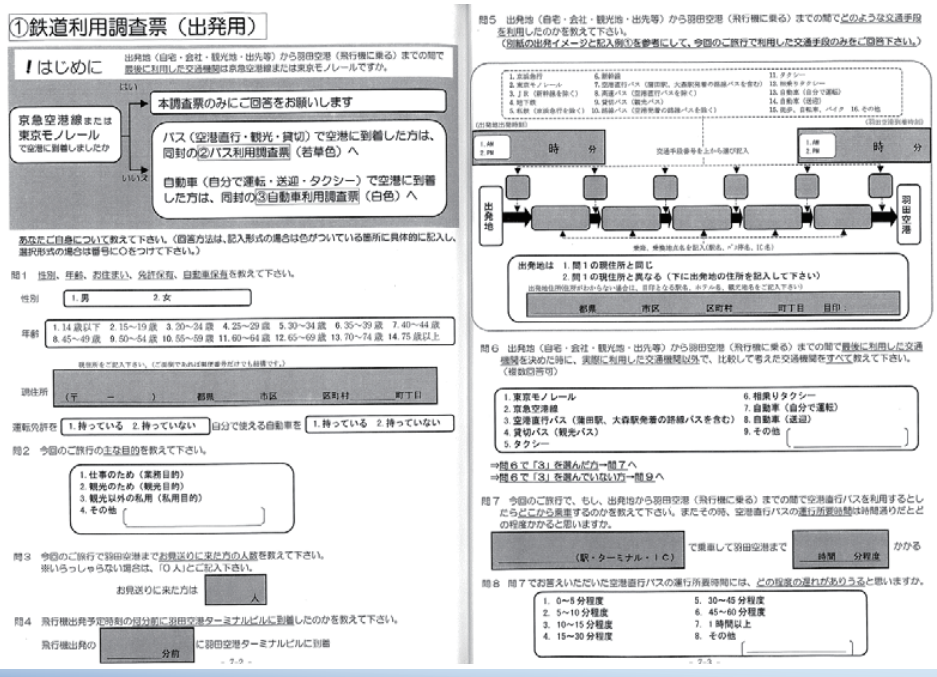
III-4 National Development Plan and Travel Demand Forecasting

Questionnaire


①鉄道利用調査票（出発用）

Ⅰはじめに

出発地（自宅・会社・観光地・出先等）から羽田空港（飛行機に乗る）までの間で最後に利用した交通機関は京急空港線または東京モノレールですか。

京急空港線または東京モノレールで空港に到着しましたか

いいえ → 本調査票のみにご回答をお願いします

はい → バス（空港直行・観光・貸切）で空港に到着した方は、同封の②バス利用調査票（若草色）へ

自動車（自分で運転・送迎・タクシー）で空港に到着した方は、同封の③自動車利用調査票（白色）へ

あなたご自身について教えて下さい。（回答方法は、記入形式の場合は色がついている箇所に具体的に記入し、選択形式の場合は番号に○をつけて下さい。）

問1 性別、年齢、お住まい、免許保有、自動車保有を教えて下さい。

性別 1. 男 2. 女

年齢 1. 14歳以下 2. 15～19歳 3. 20～24歳 4. 25～29歳 5. 30～34歳 6. 35～39歳 7. 40～44歳 8. 45～49歳 9. 50～54歳 10. 55～59歳 11. 60～64歳 12. 65～69歳 13. 70～74歳 14. 75歳以上

ご住所 （〒 － ） 都県 市区 区町村 町丁目

運転免許を 1. 持っている 2. 持っていない 自分で使える自動車を 1. 持っている 2. 持っていない

問2 今回のご旅行の主な目的を教えて下さい。

1. 仕事のため（業務目的）
2. 観光のため（観光目的）
3. 観光以外の私用（私用目的）
4. その他

問3 今回のご旅行で羽田空港までお見送りに来た方の人数を教えて下さい。
来ないらっしゃらない場合は、「0人」とご記入下さい。

お見送りに来た方は 人

問4 飛行機出発予定時刻の何分前に羽田空港ターミナルビルに到着したのかを教えて下さい。

飛行機出発の 分前 に羽田空港ターミナルビルに到着

問5 出発地（自宅・会社・観光地・出先等）から羽田空港（飛行機に乗る）までの間でどのような交通手段を利用したのかを教えて下さい。
（別紙の出発イメージと記入例①を参考にして、今回のご旅行で利用した交通手段のみをご回答下さい。）

1. 京急急行
2. 東京モノレール
3. J R（東京駅を除く）
4. 地下鉄
5. 私鉄（京浜急行を除く）
6. 新幹線
7. 空港直行バス（羽田第1・大森駅発着の路線バスを含む）
8. 高速バス（空港直行バスを除く）
9. 貸切バス（観光バス）
10. 路線バス（空港発着の路線バスを除く）
11. タクシー
12. 相乗りタクシー
13. 自転車（自分で運転）
14. 自動車（送迎）
15. 徒歩、自転車、バイク
16. その他

1. 1階 2. 2階 時 分 → 交通手段番号を上から順に記入 → 1. 1階 2. 2階 時 分

出発地 → 羽田空港

出発地は 1. 問1の現住所と同じ 2. 問1の現住所と異なる（下に出発地の住所を記入して下さい）

都県 市区 区町村 町丁目 目印：

問6 出発地（自宅・会社・観光地・出先等）から羽田空港（飛行機に乗る）までの間で最後に利用した交通機関を決めた時に、実際に利用した交通機関以外で、比較して考えた交通機関を全て教えて下さい。
（複数回答可）

1. 東京モノレール
2. 京急空港線
3. 空港直行バス（蒲田駅、大森駅発着の路線バスを含む）
4. 貸切バス（観光バス）
5. タクシー
6. 相乗りタクシー
7. 自動車（自分で運転）
8. 自動車（送迎）
9. その他

⇒問6で「3」を選んだ方→問7へ
⇒問6で「3」を選んでいない方→問8へ

問7 今回のご旅行で、もし、出発地から羽田空港（飛行機に乗る）までの間で空港直行バスを利用するとしたらどこから乗車するのかを教えて下さい。またその時、空港直行バスの運行所要時間は時間帯ごとどの程度かかると思いますか。

（駅・ターミナル・ＩＣ）で乗車して羽田空港まで 時間 分程度 かかる

問8 問7でお答えいただいた空港直行バスの運行所要時間には、どの程度の違いがありうると思いますか。

1. 0～5分程度
2. 5～10分程度
3. 10～15分程度
4. 15～30分程度
5. 30～45分程度
6. 45～60分程度
7. 1時間以上
8. その他

III-4 National Development Plan and Travel Demand Forecasting

Example of estimation results

Estimation of modal split model (tourist, business trip)

				観光他私事							
				首都圏付近居住(3肢選択)				その他地域居住(2肢選択)			
				往路(アクセス)		復路(イグレス)		往路(アクセス)		復路(イグレス)	
				パラメータ	t値	パラメータ	t値	パラメータ	t値	パラメータ	t値
所要時間		(分)	全機関	-0.0358	-4.63	-0.0756	-9.83	-0.0169	-5.40	-0.0103	-4.77
所要費用		(円)	全機関	-0.000532	-3.14	-0.00189	-7.65	-0.000307	-2.63	-0.000276	-3.27
1／運行本数		(分)	バス	-0.0403	-2.91	-0.0299	-3.72	–	–	–	–
時間信頼性指標（標準偏差）		(分)	自動車 バス	-0.108	-3.40	–	–	–	–	–	–
乗換回数	高齢者	(回)	鉄道	–	–	-0.488	-2.46	-2.85	-3.37	-2.39	-3.74
	非高齢者	(回)	鉄道	–	–	-0.407	-2.96	-2.16	-3.51	-1.37	-3.20
全体乗換回数		(回)	鉄道	-0.406	-2.10	–	–	–	–	–	–
混雑区間通過ダミー		1、0	鉄道	-0.752	-2.07	-2.50	-1.76	-1.99	-1.41	-4.64	-3.10
定数			自動車	-1.45	-3.68	-2.32	-7.56	–	–	–	–
			バス	-0.0306	-0.0680	0.512	2.20	-4.04	-4.34	-4.27	-5.80
時間価値(円/分)				67		40		55		37	
的中率				80%		77%		95%		98%	
尤度比				0.307		0.331		0.782		0.577	
サンプル数				379		792		264		725	

ケース2（乗換回数を年齢別に分ける）				業務							
				首都圏付近居住(3肢選択)				その他地域居住(2肢選択)			
				往路(アクセス)		復路(イグレス)		往路(アクセス)		復路(イグレス)	
				パラメータ	t値	パラメータ	t値	パラメータ	t値	パラメータ	t値
所要時間		(分)	全機関	-0.0811	-4.37	-0.0767	-9.04	-0.0196	-5.33	-0.0209	-5.26
所要費用		(円)	全機関	-0.000948	-1.95	-0.00106	-3.26	-0.000343	-2.24	-0.000485	-4.19
1／運行本数		(分)	バス	-0.0601	-3.52	-0.00396	-3.94	–	–	–	–
時間信頼性指標（標準偏差）		(分)	自動車 バス	-0.151	-2.12	-0.127	-4.81	–	–	–	–
乗換回数	高齢者	(回)	鉄道	–	–	–	–	–	–	–	–
	非高齢者	(回)	鉄道	–	–	–	–	–	–	–	–
全体乗換回数		(回)	鉄道	-0.971	-3.01	-0.852	-4.96	-1.78	-2.33	-1.06	-1.77
混雑区間通過ダミー		1、0	鉄道	-0.828	-1.22	-1.50	-1.12	-3.47	-2.27	-4.04	-1.70
定数			自動車	-0.335	-5.51	-4.03	-8.94	–	–	–	–
			バス	0.300	0.63	0.354	1.32	-2.08	-2.07	-0.273	0.340
時間価値(円/分)				86		73		57		43	
的中率				90%		85%		97%		95%	
尤度比				0.517		0.394		0.630		0.732	
サンプル数				464		968		428		441	

Estimation result of route assignment model (tourist, business trip)

				観光他私事目的		業務目的	
				パラメータ	t値	パラメータ	t値
乗車・乗換時間		(分)	全機関	-0.0560	-12.9	-0.0785	-14.6
発着地から駅までの所要時間		(分)	全機関	-0.0588	-5.23	-0.156	-11.3
所要費用		(円)	全機関	-0.00110	-1.88	-0.00126	-1.78
全体乗換回数		(回)	鉄道	—	—	-0.895	-7.07
乗換回数	高齢者	(回)	鉄道	-0.818	-2.14	—	—
	非高齢者	(回)	鉄道	-0.679	-5.81	—	—
時間価値(円/分)				51		62	
的中率				81%		82%	
尤度比				0.221		0.341	
サンプル数				1,691		1,721	

III-4 National Development Plan and Travel Demand Forecasting

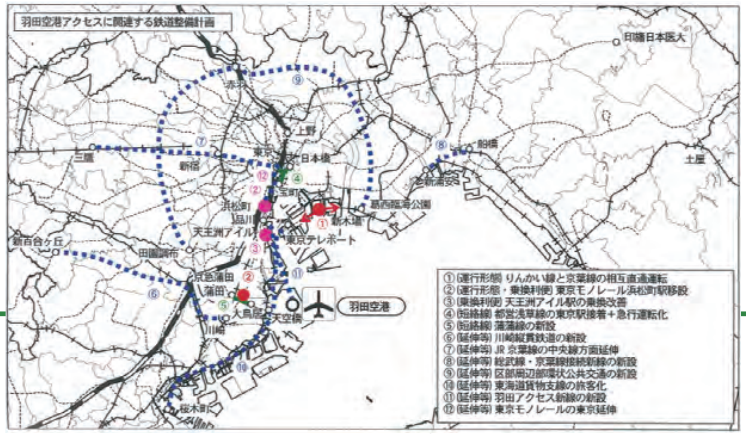
From model to project feasibility study

○ The study on the promotion of railway airport access (MLIT, 2004-2005)

As for railway access to Haneda Airport

- Consideration of current problems and issues
- Consideration of service level improvement policy （Usability, Transferability, In-train amenity improvement, accessibility improvement, etc.)
- Future plan of railway access

In this study, travel demand estimation and benefit estimation analyses are conducted on the planned route shown below



III-4 National Development Plan and Travel Demand Forecasting

The result of each evaluation on the planned lines

7．1．3 結果のまとめ

表 7-6 羽田空港アクセスのサービス改善効果試算一覧表(1)

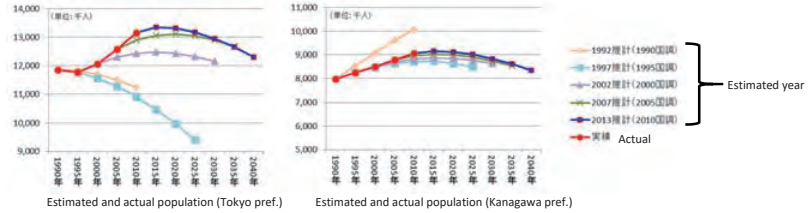
番号	種別	計画名	計画概要	羽田空港アクセス旅客に対するサービス改善効果*1（○…効果が大きい △…効果が相当程度見込める △…効果が小さい） 速達性向上(分)*2	乗換回数低減(分)*3	利用する空港旅客(千人/日)*4	列車内の快適性(上段モルール下段:京急)*5	列車内の快適性(空港アクセス旅客を1.5人換算)(上段モルール下段:京急)*5	方面別効果	空港旅客の利用者便益(億円/年)*6	利用する空港旅客1人当たりの利用者便益(円/人)	主な運行条件 上段:運行本数 中段:速度 下段:運賃	(参考)既調査による試算値*11 延長(km)	建設費(億円)	費用対効果(B/C)	調査名
①	運行形態の改善	りんかい線と京葉線の相互直通運転	新木場駅において京葉線及び武蔵野線とりんかい線の相互直通運転を行う。既に京葉線とりんかい線の相互直通運転が可能な設備が整備されている。	△ (132)	△ (29)	△ (5.5)	△ 154%→152% 119%→118%	△ 182%→178% 148%→147%	京葉線、内房・外房線、武蔵野線沿線からの速達性向上、乗換回数の低減が図られる。	3.3 時間短縮 1.0 乗換解消 0.1 費用節減 2.2	164	りんかい線～京葉線方面 3本 現行 現行	—	—	—	—
②	運行形態の改善 乗換利便の改善	東京モノレール浜松町駅移設	東京モノレール浜松町駅をJR浜松町駅東側に移設するとともに、東京モノレール浜松町駅機能部分を廃止することで、運行本数が増加する。	–	–	◎ (66.3)	◎ 154%→115% 119%→119%	◎ 182%→136% 148%→148%	所要時間、乗換回数に変化は無いことから、方面別に見た改善効果は発生しない。	—*7	—	— — 現行	—	—	—	—
③	乗換利便の改善	天王洲アイル駅の乗換改善	東京モノレール天王洲アイル駅とりんかい線天王洲アイル駅の乗換内滑化を行う。スカイウォーク、地下通路等の専用通路を整備することにより乗換利便性の向上を図る。	△ (157)	–	△ (8.1)	△ 154%→151% 119%→117%	△ 182%→178% 148%→145%	京葉線、内房・外房線沿線からの速達性向上が図られる。	8.2 時間短縮 5.4 乗換解消 1.1 費用節減 1.7	277	— — 現行	—	25～80	—	H14年度 都市鉄道整備基礎調査
④	短路線整備	都営浅草線の東京駅接着＋急行運転化	宝町～日本橋間でJR東京駅に接着する。その際、JR等との乗継内滑化を図る。また、都営浅草線内の急行運転が可能となるように浅草橋付近で追い抜き線を整備する。	○ (186) *8	△ (111)	○ (12.1)	△ 154%→153% 119%→120%	△ 182%→180% 148%→150%	北総線、京成沿線からの速達性向上が図られる。	21.7 時間短縮 4.0 乗換解消 11.9 費用節減 5.8	491	羽田空港～東京(急) 3本 品川～東京間 40km/h 都営運賃	約1.6	1700～3200	1.2以下～1.9程度	H12年度 都市鉄道調査
⑤	短路線整備	京急空港線と東急多摩川線を短絡する路線の新設（蒲蒲線）	京急空港線を大鳥居駅付近で分岐し、東急蒲田駅（地下駅）において、京急空港線と東急多摩川線を接続する。	◎ (716) *9	◎ (526) *9	◎ (28.6) *9	◎ 154%→145% 119%→104% *9 *10	◎ 182%→159% 148%→131% *9 *10	東京圏西南部、埼玉県方面の広範囲の地域からの速達性向上、東急東横線や東武東上線、西武池袋線沿線からの乗換回数の軽減が図られる。	89.1 時間短縮 28.3 乗換解消 57.4 費用節減 3.4	854	蒲田～羽田空港6本 蒲田～1.5分接方面（急）4本 蒲蒲線 30km/h 多摩川線(急)40km/h 京急運賃	4.0	800～1400	1.7～2.6	H15年度 都市鉄道整備等基礎調査
⑥	既設線の延伸等	川崎縦貫鉄道の新設	川崎駅から羽田空港を経由し、新百合ヶ丘駅に至る新線整備。	△ (107)	△ (38)	△ (3.3)	△ 154%→153% 119%→121%	△ 182%→180% 148%→150%	多摩地域、川崎市北部からの速達性向上が図られる。	14.3 時間短縮 9.7 乗換解消 3.6 費用節減 1.0	1187	急行 3本 緩行 6本 急行 52km/h 緩行 36km/h 横浜市交協	16.8	6200	2.6	H15年度 川崎市調査

＊1：本調査で評価した羽田空港アクセス旅客に対するサービス改善効果。都市鉄道旅客に対する効果は含まれていない。
＊2：「速達性向上」は、羽田空港までの時間短縮が図られるエリアの夜間人口を示す。
＊3：「乗換回数低減」は、羽田空港までの乗換回数の低減が図られるエリアの夜間人口を示す。
＊2，3：「速達性向上」「乗換回数低減」欄の「◎」「○」「△」の基準は以下のとおり。
◎…首都圏（1都3県関東地方圏）の夜間人口の3%（350万人）以上に改善効果がある事業
○…首都圏（1都3県関東地方圏）の夜間人口の1.5%（175万人）以上に改善効果がある事業
△…首都圏（1都3県関東地方圏）の夜間人口の3%（175万人）未満の改善効果である事業
＊4：「利用する空港旅客」は、整備区間を利用する空港旅客数を示す。「◎」「○」「△」の基準は以下のとおり。
◎…2015年における羽田空港利用者数の2%（2万人）以上に改善効果がある事業
○…2015年における羽田空港利用者数の1%（1万人）以上に改善効果がある事業
△…2015年における羽田空港利用者数の1%（1万人）未満の改善効果である事業
＊5：「列車内の快適性」は、東京モルール、京急空港線に対する混雑緩和を示す。「◎」「○」「△」の基準は以下のとおり。
なお、東京モルールでは、車両構造が普通鉄道の車両とは異なることから、混雑率の許容限界は130%程度以下となっていることに留意が必要である。
また、航空旅客の手荷物を考慮した混雑率として、航空旅客を1.5人換算とした試算値を合わせて示した。
◎…東京モノレールまたは京急空港線の混雑率が10ポイント以上減少する事業
○…東京モノレールまたは京急空港線の混雑率が5ポイント以上減少する事業
△…東京モノレールまたは京急空港線の混雑率の減少が5ポイント未満である事業
＊6：「空港旅客の利用者便益」は、「費用対効果マニュアル99」に基づき試算した利用者便益で、都市鉄道旅客の便益を含まない。
＊7：速達性の向上、乗換回数の低減が発生しないことから、現状の評価手法では利用者便益の試算は困難。
＊8：H11～H12年度都市鉄道調査のケース4（建設費1700億円）で試算
＊9：H15・H16年度都市鉄道整備等基礎調査の整備パターンA-1で試算
＊10：京急空港線と蒲蒲線を含む混雑率を示す。
＊11：運輸政策審議会第18号での検討、その後実施された都市鉄道調査、自治体や協議会が実施した調査を対象とした。
費用対効果分析の計算期間は30年。

III-5 Concerning about Population Forecasting

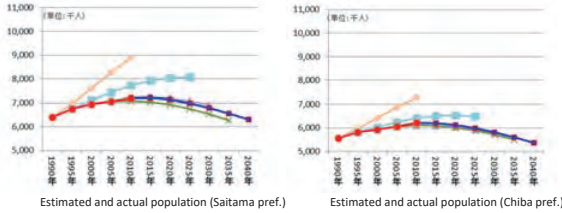
Population Data - Population Estimation from IPSS

In TMA, data of nighttime population by age group (in the scale of large zone) are obtained from the estimation from IPSS*. The estimation of total population aged 5 years old and above was conducted in March, 2013. From this estimation, projection until 2030 is utilized in projected until year 2030 which is the target year in The Transport Policy Plan No.198



Estimated and actual population (Tokyo pref.)

Estimated and actual population (Kanagawa pref.)



Estimated and actual population (Saitama pref.)

Estimated and actual population (Chiba pref.)

*IPSS: National Institute of Population and Social Security Research

Ⅳ-1
Population Forecast Modelling

TMA population forecasting model

- Based on following Railway Master Plan
  - Council of Transport Policy Plan (CTPP) No.18 (2000)
  - Council of Transport Policy Plan No.198 (2016)

- Population Forecast in CTPP No.18
- Population Forecast in CTPP No.198
- TMA railway working group

IV-1 Population Forecast in CTPP No.18 - Definition

Definition of types of population

Classification based on 1995 National Census

- Nighttime population (home-based population)
- Residence based worker (home-based working-commuter)
- Workplace based worker (workplace-based working-commuter)
- Residence based student (home-based schooling-commuter)
- School based student (workplace-based schooling-commuter)
- Daytime population = nighttime population – (residence based worker + student) + (workplace based worker + school based student)

IV-1 Population Forecast in CTPP No.18 - Flows

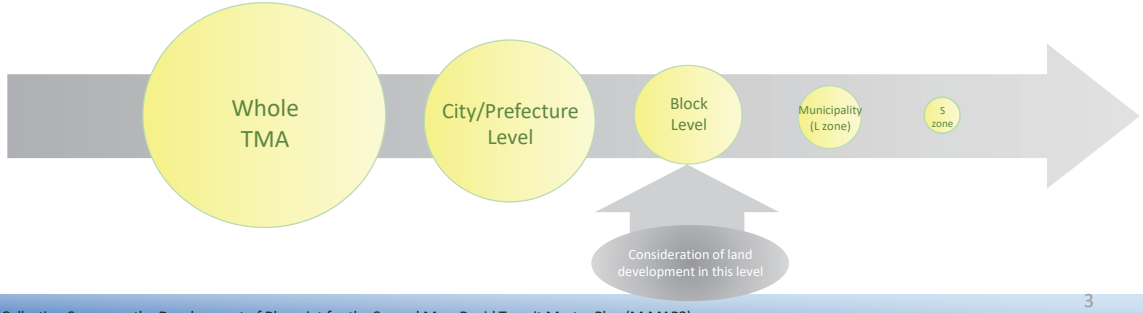
- Flows of population forecasting model

From 6 types, first, “nighttime population” is estimated. From nighttime population, “residence based worker” and “residence based student” are estimated. Similarly, from residence based, “workplace based worker” and “school based student” are estimated. Finally, “daytime population” will be estimated by using all of the 5 types of population.

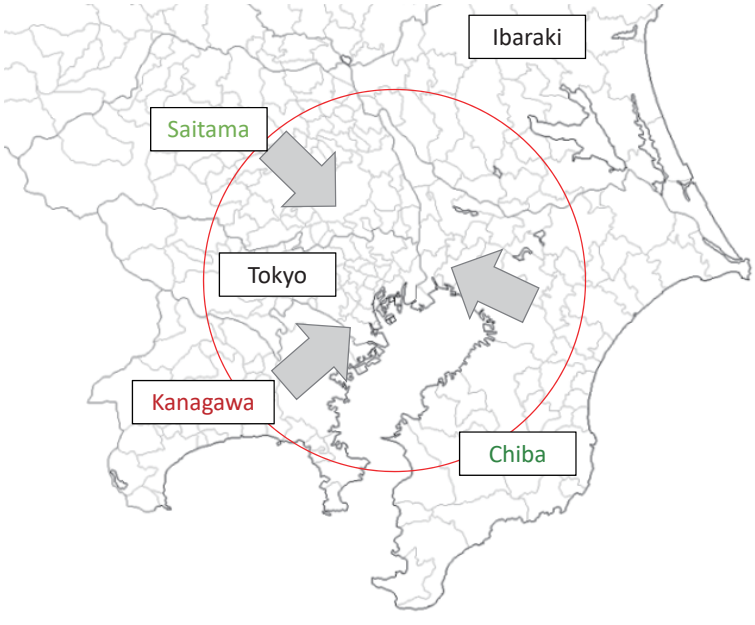
Forecasted number of residence	Residence who live here but work anywhere Residence who live here but study anywhere	Worker who work here Student who study here	Population who stay here during daytime (nighttime pop. – pop. Out + pop. In)

- Distribution of population in each zone size

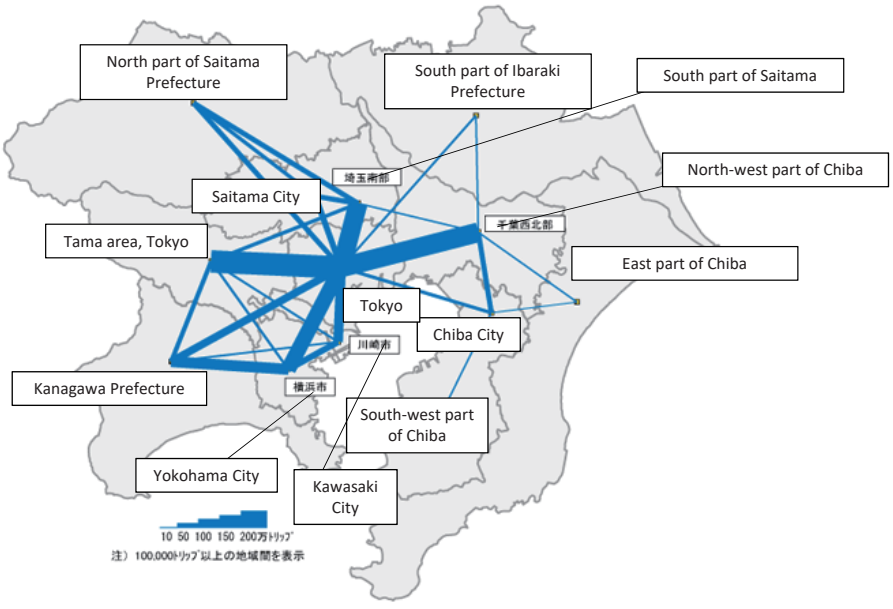
Number of population will be initially distributed from the largest zone. From such large zone, number of population will be further distributed into smaller zones



(Reference) Prefecture Level and Municipality Level



(Reference) Block Level



IV-1 Population Forecast in CTPP No.18 - Nighttime Pop.

Whole TMA population

Based on the forecasted value from “TMA Master Plan No. 5” (National Land Agency, 1999)

TMA Master Plan No. 5 = General land development plan in TMA

- To cope with the problem related to overcrowded population and monocentric development in Tokyo
- To improve the quality of living in TMA

City/Prefecture level population

Based on the natural population growth and migration

- Natural population growth rate (birth, death):
  based on the forecasted value from The National Institute of Population and Security Research (IPSS) in 1997
- Migration rate (moving in, out):
  based on the migration rate between 1993-98 from the Handbook of National Registration (Ministry of Internal Affairs and Communications)

IV-1 Population Forecast in CTPP No.18 - Nighttime Pop.

Block level population

- Based on the natural population growth and migration
- Consideration of land development

- Natural population growth rate (birth, death):
  distribution across each block is fixed, growth rate is based on City/Pref. level data
- Migration rate (moving in, out):
  based on the migration rate between 1993-98 from the Handbook of National Registration (Ministry of Internal Affairs and Communications(MIC))

IV-1 Population Forecast in CTPP No.18 - Residence Based Pop.

Residence based worker

- Estimated by Nighttime population multiply by employment rate by gender and age group

Residence Based Worker=

Nighttime Population * Employment Rate (by Gender and Age Group)

Employment Rate (by Gender and Age Group)

- Based on National Census data (Statistics Bureau, MIC) between 1975-1990

IV-1 Population Forecast in CTPP No.18 - Workplace Based Pop.

Workplace based worker

- Whole TMA = Residence based worker*α

  α=past value of ratio between “workplace based/residence based”

  : average value from 1975-1995=1.004 (based on National Census)

- City/Prefecture level

  Growth rate is fixed based on the value between 1975-1995

- Block level

  Use the actual growth value between 1975-1995 as a control value

  step1: Use the growth rate between 1975-1995 to set the growth in each year

  step2: Forecasted value can be calculated by adding the growth rate to the 1995 value

Note: In block level, we focus on the analysis in Tokyo 23 wards area and Tokyo Tama area as these two areas are rapidly developed

IV-1 Population Forecast in CTPP No.18 - Additional population from land development project

1. Land development plan and modelling

   Based on the data from the local government, the model will include the project with the expected resident over 10,000 person, or the business development with the expected worker over 5,000 person

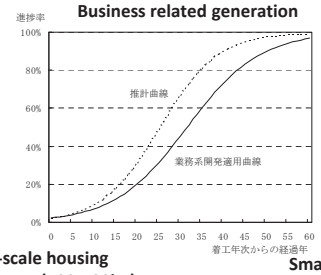
2. Progress curve (build-up curve) setting

$$y = \frac{1}{1+\exp(at+b)}$$

y : progress rate　a,b : parameter　t : years after construction

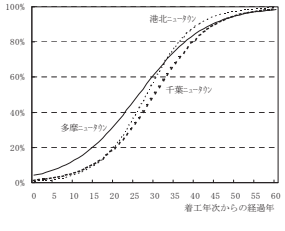
Progress rate

Business related generation

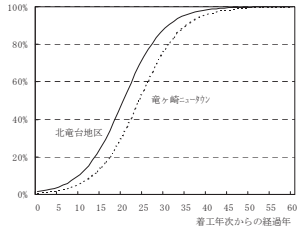


years after construction

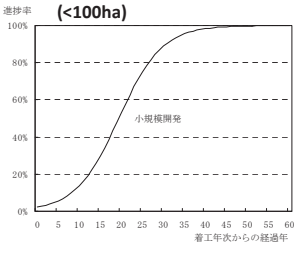
Large-scale housing development (>500ha)



Medium-scale housing development (500-100ha)



Small-scale housing development (<100ha)



IV-1 Population Forecast in CTPP No.18 - Additional population from land development project

	Night time population (1,000 person)						Workplace based worker increase (1,000 person)					Share Growth rate
		1980	1985	1990	1995	2015	1975-1980	1980-1985	1985-1990	1990-1995	1995-2015 (5y ave)	2015/1995
TMA	28,072	29,878	31,570	33,193	34,068	35,345	1,806	1,691	1,623	875	1,277	1.04
Tokyo pref.	11,640	11,585	11,795	11,824	11,742	11,258	-55	210	29	-82	-484	0.96
23 Wards	8,647	8,352	8,354	8,164	7,968	7,316	-295	2	-190	-196	-652	0.92
Tama Area	2,993	3,233	3,441	3,660	3,774	3,942	240	208	219	114	168	1.04
Kanagawa pref.	6,398	6,924	7,432	7,980	8,246	8,677	526	508	548	266	431	1.05
Yokohama	2,622	2,774	2,993	3,220	3,307	3,441	152	219	227	87	134	1.04
Kawasaki	1,015	1,041	1,089	1,174	1,203	1,263	26	48	85	29	60	1.05
Others	2,761	3,109	3,350	3,586	3,736	3,973	348	241	236	150	237	1.06
Saitama pref.	4,821	5,420	5,864	6,405	6,760	7,552	599	444	541	355	792	1.12
South	3,292	3,703	3,999	4,371	4,595	5,195	411	296	372	224	600	1.13
North	1,529	1,717	1,865	2,034	2,165	2,357	188	148	169	131	192	1.09
Chiba pref.	4,148	4,735	5,148	5,555	5,798	6,181	587	412	407	243	383	1.07
Chiba city	659	746	789	829	857	892	87	43	40	28	35	1.04
Northwest	2,161	2,600	2,904	3,220	3,372	3,681	439	304	316	152	309	1.09
Southwest	455	499	545	578	606	619	44	46	33	28	13	1.02
East	873	890	909	928	963	989	17	19	18	36	26	1.03
Ibaraki pref. South	1,065	1,214	1,331	1,429	1,522	1,677	149	117	98	93	155	1.10

Decreasing in CBD

IV-1 Population Forecast in CTPP No.18 - Additional population from land development project

	Workplace based worker (1,000 person)						Workplace based worker increase (1,000 person)					Share Growth rate
	1975	1980	1985	1990	1995	2015	1975-1980	1980-1985	1985-1990	1990-1995	1995-2015 (5y ave)	2015/1995
TMA	13,121	14,044	15,432	17,082	17,900	18,075	924	1,388	1,649	819	174	1.01
Tokyo pref.	7,049	7,300	7,886	8,611	8,752	8,806	251	586	725	141	54	1.01
23 Wards	6,118	6,234	6,681	7,249	7,268	7,301	116	447	568	19	33	1.00
Tama Area	931	1,066	1,205	1,362	1,484	1,505	135	139	157	122	21	1.01
Kanagawa pref.	2,449	2,639	2,973	3,316	3,524	3,564	190	334	343	208	40	1.01
Yokohama	966	1,031	1,151	1,292	1,393	1,408	65	120	141	101	15	1.01
Kawasaki	461	465	495	538	548	551	4	30	43	10	3	1.00
Others	1,022	1,143	1,327	1,486	1,583	1,605	121	184	159	97	22	1.01
Saitama pref.	1,647	1,887	2,135	2,417	2,627	2,667	240	248	282	210	40	1.02
South	1,057	1,241	1,428	1,633	1,781	1,812	184	187	205	148	31	1.02
North	590	646	707	784	846	855	56	61	77	62	9	1.01
Chiba pref.	1,476	1,670	1,843	2,081	2,282	2,314	195	173	237	202	32	1.01
Chiba city	252	284	314	361	414	420	32	30	47	53	6	1.01
Northwest	615	756	879	1,040	1,158	1,181	141	123	161	118	23	1.02
Southwest	214	226	243	263	283	285	11	17	20	20	2	1.01
East	394	405	407	417	428	429	11	3	10	11	1	1.00
Ibaraki pref. South	500	548	595	657	715	723	48	47	62	58	8	1.01

No change in CBD

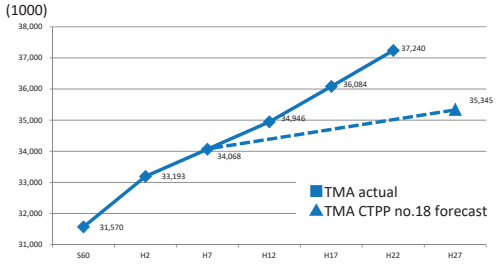
IV-1 Population Forecast in CTPP No.198 - Improvements from CTPP No.18

Improvements

By comparing the result of the forecasted value from 4 step model with the actual value, some error has been found. **Population forecast, which is the zero step in 4 step model,** could be one of the main cause of error.

