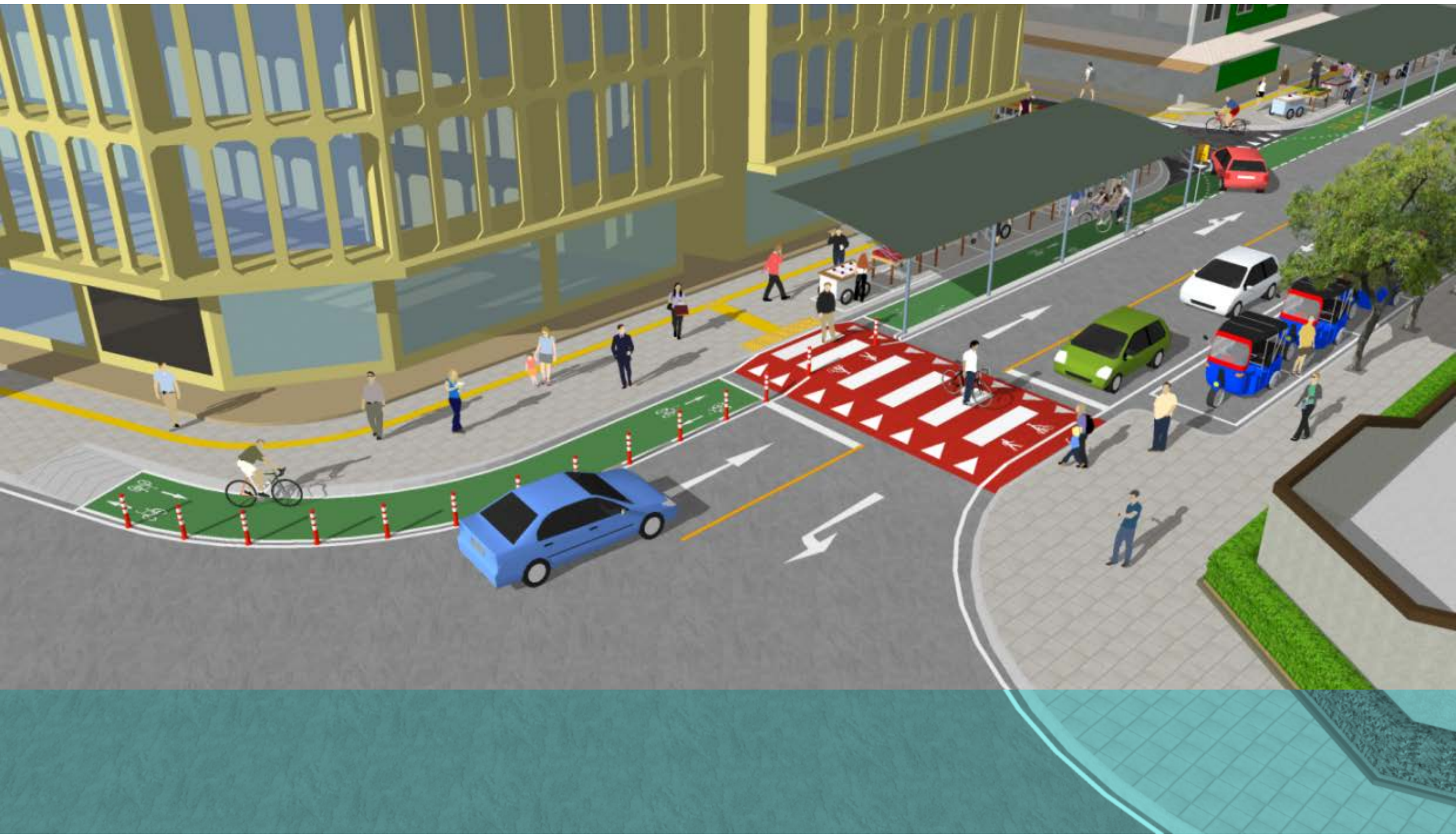

Improving Public Bus Service and Non-Motorised Transport in Bangkok

A Study for the Thailand Mobility NAMA

October 2016

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Acknowledgements

We would like to thank Paul Williams, Dr. Kunchit Phiu-Nual, Stefan Bakker, Papondhanai Nanthachatchavankul, Tali Trigg and Farida Moawad for their valuable inputs and comments.

Improving Public Bus Service and Non-Motorised Transport in Bangkok

A Study for the Thailand Mobility NAMA

Kerati Kijmanawat, Pat Karoonkornsakul (PSK Consultants Ltd.)

The Project Context

The GIZ Programme on Cities, Environment and Transport (CET) in ASEAN seeks to reduce emissions from transport and industry by providing co-benefits for local and global environmental protection. The CET Project 'Energy Efficiency and Climate Change Mitigation in the Land Transport Sector in the ASEAN region' (Transport and Climate Change (TCC) www.TransportandClimateChange.org) aims in turn to develop strategies and action plans for more sustainable transport.

As presented to the ASEAN Land Transport Working group, TCC's regional activities are in the area of fuel efficiency, strategy development, green freight, and Nationally Appropriate Mitigation Actions in the transport sector. At the national level the project supports relevant transport and environment government bodies in the Philippines, Thailand, Vietnam, Malaysia and Indonesia, for the development of national action plans and improvement of policy monitoring systems. The project is funded by the German Federal Ministry for Economic Cooperation and Development.

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Executive Summary

Background and aim: Thailand Mobility NAMA

The Thailand Mobility NAMA aims to reduce greenhouse gas emissions from urban transport and focuses on improving bus service and conditions for walking and cycling, thereby promoting modal shift and energy efficiency

Thailand, and Bangkok in particular, is experiencing rapid growth of private vehicle use, leading to congestion, air pollution, road safety issues, reduction of city liveability and greenhouse gas emissions. The modal share of public transport has been decreasing. Non-motorised transport (NMT) such as walking and cycling is drawing significant attention in recent years.

Bus and NMT are key feeder modes to the urban rail system in Bangkok, which is undergoing expansion, and these modes can increase the attractiveness and catchment area of the BTS and MRT. However, in the current situation these modes are hardly attractive and significant improvements are needed to achieve this. As a contribution to global climate change mitigation, Thailand is developing a nationally appropriate mitigation action (NAMA) 'People-centred urban mobility in Thailand' or Thailand Mobility NAMA in short. This NAMA will be submitted to the UNFCCC and international financial and technical support is requested for its implementation.

In order to improve feeder modes in Bangkok and other cities, the NAMA aims at consolidation of the bus services, improvement of public transport hubs, bus prioritisation, introduction of more energy-efficient buses and the improvement of conditions for cycling and walking. These are further enabled and encouraged by national policies, a financial mechanism and improved monitoring systems (MRV). The measures will result directly in reduced energy consumed by buses, as well as promote a modal shift from private motor vehicles to public transport, walking and cycling, thereby saving CO2 emissions and yielding sustainable development benefits.

This report aims to analyse the existing situation and develop detailed guidance and options for actions under the NAMA, specifically for bus public transport management - route optimisation, bus priority measures, bus stop design - and infrastructure measures promoting NMT as feeder mode.

Bus transport management

Improving bus service requires:

- Strong government support and institutional changes in bus management
- Enforcement of bus priority lanes and clear signage
- Improved location and quality of bus stops and interchange stations
- Real-time travel information integrated with GPS location technology
- Introduction of more fuel-efficient buses, including but not limited to hybrid or full-electric technologies

As of 2015, there are approximately 215 bus routes operated under control of the Bangkok Mass Transport Authority (BMTA), about half of which are operated by BMTA and the other half by private operators. The bus route network has grown over time without implementation of a comprehensive master plan, resulting in long and overlapping routes and inefficiencies in the systems.

In the past decade, the Thai government has initiated, with little success, various studies and plans to reform and improve the efficiency of the bus in Bangkok, including bus re-routing, organisational changes, regulatory system modification, privatisation of bus operation, bus priority measures, bus rapid transit and integrated ticketing. Root causes of failure include a complex institutional structure in which coordination and cooperation is challenging, complex decision making procedures, political difficulties, lack of practical planning and design standards, car-oriented planning, lack of bus interchange stations and driver behaviour. Future bus reform plans need to address these route causes and draw lessons from the existing experiences.

Specific recommendations for bus rerouting are the following, with more details in the main report:

- The objectives should be to reduce the extent of overlap in the routes, reduce bus operating costs and improve bus level of service.
- Evaluation can be based on passenger bus travel time and number of transfers, as well as total kilometres operated and associated GHG emissions.
- In order to be able to implement the bus re-route program, there must be a strong order from the top administrator of the Ministry of Transport. In order to further enhance coordination and political support for new plans, restructuring of the Board of Land Transport and broadening its membership to more government agencies may be required.
- Changes in the role of the bus regulator and policy committee in the Ministry of Transport can also be considered.
- Further options and requirement for government support to the bus system should be studied, the private sector should be flexible as to the location of bus stops and information signs, and better integration with other transport modes and high-quality design and location of interchange stations are essential.

In Bangkok, 35 roads have various types of bus priority measures, including peak-hour or all-day dedicated bus lanes and high-occupancy lanes, which can be used by vehicles carrying three or more passengers, either with-flow or contraflow. However, in practice these are hardly observed by private vehicles due to lacking enforcement and unclear signage and communication, the latter causing confusion with drivers. Better enforcement by the traffic police is required, e.g. through surveillance at key locations and cameras with license plate detection. Improvements can be made by reviewing the existing priority lanes, carefully planning and expanding it to a strategic network and installing clearly visible and easily comprehensible signs and road markings.

At present, there are few bus interchange stations while for the existing bus stops, maintenance, accessibility, waiting space quality and capacity, lighting and timetable information are limited; existing regulation does not include such criteria. This results in passenger's inconvenience and safety issues and reduces attractiveness of the public transport system. Guidelines for the bus shelter and environment, bus stop layout and location are elaborated in the report. For bus stations or terminals, convenient and efficient design and location, the latter also depending on bus (re)routing, and integration with the future mass transit lines are key. Real-time travel information systems, at bus stops and mobile applications, integrated with GPS vehicle location technology, are essential in improving convenience for passengers and enabling better monitoring and efficiency.

Non-motorised transport (NMT) and modal shift potential in Ari area (NAMA pilot area)

- Improving NMT conditions, together with bus service, can result in significant modal shift to (rail-based) public transport and walking and cycling

- An NMT-friendly neighbourhood requires, among others, (covered) footways and two-way bike lanes, creation of shared bicycle-vehicle lanes, relocation of paratransit hub and street vendors to different locations in the same area, pedestrian-friendly intersections, level zebra crossings, traffic calming, relocation or removal of car parking, bike sharing stations, bike parking and improved bus stops

In order to assess the current situation with regard to NMT, people's willingness to change transport modes, formulate design guidelines and provide conceptual design of one pilot area in the NAMA, we carried out a comprehensive study in the Ari area in North-Bangkok. This is a both a residential area featuring markets and restaurants as well as a major governmental district. The study includes traffic counts on one full working day and a survey among 400 government staff through questionnaires five office buildings of different ministries.

At the market area between the BTS station and paratransit hub, peak pedestrian flow is 1400-1800 pax per hour, significantly beyond sidewalk capacity. In the government district of Ari, pedestrians and cyclists, are approximately 18% and 1% of daily traffic (including 'through-traffic'), while paratransit, private motorcycles and cars take 22%, 19% and 35% respectively. An evening peak-hour occupancy rate count shows a high rate of trips without passengers for motorcycle taxis and three-wheelers and a 1.4 rate for private motorcycles, higher than for cars. Songtheaws (modified pickup truck used as shared taxi) had an average rate of 9.

50% of government employees arrive at work by car, with the remainder mainly by public transport. 40% percent of them come from the inner suburban Eastern area with 6-km average distance, with the other 60% from eight other (sub)urban areas and neighbouring provinces, part of the Bangkok Metropolitan Region. Household car, motorcycle and bicycle ownership is 63%, 51% and 18% respectively, while 84% of households own at least one vehicle.

More than 70% of respondents currently walk for purpose of travel or shopping, and most are willing to take trips of duration up to about 10 minutes. Almost half cycle predominantly for travel or shopping, the remainder for exercise or recreation. About one-third cycle two times a week or more and for almost 70% the longest duration they are willing to cycle for travel is longer than 10 minutes.

Barriers against shifting from private vehicle to public transport, ranked from most important to least important, include lack of coverage and attractiveness of metro/bus system, safety, travel time and its uncertainty, inconvenient footways and crossing, travel costs and general inconvenience or weather. The conditions for NMT, e.g. sidewalks and pedestrian crossings, cycling environment, cycle parking and bus waiting area and service, are rated 1.5-2.1 out of 5.

If a metro station will be built within 1 km of their residence, 20% of government employees would shift to public transport, and an additional 10% if bus service is improved, stations are clean, safe and convenient, and NMT conditions in Ari are significantly improved. Even without metro access, a significant shift from private vehicles to buses appears possible. In addition, shifts in access (first-mile) and egress (last-mile) trips of current public transport users can occur. The survey results suggest a shift from currently 24% NMT modal share from BTS Ari to the offices to 42% is possible when high quality infrastructure is implemented, shifting away mainly from motorcycle taxis and motorised three-wheelers.

With the planned improvements in urban rail transport and potential bus improvements, the (latent) demand for walking and cycling is expected to increase significantly. Substantial improvements in infrastructure are required to accommodate and further promote NMT. Detailed guidance to ensure an adequate level of service for footway and bike lanes based on international standards and practical application in Bangkok is provided in the report.

Based on this guidance and the surveys we propose a detailed conceptual design for an 'NMT-friendly Ari', which can be implemented in two phases. This includes e.g. (covered) footways and two-way bike lanes, creation of shared bicycle-vehicle lanes, relocation of paratransit hub and street vendors to different locations in the same area, pedestrian-friendly intersections, level zebra crossings, traffic calming, relocation or removal of car parking, bike sharing stations, bike parking and improved bus stop. Other than relocation or removal of some parking spaces, the interventions imply no major changes to the conditions for private vehicles. If in the future a change to e.g. one-way streets for cars would be considered on the main road, this would open up possibilities of even higher-quality NMT conditions including broad, more inclusive sidewalks and one-way bike lanes on either side of the main roads.

1. Introduction

1.1. Concept of Nationally Appropriated Mitigation Actions (NAMA)

Nationally appropriate mitigation actions (NAMAs) are climate change mitigation measures proposed by developing country governments to reduce emissions below business-as-usual levels and to contribute to domestic sustainable development. NAMAs can take the form of regulations, standards, programs, policies or financial incentives.

For Thailand, the GIZ project '*Energy Efficiency and Climate change Mitigation in the Land Transport Sector in the ASEAN region*'[1] (Transport and Climate Change (TCC)) is developing strategies and action plans for more sustainable transport in the region. The process of NAMA development in the transport sector is done jointly by GIZ, Office of Transport and Traffic Policy and Planning (OTP) of the Ministry of Transport, Office of Natural Resources and Environmental Policy and Planning (ONEP) and a NAMA subcommittee and Technical Working Group involving various stakeholders.

As of April 2016, a NAMA entitled '*People-centred Urban Mobility in Thailand*' is in the stage of the concept note and proposal outline, with submission to UNFCCC in the first half of 2016. The overview of potential policy measures in the Bangkok NAMA is described in Figure 1. It is anticipated the NAMA could cover several phases of implementation, e.g. 2016-2020 and 2021-2025.

