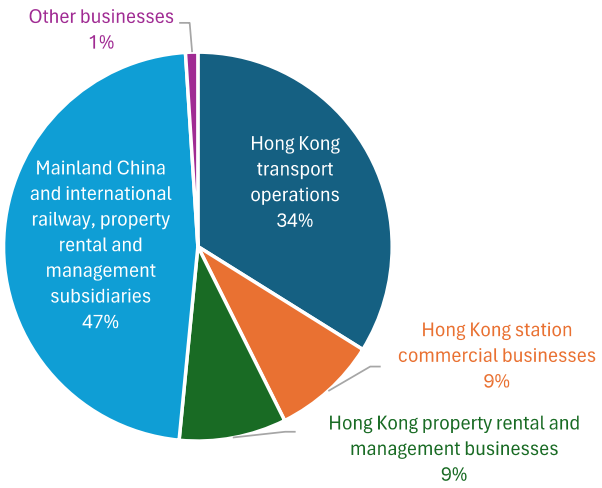
Business Segment Diversification for Financially Robust Mass Rapid Transit

3. Case Study (1) - MTR

MTR (Hong Kong) Revenue Composition

Home market core business accounts for 34% only

Business segment	Revenue (HKD bill)
Hong Kong transport operations	9,342
Hong Kong station commercial businesses	2,415
Hong Kong property rental and management businesses	2,456
Mainland China and international railway, property rental and management subsidiaries	13,079
Other businesses	282
TOTAL	27,574

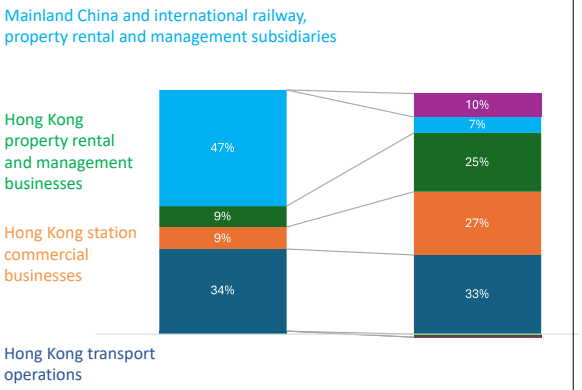


Source: MTR Interim Annual Report 2023

MTR (Hong Kong) Revenue Composition vs Earning Composition

Overseas businesses are not lucrative

Business segment	Revenue (HKD bill)	EBITDA (HKD bill)
Hong Kong transport operations	9,342	2,680
Hong Kong station commercial businesses	2,415	2,160
Hong Kong property rental and management businesses	2,456	1,998
Mainland China and international railway, property rental and management subsidiaries	13,079	532
Other businesses	282	660
TOTAL	27,574	8,030



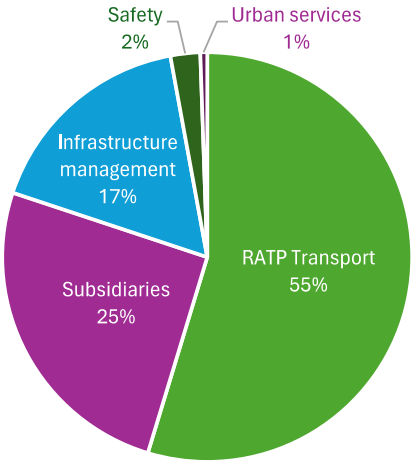
Business Segment Diversification for Financially Robust Mass Rapid Transit

4. Case Study (2) - RATP

RATP Group Revenue Composition

Home market core business accounts for 55% only

Business segment	Revenue (EUR mill)
RATP Transport	3,310
Subsidiaries	1,537
Infrastructure management	1,030
Safety	142
Urban services	33
Other services	23
TOTAL	6,076



Source: RATP Group Annual Report 2022

RATP Group Revenue Composition

"Infrastructure management" kept them afloat during COVID-19 pandemic...

Business segment	Revenue (EUR mill)	EBITDA (EUR mill)	EBIT 2018 (EUR mil)	EBIT 2019 (EUR mil)	EBITDA 2020 (EUR mil)	EBITDA 2021 (EUR mil)	EBITDA 2022 (EUR mil)
RATP Transport	3,310	-55	436	289	-87	87	-55
Subsidiaries	1,537	-11	11	18	-92	-26	-11
Infrastructure management	1,030	259	-5	0	268	262	259
Safety	142	1	-	-	0	2	1
Urban services	33	5	-	-	11	13	5
Other services	23	-6	9	12	-1	-9	-6
TOTAL	6,076	193	451	319	99	327	193

Source: RATP Group Annual Reports

Business Segment Diversification for Financially Robust Mass Rapid Transit

5. Case Study (3) - Japanese Private Railways

2. Multi-purpose Development by Rail Companies - Expectations

Examples of mass rapid transit operators benefitting from profitable business portfolio:

- Hong Kong MTR
- JR East, Tokyu, Hankyu, and many other railway companies in Japan

These examples of the successful integrated business (business diversification), embracing mass rapid transit, are the consequences of the freedom of business of the transport operators.

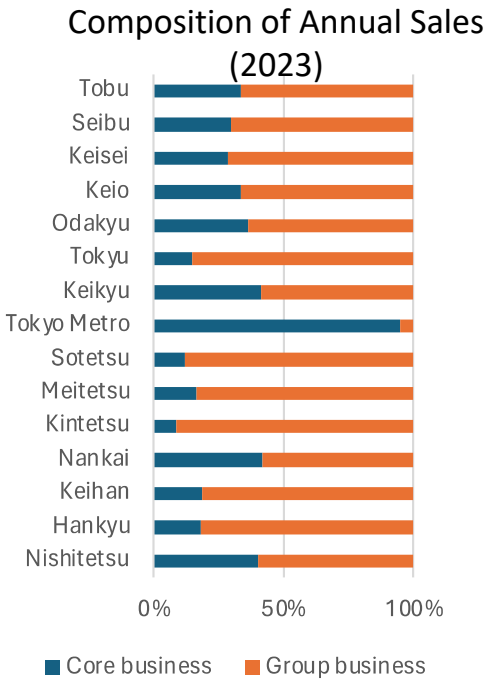
This is unlikely to happen in Bangkok unless we enhance the state-owned enterprises' PPP procurement modality*.

* If MRTA were the mass transit operator, there would be no need for PPP procurement, and MRTA could have diversified its business just as with Hong Kong MTR.

2. Multi-purpose Development by Rail Companies - Japan

- Railway operators in Japan are running their businesses on consolidated basis.
- Their core business, the railway services, comprise only a limited portion within their business portfolio.

- Incentivising the railway operators to diversify their business portfolio would realise more financially resilient (robust) and sustainable railway services.

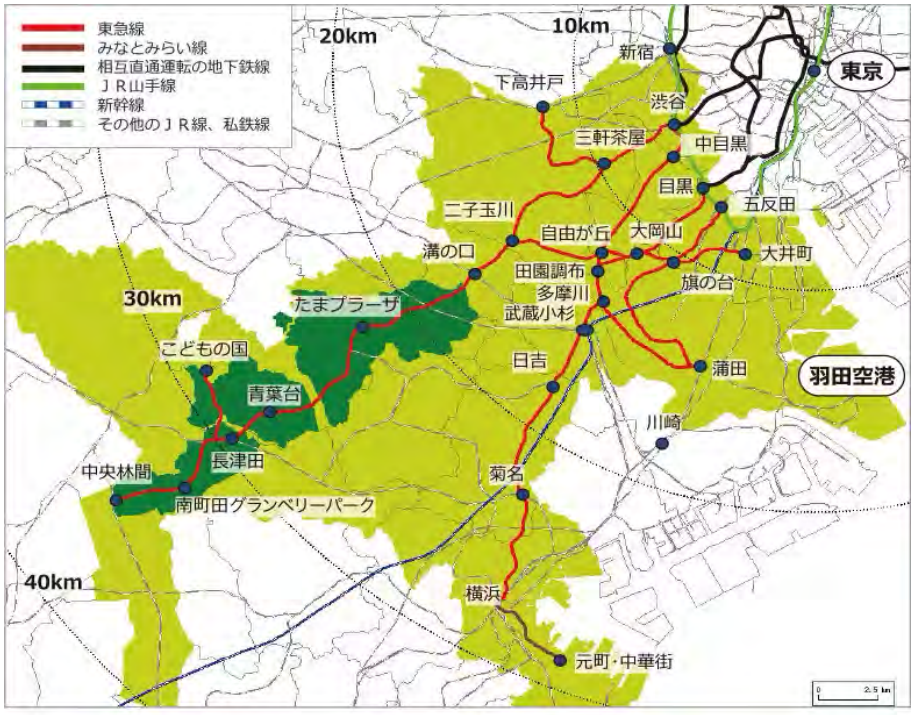


Source: respective companies' annual reports

A Railway Company's Idea of Market: "Catchment"

Tokyu Corporation Market Definition

- Area: 492 km2
- Population: 5.5 million
  (15% of the metropolitan area population)
- Per capita income:
  1.5 times of the national average.
- Final consumption expenditure:
  JPY 8.6 trillion/year



Source: Tokyu Corporation Website

Business Segment Diversification for Financially Robust Mass Rapid Transit

6. Findings and Implications

Implications

(1) Mass rapid transit regulators may encourage the operators' business segment diversification efforts.

(2) Bundled procurement of area development and mass rapid transit development will not only contribute to the operator's business segment diversification but may also enable the operator's internalised land value capturing (LVC).

(3) Focus of the bundled procurement may be on the local potential operators who are well acquainted with the real estate development and / or infrastructure development.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-12

Proposed Multi-purpose Development in Bangkok Metropolitan Region

With Referential Examples on Implementation Promotion Mechanisms for Mass Transit Development in Japan

Background Story

1. Rail (mass rapid transit), in general, is not a profitable business on its own, especially when it requires initial investment (MRTA Blue Line IRR=1.65%).

2. Mass rapid transit development, in any city, starts with lucrative sections (Green Lines). As we develop the network, marginal profitability of a new line will inevitably deteriorate due to lower ridership.

3. Nevertheless, we strongly encourage enhancing the network. As such, we must figure out a way to mitigate financial burden on the government.

4. Based on the experiences in Japan, we would like to propose two ideas to overcome the issue:

(1) Bundle mass rapid transit with more lucrative business (real estate development, for example)
=> Discussion with SEPO

(2) Introduce designated financial instruments (revolving fund) for zero interest long tenure loan,)
=> Discussion with PDMO

Contents

1. Referential Example: Yokohama Minatomirai
2. Multi-purpose Development with Railway Lines
3. Implementation Promotion Measures
4. Case Study Proposal - Khlong Toei - Suvarnabhumi Link
5. Can Government Undertakings be Bundled?

1. Referential Example: Yokohama Minatomirai

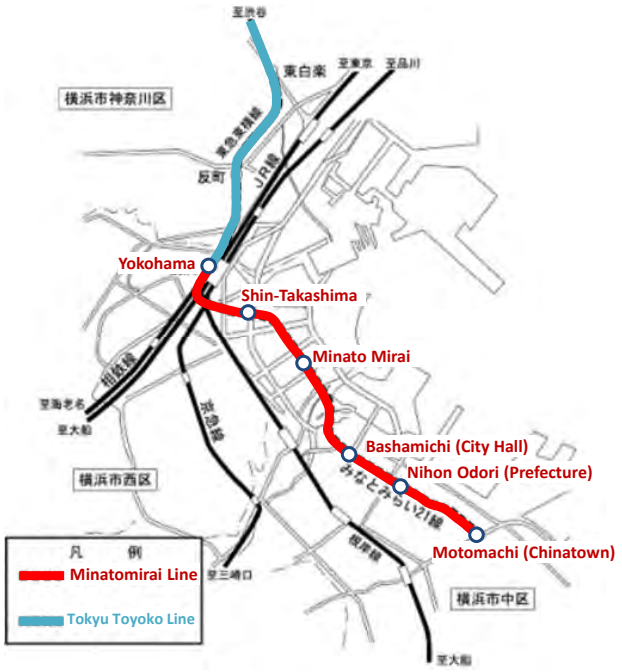
Minatomirai Line

Overview

The Company	
Company name	Yokohama Minatomirai Railway Company
Established	March 1989
Paid-in capital	JPY 50,719 million
No. of employee	114
Average age	44.3
Average annual pay	JPY 6.6 million/yr

The Line	
Line name	Minatomirai Line
Length	4.1 km
No. of station	6
Initial cost	JPY 256,300 million
Opened	February 2004

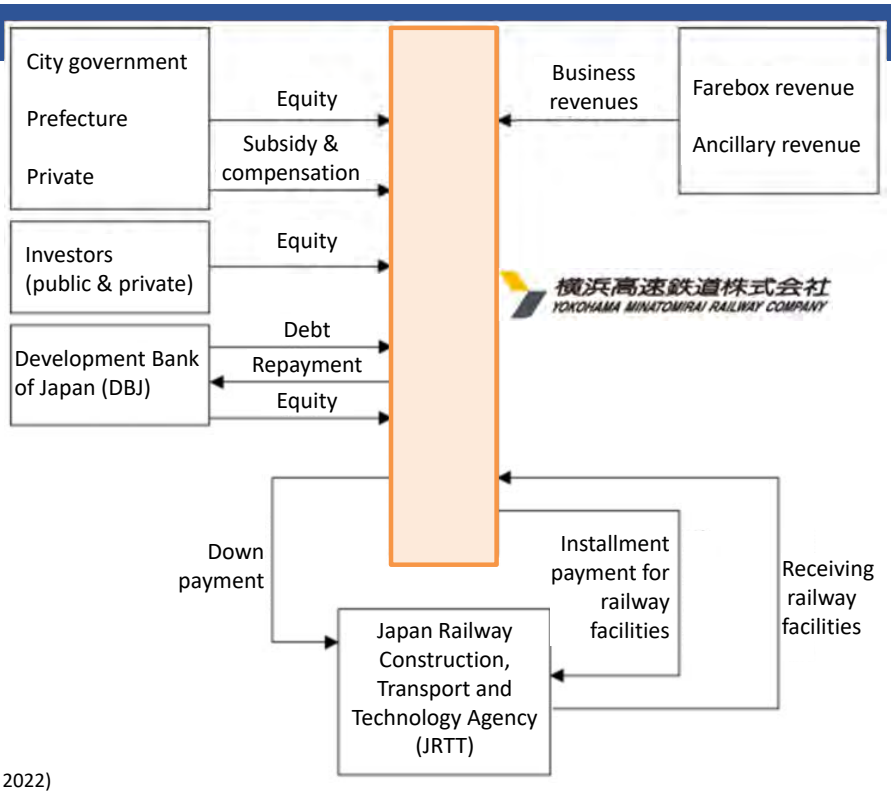
Source: financial results for 34th period (up to March 2022)



Minatomirai Line

The Company

- Received supports from the city and prefectural governments.
- Private sector invested and contributed.
- Low-cost finance was made available.

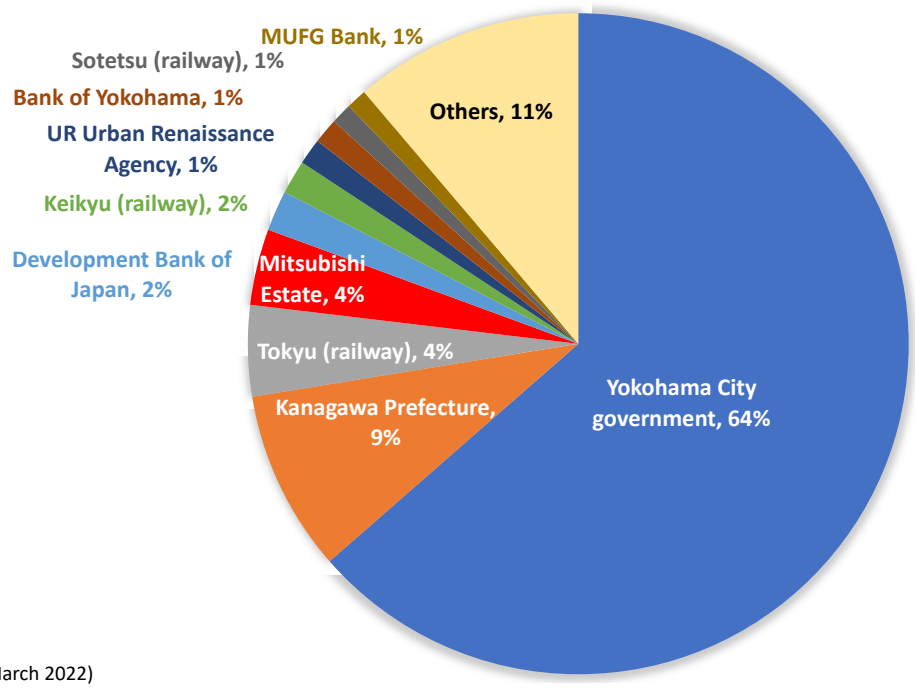


Source: financial results for 34th period (up to March 2022)

Yokohama Minatomirai Railway Company

Company
Shareholding structure

Paid in capital
= JPY 50,719 million



Source: financial results for 34th period (up to March 2022)

Minatomirai Line - Funding

Public Supports and Stakeholder Contributions:
60% of Minatomirai Line development cost is financed by zero/low interest lending facility.

Means	Amount	Note
From equity	JPY 27,200 million	Initially 50% from local gov't. 50% from private sector (A portion of the total paid in capital of JPY 50,719 million)
From the stakeholders' contribution	JPY 67,300 million	Approx. JPY 50,000 million collected amounting to ¼ of the initially estimated total investment of JPY 200,000 million Contributors = Mitsubishi Estate, UR, Yokohama City, MHI, etc. *Includes approx. JPY 20,000 million dedicated for a requested station development cost.*
From debt (1) Low interest rate	JPY 128,900 million	Financed by JRTT through FILP (Fiscal Investment and Loan Program) Interest subsidised by the central government and the prefecture
From debt (2) Zero-interest rate	JPY 32,900 million	Zero interest rate borrowing from DBJ, and commercial bank syndication
TOTAL	JPY 256,300 million	Includes land acquisition, civil, mechanical, facilities and management

Source: Compiled from financial results for 34th period Yokohama Minatomirai Railway Company



Minatomirai 21 (area development)

Minato Mirai 21





Source: Yokohama Minatomirai 21 Official Site (https://goyokohama.jp)

Source: Yokohama City Government (https://www.city.yokohama.lg.jp/kurashi/machizukuri-kankyo/toshiseibi/mm21/gaiyo.html) last updated April 2023

Minatomirai 21 (area development) in Figures

Overview and Benefits for Yokohama City	
Area	186 hectares 87 hectares of residential area 42 hectares of road and railway 46 hectares of parks and recreational ground 11 hectares of pier and harbour functions
Estimated population	Employed = 190,000 Habitant = 10,000
Visitors	2022: 61.5 million visitors 2021: 60.4 million visitors 2020: 83.4 million visitors
Investment and spendings	Development period (1983-2020) = JPY 2,534,000 million of accumulative investment Operation period (2020 onwards) = JPY 2,121,900 million/year of business expenditure
Expected contribution to the city revenue	FY2021-22: JPY 18,000 million FY2020-21: JPY 18,000 million FY2019-20: JPY 17,500 million
Economic benefits	Development period (1983-2020) = JPY 3,496,800 million of accumulative benefits Operation period (2020 onwards) = JPY 2,084,600 million/year of benefits

Source: Yokohama City Government (https://www.city.yokohama.lg.jp/kurashi/machizukuri-kankyo/toshiseibi/mm21/gaiyo.html) last updated April 2023

Minatomirai Line

Features of Minatomirai Line Development:

- Private sector supported through equity participation and contributions.

"Collaborative Participation Model"

- Driven by the city government's expectation to function as an essential infrastructure for a prosperous and profitable area development.

- Major portion (50%) of the construction cost was financed through JRTT, the Railway Construction, Transport and Technology Agency with low-cost finance, to be paid back in 30 years.

"Policy Finance"

2. Multi-purpose Development with Railway Lines

Proposed Multi-purpose PPP Procurement for Less Lucrative Projects

Can we consider allocating non-rail profit to rail business so that the rail business becomes commercially attractive?

Commonly sought method:

- LVC: land value capturing



Area development company

A portion of the profit from area development (equivalent to land value increase)



Estimate, verify, collect, allocate (cash payment)

Rail development & operation company

Repayment for mass rapid transit investment repayment.

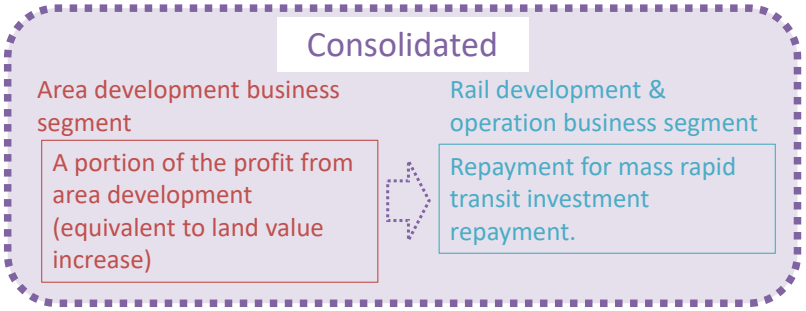


Proposed Multi-purpose PPP Procurement for Less Lucrative Projects

LVC is not easy.

- Land value increase verification is not easy and is commonly undervalued.
- Rail operator bears the full risk of land value increase.
- Development is disincentivized due to heavy financial burden for profit re-allocation (cash payment of unrealized profit).

=> Consolidation of the businesses is more realistic.



Proposed Multi-purpose Development in Bangkok Metropolitan Region

3. Implementation Promotion Measures

Measures to Tackle the Common Issue in Railway Development

The Common Issue:

"paying back the initial cost is difficult"

A simple beneficiary-pay principle is not sufficient because we need cash right now. Below are the examples of measures commonly sought:

	Measure	Theory
Measure 1	Subsidy (cash payment) for relieving the initial cost burden	(public subsidisation - grant)
Measure 2	Low-cost finance (low interest, long tenure) to relieve the debt repayment burden	(public subsidisation - loan) = Policy Finance
Measure 3	Bundle with quick return businesses	(private internal cross subsidisation)
Measure 4	LVC, taxation, or any gain returning mechanism	(external subsidisation) Facilitates measures listed above

Measures to Tackle the Common Issue in Railway Development

Measures implemented with Yokohama Minatomirai Line

Measures	Yokohama Minatomirai Line	Implication
Measure 1 = Subsidy for relieving the initial cost burden (public subsidisation - grant)	1) City, prefectural, and the central governments paid subsidies.	The governments may not have enough cash to subsidise.
Measure 2 = Low-cost finance to relieve the debt repayment burden (public subsidisation - loan)	2) DBJ loan 3) JRTT financing (P-sen method) 4) City and prefectural governments subsidised loan interests	Policy Finance: Bond issuing by SOEs is the mechanism we can also use here in Thailand.
Measure 3 = Bundle with quick return projects (private internal subsidisation)	**5) Mitsubishi Estate (MEC), the major developer paid a contribution for the railway development.** **6) Tokyu, MEC, and many others invested in the railway company**	**Companies were asked to contribute in return for their profits with their proper businesses.**
Measure 4 = LVC or any land price gain returning mechanism (external subsidisation)	Internally calculated to justify the measures listed and implemented above.	Calculation was not the issue; it was the cash issue.

Source: JICA Expert Team

Measures to Tackle the Common Issue in Railway Development

Measures which can be implemented in Bangkok

Measures	If applied to Bangkok	Implication
Measure 1 = Subsidy for relieving the initial cost burden (public subsidisation - grant)	1) IF MRTA is developing the physical infrastructure (or financially supporting), it is somehow same as public grant subsidisation.	MRTA's infrastructure development eliminates burden on repayment. Low cost concession rate functions as subsidy.
Measure 2 = Low-cost finance to relieve the debt repayment burden (public subsidisation - loan)	2) Is there any scope for low interest long tenure loan? **3) MRTA developing and owning the infrastructure (vertical separation) is already implemented.** 4) Interest subsidisation may not be available.	
Measure 3 = Bundle with quick return projects (private internal subsidisation)	5) The landowners and the developers may contribute to in cash to specific station development. **6) The landowners' and the developers' equity participation in the railway company to be made mandatory.**	The beneficiaries who can participate are landowners, developers, tenants, and service providers.
Measure 4 = LVC or any land price gain returning mechanism (external subsidisation)	7) Land price gain tax gain may be calculated individually for each stakeholder.	