- TMA nighttime population

  Forecasted population from CTPP No.18 (which is based on the 5th TMA master plan) is underestimated

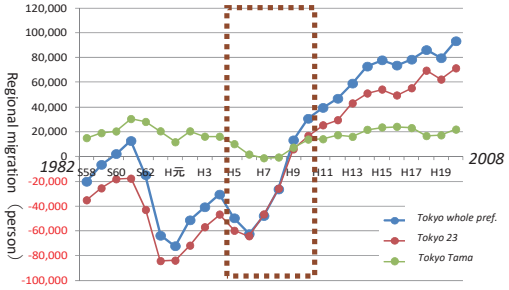


Comparison between forecasted and actual nighttime population

- Prefecture, block level nighttime population

  Based on the migration rate from 5 years (before) average

  - 23 ward area, Tama area, Yokohama, Kawasaki, Chiba, etc. are underestimated
  - Saitama north block is overestimated

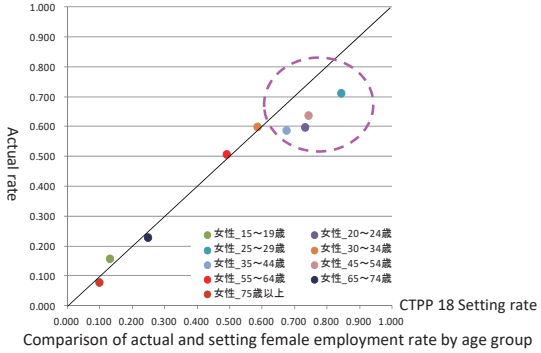


Transition in migration in Tokyo

IV-1 Population Forecast in CTPP No.198 - Improvements from CTPP No.18

Improvements

- Prefecture, block level home based worker
  - Female employment rate is increasing.
  - CTPP no. 18 estimation is based on the trend from National Census between 1975-1990



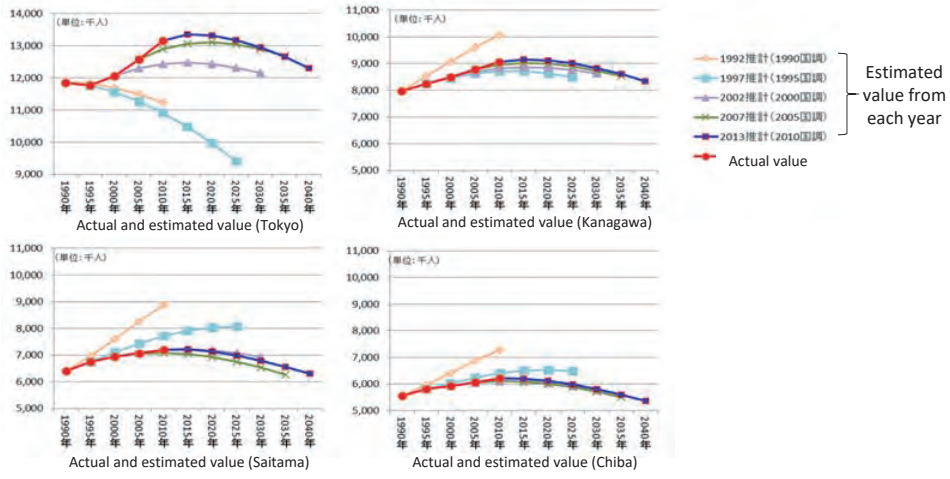
Comparison of actual and setting female employment rate by age group

IV-1 Population Forecast in CTPP No.198 - Nighttime Pop.

nighttime population | residence based worker | workplace based worker | daytime population
residence based student | school based student

- Utilize the forecasted data from IPSS

  From the whole TMA level to L zone level, nighttime population data by gender and age group is based on the data published by The National Institute of Population and Security Research (IPSS). Data until 2030 is used (target year of CTPP No. 198)

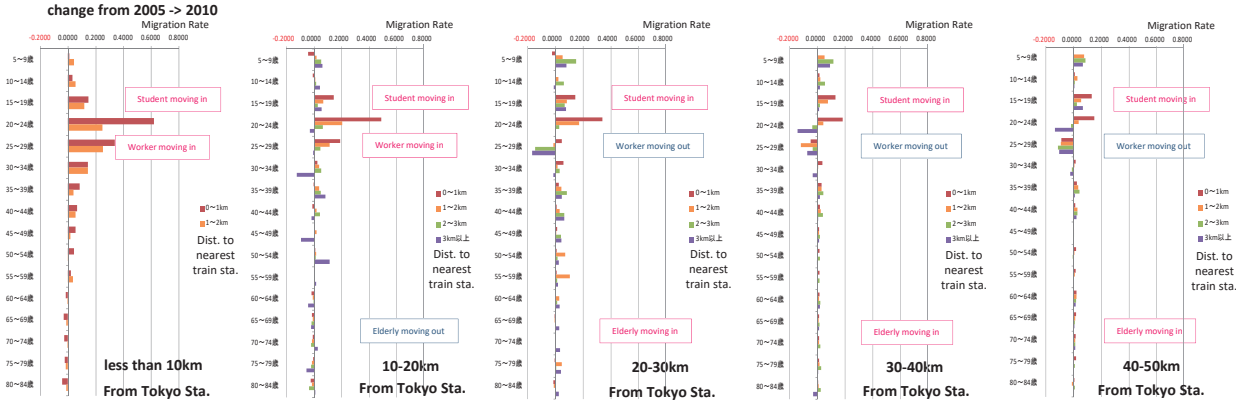


IV-1 Population Forecast in CTPP No.198 - Nighttime Pop. (Migration rate)

nighttime population | residence based worker | workplace based worker | daytime population
residence based student | school based student

- Change of migration rate by distance to CBD (Tokyo Sta.) and by age group

  In S zone level, distance to city center, distance to the nearest train station, and land development are considered in the process to estimate nighttime population by gender and age group



- Young people: move closer to CBD, closer to train station
- Elder people: moving out from CBD, to suburban area

IV-1 Population Forecast in CTPP No.198 - Residence based worker and scenario setting

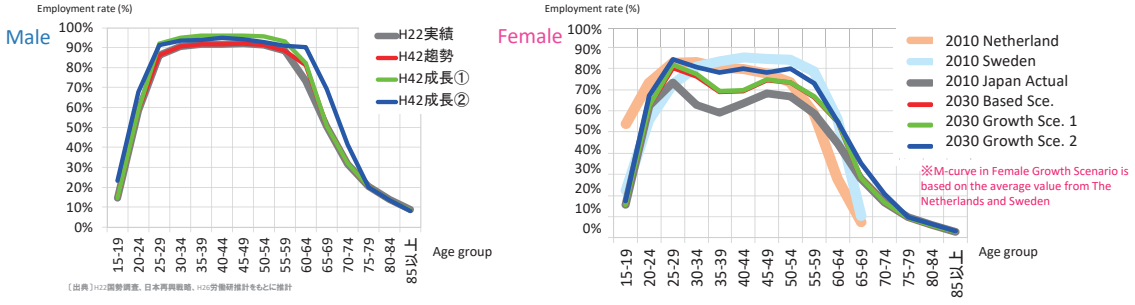
nighttime population | residence based worker | residence based student | workplace based worker | school based student | daytime population

■ Multiple scenario setting

Recent employment trend, especially participant rate of women and elderly, as well as government policies are taken into account in scenario development

Scenario overview and employment rate

Scenario	Hypothesis	Male, Female (<25)	Male (25-59)	Female (25-59)	Male, Female (60-64)	Male, Female (>65)
Base Scenario	Continue of the current employment trend	same	Declining trend stop	Increase as current rate	Increase as current rate	same
Growth Scenario 1	Original scenario	same	Increase until the past peak	Increase more than current rate	Increase 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



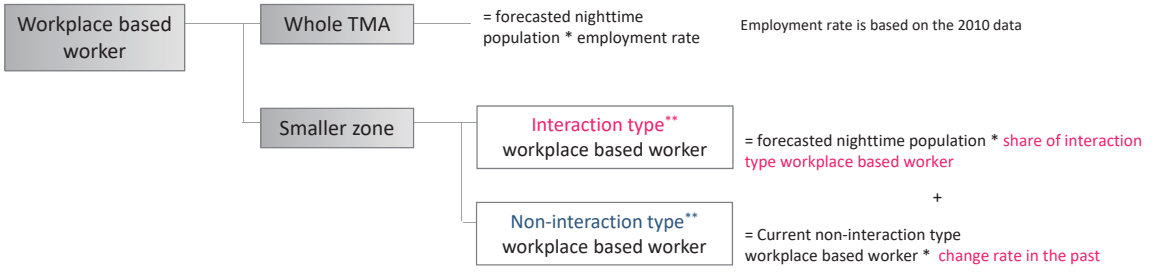
Employment rate by age group in Male and Female

IV-1 Population Forecast in CTPP No.198 - Residence based pop. and industrial sector

nighttime population | residence based worker | residence based student | workplace based worker | school based student | daytime population

■ Estimation of workplace based worker: industrial sector classification based on worker's movement

Estimation is based on daytime population and the coefficient. Coefficient estimation is based on the type of industry. Two types of industry are classified; first, interaction type, second, non-interaction type.



** Classified based on the correlation between nighttime population and workplace based worker in each sector

IV-1 Population Forecast in CTPP No.198 - Population growth based on land development

nighttime population	residence based worker	workplace based worker	daytime population
	residence based student	school based student	

■ Land development

Under these criteria, additional estimation of land development is conducted. Land development data is given by the local government

Plan with expected nighttime population over 2,000 people (or over 1,000 unit),
Plan with expected workplace based worker over 2,000 people (or over 50,000m²)

Separate estimation by 2 types of development

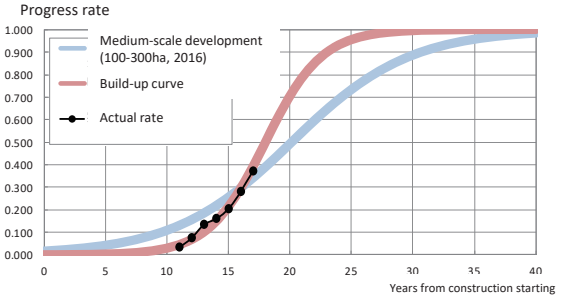
- "building"development (building structure is clearly defined)
- "land" development (building structure is not defined)

[reference] Build-up curve

After the opening of the project, it might take some time for the people to move in. In CTPP no.198, we tried to explain the relationship between the progress (actual/target) and years taken by a build-up curve from logistic function

$$y = \frac{1}{1+\exp(at+b)}$$

y : progress rate a,b : parameter t : Years from construction starting



Comparison between curve used in CTPP No. 198 and actual growth from Koshigaya Lake Town development

IV-1 Population Forecast in CTPP No.198 - Improvements from CTPP No.18

■ Comparison of population forecast method between CTPP no. 18 and no. 198

		nighttime population	residence based worker	workplace based worker	daytime population
No. 18	Data	• from TMA Master Plan No. 5	• Employment rate from 1995 National Census	• Day/night time worker ratio, and growth rate from 1995 National Census	• night pop. – (residence based worker + student) + (workplace based worker + school based student)
	Main Estimation	– data in S zone level is based on the statistics from the local government	• Nighttime pop*Employment rate	• residence based worke* day/night time worker ratio Estimation for city/pref. level or smaller level: Workplace based worker*growth rate, Use larger level value as a control total value	
No. 198	Data	• from IPSS (2013 data)	• Employment rate -> estimated from scenarios	• Day/night time worker ratio, and growth rate from 2010 National Census	• night pop. – (residence based worker + student) + (workplace based worker + school based student)
	Main Estimation	– data in S zone level is based on the value from National Census. Also, the distance from home to the nearest station is considered	• Nighttime pop*Employment rate	• residence based worker* day/night time worker ratio Estimation for city/pref. level or smaller level: (Commuting type)night pop.*share of commuting type (Non-commuting type)current non-com. *growth rate Use larger level value as a control total value	

		residence based student	school based student
No. 18	Data	• School enrollment rate from 1995 National Census	• Day/night time student ratio from 1995 National Census
	Main Estimation	• Nighttime pop* School enrollment rate	• residence based student *Day/night time student ratio
No. 198	Data	• School enrollment rate from 2010 National Census	• Day/night time student ratio from 2010 National Census
	Main Estimation	• Nighttime pop*School enrollment rate	• residence based student*Day/night time student ratio

Improvements from CTPP no.18 are in red

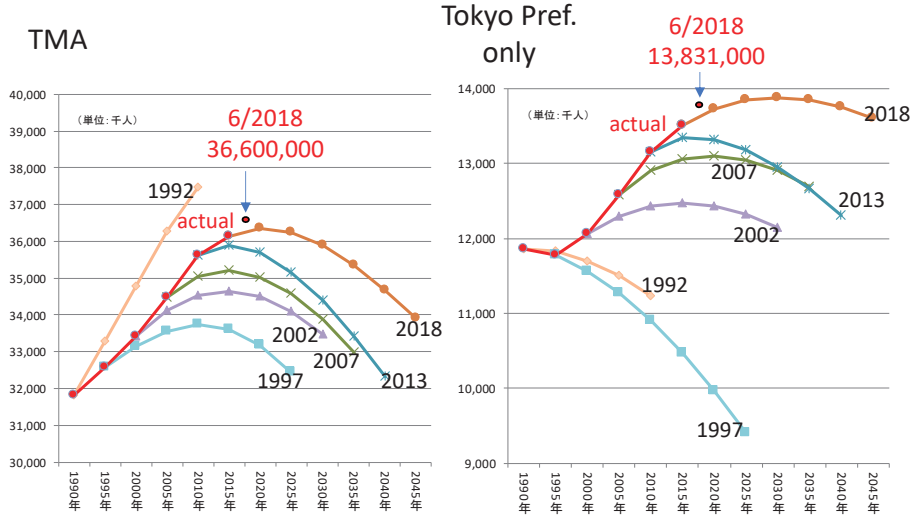
IV-1 TMA railway working group

- For the future railway development, railway companies in TMA are actively participate in the working group. Following issues are usually discussed;
  - Development of an original demand forecasting model for TMA
  - Relationship between resident along the line and railway demand
  - Attractiveness improvement
  - International competitiveness
- Organization structure
  - Chairman: Prof. Morichi Shigeru
  - Railway Company: Tokyo Metro, JR East, Tokyu Corp., Odakyu Group, Tobu Railway, Seibu Holdings
  - Secretariat: Japan Transport Research Institute
  - Consultant: CRP (staff in charge: Mr. Sakashita, Mr. Tsuchiya, Mr. Ikeda)

In order to check the statistics published by the government, It is also important for private agencies to conduct their own estimation

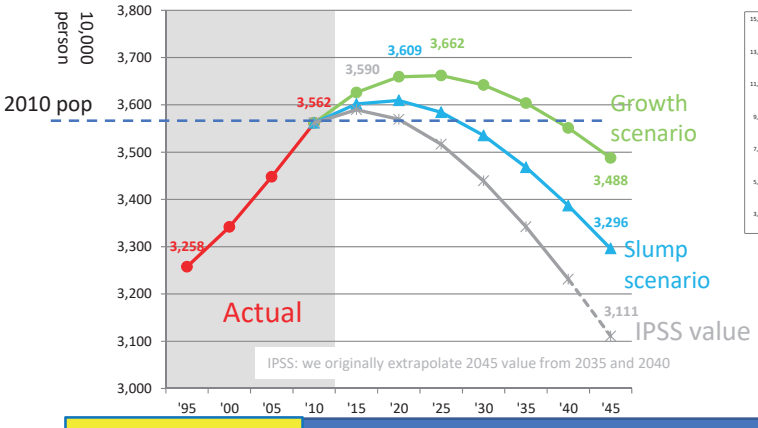
IV-1 TMA railway working group: Original demand forecasting model for TMA

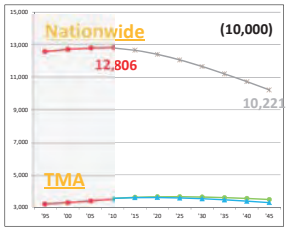
Comparison between forecasted population from IPSS and actual population



Based on the forecasted population from National Census and Resident Registration, current population (June 2018) in TMA is already over the forecasted population in 2020 by IPSS (2018 estimation version)

IV-1 TMA railway working group: Original demand forecasting model for TMA



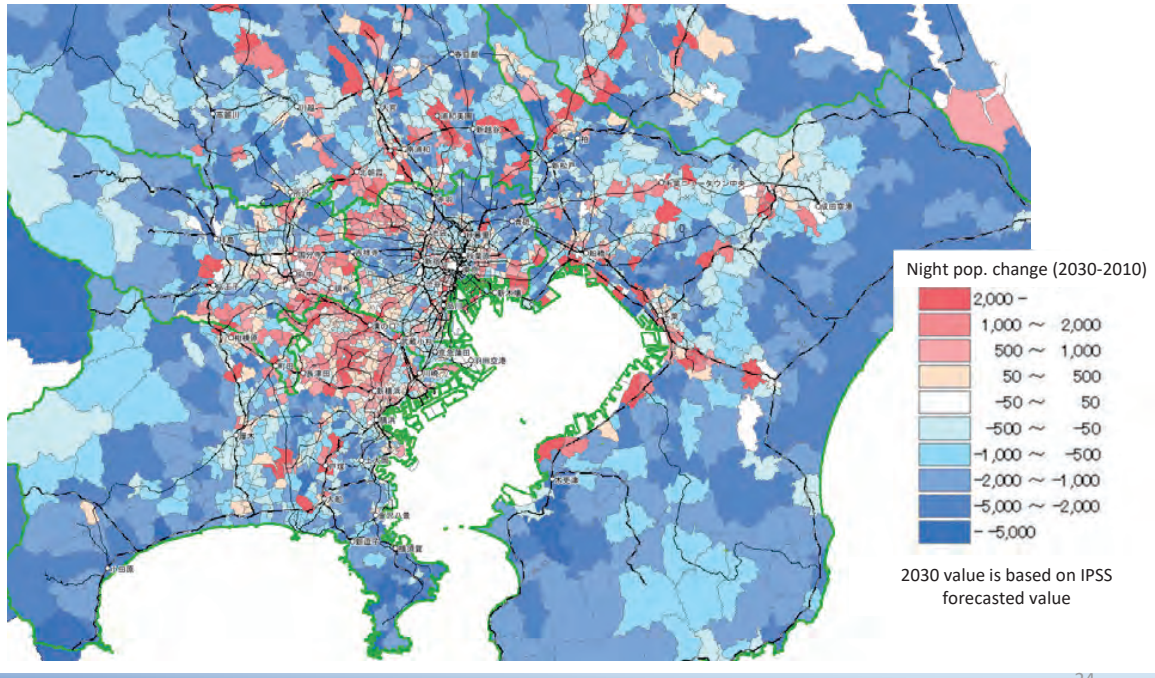


SUMMARY

- Scenario forecasted population is higher that from IPSS compare to actual population in 2010: decreasing at -2% (2045 growth sce.), -7% (2045 base sce.)
- Population reach its peak in 2025 (growth sce.), and in 2020 (base sce.)

IV-1 TMA railway working group: Original demand forecasting model for TMA

Population in TMA is decreasing in overall, but along the railway lines, population is increasing!



Ⅳ-2
Demand Forecast Modelling

TMA urban transportation demand forecasting model

- Based on following Railway Master Plan
  - Council of Transport Policy Plan (CTPP) No.18 (2000)
  - Council of Transport Policy Plan No.198 (2016)

1. Initial conditions
2. Urban transportation demand forecasting
3. Airport/HSR station access demand forecasting

CTPP No.18

4. Improvements in CTPP No.198 → CTPP No.198

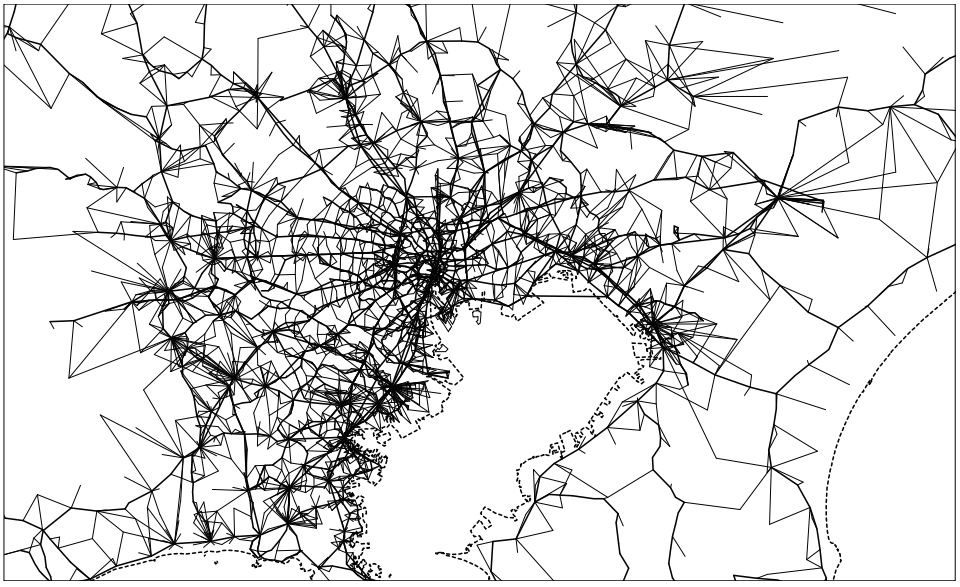
IV-2 (1) Initial Conditions

Model Structure | Population Forecast | **Initial Conditions** | Urban Transport Forecast | Airport/HSR Forecast

1. Urban network structure
   - **Railway** network structure
     - ✓ Initial conditions for network structure
       - ➢ Current railway network
       - ➢ Future railway network
     - ✓ Network setting
       - ➢ Node setting
       - ➢ Railway link setting
       - ➢ Railway transfer station setting
       - ➢ Railway station access-egress setting

IV-2 (1) Initial Conditions

Railway station access-egress setting



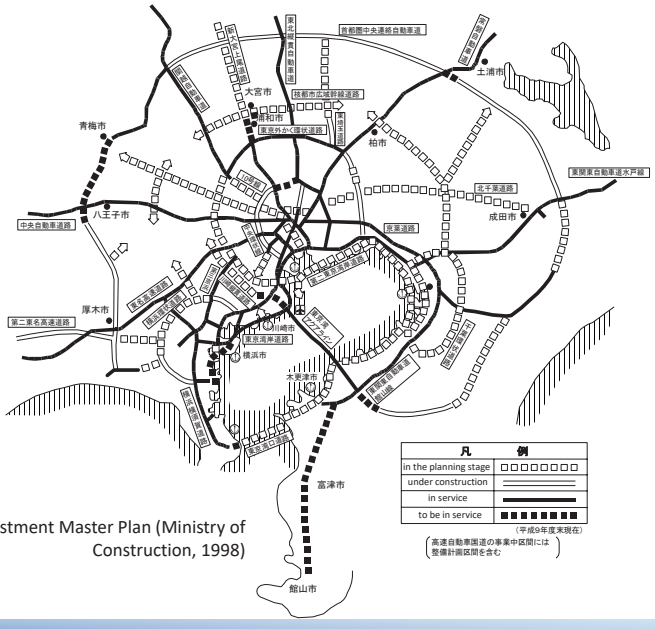
IV-2 (1) Initial Conditions

1. Urban network structure

- **Highway** network structure
  - ✓ Initial conditions for network structure
    - ➢ Current railway network
    - ➢ Future railway network
      - ➢ Access-controlled highway network (expressway)
      - ➢ Local highway/road network
  - ✓ Network setting
    - ➢ Node setting
    - ➢ Highway link setting
    - ➢ Expressway entry/exit link setting

IV-2 (1) Initial Conditions

TMA Future Expressway network



Source: 5-Years Highway Investment Master Plan (Ministry of Construction, 1998)

IV-2 (1) Initial Conditions

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast

Highway link setting

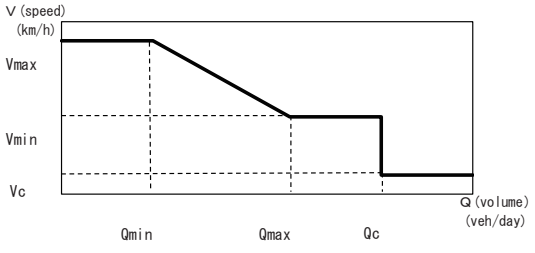
IV-2 (1) Initial Conditions

2. Transport service condition

- Railway service condition
- Highway service condition
  - ✓ Time-related service data setting
    - ➢ Q - V Model
  - ✓ Cost-related service data setting
    - ➢ Toll
    - ➢ Vehicle Operating Cost (VOC)
- Bus service condition

IV-2 (1) Initial Conditions

- Q - V Model



Vmax: maximum velocity
Vmin: minimum velocity
Vc : velocity at traffic congestion

- VOC for by each trip purpose

Trip purpose	VOC/veh (yen/veh-km)	Average passenger (pas/veh)	VOC/pas (yen/pas-km)	Equivalent of trip purpose from the Highway Census
	A	B	A／B	
Commuting (work)	27.3	1.13	24	Go to work
Commuting (school)	27.3	1.60	17	Go to school
Private/ Leisure	27.3	1.56	18	Family related・shopping・social・recreation (within TMA)
Business related	27.3	1.26	22	Business-A (not hauling work, go back to office is excluded)

IV-2 (1) Initial Conditions

3. Other conditions
   - Estimation of modal split parameter
   - Forecasted modal split
     - ✓ Actual vehicle ownership in municipality level
     - ✓ Vehicle ownership growth rate
   - CBD data setting
     - ✓ Parking lot
     - ✓ Traffic congestion

IV-2 (1) Initial Conditions

- Vehicle ownership growth rate estimation: Regression Analysis

$$R_i(t) = \alpha_i * \ln(t\text{-}1969) + \beta_i$$

Where,
T: year
α, β: parameter of prefecture *i*
$R_i(t)$: vehicle ownership per household in prefecture *i*, year *t*

- Vehicle ownership growth rate estimation result

prefecture	Parameter		Growth ratio (2015/1995)
	α	β	
Tokyo	0.108	0.201	**1.078**
Kanagawa	0.195	0.120	**1.109**
Saitama	0.260	0.079	**1.128**
Chiba	0.254	0.059	**1.126**
Ibaraki	0.376	0.044	**1.140**

IV-2 (2) Urban transportation demand forecasting

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast

1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

4-step model

1) Generation & Attraction

2) Distribution

3) Modal Split

4) (Railway Lines) Route Assignment

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast

1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- 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)

$$\alpha = \frac{G_{current}}{X_{current}}$$

(Future generation (or attraction) volume)

$$G_{future} = X_{future} \times \alpha$$

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)

$$G_{future} = \alpha + \beta \times X_{current}$$

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.

By considering the stability of the result, this master plan use **Trip Rate** method

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

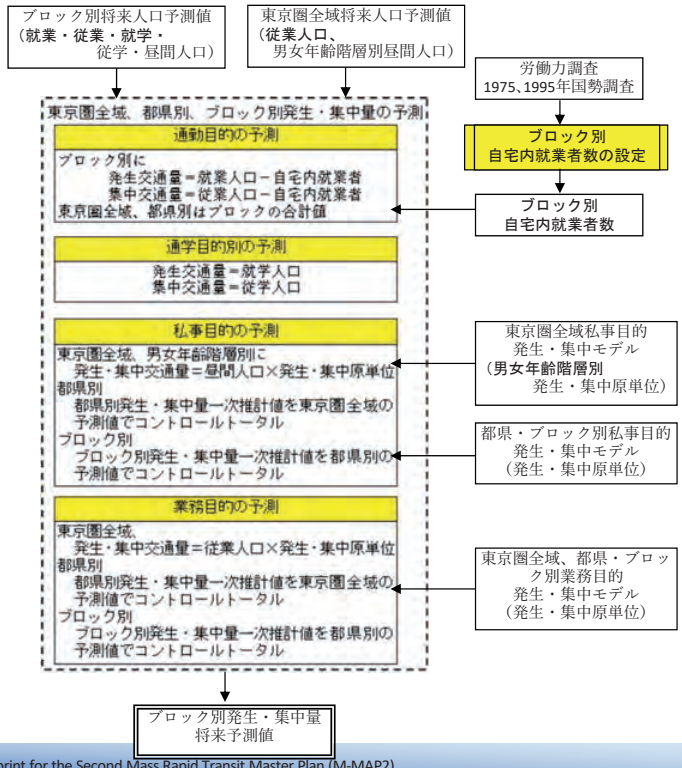
Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast

1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Methodology (trip rate)
  - Generation (or attraction) volume

  = Number of forecasted population (by each population categorization)*Trip rate
- Trip purpose
  - Commuting (work)
  - Commuting (school)
  - Private
  - Business related
  - Back home

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction



IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

- Commuting (work) trip
  - Methodology

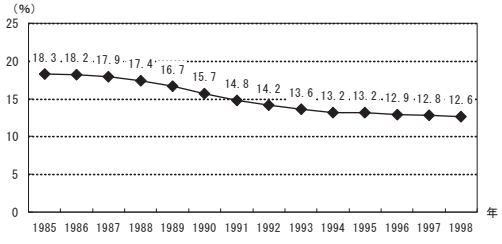
> Generated Volume = Home based worker – People who work and stay in the same zone
>
> Attracted Volume = Workplace based worker – People who work and stay in the same zone

  - People who work and stay in the same zone
    - First, set the total number of people who work and stay in the same zone in whole TMA as a control total value
    - Then, conduct an iteration with until the equilibrium is reached

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

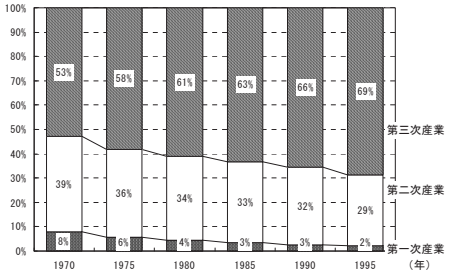
Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast
1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Transition of share of self-employed/home office worker



Source: Labor force survey (Management and Coordination Agency(MCA))

- Transition of share of employment in each sector



IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast

1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Commuting (school) trip
  - Methodology

Generated Volume = Home based student

Attracted Volume = Workplace based student

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast

1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Private trip
  - Methodology

<u>TMA level, by gender and age range</u>

Volume = Daytime population*Generation (or attraction) trip rate

↓

<u>Prefecture Level</u>
Iteration with TMA level volume as a control total value

↓

<u>Block Level</u>
Iteration with prefecture level volume as a control total value

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

- Generation and Attraction trip rate in TMA by gender and age group

Gender & Age group			Daytime pop in 1993 (1000 person)	Generated volume* (1000 person)	Attracted volume* (1000 person)	Generation trip rate	Attraction trip rate
			A	B	C	B／A	C／A
Male	Children	<15	2,704	882	1,055	0.326	0.325
	Workforce	15～64	12,895	4,043	4,010	0.314	0.312
	Elderly	>65	1,533	759	626	0.495	0.493
Female	Children	<15	2,575	840	1,003	0.326	0.325
	Workforce	15～64	12,079	10,641	10,587	0.881	0.877
	Elderly	>65	2,131	1,214	1,022	0.570	0.567

*Note: Generated and Attracted volume is based on the result from Person-Trip Survey

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast
1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

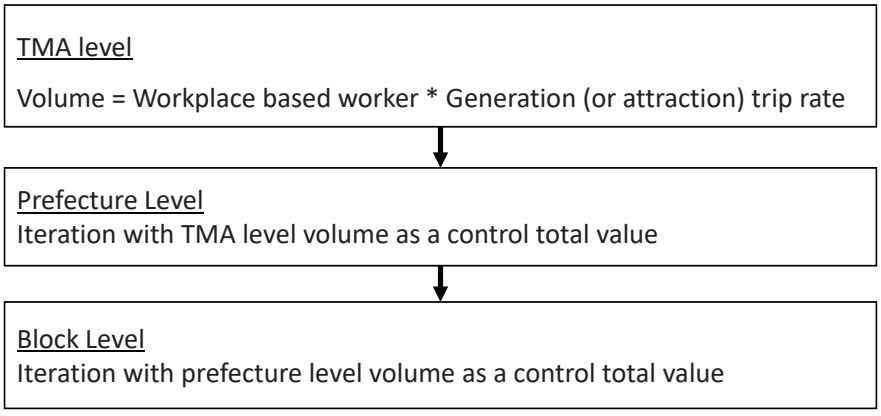
- Generation and Attraction trip rate in prefecture and block level by gender and age group

Prefecture / Block	Daytime pop in 1993 (1000 person)	Generated volume* (1000 person)	Attracted volume* (1000 person)	Generation trip rate	Attraction trip rate
	A	B	C	B／A	C／A
Tokyo	14,586	7,462	7,517	0.512	0.515
23 wards	11,290	5,473	5,545	0.485	0.491
Tama area	3,296	1,989	1,972	0.603	0.598
Kanagawa	7,309	4,167	4,115	0.570	0.563
Yokohama	2,938	1,670	1,663	0.568	0.566
Kawasaki	1,070	589	564	0.550	0.527
Others	3,301	1,909	1,888	0.578	0.572
Saitama	5,639	3,265	3,187	0.579	0.565
South	3,796	2,227	2,185	0.587	0.576
North	1,843	1,038	1,003	0.564	0.544
Chiba	4,936	2,782	2,792	0.564	0.566
Chiba city	812	418	424	0.514	0.522
Northwest	2,680	1,597	1,607	0.596	0.600
Southwest	563	270	266	0.479	0.473
East	881	498	495	0.565	0.562
Ibaraki south	1,447	704	691	0.486	0.477

*Note: Generated and Attracted volume is based on the result from Person-Trip Survey

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

- Business related trip
  - Methodology



IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

- Generation and Attraction trip rate in TMA, prefecture and block level by gender and age

	Daytime pop in 1993 (1000 person)	Generated volume* (1000 person)	Attracted volume* (1000 person)	Generation trip rate	Attraction trip rate
	A	B	C	B／A	C／A
Tokyo Metro. Area	17,638	8,740	8,655	**0.496**	**0.491**
Tokyo	8,709	4,092	4,153	**0.470**	**0.477**
23 wards	7,272	3,399	3,491	**0.467**	**0.480**
Tama area	1,437	692	662	**0.482**	**0.460**
Kanagawa	3,456	1,613	1,571	**0.467**	**0.455**
Yokohama	1,359	671	654	**0.494**	**0.481**
Kawasaki	548	251	249	**0.459**	**0.454**
Others	1,548	690	669	**0.446**	**0.432**
Saitama	2,551	1,460	1,389	**0.572**	**0.544**
South	1,726	957	898	**0.554**	**0.521**
North	825	503	491	**0.610**	**0.595**
Chiba	2,212	1,145	1,117	**0.518**	**0.505**
Chiba city	394	166	169	**0.422**	**0.429**
Northwest	1,117	521	499	**0.466**	**0.447**
Southwest	276	126	125	**0.458**	**0.454**
East	424	331	324	**0.781**	**0.763**
Ibaraki South	710	430	424	**0.606**	**0.597**

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

- Back home trip
  - Methodology

Generated volume = Attracted volume from Commuting (Work+School) + Private

Attracted volume = Generated volume from Commuting (Work+School) + Private

- Total trip
  - Methodology

Total generated volume = Generated volume from
Commuting (Work + School) + Private + Business + Back Home

Total attracted volume = Attracted volume from
Commuting (Work + School) + Private + Business + Back Home

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Generation & Attraction volume by prefecture

Commuting (work) trip

42% of workers agglomerated in Tokyo CBD

1,000person/day

	1995		Forecasted 2015		2015/1995	
	Gen. Volume	Att. Volume	Gen. Volume	Att. Volume	Gen.	Att.
TMA	15,885	15,937	16,552	16,616	1.042	1.043
Tokyo pref.	5,572	8,032	5,438	8,285	0.976	1.031
23 Wards	3,815	6,711	3,583	6,909	0.939	1.029
Tama Area	1,756	1,320	1,854	1,376	1.056	1.042
Kanagawa pref.	3,933	3,184	4,068	3,304	1.034	1.038
Yokohama	1,582	1,274	1,612	1,317	1.019	1.034
Kawasaki	601	498	620	512	1.032	1.028
Others	1,751	1,413	1,836	1,475	1.049	1.044
Saitama pref.	3,107	2,220	3,484	2,355	1.122	1.061
South	2,176	1,540	2,453	1,622	1.127	1.053
North	930	680	1,031	734	1.109	1.079
Chiba pref.	2,637	1,927	2,833	2,052	1.074	1.065
Chiba city	410	384	422	398	1.030	1.037
Northwest	1,593	1,002	1,735	1,063	1.089	1.061
Southwest	273	246	282	259	1.032	1.052
East	361	296	395	333	1.093	1.124
Ibaraki pref. South	637	575	729	620	1.144	1.079

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Generation & Attraction volume by prefecture
Commuting (school) trip

Decreasing due to low birth

1,000person/day

	1995		Forecasted 2015		2015/1995	
	Gen. Volume	Att. Volume	Gen. Volume	Att. Volume	Gen.	Att.
TMA	5,601	5,614	4,446	4,454	0.794	0.793
Tokyo pref.	1,802	2,179	1,297	1,549	0.719	0.711
23 Wards	1,142	1,501	770	1,016	0.674	0.677
Tama Area	660	678	527	533	0.798	0.786
Kanagawa pref.	1,349	1,224	1,104	1,023	0.818	0.836
Yokohama	532	499	427	409	0.802	0.820
Kawasaki	183	151	149	126	0.813	0.831
Others	634	574	528	489	0.833	0.851
Saitama pref.	1,170	1,035	1,015	919	0.867	0.888
South	767	676	671	601	0.875	0.889
North	403	359	343	318	0.852	0.886
Chiba pref.	1,004	918	796	746	0.793	0.812
Chiba city	147	147	113	113	0.771	0.766
Northwest	602	534	490	442	0.814	0.828
Southwest	104	96	80	77	0.770	0.804
East	151	141	112	114	0.742	0.807
Ibaraki pref. South	276	258	235	217	0.852	0.841

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Generation & Attraction volume by prefecture
Private trip