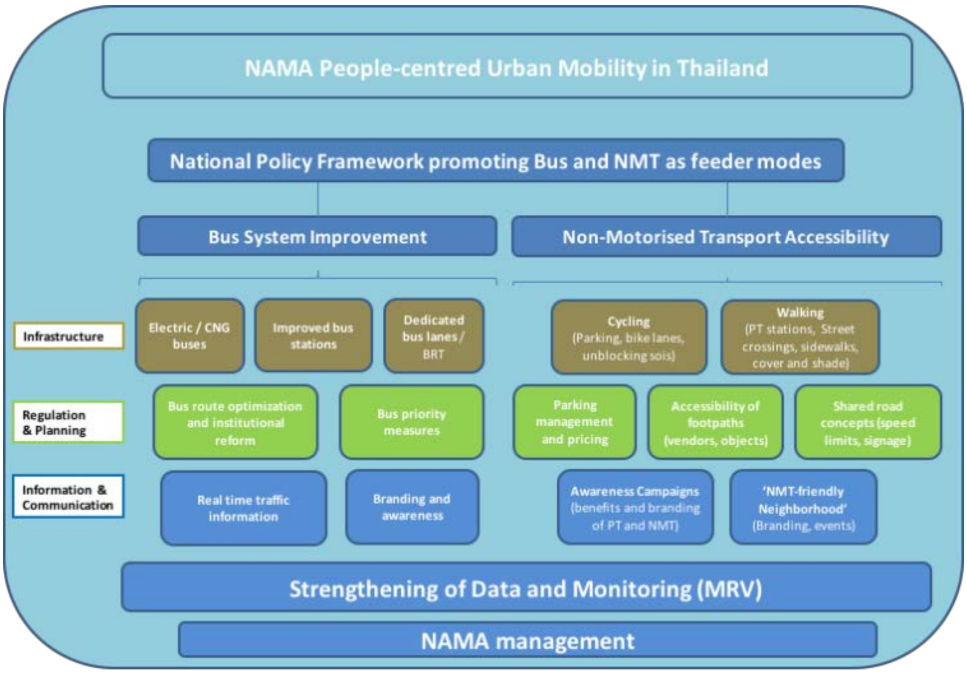


Figure 1: Preliminary overview of potential policy measures in the Thailand Mobility NAMA (Source: GIZ, 2016)

[1] www.TransportAndClimateChange.org

Improving feeder modes of the urban rail network in Bangkok, which is undergoing heavy expansion, is of key importance. Proposals for improving bus service and non-motorised transport conditions are being made that should provide better intermodal connectivity and an overall more attractive public transport system. Initial policies have been developed, however there is a lack of technical capacity and experience, and a more consistent and long-term framework is required to make a true impact, which are provided by this NAMA.

1.2. Role of Public bus and NMT in Greenhouse gas emission reduction

Given the rapid extension of the rail-based public transport system, ongoing policies to improve bus service and conditions for walking and cycling, this NAMA aims to contribute to sustainable transport and reduce GHG emissions in the Bangkok Metropolitan Region (BMR) and other cities in Thailand by:

- Optimising the bus system and its management, which ensures higher occupancy rates and less vehicle-kms and thereby fuel consumption and CO_2 emissions while retaining or increasing the level of service and attractiveness to passengers
- Introducing more fuel-efficient buses, e.g. powered by electricity, (plug-in) hybrid systems and/or natural gas, thereby reducing the CO_2 emissions per vehicle-km driven
- Shifting access modes to public transport stations and other short trips from motorised to non-motorised transport
- Increase public transport ridership by improving the connectivity between NMT, buses and rail-based public transport, which would result in a modal shift from private to public modes or an 'avoided' future modal shift from public to private modes.

Within the Avoid-Shift-Improve paradigm (e.g. GIZ, 2011) this NAMA focuses on 'shift' and 'improve'.

These objectives will be achieved by two main urban transport policy components: bus transport management and NMT accessibility of public transport stations (see Section 4.3.4 for more details). These are further enabled by a national policy component, a mechanism for technical and financial assistance and an improved data and MRV system.

Component 1 is bus public transport management, which ensures improved service with less duplication of routes and enhancing the role of buses as feeder mode.

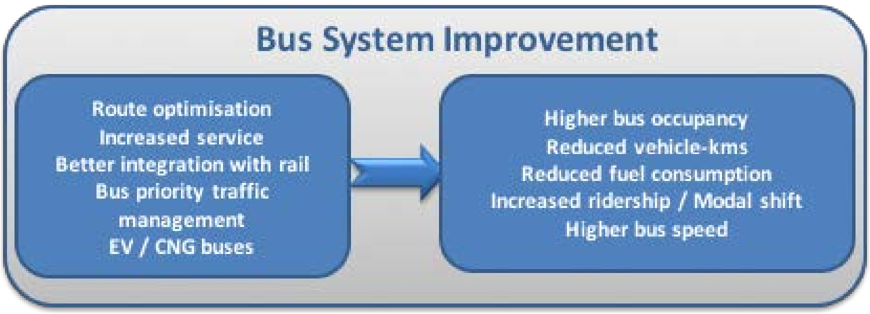


Figure 2: Impact of bus transport management (Source: GIZ, 2016)

Component 2 is NMT Accessibility of Public Transport Hubs. The figure below shows the planned mode shift towards low-carbon means of transportation as well as the anticipated changes in the future modal split.

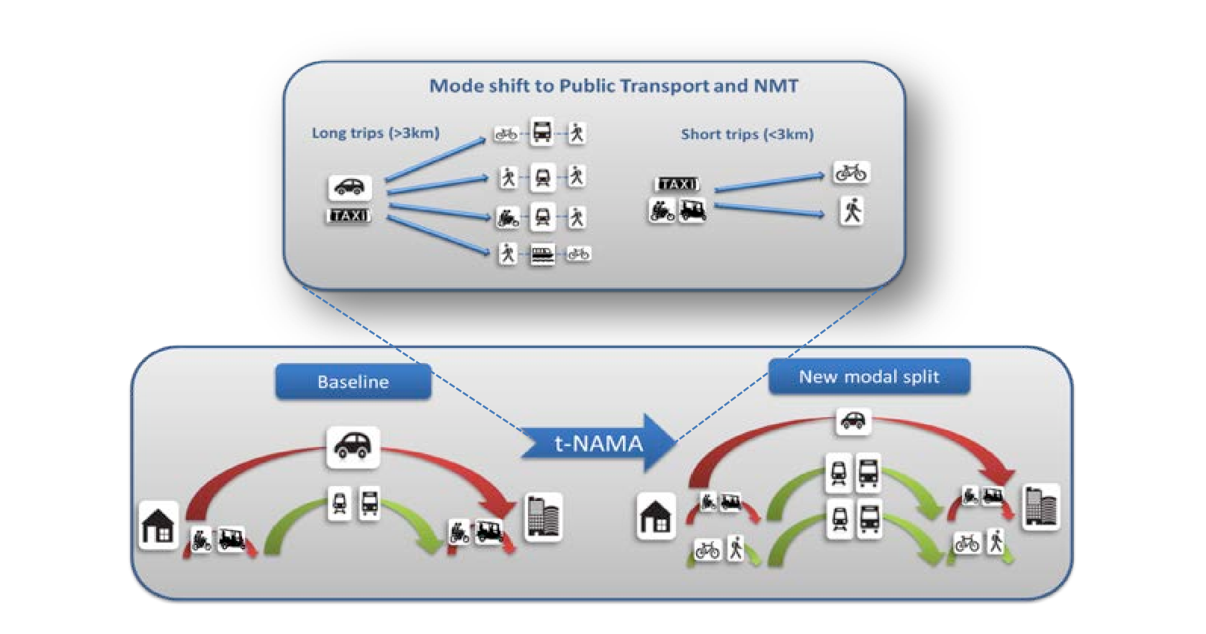


Figure 3: Shift toward public transport and NMT (Source: GIZ, 2016)

1.3. Purpose of the report

This report outlines the comprehensive studies and surveys that were carried out in support of the transport NAMA People-centred Urban Mobility in Thailand. The key objective is to suggest which policy interventions could make sense for the NAMA proposed for Bangkok, and what impacts may be expected.

This report develops detailed options for actions under the NAMA, and specifically provides the following outputs:

- Public Bus Transport Management/Improvement in Bangkok and Vicinity
  - Review of previous bus reroute plan(s), including recommendations and inputs to the ToR for the upcoming *Bus system in Bangkok and vicinity development masterplan* conducted by the Department of Land Transport (DLT)
  - Summary of collected analysis on existing and previous bus priority policies, including appropriate recommendations of bus priority policies in medium and long term to DLT for further transport modelling analysis.
  - Review of current bus station situation with a special view on intermodality
  - Recommend practical concept for bus station in Bangkok
- Role and Potential for Non-Motorised Transport (NMT) as Access Modes to Public Transport System in Bangkok based on the Survey of a Pilot Area
  - Current travel behavior of people in pilot area
  - Current perception of people about walking and cycling as public transport access mode
  - Potential of modal shift from motorised paratransit to NMT as access modes to major public transport modes

- Potential for modal shift (or avoided future shift) from private vehicles to Fixed-route mass transit if NMT and public bus conditions are improved with fully extended MRT system
- Level of required changes in NMT/bus conditions to harness this potential

2. Public Bus Transport Service Improvement in Bangkok and Vicinity

2.1. Objectives

According to the transport NAMA concept note, the objective of transport NAMA is to improve bus operation to obtain environmental benefits:

- Reduce emissions per bus-km by rerouting most of the existing bus routes and improve the network operational efficiency by introducing proper bus scheduling system along with ITS (Intelligent Transport System) technology in which ensures less vehicle-kms and thereby fuel consumption
- Shift transport demand from private motorised traffic/ taxis to public transport by increasing Level of Service (LOS) of the bus service, together with attractiveness of the Mass Transit System (MRT) leading to lower gCO_2 per pkm

During the past decade, the Thai government has understood the problems in public bus services and GHG emission from an inefficient public bus system. Many studies were initiated with the intention to find the appropriate solutions and the quality of services improvement in various aspects, e.g. bus re-routing, re-organisation of Bangkok Mass transit Authority (BMTA), re-structure the bus regulating system, privatisation of bus operations and performance based contracts (PBC), upgrading public bus waiting area, bus maintenance depot and bus station development, bus priority and Bus Rapid Transit system (BRT), integrated ticketing system or e-ticket, GHG reduction from new NGV buses etc. However, all of those projects and plans struggled at some stage and none of them have accomplished its objectives until now.

Recently, the Ministry of Transport (MoT) assigned the Department of Land transport (DLT) to be responsible for studying and planning for comprehensive reform of the regulation, operation, vehicles and level of service of the whole public bus network. As of May 2015, a bus management, rerouting and optimisation plan, as well as institutional changes, are being studied and developed to improve the level of service of the bus system in the city, increase efficiency and reduce duplication of routes. This plan is intended to be completed by mid-2016.

The purpose of the bus study component described in this chapter is to:

- To share the findings with the Department of Land Transport (DLT) for the development of the upcoming bus reform plan
- To recommend what should be done in the upcoming bus reform plan by adapting international successful practices/guidelines with the current situation of Bangkok
- To ensure that the failures and problems from the previous plans will be taken into consideration and be avoided by relevant stakeholders

This chapter covers the following topics: Root causes of public bus system problems (chapter 2.2), Bus reform plans and route optimisation (chapter 2.3), Bus lanes and traffic light management (chapter 2.4), and Bus stops and bus stations (chapter 2.5).

2.2. Bus reform plans and route optimisation

To ensure that the upcoming bus reform plan, *Bus system in Bangkok and vicinity development masterplan plan* (DLT, 2016), will have highest possible chance of successful implementation, the failures occurred in the past must be noticed and prevented. Root causes of public bus systems problems must also be included and solved by the new reform plan.

This chapter aims to summarise the good practises from previous bus reform plans, investigate the cause of implementation failures and conclude with recommendations to prevent failures and solve all important public bus system problems. The topics included in this chapter are: The previous bus reform plan review (chapter 2.2.1) and the good practises from previous bus reform plan (chapter 2.2.2).

2.2.1. Previous bus reform plan review

A number of studies for improving bus services and reorganise structure of the bus authority were undertaken by Thai government since 1990 with the intention to uplifting the level of service to meet the passenger's needs and travel behaviour. However, the improvement plans from those studies were delayed and were not implemented, which makes the current bus system outdated by more than 20 years.

The topic of previous bus reform and development study since 1992 in every category and their objectives are summarised in Table 1.

Table 1 Previous bus reform plan summary

No.	Date	Study Report	Main Topic	Area of study
1	1992	**Public transit network system** by Office of the Commission for the Management of Land Traffic	**New bus operating system (1st)** Guided bus system	- Exclusive right of way (3 routes) - Park & Ride - Promoting connectivity of water transport and intercity rail - Improvement of facilities
2	1996	**Integrated management/ operation system of public transit system Phase 1** by Office of the Commission for the Management of Land Traffic	**Integrated ticketing system (1st)**	- Integrated fare structure - Contactless smart card for common ticket - Installing ticket vending machine at major bus stops - Central clearing house
3	1997	**Feasibility study of criteria for transferring BMTA to BMA** by Ministry of Transport (MOT)	**Bus authority structure (1st)** Establish Bangkok Mass Transit Cooperation	- Public service obligation (PSO) by BMA - BMA is the major shareholder at 70% - Invest by issue 2,000 million baht BMA bond - Early retirement 3,000 worker
			Bus operation and facilities (1st) Restructure route operation and	- Under single agency - Relocate bus stops location - Redevelop bus stop waiting areas and shelters - License minivans system
			Preliminary Bus re-route (1st) All route	- Re-route for 86 routes
4	1998	**Public transit network system (2nd study)** by Office of the Commission for the Management of Land Traffic	**New bus operating system (2nd)** Guided busways	- 3 routes of busway - Park & Ride - Promoting connectivity of water transport and intercity rail
5	1998	**Integrated management/ operation system of public transit system (Phase 2)** by Office of the Commission for the Management of Land Traffic	**Preliminary Bus re-route (2nd)** BMTA route for Urban rail systems integration	- Minor change for integrated with Urban rail systems - Terminate microbus service that duplicate with Metro route
			Bus operation and facilities (2nd) Transfer stations	**-** Develop 8 transfer stations for public bus system and urban rail system

No.	Date	Study Report	Main Topic	Area of study
6	1998	**Feasibility survey and conceptual design for exclusive median bus lanes on Petchburi Road** by Office of the Commission for the Management of Land Traffic	**New bus operating system (3rd)** Exclusive bus lane	- 7.45 km Median bus lane - 10.55 km Curb-side bus lane
			Bus priority measures (1st)	- Priority traffic signal - Right-turn storage lane - Bus waiting area on Median - Pedestrian crossing with signal
7	2002	**Fundamental database and efficiency improvement in management (Phase 1)** By Bangkok Mass Transit Authority (BMTA)	**Bus authority structure (2nd)** Costs analysis	- Revenue and costs structure in organisation-level - Cost of Public service obligation (PSO) - Geographic and demographic - Peer operator comparison - Reduce employee benefit - Future development framework suggestions • Decentralise authority to 8 depots for privatization preparation in order to create true competition • Increase Non-air condition bus fare from 3.5 to 4 baht • Re-route for better efficiency and connect with other public transit • Revise conditions in maintenance contract • Early retirement • New employment and outsourcing for re-sizing to compact organisation
8	2002	**Development of integrated ticketing system for public transit in Bangkok and vicinity** by Department of Land Transport (DLT)	**Integrated ticketing system (2nd)**	- Contactless smart card for common ticket - Central clearing house - Expanding service for other public transport and other product/service payment