Source: JICA Expert Team

Proposed Multi-purpose Development in Bangkok Metropolitan Region

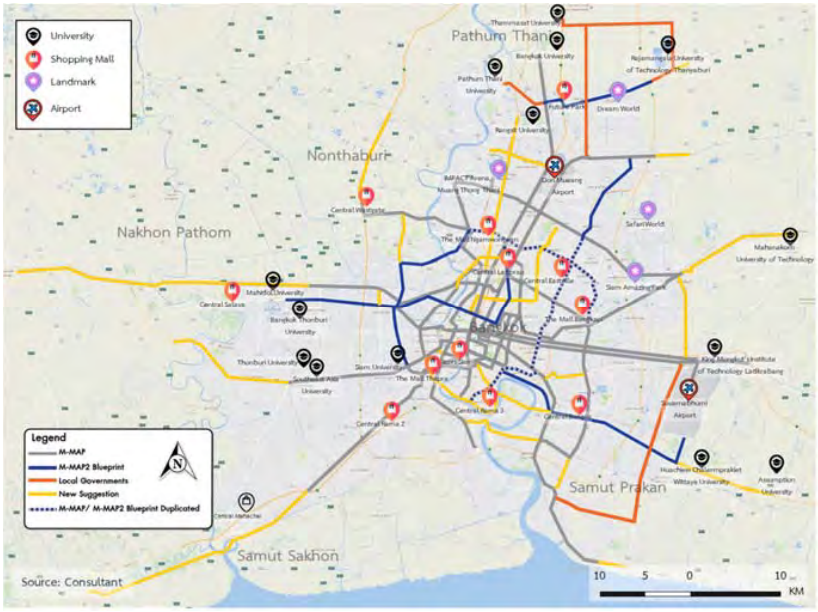
4. Case Study Proposal
Khlong Toei - Suvarnabhumi Link

Khlong Toei - Suvarnabhumi Link

Among the New M-MAP2 Blueprint Lines

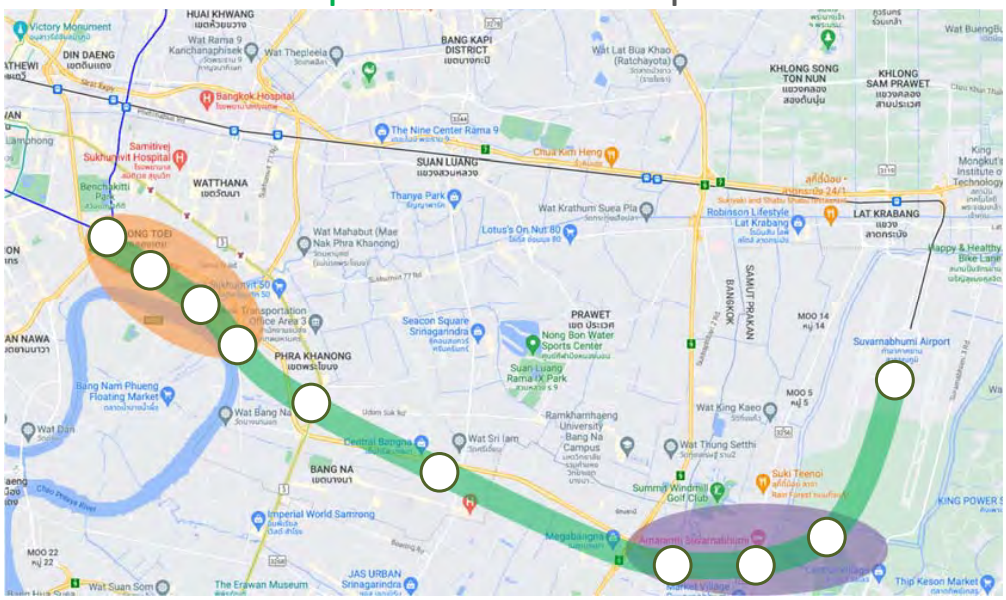
Three new lines were were suggested by the Provincial Administrative Organization (PAO) in the M-MAP2 blueprint:

- Bangkok
- Pathum Thani
- Samut Prakan



(Rail + Area Development Multi-purpose Project: Impression)

Commercial area, residential area may be developed in conjunction with the mass rapid transit development.



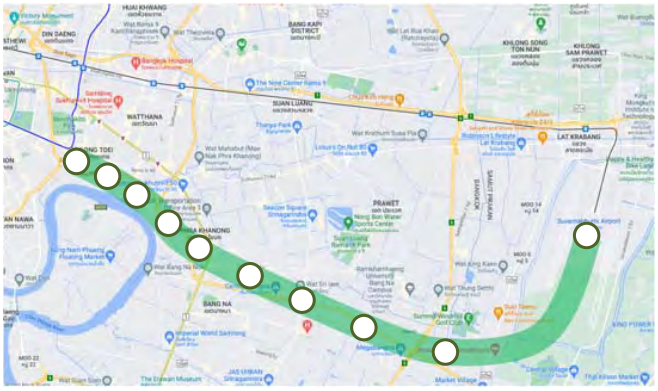
Note:

- Rail (mass rapid transit) will not be profitable by itself due to its heavy investment cost, but if it is combined with the area development, it is worth being implemented.
- Such integrated development may require the involvement of many authorities and stakeholders, which may hinder the implementation.

Khlong Toei - Suvarnabhumi Link

Overview (Rough Assumptions)

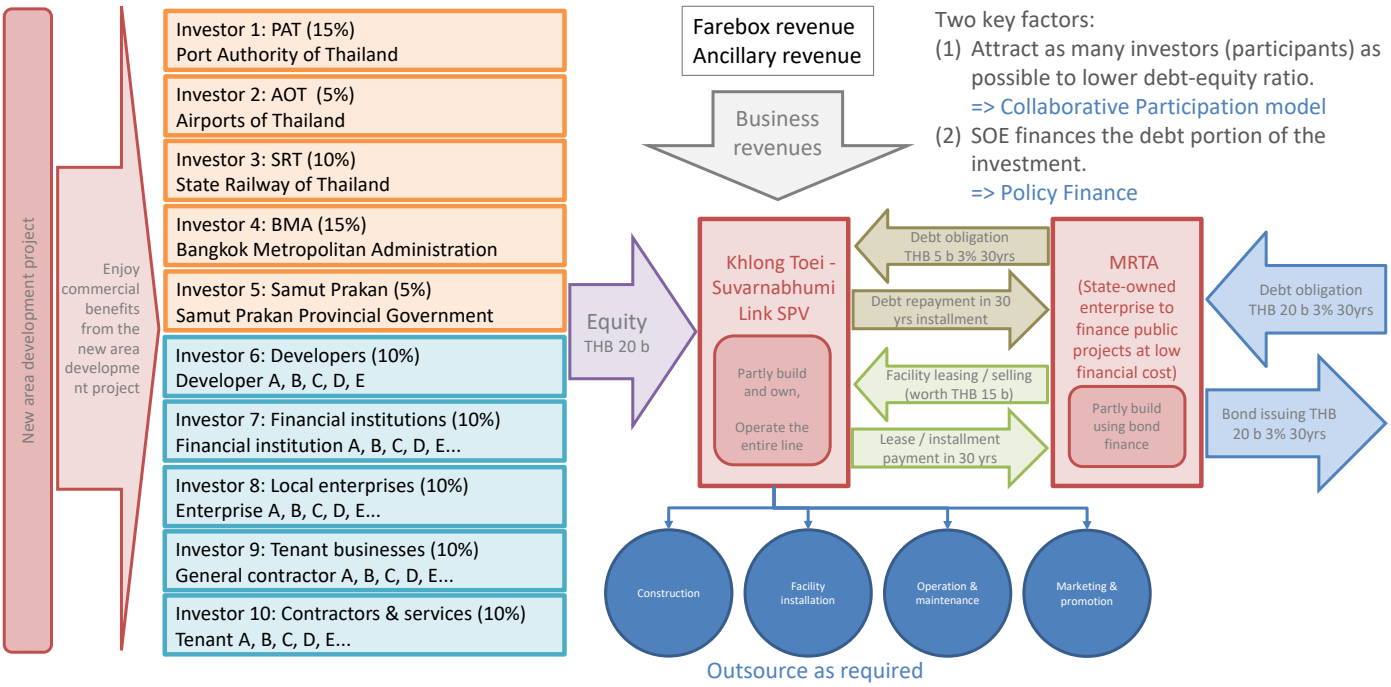
The Line	
Line name	Khlong Toei Suvarnabhumi Link
Length	30 km (approx.)
No. of station	10 1) Khlong Toei, 2) Customs, 3) Port authority, 4) Sukhumvit 50, 5) Phra Khanong, 6) Bang Na, 7) Bang Kaeo, 8) Racha Thewa, 9) Bang Phli, 10) Suvarnabhumi Airport
Initial cost	THB 40,000 million (= 1,600 億円) Underground = 10 km @ THB 2,000 million km Elevated = 15 km @ THB 600 million / km Surface = 5 km @ THB 300 million / km + Station = 10 @ THB 1,000 million
O&M cost	THB 2,000 million /yr (5% of initial cost)
Operation	From 2030



Ridership and fare	Farebox revenue
Average 240,000 / day	THB 4,380 million / yr
Average fare = THB 50	

Source: JICA Expert Team Proposal

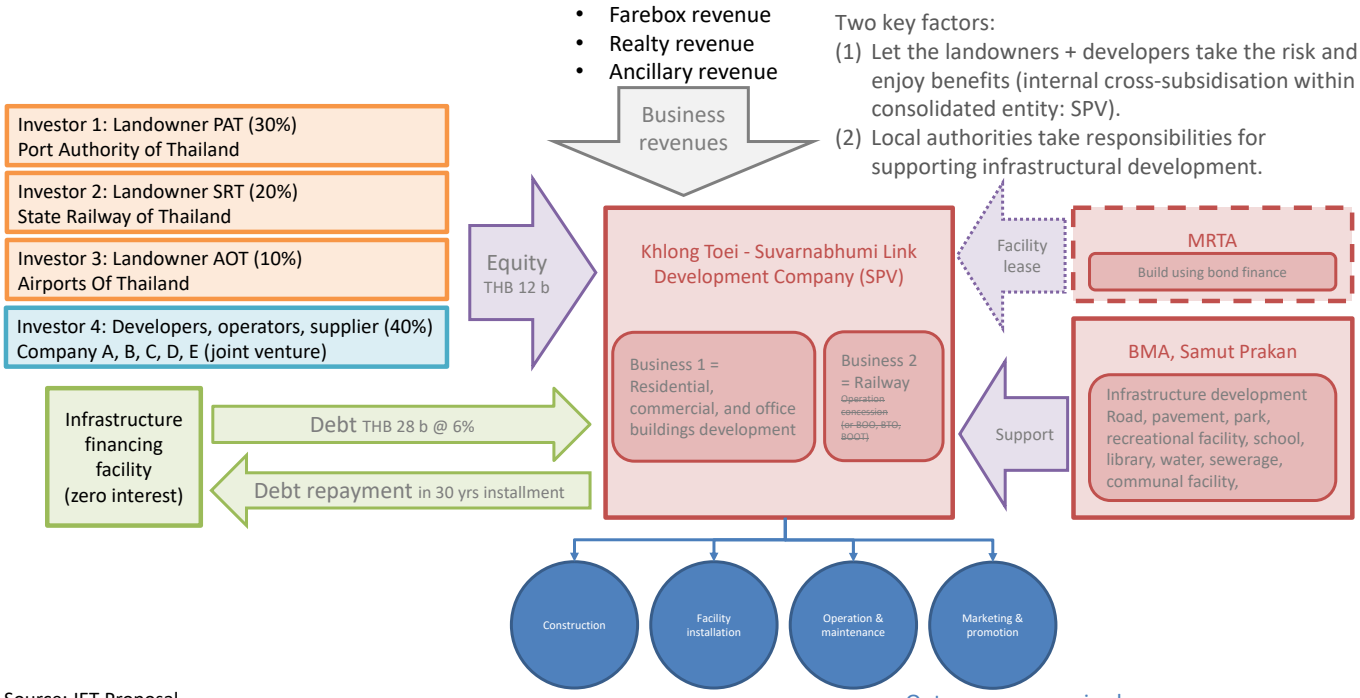
Khlong Toei - Suvarnabhumi Link (Rail business focused model)



Two key factors:
(1) Attract as many investors (participants) as possible to lower debt-equity ratio.
=> Collaborative Participation model
(2) SOE finances the debt portion of the investment.
=> Policy Finance

Source: JICA Expert Team Proposal

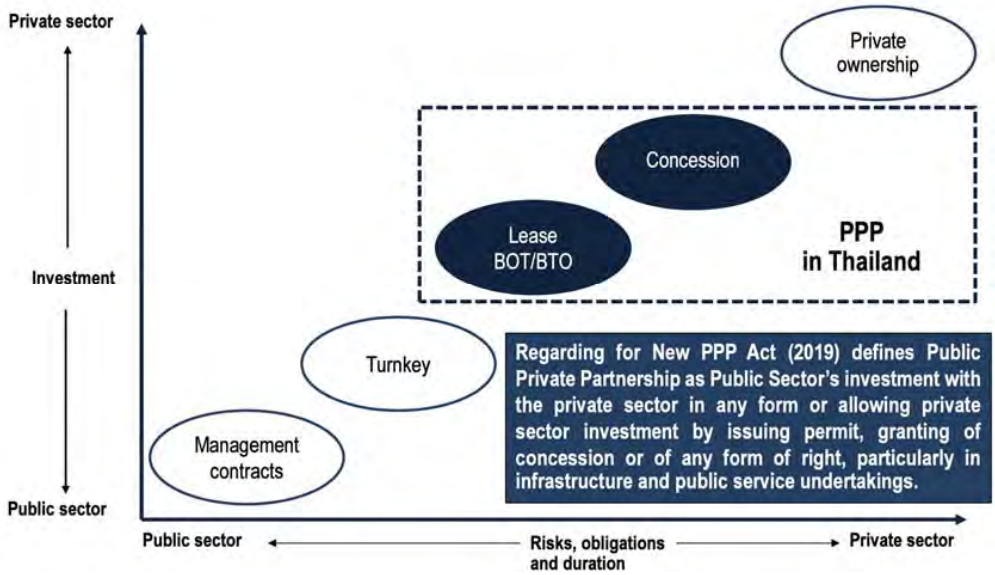
Khlong Toei - Suvarnabhumi Link (Integrated development model)

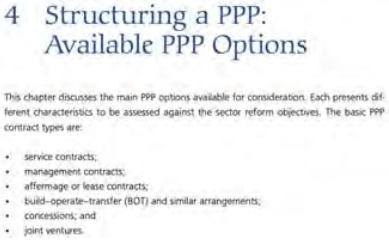


Source: JET Proposal

JV is Also an Option Within PPP Procurement

Government Undertakings must be entrusted through PPP procurement.





4 Structuring a PPP: Available PPP Options

This chapter discusses the main PPP options available for consideration. Each presents different characteristics to be assessed against the sector reform objectives. The basic PPP contract types are:

- service contracts;
- management contracts;
- affermage or lease contracts;
- build–operate–transfer (BOT) and similar arrangements;
- concessions; and
- joint ventures.

Source: SEPO

Source: ADB, PPP Handbook

Khlong Toei - Suvarnabhumi Link

Stakeholder Analysis (1) - Landowner + developer, financial institutions

PAT and SRT (landowners), developers and financial institutions who tie up with the landowners	
Requirement	• The stakeholder owns a large area of land for development adjacent to the planned mass rapid transit station. • The land price is expected to boost with the area development with good access to the mass rapid transit.
Role as the developer	• Establish an affiliated developer company (tie up with a well-established private developer if required). • The land may be retained with the landowner. • Let the affiliated developer company pursues the area development by leasing or selling (on leasehold) the properties.
Role as the mass rapid transit co-owner / operator	• Participate in the mass rapid transit SPV as a co-founder and shareholder. • Let SPV develop the mass rapid transit infrastructure and / or use MRTA infrastructure. • Let SPV operate the mass rapid transit business (tie up with an experienced operation company if required).
What to give to the SPV	• Buy the SPV shares
Benefit from the SPV	• Land price increase (= more profit with real estate business) due to high accessibility with the mass rapid transit.

Source: JICA Expert Team Proposal

Khlong Toei - Suvarnabhumi Link

Stakeholder Analysis (2) - Provincial Administrative Organisations

BMA and Samut Prakan	
Requirement	• The stakeholder wants wider area vitalisation on the occasion of mass rapid transit development.
Role as the local government	• Develop urban infrastructure (road, pavement, park, recreational facility, school, library, etc.) to induce harmonised development of the areas adjacent to mass rapid transit stations.
Role as the mass transit co-owner / operator	• Participate in the rail SPV as a co-founder and a major shareholder. • Let SPV develop mass rapid transit infrastructure and / or use MRTA infrastructure. • Let SPV operate the mass rapid transit business (tie up with an experienced operation company if required).
What to give to the mass rapid transit	• Buy the SPV shares • Develop supporting infrastructure (indirectly supporting the mass rapid transit business)
Benefit from the mass rapid transit operation	• Boost tax revenue with the increase in population, attracting business location, and land price increase.

Source: JICA Expert Team Proposal

Khlong Toei - Suvarnabhumi Link

Stakeholder Analysis (3) - Tenants and locating businesses

Companies relocating their offices to the development area, Shopping malls, hotels, entertainment facilities, + AOT	
Requirement	• The stakeholder moves into the new development area (= client of the landowner-affiliated developer).
Role as the tenants and locating businesses	• The stakeholder generates income through its business at the new development area.
Role as the mass transit co-owner / operator	• Participate in the rail SPV as a minor shareholder. • Let SPV develop mass rapid transit infrastructure and / or use MRTA infrastructure. • Let SPV operate the mass rapid transit business (tie up with an experienced operation company if required).
What to give to the mass rapid transit	• Buy the SPV shares.
Benefit from the mass rapid transit operation and the landowner-affiliated developer	• Become eligible to move into and conduct business at the new development area. • Enjoy better business environment thanks to the good accessibility offered by the mass rapid transit.

Source: JICA Expert Team Proposal

Khlong Toei - Suvarnabhumi Link

Stakeholder Analysis (4) - Contractors and service providers

Contractors, engineering companies, telecom, goods and service provides outsourced from the landowner+developer	
Requirement	• The stakeholder is selected through competitive bidding to provide goods and services to the landowner-affiliated developer or the SPV.
Role as the Contractors and service providers	• The stakeholder generates income through its business with the landowner-affiliated developer or the SPV.
Role as the mass transit co-owner / operator	• Participate in the rail SPV as a minor shareholder. • Let SPV develop mass rapid transit infrastructure and / or use MRTA infrastructure. • Let SPV operate the mass rapid transit business (tie up with an experienced operation company if required).
What to give to the mass rapid transit	• Buy the SPV shares.
Benefit from the mass rapid transit operation and the landowner-affiliated developer	• Become eligible to provide goods and services to the landowner-affiliated developer or the SPV.

Source: JICA Expert Team Proposal

Khlong Toei - Suvarnabhumi Link

Stakeholder Analysis (5) - State Enterprise for MRT Development

MRTA	
Requirement	• The stakeholder is responsible for promoting the development of mass rapid transit.
Role as the mass rapid transit developer	• The stakeholder develops whole or part of the mass rapid transit network by itself (at least the land acquisition) either to be operated by a private entity (= vertical separation) or to be sold to the operator SPV (= analogy to JRTT P-sen method).
Role as the financial facilitator	• Obtain low cost finance through issuing of the state enterprise bonds (or any other measures if available*). • Let SPV use a whole or part of the low-cost finance.
What to give to the mass rapid transit	• Facility lease / selling. • Low-cost finance (debt).
Benefit from the mass rapid transit operation	• Lease fee / payback for the facility sold in installments. • Payback for the low-cost finance.

* Postal savings and insurances were used to finance public works in FILP: Fiscal Investment and Loan Program in Japan up to the 1990s.

Source: JICA Expert Team Proposal

Khlong Toei - Suvarnabhumi Link

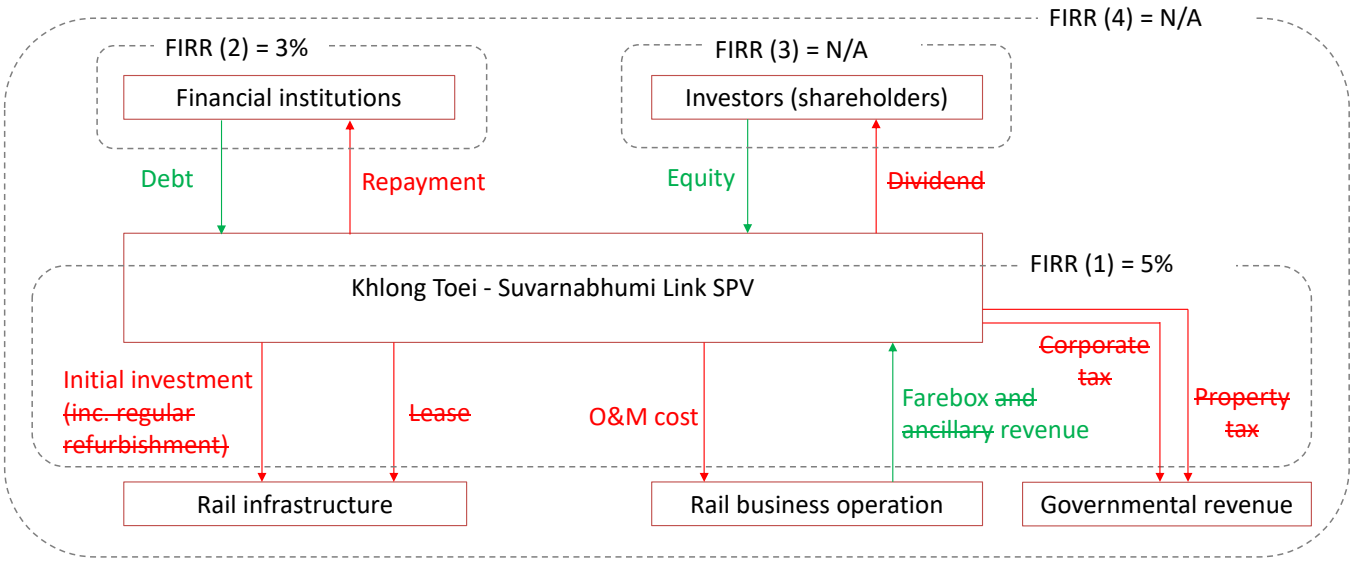
Stakeholder Analysis (6) - MRT Operating Company (SPV)

SPV	
Requirement	• The stakeholder is entrusted by many participants (both public and private) to partly develop and wholly operate the mass rapid transit linking the newly-developed areas with the CBD and the airport.
Role as the mass rapid transit developer	• The stakeholder develops the whole or the part of the mass rapid transit line (except for the part developed and offered by MRTA) by itself.
Role as the mass rapid transit operator	• The stakeholder operates the mass rapid transit using resources (including finance) assigned by the management (SPV board), and under the regulation of MRTA. • Outsource any goods and service provisions as required.
What to give to the shareholders	• Offer mass rapid transit service that contributes to increasing the value of the land and improves the living / business environment of the newly developed area.
What it gets from the shareholders	• Equity participation and managerial decisions.

Source: JICA Expert Team Proposal

Khlong Toei - Suvarnabhumi Link

Feasibility (Simplified Financial Analysis)



Khlong Toei - Suvarnabhumi Link

Issues (1) with the landowners

- How can we persuade the landowners on the necessity of having the mass rapid transit?
- How can the landowners formulate their affiliated area development enterprises?
- How can the landowners encourage (or make it mandatory) for the tenants, locating businesses, contractors and service providers, etc. to participate in the SPV?

Issues (2) with the financial authority (SEPO?) and MRTA

- Will the Ministry of Finance allow this non-competitive (but collaborative) private participation business scheme to be applied?
- Can MRTA develop a whole or part of the line using its own budget? If so, will it offer the infrastructure usage at moderate cost (whether it is for lease or for sale)?
- Will MRTA function to offer low-cost finance for the SPV? If not, who else will do it?

Issues (3) with the PAOs

- Will the PAOs cooperate (financially and institutionally) by (i) participating in the SPV, and by (ii) developing supporting / connecting infrastructures?

Issue (4) with the planning

- Will there be sufficient demand? Will the economic climate be favourable? Will it contribute to modal shift from car usage to mass rapid transit? Will it be financially feasible (WACC < FIRR)?
- Will there be an appropriate integration with the rest of the transportation network?

5. Can Government Undertakings be Bundled?

Current Framework in Thailand - Background

- Public-private partnerships (PPPs) were formally introduced into the Thai legal framework by Private Participation in State Undertakings Act BE 2535 (1992) (PPSU Act).
- In 2013 the Private Investment in State Undertaking Act 2013 (PISU Act) was introduced to further promote investment using PPP procurement scheme.
- In 2019 the Public-Private Partnership Act BE 2562 (2019) (PPP Act) was enacted replacing the PISU Act.
  The PPP Act in Thailand was passed by the National Legislative Assembly and became effective in March 2019.

Current Framework in Thailand - Stipulations in the PPP Act

Substantial Contents:

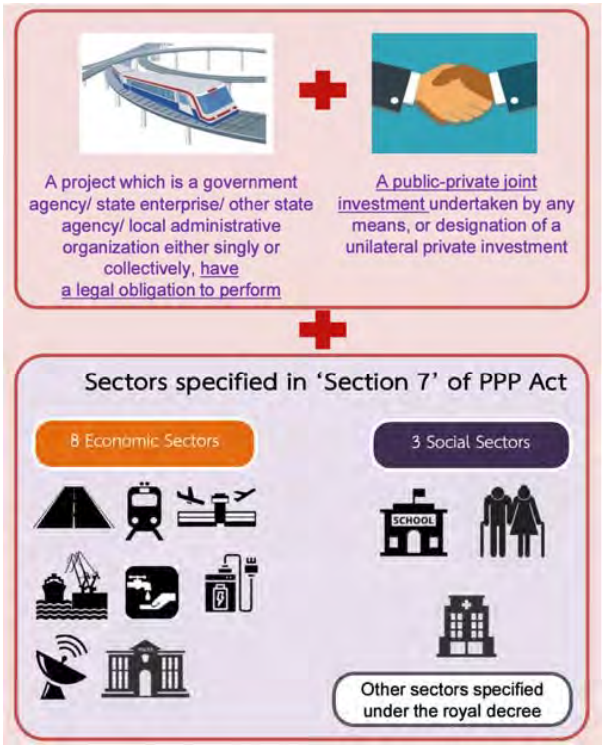
Chapter 3 PPP Policy Commission
Chapter 4 Preparation and Operation of Projects
- Part 1 Submission of Projects
- Part 2 Selection of Private Parties
- Part 3 Supervision of Partnership Projects
- Part 4 Partnership Agreement Amendment and Re-conclusion of Agreements
- Part 5 Exercise of Powers for Public Interests
- Part 6 Public-private Partnership Promotion Fund
- Part 7 Miscellaneous Provisions
- Part 8 Penalty

Source: extracted from SEPO unofficial translation

Current Framework in Thailand - Scope

Infrastructure and services for the following sectors must comply with the Act:

(1) roads, highways, express ways or transport by road;
(2) railways, mass transit or transport by rail;
(3) airports or transport by air;
(4) ports or transport by water;
(5) water management, irrigation, waterworks or water treatment;
(6) energies;
(7) telecommunications or communications;
(8) hospitals or public health;
(9) schools or education;
(10) residences or facilities for low or middle-income people, the elderly, underprivileged people or people of disabilities;
(11) exhibition centres and conference centres;
(12) any other undertaking as prescribed in the Royal Decree.



Source: SEPO

Can Government Undertakings be Bundled?

- Our understanding is that under the PPP Act 2019, there is no inhibiting stipulation for the procurement of “multi-purpose” development projects.
- A package deal by bundling profitable land development and non-profitable mass rapid transit development may also be possible even under the current legal requirements.

Can Government Undertakings be Bundled?

Create a development project by bundling mass rapid transit and real estate development / operation

What government should do	Formulate a “bundled” project (which may be separated into packages, appropriately) comprised of rail business and relevant profitable business (real estate development, for example), and grant implementation right(s) to a selected private business implementor.
(Example)	As in the previous slide, procure a private entity (joint venture of companies and government organizations) who will implement both rail and area development in one package.
How government will benefit	The government can make use of its property (underutilized land) to mitigate the burden of the new mass rapid transit development.
Constraints	Will SEPO allow such government undertakings to be bundled for PPP procurement? => If not, a Joint-venture undertaking may be sought as an option.