1,000person/day

	1995		Forecasted 2015		2015/1995	
	Gen. Volume	Att. Volume	Gen. Volume	Att. Volume	Gen.	Att.
TMA	18,559	18,480	19,206	19,124	1.035	1.035
Tokyo pref.	7,480	7,536	7,331	7,389	0.980	0.981
23 Wards	5,451	5,524	5,249	5,323	0.963	0.964
Tama Area	2,029	2,012	2,082	2,066	1.026	1.027
Kanagawa pref.	4,216	4,163	4,457	4,404	1.057	1.058
Yokohama	1,691	1,684	1,775	1,768	1.050	1.050
Kawasaki	589	565	621	596	1.054	1.054
Others	1,936	1,915	2,061	2,040	1.065	1.065
Saitama pref.	3,332	3,253	3,657	3,571	1.097	1.098
South	2,275	2,232	2,513	2,467	1.104	1.105
North	1,057	1,021	1,144	1,105	1.082	1.082
Chiba pref.	2,828	2,838	3,009	3,021	1.064	1.065
Chiba city	428	435	444	451	1.037	1.037
Northwest	1,622	1,632	1,759	1,770	1.084	1.085
Southwest	274	270	283	280	1.034	1.034
East	504	501	523	520	1.038	1.038
Ibaraki pref. South	703	690	752	739	1.071	1.071

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Generation & Attraction volume by prefecture

Business related trip

1,000person/day

	1995		Forecasted 2015		2015/1995	
	Gen. Volume	Att. Volume	Gen. Volume	Att. Volume	Gen.	Att.
TMA	8,870	8,784	8,956	8,870	1.010	1.010
Tokyo pref.	4,109	4,172	4,134	4,198	1.006	1.006
23 Wards	3,395	3,489	3,409	3,505	1.004	1.004
Tama Area	715	683	725	693	1.014	1.014
Kanagawa pref.	1,644	1,602	1,662	1,620	1.011	1.011
Yokohama	688	670	695	677	1.011	1.011
Kawasaki	251	249	253	250	1.005	1.005
Others	705	683	715	693	1.014	1.014
Saitama pref.	1,503	1,430	1,525	1,452	1.015	1.015
South	987	927	1,004	943	1.017	1.017
North	516	503	521	509	1.011	1.011
Chiba pref.	1,181	1,153	1,197	1,169	1.014	1.014
Chiba city	175	178	178	181	1.016	1.016
Northwest	541	519	553	530	1.022	1.022
Southwest	130	129	131	130	1.007	1.007
East	335	327	336	328	1.003	1.003
Ibaraki pref. South	433	427	438	432	1.011	1.011

54% of workers in TMA have a trip outside office

Commuting (work) trip volume (1,000 per/day)

Forecasted 2015		2015／1995	
Gen. Volume	Att. Volume	Gen.	Att.
16,552	16,616	1.042	1.043
5,438	8,285	0.976	1.031
3,583	6,909	0.939	1.029
1,854	1,376	1.056	1.042
4,068	3,304	1.034	1.038
1,612	1,317	1.019	1.034
620	512	1.032	1.028
1,836	1,475	1.049	1.044
3,484	2,355	1.122	1.061
2,453	1,622	1.127	1.053
1,031	734	1.109	1.079
2,833	2,052	1.074	1.065
422	398	1.030	1.037
1,735	1,063	1.089	1.061
282	259	1.032	1.052
395	333	1.093	1.124
729	620	1.144	1.079

Northwest	1,593	1,002
Southwest	273	246
East	361	296
Ibaraki pref. South	637	575

IV-2 (2) Urban transportation demand forecasting
1) Generation & Attraction

Generation & Attraction volume by prefecture

Total trip

1,000person/day

	1995		Forecasted 2015		2015/1995	
	Gen. Volume	Att. Volume	Gen. Volume	Att. Volume	Gen.	Att.
TMA	88,946	88,860	89,355	89,268	1.005	1.005
Tokyo pref.	36,709	36,772	35,421	35,485	0.965	0.965
23 Wards	27,539	27,634	26,259	26,354	0.954	0.954
Tama Area	9,170	9,139	9,163	9,131	0.999	0.999
Kanagawa pref.	19,713	19,671	20,022	19,980	1.016	1.016
Yokohama	7,949	7,931	8,003	7,984	1.007	1.007
Kawasaki	2,838	2,835	2,875	2,873	1.013	1.013
Others	8,927	8,905	9,145	9,123	1.024	1.024
Saitama pref.	15,620	15,547	16,527	16,453	1.058	1.058
South	10,654	10,594	11,330	11,270	1.064	1.064
North	4,965	4,952	5,196	5,183	1.047	1.047
Chiba pref.	13,332	13,304	13,654	13,626	1.024	1.024
Chiba city	2,126	2,129	2,119	2,122	0.997	0.997
Northwest	7,526	7,503	7,812	7,789	1.038	1.038
Southwest	1,393	1,392	1,392	1,391	0.999	0.999
East	2,288	2,281	2,332	2,324	1.019	1.019
Ibaraki pref. South	3,571	3,565	3,730	3,724	1.044	1.044

IV-2 (2) Urban transportation demand forecasting
2) Distribution

- Three methods in Distribution

Current Pattern Method

Incorporate the growth rate and distribute each O-D by Frater Method

$$T_{ij} = t_{ij} \cdot \frac{G_i}{g_i} \frac{A_j}{a_j} \frac{1}{2} \left(\frac{g_i}{\sum_j t_{ij} \cdot A_j / a_j} + \frac{a_j}{\sum_i t_{ij} \cdot G_i / g_i} \right)$$

T_{ij} :Forecasted volume between zone i, j
A_j :Forecasted attracted volume in zone j
t_{ij}
a_j :Current volume between zone i,j
:Current attracted volume in zone j
G :Forecasted generated volume in zone i
g :Current generated volume 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

IV-2 (2) Urban transportation demand forecasting
2) Distribution

1. **Current Pattern Method**
   → **Based Method**
   - In TMA, most of the urban areas are already developed
   - Fix the number of commuters between suburban and CBD
   - Assuming no large scale development

2. **Similar Pattern Method**
   Based on the assumption that there is a land development along the new railway line
   - Assuming more people with long commuting distance to CBD
   - Imitate the travel pattern in the nearby development

3. **Gravity Model**
   - Area with expected land development, but no past development nearby to mimic
   - New travel pattern is assumed

IV-2 (2) Urban transportation demand forecasting
2) Distribution

Application of Similar Pattern Method

Applied to: Tsukuba Express (new)
(Invested to relieve the congestion to CBD in Joban Line)

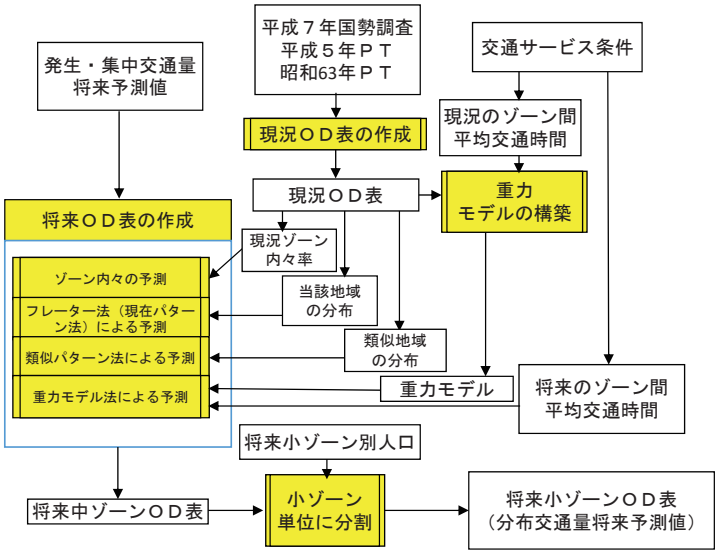
Based from: JR Joban Line (existing)
(Heavy congested suburban commuting line)

IV-2 (2) Urban transportation demand forecasting
2) Distribution

- Methodology
  - Analyze at M zone level (TMA = 641zones)
  - Intrazone forecast volume → Use the current share of the intrazone trip
  - Interzone forecast volume → Gravity Model
- Analysis Flow
  - Estimate the current O-D table
  - Structure the gravity model and apply
  - Forecast the future O-D table

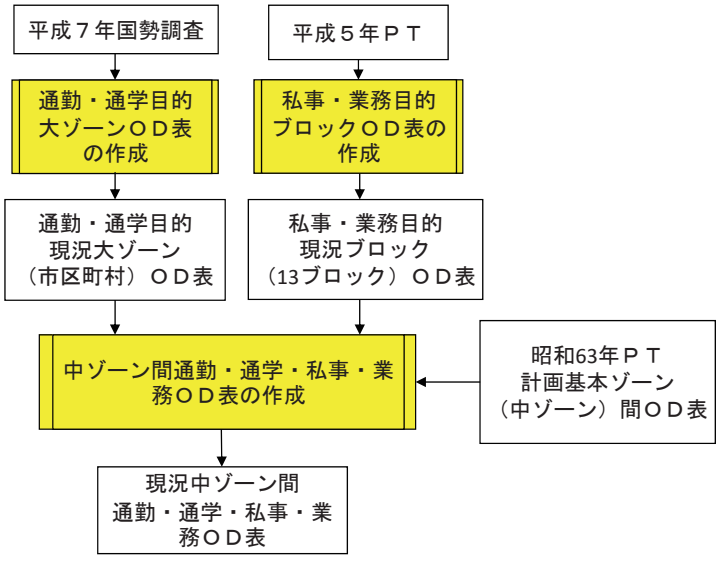
IV-2 (2) Urban transportation demand forecasting
2) Distribution

- Distribution Analysis: Flowchart



IV-2 (2) Urban transportation demand forecasting
2) Distribution

- Current O-D table estimation: Flowchart



IV-2 (2) Urban transportation demand forecasting
2) Distribution

- Gravity Model

$$T_{ij} = G_i \frac{\left(1+\alpha\delta_j\right)A_j^{\beta} / D_{ij}^{\gamma}}{\sum_j \left(1+\alpha\delta_j\right)A_j^{\beta} / D_{ij}^{\gamma}}$$

Where,

T_{ij} : Distributed volume between zone *i, j* (person/day)

G_i : Outflow volume from *i*

(person/day, Outflow volume = Generated volume - Intrazone volume)

A_j : Inflow volume to *j*

(person/day, Inflow volume = Attracted volume - Intrazone volume)

D_{ij} : Travel time between zone *i, j* (minutes)

δ_j : CBD dummy (CBD = 1, other area = 0)

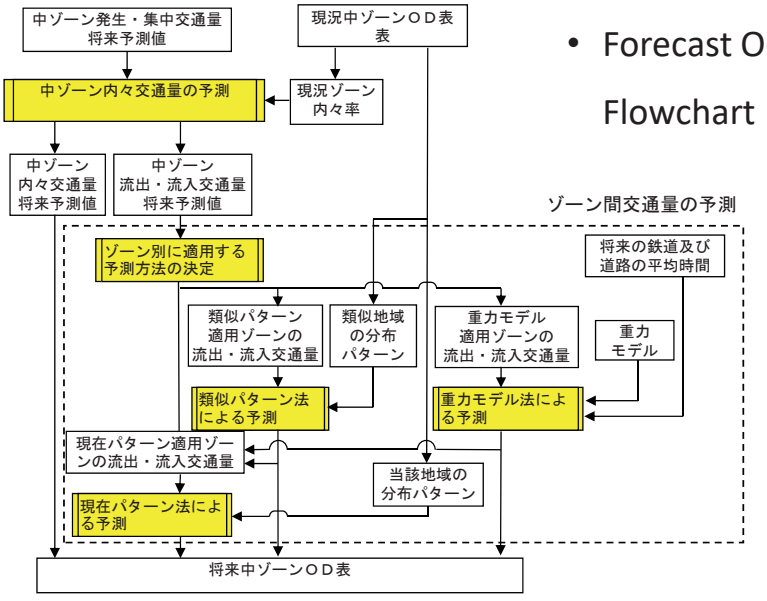
$\kappa, \alpha, \beta, \gamma, \varepsilon$: Model parameter

IV-2 (2) Urban transportation demand forecasting
2) Distribution

- Estimated parameter from Gravity Model

	Purpose	α	β	γ	ε	κ	r	F-stat
distribution	work	0.6408	0.551	2.109			0.75	130.7
	school	—	0.238	2.309			0.87	99.6
	private	—	0.513	1.390			0.73	722.8
	business	—	0.734	1.176			0.77	1,074.6
Attraction	work	—	0.417	2.132			0.83	124.5
	school	—	0.667	2.709			0.86	70.0
	private	—	0.463	1.476			0.76	1,267.1
	business	—	0.357	1.288			0.78	1,544.7

IV-2 (2) Urban transportation demand forecasting
2) Distribution



- Forecast O-D table estimation: Flowchart

IV-2 (2) Urban transportation demand forecasting
2) Distribution

Distribution volume by prefecture

Commuting (work) trip

Trip from Saitama to Tokyo CBD (23 wards) increase by 20%

(1,000person/day)

Attraction (to) / Generation (from)		Tokyo	23 ward	Tama	Kanagawa	Saitama	Chiba	Ibaraki south	Sum	Outflow Sum
Tokyo		5,157	4,029	1,128	189	126	74	4	5,550	393
		5,025	3,865	1,160	193	114	70	2	5,403	378
	23 ward	3,543	3,463	79	98	88	68	4	3,801	433
		3,323	3,253	70	92	79	65	2	3,561	443
	Tama	1,614	565	1,048	91	38	6	1	1,749	223
		1,702	613	1,090	101	34	4	0	1,842	232
Kanagawa		951	854	96	2,943	8	11	1	3,913	970
		999	895	105	3,039	4	8	0	4,050	1,011
Saitama		1,000	924	76	15	2,016	31	10	3,071	1,056
		1,203	1,116	87	16	2,160	36	9	3,424	1,264
Chiba		785	777	8	17	28	1,772	27	2,629	857
		877	870	7	16	28	1,877	23	2,821	945
Ibaraki south		68	67	1	2	11	34	497	612	115
		106	105	1	2	16	50	515	688	173
Sum		7,961	6,651	1,310	3,165	2,189	1,922	540	15,776	
		8,210	6,851	1,359	3,266	2,321	2,040	549	16,386	
Inflow Sum		2,804	3,188	261	222	173	150	43		
		3,185	3,598	270	227	162	163	34		

(upper: 1995, lower: 2015)

IV-2 (2) Urban transportation demand forecasting
2) Distribution

Distribution volume by prefecture

Trip from Saitama to Tokyo CBD (23 wards) increase by 9%

Total trip

(1,000person/day)

Attraction (to) / Generation (from)		Tokyo	23 ward	Tama	Kanagawa	Saitama	Chiba	Ibaraki south	Sum	Outflow Sum
Tokyo		31,362	22,986	8,377	1,924	1,749	1,275	117	36,428	5,065
		29,788	21,466	8,322	1,939	1,899	1,328	151	35,104	5,316
	23 ward	22,961	21,837	1,124	1,497	1,511	1,234	112	27,315	5,479
		21,438	20,320	1,118	1,491	1,654	1,292	146	26,022	5,702
	Tama	8,402	1,149	7,253	426	238	41	5	9,113	1,860
		8,350	1,146	7,203	448	245	36	4	9,082	1,879
Kanagawa		1,954	1,528	426	17,471	65	82	9	19,581	2,110
		1,968	1,518	450	17,742	61	77	8	19,857	2,114
Saitama		1,792	1,551	240	69	13,424	136	47	15,469	2,045
		1,941	1,693	248	65	14,115	143	53	16,317	2,202
Chiba		1,306	1,265	41	83	130	11,652	136	13,306	1,655
		1,354	1,320	35	77	137	11,892	149	13,609	1,717
Ibaraki south		118	114	5	8	48	134	3,141	3,449	308
		151	147	4	7	52	147	3,191	3,549	358
Sum		36,532	27,443	9,089	19,555	15,416	13,280	3,449	88,233	
		35,203	26,144	9,058	19,830	16,264	13,587	3,551	88,435	
Inflow Sum		5,169	5,606	1,836	2,084	1,992	1,628	309		
		5,414	5,824	1,855	2,088	2,149	1,696	361		

(upper: 1995, lower: 2015)

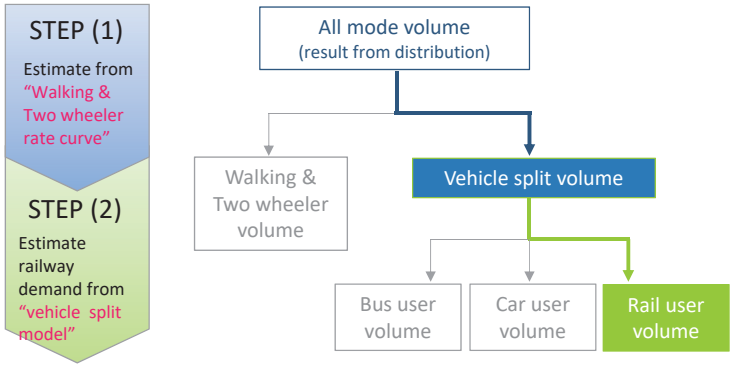
IV-2 (2) Urban transportation demand forecasting
3) Modal Split

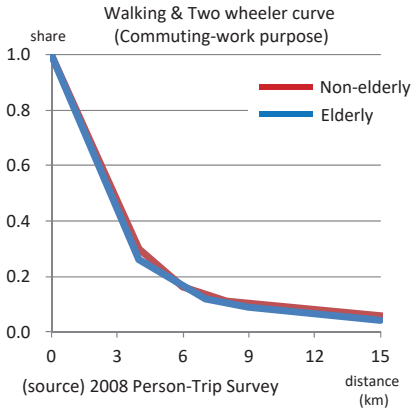
- Methodology
  - Estimate two separate model: “Walking & Two Wheeler Model” and “Vehicle Split Model”
- Analysis Flow
  - Interzone
    - O-D table from distribution -> divide into “Walking & Two Wheeler O-D table” and “Vehicle Split O-D table”
    - From “Vehicle Split O-D table” -> divide into “Railway O-D table”, “Bus O-D table” and “Car O-D table”
  - Intrazone
    - Based on the current modal split

IV-2 (2) Urban transportation demand forecasting
3) Modal Split

Two step in Modal Split estimation process

STEP1: Forecast "Walking & Two Wheeler volume" and "Vehicle Split volume"
STEP2: From "Vehicle Split volume", forecast the volume by "Rail", "Bus" and "Car"





IV-2 (2) Urban transportation demand forecasting
3) Modal Split

As for vehicle split model, two models namely, aggregate model and disaggregate model are usually applied

Comparison between aggregate model and disaggregate model

Characteristics	Aggregate Model	Disaggregate Model
Explanatory Variable	Zone-aggregate selection probability	Individual selection probability
Theoretical Background	(Mostly) Empirical Based	Random Utility
Pros & Cons	Simplicity in model construction	Clear explanation in terms of theory
	1 zone = 1 sample, therefore, huge amount of survey is needed	Simple to test many policy variables
		Less no. of sample = OK

Disaggregate model is based on the Random Utility Theory, where individual selection is based on their utility maximization. Distribution of utility varies on the function assumption. General model is shown below.

■ 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)
e =2.71828
Ti, Ci, D: explanatory variable of utility when selecting mode i
A: Utility estimation parameter
Pi: Probability of selecting mode i
Vi: Utility when selecting mode i

Pros: simple to estimate the parameter (than Probit model)

Cons: Concern about the violation of IIA assumption in the area with high density railway network

IV-2 (2) Urban transportation demand forecasting
3) Modal Split

- Walking & Two Wheeler Model

$$P^{walk}{}_{ij} = p^{walk}{}_{ij} + \left(P_0{}^{walk}{}_{IJ} - p_0{}^{walk}{}_{IJ}\right)$$

Where,

$P^{walk}{}_{ij}$: Corrected share of walk & 2wheel between zone *i, j* in S zone level

$p^{walk}{}_{ij}$: Estimated share of walk & 2wheel between zone *i, j* in S zone level

$P_0{}^{walk}{}_{IJ}$: Expected share of walk & 2wheel between zone *I, J* in L zone level ($i \in I, j \in J$)

$p_0{}^{walk}{}_{IJ}$: Current share of walk & 2wheel between zone *I, J* in L zone level ($i \in I, j \in J$)

Where,

$$p_0{}^{walk}{}_{IJ} = \frac{\sum_{i \in I}\sum_{j \in J}(p_0{}^{walk}{}_{ij} \times Q_{ij})}{Q_{IJ}}$$

$p_0{}^{walk}{}_{ij}$: Current share of walk & 2wheel between zone *i, j* in S zone level

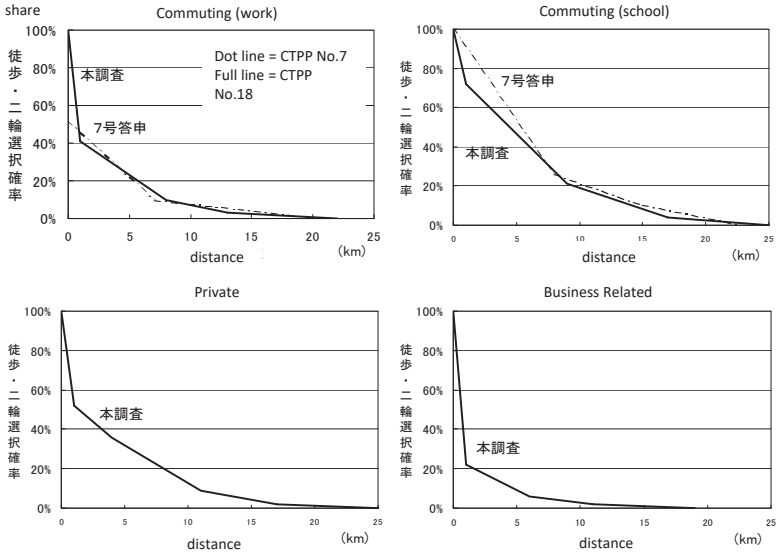
Q_{ij} : Current all mode volume between zone *i, j* in S zone level

Q_{IJ} : Current all mode volume between zone *I, J* in L zone level ($i \in I, j \in J$)

IV-2 (2) Urban transportation demand forecasting
3) Modal Split

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast
1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Walking & Two Wheeler Model curve



IV-2 (2) Urban transportation demand forecasting
3) Modal Split

- Vehicle Split Model

Where,

$$P_{ij,m} = \frac{\exp(V_{ij,m})}{\sum_{m'} \exp(V_{ij,m'})}$$

$P_{ij,m}$: Probability of selecting mode *m* when travel between zone *i, j*

$V_{ij,m}$: Utility when mode *m* is used when travel between zone *i, j*

Where,

$$V_{ij,m} = \theta_1 X_{ij,m,1} + \theta_2 X_{ij,m,2} + \cdots + \theta_n X_{ij,m,n} \cdots$$

θ_n : Utility estimation parameter

$X_{ij,m,n}$: explanatory variable of utility when mode *m* is used when travel between zone *i, j*

IV-2 (2) Urban transportation demand forecasting
3) Modal Split

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast
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- Vehicle Split Model parameter

		Commuting-work	Commuting-school	Private	Business
Time	Minutes	-0.0263 (-7.9)	-0.0254 (-4.2)	-0.0169 (-6.8)	-0.0252 (-7.1)
Cost	Yen	-0.000584 (-2.0)	-0.00150 (-2.1)	-0.000792 (-3.0)	-0.000555 (-1.7)
No. of car own	Car	0.601 (8.4)	0.645 (5.3)	1.14 (15.0)	0.286 (3.4)
CBD Dummy	Rail	0.307 (2.6)	0.711 (3.5)	0.596 (5.7)	0.220 (2.0)
Constant	Car	-0.274 (-2.0)	-1.23 (-5.3)	-0.886 (-7.9)	-0.264 (-2.3)
	Bus	-1.31 (-7.5)	-0.720 (-2.7)	-0.519 (-4.4)	-3.18 (-10.4)
Accuracy Rate		70.0%	83.8%	66.1%	69.0%
ρ^2		0.226	0.284	0.196	0.180
Sample Size		2,033	925	2,263	1,847
(ref.) Value of Time		45(yen/min)	17(yen/min)	21(yen/min)	45(yen/min)

- Value of time = Time parameter/Cost parameter
- money earn from 1 minute of travel time shorten ≒ money earn from 1 minute of working time

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

- Methodology
  - Railway route assignment modelling
  - Parameter estimation and demand forecasting
- Railway route assignment
  - Consideration of in-train congestion relieve

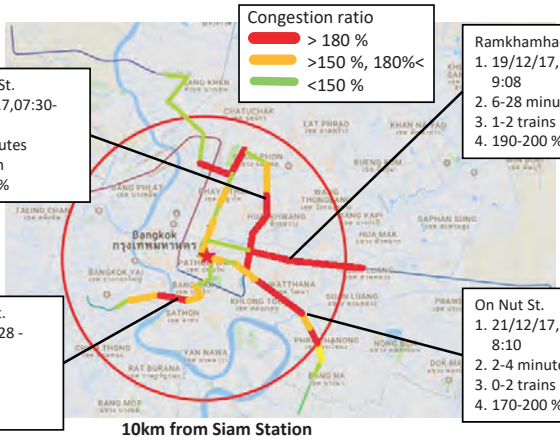
  Link congestion index = Link travel time*Link congestion rate^2
  - Consideration of the route similarly
    - Disaggregate Probit Model

(Reference) Congesting Rate from Bangkok

■ **Current Issues**

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

Tokyo's Target



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

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

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

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

10km from Siam Station

*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)

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

As for modal split model, two models namely, aggregate model and disaggregate model are usually applied

Comparison between aggregate model and disaggregate model

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		Less no. of sample = OK

Disaggregate model is based on the Random Utility Theory, where individual selection is based on their utility maximization. Distribution of utility varies on the function assumption. General model is shown below.

■ Probit Model

In this model, utility probability distribution is based on Normal Distribution.

In CTPP no.18, we try to maintain the IIA assumption by avoiding logit model and applying probit model.

- With more route choice, more multiple integral is needed. So it is quite difficult to clearly explain the meaning of parameters.
- Railway line independency is not assumed (No. IIA)

- Based on the theoretical background, **Disaggregate model** is used
- In order to deal with railway route selection problem, **Probit model** is used

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast
1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Railway Route Assignment parameter estimation result

From disaggregate probit model

Variables		Unit	Parameter			
			Work	School	Private	Business
Time	On-board time	Min	-0.0943 (-8.09)	-0.0597 (-5.77)	-0.0494 (-2.86)	-0.0499 (-3.29)
	Access/egress	Min	-0.127 (-11.7)		-0.0583 (-4.30)	-0.0599 (-5.82)
	Access	Min		-0.0691 (-6.20)		
	Egress	Min		-0.0603 (-5.69)		
	Transfer + waiting time	Min	-0.112 (-10.7)	-0.0793 (-8.71)	-0.0722 (-4.15)	-0.0687 (-4.52)
Cost	Total user cost	Yen	-0.00200 (-3.98)	-0.00388 (-7.14)	-0.00233 (-3.00)	-0.00103 (-1.57)
Congestion index			-0.00869 (-3.34)	-0.00177 (-0.80)		
Route similarity parameter			0.436 (2.71)	0.161 (1.40)	0.513 (1.20)	0.214 (1.06)
ρ^2			0.390	0.331	0.172	0.156
Sample Size			1,218	811	436	357

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

- Railway Route Assignment volume forecasting result

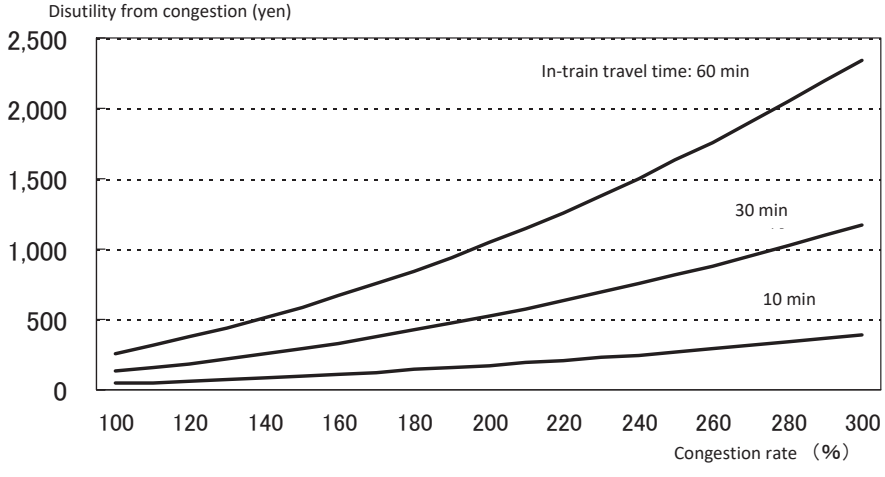
From disaggregate probit model

		1995	2005	Growth volume	Growth rate
All mode (10,000 person)	総交通流動(万人)				
Commuting (work)	通勤	1,578	1,639		3.9
Commuting (school)	通学	558	438	▲ 120	▲ 21.4
Private	私事	1,841	1,905	65	3.5
Business	業務	871	879	8	0.9
Airport/HSR	空港・幹線	60	81	21	35.4
Sum (exclude back home)	計（帰宅を含む）	8,881	8,921	40	0.5
Railway (10,000 person)	鉄道流動(万人)				
	通勤	666	710	45	6.7
	通学	151	113	▲ 38	▲ 25.2
	私事	248	248	0	0.0
	業務	161	168	7	4.3
	空港・幹線	46	62	16	34.7
	計（帰宅を含む）	2,334	2,369	35	1.5
Railway Share	鉄道分担率(%)				
	通勤	42.2	43.3	1.1	—
	通学	27.1	25.8	▲ 1.3	—
	私事	13.5	13.0	▲ 0.5	—
	業務	18.5	19.1	0.6	—
	空港・幹線	76.2	75.8	▲ 0.4	—
	計（帰宅を含む）	26.3	26.6	0.3	—
Inflow to 23 wards area (Tokyo CBD. 10,000 person)	区部流入交通量(万人)				
All purpose All mode	全目的全手段　計	574	601	27	4.7
All purpose railway only	全目的鉄道利用　計	458	484	26	5.6
Commuting work railway only	通勤目的鉄道利用　計	283	321	38	13.2
Commuting school railway only	通学目的鉄道利用　計	43	30	▲ 14	▲ 31.2

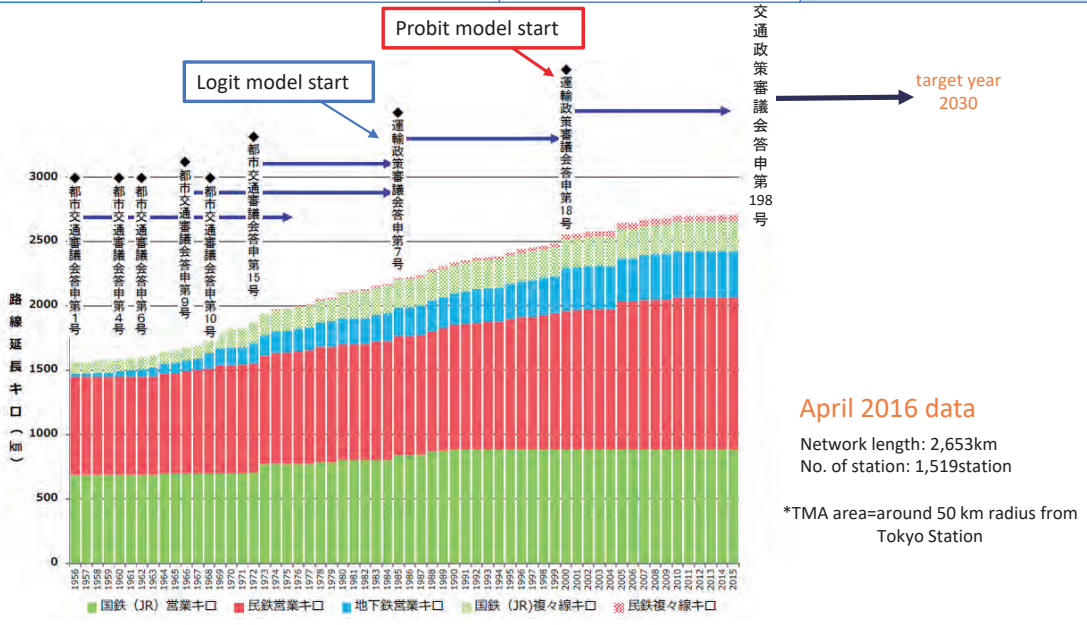
IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Model Structure | Population Forecast | Initial Conditions | Urban Transport Forecast | Airport/HSR Forecast
1) Generation & Attraction | 2) Distribution | 3) Modal Split | 4) Railway Route Assignment

- Congestion index cost setting



IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment



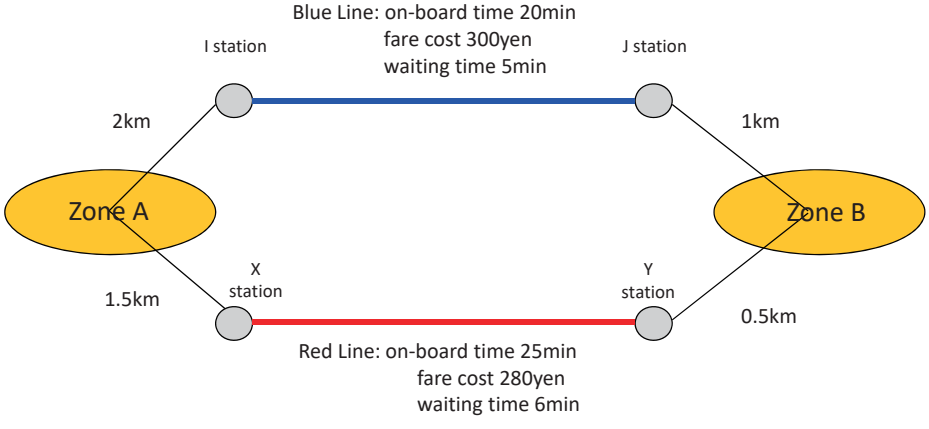
April 2016 data

Network length: 2,653km
No. of station: 1,519station

*TMA area=around 50 km radius from Tokyo Station

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Problem in logit model



Assuming 10,000 people travel from Zone A → Zone B and there are two options, Blue line and Red line

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

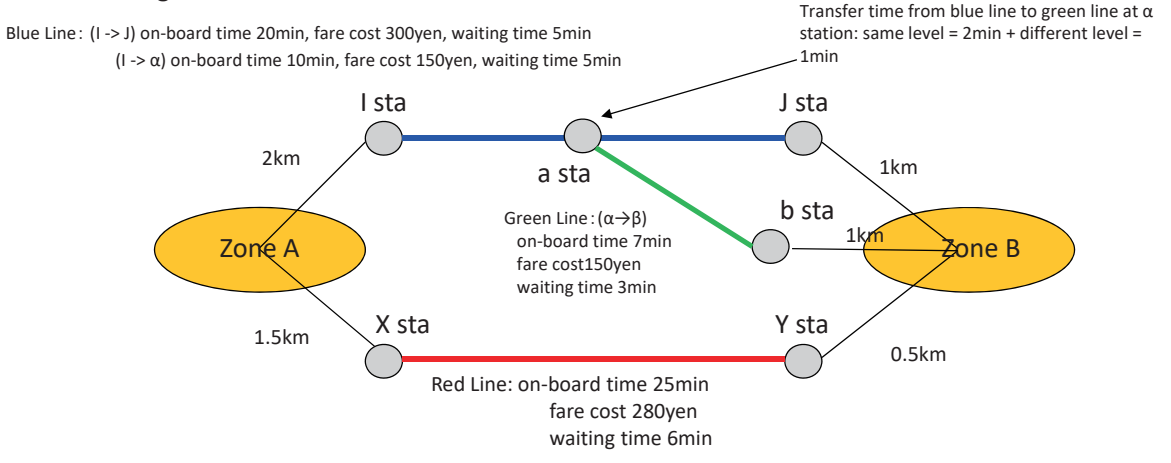
Problem in logit model

Estimation result from Logit model

Variable	Parameter	t-value
On-board time (min)	-0.164	-9.80
Fare cost (yen)	-0.00323	-3.69
Access distance (km)	-1.746	-17.6
Egress distance (km)	-1.238	-14.6
Same level transfer time (min)	-0.193	-5.65
Different level transfer time (min)	-0.299	-4.56
Waiting time (min)	-0.188	-5.48
ρ^2	0.302	
Accuracy rate	80.0%	
Sample size	900	

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Problem in logit model



Assuming 10,000 people travel from Zone A → Zone B and there are three options, Blue line, Red line and Green line

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Problem in logit model

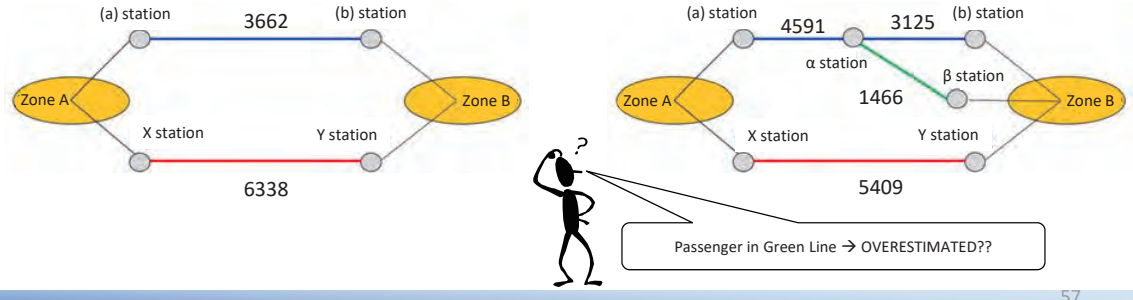
before

Route	Passenger
BLUE	3,662
RED	6,338

Introduction of green line

after

Route	Passenger
BLUE only	3,125
RED	5,409
BLUE -> GREEN	1,466



IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Problem in logit model

The assumption when the utility of from each choices are not affecting the selection probability of each others