No.	Date	Study Report	Main Topic	Area of study
9	2003	**Guidelines for receiving public bus management** by Bangkok Metropolitan Administration (BMA)	**Bus authority structure (3rd)**	**Method 1: Transfer all authority and labour from BMTA to BMA as a Cooperation** **Method 2:** - Option 1: Transfer Non-AC bus authority and concession to BMA within 3 years, then BMA will operate 15%, give concession 85% - Option 2: Transfer all bus authority and concession to BMA within 3 years, then BMA will operate 100% - Option 3: Transfer Non-AC bus authority and concession to BMA within 3 years, then BMA will give concession 100% **Method 3: Transfer only the routes that connect to other public transit, then BMA will give concession**
10	July 2004	**BMTA route planning and scheduling project in Bangkok and vicinity** by Office of Transport and Traffic Policy and Planning (OTP) Loan from Japan Bank for International Cooperation (JBIC)	**Full-scale bus re-route (1st)**	- Divided to 7 operation districts with 181 routes - Bus Rapid Transit (BRT) 9 routes, 228 km *See route map in Annex 2A: Bus re-route map from previous study* - Model analysis and validation - Implementation plan
			Bus authority structure (4th)	- Restructure organisation and regulation of public bus authority in Bangkok and vicinity by establish 'Bus Transit Agency' for manage and control all bus operators and contracts - Competitive tendering by using Performance-based contracts (PBC). - Establish Bangkok and Regional Transit Authority (BRTA), responsible for all public transit planning, including; bus and water transport
11	2005	**Design of Exclusive lanes for public bus in Bangkok and vicinity** by Office of Transport and Traffic Policy and Planning (OTP)	**New bus operating system (4th)** Detail design of Bus Rapid Transit System (BRT)	- System design - Station design - BRT route master plan - Feasibility study: EIRR 24.96% and FIRR 13.88% (Case: distance fare at 8-18 baht)

No.	Date	Study Report	Main Topic	Area of study
12	2009	**Public bus system management and connectivity in Bangkok and vicinity** by Office of Transport and Traffic Policy and Planning (OTP)	**New bus operating system (5th)** BRT master plan	- Combine 2 BRT master plans (OTP, BMA): 10 routes, 220 km - Feasibility study: EIRR 38.61%, NPV 21,741 million baht, B/C 1.96
			Bus operation and facilities (3rd) Revision of bus operating management at BMTA depots	- Suggest to have daily update bus schedule base on daily collected data
			Data analysis (1st) Revision of BMTA database and suggestion	- Passengers number and high demand bus stops - Level of service - Depot management and vehicle operating costs - Origin-Destination of suburban passengers
13	Sep 2009	**Public bus system development in Bangkok and vicinity** by Office of Transport and Traffic Policy and Planning (OTP)	**Full-scale bus re-route (2nd)**	- Total 155 routes: Radial 92 routes, Circumferential 26 routes, Cross town 18 routes, Expressway 19 routes - 30 bus transfer stations - All routes and station are already approved by the cabinet *See route map in Annex 2A: Bus re-route map from previous study*
			Bus operation and facilities (4th)	**Design and develop Bus tracking system** - GPS device on buses and Central Control Center - LED pocket monitor for bus driver, communicate from control center - Program for real-time bus operating management **Design and develop Real-time passenger information system** - LED screen at bus stops: display route number, name and waiting time **Applied software for bus operating management** - Time tabling/ Blocking/ Maintenance schedule **Pilot project** - Establish Central control center at BMTA district No.5 office - Install GPS device on 100 buses, LED pocket monitor for bus driver on 30 buses, LED screen at 20 bus stops - Improve applied software: bus driver break time, scheduling and runcutting, real-time bus operating management for 4 routes - Passenger's satisfaction survey before-after the pilot project
			Data analysis (2nd)	- Number of passengers assessment and analysis

Most of the studies and plans stated above were not actually implemented successfully or sustained according to political difficulties and lack of readiness in governmental support. Only one out of five BRT routes from the whole BRT master plan was implemented.

From the review of previous plans, there are two formal studies related to bus route rationalization and full-scale bus re-route plan, which are *BMTA route planning and scheduling project in Bangkok and vicinity* (OTP, 2004) and *Public bus system development in Bangkok and vicinity* (OTP, 2009). The main themes of the studies are:

- Report No. 1 focuses on Public Bus Route Optimization. The results of the study include a set of new public bus route derived from Sketch Planning model. The demand was estimated from a set of old home interview survey calibrated with a new set of small amount of home interview survey. Since the number of public bus passengers has been deteriorated recently, therefore the study survey yield small sampling of passengers. Then passengers desire lines were derived and the new public bus routes were proposed followed the derived desire lines.
- Report No. 2 focuses on Public Bus Route Rationalization and a Pilot Project to implement a new route with proposed ITS technology deployment. This study performed a comprehensive on-board bus survey by counting passenger boarding and alighting at every bus stop. The surveyors stayed on the buses for the entire day and counting and interview passengers. The survey was carried out for 3 days. New routes were derived from reviewed the existing routes, compute VOC (vehicle operating cost and revenue, followed standard route design and finally discussed each route in details with the driver. The results were satisfactory and accepted by the Board of Land Transport and adopted to be used by BMTA. However, these new proposed routes were never implemented for the reason that the administration just added the new routes to the old routes without taking out the old routes from the system. Therefore, presently, BMTA may be able to operate on both old and new routes. However, since the new routes are much shorter and require to transfer to circumferential routes in the central area and good transfer facilities. Therefore, the new routes has never been implemented. Other reason included co-ordination difficulties and communication barriers between institutes.
- Report No. 2 also carried out a pilot project to test the new development of Bus Schedule Plan using GPS. The trial was very satisfactory, but again, the proposed ITS development for the pilot project was never widely implemented on street and in the BMTA District.

2.2.2. Good practises and lessons learned from previous study

The Report No.2: *Public bus system development in Bangkok and vicinity* (OTP, 2009) is the latest bus reform study which is approved by a steering committee which includes representatives from various relevant agencies e.g. OTP, DLT, BMTA, BMA, Traffic police and Ministry of Finance. This study composed of practical implementation procedure, which other study/plans didn't include, as well as many good practises that should be also applied to new *Public bus system in Bangkok and vicinity development masterplan* (DLT, 2016).

The good practises and lessons learned from the Report No.2: *Public bus system development in Bangkok and vicinity* (OTP, Sep 2009) are suggested[2] as follows:

Purpose of re-route

Designing the system to be demand-oriented is the key to boosting patronage and revenues, particularly by reducing travel times (increase bus speeds and through improvements in passenger infrastructure), improving accessibility and system integration. New Route development has placed a high emphasis on

[2] Dr. Kunchit Phiu-nual, the project manager of that study, personal communication

meeting passenger needs, incorporating planned transfer points for greater convenience and travel choice and developing bus priority along major corridors.

In comparison to the existing network, the new bus route design offers:

- Improve bus level of services especially bus schedule (headway)
- Improve travel speed for the entire route, specifically on the radius routes from suburban to the Central Business District (CBD)
- Improve bus operating cost
- Improved accessibility (more routes on new roads with increased frequency of service and reduced route duplication)
- Better route directness
- Increased use of expressways for express bus services
- Managed bus transfer locations to improve network benefits

Concept of re-route criteria

There are several criteria that were used in the study. These are:

- Route Characteristics
- Performance Characteristics
- Demand Characteristics
- Service on Main road and Scheduling

The ToR for the Bus Re-route study specified that the main objectives of the studies are to reduce routes repetition, reduce bus operating cost, and improve bus level of services. Therefore, the design of the new route design was adopted from these objectives:

- Before working on the bus re-route, two major studies were carried out. Firstly, the study team gathered all the old (existing) bus routes and put them on the GIS map. Each route was studied in details including route length, estimated travel time, no. of passenger, etc. and route layout form. The route was classified into trunk line feeder line, circumferential line and combination. The route lay out form was classified into radial, circumferential/circular, combination and cross town. Also the existing bus route was classified into different route types such as end-to-end route using the same street for both trips, end-to-end route using different street, circular routes with the same ends or different ends, and an expressway route. Secondly, comprehensive boarding and alighting data were gathered and analysed. Graphs of boarding and alighting were plotted for each route. Some of the routes operated by the private sector are also measured and revenues were estimated for each run.
- Then some of the major bus operating variables were studied for each route, including route length, route travel time (both peak and off-peak period), total passenger, total revenue, area served, number of buses available etc. Then basic route design parameters were formed as a guideline for the re-routing process. Mainly, the parameters include maximum route travel time, maximum route length, area served (coverage), major/minor street served, destination served (such as inside CBD, near CBD) number of major loading points, length of route for different route lay out form, number of turns, etc.
- Finally, the re-route for the trunk lines was made first, based on the old route layout form and type. Modification was made based on route travel time, route length, major streets served, less number of turns on minor street etc. Most of the modifications made were to shorten the route length and route end outside the CBD (along the ring road or assumed ring road) where most passengers alighted. The new trunk line route was designed to serve mainly major streets; if necessary, only the final portion of the route might turn into minor streets. The trunk line routes were made radial from suburban to city centre or CBD and end at the ring road or assumed ring road. Some radial routes (routes with most passengers alighted at the final destination in the CBD) were made to go into the CBD area for the

purpose that passenger don't have to transfer. The radial CBD routes were selected based on number of passenger needed to go into the CBD. Many existing (old) radial routes were turned into minor and local streets to reach more passengers; and were also re-routed to be on major streets for the reason of shortening the route length and travel time. In this case some new feeder routes were proposed to serve the local area where old trunk routes served were taken out. In some case where there are a lot of passengers (major loading points) in the area (that the old radial routes served), new trunk routes were proposed. Some of the existing bus routes that were on the same section of the street (such as Lat Phrao rd.) and competed for the same group of passengers were considered and some routes taken out based on the area served, route coverage and destination location etc.

- Then the existing (old) circumferential/circular routes were reviewed/analysed using the same method. The re-route were made the same way. Since most of the existing (old) routes were not circumferential, a number of new circumferential routes were introduced. This is considered necessary because many newly proposed radial routes ended before going into the CBD. Many new proposed circumferential routes will also come into the city centre. Some routes were designed to link with outlining area where new CBD is extended.
- After completing the circumferential routes, the cross town and expressway routes were studied/analysed using the same method mentioned before. Most of the cross town routes are along major streets outside the CBD, while the expressway is also crosstown but on the expressway pass through the CBD area. New proposed expressway routes were also proposed. The main reason is to take passengers from suburb to the CBD, but available only at the location where expressway ramps existed. Most of the routes will make round trip and come back to the origin with a short stop inside the CBD. New feeder routes are also proposed to cover the area where no bus routes serve. Suggestions related to bus size and different ends for each route were also proposed.
- After completing the re-route, a number of basic bus route performance indices were calculated for the new proposed routes. They included route length, estimated travel time, route repetition on major streets, street and area coverage, etc. Finally, these indices were compared with indices of the existing bus routes.

Measures used

- **Bus transfer station**

Bus transfer stations are the locations where lots of passenger transfers were made. These locations usually lied around the ring road or assumed ring road or where a number of bus meet such as the Victory Monument. These stations were not proposed to be a major bus station that need to rebuilt for the entire city, but rather a major point of transfer where bus stop were rearranged such that the bus stop would not cause traffic congestion problem. The concept is differed from the proposed bus station made by other studies and OTP in which they used a hub-and-spoke concept.

- **Bus travel time**

Bus travel time is one of the most important variables that used to describe bus performance for different routes. Bus travel time is the time taken for the bus to travel along the entire route or selected sections. The travel time covers bus run time, bus stop time at the bus stop, delay time at signalised intersections, and major delay locations such as street market, school etc. and delay due to slow traffic. Generally, most Thais perceived bus travel time to include waiting time at the bus stop as well.

Bus travel time is estimated from the bus travel speed collected during the bus route data collection. Bus travel time was also used to compute new route travel time as well. Therefore, bus waiting time is important in this study and the variable is included in the new proposed bus route.

- **Number of transfers**

Number of transfers is a measure made of passenger transferring buses from one route to another route during the travel from any origin to destination. The variable is a major index for compare performance of the new proposed bus routes versus the existing ones.

Firstly, 100 O-D were assumed by randomly point the origin and the destination on the map. Then assume that each passenger made a bus trip from an O to a specific D, until all 100 of them. Bus travel time along different sections of the street along the route was estimated. On the trip, bus transfer from one route to the next on each trip was counted. The number of transfers was compared between the trips made on the existing routes and the new proposed routes. Most of the trip on the new proposed routes made less transfer than the existing (old) routes.

Since most of the bus route in Bangkok provided by BMTA and the private bus operators are very long because of their belief that the longer the route the more area coverage leading to more bus passengers. Therefore, the new proposed routes which are much shorter should not lead to more transfer for each passenger trip. Results of the study indicated that in all 100 O-D trips randomly selected, no one trip take longer travel time and only a few trips that has more transfer.

Expected route operation improvement from re-route

The differences in operation between existing operating route and new operation route is shown Table 2**,** which shows estimated travel characteristics based on the 100 O-D trip simulations in the model.

Table 2 Characteristics of existing operating route and new operating route from study estimation

Average trip characteristics	Existing operating route (214 routes)	New operating route (155 routes)
Average waiting time at origin bus stop (min)	15	6
Average waiting time at intermediate bus stop (min)	12.4	8
Average transfer (times/trip)	1.73	1.93
Average travel distance (km/trip)	34.35	30.45
Average waiting time (minute/trip)	43.80	24.90
Average on-vehicle time (minute/trip)	131.75	81.13
Average total travel time for passenger (minute/trip)	175.55	106.03

From the estimation results in the Table 2-2, though the average transfer is increase from 1.73 to 1.93 times/trip, the average travel distance and time use is expected to be reduced after re-routing. Especially, the waiting time is approximately halved and the average total travel time per trip is decreased from 175.55 to 106.03 minute. This means that the new route will provide higher level of service, higher reliability and efficiency for passengers.

Implementation of Pilot project and software for bus scheduling and management

The pilot project was tested for 3 months in the beginning of year 2009 and fully implemented since July 2009 for 1 year. The pilot project involved 3-4 major bus routes in District 5, totally about 30-50 buses. The main objective of the pilot project was twofold. The first one is to test a new fleet management software program developed by the study team while the second is to learn about issues and problems related to implementation of the new bus re-route.

During the course of the study, another small study team with expertise in software development was set up to develop a bus schedule software program. The program was quite similar to truck fleet management software. The program was still available for use and install in the District 5 in Sa-mae Dum. The software program takes in GPS data sent from the bus via GSM. The real time data was interpreted to show spot speed, travel time along different section, the time arrived at and leave the major bus stops and major intersections. The information was taken to compute route schedule, bus travel distance and bus maintenance, driver assignment and other necessary information such as revenues, etc. The information was used to understand each bus performance along the route assigned.

The project was expected to operate continuously until present and be expanded to all other routes and other district, however, the project was not implement further after 1 year of operation due to political reasons.

Successes and failures in full-scale implementation

As mentioned above, implementation of the pilot project was made in order to test the software programs developed to compute daily bus schedule, drivers and bus workers schedule and bus maintenance schedule. Another reason is to understand issues and problems related to deployment of the new proposed bus re-route program.

The pilot program started with installation of the GPS and communication box in about 20-40 buses. New computer room had been built, and two new computer servers had been installed in the computer room in District 5 (Sa-mae Dum). Real-time GPS data from each bus was transmitted to the main server every 5 seconds. Locations and speeds (spot speeds) of the buses were plotted on a GIS based map with bus routes and a few other necessary information. The information was used to calculate travel speed, travel time and used them to adjust daily bus schedule. At the same time, a number of 0.5x2.0 meter LED-box had been installed at all major bus stops along the test route. Predicted bus arrival time for the coming bus in the next 30 minutes for all bus routes at that bus stop was shown on the LED-box. The pilot trial of the software program was success even though there are a number of modifications to fit the need of the BMTA dispatchers. The software program was developed to serve 4 purposes: to produce bus time table, driver and fare collector timetable, bus maintenance timetable, collecting bus operating data along the routes, i.e. Bus travel time and speed along selected sections, etc.