Conclusion

- If multi-purpose development projects were to be promoted (by encouraging bundled procurement or allowing public-private joint ventures' undertakings), we can make the most of the public assets (lands) for further improvements of the mass rapid transit network.

- Further:
  If PPP Fund can be made available for such procurement at preferential condition (zero-interest rate long tenure lending), it will significantly contribute to expediting the mass rapid transit network development.
  => to be discussed separately with PDMO.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-13

Developing a Business Schemes for Privately-operated Rail Services

Contents

1. Overview

2. Integration vs Separation

3. Alternatives and Conclusion

1. Overview

1.1 Background

- Purple Line Southern Extension is being pursued. Infrastructure development has already been arranged.
- We now have to consider an optimal operation arrangement making use of the private sector business skills.
- Seamless operation with the existing part of the line is an essential element of the service.
- In parallel, privatisation of the Red Line operation is also an issue to be considered.

1.2 Motivation for Promoting Private Rail Service

- Why do we want mass transit to be privately operated?

Profit-oriented business management
- Business diversification
- Proactive marketing
- Efficient service delivery

↓

Minimising the need for continuous governmental financial support

↓

Financially sustainable (if not autonomous) rail service provision

⇒

Competitive bidding

and / or

an environment to induce competition during the service delivery period

1.3 Steps Simplified (1) - open the door to a wider scope of participants

The first defines whether we can proceed or not.

- Seek for a potential private operator (initial market sounding).
- Identify the benefits they can offer

↓

- Prepare a realistic and attractive deal to achieve a successful procurement (competition is a must).

↓

- Let the operators to make business effort to gradually minimise the governmental financial support.

⇐

Bidders are your customers

a. Release as much information as possible (issue and revise the prior information notice (PIN) as required;
b. Convene public consultation against various stakeholders (involving relevant authorities (financial, regional, municipal, etc.).
c. Approach relevant sector businesses (operators of other transport modes, telecom, investment funds, etc.)

1.3 Steps Simplified (2) - make it fatter or leaner

Among the three steps, the second step require the most attention.

- Seek for a potential private operator (initial market sounding).
- Identify the benefits they can offer

↓

- **Prepare a realistic and attractive deal to achieve a successful procurement (a mechanism to induce competition).**

↓

- Let the operators to make business effort to gradually minimise the governmental financial support.

Cattle Fattening Measures

a. Investing, lending
b. Revenue protection (VGF) — Chapter 2
c. Freedom of operation (in setting the minimum level of service)
d. Bundling with profitable business
e. Making the business leaner through functional separation — Chapter 3
f. Facilitating the operator's continuation / exit scenario preparation

1.3 Steps Simplified (3) - an exit scenario (succession is one of the exits)

The ending should also be made visible.

- Seek for a potential private operator (initial market sounding).
- Identify the benefits they can offer

↓

- Prepare a realistic and attractive deal to achieve a successful procurement (competition is a must).

↓

- **Let the operators to make business effort to gradually minimise the governmental financial support.**

"All's Well That Ends Well"

a. The financial authority wants to have an exit scenario for a project, more than anyone else.
b. A regulator role to monitor the operator's performance will be required (representing the interest of the users).
c. Regular monitoring report may include cost saving effect calculation.

2. Integration vs Separation

2.1 Integration vs Separation

Integration or separation for making the deal more attractive.

Integration	Separation
• Bidding out a promising business (urban land development, commercial service provision, etc) together with less profitable business. • Concession for an urban commuter line + suburban access line.	• Extracting a specific work out from an integrated service will facilitate the participation of more specialised contractors. • By separating a financial burden off the business scheme, the business may become more attractive.

2.2 Reasons for Separation

- ❖ In many of the cases, functional separation of a business (including railway service provision) entails fragmentation risks.*
- ❖ A common definition of a PPP business scheme (against outsourcing) refers to the entrustment of an integral portion of the service.

=> Cons

- ❑ Vertical separation is essential to create an environment for competition among the train operators.
- ❑ Further separation is effective for simplifying the service delivery requirements, which will open the door for more entrants.

=> Pros

** Note: separation may also facilitate integration with the other (existing) infrastructure / services.*

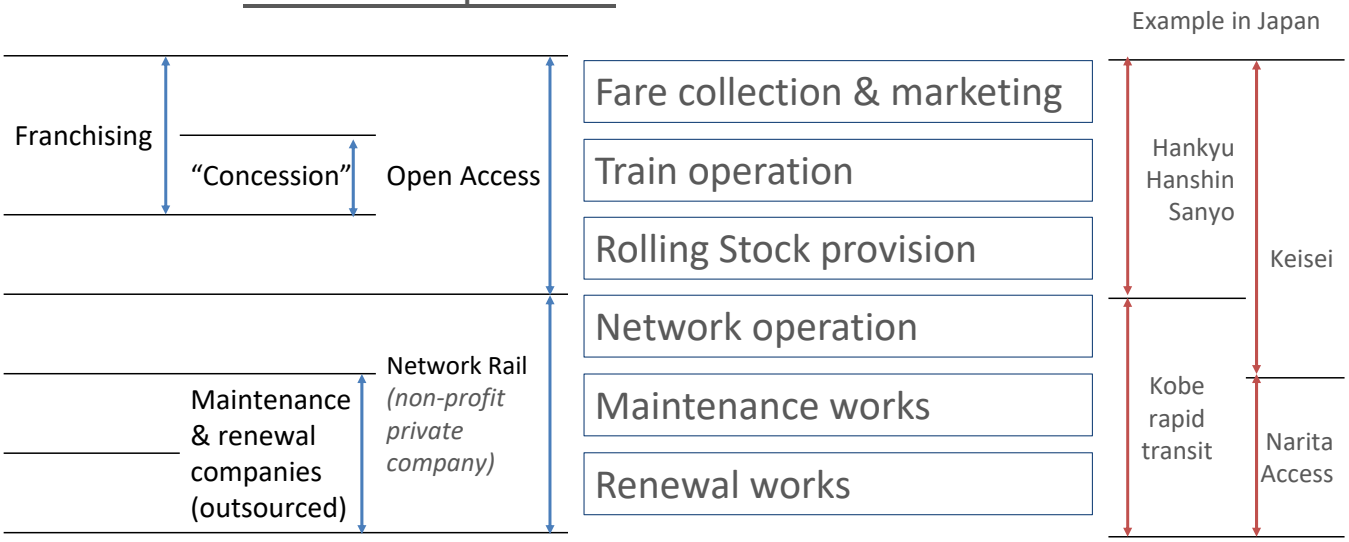
2.3 Separation of Operational Functions

What is the Existing Ultimate Form of Separation?

	Example of UK rail operation scheme	
Fare collection & marketing	Franchisee	Government
Train operation		"Concessionaire"
Rolling Stock provision	ROSCO (Rolling Stock leasing companies) + builders	
Network operation	Network Rail	
Maintenance works	Maintenance companies	
Renewal works	Renewal companies	

2.4 Separation Examples

Japan's separation is due to physical reason while UK separation is intended to create competition.



2.5 Forms of Participation in Rail Service

Participation patterns in Functionally-separated Environment

	1. "Concession"	2. Franchising	3. Open Access Operation
Examples	London overground, DLR, (US, Mexico, Taiwan...)	Many in UK (only)	Heathrow Express, Eurostar, (Europe)
Mechanism	Concessionaires are paid against the service delivered (train service operated).	Franchisees operate the trains without the possession of substantial assets.	Train operators purchase specific "train paths" within the railway network.
Features	Strict service standard requirements imposed.	Significant extent of freedom of business is granted.	Unsolicited service
Fare collection, Marketing effort Ridership risk	Ridership risk is not attributed to the concessionaires. (= PPP Gross Cost)	Franchisees bears the ridership risk. (= PPP Net Cost (+ MRG))	Train operators bears the ridership risk. (No subsidy no guarantee)
Major outsourcing costs	Concession (track usage) (Rolling stock lease)	Track access & station usage Rolling stock lease	Train path charge
Revenue	Availability payment from government	Payment linked to the collected revenue. Minimum revenue guaranteed.	Collected fare.

Developing a Business Schemes for Privately-operated Rail Services

3. Alternatives and Conclusion

3.1 From PPP to Privatisation

Options for Rail Service Provision Supports

Scheme	Support for operation	Exit scenario for MOF
0. Open Access (on existing infrastructure)	None	N/A
1. PPP Net Cost BTO	None (MRG if applicable)	
2. PPP Gross Cost BTO	Revenue guarantee	Subsidy for revenue guarantee will gradually decrease with the operator's efforts.
3. Infra & rolling stock separation BTO	Revenue guarantee Rolling stock acquisition	
4. Public Corporation	Operation cost - farebox revenue	With the operator's efforts, operation will become profitable, to be privatised. => Sales profit + capital gain

3.2 Conclusion

- ✓ Inducing competition is the requisite for a PPP business scheme.
- ✓ Fattening / making it leaner through good bundling / separation will make the business scheme acceptable to all.
- ✓ Shifting the cost from current expenditure to capital investment may facilitate funding.
- ✓ Public (governmental sector) rail operation may also become an option if we emphasise on the eventual privatisation plan as the exit scenario for the financial authority.

Why Should We Go For Private Operation?

Public-Private Partnership Project Delivery Plan 2020 – 2027

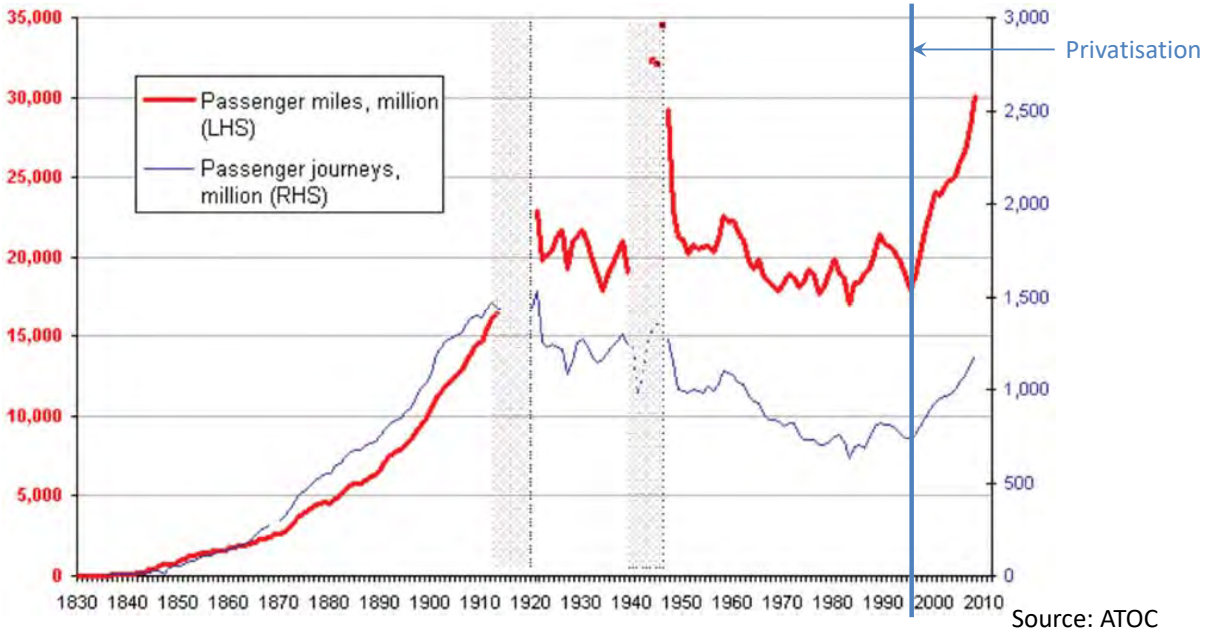
Six projects are listed on the latest PPP delivery plan (BM Area).

Title	Authority, Scheme	Cost
Mass Rapid Transit (MRT) Orange Line Bang Khun Non - Min Buri (Suwinthawong) [H]	MRTA (Gross cost BTO) East section to be constructed by MRTA	235,320 (private = 128,127)
Mass Rapid Transit (MRT) Purple Line Tao Pun – Rat Burana (Kanchanaphisek Road) [H]	MRTA (Gross cost BTO)	124,792 (private = 11,840)
Mass Rapid Transit (MRT) Blue Line Bang Khae – Phutthamonthon Sai 4 [H]	MRTA (Net cost)	21,197 (private = 6,262)
Light Rail Double Track Transit System (Bang Na – Suvarnabhumi Airport) [I]	BMA	27,892
Monorail Grey Line (Watcharaphon – Thong Lo and Phra Khanong – Rama III) [I]	MRTA	45,925
Monorail Grey Line (Lumpini – Tha Pra) [I]	MRTA	45,925

Source: SEPO

Rail Privatisation Effect

Users increased sharply with the privatisation (case of railways in UK)



Source: ATOC

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-14

Infrastructure Financing Facility (Revolving Fund) for Mass Rapid Transit Development

With Referential Examples of Fiscal Investment and Loan Program in Japan

Background Story

1. Rail (mass rapid transit), in general, is not a profitable business on its own, especially when it requires initial investment (MRTA Blue Line IRR=1.65%).

2. Mass rapid transit development, in any city, starts with lucrative sections (Green Lines). As we develop the network, marginal profitability of a new line will inevitably deteriorate due to lower ridership.

3. Nevertheless, we strongly encourage enhancing the network. As such, we must figure out a way to mitigate financial burden on the government.

4. Based on the experiences in Japan, we would like to propose two ideas to overcome the issue:

(1) Bundle mass rapid transit with more lucrative business (real estate development, for example)
=> Discussion with SEPO

(2) Introduce designated financial instruments (revolving fund for zero interest long tenure loan)
=> Discussion with PDMO

Contents

1. Low-cost lending is essential for the financial viability of rail projects

2. Japan's revolving fund: key instrument for infrastructure development

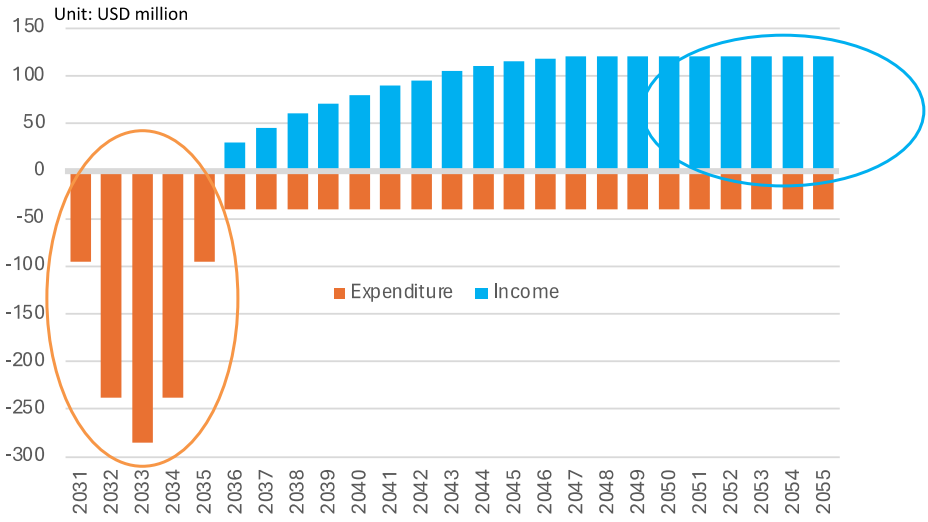
3. FILP - Fiscal Investment and Loan Program

4. Advantages of policy financing over conventional fundings

5. Proposed Discussion Topics

1. Low-cost lending is essential for the financial viability of rail projects

A typical free cashflow of a mass rapid transit project
=> the project implementor needs to borrow a substantial amount of money....



... But to be reimbursed (paid back) in future.

1. Low-cost lending is essential for the financial viability of rail projects

Thai Government has not addressed to relieving financing cost in PPP procurement.

	BTS (Green lines initial sections) Net cost BTO (civil) / BOT (M&E)	Net cost BOT MRTA (Blue initial section)	Net cost BTO MRTA (Pink, Yellow)	Gross cost BTO MRTA (Purple, Blue extension)	SOEs (Airport Rail Link, Red lines)
Land acquisition cost	ROW from gov't	Government	Government	Government	ROW from gov't
Financing cost	-	-	-	-	Not required
Infrastructure cost	-	Government	Government's fixed subsidy for the first 10 years	Gov't payback	Government
M&E cost	-	-		Government's remuneration	Government
Rolling stock cost	-	-			Government
O&M cost	-	-			Government

Source: JICA Expert Team compilation

2. Japan's revolving fund: key instrument for infrastructure development

Zero/low interest lending from revolving fund has been commonly used as the government's policy implementation instrument in Japan.
It has been playing an essential role in rationalizing the country's economic infrastructure.

Purpose	Managing institution	Beneficiary
Toll road development	JEHDRA (Japan Expressway Holding and Debt Repayment Agency)	Toll road operators
Railway development	JRTT (Japan Railway Construction, Transport and Technology Agency)	Railway operators
Urban revitalization	Ministry of Land, Infrastructure, Transport and Tourism	Area development associations
Airport development	Ministry of Land, Infrastructure, Transport and Tourism	Private companies
Ports and harbour containerization	Ministry of Land, Infrastructure, Transport and Tourism	Private companies
Fishing harbour development	Ministry of Agriculture, Forestry and Fisheries	Communities, Individuals
Telecom access rationalization	Ministry of Internal Affairs and Communications	Prefectures
SMEs emergency lending	JFC (Japan Finance Corporation) Shoko Chukin Bank	SMEs
Living Welfare Lending for - Living expenses - Welfare expenses - School expenses - Housing expenses	Ministry of Welfare and Labour	Low-income households

Source: JET compilation from various governmental documents

2. Japan's revolving fund: key instrument for infrastructure development

Recent case of railway development financing in Japan:
60% of Minatomirai Line development cost is financed by zero/low interest lending facility.

Means	Amount	Note
From equity	JPY 27,200 million	Initially 50% from local gov't. 50% from private sector (A portion of the total paid in capital of JPY 50,719 million)
From the stakeholders' contribution	JPY 67,300 million	Approx. JPY 50,000 million collected amounting to ¼ of the initially estimated total investment of JPY 200,000 million Contributors = Mitsubishi Estate, UR, Yokohama City, MHI, etc. *Includes approx. JPY 20,000 million dedicated for a requested station development cost.*
From debt (1) Low interest rate	**JPY 128,900 million**	**Financed by JRTT through FILP (Fiscal Investment and Loan Program) Interest subsidised by the central government and the prefecture**
From debt (2) Zero-interest rate	**JPY 32,900 million**	**Zero interest rate borrowing from DBJ**, and commercial bank syndication
TOTAL	JPY 256,300 million	Includes land acquisition, civil, mechanical, facilities and management

Source: Compiled from financial results for 34th period Yokohama Minatomirai Railway Company

2. Japan's revolving fund: key instrument for infrastructure development

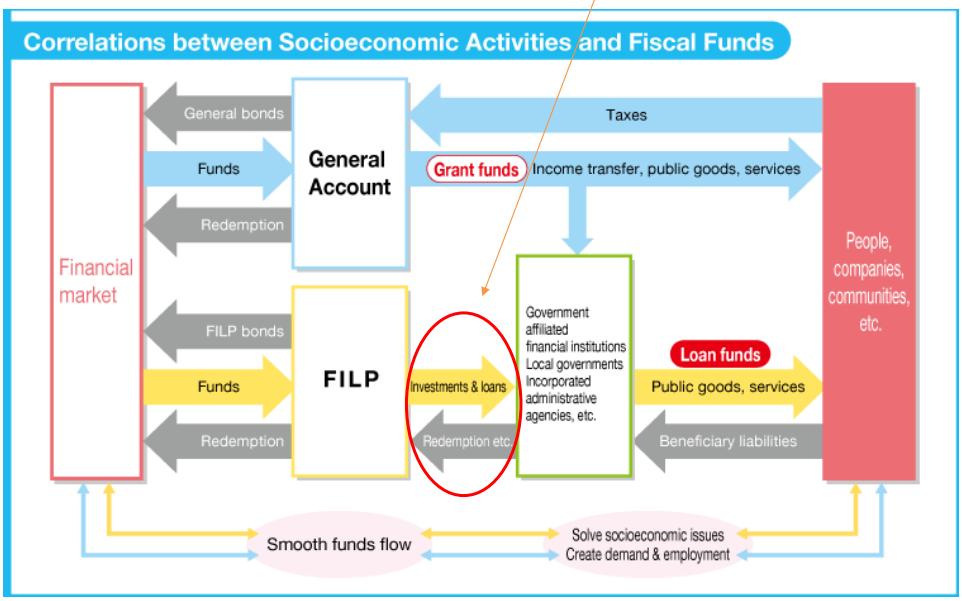
Recent case of railway development financing in Japan:
30% of Sotetsu-Tokyu Through Line development received low interest lending facility.

Means	Amount	Note
1/3 from the central government	JPY 66,000 million	Subsidy
1/3 from local governments	JPY 66,000 million	Subsidy (1/9=Kanagawa Prefecture, 2/9= Yokohama City)
1/3 debt financing by JRTT utilising FILP	**JPY 69,800 million**	**Tenure= 10 years among which the first 3 years are the grace period. Interest rate = 1.89 % Principal = JPY 66,000 million, Interest = JPY 3,800 million**
TOTAL	JPY 236,000 million	JPY 198,000 Includes land acquisition, civil, mechanical, facilities and management JPY 236,000 million including the cost of finance (JPY 38,000 million)

Source: Compiled from JRTT document on Sotetsu-Tokyu Through Line Development Project

3. Japan's FILP - The Alternative Budget

- FILP's special account functions as a revolving fund.

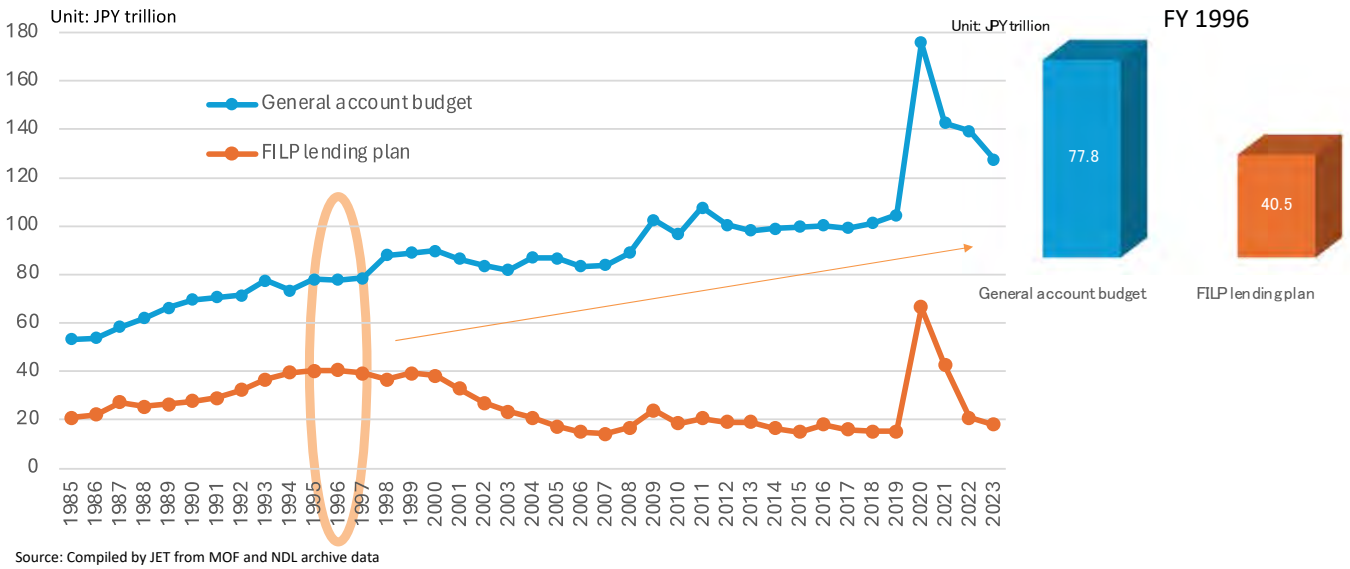


General Account:
(Grant funds) which do not impose a repayment obligation, such as subsidies of budgetary measures with taxes as the main fiscal source.

FILP:
(Loan funds) which assume a future return, such as loans and investments with redemption of capital, interest or dividends, etc.

Source: MOF Finance Bureau, FILP Report 2012

3. Japan's FILP - more than 50% addition onto General Account Budget



Source: Compiled by JET from MOF and NDL archive data

4. Advantages of revolving fund over conventional fundings

Zero-interest lending has many benefits over conventional fundings.

	Construction cost reimbursement	Zero-interest lending
How will the money be paid?	• Annuity payment from the general budget (rail operators should bear the full investment cost until reimbursed)	• Total amount paid at once from designated fund (no need for the rail operators to arrange for financing)
Bookkeeping	• Current / capital expenditure (it is a cost payment)	• Financial transaction (money will be reimbursed)
What should the rail operators do?	• Make financing arrangements with financial institutions and bear the financing costs (costly and burdensome for the rail operators)	• Just borrow and reimburse the money (no cost for the rail operators)
Pros and cons	• Government needs not make any financial arrangements • Government does not have to bear the opportunity cost for the interest earning	• Cost of finance will be far lower (even zero), significantly contributing to the project viability • Reimbursed money can be revolved (revolving fund)

Source: JICA Expert Team compilation

5. Proposed Discussion Topics

- Existing infrastructure finance (Infrastructure Finance Fund (IFF), PPP Fund) cannot offer sufficiently low-cost (zero/low interest long tenure) money for marginal infrastructure development projects.
  => a revolving fund under a governmental financial institution?