With this assumption, probability of selecting choices with high similarity could be overestimated, while other choices could be underestimated

IIA

Independence from irrelevant alternatives

Especially in TMA where various routes can be selected within one O-D

This is the main limitation of Logit Model when applying to TMA demand forecasting

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Probit Model

Parameter Estimation from Probit model
(Commuting-work purpose)

Variables	Estimated	t-value
On-board time (min)	-0.0943	-8.09
Total cost (yen)	-0.00200	-3.98
Transfer + waiting time (min)	-0.112	-10.7
Access, egress time (min)	-0.127	-11.7
Congestion index	-0.00869	-3.34
Route similarity parameter	0.436	2.71
ρ^2	0.390	

Railway on-board VOT=47.2¥/min

IV-2 (2) Urban transportation demand forecasting
4) Railway Route Assignment

Probit Model

Actual Example: from Omiya -> to Kanda

a. Omiya (via Tohoku-Takasaki line) – Ueno - (via Yamanote line) - Kanda

b. Omiya (via Tohoku-Takasaki line) – Ueno - (via Keihin-Tohoku line) - Kanda

} Multiple choice between Omiya and Ueno

c. Omiya (via Keihin-Tohoku line) – Kanda

	1995 Metropolitan Transport Census (actual)	Without route similarity parameter	With route similarity parameter
a. Tohoku-Takasaki -> Yamanote	33% } 48%	28% } 52%	27% } 47%
b. Tohoku-Takasaki -> Keihin-Tohoku	15%	24%	20%
c. Keihin-Tohoku only	53%	47%	52%
sum	100%	100%	100%

IV-2 (3) Airport/HSR station access demand forecasting

4-step model

1) Generation & Attraction

2) Distribution

3) Modal Split

4) (Railway Lines) Route Assignment

IV-2 (3) Airport/HSR station access demand forecasting

- Parameter estimation (modal split airport access)

		Business	
time	Total time (min)	-0.0657	(-17.6)
Cost	Total cost (¥)	-0.00139	(-10.5)
Constant	Car	2.556	(12.2)
	Bus	-0.285	(- 3.1)
Accuracy rate		73.9 %	
ρ^2		0.1785	
Sample size		1,351	
(ref.) Value of time		47 (¥/min)	

( ): t-value

IV-2 (3) Airport/HSR station access demand forecasting

- Parameter estimation (Haneda airport access route assignment)

Variable		Unit	Parameter	
			Private	Business
Time	On-board time	Min	−0.0494	−0.0499
	Access/Egress time	Min	−0.0583	−0.0599
	Transfer + Waiting time	Min	−0.0722	−0.0687
Cost	Total cost	Yen	−0.00233	−0.00103

IV-2 (3) Airport/HSR station access demand forecasting

- Parameter estimation (Narita airport access route assignment)

Variable	Unit	Estimates	
Total travel time	Min	−0.0943	(−8.1)
Total travel cost	¥	−0.00200	(−4.0)
No. of Transfers	time	−0.00869	(−3.3)
Express dummy		0.436	(2.7)
ρ^2		0.568	
Accuracy rate		88.0 %	
Sample size		1,033	

Note 1) ( ) t-value
Note 2) Express dummy = 1 if Narita Express or Skyliner is used, 0 otherwise

IV-2 (3) Airport/HSR station access demand forecasting

- Parameter estimation (HSR station access modal split)

		Business	Leisure
Time	Total time (min)	-0.0313 (-3.9)	-0.0323 (-7.3)
Cost	Total cost (¥)	-0.000374 (-3.9)	-0.000580 (-5.3)
Constant	Car	-0.437 (-3.5)	-0.432 (-2.6)
	Bus	-3.48 (-10.5)	-0.348 (-2.3)
Accuracy Rate		82.9 %	76.6 %
ρ^2		0.164	0.142
Sample size		2,577	1,580
(ref.) Value of Time		84 (¥/min)	56 (¥/min)

( ): t-value

IV-2 (4) Improvements in CTPP No.198

1) Problems in CTPP No. 18

2) Expected changes in the future

3) Improvements in demand forecasting model

IV-2 (4) Improvements in CTPP No.198
1) Problems in CTPP No. 18

Estimation accuracy in CTPP No. 18

In CTPP No.18, targeting estimation accuracy is expected within ±10%

However, when compare the actual value with the estimated value from CTPP No.18, in year 2005 value, several estimations outside the accuracy range of 10% have been found

Comparison of actual and estimated volume (2005)

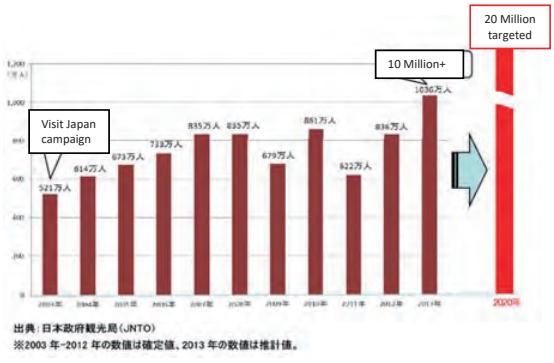
Day volume (person/day)

direction	Name of lines	section		actual	forecasted	fore-act	fore/act
多摩方面	中央緩行線	新宿	大久保	267,994	300,035	32,041	1.12
	中央快速線	新宿	中野	750,927	610,988	−139,940	0.81
	東西線	落合	高田馬場	126,741	125,740	−1,001	0.99
	京王線	新宿	初台	704,725	692,545	−12,180	0.98
	西武新宿線	西武新宿	高田馬場	195,709	186,090	−9,620	0.95
		計		2,046,096	1,915,397	−130,699	0.94
神奈川方面	京浜東北線	品川	大井町	593,914	457,424	−136,490	0.77
	東海道本線	品川	川崎	419,186	378,451	−40,736	0.90
	横須賀線	品川	西大井	279,681	206,949	−72,733	0.74
	京急本線	品川	北品川	353,818	331,607	−22,212	0.94
	小田急小田原線	新宿	南新宿	486,120	490,551	4,431	1.01
	東急東横線	渋谷	代官山	433,310	316,741	−116,570	0.73
	東急田園都市線	渋谷	池尻大橋	632,841	580,290	−52,551	0.92
		計		3,198,870	2,762,011	−436,859	0.86
埼玉方面	東北本線	上野	尾久	355,834	392,584	36,750	1.10
	京浜東北線	田端	上中里	420,830	307,196	−113,635	0.73
	埼京線	池袋	板橋	683,351	674,927	−8,425	0.99
	都営三田線	巣鴨	西巣鴨	193,869	197,322	3,453	1.02
	日比谷線	入谷	上野	374,656	402,911	28,255	1.08
	有楽町線	要町	池袋	318,124	253,807	−64,317	0.80
	西武池袋線	池袋	椎名町	507,656	591,641	83,985	1.17
	東武東上線	池袋	北池袋	517,174	608,998	91,824	1.18
		計		3,371,494	3,429,383	57,889	1.02
千葉方面	総武緩行線	秋葉原	浅草橋	699,881	597,707	−102,174	0.85
	総武快速線	東京	新日本橋	360,552	390,413	29,861	1.08
	京葉線	東京	八丁堀	178,493	128,734	−49,759	0.72
	都営浅草線	新橋	東銀座	238,269	206,618	−31,652	0.87
	都営新宿線	岩本町	小川町	224,629	188,215	−36,414	0.84
	京成本線	日暮里	新三河島	130,977	149,024	18,047	1.14
	東西線	大手町	日本橋	482,102	462,297	−19,805	0.96
		計		2,314,903	2,123,007	−191,897	0.92
常磐方面	常磐快速線	日暮里	三河島	497,787	395,316	−102,471	0.79
	千代田線	町屋	西日暮里	432,744	401,866	−30,878	0.93
		計		930,531	797,182	−133,349	0.86

IV-2 (4) Improvements in CTPP No.198
2) Expected changes in the future

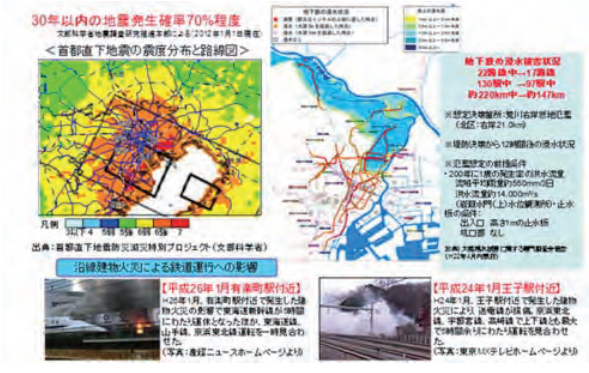
Increasing in Tourism

- Foreign tourist → Setting the new target



Large-scale disaster and aging infra.

- Consideration of the disaster risk



Sample categorization

1) Generation & Attraction → 2) Distribution → 3) Modal Split → 4) Railway Route Selection

No.18

1) Generation & Attraction

Purpose	Gender	Age group
Commuting (work)	Male	5y. range
	Female	5y. range
Commuting (school)	Male	2 groups
	Female	
Private	Male	3 groups
	Female	
Business Related	Male	N/A
	Female	
Back home	Male	N/A
	Female	

2) Distribution

目的区分	性別	年齢区分
通勤	男女共通	全年齢統合
通学	男女共通	
私事	男女共通	
業務	男女共通	
帰宅	男女共通	

3) Modal Split

目的区分	性別	年齢区分
通勤	男女共通	全年齢統合
通学	男女共通	
私事	男女共通	
業務	男女共通	
帰宅	男女共通	

4) Railway Route Selection

目的区分	性別	年齢区分
通勤	男女共通	全年齢統合
通学	男女共通	
私事	男女共通	
業務	男女共通	
帰宅	男女共通	

No.198

1) Generation & Attraction

Purpose		Gender	Age group
Commuting (work)		Male	5y. range
		Female	5y. range
Commuting (school)		Male	5y. range
		Female	5y. range
Private	From home	Male	4 groups
		Female	5 groups
	others	Male	4 groups
		Female	5 groups
Busines s Related	From home	Male	3 groups
		Female	3 groups
	From workplace	Male	3 groups
		Female	3 groups
Back home	From workplace	Male	3 groups
		Female	4 groups
	From school	Male	2 groups
		Female	2 groups
	From private	Male	4 groups
		Female	5 groups
	From business	Male	3 groups
		Female	3 groups

2) Distribution

目的区分		性別	年齢区分
通勤		男性	3区分
		女性	4区分
通学		男性	2区分
		女性	2区分
私事	自宅発	男性	4区分
		女性	5区分
	その他	男性	4区分
		女性	5区分
業務	自宅発	男性	3区分
		女性	3区分
	勤務先発	男性	3区分
		女性	3区分
帰宅	勤務先	男性	3区分
		女性	4区分
	通学先	男性	2区分
		女性	2区分
	私事先	男性	4区分
		女性	5区分
	業務先	男性	3区分
		女性	3区分

3) Modal Split

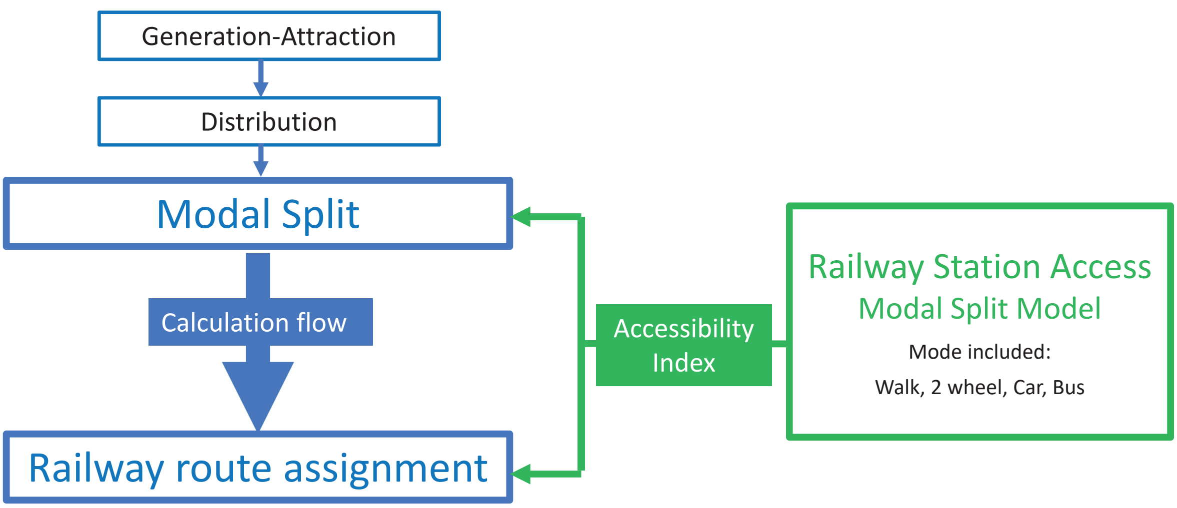
目的区分		性別	年齢区分
通勤		男女共通	2区分
通学		男女共通	全年齢統合
私事	自宅発	男女共通	3区分
	その他	男女共通	3区分
業務	自宅発	男女共通	2区分
	勤務先発	男女共通	2区分
帰宅	勤務先	男女共通	2区分
	通学先	男女共通	全年齢統合
	私事先	男女共通	3区分
	業務先	男女共通	2区分

4) Railway Route Selection

目的区分		性別	年齢区分
通勤		男女共通	2区分
通学		男女共通	全年齢統合
私事	自宅発	男女共通	2区分
	その他	男女共通	2区分
業務	自宅発	男女共通	2区分
	勤務先発	男女共通	2区分
帰宅	勤務先	男女共通	2区分
	通学先	男女共通	全年齢統合
	私事先	男女共通	2区分
	業務先	男女共通	2区分

赤色：18号答申時からの改良点

Implementing the station accessibility into the model



IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model

Station Access Model in M-MAP2

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

Conceptual Image of Inter-modal Facilities

at typical on-road station

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

at stations on SRT Line (not along major roads)

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

IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model

Station Access Model in M-MAP2

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

at terminal stations / sub-urban stations

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

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

IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model

Railway Station Access Modal Split parameter estimation (commuting)

evaluate the station accessibility improvement policy

- access point closer to station
- less cost to access
- different level → effect to elderly
- elevated/underground → at grade transfer
- more bus frequency

		Work				School	
		Non-elderly		Elderly		All-age	
		parameter	t-value	parameter	t-value	parameter	t-value
Walk/2wheel travel time (min)	Walk, 2 wheel	-0.220	-26.7	-0.127	-12.6	-0.159	-12.7
Bus/car travel time (min)	Bus, Car	-0.0911	-7.45	-0.0449	-2.67	-0.0721	-4.93
Total cost (¥)	All	-0.00603	-9.62	-0.00368	-4.15	-0.00738	-5.31
Level difference* (m)	Walk, 2 wheel	-0.0107	-4.13	-0.00885	-2.61	-0.0131	-3.45
Ln (bus frequency per hour) for private and business, per day	Bus	0.287	6.22	0.236	3.53	0.190	2.40
Constant	2 wheel	-3.02	-32.9	-2.24	-16.6	-1.91	-14.6
	Car	-6.78	-33.6	-5.16	-17.7	-4.98	-17.5
	Bus	-4.58	-17.9	-3.44	-9.17	-3.22	-9.32
ρ^2		0.376		0.267		0.268	
Accuracy rate (%)		65.2		61.4		58.7	
VOT in walk & 2 wheel (¥/min)		36.5		34.5		21.5	
VOT in car & bus (¥/min)		15.1		12.2		9.8	
Cost-level elasticity (¥/m)		1.77		2.40		1.78	
Sample size		3,000		1,000		1,000	

*station level and zone centroid level difference

IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model

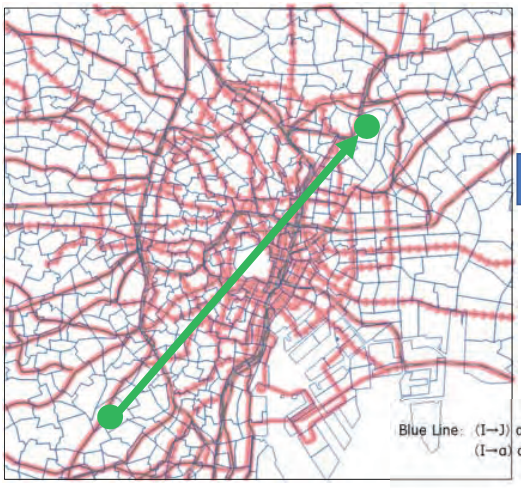
Modal Split parameter estimation (commuting)

		Work				School	
		Non-elderly		Elderly		All-age	
		parameter	t-value	parameter	t-value	parameter	t-value
Cost (yen)	All	-0.00123	-10.4	-0.000940	-7.34	-0.00561	-13.1
On-board time (min)	All	-0.0482	-18.2	-0.0389	-13.8	-0.0102	-2.13
Car ownership (veh/per)	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 Accessibility	Rail	0.446	33.6	0.504	24.0	0.148	4.93
Short distance dummy	Car	0.665	6.13	0.530	4.33	2.18	6.87
Constant	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
ρ^2		0.740		0.545		0.975	
Accuracy rate (%)		90.3		79.9		93.8	
On-board VOT (¥/min)		39.3		41.3		1.81	
Sample size		9,763		3,689		2,786	

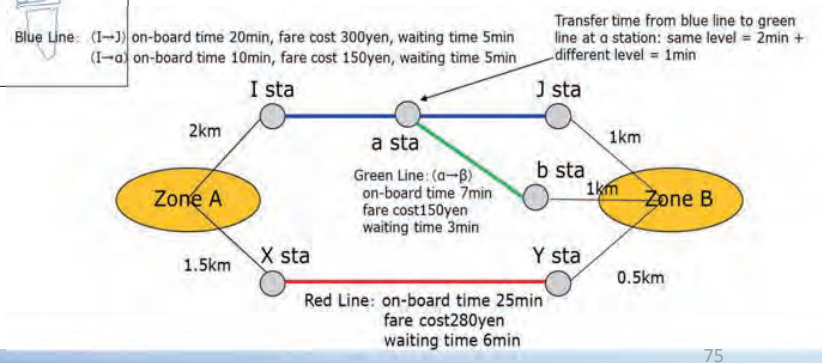
Railway Route assignment parameter estimation (commuting)

	Work				School	
	Non-elderly		Elderly		All-age	
	parameter	t-value	parameter	t-value	parameter	t-value
Fare cost (¥)	-0.00355	-3.89	-0.00325	-3.09	-0.00415	-3.94
Railway on-board time (min)	-0.151	-7.35	-0.0974	-5.62	-0.0800	-5.40
Same level transfer time (min)	-0.242	-6.54	-0.139	-4.22	-0.133	-3.51
Different level transfer time (min)	-0.313	-4.77	-0.329	-4.91	-0.137	-2.02
Waiting time (min)	-0.145	-4.24	-0.112	-3.63	-0.0784	-3.37
Congestion	-0.0122	-2.50	-0.0335	-5.42	-0.0101	-1.88
Station Accessibility	0.883	12.7	0.991	10.6	0.908	12.5
ρ^2	0.128	2.88	0.022	1.16	0.019	1.08
Accuracy rate (%)	0.440		0.389		0.433	
Railway on-board VOT	42.6		30.0		19.3	
Same level transfer VOT	68.3		42.7		32.0	
Different level transfer VOT	88.1		101		33.1	
Waiting VOT	40.7		34.3		18.9	
Sample size	1,000		500		500	

IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model



Railway route selection
SO MANY CHOICES！
What is a probability of selecting each line ?



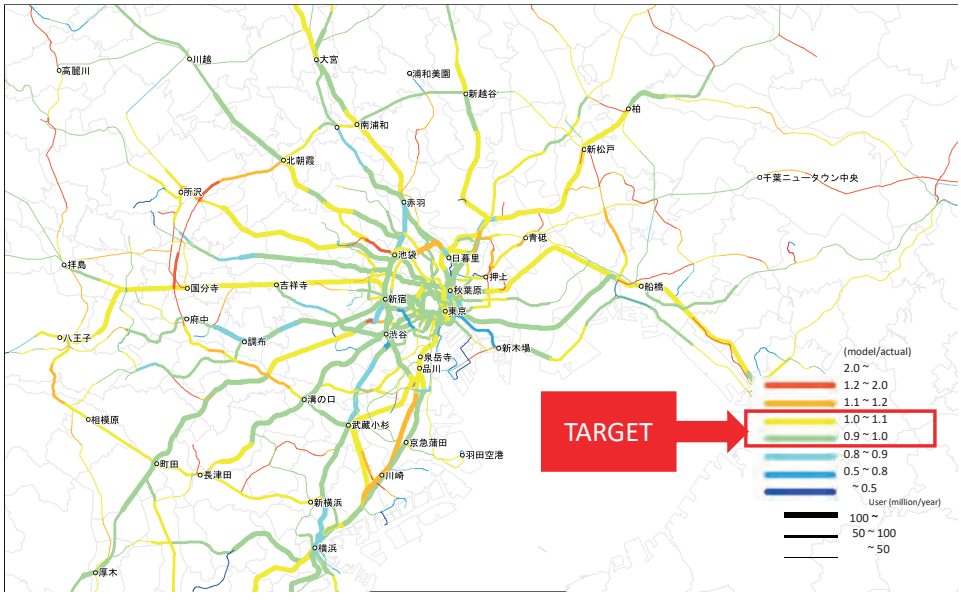
IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model

- Utilizing the actual data from Metropolitan Transportation Census (MTC)
- Visualizing the result with GIS data for better understanding

	CTPP No.7, No.18	CTPP No. 198
Parameter Estimation	[Zone centroid] • based on estimator's judgment [Zone-nearest station setting] • based on the bus route, multiple station could be set [Route setting] a) based on shortest travel time b) based on estimator's judgment **parameter estimation is conducted from randomly selected routes	[Zone centroid] • Weighted calculate from population in mesh level [Station and route setting based on MTC] a) Station List: based on the access-egress data from MTC b) Route List: based on the route O-D list from MTC c) Candidate route selection: extracted from access-egress data, station list, route list d) Top 4 candidate route: from all candidate routes, rank the route based on no.of passenger then select the candidate by considering the route overlap rate and types of train
Simulate the current condition & future forecast		a) In each O-D, select the shortest travel time route b) Select the shortest travel time route for access and egress to station c) Select the minimum cost route for access and egress to station d) Select the railway route to connect each access stations. There is also the case were station and railway route are combined as a set e) Add the railway route based on MTC in the model

IV-2 (4) Improvements in CTPP No.198
3) Improvements in demand forecasting model

Result from the model will be calibrated with the passenger result from MTC. 10% difference is targeted.



SUMMARY

Issue to be considered in BMA demand forecasting

What we want to express:

- To answer the given policy, including
  1. Modal shift from car
     - What will be the modal share in the future?
  2. Train station access
     - Changing in station access pattern (Bus, Van → Walk?, Bike?)
  3. Railway investment priority selection
     - Railway route selection modelling

SUMMARY (2)

Issue to be considered in BMA demand forecasting

What we want to express:

- To answer the given policy, including (continue)
  4. The effect of new railway development
     - Congestion relieve
     - Reduction in number of transfer
  5. Consideration of Airport, HSR and tourist demand
  6. Check the LOS setting (how it is set in the model)
  7. Check the parameter estimation
     - Negative? Positive?

Please consider these policies along with demand forecast model

Thank you for your attention
ご清聴ありがとうございました

Appendix 5

Traffic Survey

Appendix 5: Traffic Survey

Table of Contents

1. Railway Congestion Survey

1.1 Background

The most serious transport issue in the BMR is the heavy traffic congestion in the city center where BTS, MRT and ARL run across. Congestion inside of mass rapid transit train car in BMR is also serious, especially in morning and evening peak hours. Passengers may miss trains and have to wait for the next train, or even passengers can take a train, the inside will be very crowded. Seen from the results of 4 People's Perception Survey, congestion inside a train car seems crucial for BMR citizen to decide whether they take mass transit for committing or not.

Though every section in peak hours is not very congested, some of them have serious congestion. Stations on the same line have different peak hours and congested situation, which becomes worse to the city center. However, the information of congestion ratio regarding the BMR mass transit does not exist or is not open for public by the operators.

Railway Congestion Survey aimed to identify present operating situation in BMR, and raw data regarding how congested inside of a train car is and which sections have serious problems of congestion in peak hours are measured.

1.2 Objectives (Survey Items)

Following items were observed at each designated survey station:

- Congestion ratio of every train set in peak morning hours (7am to 9am)
  *1 At one station from each line, the survey was conducted from 7am to 9pm.
  *2 The standard is prepared based on the Japanese one, which is explained in detail later.
- Arrival time of each train

1.3 Survey Method

1) Preparation of the Survey

In order to implement the survey, JICA Study Team and PSK Consults Co., Ltd, hereafter called the Consultant, got permission from the mass transit operators with cooperation from OTP.

Prior to implementation of the survey, the Consultant visited each station and survey location including location of train car and door was considered and decided. The Consultant also translated the survey form from English into Thai according to necessity.

Then, the Consultant trained the surveyors to let them understand the standard of congestion ratio since the standard is not very clear. The surveyors were to measure the average congestion ration of 3 designated doors. After the trail measurement, JICA Study Team and the Consultant confirmed that the surveyors became able to measure the congestion ratio almost uniformly.

2) Field Survey

Trained surveyors measured the congestion ratio for all trains during the survey hours just before a train has departed. The surveyors also measured the arrival time of train in order to measure head of each train.

3) Definition of Congestion Ratio

Definition of congestion ratio in a train, which is used in Japan, is shown in Table 1.1. The congestion ratio has been measured by each railway operator in Japan and reported to Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

Table 1.1 Definition of Congestion Ratio

Congestion Ratio	35%	70%	100%	150%	180%	200%
Description	All the seat are occupied and no standing passengers	All the seat are occupied and standing passengers	Capacity of a train car (All seats are occupied and standing passengers with holding a bar in front of a 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.
Image	No Image	No Image				

Source: Japan Private Railway Association

In Tokyo Metropolitan Area, target average congestion ratio during peak hours at 32 sections is set at 150%, and congestion ratio of each line during peak hours is aimed to be lower than 180%. However, according to article by MLIT on 17th July 2018, 11 lines have sections whose congestion ratio is more than 180%.

4) Survey Area

JICA Study Team selected survey stations and duration of the survey based on the site visit before the actual survey. Survey locations are shown as follows.

Prepared by JICA Study Team

Figure 1.1 Route Map of each Line in BMR

5) Survey Schedule

The survey was conducted from 18th to 22nd December 2017 at 64 stations. The survey was conducted for peak hours and peak direction of each line on normal week days. For Sukhumvit station and Siam station of Si Lom line and Sukhumvit line, the survey was conducted for 14 hours from 7:30 to 21:30 in order to grasp congested situation by time.

Table 1.2 Survey Schedule

No.	Date	Station Name	Line Name	Duration	Bound to
1	18/12/2017	Tao Poon	Blue Line	7:30-9:30	Hua Lamphong
2		Bang Sue			
3		Kamphaeng Phet			
4		Chatuchak Park			
5		Phanon Yothin			
6		Lat Phrao			
7		Rachadaphisek			
8		Sutthisan			
9		Huai Khwang			
10		Thailand Cultural Center			
11		Phra Ram 9			
12		Phetchaburi			
13		Sukhumvit		7:30-21:30	
14	19/12/2017	Hua Mak	ARL	7:30-9:30	Phaya Thai
15		Ramkhamhaeng			
16		Makkasan			
17		Ratchaprarop			
18		Nonthaburi Civic Center	Purple Line	7:30-9:30	Tao Poon
19		Ministry of Public Health			

No.	Date	Station Name	Line Name	Duration	Bound to
20		Yeak Tiwanon			
21		Wong Sawang			
22		Bang Son			
23		Mo Chit			
24		Saphan Khwai			
25		Ari			
26		Sanam Pao		7:30-9:30	
27		Victory Monument			
28		Phaya Thai	Sukhumvit Line		Samrong
29	20/12/2017	Ratchathewi			
30		Siam		7:30-21:30	
31		Chit Lom			
32		Phloen Chit		7:30-9:30	
33		Nana			
34		Asok			
35		Bang Na			
36		Udom Suk			
37		Punnawithi			
38		Bang Chak			
39		On Nut			
40		Phra Khanong			
41		Ekkamai		7:30-9:30	
42		Thong Lo			
43	21/12/17	Phrom Phong	Sukhumvit Line		Mo Chit
44		Asok			
45		Nana			
46		Phloen Chit			
47		Chit Lom			
48		Siam		7:30-21:30	
49		Ratchathewi			
50		Phaya Thai		7:30-21:30	
51		Victory Monument			
52		Siam		7:30-21:30	
53		Ratchadamuri			
54		Sala Deang		7:30-9:30	Bang Wa
55		Chong Nonsi			
56		Talat Phlu			
57		Pho Nimit			
58	22/12/2017	Wongwain Yai	Silom Line		
59		Krung Thonburi		7:30-9:30	National Stadium
60		Saphan Taksin			
61		Surasak			
62		Ching Nonsi			
63		Sala Deang			

No.	Date	Station Name	Line Name	Duration	Bound to
64		Ratchadamuri			

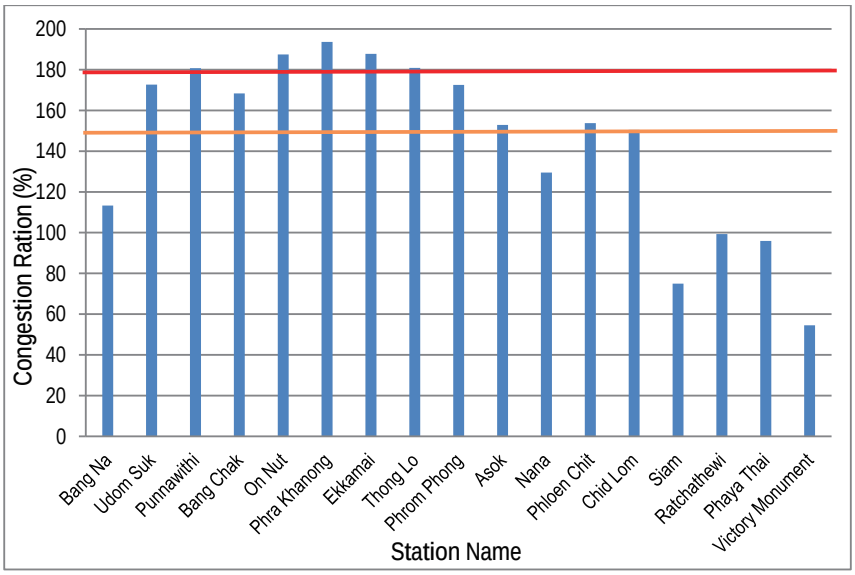
1.4 Survey Results

1) Sukhumvit Line to North Bound (Bang Na Station to Victory Monument Station)

Average congestion ratio between Bang Na station and Victory Monument station during the most congested hour, 7:44-8:43 at Victory Monument station, is shown in Figure 1.2. As seen here, most congestion sections were from Punnawithi station to Thong Lo station. At Bang Chak station, the congestion ratio is lower than other surrounding stations because additional trains departed from the station.

Congestion ratio at On Nut Station, Phra Khanong Station and Ekkamai Station was more than 180% in the peak hour, which are above the red line and all stations between Udom Suk station and Asok station had more than 150% congestion ratio.

The number of train sets during 7:44-8:43 at Victory Monument Station was 21, which means average interval between trains is 2 minutes 51 seconds.



Note: Survey time was 7:44-8:43 at Victory Monument station
Source: JICA Study Team

Figure 1.2 Average Congestion Ratio from Bang Na to Victory Monument

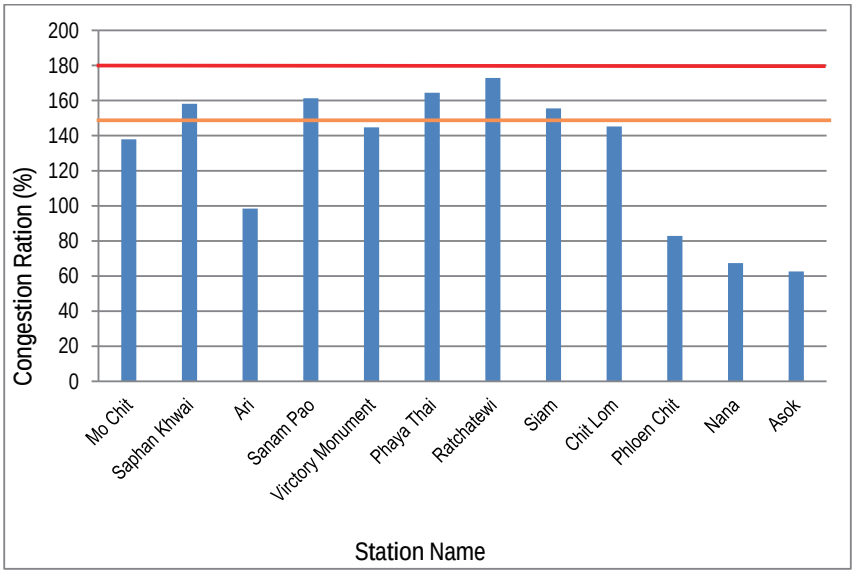
2) Suhkumvit Line to South Bound (Mo Chit station to Asok station)

Average congestion ratio between Mo Chit station and Asok station during the most congested hour, 7:59-8:58 at Asok station, is shown in Figure 1.3. As seen here, the section from Saphan Kwai station to Siam station was congested and more than 150% congestion ratio without 2 stations. At Ari station, the congestion ratio is lower than other surrounding

stations since there are a lot of office buildings and ministry buildings around the station so many passengers take off a train. Then, there is a huge bus terminal near Victory Monument station and there are many commuters who transfer from train to bus or from bus to train.

No station exceeds congestion ratio, 180 % during the peak hour at this section.

The number of trains from 7:59 to 8:58 at Asok station was 19 trains, which means the trains interval is 3 minutes 9 seconds during this time.



Note: Survey time was 7:59-8:58 at Asok station
Source JICA Study Team

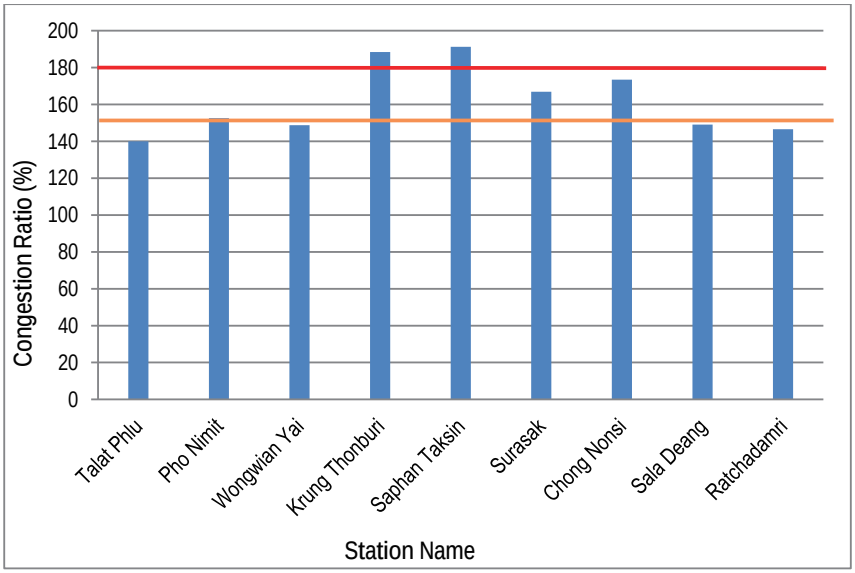
Figure 1.3 Average Congestion Ratio from Mo Chit to Asok station

3) Silom Line to North Bound (Talat Phlu station to Ratchadamri station)

Average congestion ratio between Talat Phlu station and Ratchadamri station during the most congested hour, 7:45-8:44 at Ratchadamri station, is shown in Figure 1.4. As seen here, the section from Krung Thonburi to Surasak was congested. At Wongwain Yai station, the congestion ratio is lower than other the former station because a lot of students took off there according to the surveyors.

Congestion ratio at Khrung Thon Buri Station and Saphan Taksin Station exceeds 180% during the peak hour.