Plan was made to deliver the information to the passenger communication devices. However, this was not done because the second phase of the study was not approved due to co-ordination difficulties and communication barriers between related institutes.

Another part of the pilot project is to test the new bus route proposed during the study. The study team had found a number of problems during the trial implementation. Some of the recommendations for solving problems are presented as follows:

- How to properly inform the passenger. The study team found out that passengers must be informed at least a week before the change. Portion of the route change must be clearly shown on the bus route description on the side of the bus, and at all affected bus stops.
- BMTA must run a few buses on the new route to test if the new route layout is suitable for running the proposed bus size, and if the passenger accepted the new proposed route.
- Not all new bus routes from the same district should be deployed at the same time. The new routes should be deployed first, followed by other routes with little modification
- A team of informants should be ready to politely answer all questions related to the new bus route and advantages and disadvantages of the old routes.
- After deployment of the re-route bus, there always a need for refinement and this should be made with great care because the new change would benefit some but also affect some.

- There are a number of problems occurred during the deployment of the bus re-route program. Therefore, the implementation program should be carefully made with experienced team. In other words, the people who are working directly in this field (i.e. BMTA, BMA, DLT) and the people with experience with previous bus rerouting should be involved or consulted in the new rerouting process.

Cause of difficulties and failure, and recommendations

The following are the main difficulties and failure of the study program and the bus reroute deployment:

- In order to be able to implement the bus re-route program, there must be a strong order from the top administrator of the Ministry of Transport. During the course of the former study, the steering team had no real intention to try to implement the bus re-route program or even the deployment of the trial program of the pilot project. One of the main reasons is recommendations from the study includes a number important issues to be implemented at the same time such as bus re-route should be implemented at the same time as new bus route and also new bus scheduling technique and new technology as well. Therefore, it seems that the bus re-route alone might not solve any problems.
- The complex implementation issues stated above seems to obstruct intention to implement the bus re-route program. Therefore, new organization arrangement and new duty assigned including new transport policy committee and a new public transport policy and management committee is required. The "Board of Land Transport" (the former name at that time period is "Central Transport Committee") which presently is responsible for the implementation of the bus re-route and public bus operating efficiency should be restructured to a new committee with more members from other agencies and educational institutes. This may not reduce the complexity process that must be done by the Board of Land Transport, however, this process will generate discussion and attention; and if the new proposed routes are good, most civil service officials and most bus patronage will support the new routes and that might help the committee to accept the new routes without taking another 1-2 years for evaluation. The new committee should be assigned new duties and new tasks. However, members of the new committee may come from different agencies and they might require some in-depth information about bus performance measures, implementation process, etc. Therefore, academic members might be able to provide necessary information.
- During the deployment of the trial bus route, the study team could not install LED-Box in the bus stop in Bangkok, because BMA had leased the bus stop shelters to the private sector to use the bus stop for advertisement. The private sector required the study team to pay for installation of the LED-box which is out of the scope of study team. Therefore, implementation of the technology to communicate with captive riders may require other media instead of using the bus stop alone.
- GPS data required monthly cost for the transmission and this cost must be paid out of the study fund and not from BMTSA since BMTA is under operating loss.
- To implement the trial bus re-route program, almost every agency with major responsibility in the BMA area should be informed, coordinated and participated in the program, since these agencies have some kind of basic responsibility in BMA area. They might have to participate in the changes. Also, the persons that use the bus should also provide input and idea related to bus route improvement. They should also inform their friends and other passengers about the improvement. Cause of this failure is lack of actively inform and coordination.
- Present bus operations lack the trust of passengers. Many bus routes under private operators' concession do not complete the entire route whenever they found that only a few passengers are on the bus. Therefore, one of the most important performance variables that the passengers care the most is the waiting time and trust that the bus will come and complete the route.
- Bus re-route should be the first part of the bus improvement program. The main reason for the re-routing is to improve the "level of service" of the present bus network; therefore, new technology

must be accepted and implemented in order to achieve this objective. There is no advantage of just re-route the bus or getting the new bus without improving the level of services.

2.3. Bus priority and traffic light management

2.3.1. Existing bus priority and traffic light management policies

The concept of public bus priority lanes was initiated in Bangkok and vicinity almost 40 years ago. There are 2 types of bus priority lanes currently implemented in Bangkok:

1. Bus lanes: allow only public buses and passenger transport assigned by Director General of DLT
2. HOV lanes (High Occupancy Vehicle lane or Carpool lane): allow only public buses and private passengers vehicle that has more than 3 passengers

Land traffic Act B.E. 2522 (Office of the Council of State, 1979) also stated clearly in *Section 66* that:

> *Other vehicles apart from public buses and passenger transport assigned by Director General of DLT are strictly prohibited to drive or park the in bus priority routes.*

Most of the bus lanes in Bangkok at that time were contra-flow bus lanes. A few before-after studies were carried out and showed a very successful story in that period of time. The studies reveal that the journey time of public bus is lower than the normal traffic as the bus routes are shorter than normal traffic routes and prohibit other vehicles to encumber the bus lanes.

Traffic police has been advised by the deputy prime minister to carefully enforce the regulation. As the cooperation from the police, traffic light coordination for bus were tested and implemented on a few routes was success in increasing the operation speed of public bus fleet on that route. Later, there was an effort to implement new signal priority for bus for entire Bangkok, but it was not implemented by the traffic police for the reason that the traffic police being concerned about the traffic congestion impacts on normal traffic.

Later on, some of the routes were changed from Bus lanes to HOV lanes or peak time bus lanes. The enforcement on HOV lanes and peak time bus lanes are difficult for police to monitor, so the enforcement was less strict as the time pass. As a result, the normal traffic encumbered these lanes and currently no-one actually notice which routes are bus priority routes.

The current bus priority route map and detail announced by OTP are presented in Figure 6 and Table 3**.**

Figure 4: Bus priority routes map as of 2015 (Source: Consultant, 2015)

Table 3 Bus priority routes detail as of 2015

No.	Road	From	To
Peak hours with-flow bus lanes (Duration vary by route)			
1	Charan Sanit Wong Rd.	Tha Pra Intersection	Bang Phlat Intersection
2	Phet Kasem Rd.	Phutthamonthon Sai 2 Intersection	Bang Yi Ruea Intersection
3	Lad Phrao Rd.	Bang Kapi Intersection	Lat Phrao Intersection
4	Prajadhipok Rd.	Wong Wian Yai Intersection	Pha Pok Klao Bridge
5	Phahonyothin Rd.	Khlong Bang Bua Intersection	Victory Monument Intersection
6	Sukhumvit Rd.	Bangna Intersection	Ekkamai Intersection
7	Phetchaburi Rd.	Khlongtan Intersection	Asokphetchaburi Intersection
8	Ramkhamhaeng Rd.	Lamsali Intersection	Khlongtan Intersection
9	Phaya Tai Rd.	Victory Monument Intersection	Sam Yan Intersection
10	Ratchadamnoen Nai Rd.	Lak Muang Intersection	Phan Phiphop Intersection
11	Ratchadamnoen Klang Rd.	Phan Phiphop Intersection	Phan Fa Intersection
All-day contraflow bus lanes			
1	Phloen Chit Rd.	Ratchaprasong Intersection	Na Na Intersection
2	Ratchawithi Rd.	Thanon Khao Intersection	Sanghi Intersection

3	Samsen Rd.	Si Sao Thewet Intersection	Sukhothai Intersection
4	Ratchaprarop Rd.	Makkasan Intersection	Pratu Nam Intersection
5	Ratchadamri Rd.	Pratu Nam Intersection	Ratchaprasong Intersection
6	Lan Luang Rd.	Phan Fa Intersection	Yommarat Intersedtion
7	Phetchaburi Rd.	Chitlom Intersection	Pratu Nam Intersection
All-day with-flow HOV lanes			
1	Taksin Rd.	Chomthong Intersection	Wong Wian Yai Intersection
2	Sukhumvit Rd.	Ekkamai Intersection	Bang Na Intersection
3	Charoenkrung Rd.	Samyod Intersection	Mo Mi Intersection
4	Bamrungmueang Rd.	Boriphat Intersection	Kasatsuek Intersection
5	Rama IV Rd.	Phra Khanong Intersection	Hua Lam Phong Intersection
All-day contraflow HOV lanes			
1	Rama I Rd.	Phong Phraram Intersection	Pathum Wan Intersection
2	Phetchaburi Rd.	Phet Phraram Intersection	Uruphong Intersection
3	Krungkasem Rd.	Saphan Khao Intersection	Kasatsuek Intersection
4	Dinso Rd.	Democracy Monument intersection	Sao Chingcha intersection
5	Nakhonsawan Rd.	Nang Loeng Intersection	Phan Fa Intersection
New bus lanes (since 28 November 2013)			
1	Samsen Rd.	Si Sao Thewet Intersection	Vajira Intersection
2	Ratchada Phisek Rd.	Rama IX Intersection	Wong Sawang Intersection
3	Samsen Rd.	Bang Lamphu Intersection	Si Sao Thewet Intersection
4	Ramkhamhaeng Rd.	Soi Ram Khamhaeng 39	Phacha U-thit Rd.
5	Lad Phrao Rd. (Outbound)	Happy Land Sai 1 Intersection	Lotus Bang Kapi
6	Lad Phrao Rd. (Inbound)	The Mall Bang Kapi	Macro Bang Kapi
7	Phloenchit Rd. (Outbound)	Ratchaprasong Intersection	Ploenchit freeway

The most common road marking for bus priority lane is the "bus lane" sign which is currently used in Bangkok and its vicinity is wide short broken line, as shown in Figure 7 to 9, while "HOV lanes" road marking is a diamond shape with/without number of minimum passengers, as shown in Figure 10 to 11.

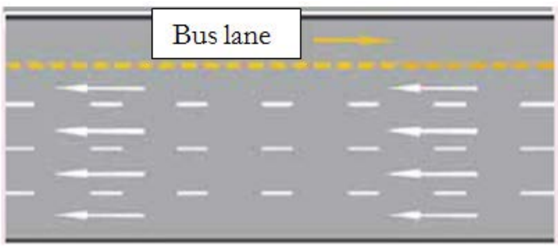


Figure 5: Contraflow bus lane road marking (Source: DLT; DoH)

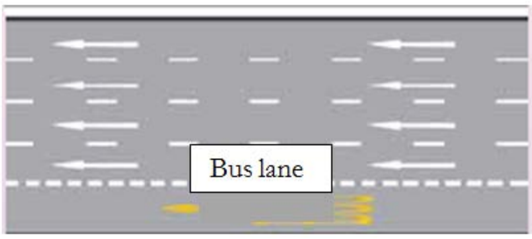


Figure 6: With-flow bus lane road marking (Source: DLT; DoH)

Figure 7: Bus lane signs (Source: DLT; DoH)

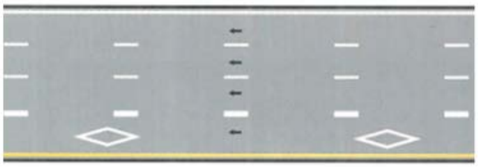


Figure 8: HOV lane road marking (Source: DLT; DoH)

Figure 9: HOV lane signs (Source: DLT; DoH)

2.3.2. Current problems on bus priority and traffic light management policies

In the past years, the traffic congestion problem has become more severe, while the enforcement and effectiveness of bus priority routes reduced dramatically due to following reasons:

Enforcement is lacking

- Thai government, BMA and Traffic police did not widely and continuously promote the existence of bus priority routes, as well as the prohibition and punishment of offenders. Traffic police are focusing on the normal traffic congestion problems and seeing the bus priority routes as less necessary than before, so the enforcement strictness is gradually reduced until virtually no offenders are captured on most routes.
- Enforcing time varies by route and by day i.e. some routes prohibit only peak hours, some routes prohibit only non-peak hours, some routes prohibit only evening, some routes prohibit only weekdays, some routes prohibit only when traffic police assign on that day. This results in confusion among road users.
- Seven new bus priority routes were implemented on 28 November 2013, however, they were not well promoted to public.

- In some newly implemented bus priority routes, traffic police capture the offenders when they are in the middle of the routes, however, traffic police did not warn the drivers beforehand at the beginning of the route which drivers can divert to other roads.
- Most of the capture locations are not sustained. Traffic police usually enforce strictly only a period of time (approximately 2-3 months). After that, drivers start to continue using bus priority routes without any capture by traffic police.

Unclear signage and communication

- Existing signs and road markings in most bus priority routes are not clear as to what is the bus priority routes, when and where they start and end specifically, which types of vehicle are allowed or prohibited.
- Existing signs and road markings in most bus priority routes hard to notice beforehand, many drivers drove into the route without noticing that it is a bus priority route.

Bus priority route network is not connected

- The existing bus lanes route network is scattered, not fully-connected or well-planned for highest level of service of public bus system. As a result, the current situation of remain bus priority routes were ineffective, low reliability and low level of service of public bus system. The examples of current bus priority routes problem are described as follows:

Encumbering by normal traffic

Other vehicles avoided the traffic congestion by getting into the bus lanes as the example situation, as shown in Figure 12. This is resulting in traffic congestion in bus priority lane and longer public buses travel time. Buses are also forced to drive in another lane to avoid the parked cars.

Figure 10: Other vehicles encumbering the bus lane (Source: Consultant, 2015)

Encumbering drop-off/ pick-up at bus stop

Other vehicles used the bus lanes and bus stops as a drop-off pick-up area which blocked the bus and forced public buses to stop on second lane instead, as shown in Figure 13. This is resulting in safety issues of boarding and alighting passengers.

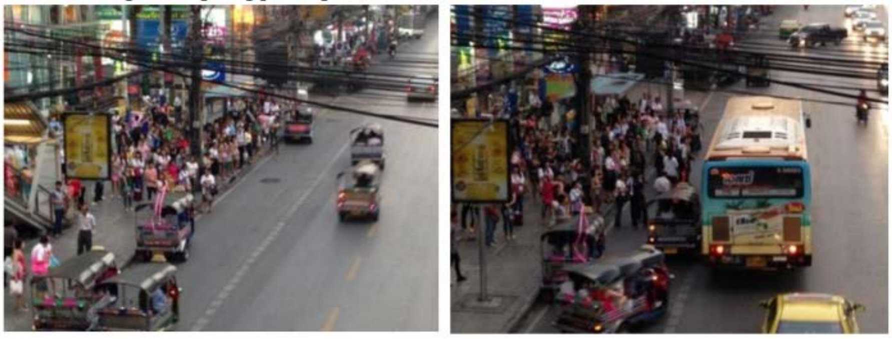


Figure 11: Other vehicles drop-off and pick-up at the bus stop area (Source: Consultant, 2015)

Being offenders without intention

Most drivers complained on the confusion of bus priority routes and did not know the existence of them. The example the problem is presented in **Figure 2.4-9** which is the newly implemented bus lane on 28 November 2013, start at Si Sao Thewet Intersection. The warning signs are blocked by other sign posts and cannot notice beforehand, signs are not contained the typical bus lanes sign but the text information that might hard to understand, no bus lanes road marking. This was resulting in around 100 caught offenders per day, who claimed that they did not know beforehand about this bus lane.

Figure 12: Bus lane sign and road marking issues at Si Sao Thewet Intersection (Source: Sunandha News, 2014)

2.3.3. Recommendations for bus priority and traffic light management policies

Improve route network

- Bus priority routes in Bangkok should be continuously and strictly implemented with the cooperation with traffic police. During new bus reform study, additional bus priority route should be assigned according to bus frequency and capacity of the road. Some existing routes must be carefully reviewed and discussed with traffic police for rearranging and extending from the scattered network to fully-connected network and better level of service. Good practise of fully-connected network from London "Red routes" is shown in Figure 15.