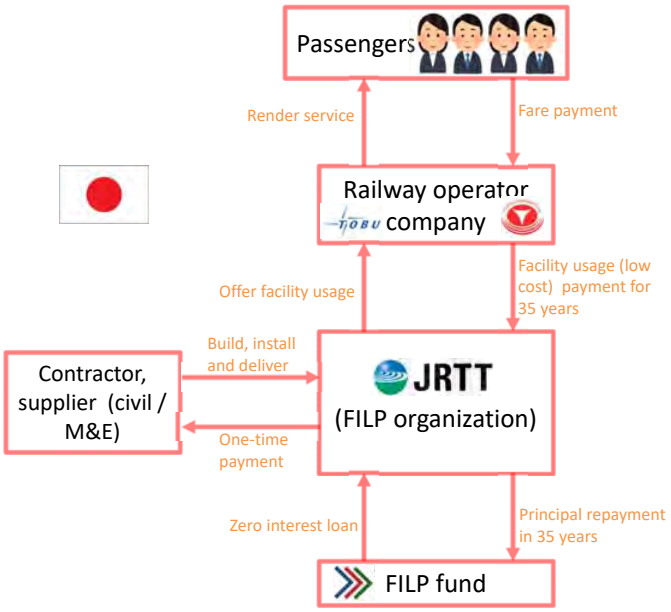
- Can Japan's FILP* be a model of policy financing instruments in Thailand (Japan's FILP has been the major financial instrument for the promotion of infrastructure development)?

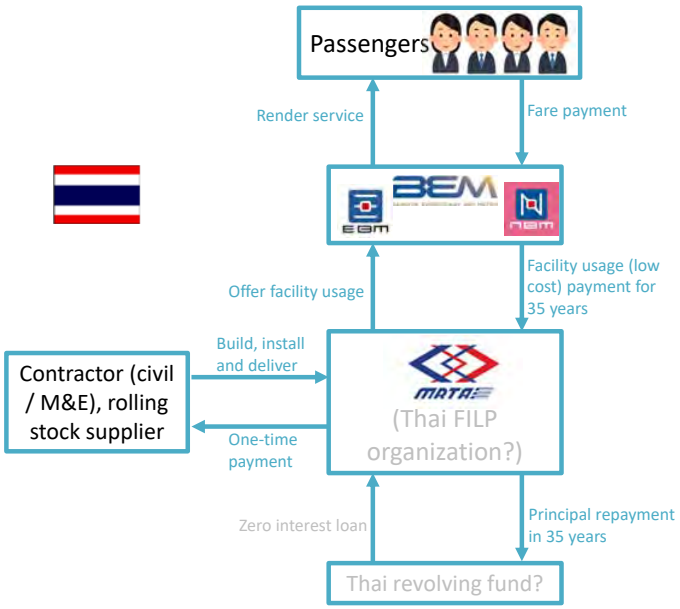
- If not, what can be the alternatives financial instruments for promoting mass rapid transit development promotion?

* Fiscal Investment and Loan Program (https://www.mof.go.jp/english/policy/filp)

5. Proposed Discussion Topics - an example

What about MRTA functioning as the FILP organization?

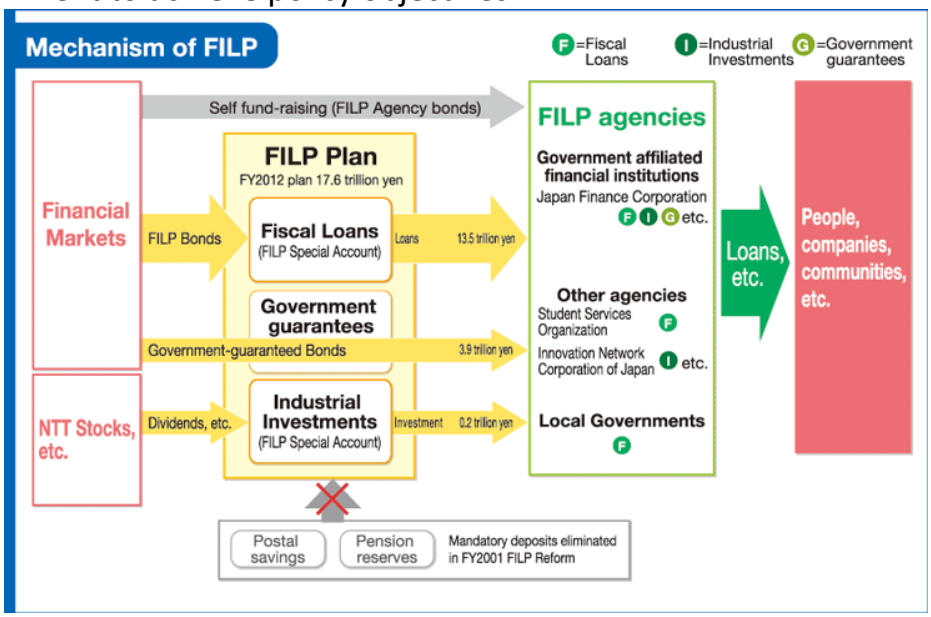




FILP (Fiscal Investment and Loan Program)
- Background Data -

(1) Japan's FILP - overview

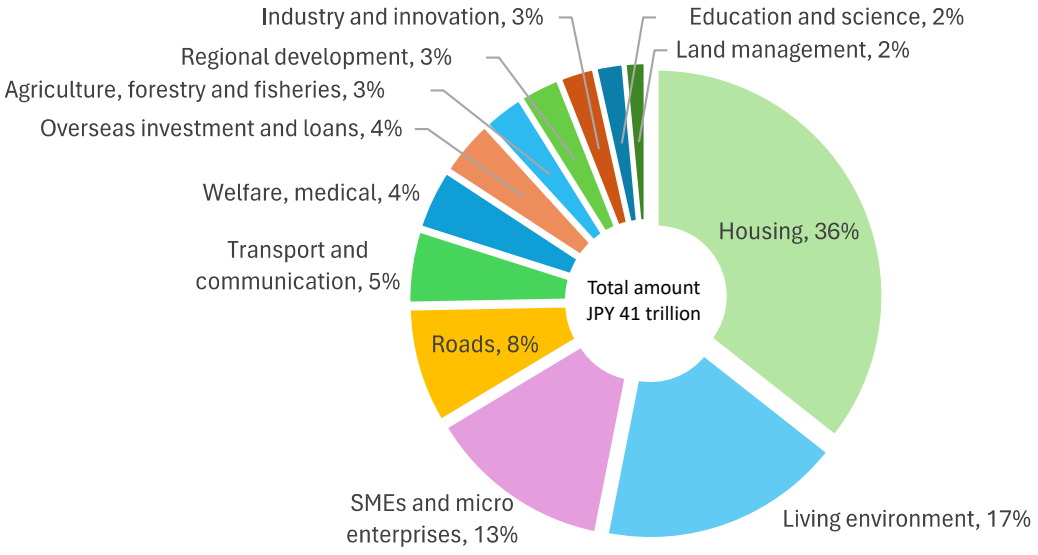
- FILP (Fiscal Investment and Loan Program) is long term low interest loan and investment by the government to achieve policy objectives.



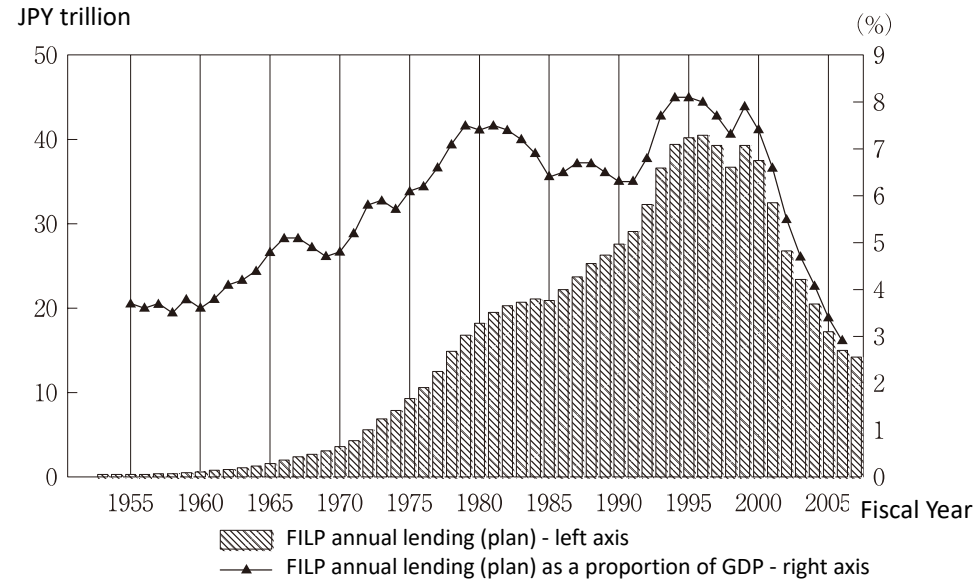
Source: MOF Finance Bureau, FILP Report 2012

(2) Japan's FILP - lending by sector

Breakdown of FILP lending plan by sector (example of FY 1996) figure



(3) Japan's FILP - annual lending scale = up to 8% against GDP



Source: ESRI publication

(4) Japan's FILP - How it started

1878
MOF Government Bond Bureau started accepting postal savings to invest in government bonds.

1912
MOF expands the scope of investment to "bank bonds" issued by Industrial Bank of Japan and Nippon Kangyo Bank.

1951
An Act was introduced to limit investment targets to national, local governments and state-owned companies.

2001
Requirements to deposit postal savings and pension reserves eliminated.
Market-based fund raising introduced.

1875
Introduction of postal savings.

1916
Introduction of pension reserves

1942
Balance of postal savings:
JPY 10 billion

1949
Balance of postal savings:
JPY 100 billion

1960
Balance of postal savings:
JPY 1 trillion

2003
Postal savings transferred to government owned corporation

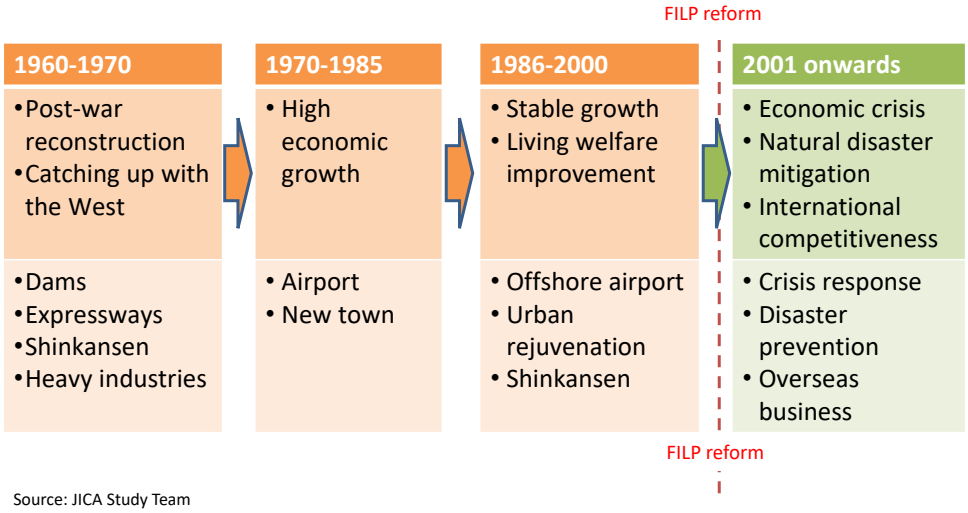
2007
Postal savings discontinued

Source: JICA Expert Team based on MOF data

FILP (Fiscal Investment and Loan Program)
- Reform -

(5) FILP: Evolution

- Roles of FILP have been changing in response to policy evolution.
- Significant reform took place in 2001.



Source: JICA Study Team

(6) FILP: Postwar Reconstruction - High Economic Growth

- Postwar reconstruction period: priorities given to basic industries (coal, steel, shipping, electricity, etc.).
- High economic growth period: infrastructure development to catch up with the Western countries, and for housing, SME and public projects.

Major field	FILP agency	FILP utilization cases
Housing	Japan Housing Corporation	Tama New Town and Takashimadaira Housing Complex development, etc.
SME support	Small Business Finance Corporation	Lending to Sony Corp., Kyocera Corp. and other corporations in their start-up and development phases
Social capital development	Japan Highway Public Corporation Japan National Railways New Tokyo International Airport Corporation	Tomei, Meishin and other expressways; Tokaido and Sanyo Shinkansen lines; Narita International Airport.
Industry	Electric Power Development Co. Japan Development Bank	Dams for electricity supply (Miboro Dam), etc. Long-term loans for basic industries (coal, steel, shipping, electric power, etc.)

Source: Extracted from MOF Finance Bureau, FILP Report 2018

(7) FILP: Stable Growth - Economic Bubble - Post Bubble

- FILP was used for large-scale new town and academic town development in major urban regions, local industrial base construction. Profitability was not necessarily high.

Major field	FILP agency	FILP utilization cases
Housing	Housing Loan Corporation Residential Land Development Corporation	Loans for housing construction Chiba New Town development, etc.
Living environment development Local development	Housing and Urban Development Corporation Japan Regional Development Corporation Water Resources Development Public Corporation	Urban redevelopment (Minato Mirai 21), academic town (Tsukuba) development, etc. Iwaki New Town and Nagaoka New Town development, rural city redevelopment Construction of Naramata, Sameura and other dams for developing and utilizing water resources
SME Support	Small Business Finance Corporation, People's Finance Corporation	Lending to SMEs and other firms that have difficulties in receiving loans from private financial institutions
Social capital development	Japan Railway Construction Public Corporation Airport Development Special Account, etc.	Construction of Nagano and other Shinkansen bullet train lines Offshore expansion and re-expansion of Tokyo International Airport (Haneda Airport)

Source: Extracted from MOF Finance Bureau, FILP Report 2018

(8) New-FILP: Response to Economic Crisis

- FILP was used for responding to the economic crisis following the 2008 Lehman Brothers collapse (Safety-Net Loans and Crisis Management Operations) for cash-strapped enterprises.

Support measures	Details
Safety-Net Loans for SMEs and micro business operators	Loans were extended to SMEs that suffered temporary sales and profit drops due to financial crisis. Total loan amount between FY2008 and FY2010 JPY 11 trillion.
Crisis Response Operations	With the Lehman shock, even large enterprises had difficulties in raising funds. In response to the Government's economic measures, Development Bank of Japan Inc. and the Shoko Chukin Bank, Ltd. provided crisis response loans. These crisis response loans totalled to about JPY 8.5 trillion.
Emergency operations to support Japanese overseas business activities	To support overseas operations of Japanese enterprises, Japan Bank for International Cooperation (JBIC) provided about 2.5 trillion yen in loans.

Source: Extracted from MOF Finance Bureau, FILP Report 2018

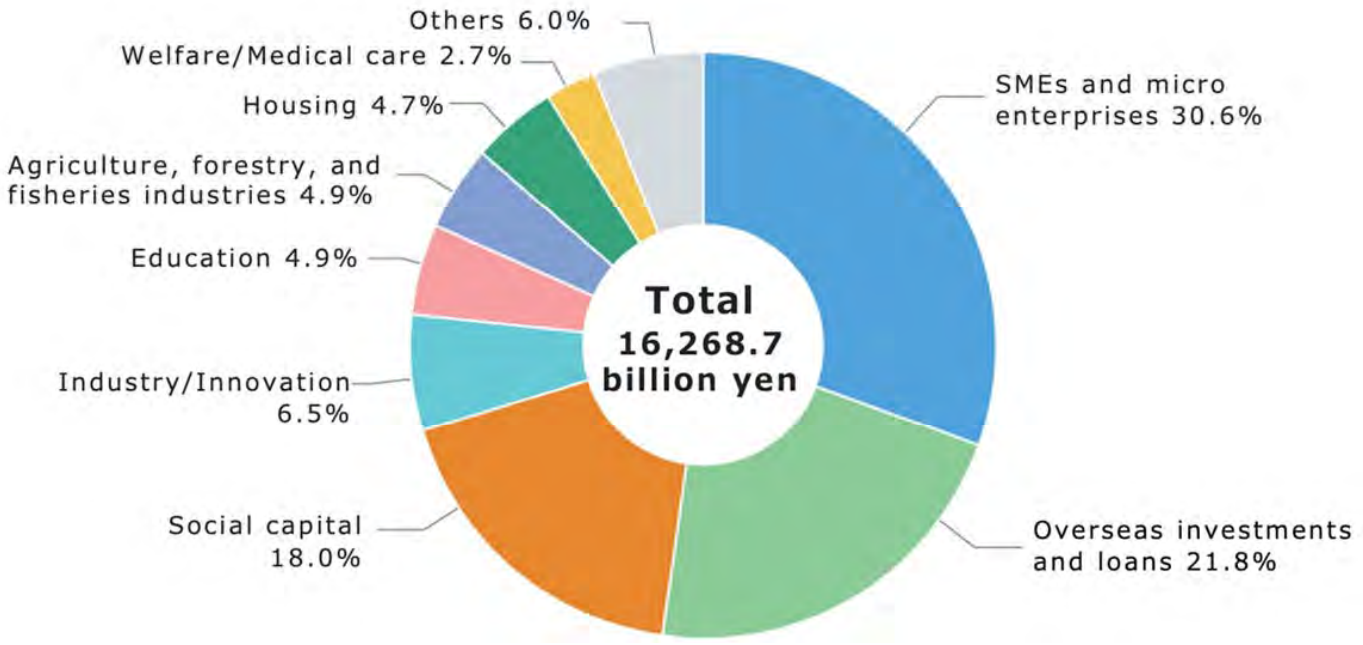
(9) New-FILP: Response to Great East Japan Earthquake

- FILP responded to the 2011 Great East Japan Earthquake by providing funds for post-disaster restoration, reconstruction, disaster prevention and reduction measures.

Support measures	Details
Financial support for enterprises, etc.	Japan Finance Corporation (JFC) created a special loan system for reconstruction from the Great East Japan Earthquake and a special capital enhancement system for supporting post-disaster reconstruction to support cash flow for enterprises. To stabilize disaster-affected business operators, Crisis response loans were also provided through designated financial institutions (Development Bank of Japan Inc. and the Shoko Chukin Bank, Ltd.).
Local government projects	FILP has provided funds for emergent and quick-impact disaster prevention/reduction measures (e.g. seismic retrofitting of public school facilities, anti-tsunami measures for rivers, etc.) based on lessons learned from the Great East Japan Earthquake.
Others	FILP has provided funds for the reconstruction of housing and healthcare/welfare facilities damaged by the Great East Japan Earthquake.

Source: Extracted from MOF Finance Bureau, FILP Report 2018

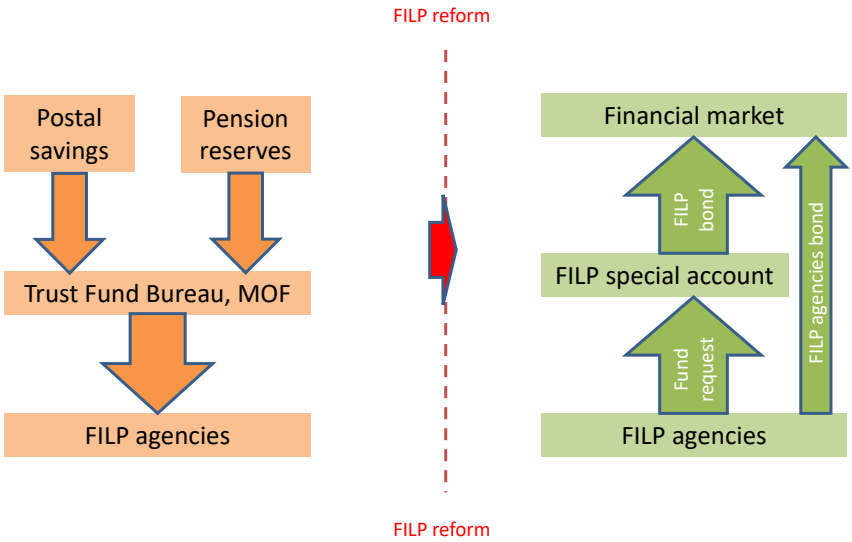
(10) FILP: Plan for FY 2023 = JPY 16 trillion = USD 108 billion



Source: Extracted from MOF Finance Bureau, FILP Report 2023

(11) FILP Reform 2001

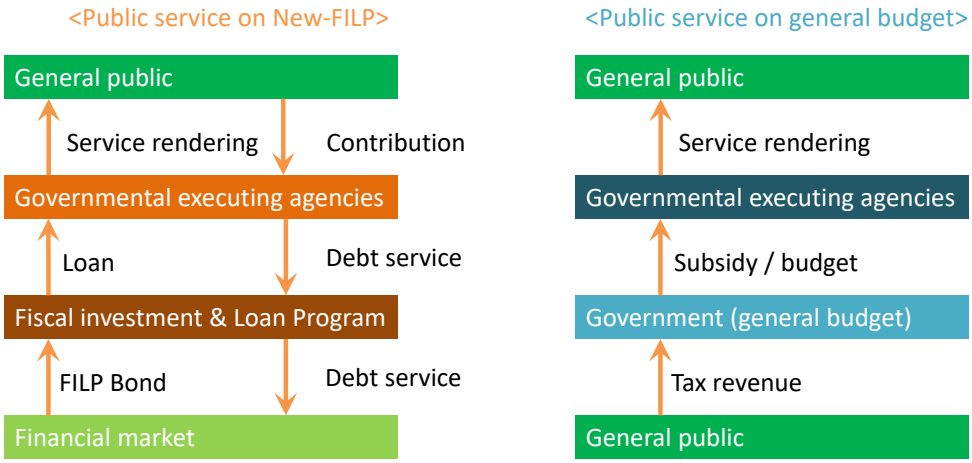
- FILP became demand-driven as compared to supply-driven.



Source: compiled JICA Study Team based on MOF documents

(12) Comparison: FILP and General Budget

- FILP has been offering long-term low interest finance for infrastructure development.
- FILP enables sustainable infrastructure funding with limited influence from tax revenue condition.



Source: compiled and translated by JET based on MOF document

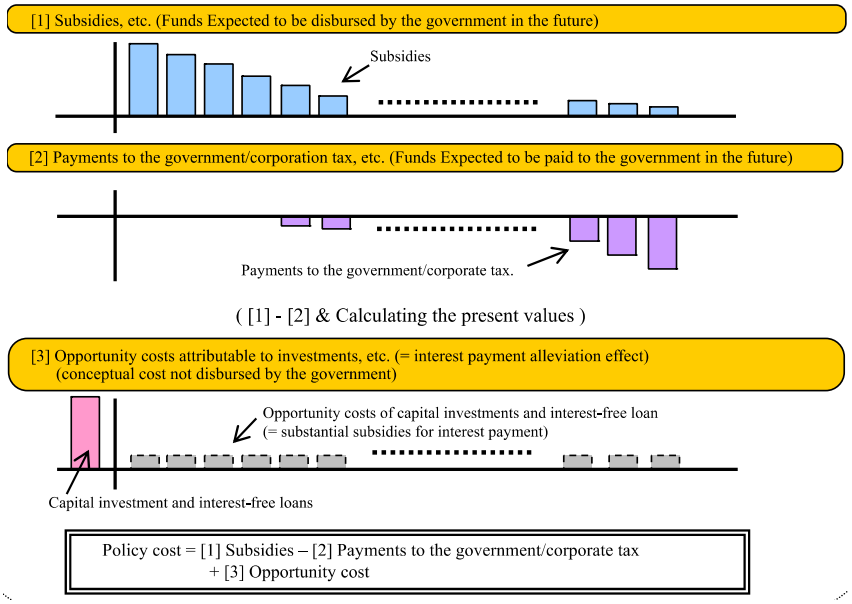
(13) New-FILP: Three Method for Providing Money

Fiscal Loan	Industrial Investment	Government Guarantee
• Fiscal Loan targets projects that are in desperate need from policy purposes. • Money is managed under the "Fiscal Loan Fund". • Subject of loans is limited to national and local governments, government-affiliated agencies.	• Industrial Investment aims at developing industry and promoting trade through capital subscriptions for essential policy projects that have potential returns but cannot be funded sufficiently by the private sector because of the high risks. • Industrial Investment is accounted for in the "Investment Account" of the "FILP Special Account".	• Government Guarantee is provided for bonds issued in financial markets by FILP agencies so that the agencies can procure funds necessary for business in a smooth and efficient way. • Government-guaranteed bonds represent debt off the Government's balance sheet.

Source: compiled JICA Study Team based on MOF documents

(14) New-FILP: Policy Cost Analysis

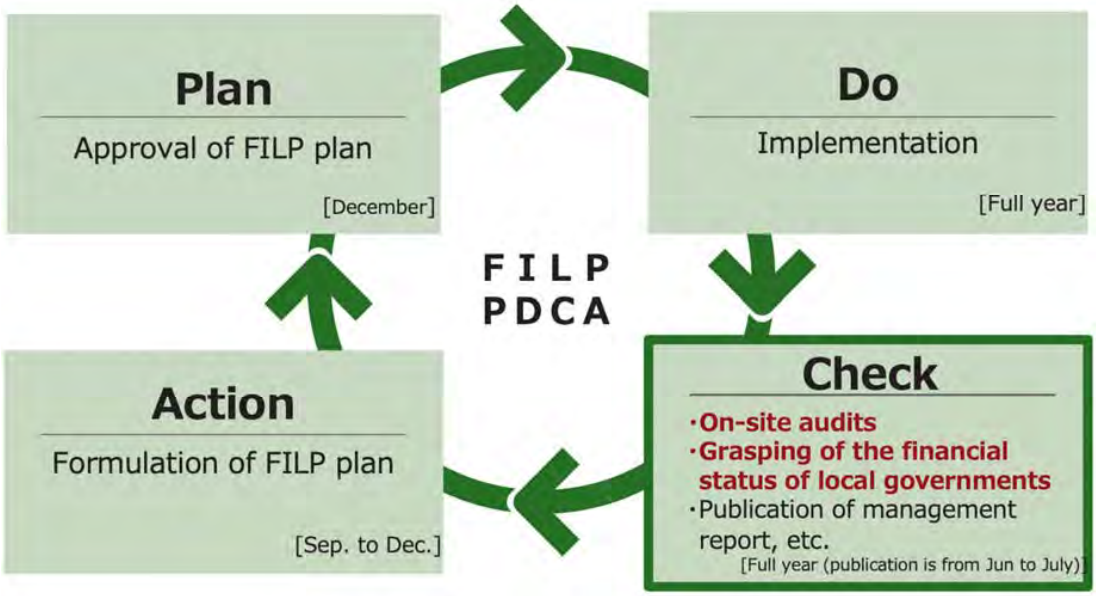
Policy Cost Analysis is a core instrument for rationalisation of FILP practice.