The number of trains from 7:45 to 8:44 at Ratchadamri Station was 16 trains, which means the train interval between trains was 3 minutes 45 seconds.



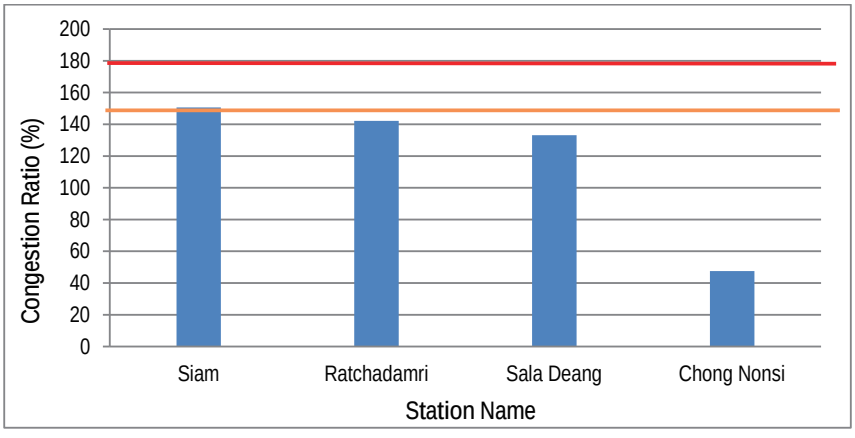
Note: Survey time was 7:45-8:44 at Ratchadamri station
Source: JICA Study Team

Figure 1.4 Average Congestion Ratio from Talat Phlu to Ratchamuri station

4) Silom Line to South Bound (Siam station to Chong Nonsi station)

Average congestion ratio between Siam station and Chong Nonsi station during the most congested hour, 7:58-8:57 at Chong Nonsi station, is shown in Figure 1.5. As seen here, this section is not very crowded since the direction from Siam to Chong Nosi is from the BMR center to BMR sub urban area. There are lots of office buildings around Chong Nonsi station so the congestion ratio dropped off rapidly there.

The number of trains from 7:58 to 8;57 at Chong Nonsi Station was 16 trains, which means the time interval between trains is 3 minutes 45 seconds.



Note: Survey Time was 7:58-8:57 at Chong Nonsi station
Source: JICA Study Team

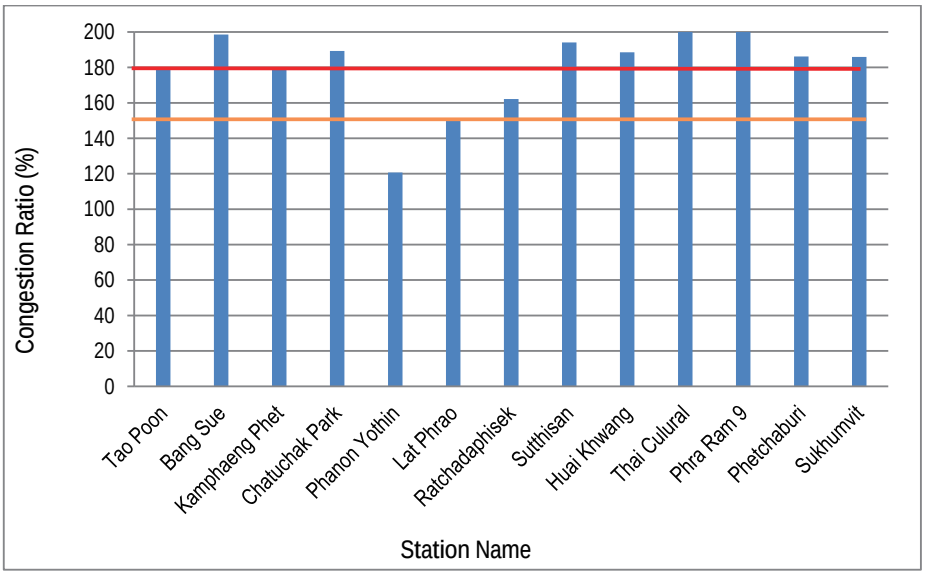
Figure 1.5 Average Congestion Ratio from Siam to Chong Nonsi station

5) Blue Line to Hua Lum Phong Station (Tao Poon to Sukhumvit station)

Average congestion ratio between Tao Poon station and Sukhumvit station during the most congested hour, 7:37-8:36 at Sukhumvit station, is shown in Figure 1.6.

Without Phahon Yothin station, the congestion ratio is more than 150% and congestion ratio at Bang Sue Station, Chatuchak Park Station, Suthisan Station, Huai Khwang Station, Thailand Cultural Station, Phra Ram 9 Station, Phetchaburi Station and Sukhumvit Station, total 9 stations, exceeds 180 %.

The number of trains from 7:34 to 8:33 at Sukhumvit station was 18 trains, which mean the time interval between trains during a peak hour is 3 minutes 20 seconds.



Note: Survey Time was 7:37-8:36 at Sukhumvit station.
Source: JICA Study Team

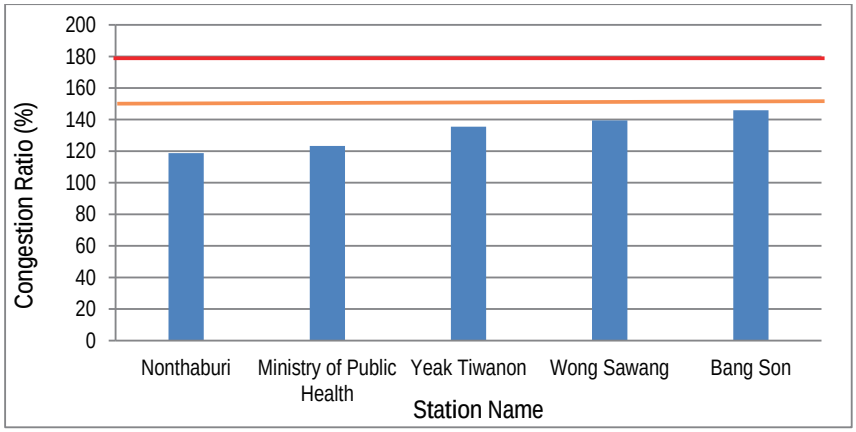
Figure 1.6 Average Cngestion Ration form Tao Poon to Sukhumvit Station

6) Purple Line to Tao Poon Station

Average congestion ratio between Nontaburi station and Bang Son station during the most congested hour, 7:31-8:30 at Bang Son station, is shown in Figure 1.7. As seen here, this section is not very crowded since Purple line is a new and the most congested hour seems earlier than 7:30 am based on the result of congestion ratio at Tao Poon station of Blue line.

No station exceeds 140% congestion ration during the peak hour.

The number of trains from 7:31 to 8:30 at Bang Son Station is 11, which means the time interval between trains is 5 minutes 27 seconds.



Note: Survey Time was 7:31-8:30 at Bang Son station
Source: JICA Study Team

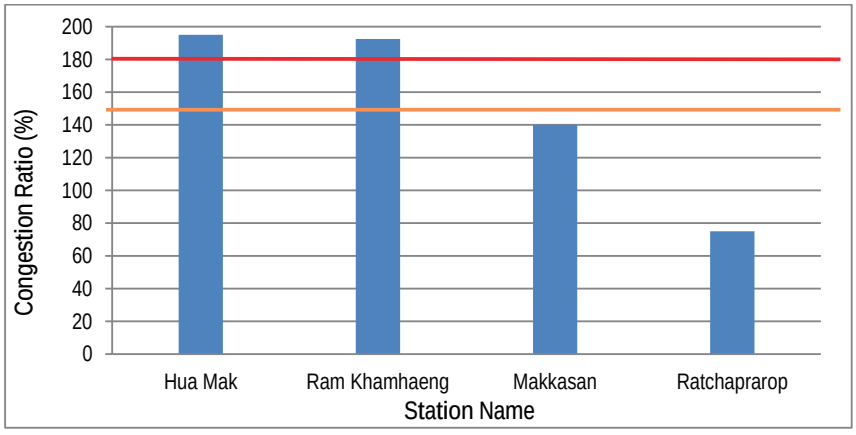
Figure 1.7 Average Congestion Ratio from Nonthaburi to Bang Son station

7) Airport Rail Link to Phaya Thai (Hua Mak to Rachaprarop)

Average congestion ratio between Hua Mak station and Rachaprarop station during the most congested hour, 8:00-8:59 at Rachaprarop station, is shown in Figure 1.8. The time table on the survey day was disordered and the train did not come with the same interval. Therefore, the congestion can be more serious than usual.

Congestion ratio at Hua Mak Station and Ram Khamhaeng Station exceeds 180% during the peak hour.

The number of trains from 7:57 to 8:56 at Ratchaprarop Station was 5 trains, which means the time interval between trains was 12 minutes.



Note: Survey Time was 8:00-8:59 at Ratchaprarop station
Source: JICA Study Team

Figure 1.8 Average Congestion Ratio from Hua Mak to Ratchaprarop station

1.5 Discussions

As seen from the results, lines connected toward the city center directory were very crowded during the commuting hours. Though the survey was planned to be conducted from 7:00 to 9:00 originally to catch the situation exactly at peak hours, operators did not allow surveyors to enter inside of stations before 7:00. Then, the peak hour of blue line and purple line seems earlier than 7:30 so this survey may not be able to get the exact peak hour information.

Though this survey was conducted based on the Japanese standard of congestion ratio, the concept of congestion ratio itself is not common in Thailand. From this aspect, the congestion ratio can be a little different from the Japanese one. Seen from the actual situation, Thai people do not go inside of a train very much and they gather tend to stay near the entrance. As a result, congestion ratio inside a train seems not homogenous and the congestion ratio near the door is relatively high.

Then, from the results, Blue line had the most serious congestion in BMR and there are some possible causes of this congestion; 1) the ridership has increased after the connection with Blue line at Tao Poon station on August 11th 2017, 2) one train set of Blue line consists of 3 cars while that of BTS trains consists of 4 cars, 3) there are a lot of connecting points with buses for commuting from north and 4) at some stations, parking space is adjacent to the station in order to promote park and ride method.

Some countermeasures should be taken for the sections whose congestion ratio is more than 180 %. Discussed in the main report, one of the solutions is to increase the number of cars for each train set. Each line was designed to accommodate 6 cars per train set while currently one train set is consisted of 3 or 4 cars. The reason why the number of cars cannot be increased seems not only because of the cost, but also because of the condition of the original contract with the maker.

Table 1.3 Capacity Expansion of Existing Mass Transit Lines

	Exiting operation		Estimated Peak Transport capacity (pphpd) (A)	Improved operation		Increased capacity (pphpd) (B)	Ratio (B)/(A)
	No. of rolling stocks	Peak Frequency		No. of Rolling stocks	Peak Frequency		
Airport Rail Link	3	6	4,200	4	10	9,300	2.2
Sukhumvit Line	4	20	22,300	4	24	26,800	1.2
Silom Line	4	20	22,300	4	24	26,800	1.2
Purple Line	3	12	10,000	4	15	16,700	1.7
Blue Line	3	12	10,000	4	15	16,700	1.7

pphpd: passengers per hour per direction

Prepared by JICA Study Team

The sections whose congestion ratio is more than 150% should be considered and continued effort should be made. In particular, Blue Line and Silom line has many sections

whose congestion ratio is between 150% and 180%. If the number of passengers near the starting station increases, the congestion ratio after the station is also correlatively increased.

These results have been reflected on M-MAP2 and some solutions such as to increase of the number of train set or to shorten the head of trains are discussed in M-MAP2. The congestion ratio is directly connected with the comfortableness of trains. Less congestion ratio can lead car captive users to use Mass Transit, so that discussion with the operators regarding this matter is crucial. At the same time, since these results are not open for public, this can be a pilot survey and hopefully will be conducted continuously by Thai government

Survey Form for Train Congestion Ratio Survey

Survey Station:_____ Direction to:_____

Date:_____ Surveyor's Name:_____

Start Time:_____ Finish Time:_____

Weather:_____

Location at the Platform:_____

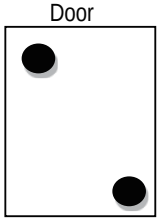
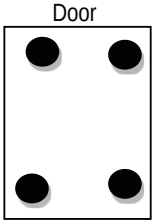
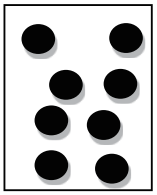
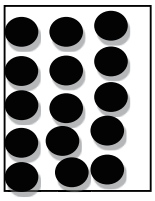
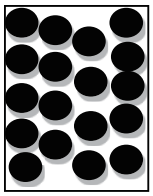
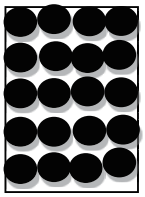
→

4	3	2	1

Remark: Congestion Ratio shall be measured by 10% (10%, 20%, 30%,…, 180%,190%, 200%).

No.	Train Number	Train Arrival time Hr : Min : Sec	Congestion Ratio Departure (%)
1		: :	
2		: :	
3		: :	
4		: :	
5		: :	
6		: :	
7		: :	
8		: :	
9		: :	
10		: :	

Table Definition of Congestion Ratio

40%	70%	100%	150%	180%	200%
All the seat are occupied and no standing passengers (Less than 2 persons standing)	All the seat are occupied and standing passengers (About 4 persons standing)	Baby car can be on a train without problems (About 8 standing persons)	Passengers can use smart phone without problems. (About 15 standing persons)	Passengers can use smart phone somehow (About 18 standing persons)	Passengers cannot use smart phone and standing passengers outside. (More than 20 standing persons)
Door 	Door 	Door 	Door 	Door 	Door 

2. Transfer Time Survey

2.1 Background

There are 5 existing MRT lines in BMR; Sukhumvit Line, Si Lom Line, Blue Line, Purple Line and Airport Rail Link. Owner and Operator of MRT lines are different; Sukhumvit Line and Si Lom Line are owned by BMR and operated by BTSC, Blue Line and Purple Line are owned by MRTA and operated by BEM, and Airport Rail Line are owned by SRT and operated by SRTET. Hence, when the line was planned and designed, the connecting point of lines seems not to be considered very well since the owner and the operator is different and they may focus only on their own benefit. As a result, stations for transfer are located far and passengers have to walk for long distance.

When you go to a mass transit station in rush hours, a long que in front of ticketing machine can be seen especially in rash hours. Though there is a smart card for mass transit lines which can be issued by an operator, the cards were different by operator by operator (now, the Manmoon card, stored value card, was issued in June 2018 but the card is not still compatible with Airport Rail Link).

In order to shorten commuting time in BMR, current commuting time from their home to office should be acknowledged and considered. Therefore, this transferring time survey was planned and conducted by JICA Study Team.

2.2 Objectives (Survey Items)

Following items were observed at target stations:

- Distance between one platform to another platform measured by the number of steps
- Drawing between platform and platform
- Transfer time between one plat form to another

2.3 Survey Method

1) Preparation of the Survey

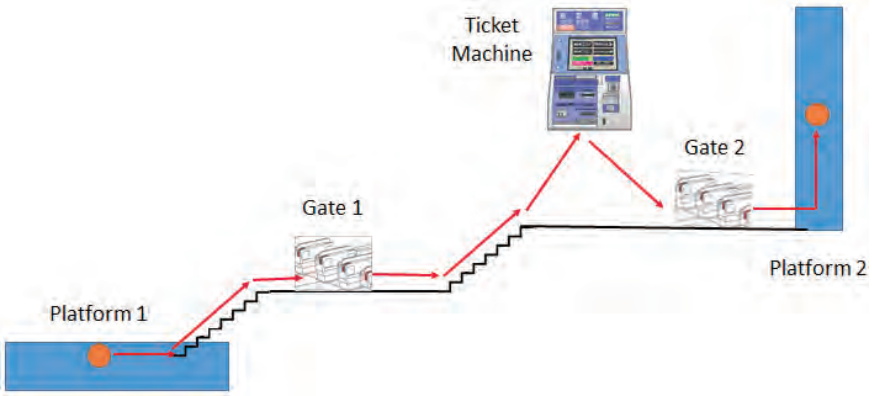
In order to implement the survey, JICA Study Team and PSK Consults Co., Ltd, hereafter called the Consultant, JICA Study Team and the Consultant confirmed the route between platform and platform at 8 stations.

Prior to implementation of the survey, the Consultant visited a station with surveyors in order to explain how to measure. The number of steps, time and drawing between platform and platform was recorded by a surveyor. The Consultant also translated the survey form from English according to necessity.

2) Field Survey

Trained surveyors conducted survey 5 times for 1 station; 1 time for measuring distance from one platform to another platform, 2 times for measuring with a smart card during 7 am and 2 times for measuring without a smart card and dropping by ticket machine during

7am to 9 am. The image of survey is shown in Figure 2.1.



Prepared by JICA Study Team

Figure 2.1 Image of Transfer Time Survey

Seen from the time sheet below, flat way and steps are distinguished when time and distance were measured separately. Then, longest way which includes ticket machine or ticket counter was measured for this survey.

3) Survey Area

There are 8 transferring points of trains and the locations are seen below. Stations No. 1, and No. 2, there is no ticketing gate since the operators for both lines are same.

Table 2.1 List of Transferring Stations

No.	Transferring Stations		
1	Siam	⇔	Siam
2	Tao Poon	⇔	Tao Poon
3	Asok	⇔	Sukhumvit
4	Phaya Thai	⇔	Phaya Thai
5	Chatuchak Park	⇔	Mo Chit
6	Phetchaburi	⇔	Makkasan
7	Chong Nonsi	⇔	Sathorn
8	Si Lom	⇔	Sala Deang

Note:

1) In the cases of No.1 and No.3, there are no gates' transfer for passengers because both lines are operated by the same company (Tao Poon Station: both are operated by BEM, Siam Station: both are operated by BTSC).

Source: Wikipedia

Figure 2.2 Location of Transfer Time Survey (8 Stations)

4) Survey Schedule

The survey was conducted from 7am to 9am on 28th, 29th and 30th November 2017 at 8 stations on normal weekdays.

2.4 Survey Results

1) Distance between Platform

Results regarding distance between platform and platform are measured and recorded on the survey sheet and the results are shown after the discussion part. Seen from the results, the measurement was conducted for round ways between platforms. When there are short flat floors between stairs and stairs, the number of steps was recorded at the cell which is above the number of steps of stairs.

The results of how to measure distance between platform and platform is shown later with the survey sheets and the distance circulated by number of steps is summarized as follows.

Table 2.2 Distance between Platforms at 8 Transfer Points

No.	Transferring Stations			Distance between Platforms (m)
1.1	Siam (Upper)	⇒	Siam (Lower)	115
1.2	Siam (Lower)	⇒	Siam (Upper)	114
2.1	Tao Poon (Blue)	⇒	Tao Poon (Purple)	112
2.2	Tao Poon (Purple)	⇒	Tao Poon (Blue)	114
3.1	Asok	⇒	Sukhumvit	208
3.2	Sukhumvit	⇒	Asok	197

No.	Transferring Stations			Distance between Platforms (m)
4.1	Phaya Thai (BTS)	⇒	Phaya Thai (ARL)	259
4.2	Phaya Thai (ARL)	⇒	Phaya Thai (BTS)	249
5.1	Chatuchak Park	⇒	Mo Chit	225
5.2	Mo Chit	⇒	Chatuchak Park	249
6.1	Phetchaburi	⇒	Makkasan	414
6.2	Makkasan	⇒	Phetchaburi	382
7.1	Chong Nonsi	⇒	Sathorn	329
7.2	Sathorn	⇒	Chong Nonsi	329
8.1	Si Lom	⇒	Sala Deang	419
8.2	Sala Deang	⇒	Si Lom	417

Note: 1. These distances does not include distances of stairs.
2.Numbers below decimal point are cleared.
Source: JICA Study Team

2) Transfer Time between Platforms

The results of transfer time between platforms are shown later with the sheets and the summery is shown in Table 2.3. The time was measure in two cases; one is the situation that a passenger buys a ticket at ticket machine and another is that a passenger has a smart card so he/she can transfer directly.

Table 2.3 Transfer Time between Platforms (average of 2 times9

No.	Transferring Stations			Ticket	Transfer time between platforms (min)	Differences between with and without a ticket (min)
1.1	Siam (Upper)	⇒	Siam (Lower)	-	1:46	-
				○	-	
1.2	Siam (Lower)	⇒	Siam (Upper)	-	1:42	-
				○	-	
2.1	Tao Poon (Blue)	⇒	Tao Poon (Purple)	-	3:12	-
				○	-	
2.2	Tao Poon (Purple)	⇒	Tao Poon (Blue)	-	3:02	-
				○	-	
3.1	Asok	⇒	Sukhumvit	-	7:17	0:59
				○	6:18	
3.2	Sukhumvit	⇒	Asok	-	5:13	0:46
				○	4:27	
4.1	Phaya Thai (BTS)	⇒	Phaya Thai (ARL)	-	6:50	2:29
				○	4:21	
4.2	Phaya Thai (ARL)	⇒	Phaya Thai (BTS)	-	6:12	0:43
				○	5:29	
5.1	Chatuchak Park	⇒	Mo Chit	-	7:15	0:48
				○	6:27	

No.	Transferring Stations			Ticket	Transfer time between platforms (min)	Differences between with and without a ticket (min)
5.2	Mo Chit	⇒	Chatuchak Park	-	6:27	0:38
				○	5:49	
6.1	Phetchaburi	⇒	Makkasan	-	10:18	1:36
				○	8:42	
6.2	Makkasan	⇒	Phetchaburi	-	9:46	0:40
				○	9:06	
7.1	Chong Nonsi	⇒	Sathorn	-	5:39	0:20
				○	5:19	
7.2	Sathorn	⇒	Chong Nonsi	-	4:37	0:22
				○	4:15	
8.1	Si Lom	⇒	Sala Deang	-	10:34	1:01
				○	9:33	
8.2	Sala Deang	⇒	Si Lom	-	12:17	1:37
				○	10:40	

*The Survey was conducted twice for the same route from 7:00 to 9:00. The information is written in time sheets.
Source: JICA Study Team

2.5 Discussions

There are several findings through this survey. One is that transfer points which are owned by the same owner have closer distance and shorter transfer time than the ones which are owned by the different owners. In particular, the distance between Makkasan station and Phetchaburi station and between Sala Deang station and Si Lom station is quite long because of this reason. In the MMAP2, discussion on connectivity between stations is crucial because this directly affects transfer time of passengers and willingness of taking mass transit. From these aspects, when new lines are planned and designed, the transfer points to other lines or other modes should be considered very well. If so, it is more convenient for passengers to use the line for commuting and the value of the line itself will be higher.

Another thing is that the time difference with ticket or without ticket is from 30 seconds to 60 seconds basically. When the surveyor transferred from one line to ARL, the difference was larger than other cases (more than 1:30 differences in both of cases). The possible reason is that the number of ticket machine and ticket counter of ARL is fewer than other lines' ones. Therefore, congestion for buying a ticket during peak hours was more serious than other lines.

Seen from the results, transfer from one line to another line takes more than 5 minutes when operators of the lines are different. Though this situation can be seen in Japan also, we usually consider this transfer time by the application or web site which searches the time including the transfer time. In the future, when the mass transit network in BMR is more developed, the transfer time can be crucial to be selected by a passenger as their first choice.

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Sukhumvit Line	Station Name	Siam	Direction to	Mo Chit
End	Line Name	BTS Silom Line	Station Name	Siam	Direction to	Bang Wa
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	84	4	114																	
	Number of Steps at Stairs		43																		

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

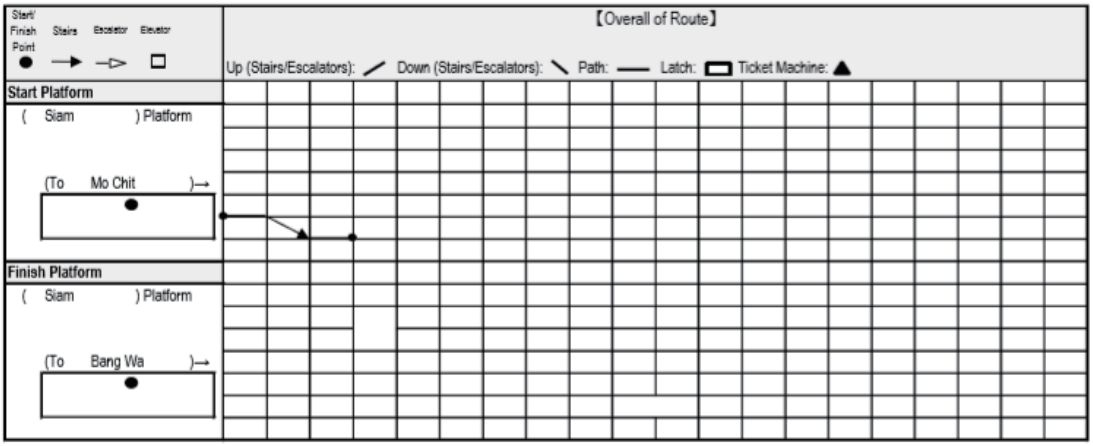


Figure 2.3 Number of Steps from Siam (Sukhumvit) to Siam (Silom)

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Silom Line	Station Name	Siam	Direction to	Bang Wa
End	Line Name	MRT Purple Line	Station Name	Siam	Direction to	Mo Chit
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	114	4	81																	
	Number of Steps at Stairs		43																		

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

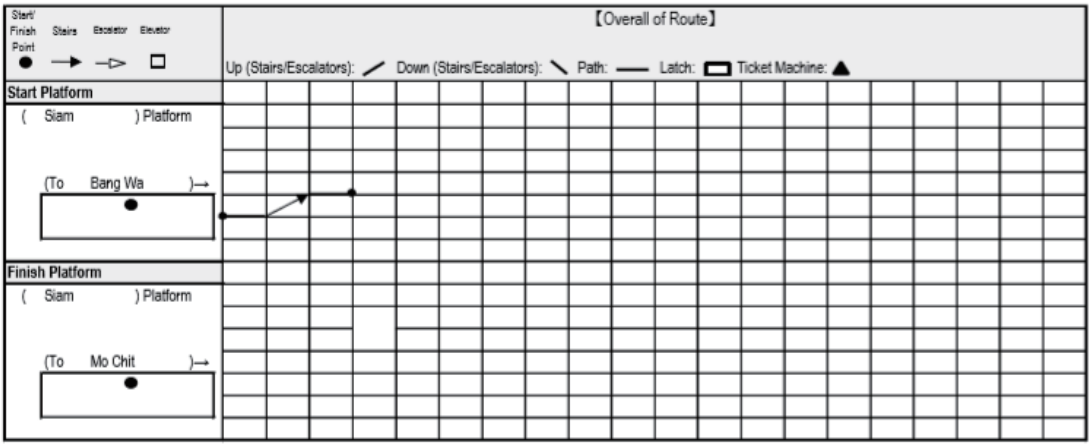


Figure 2.4 Number of Steps from Siam (Silom) to Siam (Sukhumvit)

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Sukhumvit Line	Station	Siam	Direction to	Mo Chit	Transfer within station platforms
End	Line Name	BTS Silom Line	Station	Siam	Direction to	Bang Wa	No need to buy ticket
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○																		
Time (S) 7:00 No ticket	0:28	1:08	1:51																	
Time (S) 8:00 No ticket	0:27	1:04	1:42																	

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ▷ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

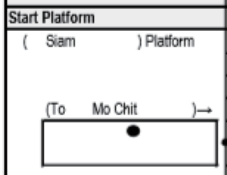


Figure 2.5 Transfer Time from Siam (Sukhumvit) to Siam (Silom)

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Silom Line	Station	Siam	Direction to	Bang Wa	Transfer within station platforms
End	Line Name	MRT Purple Line	Station	Siam	Direction to	Mo Chit	No need to buy ticket
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○																		
Time (S) 7:30 No ticket	0:46	1:24	1:53																	
Time (S) 8:30 No ticket	0:38	1:07	1:32																	

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ▷ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

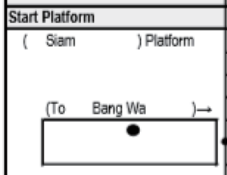


Figure 2.6 Transfer Time from Siam (Silom) to Siam (Sukhumvit)

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	MRT Blue Line	Station Name	Tao Poon	Direction to	Tao Poon
End	Line Name	MRT Purple Line	Station Name	Tao Poon	Direction to	Klong Bang Pai
Surveyor Name		Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	123	21	70																	
	Number of Steps at Stairs		52																		

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ⇨ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform

(Tao Poon) Platform

(To Tao Poon)→

Finish Platform

(Tao Poon) Platform

(To Klong Bang Pai)→

Figure 2.7 Number of Steps from Tao Poon (Blue Line) to Tao Poon (Purple Line)

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	MRT Purple Line	Station Name	Tao Poon	Direction to	Tao Poon
End	Line Name	MRT Blue Line	Station Name	Tao Poon	Direction to	Hua Lamphong
Surveyor Name		Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	70	21	125																	
	Number of Steps at Stairs		52																		

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ⇨ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform

(Tao Poon) Platform

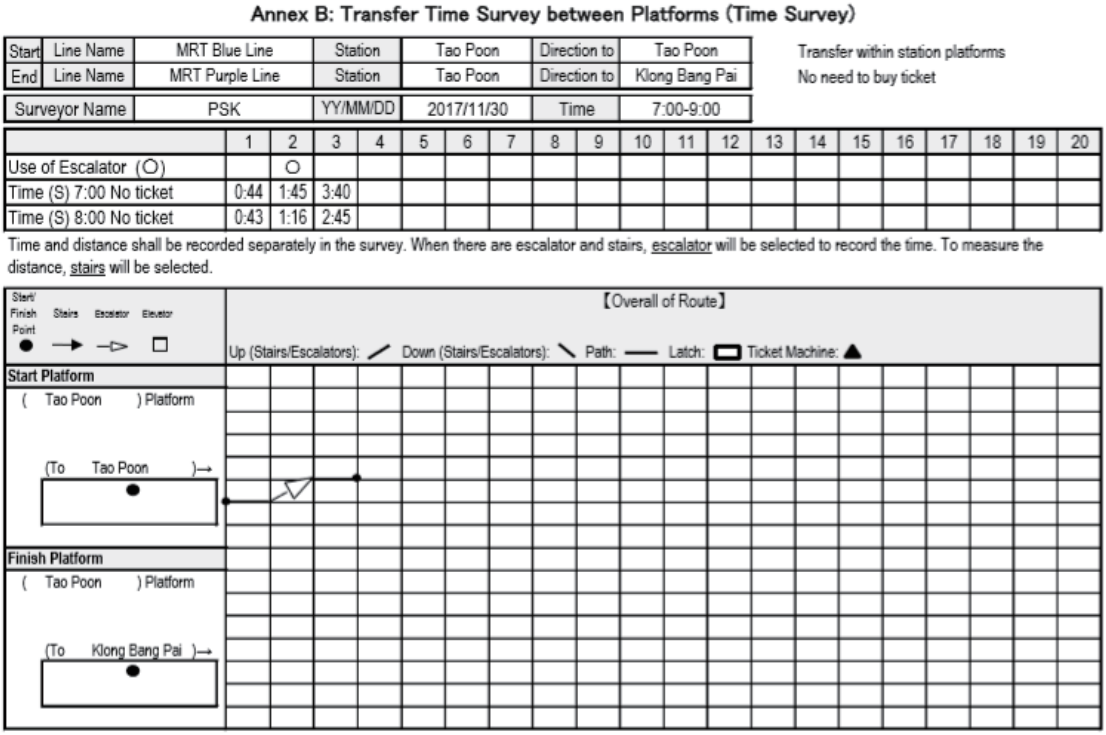
(To Tao Poon)→

Finish Platform

(Tao Poon) Platform

(To Hua Lamphong)→

Figure 2.8 Number of Steps from Tao Poon (Purple Line) to Tao Poon (Blue Line)



Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	MRT Blue Line	Station	Tao Poon	Direction to	Tao Poon
End	Line Name	MRT Purple Line	Station	Tao Poon	Direction to	Klong Bang Pai
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

Transfer within station platforms
No need to buy ticket

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○																		
Time (S) 7:00 No ticket	0:44	1:45	3:40																	
Time (S) 8:00 No ticket	0:43	1:16	2:45																	

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ▷ Elevator □

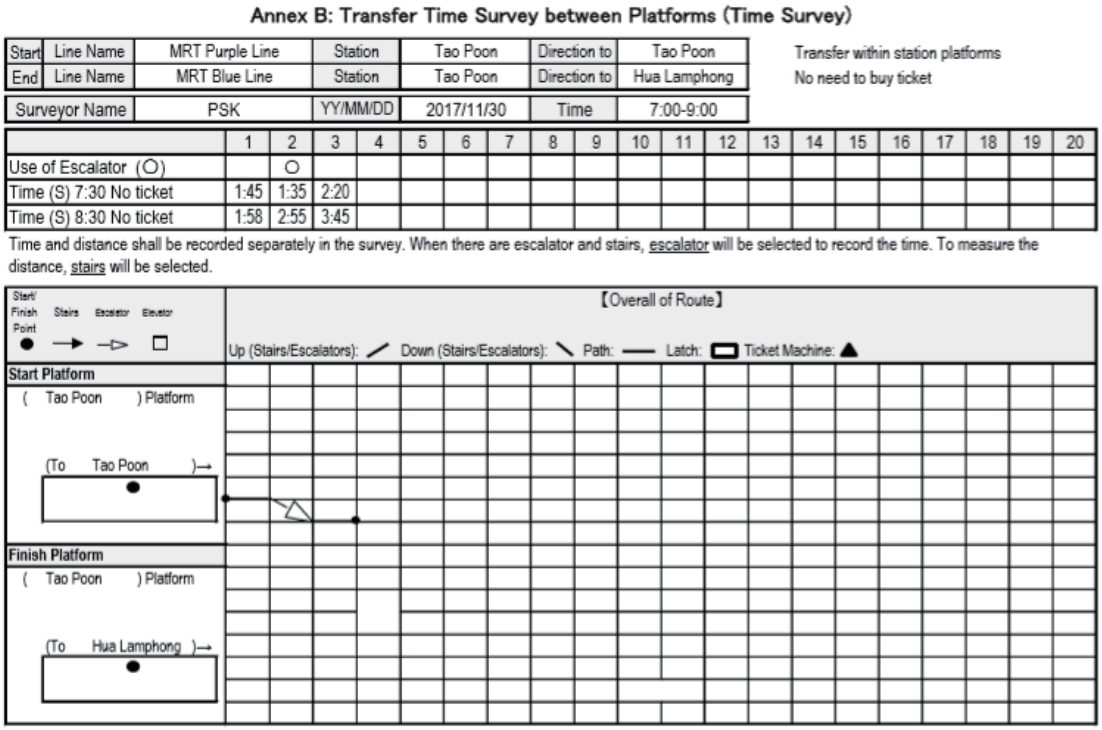
【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform
(Tao Poon) Platform
(To Tao Poon)→

Finish Platform
(Tao Poon) Platform
(To Klong Bang Pai)→

Figure 2.9 Transfer Time from Tao Poon (Blue) to Tao Poon (Purple)



Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	MRT Purple Line	Station	Tao Poon	Direction to	Tao Poon
End	Line Name	MRT Blue Line	Station	Tao Poon	Direction to	Hua Lamphong
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

Transfer within station platforms
No need to buy ticket

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○																		
Time (S) 7:30 No ticket	1:45	1:35	2:20																	
Time (S) 8:30 No ticket	1:58	2:55	3:45																	

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ⇨ Elevator □

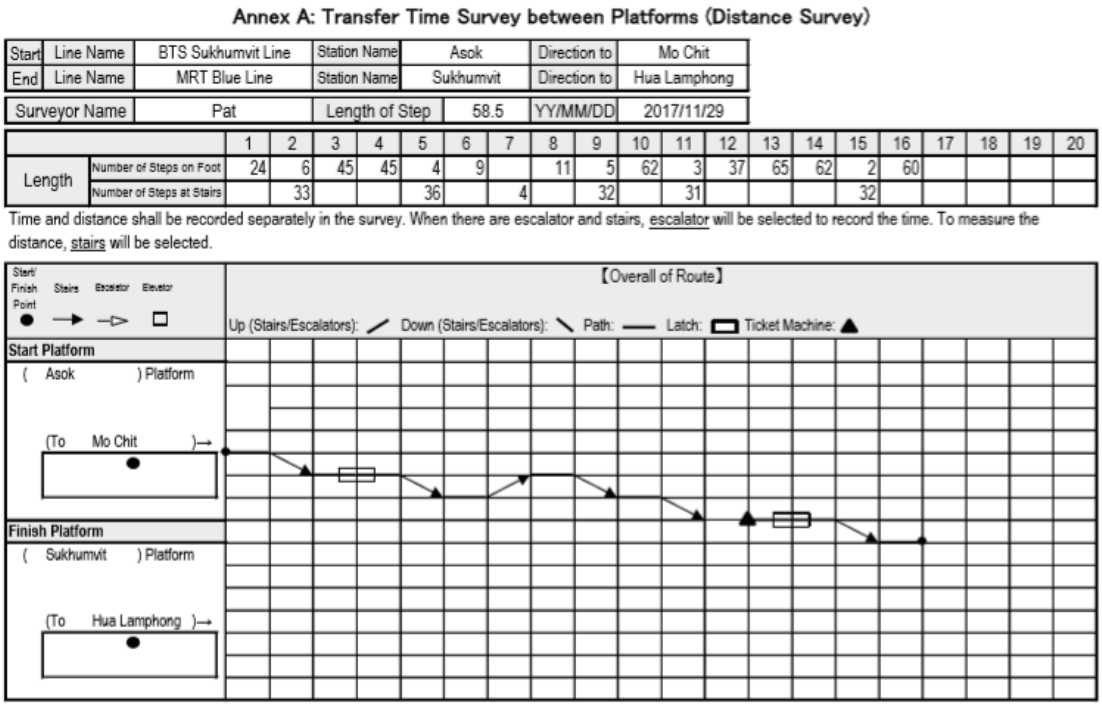
【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform
(Tao Poon) Platform
(To Tao Poon)→