- Type of the lanes (i.e. bus lane or HOV lane, peak hours or all-day enforcement) must be considered for appropriateness on each route. All peak hours bus lanes should define appropriate same enforcement period of time in order to reduce driver confusion (i.e. 7-9 am and 4-7 pm).

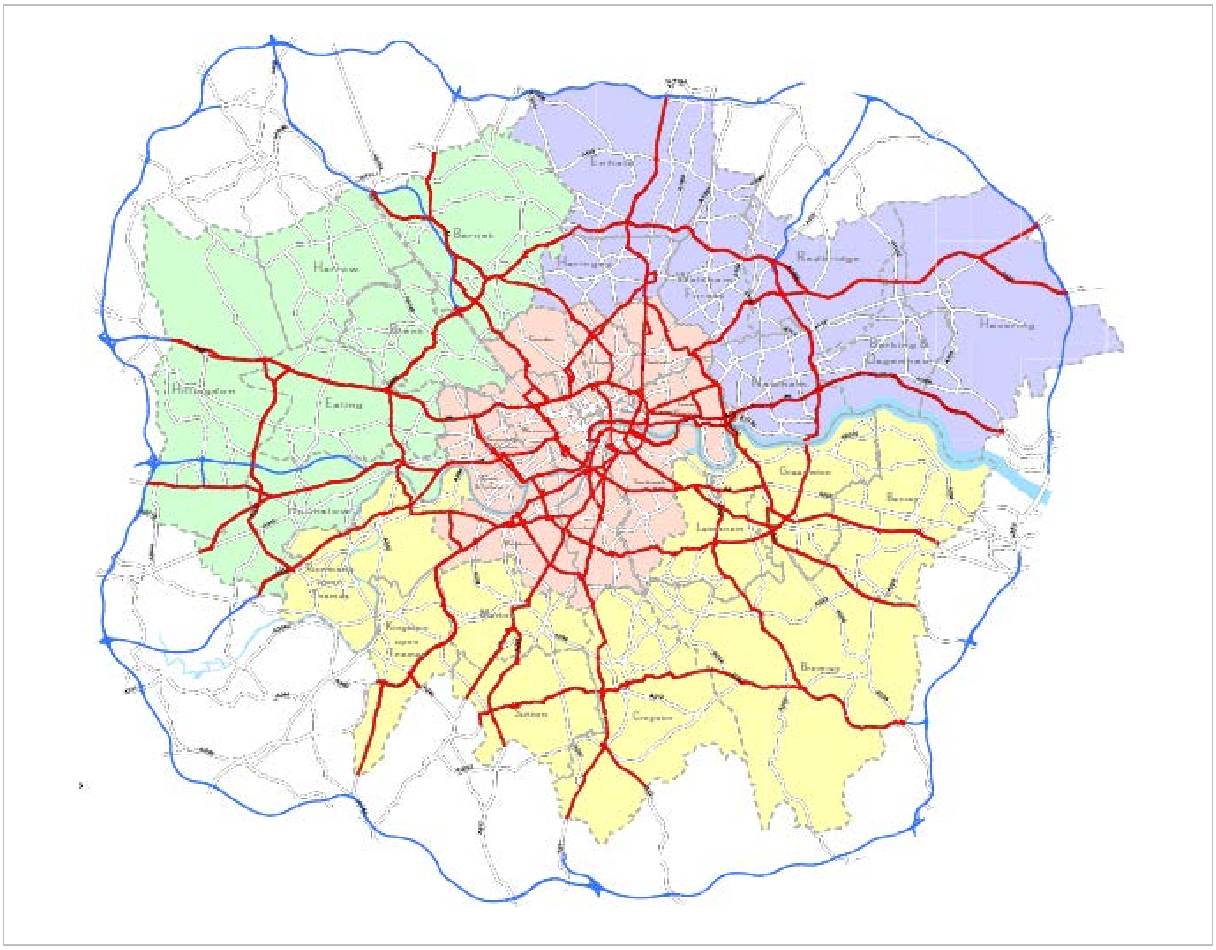


Figure 13: London "Red Routes": good practice of fully-connected bus priority route network (Source: Transport for London, 2015)

Improve public awareness and signage

- New bus priority route network and enforcing time must be publicly informed and promote to all drivers in Bangkok and vicinity by using website and brochure.
- Bus priority route warning sign must be installed along the road before reaching to the bus priority route, especially at the intersection before starting the route.
- Bus priority route sign should be installed along the route and major intersection to remind the drivers.
- All sign must be unity standard easy to understand. It should include specific authorised vehicle, duration of time, and suggestion detour for normal traffic. Good practise from the UK standard are shown in Figure 16. Further details are explained in *Traffic Signs Manual, Chapter 3: Regulatory signs* (Department for Transport, 2008).
- All sign must install at clearly be seen from driver's sight location.

Figure 14: Good practice for bus lane signs (Source: Birmingham Mail, 2014)

Figure 15: Good practice of bus lane signs (Source: Driving Test Tips, 2016)

- Strict enforcement of parking and stopping on bus priority routes by clearly indicate where the beginning points of the routes. Since the existing road marking in Bangkok, which is white or yellow dash, was ignored by drivers, so new road marking that attract drivers' attention should be implemented.
- The London "red routes" bus lanes, which are shown in Figure 18, are a kind of good practise of road marking that can attract drivers' attention. Bus priority routes in Bangkok should be adopted this concept; however, it is not necessary to paint the whole route to be red as it has higher costs of installing and maintenance. The suggested area that to should be painted are the significant locations, which are:
  - Beginning points of bus priority routes and major intersections, as shown in Figure 19, the red road marking should have overall length at least 10-20 metre with white "Bus lane" character marking.

Figure 16: London "red routes' bus lanes (Source: Transport for London, 2006)

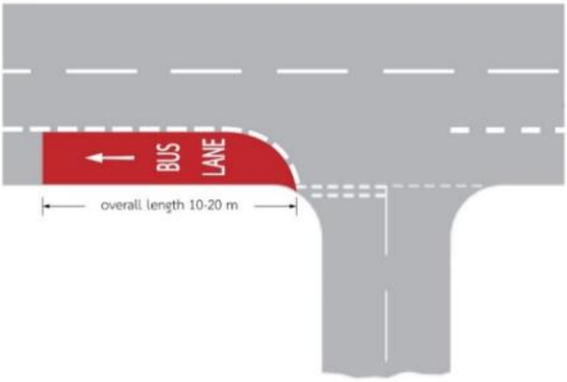


Figure 17: Example of bus lane road marking at the start point of the route and at major intersections (Source: Department for Transport, 2003)

Figure 18: London bus stop area (Source: Transport for London, 2006)

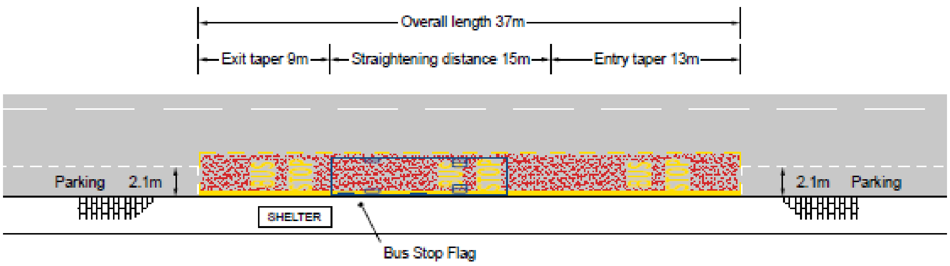


Figure 19: Example of bus stop road marking (Source: Transport for London, 2006)

- Bus stop area, as shown in Figure 20 and 21. The recommend overall red road marking length at bus stop area is 37 metre (The full-detail of bus stop design guidance will be explained in Chapter 2.3.5). This area must be strictly prohibited from other vehicles to drive or park, so all the bus can stop exactly next to the kerbside bus stop, instead of 2nd lane or before/after the waiting area. This will help reduce boarding/ alighting time and increase safety for passengers.

- In the initial implementation stage of red road painting bus priority route, traffic police should enforce it strictly by surveillance at the significant locations and inform the traffic not to use the route and blocked the bus stop area.
- Surveillance camera with license plate detecting system should be installed at along the bus priority route, especially at the significant locations, to detect the offenders and send the fine ticket to their accommodations.
- "Bus only" left turns permitted in junctions can save buses having to encounter long detours.
- Traffic signal arrangements and "real time" bus monitoring systems that give extended green or early green phases to particular buses in appropriate circumstances.

2.3.4. Bus stop and bus station

Bus stop design and location is recognised as a crucial element in the drive to improve the quality of bus services. The convenience and comfort of bus stops must not be overlooked. The current Bus stop location regulation in Thailand which are presented in *Annex 2C: Bus stop location regulation* does not include the topic passenger's level of service or comfort for selecting a location or designing a bus stop area.

Current bus stop and bus station situation

Bus stop problems

At present, most of the bus stop shelters and waiting area facilities are not properly maintained. Design of the existing bus stops lacked concern for actual passenger's behaviour regarding ho is waiting, boarding and alighting at the bus stop. This results in discomfort and discourages people to use the public bus service as well as increases risk of safety issues. The critical problems currently occurring are:

No lighting and lacing proper maintenance

More than 1,000 bus stops/shelters' lighting and maintenance were terminated since 1 January 2016. The unlit bus stop situation is shown in Figure 22. As a result, people are fear of the crimes during the night time and avoid using the bus or walk through the bus stop area.

This happened because of an unsolved disagreement between BMA and a company who receives concession for maintenance bus stop/shelters in exchange of advertisement on bus stop and footways around the bus stop. The argument started in August 2013 as BMA restrained construction of the advertising board because people complaints that the board obstruct the footway flow and reduce sightline of passengers at bus stop waiting area as shown in Figure 23. The full detail of this issue is presented in *Annex 2D: Bus shelters maintenance concession argument*

BMA has not solved the problem nor paid compensation to the company since then. The private company could not bear the costs anymore, so they sent a written consent to BMA and requested to terminate the shelter maintenance and the lighting service. The action of the BMA was just to let people being informed about the unlit bus stop location and promised to try to solve it within 3 days.

Figure 20: Unlit bus stop (Source: Daily News Thailand, 2016)

Figure 21: Before and after restrain the blocked advertisement board on footways (Source: MTHAI, 2013)

Outdated/missing route information

The route number and information at most bus stops in BMA are not consistent with actual bus route service. Some routes were terminated or diverted to other roads but the sign were not updated. Bus mark posts also vandalised as shown in Figure 24. In addition, there is no route map, or details about operating hours, headways, ticket fares, map of surrounded area, or direction for interchanging to other public transport modes.

However, there is an attempt from a private agency to implement the pilot project of bus route map at Victory Monument bus stops area since October 2015 as shown in Figure 25. The private company also distributed 150,000 copies free brochure of Victory Monument bus and van station guide and the project received good feedback from bus passengers. Currently, the agency plans to expand the project further to cover bus stops in other area of Bangkok but they are still in negotiation process with BMA and the related government agencies.

Figure 22: Vandalised and outdated information mark post (Source: Consultant, 2015)

Figure 23: Normal bus shelter with no route map (Source: Consultant, 2015)

Sight blockage from street furniture

The stairs of urban rail system station entrances and footbridges are block or reduce the sightline of passengers who are waiting for the bus. The example of this problem is shown in Figure 27.

Inadequate waiting area capacity

Bus stop waiting area space was not consistent with passenger demand in peak hour which result in overcrowding and safety issues when boarding and alighting, as seen for example in Figure 28. This happened because there is no survey on waiting passenger demand, so the design did not consider about space size and amount of facility to accommodate adequately.

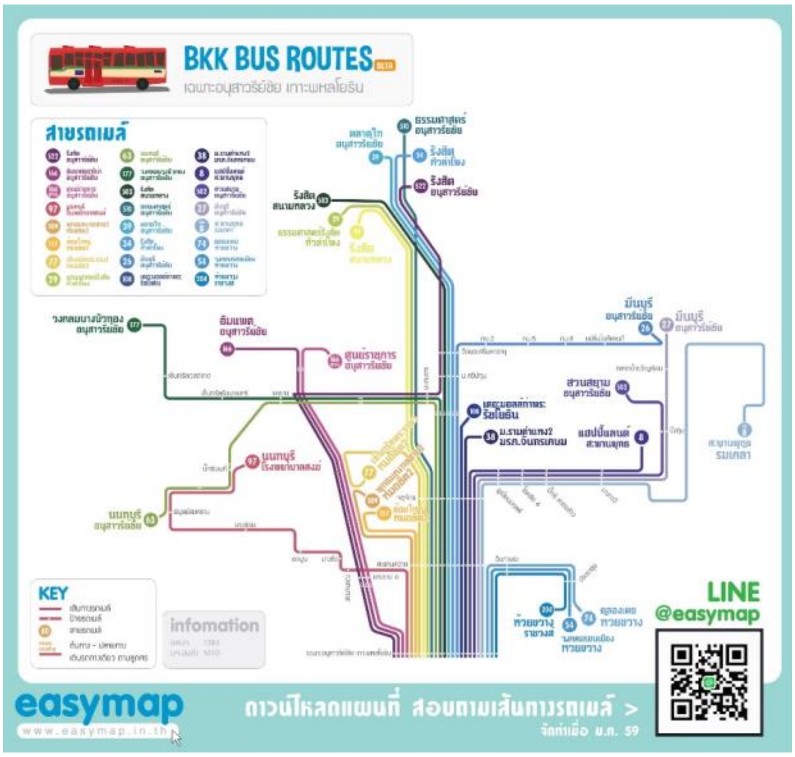


Figure 24: The pilot project bus shelter with bus route map (Source: Easy Map, 2016)

Figure 25: Sightline obstructed due to the entrance stairs of the BTS (Source: Consultant, 2015)

Figure 26: Inadequate bus waiting area (Source: Consultant, 2015)

Current bus stop locations

Most of the current bus stop locations in Bangkok and vicinity were assigned more than 20 years ago by the Land Transport Central Committee (LTCM). The locations were proposed initially using the following criteria:

- Available space on footpath
- Distance between bus stops
- Distance from major intersections that allow bus to change lanes and turn right safely

The criteria did not include the passenger's behaviour or location of attraction. As a result, passenger has to walk for a long distance unnecessarily and unwilling to use the system.

Moreover, the land use characteristic and density for areas adjacent to major roads have been changed due to land price and new urban activities, but most of the bus location has never been relocated to more appropriate location, for example, in front of the building for passengers' convenience. Consequently, much less passengers are willing to walk to the bus stop and willingness to use the system reduced.

No proper NMT facilities

Many area of the bus stop do not have enough footway width to accommodate pedestrian flow and passengers who are boarding and alighting. Passenger waiting area also block the footway which create conflicts and might result in safety issue.

Most of bus stop does not have practical and safe cycle parking area. Some others also not have enough space to accommodate demand of bicycle parking.

Bus station and intermodal transfer facilities (ITF)

Presently, there is no interchanging hub facilities for public bus system in Bangkok and vicinity, except at the Victory monument which the route number and waiting area location for interchanging is indicate in Figure 29.