Source: MOF

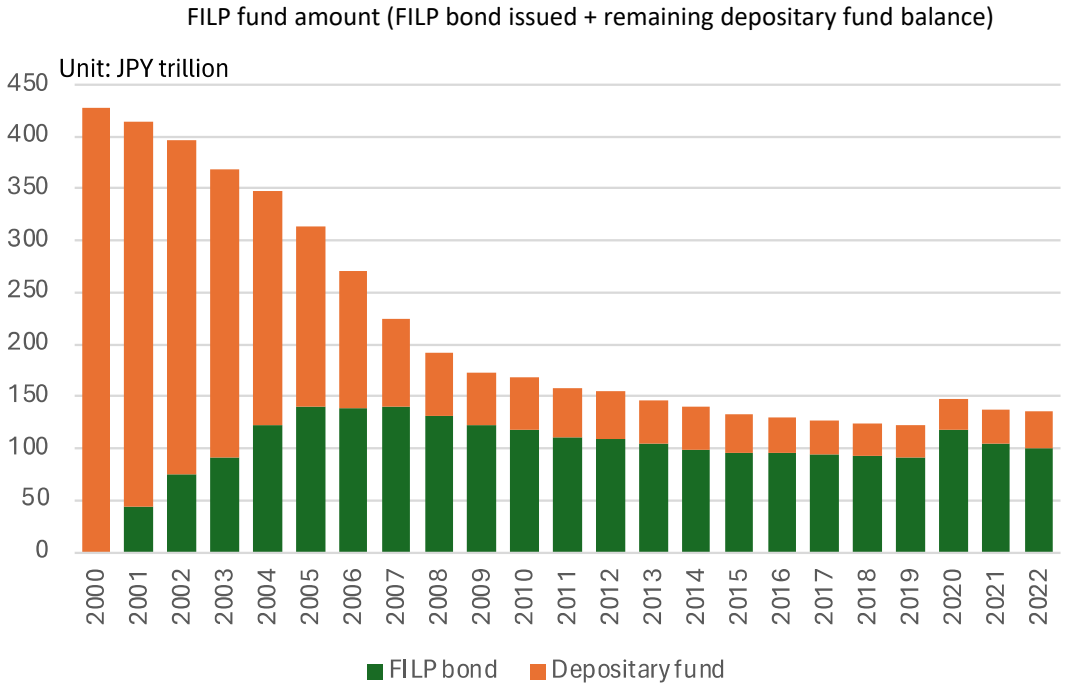
(15) New-FILP: Annual Business Operation Cycle

Annual Plan-Do-Check-Act cycle is being operated for continuous improvement.



Source: Extracted from MOF Finance Bureau, FILP Report 2023

(16) FILP has been reformed, and is still functional



Source: JET compilation based on MOF data

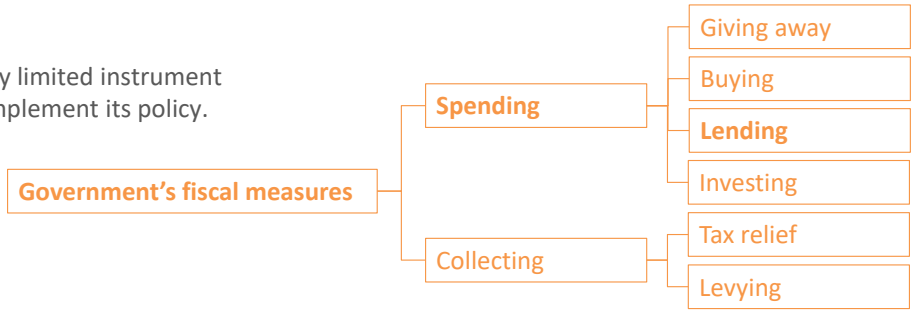
(17) FILP - summary

- FILP has played a crucial role in infrastructure development in Japan. Some other countries also have similar revolving funds.
- Application of FILP revolving fund for zero-interest infrastructure funding can be a meaningful instrument for fast-growing economies.
- Old-FILP and New-FILP are different especially in terms of the funding mechanism. Both have their own advantages and disadvantages.

FILP (Fiscal Investment and Loan Program)
- As a Policy Implementation Instrument -

(18) Lending - An Important Fiscal Instruments for Policy Implementation

- Fiscal Measures
  Lending is one of the very limited instrument for the government to implement its policy.



- Comparison of major fiscal instruments for development projects

	Subsidy (grant) = cash giveaway	Facility development (buying) and leasing	Loan	Equity investment
Action examples	• Cash subsidy • VGF (viability gap funding) • MRG (minimum revenue guarantee)	• In-kind contribution (whole or part of the infrastructure)	• **Policy financing (development bank loan)** • **Debt contribution to the project implementation company (SPV)**	• Buying shares of a project implementation company (SPV: special purpose vehicle)
Expenditure	Current expenditure	Capital expenditure	**Lending (payback expected)**	Investment (payback not expected)
Government Balance sheet	-	Asset	**Assets**	Assets
Project implementor's Balance sheet	Assets	-	**Liabilities**	Owner's equity

(19) Options for Financial Support

Financial support measures for a financially-marginal public business

Investing	Lending	Subsidising
Government acquires bonds / stocks of the public policy businesses against the stake in the businesses. The fund source may be from general budget, government bonds, treasury bills or other borrowings.	Government offers loan to the public policy businesses through governmental financial facility. Designated fund (governmental financial institutions, e.g. Government Saving Bank) is usually used for policy financing.	Government offers cash support to the public policy business, commonly in terms of MRG (minimum revenue guarantee), VGF (viability gap funding). General budget is commonly appropriated for the purpose.
Financial return is obtained in the form of dividend (not decisive). Shareholders, in principle, have the stake in the business, but are subordinated in terms of debt recovery.	Financial return is obtained in the form of interest (decisive). Lenders, in principle, are prioritised for debt recovery.	Expenditure amount is not decisive, but the government remains liable throughout the Project period.

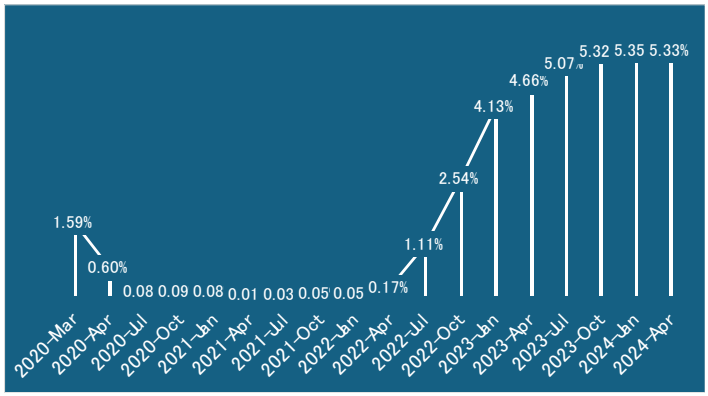
(20) Zero-Interest Lending Has Similar Impact With Grant

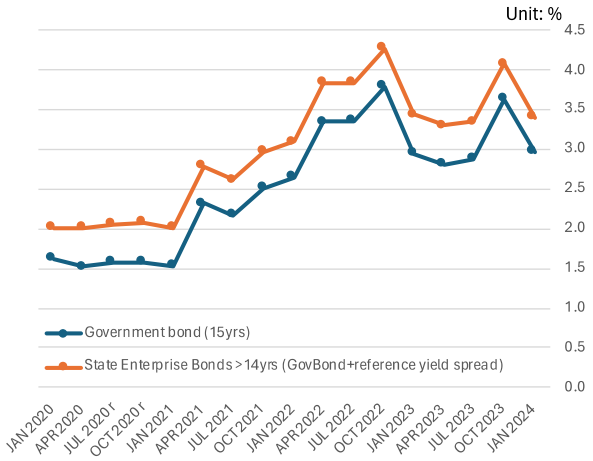
- Zero or low-interest lending brings about the benefit and flexibility comparable to grant (cash giveaway) financial support.
- For this reason, zero-interest lending is widely used also for current expenditure support.

	Grant (giveaway)	Zero-interest loan	Low-interest long-term loan	Zero-interest long-term loan
Amount	1,000	1,000	1,000	1,000
Interest rate	-	0%	3%	0%
Payback period	-	20 years	30 years	30 years
Grace period	-	5 years	5 years	5 years
Repayment method	-	Quarterly annuity	Quarterly annuity	Quarterly annuity
NPV at SDR (social discount rate) of 12%	**1,000**	**986**	**932**	**991**

(21) Desperate need for low-cost lending for mass rapid transit dev't

USD overnight interest rate has stabilized at around 5%.
THB State Enterprises Bonds yield is at around 3.5%.





Source: Compiled by JET from:
New York Fed, Secured Overnight Financing Rate (SOFR) 30-day average
Bank of Thailand, FM_RT_001_S2 : Interest Rates in Financial Market

FILP (Fiscal Investment and Loan Program)
- If Introduced in Thailand -

(22) Government Saving Funds in Thailand (reference)

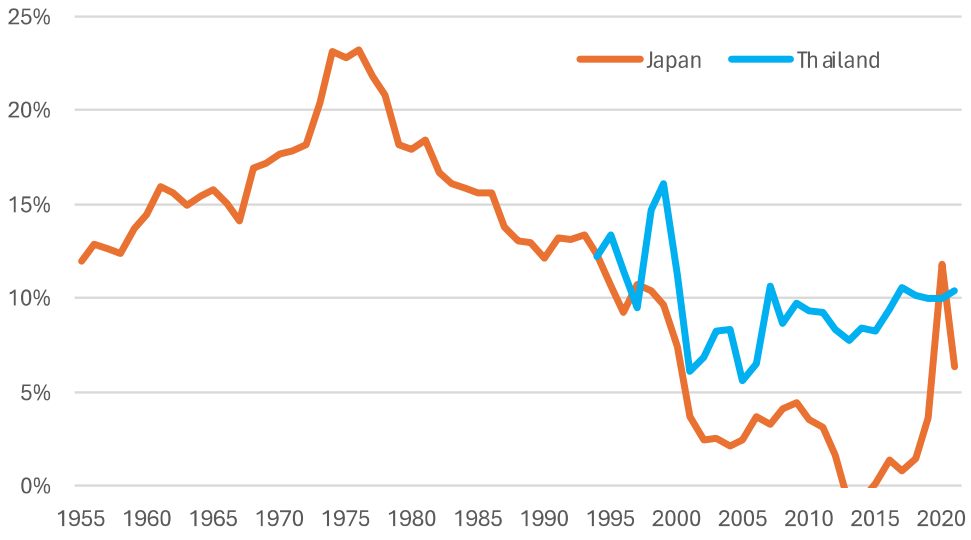
Thai health insurance and pension coverage is still limited;
=> it will be growing rapidly and significantly

	Form of contribution	Contribution criteria	Asset amount (end 2020)
Social Security Office (SSO) Fund	Saving + health insurance Compulsory / voluntary	Private employees (11 million contributors) Retired employees (1.8 million contributors) Non-registered workers	THB 2.22 trillion
Government Pension Fund (GPF)	Compulsory	Government officers (1.1 million contributors)	THB 1.06 trillion
National Savings Fund (NSF)	Voluntary	Non-registered workers (2.4 million contributors)	THB 8.2 billion
National Pension Fund (NPF)	Compulsory	Registered workers (10 million contributors)	To be established

Source: Compiled by JET from: efinancethai.com

(23) Household Savings in Thailand

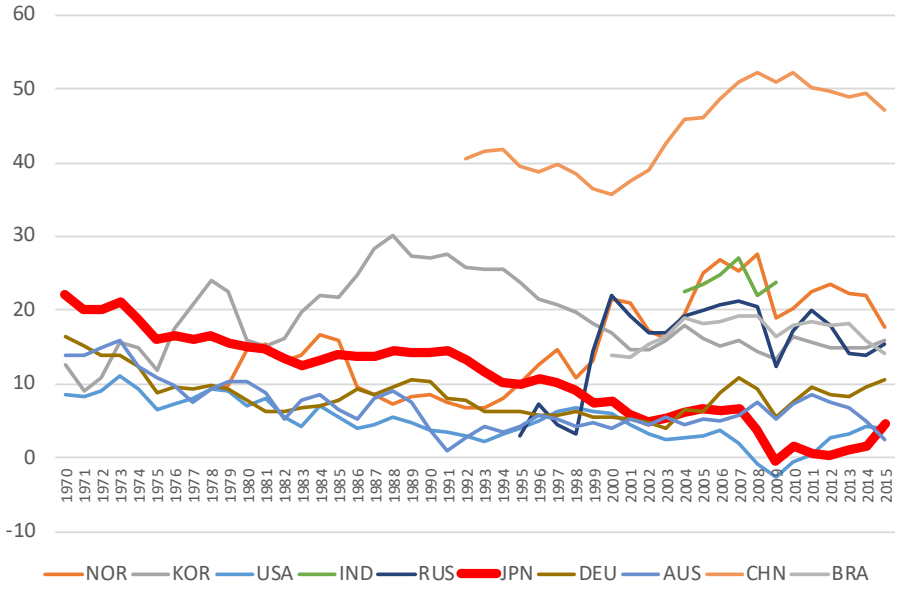
Household Savings Ratio (National Accounts)
= net household savings / net household disposable income



Source: JET compilation from National Accounts, data from NESDC (Thailand) and ESRI (Japan)

(24) Japan is not especially a high-saving nation

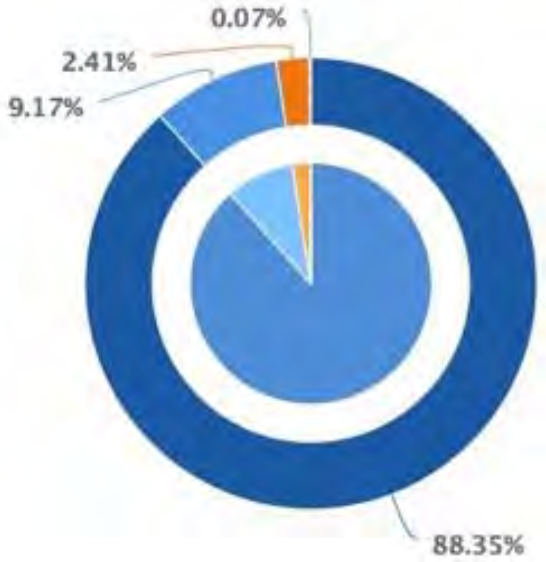
Household Savings Ratio = Total, % of household disposable income, (Unit: %)



Source: JET compilation based on OECD World Economic Outlook data

(25) Composition of the Thai Government's Debt

State Enterprises and Financial Institutions Debt comprises 11%



1. Government Debt (1.1+1.2+1.3)
9,110,892.07 Million baht

2. State Enterprise Debt (2.1+2.2)
945,976.75 Million baht

3. Special Financial Institutions Guaranteed Debt (3.1+3.2)
248,107.49 Million baht

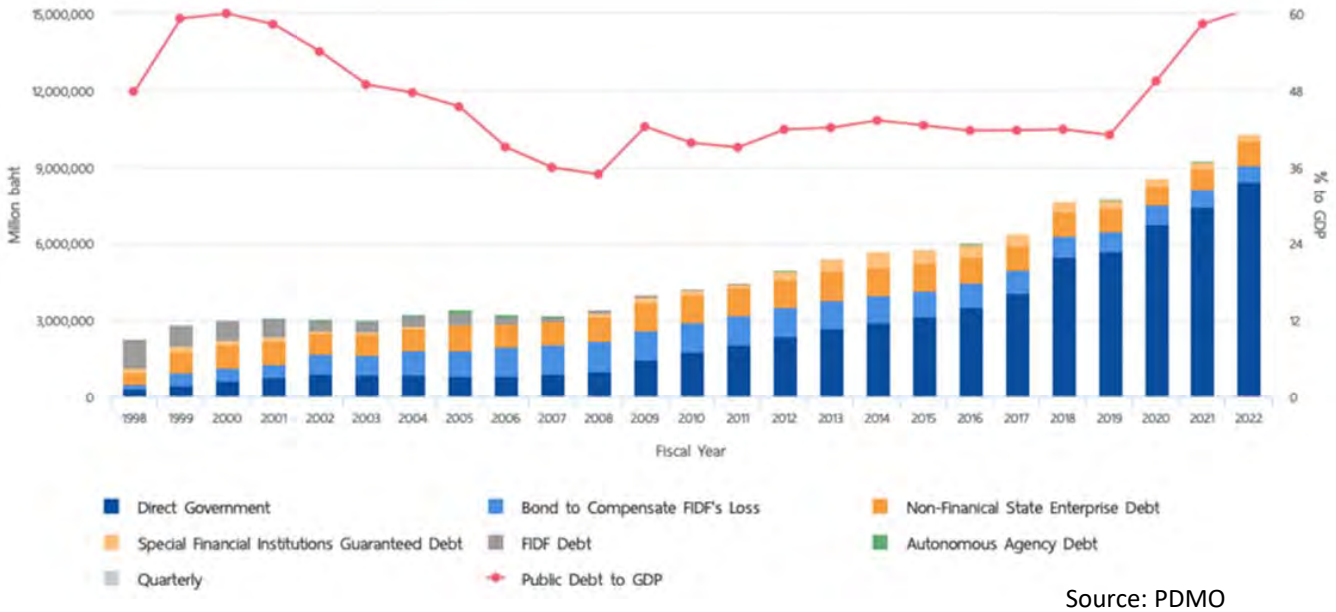
4. FIDF Debt (4.1+4.2)
0.00 Million baht

5. Government Agency Debt (5.1+5.2)
6,755.20 Million baht

Source: PDMO

(26) Thailand's Public Debt

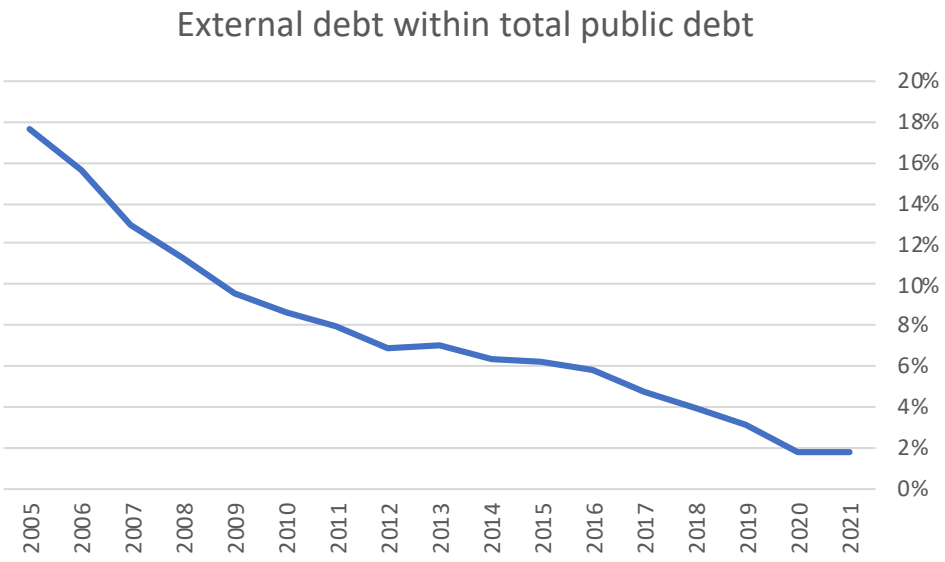
Sharp increase from 2020 but maintained at 60% against GDP



Source: PDMO

(27) External Debt within Total Public Debt

The Government is now borrowing from its own citizens.

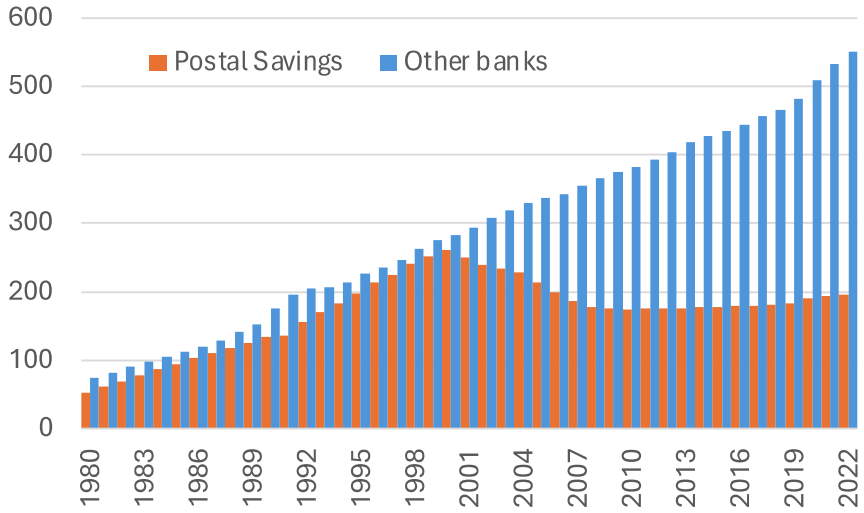


Source: PDMO

(28) Postal saving used to be dominant

Postal Savings used to dominate personal savings by half, until 2000
(Balance of personal savings by financial institutions - Unit: JPY trillion)

Note: Postal savings balance include JP Bank savings introduced after discontinuation.



Source: Compiled by JET from BOJ, MEXT and JP Bank data

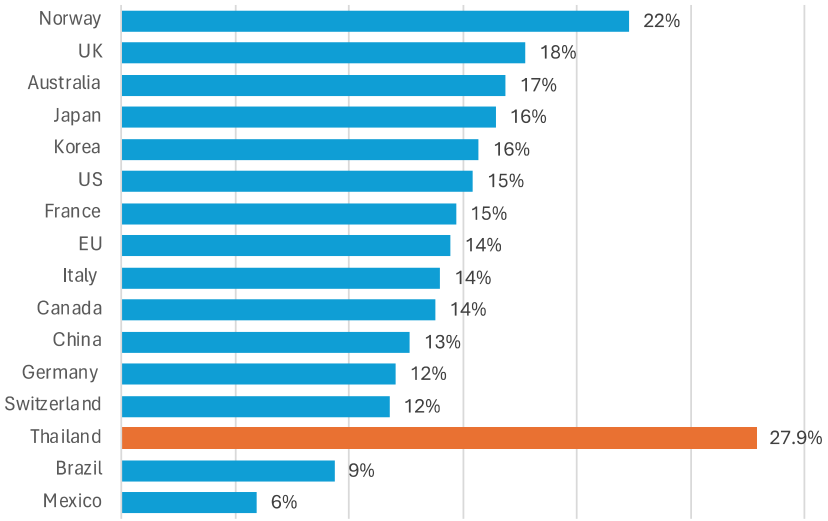
(29) Menu - Zero/low interest lending for railways

Zero Interest Rate Lending Facilities for Railways (Extract)

Programme	Direct beneficiary	Overview
Private railway companies P線方式	JRTT (JRCC)	• 1972 until around 2000 • Infrastructure is developed by JRCC and transferred to rail companies • 25 years annuity repayment • Interest over 5% is subsidized by central (1/2) and local (1/2) governments
Trunk lines and urban rail (for JR lines) CD線方式	JRTT (JRCC)	• 1965 until around 2000 • Infrastructure is developed by JRCC and leased to rail companies • 40 years annuity repayment • Interest over 5% is subsidized by central (1/2) and local (1/2) governments
New urban railways (都市鉄道整備事業)	JRTT (CATT)	• Zero-interest lending for Tsukuba Express Line development (central=40%, local=40%) • 15 years annuity repayment among the first 5 years is the grace period.
Industrial investment loan fund (産業投資貸付金)	JR, Local gov'ts	• 1989～1992 • Fund raised from selling the national telecom (NTT) shares. • NTT-B type zero-interest lending
Management stabilization fund 経営安定基金 (JRTT)	JR Hokkaido JR Shikoku	• JRTT extends zero-interest lending, JPY 220 billion to JR Hokkaido, JPY 140 billion to JR Shikoku, to be allocated to the reimbursement of the special bonds.

(30) Analysis:

Government Sector Gross Fixed Capital Formation (GFCF) / Total GFCF



Source: Compiled by JET from OECD Data Explorer - Annual investment by asset and institutional sector data for 2021

< Supplement >
Financing Less-lucrative Railways
Example Cases in Japan

Toyama LRT

Overview





Source: Toyama Chihou Railway

Toyama LRT

Portram (newly developed section north of Toyama Station)

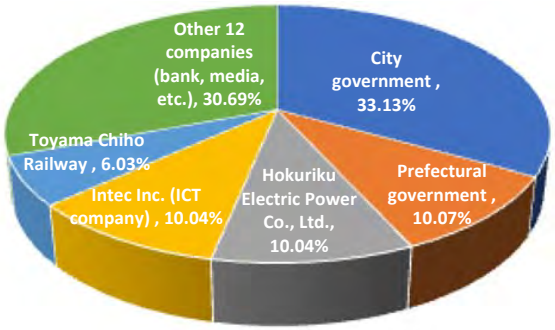
Length	7.7 km
Track	Single track (partially doubled)
Railway line portion	6.5 km
Tramway portion	1.2 km
Number of station	10
Number of stop	4
Passing point	4
Number of substation	2
Travel duration	25 minutes
Fare	JPY 210 (flat fare)

Source: Toyama Light Rail Co., Ltd. Financial Results for FY 2018-19

Toyama LRT

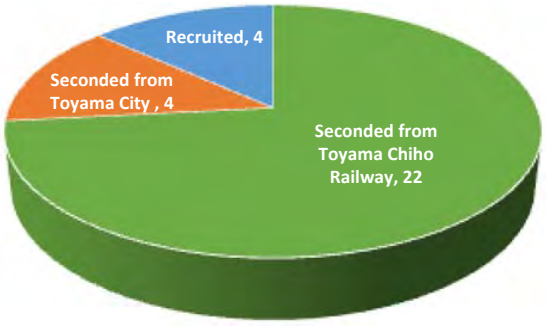
(Former) Toyama Light Rail Co., Ltd.

Paid-up capital = JPY 498 million



Positive participation of a variety of private companies.