Finish Platform
(Tao Poon) Platform
(To Hua Lamphong)→

Figure 2.10 Transfer Time from Tao Poon (Purple) to Tao Poon (Blue)



Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Sukhumvit Line	Station Name	Asok	Direction to	Mo Chit
End	Line Name	MRT Blue Line	Station Name	Sukhumvit	Direction to	Hua Lamphong
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/29

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	24	6	45	45	4	9		11	5	62	3	37	65	62	2	60				
	Number of Steps at Stairs		33			36		4		32		31				32					

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ⇨ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform
(Asok) Platform
(To Mo Chit)→

Finish Platform
(Sukhumvit) Platform
(To Hua Lamphong)→

Figure 2.11 Number of Steps from Asok to Sukhumvit

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	MRT Blue Line	Station Name	Sukhumvit	Direction to	Hua Lamphong
End	Line Name	BTS Sukhumvit Line	Station Name	Asok	Direction to	Mo Chit
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	38	2	62	25	3	62	5	11		9	4	26	15	45	6	24				
	Number of Steps at Stairs		32			31		32		4		36				33					

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

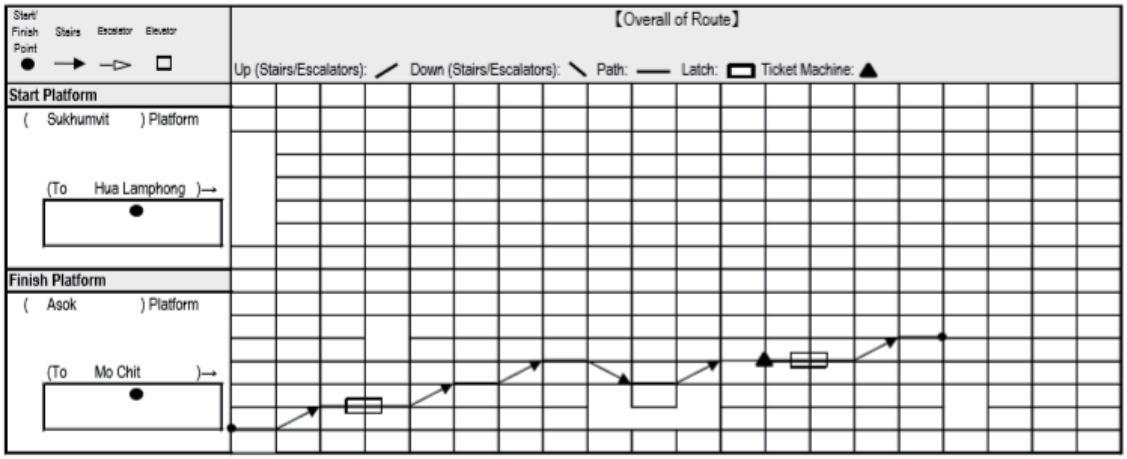


Figure 2.12 Number of Steps from Sukhumvit to Asok

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Sukhumvit Line	Station	Asok	Direction to	Mo Chit
End	Line Name	MRT Blue Line	Station	Sukhumvit	Direction to	Hua Lamphong
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)							○		○		○				○					
Time (S) 7:00 With Ticket	0:08	0:27	1:00	1:39	1:43	1:57	2:23	2:37	2:59	3:11	3:37	4:08	5:21	5:48	6:10	6:23				
Time (S) 7:00 No Ticket	0:08	0:27	1:00	1:39	1:43	1:57	2:23	2:37	2:59	3:11	3:37	4:08	6:49	7:21	7:41	7:54				
Time (S) 8:00 With Ticket	0:12	0:32	1:03	1:43	1:51	1:59	2:22	2:32	2:59	3:25	3:45	4:08	5:07	5:40	6:01	6:14				
Time (S) 8:00 No Ticket	0:12	0:32	1:03	1:43	1:51	1:59	2:22	2:32	2:59	3:25	3:45	4:08	5:47	6:08	6:30	6:50				

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

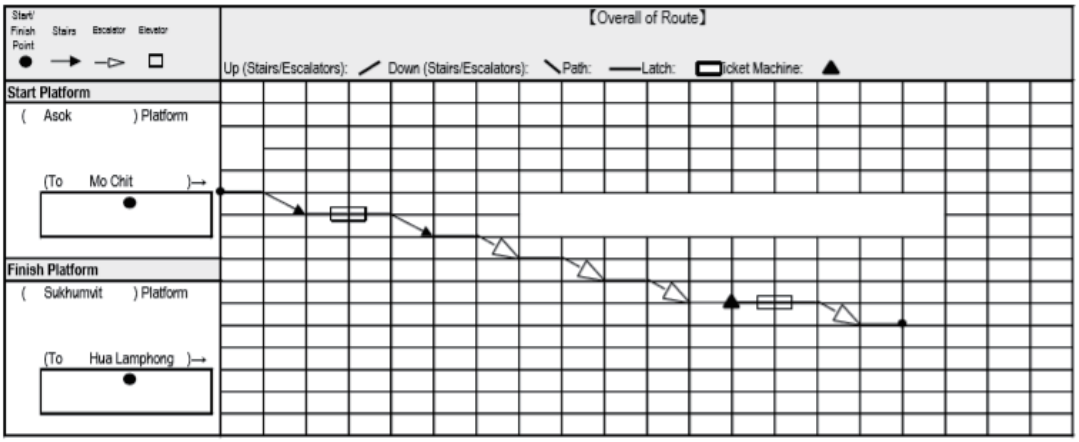


Figure 2.13 Transfer Time from Asok to Sukhumvit

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	MRT Blue Line	Station	Sukhumvit	Direction to	Hua Lamphong		
End	Line Name	BTS Sukhumvit Line	Station	Asok	Direction to	Mo Chit		
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○			○		○		○						○					
Time (S) 7:30 With Ticket	0:11	0:26	1:07	1:12	1:25	1:45	2:12	2:38	2:48	3:11	3:22	3:26	3:30	3:39	3:46	4:07				
Time (S) 7:30 No Ticket	0:11	0:26	1:07	1:12	1:25	1:45	2:12	2:38	2:48	3:11	3:22	3:26	4:20	4:30	4:39	5:11				
Time (S) 8:30 With Ticket	0:15	0:34	1:09	1:21	1:40	2:08	2:34	2:46	3:02	3:53	3:59	4:09	4:15	4:25	4:34	4:48				
Time (S) 8:30 No Ticket	0:15	0:34	1:09	1:21	1:40	2:08	2:34	2:46	3:02	3:53	3:59	4:09	4:35	4:43	4:53	5:15				

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

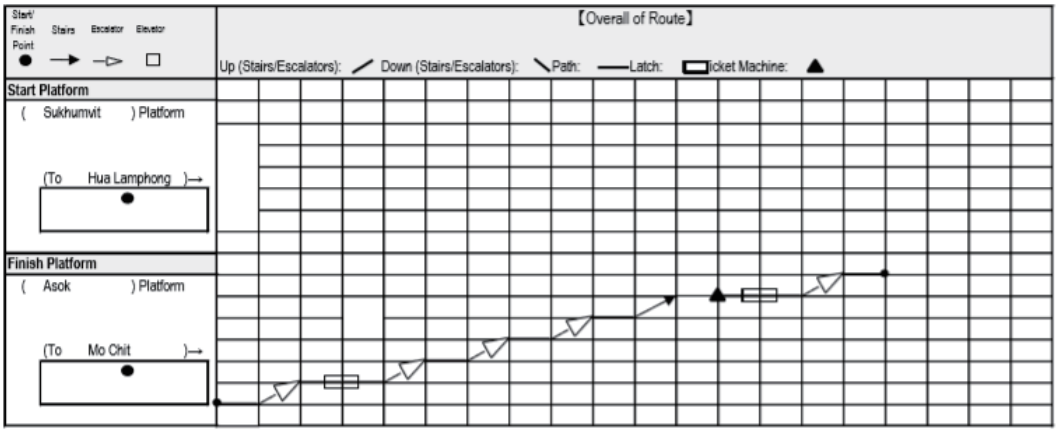


Figure 2.14 Transfer Time from Sukhumvit to Asok

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Sukhumvit Line	Station Name	Phaya Thai	Direction to	Sam Rong	
End	Line Name	Airport Rail Link	Station Name	Phaya Thai	Direction to	Suvarnabhumi	(Same Platform bacause it is Terminal stat
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/29	

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	30	6	40	160	7	45	20	40	12	80										
	Number of Steps at Stairs		42			39				46											

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

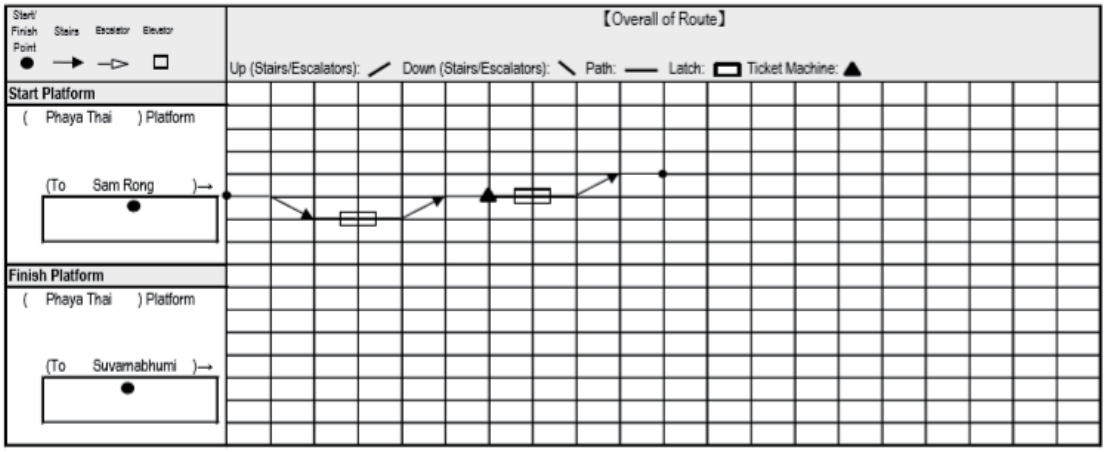


Figure 2.15 Number of Steps from Phaya Thai (Sukhumvit) to Phaya Thai (ARL)

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	Airport Rail Link	Station Name	Phaya Thai	Direction to	Phaya Thai	(Same Platform bacause it is Terminal stat	
End	Line Name	BTS Sukhumvit Line	Station Name	Phaya Thai	Direction to	Sam rong		
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/29		

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	80	12	40	31	7	150	30	40	6	30										
	Number of Steps at Stairs		46			39				42											

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

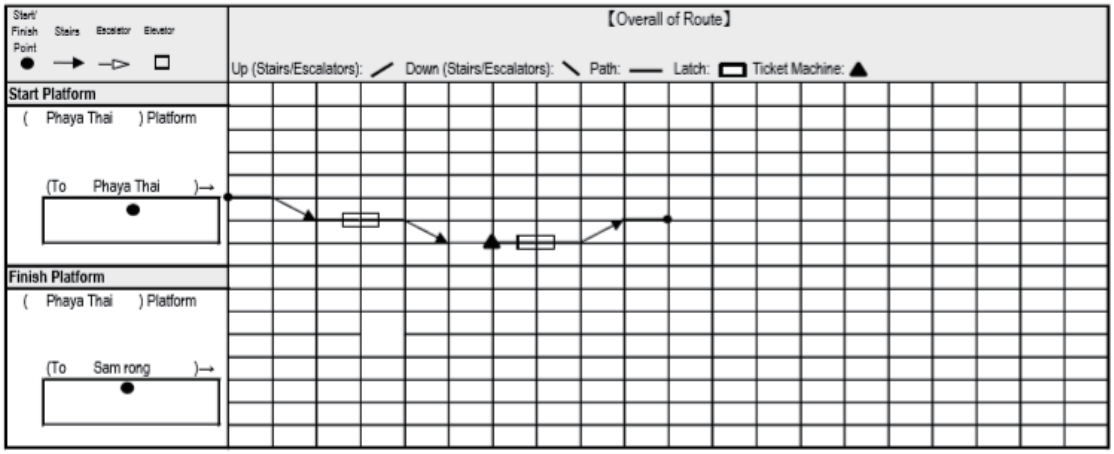


Figure 2.16 Number of Steps from Phaya Thai (ARL) to Phaya Thai (Sukhumvit)

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Sukhumvit Line	Station	Phaya Thai	Direction to	Sam Rong
End	Line Name	Airport Rail Link	Station	Phaya Thai	Direction to	Suvarnabhumi
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

Same Platform due to Terminal station

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)					○				○											
Time (S) 7:00 With Ticket	0:27	0:51	1:20	2:34	3:01	3:16	3:26	3:38	4:08	4:25										
Time (S) 7:00 No Ticket	0:27	0:51	1:20	2:34	3:01	3:16	7:45	7:57	8:27	8:44										
Time (S) 8:00 With Ticket	0:24	0:48	1:10	2:30	2:58	3:10	3:23	3:35	4:05	4:17										
Time (S) 8:00 No Ticket	0:24	0:48	1:10	2:30	2:58	3:10	4:02	4:14	4:44	4:56										

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

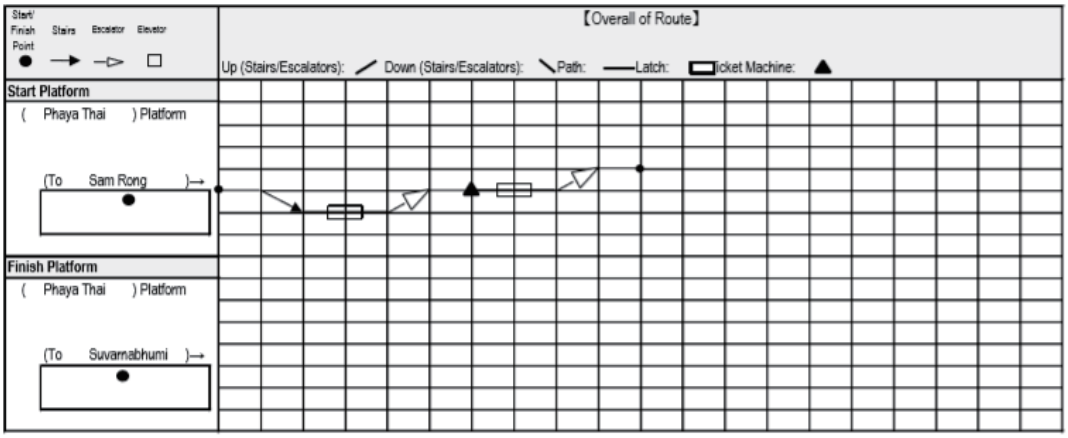


Figure 2.17 Transfer Time from Phaya Thai (Sukhumvit) to Phaya Thai (ARL)

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	Airport Rail Link	Station	Phaya Thai	Direction to	Phaya Thai
End	Line Name	BTS Sukhumvit Line	Station	Phaya Thai	Direction to	Sam rong

Same Platform due to Terminal station

Surveyor Name	PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)									○											
Time (S) 7:30 With Ticket	1:22	2:03	2:28	2:51	3:18	4:41	4:50	5:18	5:43	5:56										
Time (S) 7:30 No Ticket	1:22	2:03	2:28	2:51	3:18	4:41	5:32	6:00	6:26	6:39										
Time (S) 8:30 With Ticket	0:53	1:24	1:36	1:59	2:25	3:47	3:58	4:27	4:53	5:03										
Time (S) 8:30 No Ticket	0:53	1:24	1:36	1:59	2:25	3:47	4:41	5:10	5:36	5:46										

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

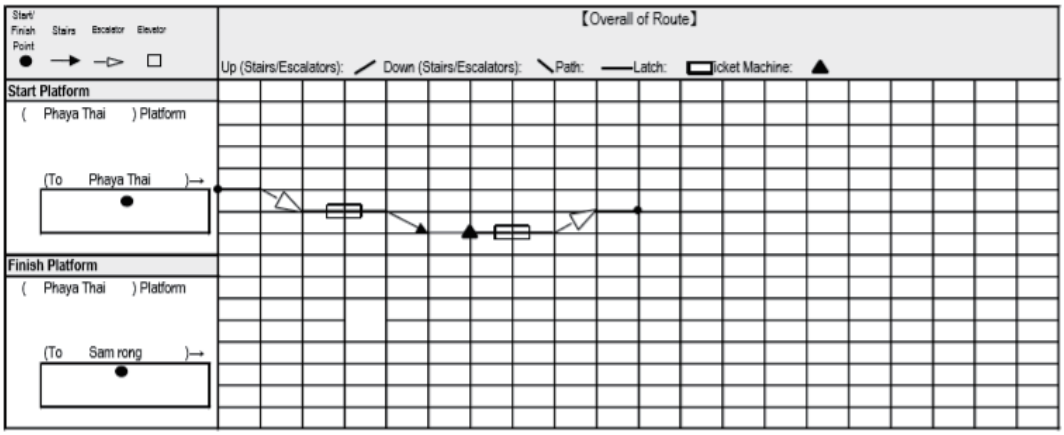


Figure 2.18 Transfer Time from Phaya Thai (ARL) to Phaya Thai (Sukhumvit)

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Sukhumvit Line	Station Name	Mo Chit	Direction to	Mo Chit
End	Line Name	MRT Blue Line	Station Name	Chatuchak	Direction to	Hua Lamphong

Surveyor Name	Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/29

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	30	4	55	71	4	27		9	6	51	2	28	34	88	4	14				
	Number of Steps at Stairs		42			45		7		52		31				30					

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

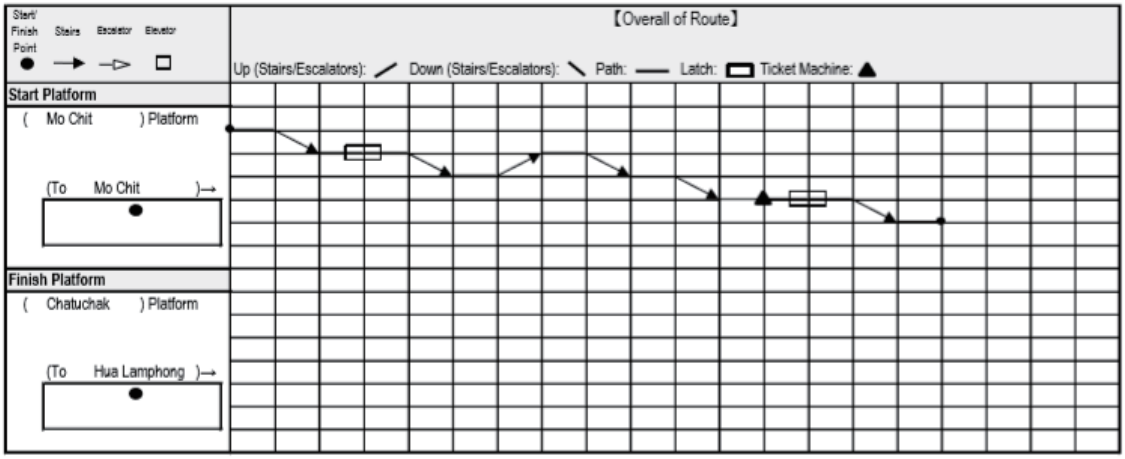


Figure 2.19 Number of Steps from Mo Chit to Chatuchak

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	MRT Blue Line	Station Name	Chatuchak	Direction to	Hua Lamphong
End	Line Name	BTS Sukhumvit Line	Station Name	Mo Chit	Direction to	Samrong
Surveyor Name		Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/29

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	14	4	88	32	2	54	6	10		32	4	56	18	16	4	46				
	Number of Steps at Stairs		30			31		52		7		45				42					

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

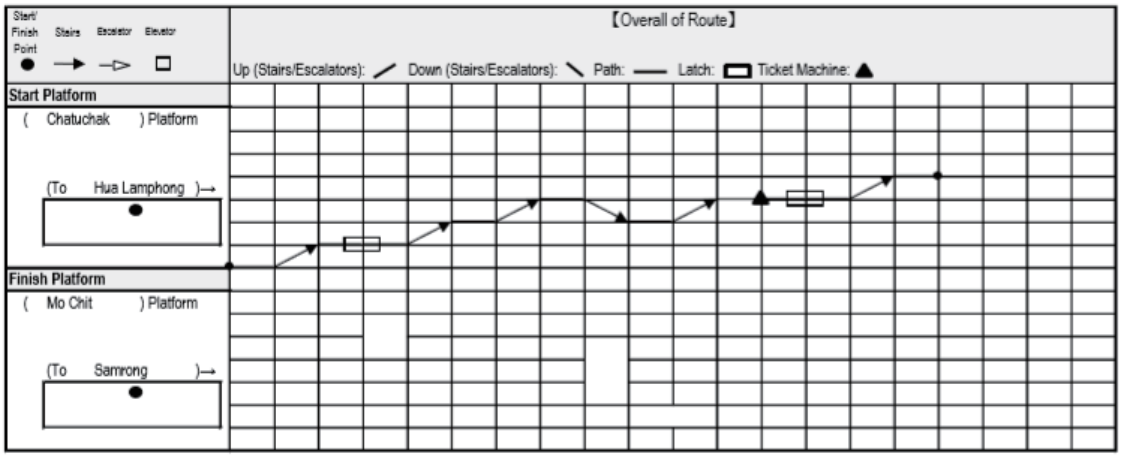


Figure 2.20 Number of Steps from Chatuchak to Mo Chit

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Sukhumvit Line	Station	Mo Chit	Direction to	Mo Chit
End	Line Name	MRT Blue Line	Station	Chatuchak	Direction to	Hua Lamphong
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)									○		○				○					
Time (S) 7:00 With Ticket	0:28	0:49	1:23	1:57	2:31	2:48	2:56	3:02	3:31	4:01	4:21	4:33	4:57	5:25	5:38	6:09				
Time (S) 7:00 No Ticket	0:28	0:49	1:23	1:57	2:31	2:48	2:56	3:02	3:31	4:01	4:21	4:33	5:15	5:43	5:56	6:27				
Time (S) 8:00 With Ticket	0:31	1:02	1:31	2:20	2:48	3:05	3:09	3:19	3:37	4:10	4:29	4:41	4:48	4:58	5:09	5:30				
Time (S) 8:00 No Ticket	0:31	1:02	1:31	2:20	2:48	3:05	3:09	3:19	3:37	4:10	4:29	4:41	5:45	5:55	6:06	6:27				

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

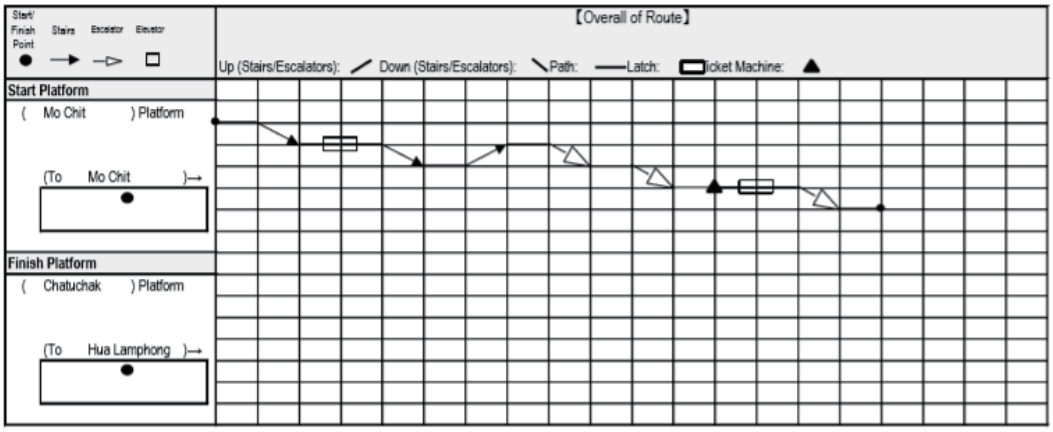


Figure 2.21 Transfer Time from Mo Chit to Chatuchak

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	MRT Blue Line	Station	Chatuchak	Direction to	Hua Lamphong
End	Line Name	BTS Sukhumvit Line	Station	Mo Chit	Direction to	Samrong
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○			○		○													
Time (S) 7:30 With Ticket	0:35	0:53	3:07	3:25	3:42	4:06	4:34	4:42	4:46	5:09	5:43	6:23	6:27	6:35	7:00	7:18				
Time (S) 7:30 No Ticket	0:35	0:53	3:07	3:25	3:42	4:06	4:34	4:42	4:46	5:09	5:43	6:23	7:16	7:24	7:49	8:07				
Time (S) 8:30 With Ticket	0:34	0:52	1:21	1:38	1:57	2:25	2:52	3:00	3:05	3:21	3:54	4:34	4:37	4:48	5:14	5:37				
Time (S) 8:30 No Ticket	0:34	0:52	1:21	1:38	1:57	2:25	2:52	3:00	3:05	3:21	3:54	4:34	5:23	5:34	6:00	6:23				

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

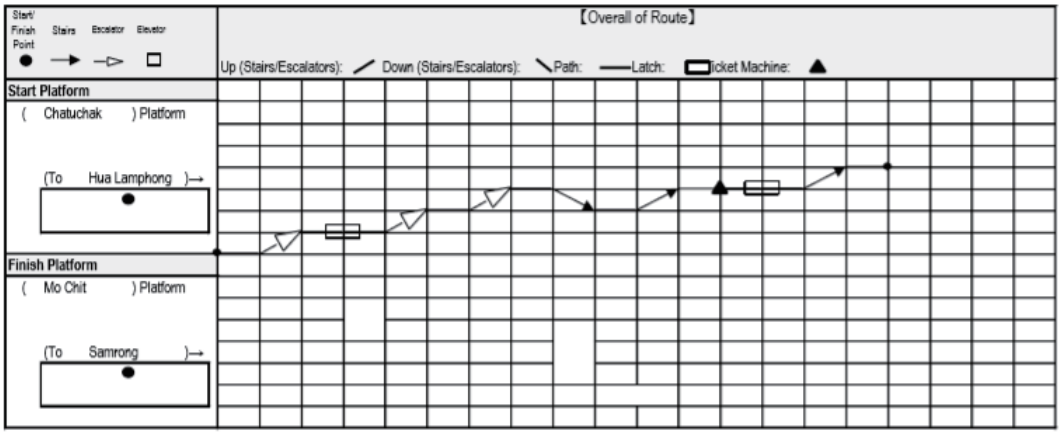


Figure 2.22 Transfer Time from Chatuchak to Mo Chit

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	Airport Rail Link	Station Name	Makkasan	Direction to	Phayathai
End	Line Name	MRT Blue Line	Station Name	Phetchaburi	Direction to	Hua Lamphong
Surveyor Name		Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	58	5	28	328	5	58		7	6	42	3	25	20	45	2	22				
	Number of Steps at Stairs		44			33		6		56		32				32					

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

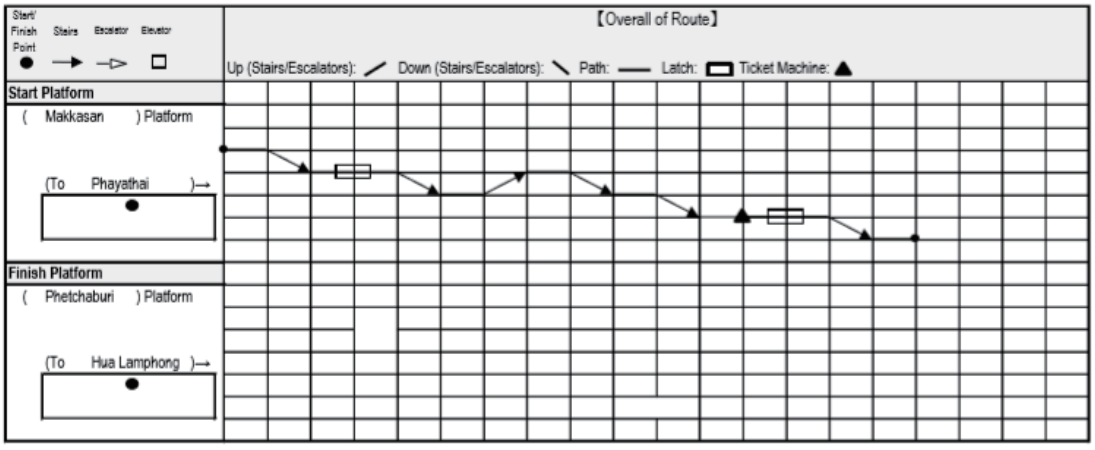


Figure 2.23 Number of Steps from Makkasan to Phetchaburi

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	MRT Blue Line	Station Name	Phetchaburi	Direction to	Hua Lamphong
End	Line Name	Airport Rail Link	Station Name	Makkasan	Direction to	Phayathai
Surveyor Name		Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	25	2	93	23	3	30	6	7		54	5	359	15	57	5	25				
	Number of Steps at Stairs		32			32		56		6		33				44					

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

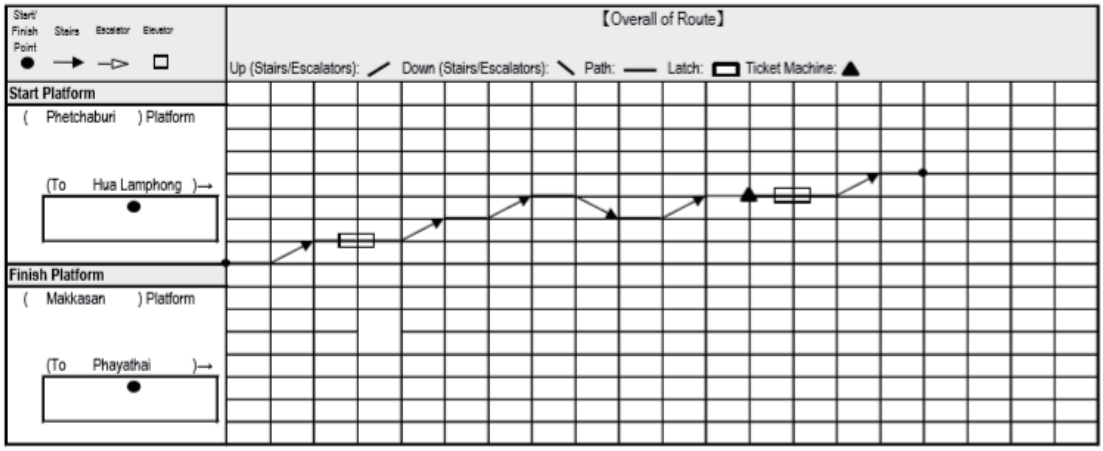


Figure 2.24 Number of Steps from Phetchaburi to Makkasan

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	Airport Rail Link	Station	Makkasan	Direction to	Phayathai
End	Line Name	MRT Blue Line	Station	Phetchaburi	Direction to	Hua Lamphong
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○			○				○		○				○					
Time (S) 7:00 With Ticket	0:33	0:51	1:08	4:46	5:06	5:21	5:31	5:54	6:27	6:53	7:13	7:28	7:47	8:22	8:44	9:04				
Time (S) 7:00 No Ticket	0:33	0:51	1:08	4:46	5:06	5:21	5:31	5:54	6:27	6:53	7:13	7:28	8:35	9:10	9:32	9:52				
Time (S) 8:00 With Ticket	0:36	1:04	1:38	5:09	5:36	6:05	6:10	6:17	6:49	7:13	7:34	7:43	8:04	8:28	8:49	9:08				
Time (S) 8:00 No Ticket	0:36	1:04	1:38	5:09	5:36	6:05	6:10	6:17	6:49	7:13	7:34	7:43	8:38	9:02	9:23	9:42				

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

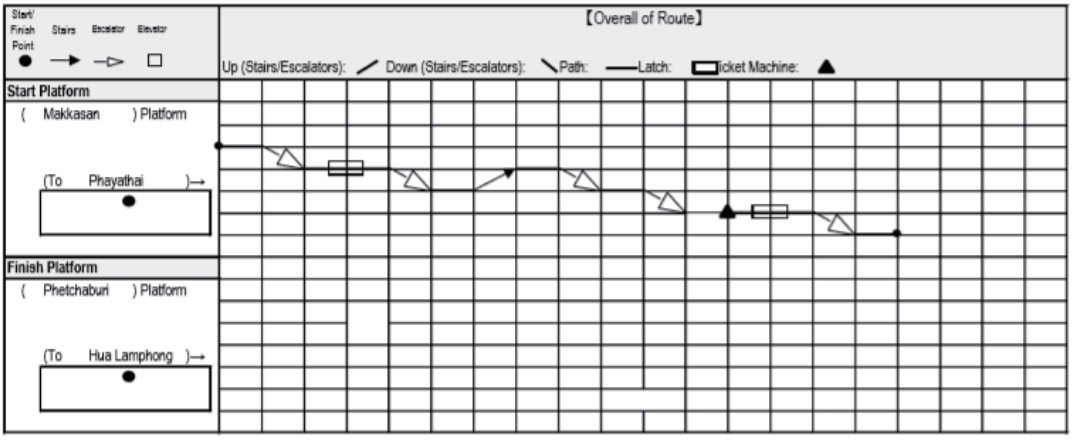


Figure 2.25 Transfer Time from Makkasan to Phetchaburi

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	MRT Blue Line	Station	Phetchaburi	Direction to	Hua Lamphong
End	Line Name	Airport Rail Link	Station	Makkasan	Direction to	Phayathai
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○		○		○					○				○					
Time (S) 7:30 With Ticket	0:25	0:46	1:34	1:47	2:09	2:23	2:55	2:59	3:04	3:35	4:02	7:23	7:53	8:08	8:35	8:45				
Time (S) 7:30 No Ticket	0:25	0:46	1:34	1:47	2:09	2:23	2:55	2:59	3:04	3:35	4:02	7:23	9:51	10:06	10:33	10:43				
Time (S) 8:30 With Ticket	0:34	0:55	1:44	1:55	2:16	2:30	3:02	3:07	3:11	3:41	4:07	7:02	7:40	7:57	8:25	8:38				
Time (S) 8:30 No Ticket	0:34	0:55	1:44	1:55	2:16	2:30	3:02	3:07	3:11	3:41	4:07	7:02	9:00	9:15	9:43	9:53				

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

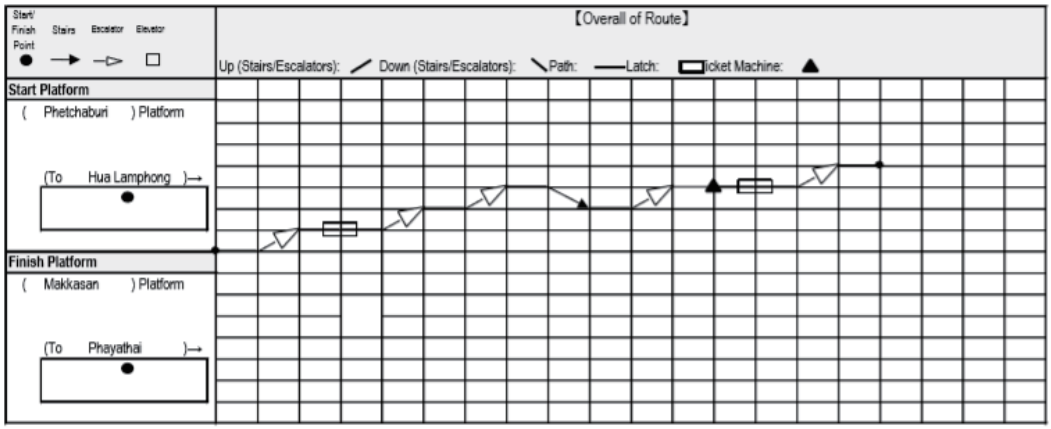


Figure 2.26 Transfer Time from Phetchaburi to Makkasan

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Silom Line	Station Name	Chong Nonsi	Direction to	National Stadium
End	Line Name	BRT	Station Name	Sathorn	Direction to	Ratchaphruek
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	33	6	45	296		68		20	39	26	6	25								
	Number of Steps at Stairs		42			11		10				30									