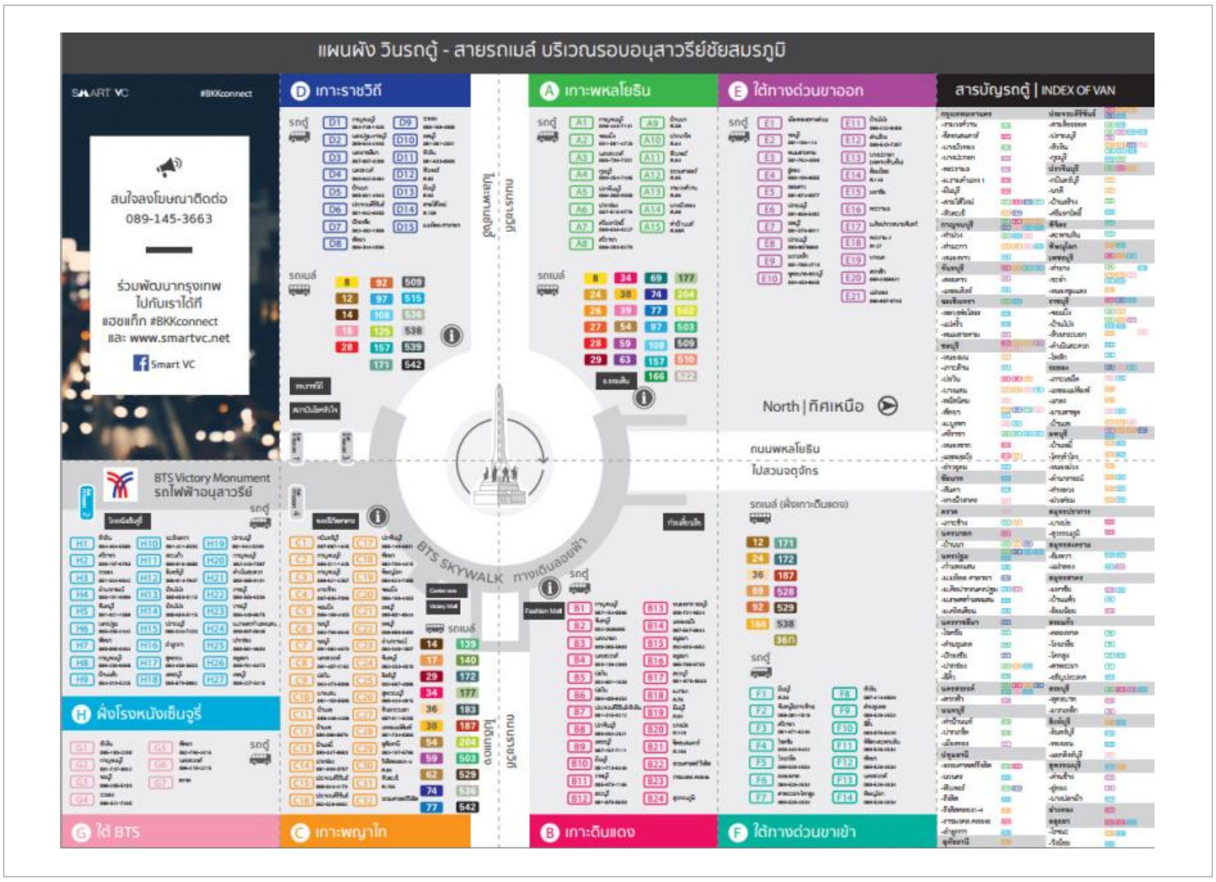


Figure 27: Public bus and van waiting area map at Victory monument area (Source: Yakstart, 2016)

This will be a critical issue when new reform routes are implemented. The issue of inadequate waiting area capacity as shown in Figure 28 will be more severe because new implemented routes introduce more interchange demand between bus routes at major interchange bus stop. These bus stops should be upgraded to bus stations to accommodate such demand and provide facilities for integrated ticketing system, disable person and elderly.

The bus stations for interchanging route should be studied, selected and designed in this bus reform plan. Moreover, the significant stations should be constructed and ready to use at the time of implementation of new reform routes.

Bus stations and Intermodal transfer facilities (ITF) assume a considerable importance since:

- They are an important access to public transport services
- They are the connecting point between different types of transport

Bus network optimization: Interchange Nodes

In many conventional bus networks where two bus routes cross each other at a junction, bus stops on the two routes are usually a long way apart, due to the traditional (car-orientated) wisdom that bus stops should not be near junctions due to the adverse impacts of stopping buses on traffic flow or speed. This philosophy is very prevalent in Bangkok. In such circumstances interchange between the two routes can involve a long walk (400m or more “around the corner”), and therefore the opportunity is often lost as passengers take more circuitous bus routes with less interchange or take other non-mass transit modes.

In well planned bus networks in smaller cities, there is usually a "Town Centre" Bus Station where most of the routes in the network will terminate, and provide convenient interchange opportunities via other routes to other areas of the city.

Near the edges of large urban areas intermodal bus stations are often provided to keep long distance or "Inter-Provincial" bus services outside the urban core, and to provide facilities for convenient interchange with urban bus routes terminating at or near the same interchange. This type of facility is reasonably well developed in Bangkok with Mo Chit (Northern), Ekkamai (Eastern) and the Sai Tai Mai (Southern). Whilst Mo Chit and Sai Tai Mai have many terminating or passing urban bus services in addition to the long-distance services, Ekkamai does not have any terminating urban services, but, being on Sukhumvit Road, it has many passing bus services and an adjacent BTS station.

Given the on-going expansion of Bangkok it would probably be desirable in the not too distant future to move the Northern Terminal from Mo Chit to Rangsit (at the end of the Red Line Railway currently under construction, and possibly move the eastern Terminal from Ekkamai to near Suvarnabhumi Airport. Relocation of these facilities is understood to be under consideration by the relevant authorities.

In larger cities, purpose–built bus interchanges are provided scattered fairly uniformly within the urban area (usually at major trip attractors such as Shopping/Entertainment complexes or large concentrations of education establishments. Many routes will terminate at such interchanges and get a good passenger load at the end of the route due to passengers interchanging from other routes serving the interchange, in addition to "walk in" passengers to the station.

In Bangkok, apart from Victory Monument (equivalent to a "Town Centre Bus station" in location), there are extremely few purpose-built urban bus stations - even at Victory Monument, although many bus services terminate or pass through there. The site is split into four smaller bus stations (One in each quadrant around the Monument formed by the four roads meeting there, and walking distances between the four quadrants are quite long and involve climbing stairs to footbridges.

In well planned cities with urban rail mass transit systems, such bus interchanges are normally provided adjacent to strategic rail stations (particularly at the ends of urban rail lines or at places where two or more rail lines cross and an interchanges station is provided.

Unfortunately in Bangkok urban rail projects have been developed with little attention to integration between rail lines or between rail and bus, and such "Intermodal facilities" are almost non-existent, or where provided (such as some minor facilities on the initial MRT Blue Line), not used by the bus services.

The purpose of the above discussion is to indicate that optimisation of a bus network does not just involve optimising routes, but also optimising the availability of stations for such routes.

Important planning and design components include:

- Safe and convenient access to and from the station,
- Sufficient and comfortable waiting area for passengers
- The infrastructure for buses, and other transport modes (taxis, motor cycle taxis, songthaews, minibuses private cars, motor cycles and pedal cycles).
- Facilities for public transport management and operating staff
- Provision of convenient and safe vehicle and pedestrian movements
- Small convenience store outlets
- Toilets for passengers and public transport operatives

2.3.5. Review of public bus stop design study

The latest study on public bus stop standard, *Consultancy for public bus stop design*, was prepared by Administration and Management College, KMITL (King Mongkut's Institute of Technology Ladkrabang) for BMTA in year 2014. The reviewing summary and prototype design from this report is presented in *Annex 2E: Review of Consultancy for public bus stop design*

There are two main purposes of the study:

- For being a bus stop facilities prototype design for BMTA in the next installation phase
- For creating new standard for BMTA in commercial management in order to increase revenue

However, the key points presented in this study are mainly focusing only on:

- Physical structure of bus shelter, route sign post and route map board
- Information display design template options for route map, sign post, area map and Real-time travel information board.

From the review, it is clear that this study was missing the purpose for the highest level of service for highest passenger's willingness to use in order to increase ridership of the whole public bus system. There are many significant aspects on passenger requirements that are missing from this study.

- The shelter design should consider main aspects from passengers' point of view, including:
  - Comfort/ Adequate space and seating
  - Convenient location
  - Sightline
  - Pedestrian flow
  - Connectivity
  - Accessibility
  - Boarding and alighting safety
  - NMT facilities
- Information display design should consider following aspects, including:
  - Large font signs for seniors
  - Sign board location that correlate with passenger's behaviour and not block the footway or sightline
  - Adequate lighting for sign board in daytime and night-time
  - Bus stop symbol visible from distance
  - All sign should be understandable for foreigners

More details of suggestions are presented in chapter 4.

2.3.6. Policy suggestions for bus stop and bus station

This chapter is the summary from several guidance for good bus stop and bus station design criteria, including: *Accessible bus stop design guidance* (Transport for London, 2006), *Improving bus service* (Transport Canada, 2012) and *Transit Capacity and Quality of Service Manual, Third* Edition (Transport research board of the National academic, 2014). The aim is to guide the DLT on the significant elements that should be include in the bus reform study for the best level of service to passengers and practical operation and development.

The suggestions are categorised into 5 aspects as follow:

Bus stop shelter and environment

The bus stop environment contains a number of features that need to be considered, as illustrated in Figure 30.

Shelters increase passenger comfort and can provide revenue. Where possible, it's desirable to provide shelters for passengers waiting at bus stops. They should be designed to accommodate the maximum number of passengers normally waiting, and to provide adequate protection from the weather. They should be well lit and ventilated, and approaching buses should be visible from inside the shelter. Where waiting times may be long it may be desirable to provide seating. Requirements differ depending on the length and frequency of journeys. Shelters at busy stops may incorporate such facilities as kiosks for newsvendors or refreshments, which may provide useful revenue.

Additionally, it is important to emphasise the need for:

- training for bus drivers on how to approach and correctly use the bus stop;
- planners and engineers to optimise the location, design and construction of bus stops;
- motorists and enforcement authorities to recognise the necessity for bus stops to be kept clear of parked vehicles.

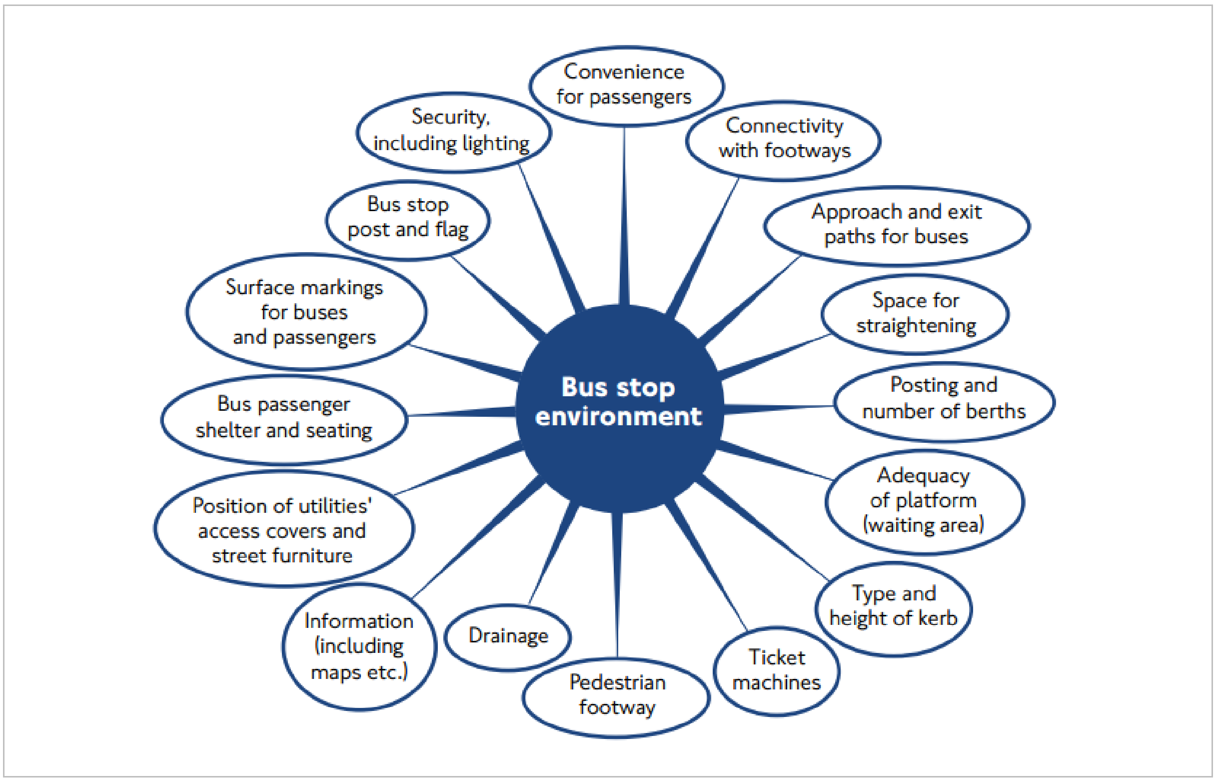


Figure 28: Features of the bus stop environment (Source: Transport for London, 2006)

When reviewing individual bus stops, and their immediate environment, designers need to take account of the wide range of issues that are discussed in Chapter 4. While these guidelines provide assistance with the decision making process, it should be recognised that each site is a unique location, with different characteristics to be taken into account.

Bus stop layout

The ideal bus stop layout will achieve the objectives shown in Figure 31. The bus should stop parallel to, and as close to the kerb as possible to allow effective use of the bus' facilities.

In the urban environment, there often exists a conflict between the demands for frontage servicing, short term parking and the need to protect a sufficient length of kerb space to allow buses to easily access a stop.

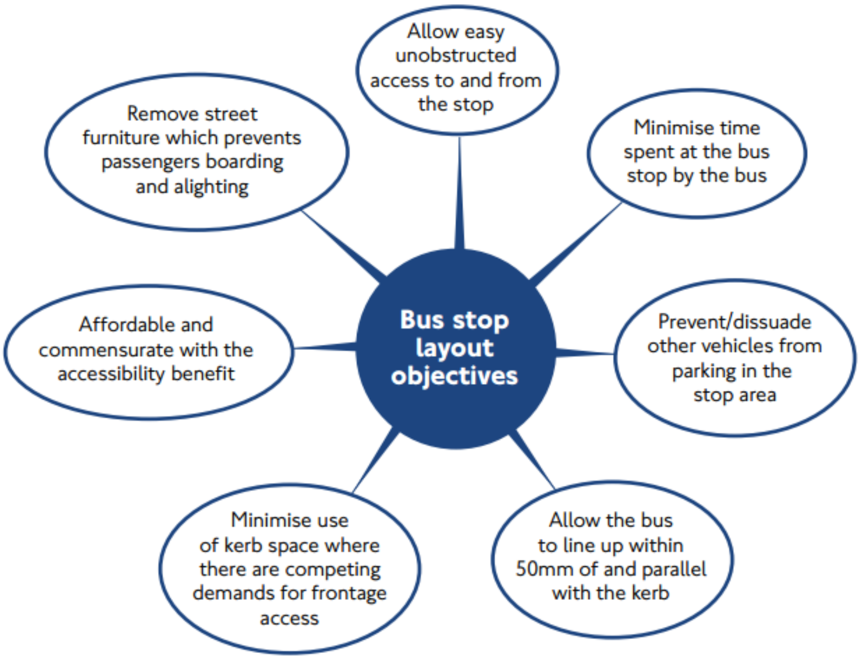


Figure 29: Bus stop layout objectives (Source: Transport for London, 2016)

Bus stop location

Bus stops must be located to allow passengers to board and alight safely and conveniently as shown in Figure 32. Ideally, they should also be situated near places of particular need, such as local shops, libraries, clubs, health facilities and sheltered housing. Stop locations are determined by BMA, district office, BMTA and the traffic police. Residents, local businesses and bus user groups may also need to be consulted by the government institutes.