Number of staff = 30

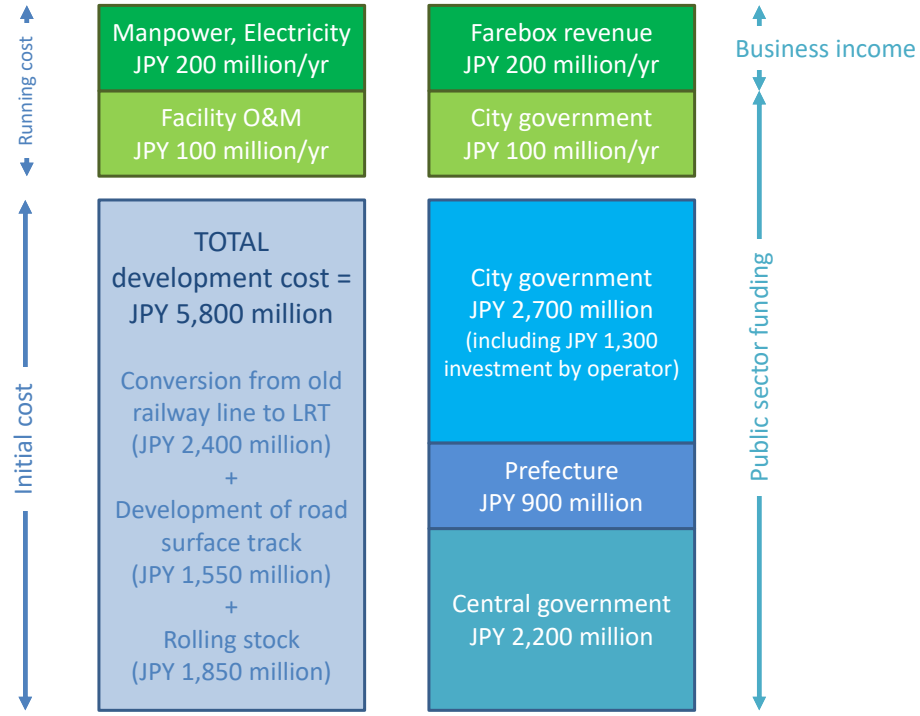


Extremely slim and flexible as an institution.

Source: Toyama Light Rail Co., Ltd. Financial Results for FY 2018-19

Toyama LRT

Funding



Source: Toyama City Gov't

Toyama LRT

Implications for less-profitable mass rapid transit plans in Bangkok Metropolitan Region

- Commitment of the local government is the key for realisation of the project.
- Positive participation of the private sector companies encourages the local government to take initiatives on the project.
- Whether the low flat fare policy turns out to be effective for modal shift or not is something to be seen (a challenging experiment).

Source: Toyama Light Rail Co., Ltd. Financial Results for FY 2018-19

Keio Sagamihara Line (19km, opened 1974-1990)

Funding for the Railway Line Development

Means	Amount	Note
From equity	JPY 27,200 million	Initially 50% from local gov't. 50% from private sector (A portion of the total paid in capital of JPY 50,719 million)
From the stakeholders' contribution	JPY 43,700 million	Tokyo Metropolitan Government JPY 15,600 million UR (Japan Housing Corporation) JPY 27,100 million Tokyo Public Housing Corporation JPY 1,000 million
Zero / low interest rate borrowing through SOE	JPY 128,900 million	Financed by JRTT through FILP (Fiscal Investment and Loan Program) Interest subsidised by the central government and the prefecture
From debt	JPY 32,900 million	Preferential borrowing from DBJ and commercial bank syndication
TOTAL	JPY 72,300 million	Includes land acquisition, civil, mechanical, facilities and management

Source: financial results for 34th period (up to March 2022)

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

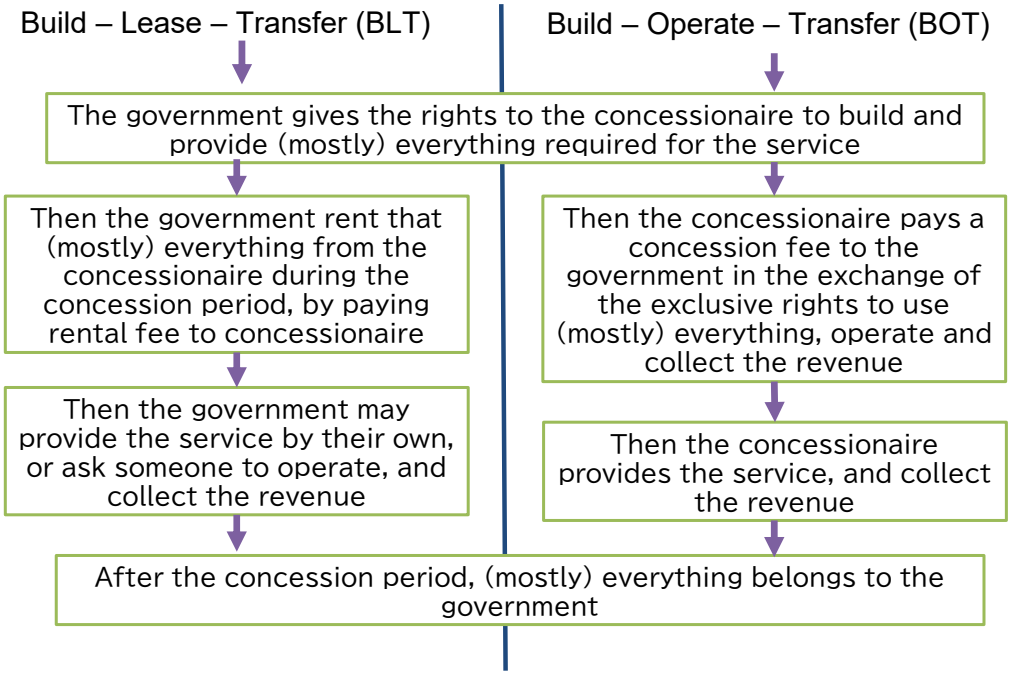
Appendix-15

PPP for Railway Business Scheme in Asian Countries

Today's Discussion

- PPP for Railway Business Scheme in Asian Countries
  - Manila MRT3
  - Kuala Lumpur Kelana Jaya Line
  - Bangkok Blue Line
  - Delhi Airport Express Line
- A summary based on "Research on PPP Urban Railway Projects in Asian Countries" by Japan Transport and Tourism Research Institute
  - https://www.jttri.or.jp/events/2017/seminar170220.html
- For general discussion about railway policy, please check JARTS's book "KISS-RAIL 2.0"
  - English version: https://www.jarts.or.jp/english_02.html
  - Japanese version : https://www.jarts.or.jp/news_detail.php?id=1110
- For detail discussion about urban rail PPP projects in Manila, Kuala Lumpur and Bangkok, please check this World Bank report
  - https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/2022-06/threecities.pdf

Types of PPP in Today's Projects

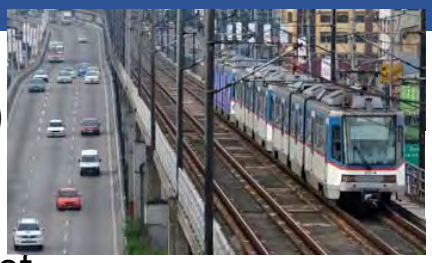


PPP in Asian Countries

- Public and private share infrastructure cost
  - PPP before 2000 = heavily relied on private funding
  - After 2000 = more involvement from the public
  - Project ownership goes back to public after PPP contract
- Concession system
  - Typically 25-30 years
  - Players are quite limited, usually from big domestic conglomerates from other industries
- Shifting towards "more public" after the opening has been usually observed
  - Or in some cases, fully public
  - Because private cannot sustain initial losses

Manila MRT3

- Second metro line in Manila
- Light rail (although it is called, MRT)
- First section opened in Dec 1999
- 17 km, 13 stations
- Running on the west-south section of the ring road “EDSA”
  - Heavily congested road
- PPP = Build-Lease-Transfer (BLT)
  - One of the weirdest schemes (at least for me)
  - Owned by private, operates by public
  - Recently not commonly used in transport project



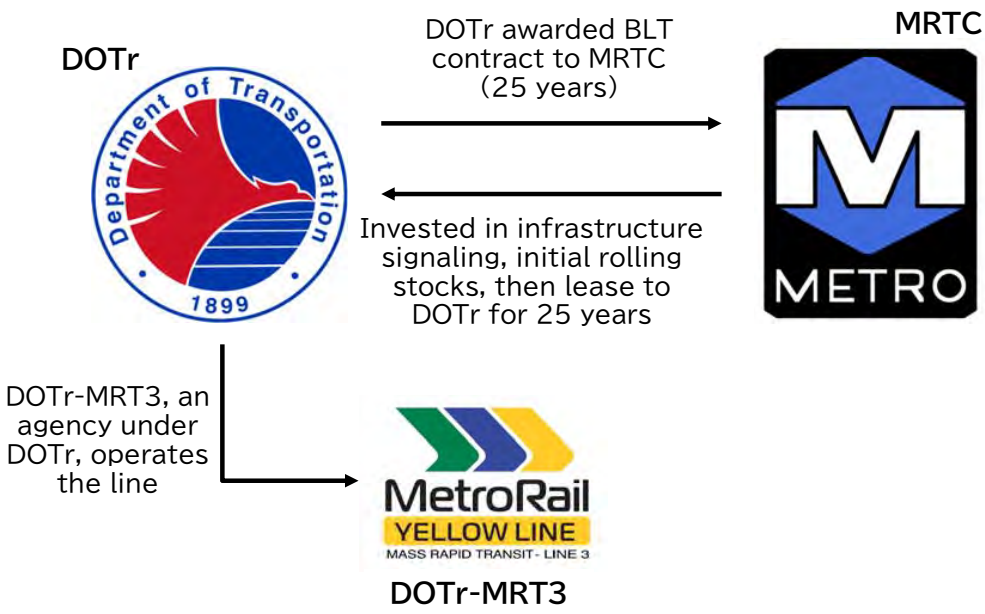
Yellow: LRT1 (light rail)
Purple: LRT2 (heavy rail)
Blue: MRT3 (light rail)



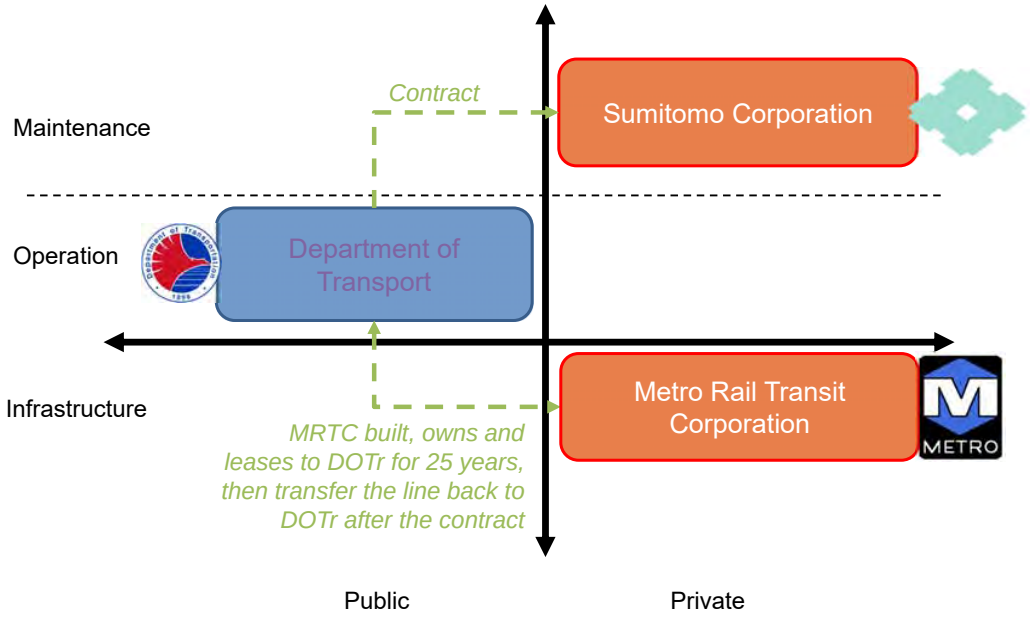
History

1991: The project was awarded to EDSA LRT Corporation, a Hong-Kong based consortium, as a BOT project
1991-1992: The project was renegotiated from BOT to BLT project.
1992-1995: Problems in financing and contract agreement. The project was stalled.
1995: EDSA LRT Corporation was purchased by Metro Rail Transit Corporation (MRTC), a consortium composed by seven local companies. The project was restarted.
1999: Partial opening
2000: Full opening
2019: Project rehabilitation started
2025: BLT contract ends

Key Players



Manila MRT3



Issue

- Low capacity on a super high demand corridor
  - Reason = LRT spec
- Very long waiting time during peak hours
  - Before COVID-19, 30 minutes plus was pretty common
  - Reason = low capacity + frequent breakdowns
- Frequent breakdown
  - Reason = poor maintenance
  - Before 2012 = maintenance by Sumitomo Corp.
    - Sumitomo provided spare parts to the rolling stocks
    - Still, some breakdown was reported
  - 2012-2019 = maintenance by several other companies
    - For DOTr, Sumitomo's cost is too expensive
    - Contract without spare parts provision
    - Frequent breakdown was reported
  - From 2019 = back to Sumitomo
    - Contracted with rehabilitation contract (JICA Loan)
    - Situation has been a little bit better



Line formed after the breakdown, Ortigas Station (Manila's major financial district)
October 4, 2022

https://newsinfo.inquirer.net/1675167/rush-hour-commuters-suffer-long-queues-due-to-mrt-3-technical-glitch



Train interior
(3-4 cars per train, one car has 3 sections)

https://commons.wikimedia.org/wiki/File:MRT-3_Train_Interior.jpg

Kuala Lumpur Kelana Jaya Line

- Second LRT line in KL
- First driverless system in KL
- First section opened in Sep 1998
- 46.4 km, 37 stations
- Running across the downtown and later extended to southwest suburban area
- Initially PPP with very high degree of private involvement, but later nationalized
  - Now 100% public





Kelana Jaya Line in Light Red (Line 5)

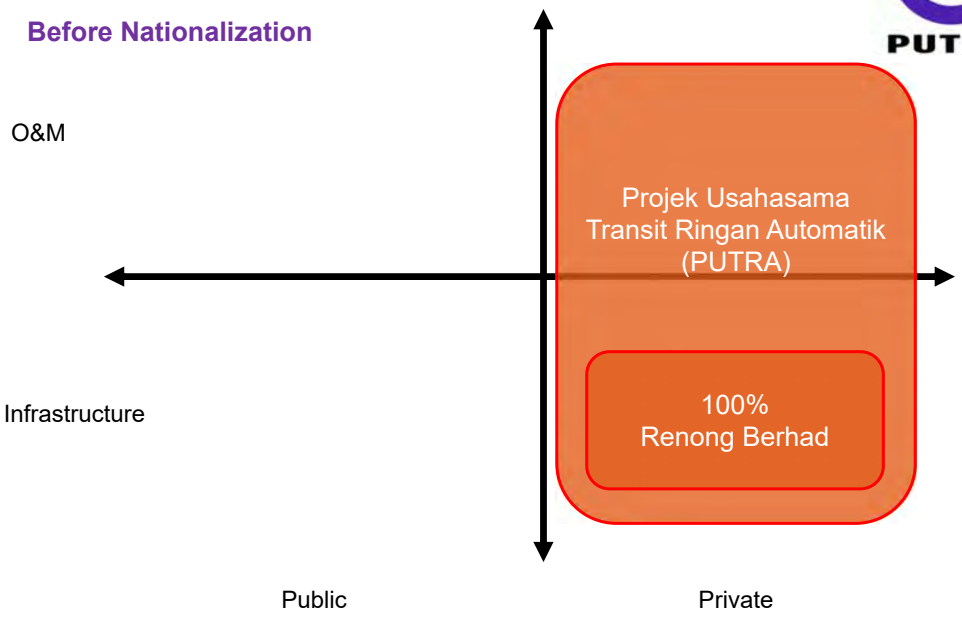
History

1994: A 60-years BOT contract was awarded from the Malaysian government to PUTRA. The LRT was branded as “PUTRA-LRT”
1998: Partial opening
1999: Full opening
1999: PUTRA failed to deliver the payment of loan interest
2002: Take over of the PUTRA-LRT asset by Prasarana. Renamed to “Putraline”
2005: Operation was transferred to Rapid KL
2006: Renamed to “Kelana Jaya Line”
2016: Southwest extension opened

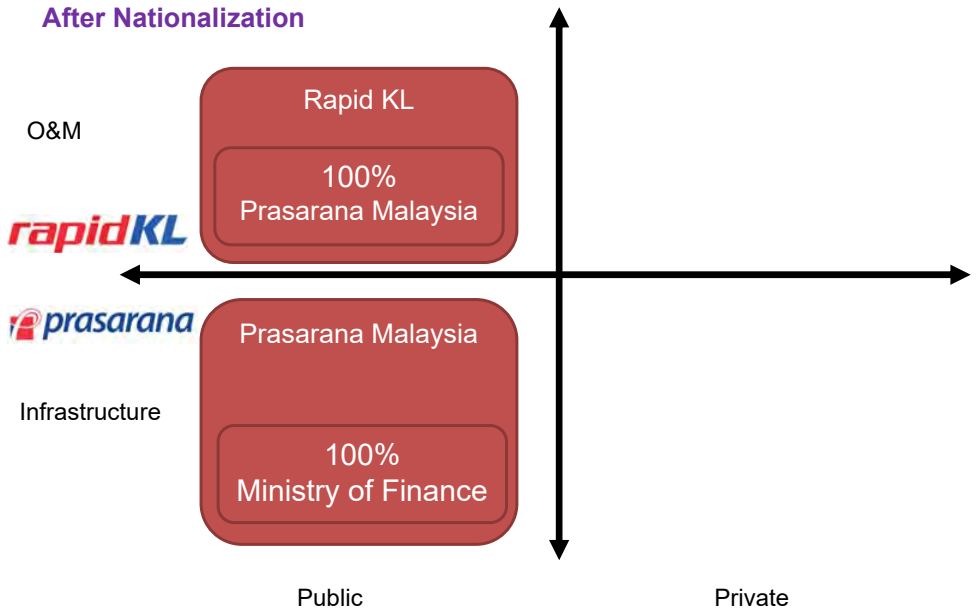
Key Players



Kuala Lumpur Kelana Jaya Line



Kuala Lumpur Kelana Jaya Line



Issue

- Inability to sustain an initial loss from private
  - Overestimated ridership + demand shortfall
  - Not only PUTRA-LRT, another LRT line, another monorail and other bus routes was also facing the same problem, and nationalized by Prasarana
- Better integration between multiple mass transit mode can be provided by the government
  - MRT, LRT, monorail, and bus has been rebranded under the name of “Rapid KL”
  - Common ticketing across system
  - In overall, Prasarana still does not generate profit
  - Healthy condition of Malaysian national finance has allowed government to constantly fund and subsidize the public transport service through Prasarana



Train Collision in Kelana Jaya Line
May 24, 2021

https://www.channelnewsasia.com/asia/2-lrt-trains-collide-kuala-lumpur-injured-klcc-kelana-jaya-1402456



Lines during rush hours, Pasar Seni Station (KL's old city district)

https://www.thevibes.com/articles/news/63324/rush-hour-lrt-mrt-users-frustrated-over-minutes-long-wait

Bangkok Blue Line

- Third metro line in Bangkok
- First (and the only) subway
- Opened in July 2004
- 48 km, 38 stations
- Originally planned as a loop line
  - Now extended into a Q shape loop
- Government partially supports the civil works
- PPP faced the problem as in KL, but approached the problem with a different solution





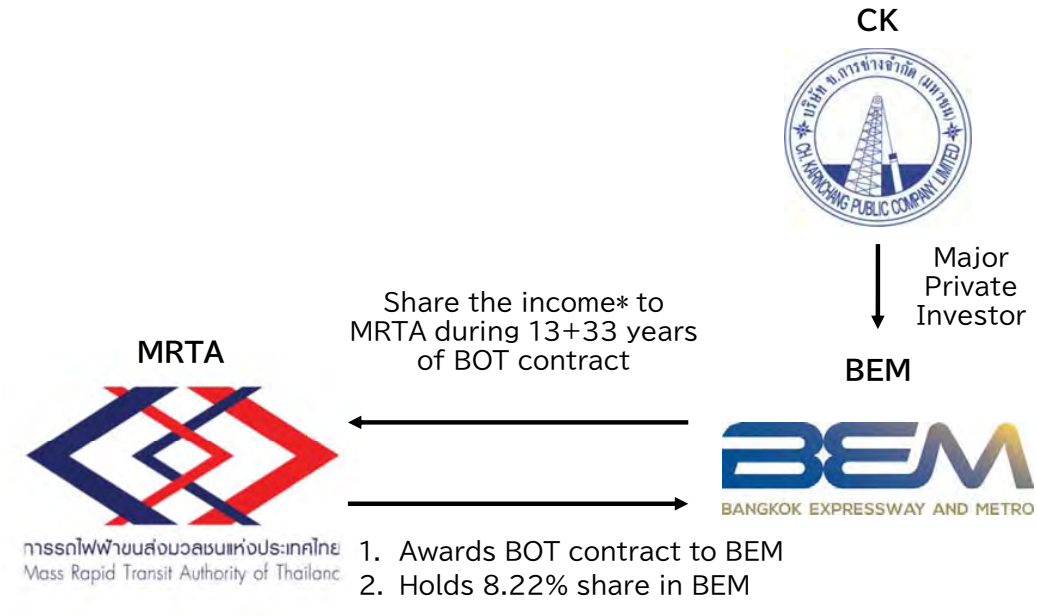
History

1996: A 25-years BOT (so called “PPP Net Cost” in Thailand) contract was awarded from the Mass Rapid Transit Authority (MRTA) to Bangkok Metro PCL (BMCL)
2004: Opening
2006: Severed deficit. Capital injection by MRTA to BMCL
- For loan repayment

2013: Another capital injection + restructure by private shareholders
- For loan repayment + investment for O&M contract in the Purple Line

2015: Merger with a Bangkok Expressway PCL (BECL). Renamed as Bangkok Expressway and Metro PCL (BEM)
2017: Section connecting the Purple Line opened. BOT contract was extended to an additional of 33 years (until 2050) 2019: Southwest extension opened
2020: West extension opened. Loop completed

Key Players

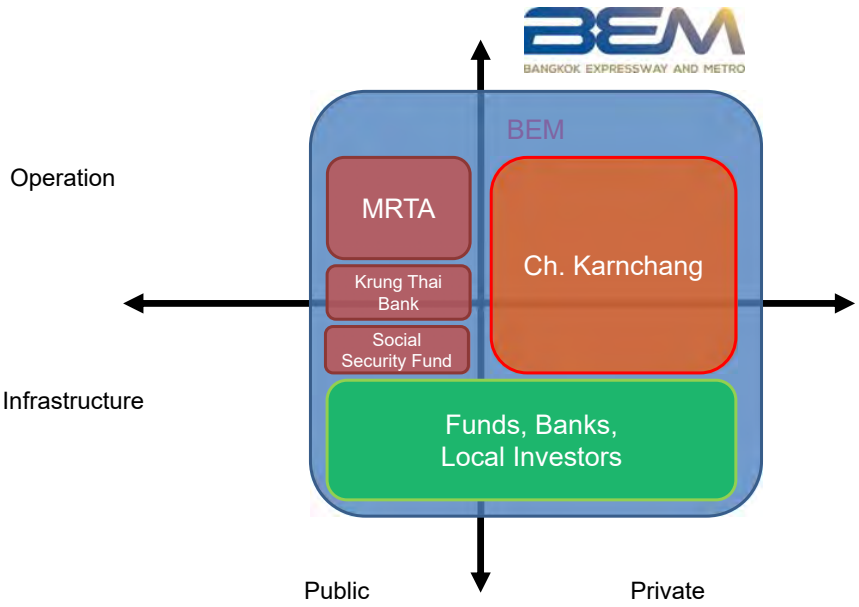


*original contract (1996) = fee payment plus income sharing
new contract (2015) = profit sharing

BECL/BEM shareholders

Opening (2004)	Equity Raising 1 by MRTA (2006)	Equity Raising 2 by Private + Banks (2015)	Merged with BECL (now, 2023)
CK 41.81%	MRTA 25.00%	CK 35.47%	CK 32.37%
BECL 18.89%	CK 24.85%	MRTA 14.57%	MRTA 8.22%
N-Park 18.75%	BECL 9.99%	Krung Thai Bank 8.28%	Krung Thai Bank 5.33%
Banks & Funds	N-Park 6.86%	Banks, funds, local investors	Social Security Fund 3.50%
	Banks, funds, local investors		Banks, funds, local investors

Bangkok Blue Line



Issue

- Initial demand shortfall
- BEM keeps the operating cost low by maintaining a “minimum level of service”
  - New rolling stock was introduced as less as possible
  - Seats were taken off to increase standing capacity
- Poor network integration
  - No common fare structure with other lines. Entry fee must be paid when transferring to lines outside MRTA’s supervision
  - Common in Japan, but not common in other countries
- Contract extension in 2017 was signed without public consensus
  - Longer concession period
  - Lower return to the government
  - In return, users can transfer to Purple Line without procuring a separate contract, which will require further procurement time



Lines during rush hours, Sukhumvit-Asok Station

Taken by me, Feb 2023
Took me 5 minutes to get inside the train



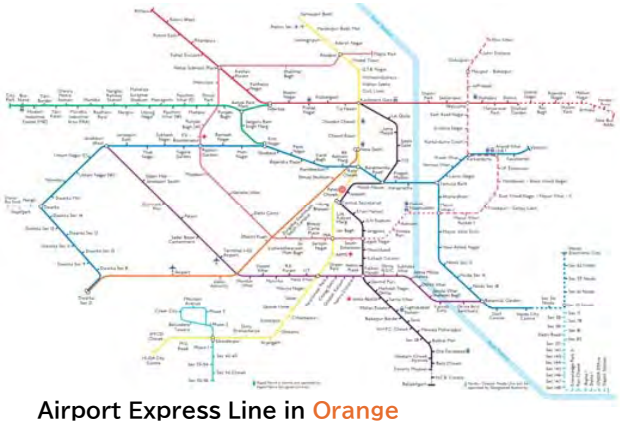
To increase the capacity without procuring new cars, half of the seats has been taken off since 2017

Taken by me, a week after the picture above

Delhi Airport Express Line



- 6th metro line in Delhi
- Opened in Feb 2011
- 22.7 km, 6 stations
- Similar PPP scheme as in Bangkok Blue Line
  - Government shares the civil cost, then receive a revenue share and concession fee during contract period
- Same outcome as KL Kelana Jaya Line
  - Government takeover
- Cheap fare. Clean car.
  - New Delhi Station to IGI Airport = 60 rupee =#üá#¼ö



Airport Express Line in Orange

History

2008: A 35-years BOT contract was awarded from the Delhi Metro Rail Corporation (DMRC) to Delhi Airport Metro Express Pvt. Ltd. (DAMEPL).
- Other lines are invested and operated by DMRC without PPP
- Construction of civil structure by DMRC
- Concession fees of $10.53 mil per year
- Share 1 to 5 % of gross rev for 15 years
- Land-development right

2011: Opened

2012: Closed for repairing. About half a year.