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

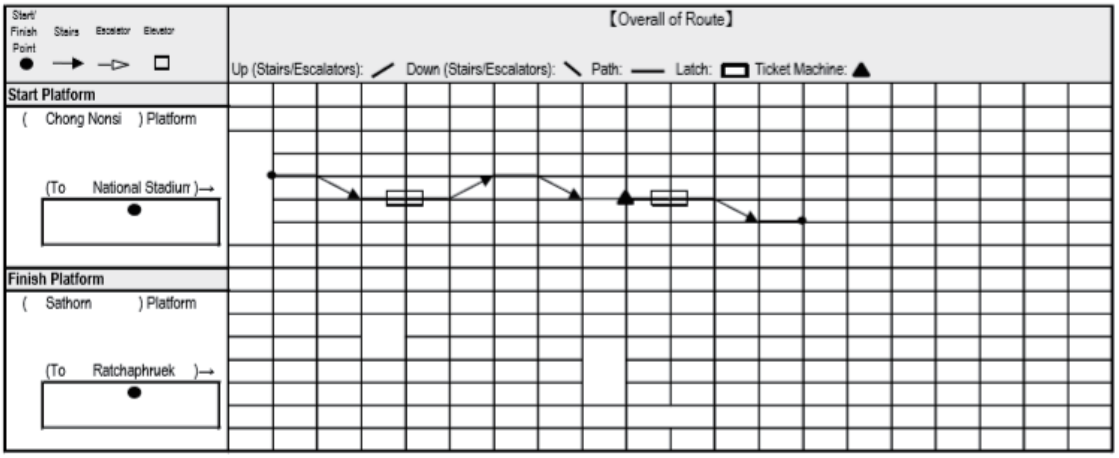


Figure 2.27 Number of Steps from Chong Nonsi to Sathorn

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BRT	Station Name	Sathorn	Direction to	Terminal Station
End	Line Name	BTS Silom Line	Station Name	Chong Nonsi	Direction to	National Stadium
Surveyor Name		Pat	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	25	6	55	25		69		280	57	18	6	23								
	Number of Steps at Stairs		30			10		11				42									

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

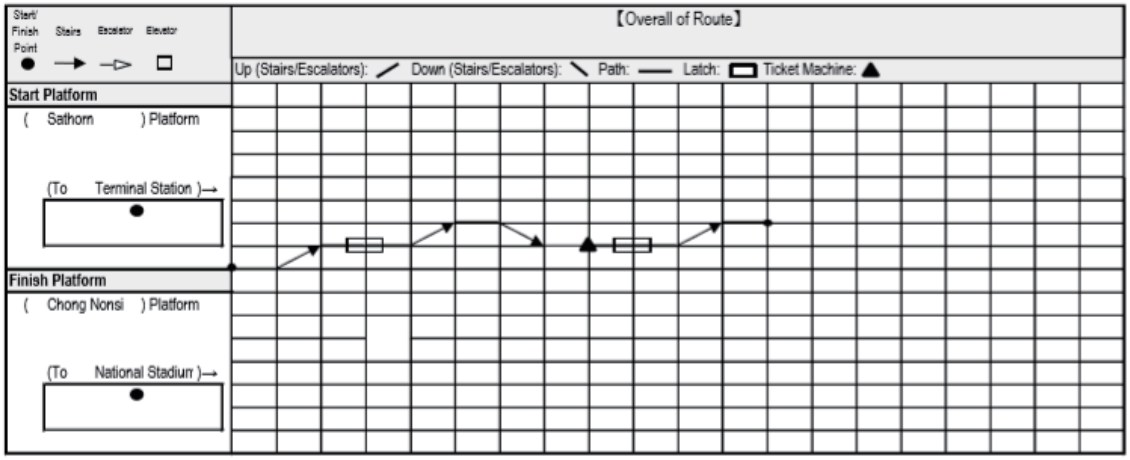


Figure 2.28 Number of Steps from Sathorn to Chong Nonsi

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Silom Line	Station	Chong Nonsi	Direction to	National Stadium
End	Line Name	BRT	Station	Sathorn	Direction to	Ratchaphruek
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)											○									
Time (S) 7:00 With Ticket	0:06	0:31	1:01	3:46	3:59	4:24	4:35	4:41	4:46	4:52	5:03	5:09								
Time (S) 7:00 No Ticket	0:06	0:31	1:01	3:46	3:59	4:24	4:35	4:41	5:01	5:07	5:18	5:24								
Time (S) 8:00 With Ticket	0:08	0:48	1:18	3:33	3:48	4:23	4:35	4:45	4:55	5:04	5:19	5:29								
Time (S) 8:00 No Ticket	0:08	0:48	1:18	3:33	3:48	4:23	4:35	4:45	5:20	5:29	5:44	5:54								

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

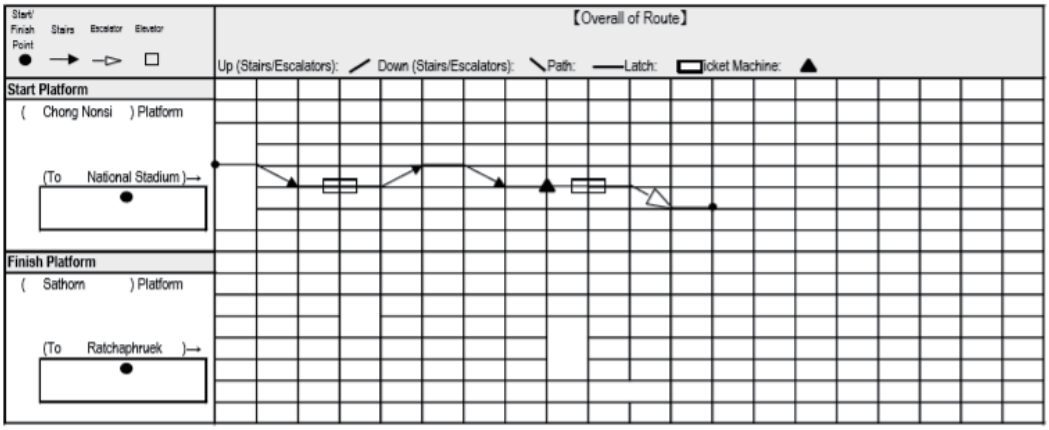


Figure 2.29 Transfer Time from Chong Nonsi to Sathorn

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BRT	Station	Sathorn	Direction to	Terminal Station		
End	Line Name	BTS Silom Line	Station	Chong Nonsi	Direction to	National Stadium		
Surveyor Name	PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00			

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○									○									
Time (S) 7:30 With Ticket	0:06	0:17	0:27	0:35	0:45	1:05	1:16	3:31	3:41	3:51	4:03	4:09								
Time (S) 7:30 No Ticket	0:06	0:17	0:27	0:35	0:45	1:05	1:16	3:31	4:01	4:11	4:23	4:29								
Time (S) 8:30 With Ticket	0:07	0:22	0:37	0:47	0:57	1:27	1:37	3:37	3:52	4:02	4:15	4:21								
Time (S) 8:30 No Ticket	0:07	0:22	0:37	0:47	0:57	1:27	1:37	3:37	4:17	4:27	4:40	4:46								

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ▷ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform
(Sathorn) Platform
(To Terminal Station)→

Finish Platform
(Chong Nonsi) Platform
(To National Stadium)→

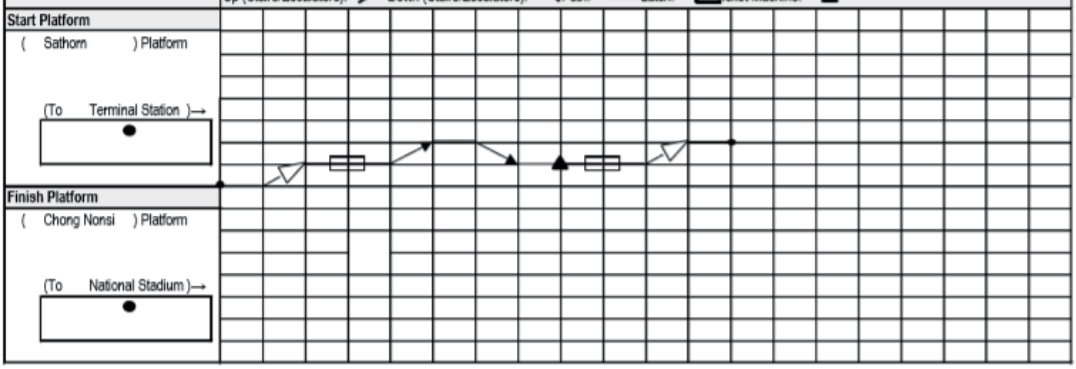


Figure 2.30 Transfer Time from Sathorn to Chong Nonsi

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	BTS Silom Line	Station Name	Saladaeng	Direction to	National Stadium		
End	Line Name	MRT Blue Line	Station Name	Silom	Direction to	Hua Lamphong		
Surveyor Name	Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/28			

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	14	6	47	328	6	61		17	36	80	33	86								
	Number of Steps at Stairs		42			36						107									

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

Start/ Finish Point ● Stairs → Escalator ▷ Elevator □

【Overall of Route】

Up (Stairs/Escalators): ／ Down (Stairs/Escalators): ＼ Path: — Latch: ▭ Ticket Machine: ▲

Start Platform
(Saladaeng) Platform
(To National Stadium)→

Finish Platform
(Silom) Platform
(To Hua Lamphong)→

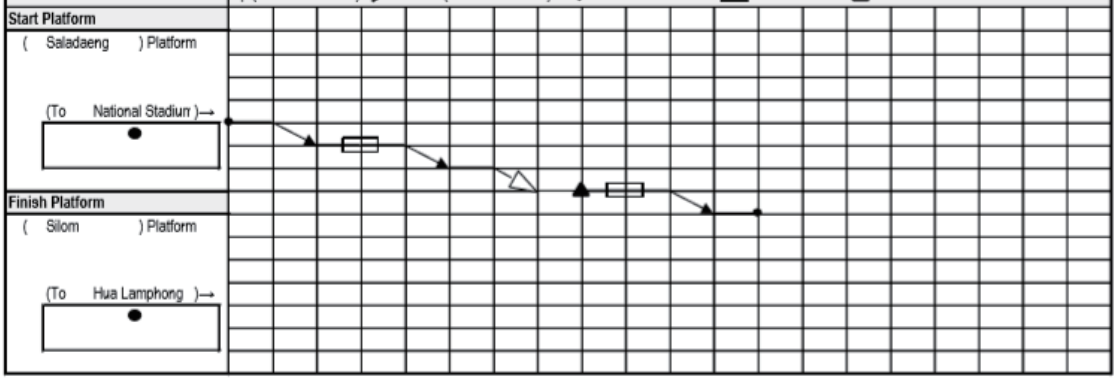


Figure 2.31 Number of Steps from Saladeang to Silom

Annex A: Transfer Time Survey between Platforms (Distance Survey)

Start	Line Name	MRT Blue Line	Station Name	Silom	Direction to	Hua Lamphong
End	Line Name	BTS Silom Line	Station Name	Saladaeng	Direction to	National Stadium
Surveyor Name		Nunnapas	Length of Step	58.5	YY/MM/DD	2017/11/28

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length	Number of Steps on Foot	82	33	64	36		54	6	336	17	23	6	60								
	Number of Steps at Stairs		107					36				42									

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

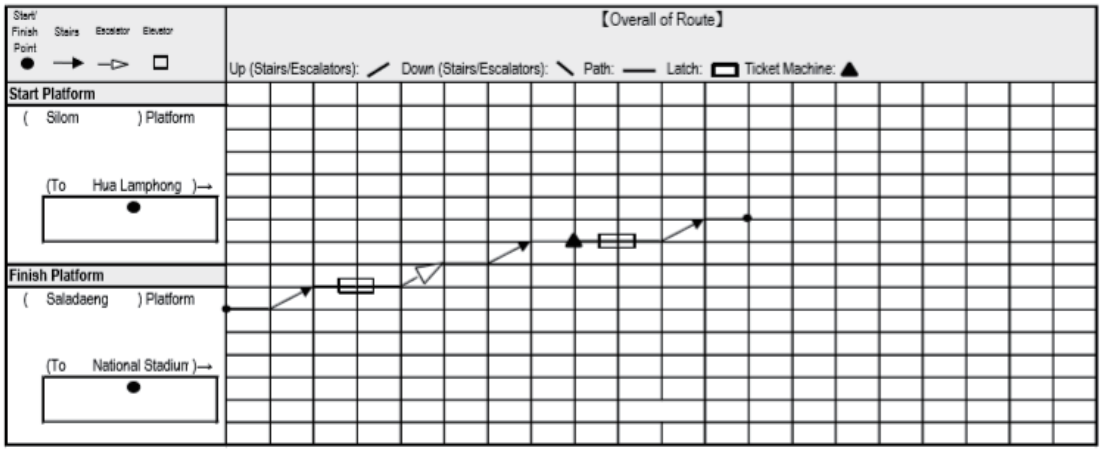


Figure 2.32 Number of Steps from Silom to Saladeang

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	BTS Silom Line	Station	Saladaeng	Direction to	National Stadium
End	Line Name	MRT Blue Line	Station	Silom	Direction to	Hua Lamphong
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)							○				○									
Time (S) 7:00 With Ticket	0:25	0:56	1:43	5:01	5:27	6:01	6:39	7:30	8:18	9:16	10:10	11:03								
Time (S) 7:00 No Ticket	0:25	0:56	1:43	5:01	5:27	6:01	6:39	7:30	10:23	11:01	11:59	13:53								
Time (S) 8:00 With Ticket	0:33	0:58	1:46	4:58	5:21	5:57	6:29	7:01	7:48	8:32	9:24	10:17								
Time (S) 8:00 No Ticket	0:33	0:58	1:46	4:58	5:21	5:57	6:29	7:01	9:13	10:57	11:49	12:42								

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

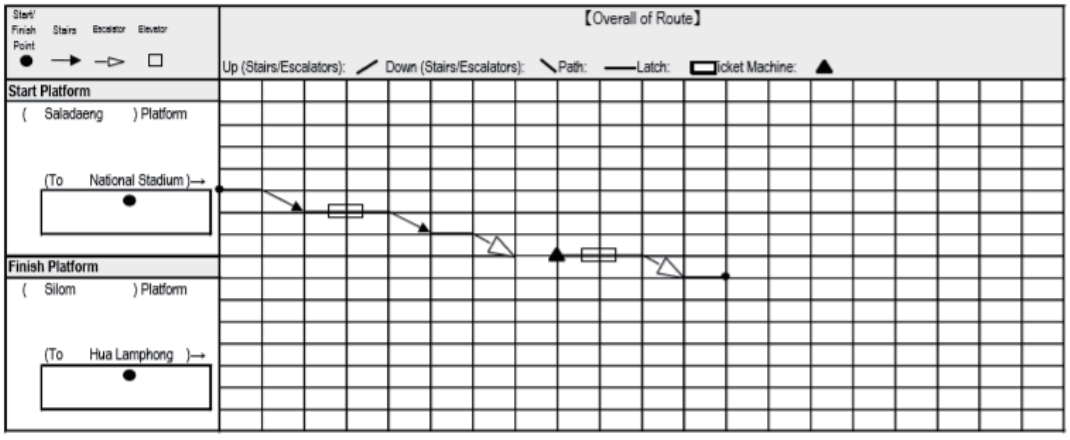


Figure 2.33 Transfer Time from Sala Daeng to Silom

Annex B: Transfer Time Survey between Platforms (Time Survey)

Start	Line Name	MRT Blue Line	Station	Silom	Direction to	Hua Lamphong
End	Line Name	BTS Silom Line	Station	Saladaeng	Direction to	National Stadium
Surveyor Name		PSK	YY/MM/DD	2017/11/30	Time	7:00-9:00

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Use of Escalator (○)		○			○		○				○									
Time (S) 7:30 With Ticket	0:53	1:46	2:34	3:11	3:51	4:35	4:52	7:54	8:09	8:34	9:07	9:41								
Time (S) 7:30 No Ticket	0:53	1:46	2:34	3:11	3:51	4:35	4:52	7:54	8:56	9:21	9:54	10:28								
Time (S) 8:30 With Ticket	0:54	1:50	2:35	3:08	3:47	4:31	4:51	7:49	8:01	8:27	8:57	9:26								
Time (S) 8:30 No Ticket	0:54	1:50	2:35	3:08	3:47	4:31	4:51	7:49	9:15	9:41	10:11	10:40								

Time and distance shall be recorded separately in the survey. When there are escalator and stairs, escalator will be selected to record the time. To measure the distance, stairs will be selected.

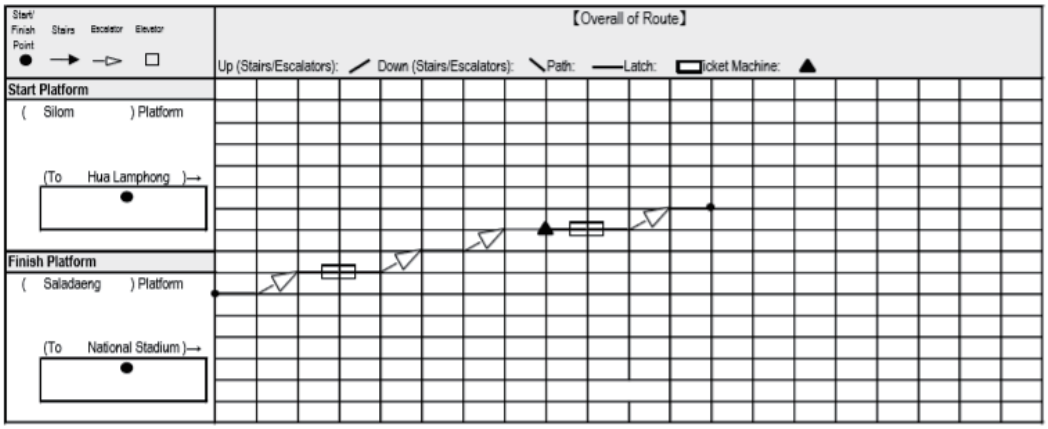


Figure 2.34 Transfer Time from Silom to Sala Daeng

3. Train Waiting Time Survey

3.1 Background

The most serious transport issue in the BMR is the heavy traffic congestion in the city center where BST, MRT and ARL run across. Congestion inside of mass rapid transit train car in BMR is also serious, especially in morning peak hours. Congestion at platform has been also serious, and a lot of passengers have to miss trains in order to get inside a train which has been already full when the train arrives at the station.

In destination based survey, time from home to office was measured in order to know how people in BMR commute to their office at the city center and how long it takes for their commuting. If the waiting time will be shorter, total commuting time will be also shorter and satisfaction of passengers to mass transit can be higher (this can be seen from the results of People's Perception Survey).

Through this waiting time survey, actual waiting time and number of missed trains was measured at major 10 congested stations in BMR.

3.2 Objectives (Survey Items)

Following items were observed at each designated survey station:

- Actual waiting time at platform (start time and end time),
- Number of missed train before getting on a train because of congestion.

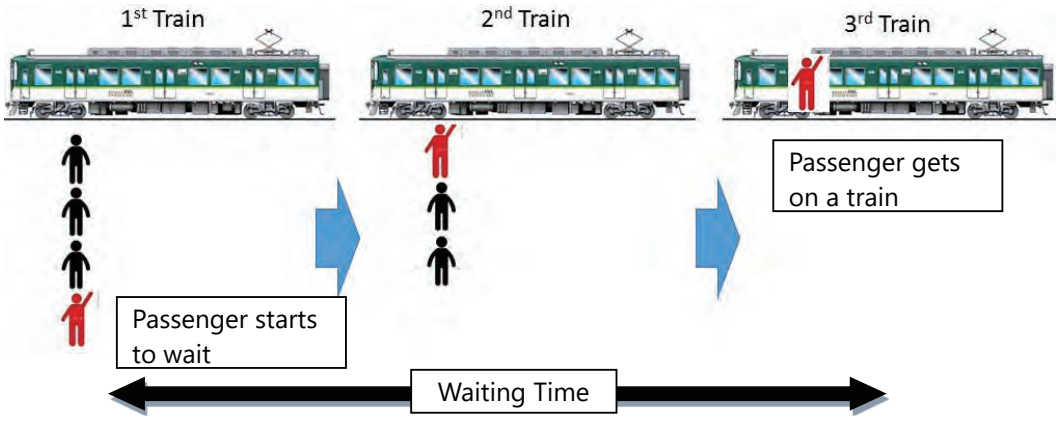
3.3 Survey Method

1) Preparation of the Survey

In order to implement the survey, JICA Study Team and PSK Consults Co., Ltd, hereafter called the Consultant, got permission from the mass transit operators with cooperation from OTP.

Prior to implementation of the survey, the Consultant visited each station and survey location including location of train car and door was considered and decided. This information was recorded by a surveyor. The Consultant also translated the survey form from English into Thai according to necessity.

Then, the Consultant trained the surveyors in order to let them understand how to measure waiting time with the figure as follows.



Source: JICA Study Team

Figure 3.1 Image of the Train Waiting Time Survey at Platform

2) Field Survey

Trained surveyors measured waiting time for target passengers during the survey hours. The surveyors also measure number of missed trains since interval of trains is not same and the information is useful to grasp how serious the congestion is.

3) Survey Area

JICA Study Team selected survey stations and duration of the survey based on the site visit before the actual survey. Survey locations are show

4) Survey Schedule

The survey was conducted from 7:00 to 9:00, 18th to 22nd December 2017 at 10 major congested stations selected by JICA Study Team and the Consultant. The survey was conducted for peak hours and peak direction of each line on normal week days.

Table 3.1 Survey Schedule

No.	Date	Station Name	Line Name	Duration	Bound to
1	18/12/2017	Lat Phrao	Blue Line	7:30-9:30	Hua Lam Phong
2		Huai Khwang			
3		Phra Ram 9			
4	19/12/2017	Ramkhamhaeng	Airport Rail Link		Phaya Thai
5	20/12/2017	Victory Monument	Sukhumvit Line		Samrong
6	21/12/2017	On Nut			Mo Chit
7		Udom Suk			
8	22/12/2017	Saphan Taksin	Si Lom Line		Siam
9		Krung Thonburi			
10		Wongwian Yai			

3.4 Survey Results

The survey results are summarized and shown in Table 3.2. As seen in the table, surveyors basically count waiting time for trains by 3 surveyors during 7:30 to 9:30 on weekdays, on the same day with Railway Congestion Survey. There are 3 surveyors at each station and they were allocated at 3 spots differently.

Table 3.2 Results of Waiting Time at 10 Stations

No.	Station Name	Platform Location	Average Waiting Time	Average No. of missed trains	Measured Time
1	Saphan Taksin (To Siam)	1	0:17	0.14	7:43-8:42
2		2,3	0:16	0.14	7:35-8:34
3		4	0:37	0.33	7:50-8:49
4	Krung Thonburi (To Siam)	1	1:58	0.7	7:41-8:40
5		3	3:27	1.25	7:14-8:13
6		4	2:03	0.7	7:32-8:31
7	Wangwian Yai (To Siam)	1	2:10	1	7:30-8:29
8		2,3	1:58	0.78	7:38-8:37
9		4	0:34	0.23	7:37-8:36
10	Lat Phrao (To Hua Lumphong)	1	2:52	0.73	7:30-8:29
11		2,3	1:23	0.38	7:44-8:43
12		4	2:45	0.8	7:41-8:40
13	Huai Kwang (To Hua Lumphong)	1	5:30	1.18	7:33-8:32
14		3	7:11	2	7:33-8:32
15		4	2:03	0.6	7:36-8:35
16	Phra Ram 9 (To Hua Lumphong)	1	2:02	0.5	7:37-8:36
17		2,3	4:30	1.11	7:30-8:29
18		4	3:18	0.9	7:30-8:29
19	Victory Monument (To Samrong)	1	0:49	0.25	7:51-8:50
20		2,3	1:59	0.61	7:46-8:45
21		4	1:37	0.357	7:46-8:45
22	Ramkhamhaeng To Phaya Thai	1	22:57	1.5	7:48-8:47
23		2,3	15:32	1.5	7:48-8:47
24		4	36:54	2	7:48:8:47
25	On Nut (To Mo Chit)	1	4:03	1.33	7:21-8:20
26		2,3	0:51	0.29	7:28-8:27
27		4	2:07	0.69	7:28-8:27
28	Udom Suk (To Mo Chit)	1	0:58	0.31	7:30-8:29
29		2,3	0:32	0.235	7:30-8:29
30		4	0:10	0.053	7:30-8:29

Source: JICA Study Team

3.5 Discussions

The survey results show several findings to be discussed. One is that without Airport Rail Link line, the que for waiting trains seems not very serious so the waiting time and average number of missed trains is also not serious. Regarding the Airport Rail Link line, trains did not come on time because of disorder of time table so the result is a little irregular. However, a surveyor who uses ARL line for commuting said that she has to wait for 20 or 30 minutes to take a train in morning peak hours since the frequency of trains are not very often, and the inside of a train is already congested since the train has accommodated passengers at former stations.

As seen from the results, waiting time and number of trains are different depending on the location of platform. The congested locations are generally close to an elevator. In Japan, station staff guides train passengers to less busy platforms in peak hours. These types of attempts can be helpful to reduce the length of waiting lines and equalize the number of passengers at each platform for the same line.

Another thing is that serious traffic congestion can be seen especially at Blue Line and ARL line since the train set is consisted of 3 cars and on the other hand, that of Si Lom and Sukhumvit Line is consisted of 4 cars. Seen from results of the Train Congestion Survey, the interval of trains of blue line in a peak hour is 3 minutes 20 seconds so this can be shorter somehow (interval between trains of Marunouchi Line in Tokyo during the peak hour is 1 minutes 50 seconds according to the Nikkei article on 21 December 2018). This means that it is technically possible to increase the number of train sets. On the other hand, it can be a solution for mitigating the congestion to increase the number of cars for 1 car set from 3 cars to 4 or 6 cars in the future.

Also, regarding the Silom Line, the train interval cannot be shorter anymore because of technical reason; the section between Krung Thon Buri station and Saphan Taksin station is only one-way operation. Hence, a train at one side has to wait for a train of another side. As a result, train interval cannot be shorter anymore and this cause congestion inside of a train around this section in peak hours.

In conclusion, through the survey, not only we could grasp current situation, but also could figure out several issues caused by long waiting time. If the waiting time is shorter, total travel time will be shorter and congestion at a platform will be improved. Furthermore, satisfaction with the mass transit will be improved.

4. People's Perception Survey

4.1 Background

Traffic congestion is one of the most serious problems in BMR and tremendous economic loss is caused by the congestion. Thailand is categorized into middle developed countries and therefore, a lot of people in Bangkok can afford a car so the number of cars in Bangkok has increased year by year.

Willingness to use public transportation is crucial when passengers decide the transportation mode. Through the discussions with OTP, they concerned very much on car captive users, who may not change their mode choice from by their own car to by mass transit. If so, even though there is enough population along the line and new lines are constructed in the future, the number of passengers cannot be expanded.

One of the goals of M-MAP2 is that how to increase the ridership of public transportation and how to shift the car users to public transport. This survey seeks people's perception to the current mass transit and future mass transit in BMR. The survey also seeks what types of factors are important for passengers to decide their mode or which points should be improved in the current public transportation.

4.2 Objectives (Survey Items)

Items as follows were surveyed through this survey. The target is visitors and tourists at 10 touristic spots and 20 commercial facilities in BMR.

- Transportation mode
- Satisfaction with the current mass transit
- Commuting situation from home to office (time, fare and etc.)
- Negative points of mass transit
- Recognition on future development plan of mass transit systems in BMR

4.3 Survey Method

1) Preparation of the Survey

In order to implement the survey, JICA Study Team and PSK Consults Co., Ltd, hereafter called the Consultant, got permission from BMA by way of OTP in order to conduct survey at 30 survey spots.

2) Field Survey

Prior to implementing the survey, the Consultant visited the survey spots. At each survey spot, 30 persons were interviewed randomly.

The survey sheet was prepared by JICA Study Team at first in English and the survey sheet was translated into Thai by the Consultant. The survey sheet was confirmed as understandable by several Thai staff.

3) Survey Area and Survey Schedule

The 30 spots, 20 commercial spots and 10 touristic places, are listed as follows. These locations are widely selected in BMR in order to get variety of samples. The variety can be helpful to see the difference area by area but we could not analyze to that extent in this survey.

Table 4.1 List of Locations of Tourism Spot

Location	Duration	Target Period	Authority
Taling Chan Floating Market	9-17	25th- 31st Nov.	BMA
Khao San Road			
Wat Pho			
Asiatique			
Central World			
Baiyoke Tower 2			
Chatchak Market			
Jim Thompson House			
Ferry Station of Saphan Taksin			
China Town			

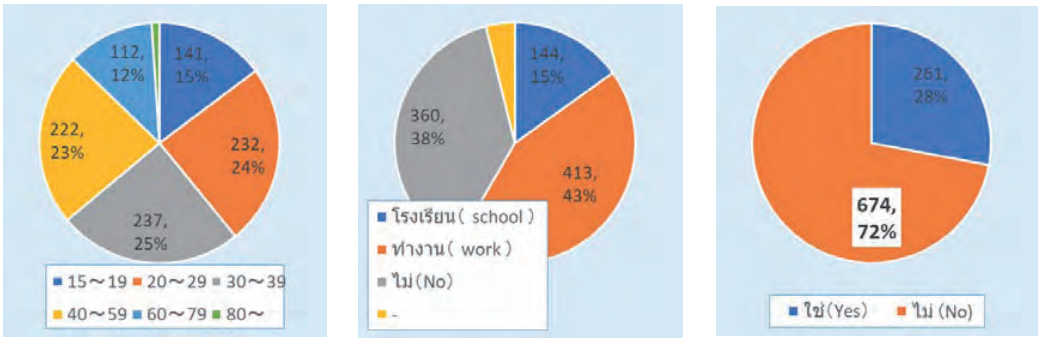
Table 4.2 List of Locations of Commercial Facility

Location	Duration	Target Period	Authority
Future Park Rangsit	9-17	25th- 31st Nov.	BMA
Mega Bang Na			
Centralplaza Bang Na			
Central Latphrao			
Rama II			
CentralPlaza Pinklao			
The Old Siam			
Central Plaza Rama Ⅲ			
Seacon Square			
The mall Tha Phra			
The Street Ratchada			
Central Plaza Grand Rama 9			
Terminal 21			
The EmQuartier			
Platinam Fashion Mall			
MBK Center			
Victory Mall			
Silom Complex			
CentralPlaza Rattanathibet			
Central Plaza			

4.4 Survey Results

1) Basic Information of Samples

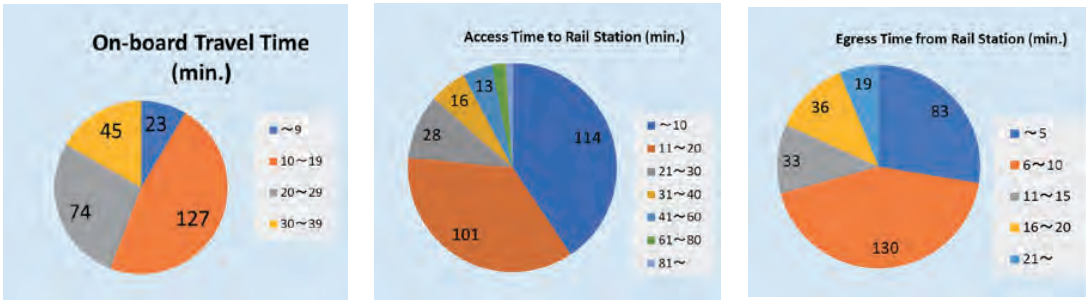
Total number of the samples was 954; 277 samples at tourism site, 585 samples at commercial site and 92 samples at office. Attribute of the samples are shown below. Age of interviewees are widely spread seen from the figure below and 646 samples, 72 % of the total, do not own their own car.



1. Age **2. Worker / Student** **3. Car Ownershipe**

Figure 4.1 Attribute of Samples (n=954)

Then, information on average on-board travel time, access time to railway station and egress time from railway station is shown below. About 75% of the samples took less than 20 minutes for their access and egress time from railway station. Then, seen here, more than half of samples took less than 20 minutes on board time.



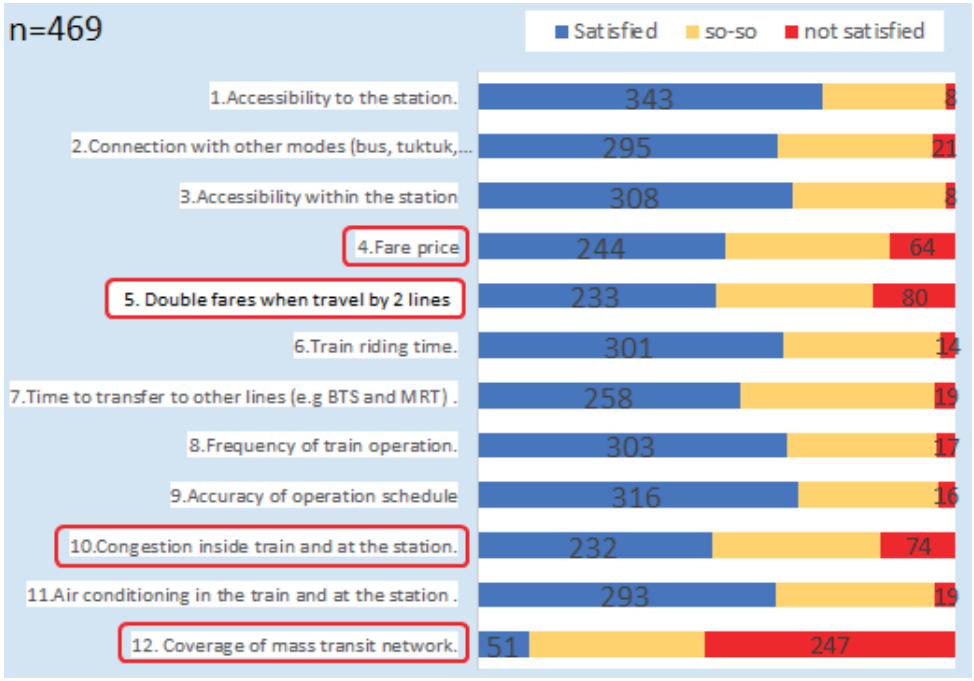
1, On-board Travel Time (min) **Access Time to Railway Station (min)** **3. Egress Time from Railway Station (min)**

Figure 4.2 Figures regarding Travel Time

2) Satisfaction to the Current Mass Transit Services

12 items are inquired based on the interview sheet. According to the results below, the

interviewees are basically satisfied with the mass transit since most of them answered "satisfied" or "so so" for questions. On the other hand, there seems 3 points that the satisfaction of samples is relatively lower than other topics; 1) fare for Mass Transit, 2) congestion of inside of a car, and 3) coverage area of mass transit network in BMR. In particular, more than half of samples are unsatisfied with the coverage area of mass transit network in BMR.



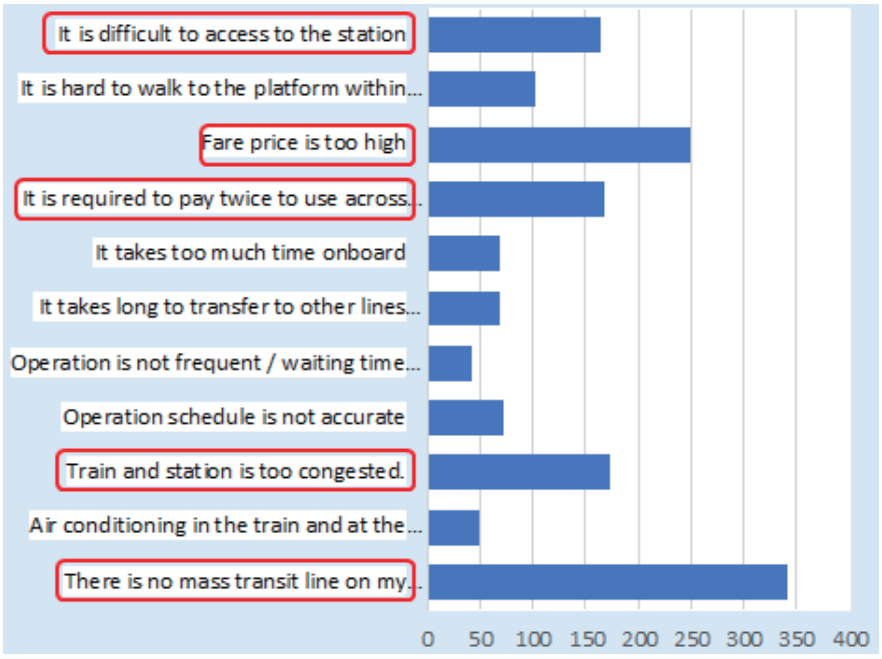
Source: JICA Study Team

Figure 4.3 Satisfaction to the Current MRT in BMR (n=469)

3) Reason why the Users Not Use Mass Transit

There are several reasons why people do not use mass transit as follows. The reasons why they do not use are same as the lower satisfactions on the current mass transit. According to the result, the coverage of the mass transit network is one of the main reasons why the people in BMR will not take the current mass transit. Current coverage area (800m from a station) by mass transit as of 2017 is shown in Figure 4.5 and the coverage area is much less than the one planned in M-MAP.