Additionally, there are suggestions about where to locate the bus stop and amount of stops/shelters in a location:

Space between stops between 300 and 600 meters

For city bus services, an appropriate distance between stops is normally between 300 and 600 meters, although other considerations must also be applied in determining the precise locations. Spacing stops at rigidly regular intervals will inevitably result in some being located in inconvenient, unnecessary or dangerous positions.

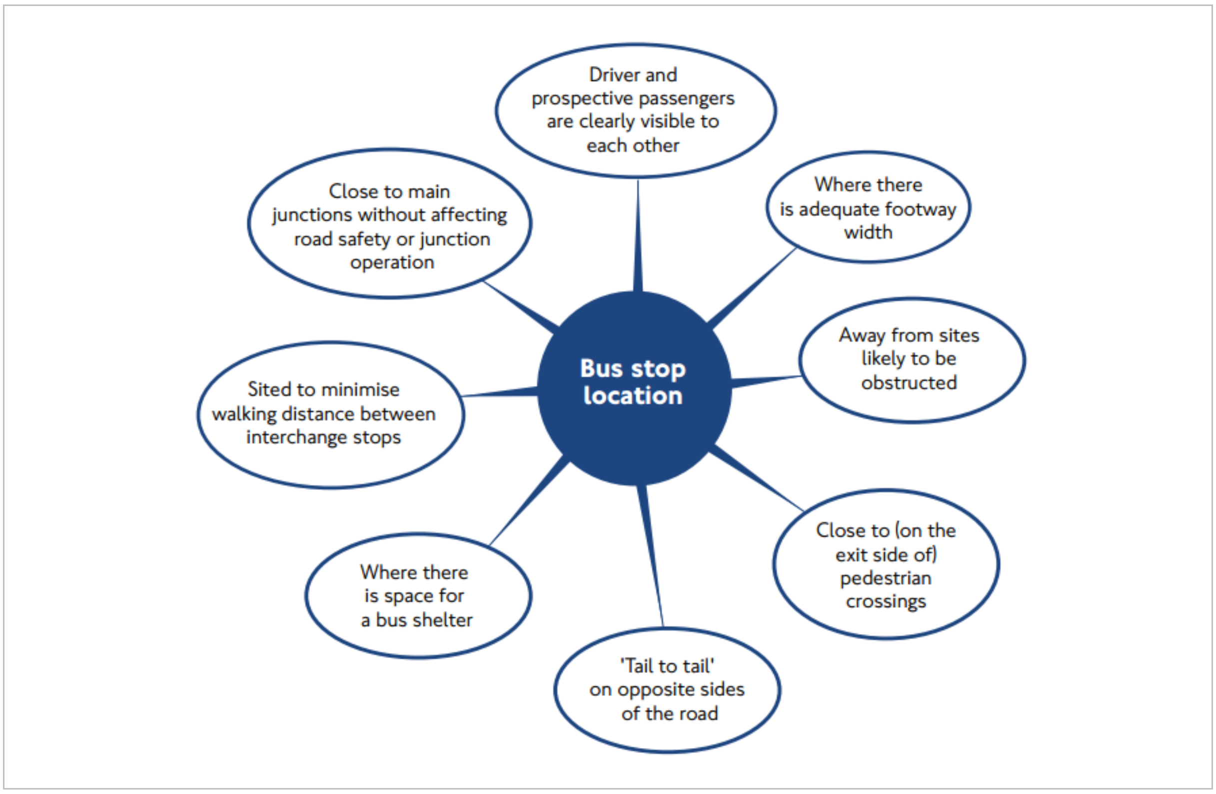


Figure 30: Considerations for bus stop locations (Source: Transport for London, 2006)

Separating stops for high-frequency routes

Where a number of different bus routes serve the same location, providing a high combined frequency, it may be necessary to provide separate stops for different destinations or groups of destinations in order to reduce congestion at stops caused by several buses loading simultaneously. As a general rule, if it is a regular occurrence throughout the day for more than two buses to different destinations to be loading simultaneously at a stop, it will be advantageous to separate them.

Routes should be grouped so that where several different routes serve the same intermediate points or operate for a significant distance along a common corridor, all use the same stop. It's unsatisfactory if passengers have a choice of bus routes but cannot know which stop to wait at for the next bus to their destination.

Separating stops for different bus services and types

It's also usually appropriate, particularly at busy points, to segregate stops for standard and premium quality or air-conditioned buses, even if they are operating on the same route, since the two markets are usually quite separate.
Problems may arise if buses of different configurations, for example buses with entrances in different positions, use the same bus stop. All buses should stop with their entrance doors at the head of the passenger queue. A bus with its entrance at the front should stop with its front at the head of the queue. But one with its entrance at the rear should stop with its front anything up to 15 meters forward of this position. This obviously has implications for any parking restrictions adjacent to the stop.

Similarly, if safety barriers are placed to prevent passengers from entering the road other than at the head of the queue, these may obstruct one of the entrances of a bus that has more than one entrance, or an exit door of a bus that has a separate entrance and exit. If a change is made to the standard bus configuration, it may be necessary to make alterations at all bus stops on the routes affected.

Bus station, bus terminal and Intermodal transfer facilities

A bus terminal, or terminus, is the point where a bus route starts or ends, where vehicles stop, turn or reverse, and wait before departing on their return journeys. It's also where passengers board and alight from vehicles. It also often provides a convenient point where services can be controlled from.

The size and nature of a terminal may vary, from a roadside bus stop with no facilities for passengers or bus crews, to a purpose built off-road bus station offering a wide range of facilities.

If the number of vehicles arriving and departing is low, a roadside bus stop, with no facilities, will normally be adequate. With a large number of vehicles arriving and departing, it may be necessary to provide off-road bus station facilities for the convenience of passengers and to reduce traffic congestion.

Terminals versus stations

Although the terms bus terminal and bus station tend to be used synonymously, the latter is normally more correct since in most cases there are some routes which pass through the station without terminating there.

The term bus station is normally used to refer to an off-road location with at least basic facilities for passengers, while a terminal may be a fully equipped bus station but might equally be merely a point in the road.

In many cities the majority of passengers start and end their journeys at bus stations, and a significant proportion of operators' revenue may be collected at these points.

Stations and terminals are important elements

Bus stations and terminals are a significant element in the operation of bus services. Their design and location affect the efficiency of a transport system, and its impact on other road users. Some stations are regarded more as landmarks than as utilities, and as such are often of prestigious rather than practical design, which may detract seriously from their efficiency.

Local bus services in many towns and cities are centred on bus stations. Often there are large stations in the central area, with smaller ones at the outer ends of the routes. There may also be intermediate stations, especially at points where many passengers interchange between different bus routes, although most intermediate passengers on urban services board and alight at roadside bus stops.

Bus stations may also be used for parking between journeys for buses which are away from their home bases. But they should not normally be regarded as long term parking facilities, particularly in locations where land is expensive. When they are not required for loading, buses should be parked elsewhere, preferably at depots where there are facilities for vehicle servicing and cleaning. Buses should not normally be permitted to park in streets adjacent to bus stations.

Efficient systems limit bus time at stations

If buses are utilised efficiently, it should not be necessary for them to spend much more time at bus stations than is required for loading and unloading. The requirement to park large numbers of buses for long periods between trips is often a reflection of inefficiency or excess capacity in the industry. Although it may be unavoidable at off-peak times if there is a significant difference between peak and off-peak service levels.

In practice it is necessary to achieve a realistic compromise with regard to parking at bus stations. While it's expensive to provide parking space at city centre terminals, it can also be expensive and inefficient for buses to be driven for long distances to remote parking areas, particularly if traffic congestion is a serious problem.

It may be appropriate for bus operators to be charged for parking on a time basis to discourage them from parking their vehicles for too long. Calculating these charges should take into account the cost of providing parking facilities. But it should not be so high that it encourages operators to park their vehicles elsewhere when this would be uneconomic or undesirable not only to the operator but to the community.

Locating bus stations for urban services

It's essential that stations are not only constructed to a suitable design and with adequate capacity, but also that they are suitably located.

There are a number of considerations in deciding the best location. The location should be where routes should logically connect or terminate, as determined by passenger demand patterns. If the station is used as an intermediate stopping point on routes passing through, it should be conveniently located for passengers joining or leaving vehicles.

Sometimes the location of stations for different classes of vehicles is influenced by the catchment areas of the passengers. For example, the majority of people using air conditioned buses may live in a different part of the city from those using standard services.

An efficient urban bus route network in any medium or large city will inevitably require a large number of terminal points, not only at the ends of each route but at various intermediate points where some vehicles may turn short.

Simple terminal points do the job

It would be both uneconomic and unnecessary to construct large complex terminal facilities at all of these points. In the majority of cases all that is required is the facility for vehicles to turn, without obstructing or endangering other traffic, and sufficient space at the curb or alongside the road for a reasonable number of vehicles to stand between journeys.

It's often appropriate, where the road layout permits, for buses to follow a loop round the block at the end of the route, standing between journeys at a roadside stop at some point in the loop, or immediately before or after it.

Similarly, bus stations en route will be required only where demand justifies their provision. As a guide, an off-street bus station may be justifiable if the number of buses standing simultaneously loading, unloading or waiting to depart regularly exceeds 10 or 12, although much will depend on the road layout, and the volume of other traffic. If the road is very wide and there is little traffic, roadside bus stops may cater adequately for up to five buses loading simultaneously on each side of the road.

If suitable off-street terminal sites are not available it's usually preferable for routes to terminate on-street, even in central areas, rather than for terminals to be sited at inconvenient locations.

Efficient routing minimises the need for terminals

Efficient routing can minimise the number of routes which must terminate in busy central areas, while efficient scheduling and regulation of departures can minimise vehicle waiting times. Provided there is no excess capacity in the system, no more than two or three vehicles on any one route need be waiting at the central terminal point at any time, so that disruption to traffic can be minimised.

Where bus stations are required, they should be located near to points of high demand for maximum passenger convenience. The location of stations is often determined primarily by the availability of sites, and as a result they are often in inappropriate locations, causing inconvenience to passengers using them, and increasing vehicle operating costs by increasing the distances travelled.

Central area terminals can create congestion

In many cities there are one or more terminal bus stations in the central area. If there is a single central bus terminal, this is convenient for passengers interchanging between routes. However, if there are very many bus movements a single terminal may be impractical, requiring a very large area of land, and creating congestion both within the station itself and on surrounding streets. In large cities, there are often several terminals, usually located around the periphery of the central area.

Where there are several central terminals, there are normally different terminals serving different groups of routes or destinations. Each terminal should ideally be located close to the corridor served by its group of routes. This minimises the number of buses crossing the central area and reduces traffic congestion caused by buses. But it may mean that the majority of passengers must walk some distance into the centre to complete their journeys, and passengers interchanging between routes may be seriously inconvenienced by having to walk from one terminal to another.

An alternative is to allocate routes to terminals in such a way that every route crosses the city centre before reaching its terminal. This may increase passenger convenience, but may also increase the level of traffic congestion, and requires a greater number of buses to provide an equivalent service.

While urban bus services are often severely hampered by traffic congestion, the buses themselves may also contribute to congestion in the city. In particular, city centre bus terminals can cause severe traffic congestion through the concentration of buses arriving and departing. This is particularly so where buses load at the kerbside rather than in off-street bus stations.

Operating from suburb to suburb can decrease congestion

The congestion caused by buses terminating in central areas can be alleviated by linking bus routes so that the majority operate across the city from one outer suburb to another, stopping in the central area for no longer than is necessary to set down and pick up passengers. All terminal points will be outside the central area. This means less disruption is caused to other traffic and there is likely to be more space for buses to stand for long periods, as may be necessary at off-peak times.

Additional advantages from this type of operation are that bus utilization may be improved by reducing the number of times when a bus has to turn. Additional links are also provided for passengers whose journeys take them across the city centre.

A potential disadvantage is irregularity of services, caused by eliminating the opportunity to compensate for traffic delays by adjusting layover times at central terminal points, although such delays may be reduced through minimising bus-induced congestion.

Where routes are linked to operate across the city centre, there can be a benefit in providing facilities for passengers to interchange between routes. These facilities may take the form of purpose-built off-road facilities, or roadside bus stops with shelters, perhaps linked by pedestrian bridges or subways.

With these kinds of facilities, the location should not require buses to deviate significantly from their routes; otherwise much of the benefit of operating through services is lost. However, with appropriate routing, it should be unnecessary for the majority of passengers to transfer between bus routes in the city centre, and extensive interchange facilities should not be required.

Off-street bus stations in city centres are, in any case, often a wasteful use of expensive land, although this may be offset by the development of property above the station.

How to achieve more bus stations and intermodal interchanges

As indicated in Chapter 2.3.1, the current situation regarding the availability of bus stations and inter-modal interchanges is very poor. To improve this situation needs concerted action as follows:

- OTP and BMA to ensure that the design of future Bangkok Mass Transit lines (urban rail, suburban rail, monorail or BRT) includes provision of associated intermodal interchange facilities at strategic locations.
- OTP and BMA to research existing mass transit lines and identify where possible land suitable for development of intermodal facilities (e.g. part of car park adjacent to Mo Chit BTS and Chatuchak Park MRT stations).
- Land at strategic locations under elevated expressways to be considered for provision of bus terminals.
- Large shopping malls be approached to develop bus terminals in part of their at-grade car parking facilities (e.g. At Tesco Lotus next to Onnut BTS, Future Park Rangsit, Fashion Island, Macro Bangkapi etc.).
- Existing on-street bus terminals to be provided with “Bus parking only” road signs and/or markings for more reliable operations.
- Additional on-street bus terminal space to be identified in strategic areas.
- Move bus stops closer to junctions with other crossing bus routes (on “far” side of junction) to become the standard practise.

Real-time travel information

An optimised station design combined with a good information system, including timetables, facilitates the processing of passengers and reduces travel times will make public transportation as a whole more attractive. Real time information systems provide individual passengers with up-to-date departure and arrival times, both at the stop and remotely via a website or smartphone app. The system is integrated with a GPS vehicle location technology, and can be also used to manage the service provision in real time, and monitor the performance of the driver (driving style, stops, etc.). Commuters can plan and adjust their journeys according to current conditions in the network, which increases user satisfaction as waiting times and unexpected delays are minimised. BMTA has already plans that include the installation of GPS systems in all new buses.

Measures include design aspects like real-time travel information board, improved accessibility to the bus station, waiting area, and infrastructure for buses with an aim to support effective and convenient handling of passenger flows. It also includes design and mechanism of Real-time travel information boards installed at the bus station.

Further international practical guidelines for designing bus transit environment and management which are strongly recommended to be reviewed before designing guidelines for Bangkok are listed as follow:

- Accessible Bus Stop Design Guidance (Transport for London, 2014)
- Improving Bus Service (Transport Canada, 2012)
- Signing Standards Manual (King County Metro, 2008)
- Transit Capacity and Quality of Service Manual – 3rd edition (Transport Research Board of the National Academies, 2013)
- Transit Design Guidelines (OmniTrans, 2013)

3. Role and potential for NMT as access modes to the public transport system in Bangkok

3.1. Objectives and study area

According to the transport NAMA concept note, the first phase of NMT improvement intervention is planned to establish at least 2 potential pilot areas. Each pilot area has its unique characteristics, land use and travel behaviour; therefore, more information is required to appreciate NMT's potential role in each pilot area.

The objective of transport NAMA is to improve NMT attractiveness to reach mode shifts in two ways:

- Shift transport demand from private motorised traffic to public transport, by improving NMT conditions and also the connectivity and accessibility between NMT and public transport, leading to lower gCO_2 per pkm.
- Shift transport demand from motorised paratransit (motorised three-wheelers /motorcycle taxis) to NMT, by improving NMT conditions and also the connectivity and accessibility between NMT and public transport, leading to lower gCO_2 per pkm.