2013: Reopened, at a reduced speed (until now)
- Designed at 135 km/h

2013: Take over of the asset by DMRC

2023?: Extension (shared with Blue Line) open
- Trial run has started since 2022

Key Players

R-Infra

RELIANCE Infrastructure

Major Private Investor

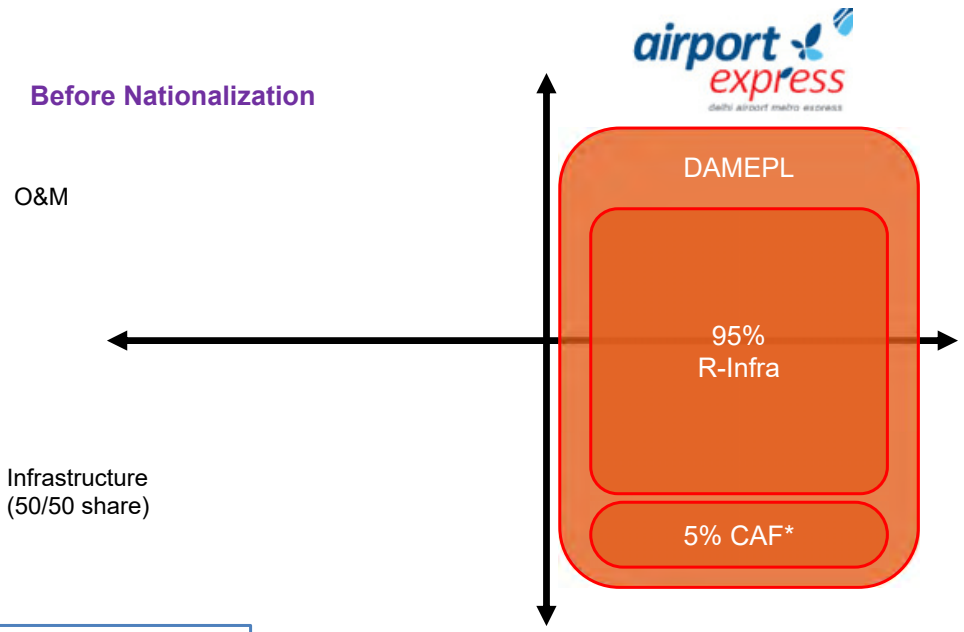
DMRC

Pays fee + shares income with DMRC during 30 years BOT contract

DAMEPL

airport express

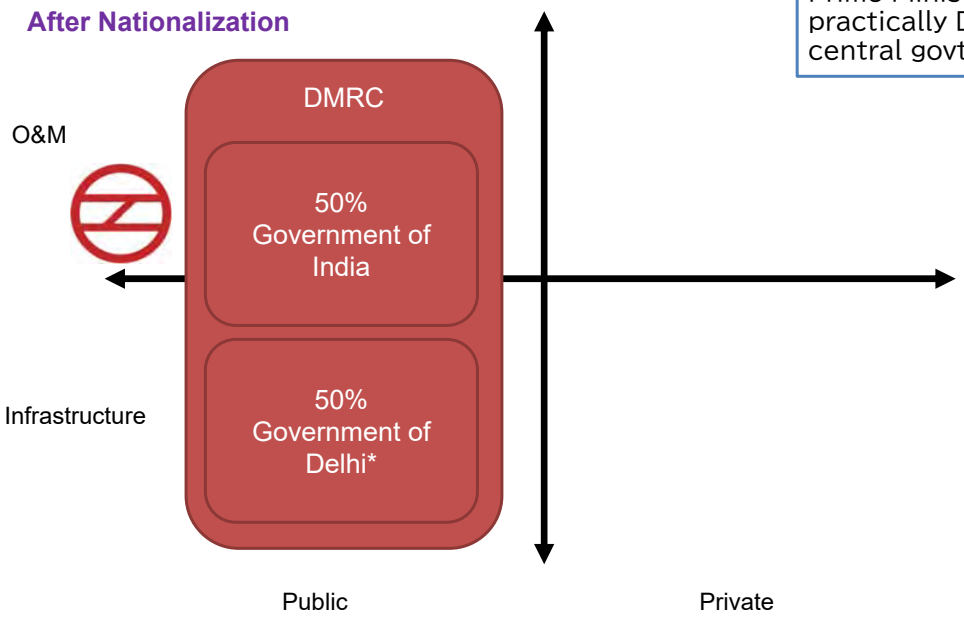
Delhi Airport Express Line



*Construcciones y Auxiliar de Ferrocarriles, a Spanish rolling stock manufacturing company

Delhi Airport Express Line

*Executives are appointed by Prime Minister of India, so practically DMRC is 100% central govt owned.



Issue

- Initial demand shortfall + delay fines + service suspension = lead to DAMEPL bankruptcy
- Poor quality infrastructure
  - Lower the service speed
- Poor accessibility to some stations
- Arbitration between DMRC and DAMEPL still continues
- Fare and operating cost are heavily subsidized by the government
  - Also applies to other lines in Delhi metro, as well as other mass transit systems across India
  - Cross subsidy from the lines with high demand



City check-in counters at New Delhi Station

https://www.livemint.com/companies/news/airasia-spicejet-goair-passengers-can-now-check-in-at-new-delhi-metro-station-11574144131268.html



Terminal Station (Dwarka Sector 21) in the middle of nowhere, waiting for the development around the station

Discussion

- Common problems in PPP
  - Initial loss, mainly due to
    - Demand shortfall / overestimation
    - New operator has no experience
    - Low debt capacity / poor cash flow
- Government intervention
  - Manila = limited intervention
    - No significant service improvement
  - Bangkok = some intervention
    - Service has been improved, but poor network integration
    - No cross subsidy
  - KL, Delhi = full intervention
    - Service has been improved, better network integration
    - Financial burden to the government

Discussion

- Government must intervene at some point
- Why not intervene at the beginning?
- For earlier lines, financial risks should be shared to the public
  - Government support until breakeven point
  - Loan = long grace period / interest-free period
  - Equity (Bangkok MRTA style) = more capital + cash flow at the beginning, then equity can be sold once the breakeven point was reached
  - Support for the civil work should be mandatory
  - Consortium with experienced partners (from abroad)
- For later lines with high demand risk, PPP may not be a good option
  - In Japan, many local-government led third sector companies are still struggling
  - TOD could be a solution, but requires a huge effort
  - Tram, BRT, or simply bus, could be a better solution

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

Appendix-16

Bus Transportation as a part of Urban Public Transportation System

Contents

PART A. Bus Transportation in Tokyo Metropolitan Area (TMA)

1. Overview of Bus Transportation in Japan
2. Urban Development and Public Transportation

PART B. Bus Transportation in Bangkok Metropolitan Region (BMR)

1. Overview of Bus Transportation in Thailand
2. Current Situation and Challenges of Bus Transportation in BMR

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

PART A. Bus Transportation in Tokyo Metropolitan Area (TMA)

1. Overview of Bus Transportation in Japan

1.1 Image of Bus Transportation







Regular Bus



Mini Bus



Articulated Bus

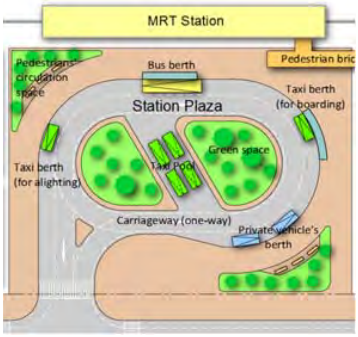
Source: ALMEC Corporation

1.1 Image of Bus Transportation

Concept of station plaza as inter-modal transfer facility

Taxi berth





Motorcycle/bicycle parking



Bus Terminal in front of the railway station







Source: ALMEC Corporation

1.1 Image of Bus Transportation







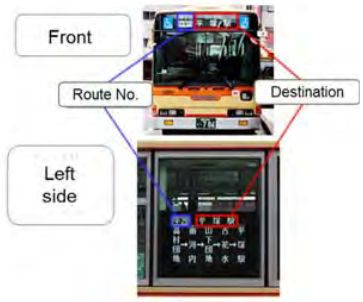






Source: ALMEC Corporation

1.1 Image of Bus Transportation











1.2 History of Bus Business

Year	Contents	Notes
1902	First bus start operation	Entry by individuals and small enterprises were common
1913	Bus business by railroad operator	Bus operations by private operators and micro-enterprises are taken over by railroad operator
1923	Expansion of bus operation	Tram operation were suspended because of big earthquake in Tokyo
1933	Establish of Automobile Traffic Business Act	1 Operator in 1 Bus Route ⇒ *Integration of bus operator*
After WW2	Increase in transportation due to economic growth	Also increase in private vehicle
1951	Establishment of Road Transport Act	
1960's～2000's	*Increase traffic jam ⇒ Increase delay ⇒ Decrease service ⇒ Lose reliable <Negative Spiral>*	
2002	Revision of Road Transport Act (Deregulations)	• From license system for each route to a permit system for each operator ⇒*Freedom of entry and withdraw* (each municipality considers the existence or non-existence of routes) • Introduction of operation manager

Source: ALMEC Corporation

1.3 Act for Bus Business

Bus Business in Japan = Based on the **Road Transport Act**

- **To ensure that the operation of road transport services is appropriate and reasonable.**
- **To promote the smooth and reliable provision of services that accurately respond to the diversification and sophistication of user demand in the field of road transportation.**
- **To ensure the safety of transportation, protect the interests of users of road transportation and promote their convenience.**
- **To promote the comprehensive development of road transportation.**
- **To promote the public welfare.**

Road Transport Act

Road Transport Act Enforcement Regulations

- ✓ Business Plan
- ✓ Operation Plan
- ✓ Fares
- ✓ Safety Management and Transportation Safety
- ✓ Operation Management

Regulations on the Transport of Passenger Vehicle Transport Business

Items to be implemented by the operation manager.

Source: ALMEC Corporation

1.4 Involvement by Government in Bus Business

Roles of Government, Bus Operator and Citizens

Government	• Establishment of laws and regulations to ensure safety and user convenience and establishment of a basic framework • Establishment of subsidy system
Local Government	• Ensure transportation services to improve quality of life • Improvement of the environment for bus operations • Planning of transportation system in the region • Consideration of measures to maintain individual livelihoods
Bus Operator	• Provide safe, comfortable, and inexpensive operational services • Implementation of proposals to revitalize bus usage by users
Citizens	• The final decision is made on whether or not a bus is necessary, so daily bus use affects the maintenance of the route.

Source: ALMEC Corporation

1.4 Involvement by Government in Bus Business

Local Public Transportation Conference

1. Local government provides opportunities to discuss transportation issues, including bus services.
2. Members
   - Prefectural (Local) government
   - Agency of the Ministry of Land, Infrastructure, Transport and Tourism
   - Transportation operators (bus, taxi, etc.)
   - Representatives of citizens and users
   - Road administrators
   - Traffic police
3. Discuss about

A) Formulation of Regional Public Transportation Plan
- Discuss desirable passenger transportation services for the region area.

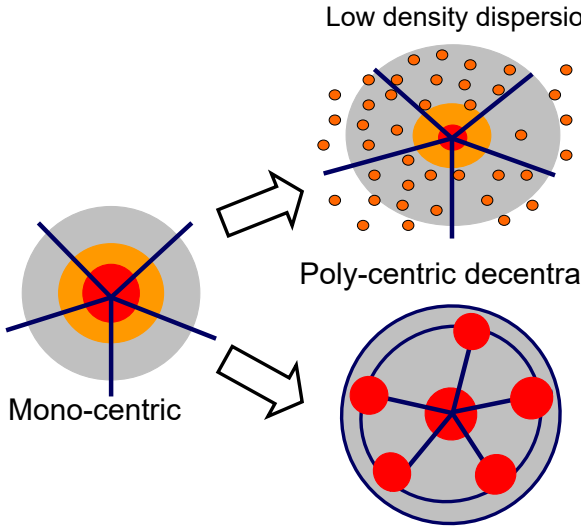
B) Establishment of bus route to ensure maintenance of daily life
- Subsidy for specific bus route by the national or local government is provided to the bus operator.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

PART A. Bus Transportation in Tokyo Metropolitan Area (TMA)

2. Urban Development and Public Transportation

2.1 Sustainable Urban Structure with Public Transportation



- **Car-oriented sprawl**
  →Undesirable !

- **Public-transport oriented poly-centric form**
  → Desirable !

※TOD (Transit Oriented Development) in long term To build up desirable urban structure

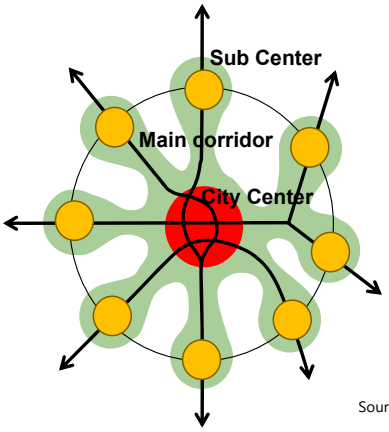
Source: S.Morichi

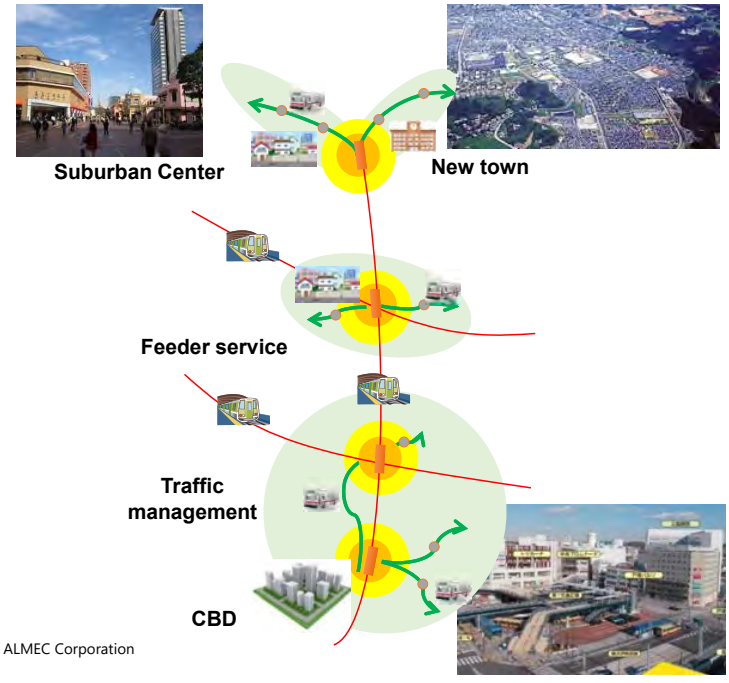
Benefits of TOD:

- Maximized and efficient use of public transport and transport improvement **(transport context)**
- Mixed and compact landuse at and around station **(urban context)**

2.2 Role of Urban Railway and Bus Transportation

- **Urban railway** serves for major corridors with high transport capacity
- **Bus transportation** serves for minor corridors and access to the station





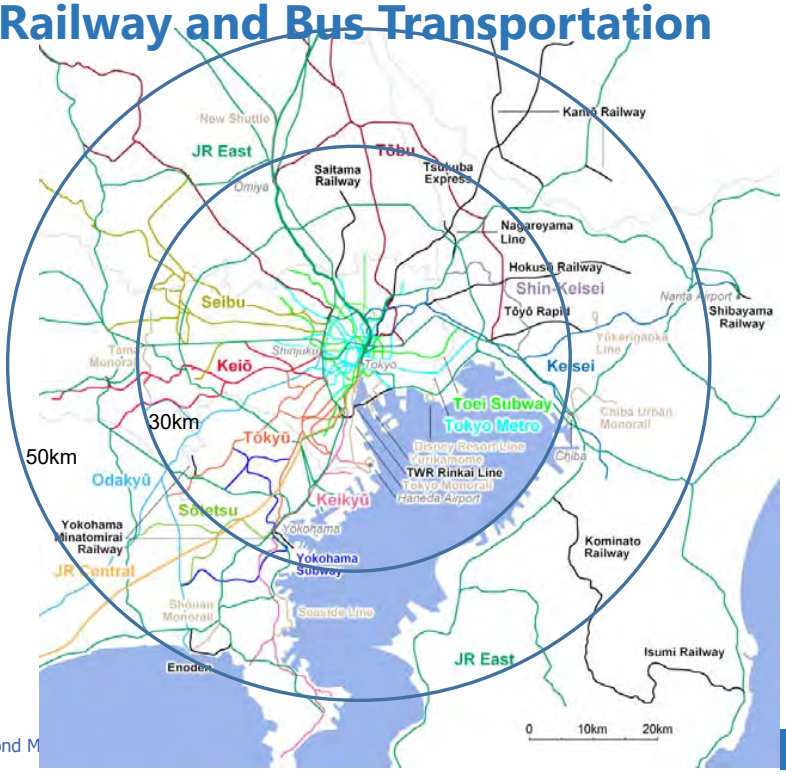
Source: ALMEC Corporation

2.2 Role of Urban Railway and Bus Transportation

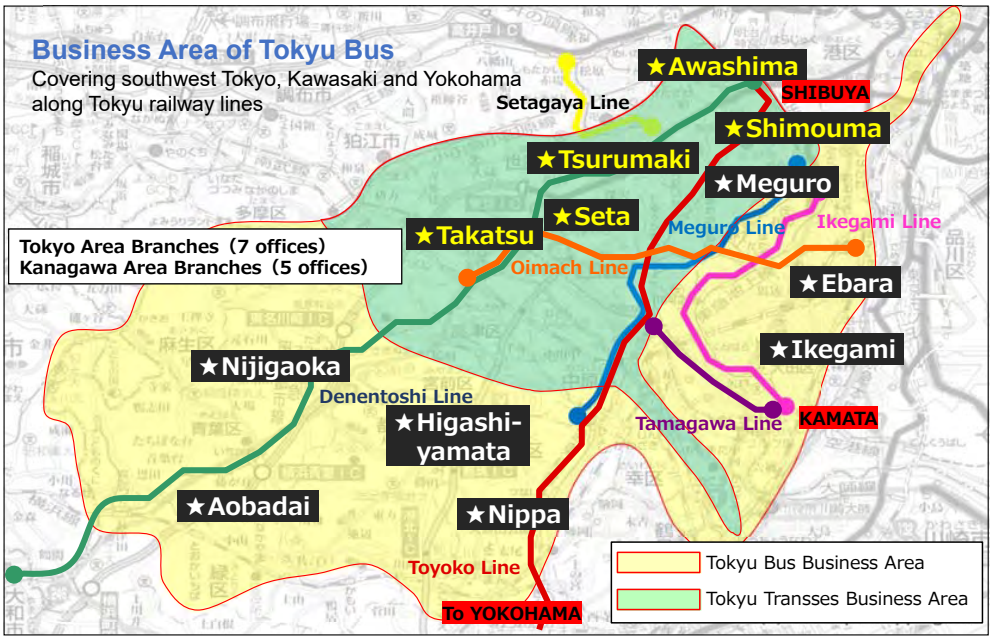
Railway Network in TMA

	No of Companies	Length (Km)
1 High Speed Rail		
JR East	1	887.2
Private Rail	17	1101.5
(Major)	(8)	(907.5)
(Other)	(9)	(194)
2 Metro		357.5
Tokyo Metro	1	195.1
Toei Subway	1	109.0
Yokohama Subway	1	53.4
3 Monorail/AGT	10	112.4
4 Tram	2	17.2
Total		2475.8

Source: M. Ito



2.3 Example of Tokyu Bus Company



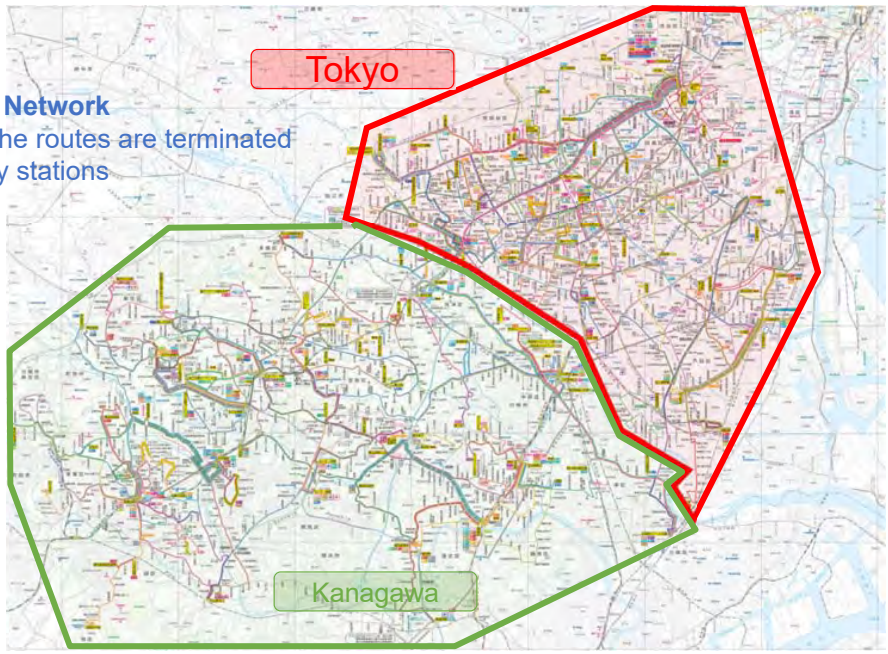
Offices	Buses
Awashima	61
Shimouma	50
Tsurumaki	84
Seta	81
Meguro	91
Ebara	54
Ikegami	64
Takatsu	93
Nippa	115
Aobadai	81
Nijigaoka	119
Higashi-Yamata	75
Total	968

Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

Bus Route Network

- Most of the routes are terminated at railway stations



Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

Tokyo Area





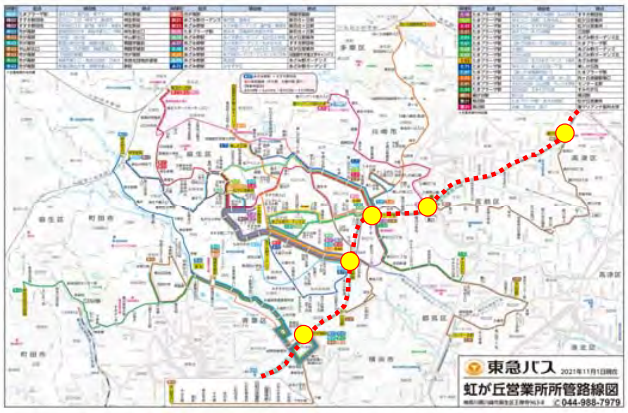
In Tokyo, bus routes mainly complement railway network, which runs between east and west, and they basically run on the major road and residential road. On the other hand, some routes run between south and north to support daily life.

Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

Kanagawa Area



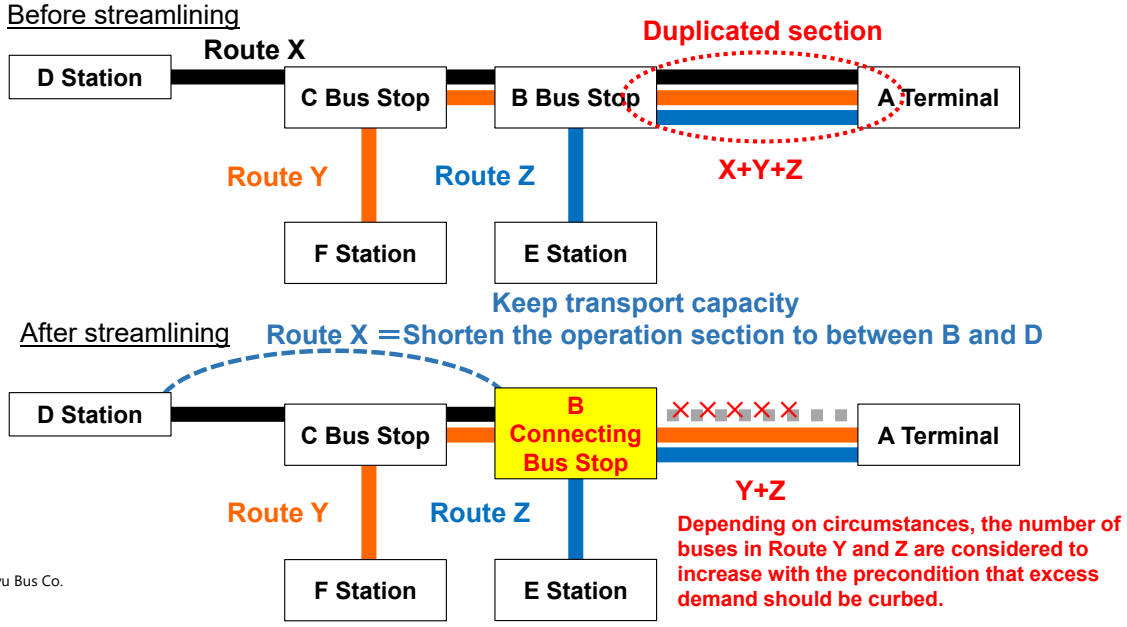


In Kanagawa, because of the number of urban railways are less than in Tokyo and the longer distance between stations, bus routes are spread radially from each station.

Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

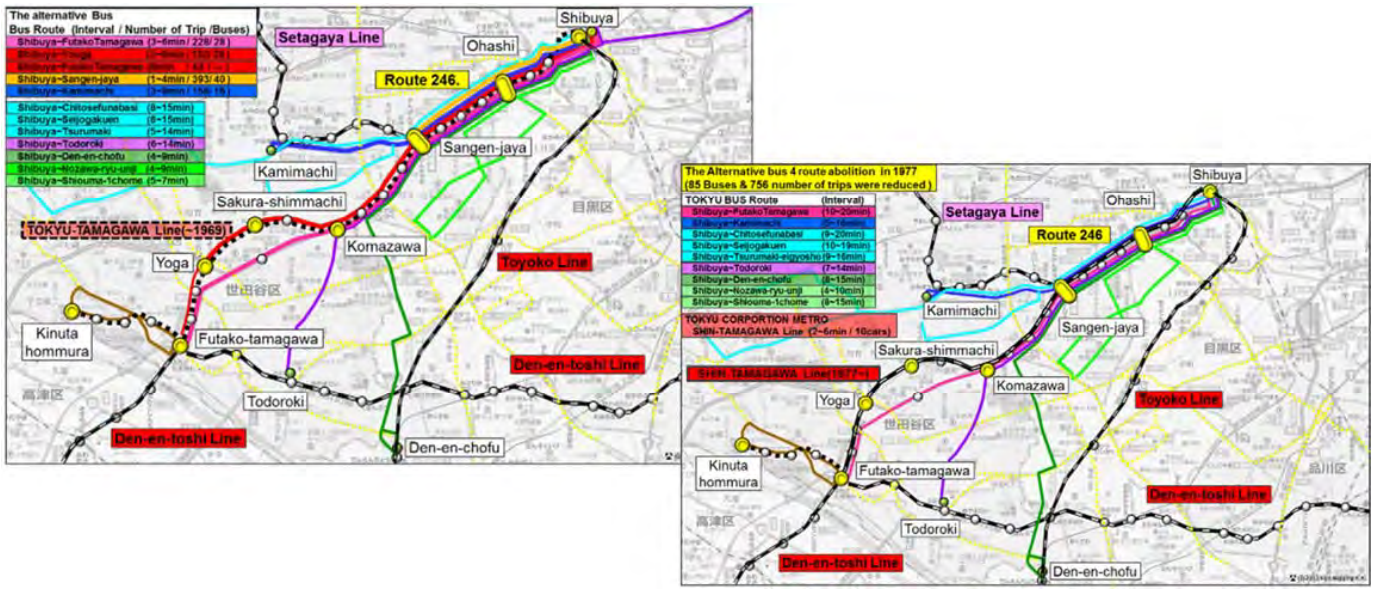
Example of route efficiency improvements - Elimination of overlapping service sections -



Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

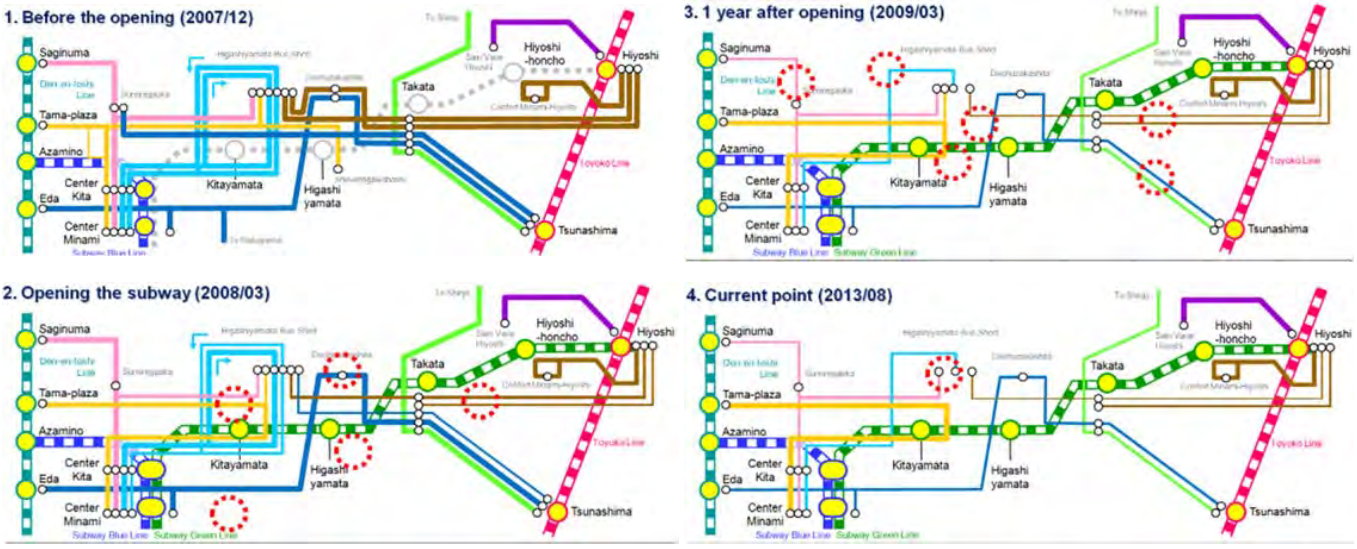
Bus Routing when the Tokyu Tamagawa Line was replaced to subway (1969-1977)



Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

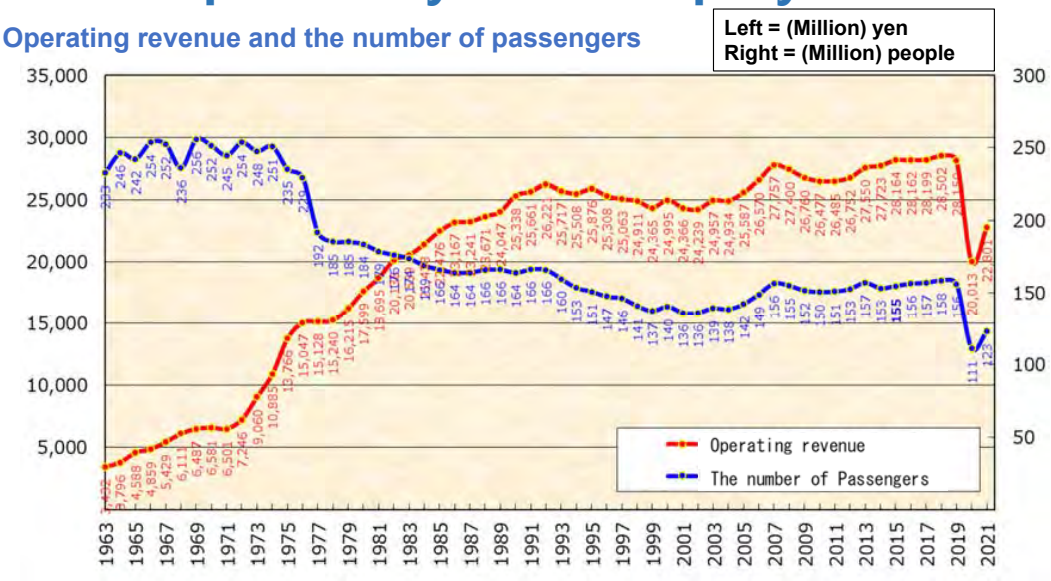
Bus Routing when the Yokohama City Subway Green Line is opened



Source: Tokyu Bus Co.

2.3 Example of Tokyu Bus Company

Operating revenue and the number of passengers



- **Operating revenue** **22.8 billion yen per year** (62 million yen per day)
- **Passengers** 123 million people per year **(337 thousand people per day)**

Source: Tokyu Bus Co.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

PART B. Bus Transportation in Bangkok Metropolitan Region (BMR)

1. Overview of Bus Transportation in Thailand

1.1 Related Organization

■ Bus Service-Related Organizations

Agency	Major Related Duties	Category
Department of Land Transport (DLT)	• Manage land transportation in Thailand • License bus operators and drivers • Conduct safety inspections and investigations	Regulator and Policy maker
Office of Transport and Traffic Policy and Planning (OTP)	• Develop transportation policies, plans, and research in Thailand • Manage intermodal transportation facilities (ITF)	
Bangkok Mass Transit Authority (BMTA)	• Manage public bus system in BMR • Allocate bus routes and schedules • Collaborate with government transportation agencies	Operator (State)
Bangkok Mass Transit System Public Company Limited (BTS)	• Operate BTS and BRT [Ratchapruek – Sathorn] • Plan and implements BRT routes and services	Operator (Private)
Department of Highways (DOH)	• Plan, design, construct, and maintain road infrastructure (e.g., highway, rural road, expressway) • Conduct research and development and coordinate with other agencies.	Infrastructure Administrator
Department of Rural Road (DRR)		
Expressway Authority of Thailand		
Bangkok Metropolitan Administration	• In charge for local road • Plan, design, construct, and maintain road site facilities (e.g., bus stop & sign)	
Royal Thai Police	• Enforce traffic law and vehicle including bus on the road. • Investigates traffic accident and violation.	Enforcer

1.2 Acts Related Bus Service Business in Thailand

Bus Business in Thailand is mainly Based on the **Land Transport Act B.E. 2522 (1979)**

- **Regulating and governing all land transport systems in Thailand, including bus transport.**
- **Providing guidelines for the licensing, registration, and operation of bus services.**
- **Ensuring the safety of passengers and drivers.**
- **Establishing standards for bus design, construction, and maintenance.**
- **Setting rules and regulations for bus fares, routes, and schedules.**
- **Defining the rights and responsibilities of passengers and bus operators.**
- **Providing penalties for violations of the law.**

Motor Vehicle Act B.E. 2522 (1979)	Setting the regulations for the registration and use of motor vehicles.
Road Traffic Act B.E. 2522 (1979)	Regulations for driving and operating buses on public roads.
Bus Operation Control Act B.E. 2535 (1992)	Licensing of bus operators and drivers.
Ministerial Regulation on Standards and Procedures for Passenger Transport by Motor Vehicles B.E. 2548 (2005)	Setting the standards and procedures
Public Transport Act B.E. 2556 (2013)	Regulates public transport services.

1.3 Classification of Bus Route in Thailand

Type	Route	Ex. Operators
Category 1 (ñíÃº1)	Passenger vehicles within Bangkok, municipalities, provincial administration, and connected routes	State: BMTA, Private: Thai Smile Bus, Smart Bus
Category 2 (ñíÃº2)	Passenger vehicles from Bangkok and other regions	State: The Transport Company Limited (¼Ç)
Category 3 (ñíÃº3)	Passenger vehicles between provinces or between districts within a region	State: The Transport Company Limited (¼Ç)
Category 4 (ñíÃº4)	Passenger vehicles that may consist of only one main route and both main and subsidiary routes separated to districts, villages, or communities	State: The Transport Company Limited (¼Ç)

Source: DLT

1.4 Bus Fleet Types in BMR


Regular Bus



Air-conditioned bus


Micro Bus



Mini van

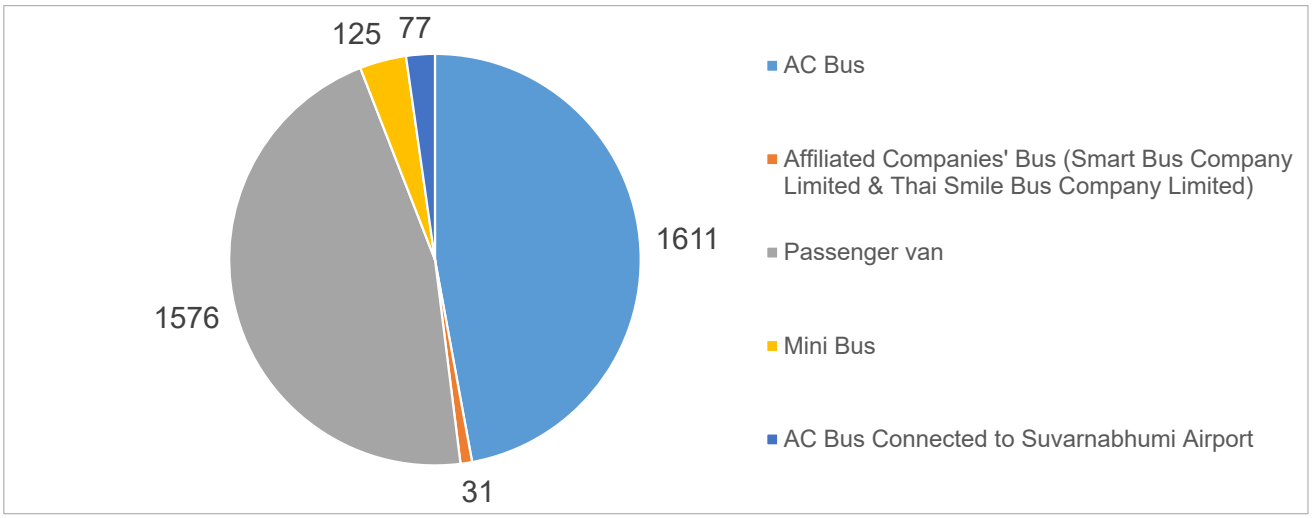

Airport Bus


EV Bus

Source: JET

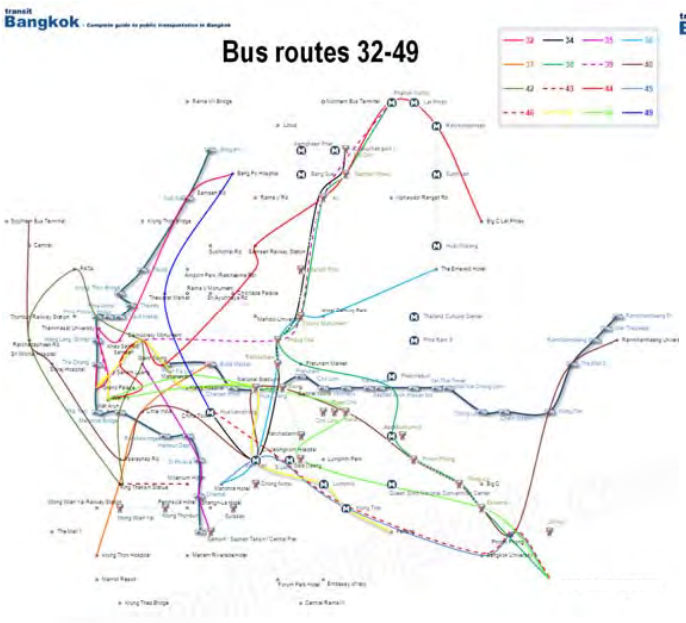
1.5 Main Bus Service in BMR

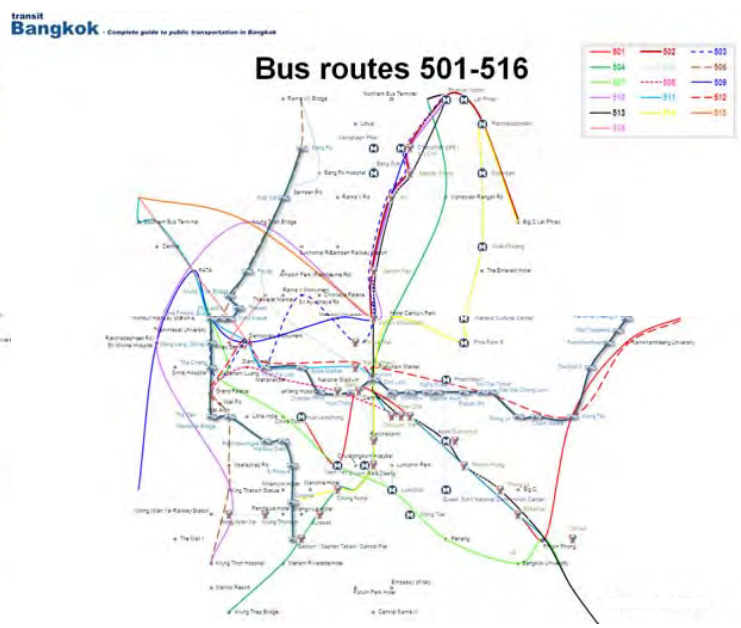
- In BMR, BMTA is the main transport operators
- The Proportion of BMTA Bus is shown below



Source: Bangkok Mass Transit Authority (BMTA)

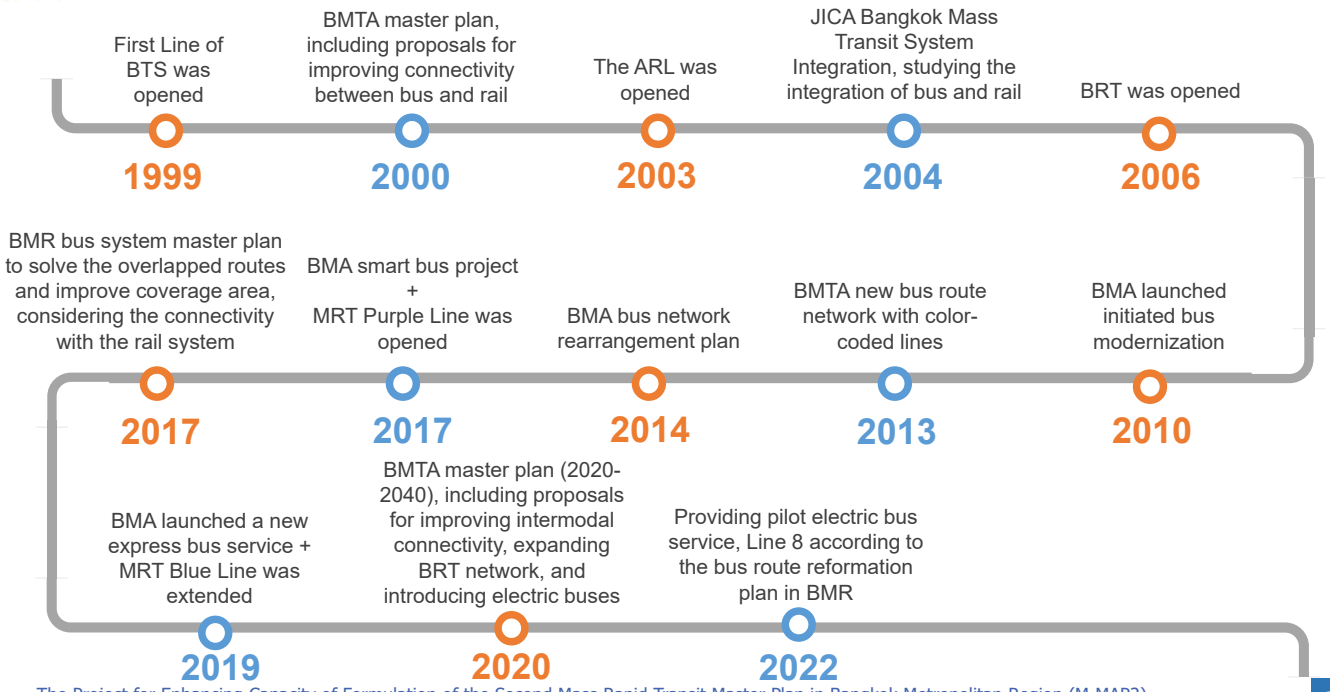
1.6 Examples of Bus Route Structures in BMR





Source: Transitbangkok

1.7 History of the Bus and Rail Coordination in BMR



1.7 History of the Bus and Rail Coordination in BMR (Cont.)

Year	Title	Conducted by	Purpose
2004	Bangkok Mass Transit System Integration Study	Japan International Cooperation Agency (JICA)	Recommendations for improving connectivity between two systems, such as developing intermodal transfer facilities and implementing coordinated schedules
2006	Transit Integration Planning in Bangkok, Thailand	Urban Land Institute (ULI)	Transit integration planning in Bangkok, including the integration of bus and rail systems and recommendations for improving its connectivity, such as developing intermodal transfer facilities (ITF) and coordinated schedules
2014	Bangkok Transit System Study	Japan International Cooperation Agency (JICA)	Recommendations for improving connectivity between different transport modes, including the bus and rail systems by emphasizing ticket systems integration and improvement of ITF.
2015	The Public Transport System in Bangkok: Current Status and Future Development	International Association of Public Transport (UITP)	The need for improving connectivity between transport modes, including buses and rail systems, and measures such as the ticket systems integration and improvement of ITF.

1.7 History of the Bus and Rail Coordination in BMR (Cont.)

Year	Title	Conducted by	Purpose
2016	Evaluation of Public Transport Integration in Bangkok, Thailand	Asian Development Bank	The study evaluates the integration of public transport modes in Bangkok, including the connectivity between buses and the rail system. The study highlights the need for improvement of intermodal transfer facilities and the adoption of a multi-modal fare collection system to enhance the connectivity and convenience of public transportation in Bangkok
2017	Bangkok Bus Rapid Transit Feeder Study	Bangkok Mass Transit Authority (BMTA)	The study analyzes different scenarios for improving connectivity and provides recommendations for the optimal design of feeder bus services.
2020	A study on the development of a transport network linking travel patterns to reach BTS stations and airports in Bangkok and its vicinity	Office of Transport and Traffic Policy and Planning (OTP)	The project aims to analyze and improve connectivity between Bangkok's mass transit rail system, airports, and other transportation systems, proposing alternative options and facilities for accessing stations and developing transportation plans.
2021	The Public Transport System in Bangkok: Current Status and Future Development	Asian Development Bank	Asian Development Bank analyzes the potential for transit-oriented development (TOD) in Bangkok and provides recommendations for improving connectivity between the rail and bus systems. The report suggests measures such as the development of multi-modal transfer hubs and the integration of land use planning with transport planning.

The Project for Enhancing Capacity of Formulation of the Second Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-MAP2)

PART B. Bus Transportation in Bangkok Metropolitan Region (BMR)

2. Current Situation and Challenges of Bus Transportation in BMR

2.1 Road-Based Public Transport Modes in BMR


Bus (Main route)


Minivan (Main and sub routes)


Taxi (Paratransit)



Songthaew
(Sub route, short distance)


Tuk-Tuk (Paratransit, short distance)


Motorcycle Taxi (Feeder, very short distance)


Mini Songthaew (Sub route, short distance)

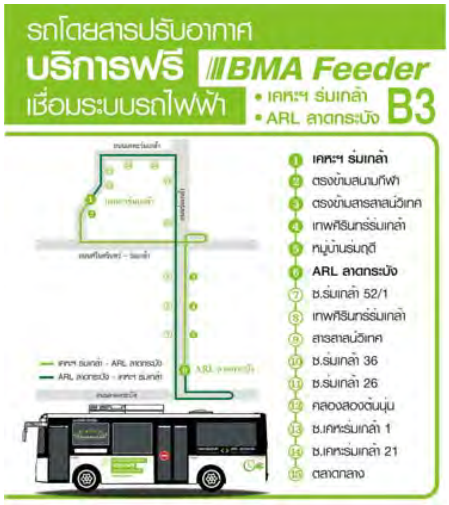
Source: JET

2.2 Examples of Current Bus Projects in BMR

■ **Additional bus feeder to connect with metro line**

BMA Feeder







BMA Feeder has 2 routes:

- B2: Bangkok City Hall 2 – BTS Sanam Pao Station
- B3: Kheha Rom Klao – ARL Lat Krabang Station

Source: BMA

2.2 Examples of Current Bus Projects in BMR

■ **Additional bus feeder to connect with metro line (Cont.): Red Line**

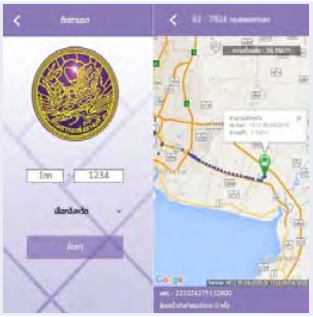
Modifying the bus route to connect to the SRT Red Line

No.49	No.67	No.79	No.522
			
• **Existing route**: Bangkok Bus Terminal (Chatuchak)-Hua Lamphong • **New route:** **Bang Sue Grand Station** - Hua Lamphong - **Bang Sue Grand Station** - Yommarat - Hua Lamphong	• **Existing route**: Wat Samian Nari - Central Rama 3 • **Added route:** **Bang Sue Grand Station** - Central Rama 3 (Only AC bus)	• **Existing route**: Bang Khae Garage (Wat Muang) – Ratchaprasong • **Added route:** Boromarajonani Garage - **Bang Bamru Station** - Bangkok Bus Terminal (Pinklao) (Only AC bus)	• **Existing route**: Rangsit - Ngamwongwan - Victory Monument • **Added route:** **Rangsit Station Red line – Yeak Kor Por Aor BTS Station** (Only AC bus)

2.2 Examples of Current Bus Projects in BMR

■ **Bus Service Information Improvement**

Technology

VIABUS	BKKTransit.net	On-Board Information	DLT GPS App
			
Real-time bus tracking and stations/route search engine	Application with stations/route search engine	Bu utilizing real time GPS data, stopping alerts on screen and estimated arrival time.	Real-time bus tracking with location and speed

2.2 Examples of Current Bus Projects in BMR

■ **Bus Service Information Improvement (Cont.)**

Bus Stops	
Smart Bus Stop	**New Bus Stop Sign Design by MAYDAY**
	
Bus stop with real-time information board, CCTV for security and PR panel	New bus stop sign with more information such as route and major connection points

2.2 Example of Current Bus Projects in BMR

■ **Immerging new technology in bus feeder service**

5G Autonomous Bus Feeder of Chula	
	

Source: Chula

2.3 Challenges

■ Inadequate Bus Feeder

- Lack of alternative bus feeders route
- Rapid increase of motorcycle taxis, Tuk-Tuk due to inadequate bus feeder
- Private side has to provide shuttle service by themselves



Private Shuttle Service to Railway Station



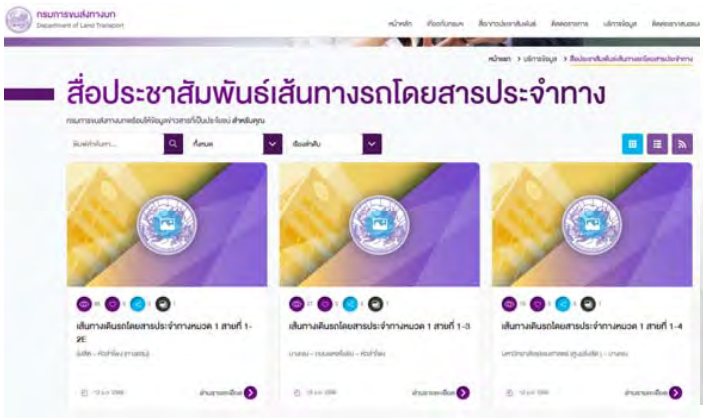


Motorcycle taxi and Tuk-Tuk service as a feeder

2.3 Challenges

■ Bus information system has not fully developed

- Although there are bus route maps available, it is still inconvenience to access
- requiring personal experience or GPS application





Source: DLT

2.3 Challenges

- **Lack of Intermodal Transport Facility (ITF) and its planning**
- **Coordination among different organizations (Transport & Urban Sides)**



Different elevation platform



Traffic congestion at the station

2.3 Challenges

- **Railway is still not fully considered as major mode**
  - Frequent stopping/transfer and lack of rapid service train
  - Road transport prioritized: ex. Bridge obstructs the construction of railway
  - Lack of completion of rail network
- **DLT has committee to consider bus schedule rearrangement**
  - Bus schedule rearrangement was considered when new railway line comes
  - However, exchanging schedule data between bus and rail operators is currently challenging
  - Some operators coordinate with other modes by using only their own data
- **Master plan for bus and rail should be developed together**
  - Should not duplicate with rail network
    - Urban railways serves for major corridor
    - Bus serves as minor or feeder
  - Bus should serve for major corridor without railway
  - When railway is highly congested, bus can be supplemented as alternative choices