Seen from the results, fare of the mass transit is also a bottleneck for some users when they consider taking the mass transit. Then, when a mass transit user takes two lines of mass transit, they have to pay fare twice if operators of two lines are different such as the transfer from Chatchak station of Blue line to Mo Chit station of Sukhumvit line.



Source: JICA Study Team

Figure 4.4 Reasons Not to Use the MRT in BMR (n=561)

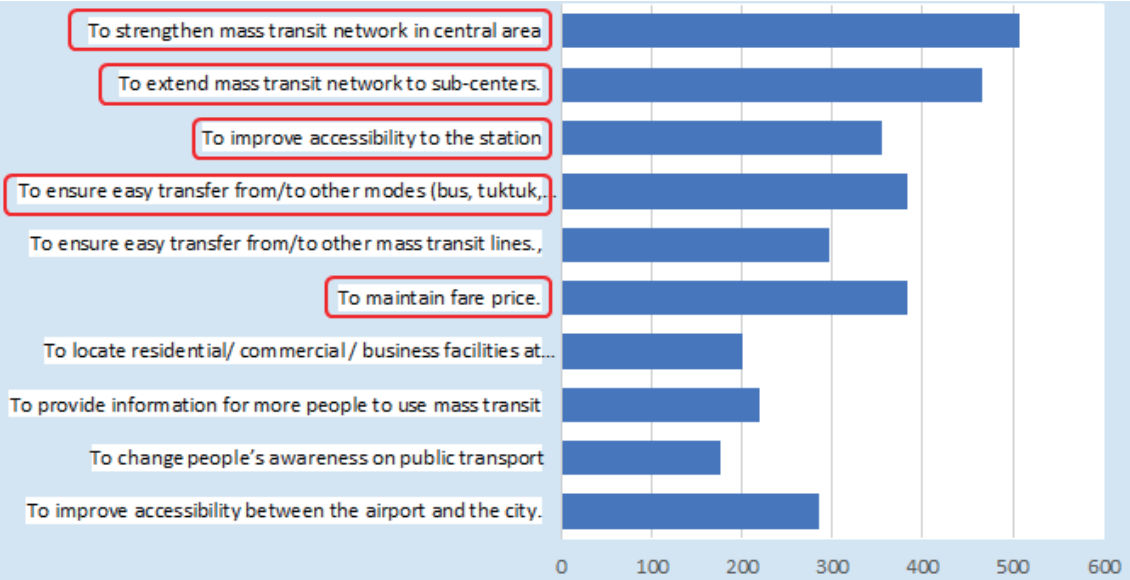
Source: JICA Study Team

Figure 4.5 Station Coverage (800m) in the central area (2017, Left) and Future Station Coverage (800m, M-MAP Plan, Right)

4) Important Actions for Future Mass Transit Development

The results of important actions for future mass transit development are shown in Figure 4.6. More than half of participants agreed "to strengthen mass transit network in central area" and "to extend mass transit network to sub-centers". Both of answers include the necessity of improvement of mass transit network in BMR and this opinion can be seen in the former questions. In addition, improvement of accessibility at a station or to other

transportation mode seems important for the interviewees.



Source: JICA Study Team

Figure 4.6 Important Actions for Future Development of MRT in Bangkok (n=953)

4.5 Discussions

From the results of this people's perception survey, 3 main desires by the interviewees to the current and future mass transit in BMR can be recognized.

One is that the current mass transit network in BMR is very weak and this situation can be seen in Figure 4.5. The current network covers only limited area in BMR so limited people can commute to office or go to the city center merely by the mass transit. This is directly connected with one of five major policy directions in M-MAP2 shown in Figure 4.7. At the same time, connectivity between line and line should be considered and strengthened. This connectivity has 2 meaning; one is the distance between station should be shorter and another is the fare since under the current situation, passengers have to pay double for some transfer.

Second is that accessibility to a station has some problems when the people in BMR take the mass transit. One of the problems is that there is poor access from their home to the station. At mass transit station near city center, the station can be easily accessed by buses or by other lines. Whereas, some of mass transit station has difficulty to access the station such as Ban Thap Chang station of ARL, which is usually accessed by a motor bike or by a private car since the bus stop is little far from the station. When a new mass transit station is considered, connectivity with other transportation modes should be carefully assessed. Some stations of Purple line and Blue line accommodate parking area adjacent to the station and this promotes park and ride system for the commuters.

Third is that the fare price is high or the total cost for commuting by mass transit is high.

Basically, the fare of mass transit is 2 or 3 times more than that of air con bus along the same route. Thai staff in office said that they may take a bus longer distance even though transfer point from bus and mass transit since taking mass transit for a long time is more costly. Then, another point is already explained that if the operator of mass transit is different line by line, a passenger has to pay for both of rides. This seems very large barrier for the local people since the fare for the mass transit is not very cheap for them. In the future, the network will be expanded so a passenger may have to pay 3 times or 4 times to commute to their workplace under the current system. Manmoon card has been recently introduced in Bangkok and this card is compatible between Blue line, Purple line and BTS lines so far. This approach will be connected to the basic fare sharing between operators in the future.

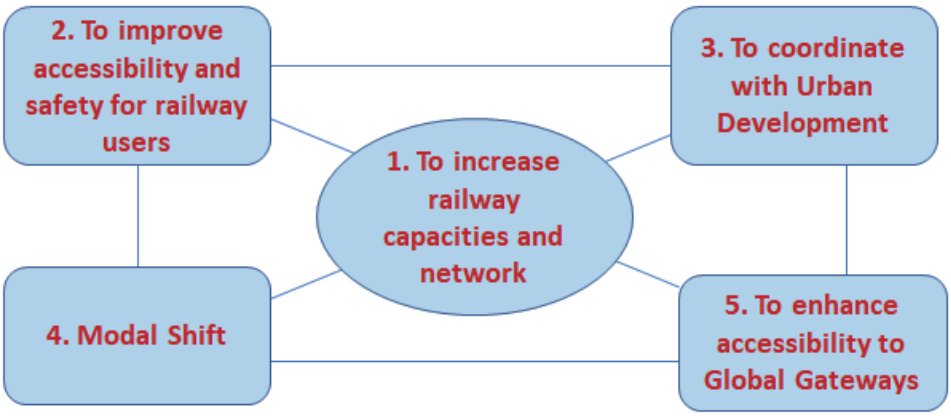


Figure 4.7 Five Major Policy Directions of Urban Railway Development in M-MAP2

Also, many of participants of the survey cared about the congested situation inside of a train. As seen from the results of railway congestion survey and train waiting time survey, a train and the platform during peak hours are very congested and this is unsatisfied by large portion of passengers. High demand for the mass transit itself is good news but on the other hand, capacity of mass transit should be considered and improved at that time.

This People's Perception Survey is a trial to grasp what is required by people for the mass transit in BMR. The survey was conducted at variety of areas in BMR but the size is still not enough. However, several trends mentioned above were acknowledged through this pilot survey. The results of this survey hopefully lead the future policy direction on the mass transit in BMR or connects to the improvement of the service in the future.

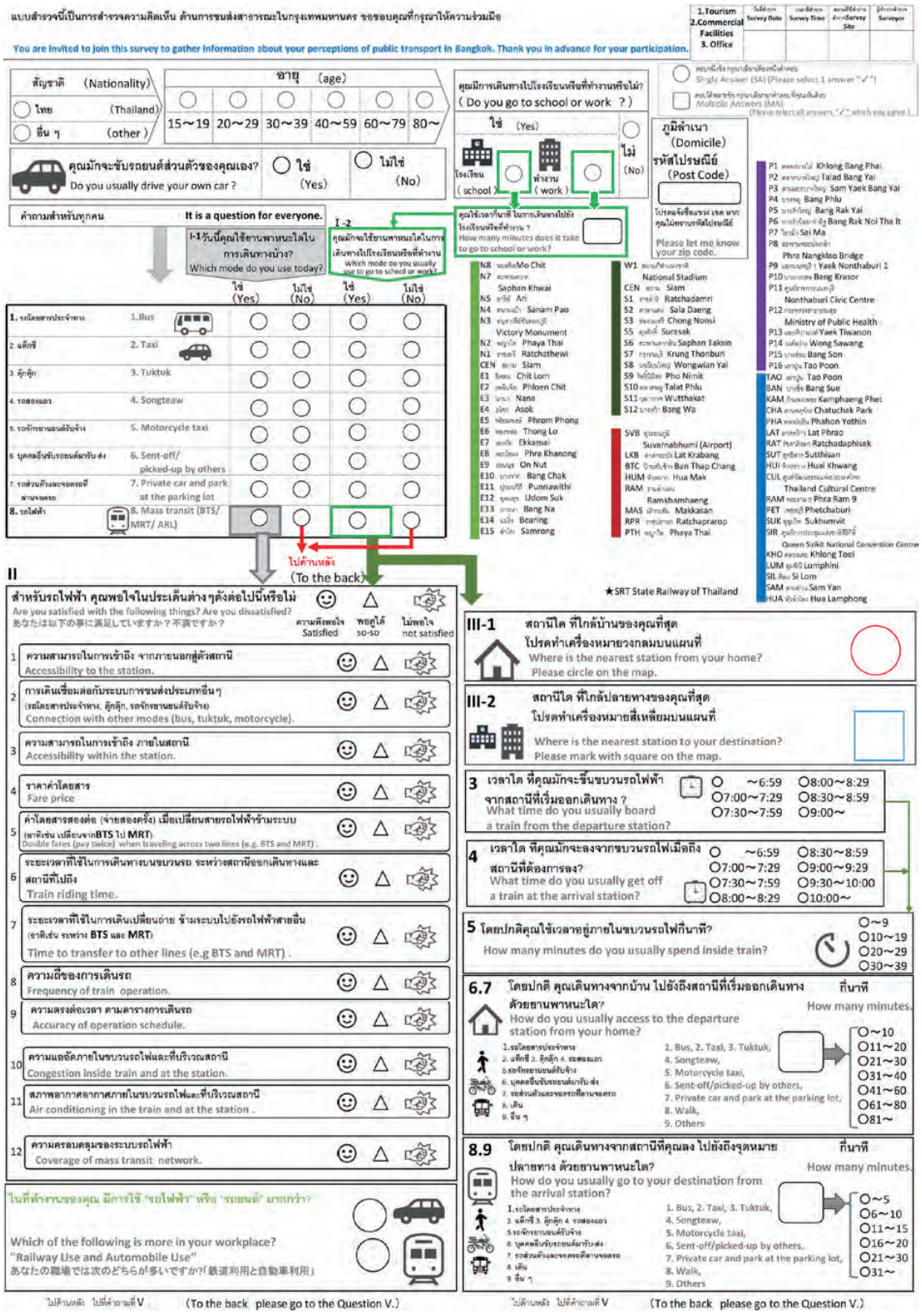


Figure 4.8 Interview Sheet of People's Perception Survey 1

Ⅳ ทำไมคุณถึงไม่เลือกเดินทางโดยรถไฟฟ้า ?

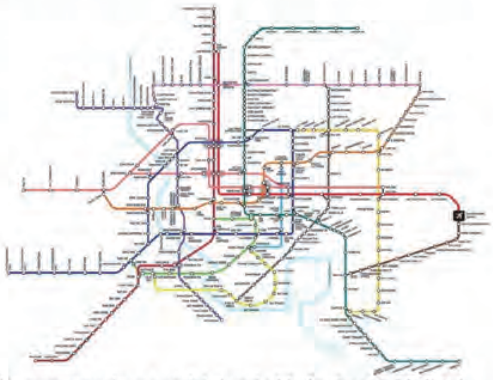
- ☐ มีความลำบากในการเดินทางเข้าถึงสถานี
- ☐ มีความลำบากในการเดินไปยังชานชาลาภายในสถานี
- ☐ ราคาค่าโดยสารสูงเกินไป
- ☐ จำเป็นต้องชำระเงินสองครั้งในการเปลี่ยนไปใช้เส้นทางสองสายหรือมากกว่า (อาทิเช่น BTS และMRT)
- ☐ ระยะเวลาที่ใช้บนรถไฟฟ้านานเกินไป
- ☐ ระยะเวลาที่ใช้ในการเปลี่ยนถ่ายไปยังเส้นทางสายอื่น ๆนานเกินไป (เช่น จาก BTS ไปยัง MRT)
- ☐ การเดินรถมีความถี่น้อยเกินไป /ใช้เวลารอขบวนรถไฟขบวนถัดไปนานเกินไป
- ☐ รถไฟฟ้ามาช้า ไม่ตรงตามกำหนดการเดินรถ
- ☐ มีความแออัดมากเกินไปภายในขบวนรถและบริเวณสถานี
- ☐ สภาพอากาศในขบวนรถไฟฟ้าและบริเวณสถานีไม่เหมาะสม
- ☐ ไม่มีเส้นทางรถไฟฟ้า ในแนวเส้นทางการเดินทางของฉัน

Ⅳ Why you do NOT use mass transit ?(MA)

- ☐ It is difficult to access to the station.
- ☐ It is hard to walk to the platform within the station.
- ☐ Fare price is too high.
- ☐ It is required to pay twice to use across two or more lines (e.g. BTS and MRT) .
- ☐ It takes too much time onboard.
- ☐ It takes long to transfer to other lines (e.g. BTS to MRT) .
- ☐ Operation is not frequent / waiting time for the next train is too long.
- ☐ Operation schedule is not accurate.
- ☐ Train and station is too congested.
- ☐ Air conditioning in the train and at the station is not comfortable.
- ☐ There is no mass transit line on my traveling route.

Ⅴ คุณรู้ข้อมูลเกี่ยวกับแผนการพัฒนาระบบขนส่งมวลชนทางรางในกรุงเทพมหานครในอนาคตหรือไม่
Do you know about future development plan of mass transit systems in Bangkok?

◯ ใช่ (Yes) ◯ ไม่ใช่ (No)



-2 โครงข่ายระบบขนส่งมวลชนทางรางเป็นสิ่งที่จำเป็นอย่างยิ่งสำหรับกรุงเทพมหานคร เพราะว่า?

- ☐ เพื่อพัฒนาเมืองให้เป็นศูนย์กลางเศรษฐกิจใน AEC (ประชาคมเศรษฐกิจอาเซียน)
- ☐ เพื่อพัฒนาให้เป็นเมืองน่าอยู่อาศัยสำหรับประชาชนทุกคนรวมทั้งผู้สูงอายุ
- ☐ เพื่อพัฒนาให้เป็นเมืองที่น่าสนใจสำหรับนักท่องเที่ยว
- ☐ เพื่อพัฒนาให้เป็นเมืองสีเขียวและเมืองแห่งสุขภาพ
- ☐ เพื่อพัฒนาให้เป็นศูนย์กลางการบริหารประเทศและระหว่างประเทศ

Why mass transit network is inevitable for Bangkok? (MA)

- ☐ To be economic hub in AEC (Asian Economic Community).
- ☐ To be livable city for all citizens, including aged people,
- ☐ To be attractive city for tourists.
- ☐ To be green and healthy city.
- ☐ To be a center for national and international administration.

-3 ถ้าระบบขนส่งมวลชนทางรางได้รับการปรับปรุงให้ดีขึ้น คุณคิดว่าคุณจะใช้บริการให้บ่อยขึ้นกว่านี้หรือไม่?

- ◯ ใช่
- ◯ ไม่ใช่

If mass transit system is improved, do you think you will use more frequently?

- ◯ Yes
- ◯ No

-4 คุณคิดว่ากิจกรรมใดบ้างที่สำคัญในการพัฒนาระบบขนส่งมวลชนทางรางในอนาคต

- ☐ เสริมสร้างโครงข่ายระบบขนส่งมวลชนทางรางในบริเวณใจกลางเมือง ให้ครอบคลุมใจกลางเมืองมากยิ่งขึ้น
- ☐ ขยายโครงข่ายระบบขนส่งมวลชนทางรางไปยังบริเวณพื้นที่ชุมชนหลักที่อยู่รอบนอก
- ☐ ปรับปรุงความสามารถในการเข้าถึงสถานีให้เข้าถึงได้ง่ายขึ้น
- ☐ พัฒนาเส้นทางการเดินเปลี่ยนถ่าย ไปยังระบบขนส่งประเภทอื่น ๆ ให้ง่ายขึ้น (รถโดยสารประจำทาง, ตุ๊กตุ๊ก ฯลฯ)
- ☐ พัฒนาเส้นทางการเดินเปลี่ยนถ่าย ไปยังระบบรถไฟฟ้าอื่น ให้ง่ายขึ้น
- ☐ ตรึงราคาค่าโดยสาร
- ☐ จัดเตรียมพื้นที่ที่อยู่อาศัย / พื้นที่เชิงพาณิชย์/ สิ่งอำนวยความสะดวกทางธุรกิจ ให้อยู่ใกล้สถานี
- ☐ ให้ข้อมูลสำคัญแก่ประชาชนเพื่อกระตุ้นให้ใช้ระบบขนส่งมวลชนเพิ่มมากขึ้น
- ☐ เปลี่ยนทัศนคติของประชาชนเกี่ยวกับระบบขนส่งสาธารณะ
- ☐ ปรับปรุงความสามารถในการเข้าถึงระหว่างสนามบินและตัวเมือง

If mass transit system is improved, do you think you will use more frequently?

- ◯ Yes
- ◯ No

Please select the important actions for future mass transit development.(MA)

- ☐ To strengthen mass transit network in central area.
- ☐ To extend mass transit network to sub-centers.
- ☐ To improve accessibility to the station.
- ☐ To ensure easy transfer from/to other modes (bus, tuktuk, etc).
- ☐ To ensure easy transfer from/to other mass transit lines.
- ☐ To maintain fare price.
- ☐ To locate residential/ commercial / business facilities at station area.
- ☐ To provide information for more people to use mass transit.
- ☐ To change people's awareness on public transport.
- ☐ To improve accessibility between the airport and the city.

Figure 4.9 Interview Sheet of People's Perception Survey 2

Appendix 6

Workshop on Safety for Railway Operation

Appendix 6

Pursuit of safety in Japan

2019. 02. 08

The history of railroad evolved by "learning from accidents".
Establishment of regulations and installation of security equipment.

1869 1927 1964 2019

1951 1962 1968 1978 1993

human error	human error	fire	A strong wind	Flood damage

1 Securing safety is the life of transport.
2 Compliance with the regulations is the foundation of safety.
3 Strictness of office is a requirement of safety.

1988 1993

Misoperation	earthquake

Stop train if you think it is dangerous!

1962

human error

Evolution of train signals.

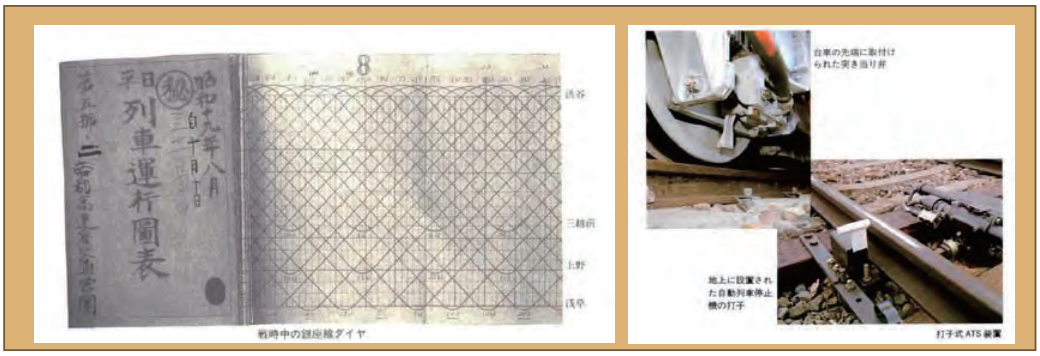
Circuit display formula
(Route signal)

Speed indication formula
(Speed signal)

In-car signal

The subway is high-density driving from the beginning of operation.
Even if the driver overlooks the signal, it can stop with the "automatic train stop device"

1869 1927 2019



1968 Accidents burning "trains that should not burn" occur

1978 A train that is running is caught in a tornado, The rear three of the 10 car train are derailed, 2 of them rolled over

1993 The heavy rain caused by the typhoon floods the station premises and is canceled

Pursuing the cause of "accident" by the Transportation Safety Commission and "Safety management regulations"

MLIT
Ministry of Land, Infrastructure, Transport and Tourism

Railway Bureau

- Railway Business Ac
- Railway Operation Act

JTSB
運輸安全委員会
Japan Transport Safety Board

Investigate the cause of the accident and investigate the cause of the damage caused by the accident.

DATA BASE

Railway operator

JR東日本　東急電鉄　Etc.

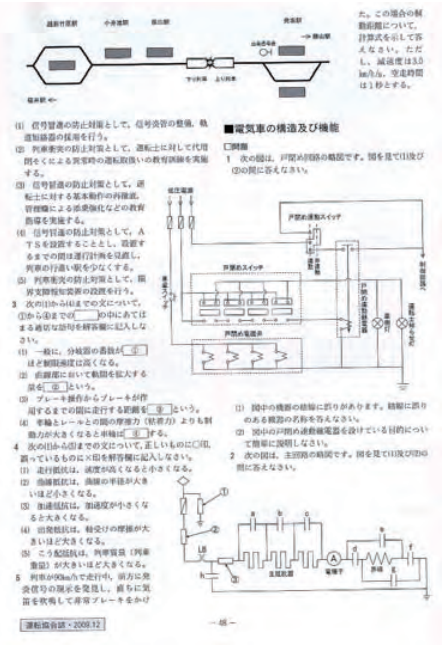
Railway Technical Research Institute

Japan Private Railway Association

Japan Train Operation Association

https://mainichi.jp/articles/20160414/k00/00m/040/116000c

JTOA (Japan Train Operation Association)



Safety management provision.

Code of conduct of executives and employees related to safety of transportation? (Article 3, paragraph 2 of the Safety Management Regulations)

(1) Secure safety shall be given top priority and efforts will be made to achieve the mission of transport by cooperating cooperatively.
(2) We understand the laws concerning the safety of transportation and regulations related thereto (hereinafter referred to as "related laws and regulations, etc.") well, and comply with it and carry out duties strictly and faithfully.
(3) We always try to understand the situation on transport safety.
(4)As we perform our duties, we strive to enforce confirmation regardless of speculation, and if there is doubt, we will treat it as safest.
(5) In the event of a situation where there is a risk of accidents, accidents, disasters or other situations that may interfere with securing the safety of transportation (hereinafter referred to as "accidents, disasters, etc."), Cooperate mutually to promptly take safe and appropriate measures.
(6) Transfer information related to safety quickly and accurately to relevant places and try to share them.
(7) Always act with problem consciousness and actively deal with when it is necessary to review work.

Evaluation by MLIT

Received periodic transport safety management evaluation by the Ministry of Land, Infrastructure and Transport, and reflected in reviewing the safety management system.
Transport safety management evaluation contents
【Implementation period】
October 31, 2017 - November 1
【Evaluated efforts (excerpt)】
◎ The top management should grasp the problems accompanying the change in the environment surrounding the company, aim to respond by combining improvements in the competence of the teaching side and the system to arrange, transfer and transfer the technology to be handed over.
◎ The fact that collecting information is also collected from group companies in addition to our own company, and furthermore, the collection promotion efforts show that the collection number is increasing.
◎ With regard to "cross-division training" where individual employees think and act actively, they are implementing measures that can link safety awareness to practice and can expect to contribute to preventive maintenance of accidents.
◎ We are trying to make efforts to revitalize internal audits.
【Items to expect further efforts】
◎ Advance measures to prevent further penetration and dissemination about precautionary preservation thinking.

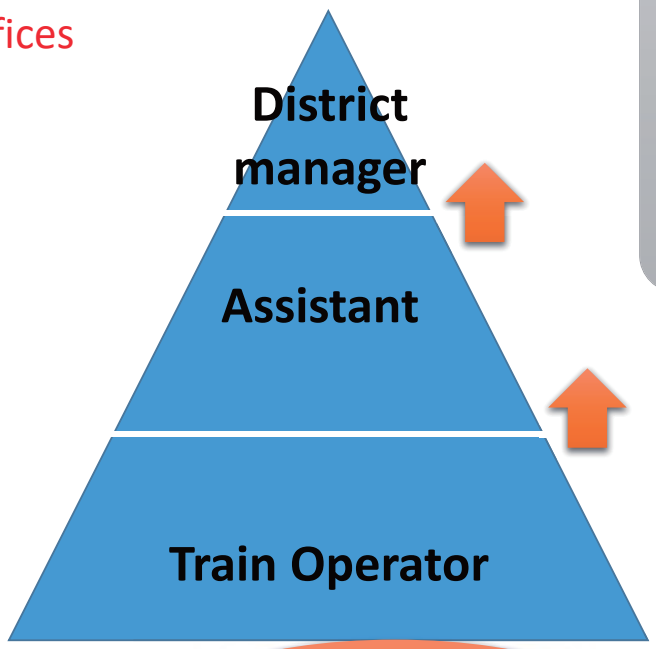
Tokyo Metro operate 9 subway lines with 195 km of track. Minimum operation interval is 2 minutes. Tokyo Metro is responsible for a core part of the railway network in Tokyo.

km	14. 3	27. 4	20. 3	30. 8	24. 0	28. 3	11. 9	16. 8	21. 3	195. 1
stations	19	28	21	23	20	24	11	14	19	179
No of car /train	6	6	7&8	10	10	10	8&10	10	6	
No of car	240	336	296	520	408	540		250	138	2728
No trip/day	374	300	284	290	255	249	246	289	187	
Train operator	○	○	○	○	○	○	○	○	○	
Conductor	○	×	○	○	○	△	○	×	○	

With 2,700 drivers, conductor
We offer operation service.
Customers 7.24 million per day

Human resource development continues even after training train operator. (Experienced driver and transferred to headquarters department and development of new model rolling stock.)

Field Offices



Station staff

conductor

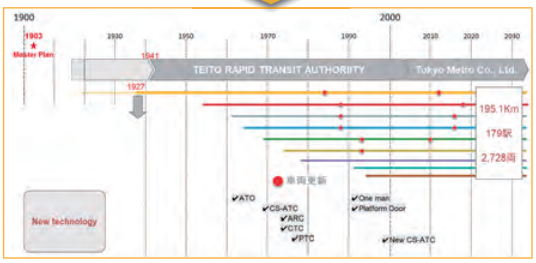
Train Operator training

Head Office

Safety Affairs Dept.

Railway Headquarters

Operation Dept.



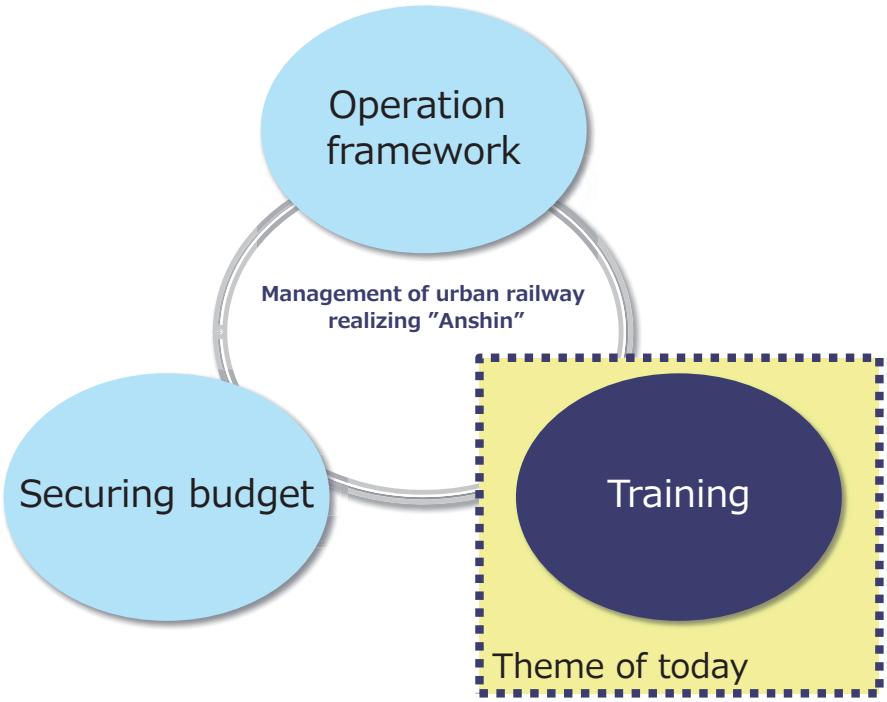
Policies and Initiatives of Tokyo Metro Comprehensive Learning and Training Center

1. Tokyo Metro’s Policy

2. Tokyo metro’s Training Program

Key points of railway Operation

The key points of railway management are “Operation framework", “Securing budget" and “Training". "Training" is the theme of today.

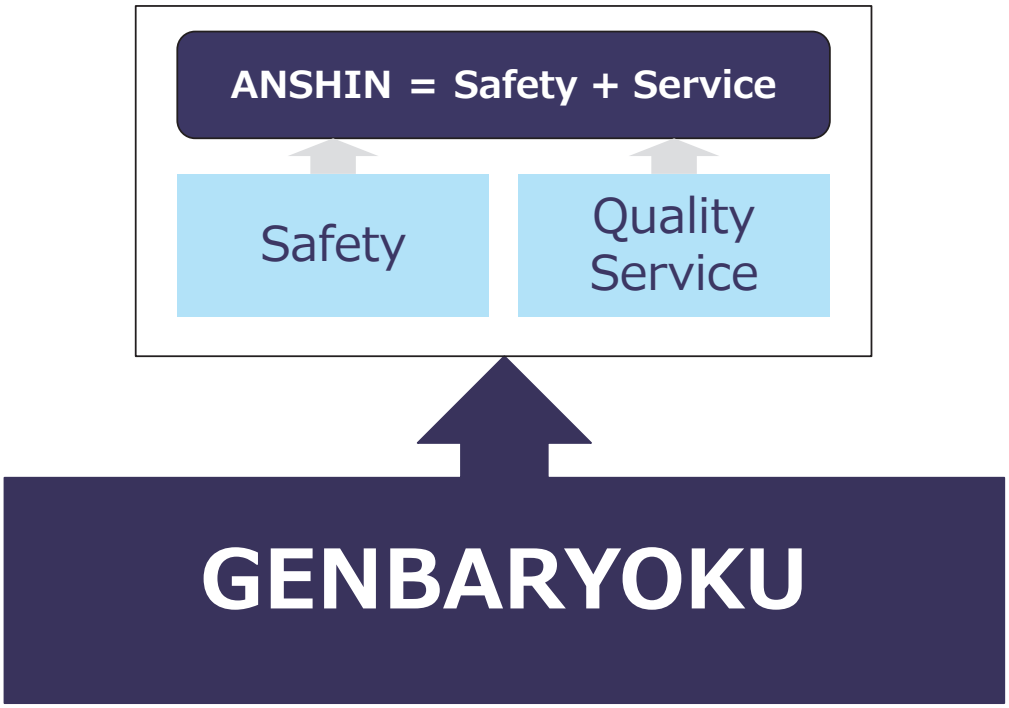


Tokyo Metro’s Policy ～Important ideal in subway operation～

- Our key concept is “ANSHIN”
- We believe that the key to providing customers with ANSHIN is the combination of safety and quality service.

ANSHIN and GENBARYOKU

GENBARYOKU is important to realize “ANSHIN“



GENBARYOKU

What’s GENBARYOKU ?

Tokyo Metro's Training Policy ～Developing Personnel to Provide ANSHIN～

❑ Through the Comprehensive Learning and Training center, we ensure these ideals to put into practice.

Developing Personnel to Provide ANSHIN

Comprehensive Learning and Training Center

Human Resources

- Providing Staff with extensive training
- Promoting cross-departmental Coordination

Facilities

- Integrated Training Facilities
- Training line that simulates a real operational subway line

Overview of Comprehensive Learning and Training Center

○Establishment: April 2016
○Overall Site Area: Approximately 27,000 ㎡ (Approx. size of 4 soccer fields)
○Building: 5-stories, Total Floor Area: Approximately 19,000 ㎡
○Training Lines: Total Track Length Approximately 700m

1. Tokyo Metro's Policy

2. Tokyo metro's Training Program

Type of Staffs Trained at the Center

The center trains staffs from various departments and occupations involved in railway business.

Type of Staff	Department	Main work content
Operation • Involved directly in train operation	**Train Operation Dept.**	• Train operation control • Driving of trains • Guidance within trains and door operation
	Station Service Dept.	• Passenger guidance and platform organization • Station point operation
Technical • Involved in development & maintenance of facility and structures for safety and stable operation	**Rolling Stock Dept.**	• Disassembly, cleaning, repair and improvement of train cars • Inspection and maintenance of train cars
	Infrastructure Maintenance Dept.	• Inspection, maintenance and replacement of railway track • Tunnel inspection and repair • Building, station inspection and repair
	Electrical Facilities Dept.	• Inspection and repair of power supply • Inspection and repair of overhead wiring and air conditioning • Inspection and repair of optical and wireless communications
Corporate • Supervise field operation of train service • Planning & implementation of business operation	**Renovation & Construction Dept.**	• Installation of barrier-free facilities • Expansion and improvement work of stations





Features of Comprehensive Learning and Training Center

With a variety of facilities and training programs that enable comprehensive learning, the Center plays an important role in enhancing staff's service quality.

Training Programs

For Managerial Staffs
- ✓ Provides opportunity to experience and learn comprehensively across all functions

For Operation & Technical Staffs
- ✓ Provides practical training to enhance individual capabilities required in respective duties

Cross-Departmental
- ✓ Provides training to strengthen coordination across departments and enhance ability to respond rapidly and effectively under emergency situation

Facilities

Under Realistic Environment
- ✓ Allow trainees to learn practically with real models of facilities used in service line, along with classroom lectures

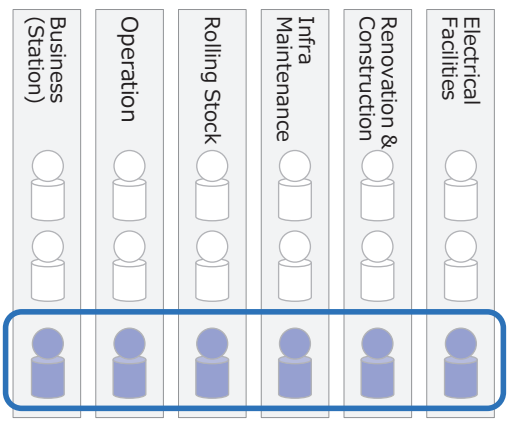
Without Time Constraint
- ✓ Allow training to be conducted without restriction of service hour, construction & design schedule etc.

Risk-free
- ✓ Allow trainees to learn without fear of failure

【Safety Training】 Cross-departmental Training Program

This program allows staffs from different departments work together using their own expertise.
- ✓ Conducting a simulation training to recover an accident or trouble that has occurred in the past
- ✓ Each department collaborate to minimize recovery time

Cross-department Collaboration



Training is conducted with staffs from different departments

Overview

- Objective
  - Reinforcement of collaboration roles in different departments
  - Experience necessity for speedy response measures
  - Mutual discussions among participants

- Training Contents
  - Service disruption due to signal failure
  - Rail failure
  - Signal failure near a point
  - Point failure
  - Damage or smoke spotted from a pantograph
  - Smoke spotted from under a train car
  - Management of injury accident

【Safety Training】

Training in cooperation
with the administration etc.

Countermeasure Headquarters Establishment
and Operation Training

Accident assumption training

Accident assumption training

Training Program for Driver

Presently, we are educating total of 1,344 drivers and 914 conductors (At June 2017).
We have program to educate 100 new drivers and conductors every year.

Education Program (Driver)

In addition to initial training, program offers follow-up training, emergency training, accreditation system to enhance driver's capability

Initial Training

Registration Examination

Academic Studies Completion Examination

Skills Completion Examination

Academic Studies **3.5months**

Skills Training **4.5months**

1.5months for Conductor

2months for Conductor

Continuous Training

- ☐ Follow-up Training (Year 1, 3)
- ☐ Emergency Training
- ☐ Driving Skill Accreditation System etc.

Continuous Training (Driver)

Using Simulator

- Natural disaster (earthquake, flood)
- Injury accident
- Last minute rush on board
- Smoke detection from car
- Various train car trouble
- Signal failure
- Other types of trouble

More than 150 training cases in total

Using Training Line

1. Driving without signal indication due to car failure
2. Controlling and driving from rear car due to failure of front driving cab
3. Stopping in between stations and driving backwards to the original station
4. Driving under situation when the door close indicator is malfunctioning
5. Adjusting the train position when overdriving

Facilities of Comprehensive Learning and Training Center

For Train Crew

Train Simulator Room

For Traffic Control

Signaling Training Room

Training Programs Using Mock-up Structures

Using mock-up structures in the Center allows trainees to experience and learn practically, applying what they learned in academic studies.