The possibility of achieving these objectives is currently based on assumptions and limited evidence, and need further analysis to indicate the plausibility and extent of the expected impacts.

Therefore, this chapter aims to conduct comprehensive study in various aspects that relevant to transport mode choice in a pilot area, including: passenger travel behaviour, people's perception on existing public transport services and NMT environment conditions, and willingness to shift transport according to levels of future intervention. The goal of this study is to summarise existing transport situation and formulate the design guideline for NMT intervention and customised concept design of 1 pilot area based on the findings from the survey.

The topics included in this chapter are: Survey location and methodology (3.2); traffic count survey result and analysis (3.3); origin-destination survey result and analysis (3.4); general characteristic of target user (3.5); current perception of fixed route mass transit and NMT (3.6); current NMT characteristics and future passenger estimation (3.7); and level of intervention and potential of future modal shift (3.8).

The selected pilot area is Ari area in North Bangkok. The approximate boundary of Ari area is shown in the map in Figure 33 with black frame. The area has high traffic volume and travel demand throughout the day due to its diversity of land use purpose. The area is mixed between Financial & IT offices district, Government office district, Residential area in both low-rise and high-rise, and Dining destination.

The centre of Ari area, the beginning of Soi Ari (Soi Phahonyothin 7), is considered as a large transit hub for people who travel to/from this area. There is an urban rail transit station - BTS Ari station, 2 bus stops located on each side of the Phahonyothin road adjacent to the BTS Ari station, and paratransit hub at the beginning of Soi Ari.

From the observation, Soi Ari is the main access for civil servants who are working in the Governmental offices district in West side of Ari area. Apart from private vehicles and taxis, people travel to Ari area by using BTS and public bus, then transfer to motorised paratransit or NMT mode before travelling into Governmental offices district. The major access route is indicated by blue arrows in Figure 33, including, Soi Ari (Soi Phahonyothin 7), the road inside Governmental Offices district and Soi Ari Samphan (Rama VI Soi 30). Though the distance is only approximately 500-1,500 metre, which is in the possible range for walking or cycling, high volume of people choose to take motorised paratransit instead. Therefore, surveys are conducted to study the potential of NMT conditions improvements along the major access route from BTS Ari station to Governmental offices district, and future modal shift based on intervention options.

Figure 31: Ari neighbourhood land use map and potential pilot route for improving NMT conditions (Source: Consultant, 2015)

3.2. Survey location and methodology

There are 2 types of survey that were conducted in order to have a better understanding for difference aspects:

- Traffic count survey: for getting an overview of current situation of travel behaviour and modal share for home-based trip to workplace on Ari area
- Interview survey by questionnaire: for investigating people's perception and willingness on transport mode choice

The connectivity and accessibility between NMT and public transport in Ari area is also the principle concerns in this study. The result summary and recommendations of NMT interventions is illustrated further in this chapter.

3.2.1. Traffic count survey location and methodology

This survey was conducted by using "stationary gate method" whereby transport modes that cross an imaginary line perpendicular to the footway or road are counted. The direction of travel is also noted. The survey collected both number of vehicles and number of passengers on each vehicle (exclude public transport drivers and paratransit drivers). The 15-minute accumulated number of each transport modes from 06:00 to 20:00 (all-day 14-hr) is recorded. Existing environment of Ari area, especially around survey location, is observed for significant travel behaviour and limitations.

The survey location is divided into 3 groups for different aspects and modes count as indicated in Figure 33.

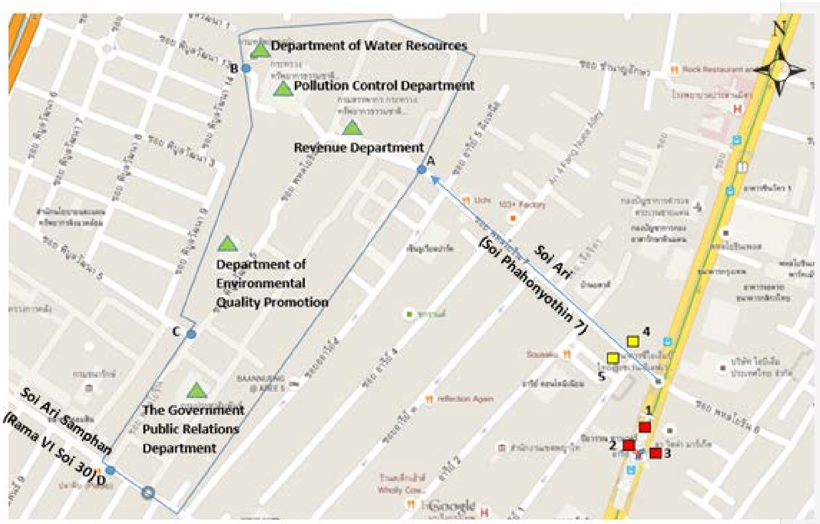


Figure 32: Survey location map (Source: Consultant, 2015)

Group 1: Fixed-route mass transit passenger from/to Ari area

Collect from 3 major Public transport station on Phahonyothin road, next to the beginning of Soi Ari, which is indicated in red square in Figure 34.

- Location 1: BTS Ari station – North Exit
  - collect enter and exit number of BTS passengers at fare collection gate
- Location 2: Ari bus stop – Northbound
  - collect board and alight number of public bus passengers at bus stop
- Location 3: Ari bus stop – Southbound
  - collect board and alight number of public bus passengers at bus stop

Group 2: NMT passenger and Motorised-paratransit passenger in Soi Ari

Collect from 2 locations at the beginning of Soi Ari which is indicated by yellow square in Figure 34, including:

- Location 4: Beginning of Soi Ai– North side footway
- Location 5: Beginning of Soi Ai– South side footway (Paratransit hub)
  - collect inbound and outbound number of NMT passenger: pedestrian and bicycle users
  - collect inbound and outbound number of Paratransit transfer passengers (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw

Note: Inbound direction of Soi Ari is from Phahonyothin road to Governmental offices district as indicate in blue arrow in Figure 34.

Group 3: All traffic to/from indicated closed study area of governmental offices district

Collect from 4 main entrance gates of a "closed study area" as indicated by blue boundary in Figure 34. This closed study area is only one part of Governmental offices district in Soi Ari. This area is suitable for collect traffic count data since it has only 4 main gates that the traffic get through. The other area of Governmental offices district has a large number of gates which is difficult to monitor and collect traffic data.

The selected traffic survey locations at 4 gates, which is indicated by blue circle in Figure 34, including:

- Location A: Revenue Department gate
- Location B: Department of Water Resources gate
- Location C: Soi Phibunwatthana 5 gate
- Location D: The Government Public Relations Department gate
    - collect enter and exit number of NMT passenger: pedestrian, and bicycle users
    - collect enter and exit number of Paratransit vehicle and passengers (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw
    - collect enter and exit number of Private vehicle and passengers: private car and private motorcycle

The figures of current environment of the survey location and full detail data count of each location is presented in *Annex 3A* Figure 3A-2 to 3A-11 and the survey results are analysed further in this chapter

Note:

- Governmental-use van and truck is also found in the area, but they are excluded in the survey and analysis because they are not the main transport mode for home-based trip to workplace. The survey result shows the abnormal high volume of Govermental-use van vehicles and passengers due to Department of Revenue Sports day on that day. Therefore, the minivan passengers and vehicle counts are excluded from this analysis because it is non-home based trip and occurred from special event that only happened on that survey day.
- Heavy rain may, which occurred in the evening peak hour, may significantly affect pedestrian and public transport passengers.
- Although a person may be counted in 2 or 3 groups of location, the analysis is design to not double count people who use the same mode between groups of location by excluding the through traffic from the analysis
- People who use public bus at Rama IV road is considered to be much lower than Phahonyothin road, so it is excluded from the survey and analysis.
- This traffic count can specify the through traffic that use the road inside Governmental Offices district as a shortcut from Soi Ari to Soi Phibunwatthana 5 and Soi Ari Samphan (Rama VI Soi 30) by calculating the difference number of vehicle and passengers between travel in and travel out at the same 15-minute period of time. The analysis in this chapter may or may not include this though traffic due to objective of that analysis.

3.2.2 Interview survey location and methodology

This survey interviewed people working in Governmental offices district by giving a questionnaire to them in the office building. The questionnaire form is in *Annex 3B*. The respondents are randomly selected from 5 main buildings in Governmental offices district in the **closed study area** which is indicated by green triangle in Figure 34, including:

- Department of Water Resources
- Pollution Control Department
- Revenue Department
- Department of Environmental Quality Promotion
- The Government Public Relations Department

This survey aims to collect at least 400 copies of questionnaire in order to have an acceptable sample size with 95% confidence interval. The questionnaire interview survey was conducted during 2-16 September 2015 and 458 copies were completed.

The respondents were categorised into 2 cases based on main transport mode used for travel to Ari area, which are:

- Case 1: Door-to-Door Motorised vehicle
- Case 2: Fixed-route Mass transit

The reason of categorise is to investigate and understand the differences between those 2 cases in terms of travel behaviour, perception of NMT and public bus, and willingness to shift transport modes after having NMT and public bus intervention.

The overall interview survey results summary is presented in *Annex 3C* and the survey results are analysed further in this chapter

3.2.2. Traffic count survey result and analysis

From the various transport modes traffic data collected from survey locations, this section categorises the results of traffic count survey into 5 analyses, including:

- Long distance modal share estimation
- Fixed-route mass transit travel behaviour
- NMT and Motorised-paratransit travel behaviour
- Closed study area travel behaviour
- Occupancy rate and CO_2 emission rate

The analysing method, results summary, and recommendations of each analysis are explained further in this chapter.

Long distance arrival modal share estimation in morning peak hour

This estimation is analysed from the traffic count survey data by using collected number of passengers focusing on the transport mode people use for travel from *outside* to *inside* Ari area. Since the 'whole' Ari area is an open area and difficult to collect all the traffic travelling in and out of this area, the 'closed study area' in Governmental office district is assigned to represent general modal share of people who come to work in Ari area with following assumption:

- This modal share estimation is using Morning peak hour arrival traffic count from 06:00 to 10:00 which covers all typical weekday travel behaviour of people who come to work in closed study area.
- This estimation is focusing on 5 main long-distance transport modes which people use to travel from *outside* to Ari area, for instance: Urban rail (BTS), Public bus, Private car (including minivan), Private motorcycle, Motorcycle taxi and Taxi.
- 5 main long-distance transport is categorised into 2 cases:
    - Case 1: Door-to-Door Motorised vehicle i.e. Private car (including minivan), Private motorcycle, and Taxi. The traffic count survey of Case 1 was conducted on Tuesday 1 September 2015 at Location A, B, C and D as indicated in Figure 34. These modes are direct travel (not require NMT or paratransit).
    - Case 2: Fixed-route mass transit i.e. Urban rail (BTS) and Public bus. The traffic count survey of Case 2 was conducted on Tuesday 1 September 2015 at Location 1, 2 and 3 as indicate in Figure 34. These modes require NMT or paratransit egress mode to complete the journey. (This also consider the bicycle users in the future after having the bike lane, bike sharing scheme and cycle parking facilities)
- Case 1: Door-to-Door Motorised vehicle passengers are considered *only* people who stay in the closed study area

Note: This analysis is excluding through traffic that use the road inside Governmental Offices district as a shortcut from Soi Ari to Soi Phibunwatthana 5 and Soi Ari Samphan (Rama VI Soi 30) by using arrival count deducted by departure count

- Case 2: Fixed-route mass transit passengers are considered *only* the passengers who *travel into Soi Ari* after alight from BTS or public bus from Phahonyothin road. Since the traffic count data result cannot directly conclude the number of Fixed-route mass transit passengers who *travel into Soi Ari*, this can be solved by assuming that *all* NMT and paratransit passengers who travel into Soi Ari and pass the Location A as indicated in Figure 34 has transfer from a Fixed-route mass transit mode, with the same proportion of total Fixed-route mass transit passengers. The total NMT and paratransit passengers who *travel into Soi Ari* is equal to Fixed-route mass transit passengers who *travel into Soi Ari*.

Note: Fixed-route mass transit passengers who did not travel into Soi Ari is excluded from this analysis. People who come by public bus from Rama IV road (orange road on the left side in Figure 34) are also not identified in this analysis since their egress route is not Soi Ari. These are uncertainty of Fixed-route Mass transit passengers' estimation in this analysis.

Results summary

According to *Annex 3A* Table 3A-1 and Table 3A-3, the Morning peak arrival of Fixed-route mass transit traffic count data at Location 1, 2 and 3 is presented in Table 4, while that of motorised vehicle and NMT at Location A, B, C, D for closed study area is presented in Table 5.

Table 4 Morning peak hour arrival traffic count data for Fixed-route Mass transit in Ari area

Type	Location	Mode	Count data	Total	Percentage
Fixed-route Mass transit *(Alight)*	1	Urban rail (BTS)	4,407	4,407	51.4%
	2	Public bus (Northbound)	1,781	4,164	48.6%
	3	Public bus (Southbound)	2,383		
Total				**8,571[3]**	**100%**

Table 5 Morning peak hour arrival traffic count data for closed study area

Type	Location	Mode	Count data	Percentage
Door-to-Door motorised vehicle *(Include through traffic)*	A,B,C,D	Private car	3,812	42.4%
		Private motorcycle	1,384	15.4%
		Taxi	295	3.3%
	Total		**5,491**	**61.1%**
NMT and Paratransit	A,B,C,D	Pedestrian	1,430	15.9%
		Bicycle	98	1.1%
		Motorcycle taxi	1,062	11.8%
		Motorised-three wheeler	518	5.8%
		Songthaew	383	4.3%
	Total		**3,491**	**38.9%**

[3] This total 8,571 public transport alighting is include not only people who travel to governmental office district in Soi Ari but also Financial and IT offices district, residential area on West side of Phahonyothin road, and further catchment area for walking and paratransit.

Grand Total	8,982	100%

Table 4 indicates that Urban rail and Public bus passengers has quite the same proportion at 51.4% and 48.6% respectively. Table 5 reveals that the highest percentage transport mode for travel to closed study area is Private car at 42.4%. However, the result from those tables cannot be compare the modal share between Case 1: Door-to-Door Motorised vehicle passengers who stay in the closed study area and Case 2: Fixed-route mass transit passengers.

Therefore, the long distance arrival modal share is estimated by using method as explained in assumption 4) and 5) above, which is different from 5. This estimation use the selected data for Case 1: Door-to-Door motorised vehicle (exclude through traffic) to represent number of passengers who travel directly from home to closed study area, and use NMT and Paratransit at Location A (travel into Soi Ari and pass Location A) data to represent number of passengers who travel by Fixed-route mass transit (Case 2) to in front of Soi Ari then transfer to NMT and Paratransit to closed study area. The result is present in Table 6.

The majority of people who travel into closed study areas during morning peak use Door-to door transport (59.3%), while the rest (40.7%) travelled by NMT and Paratransit from in front of Soi Ari. The Morning peak hour arrival traffic count data for long distance modal share estimation is shown in Figure 35.

Table 6 Morning peak hour arrival traffic count data for long distance modal share estimation

Type	Location	Mode	Count data	Percentage
Case 1: Door-to-Door motorised vehicle *(Exclude through traffic)*	A,B,C,D	Private car	2,091	50.7%
		Private motorcycle	288	7.0%
		Taxi	67	1.6%
	Total		**2,446**	**59.3%**
NMT and Paratransit (*travel into Soi Ari and pass Location A*)	A	Pedestrian	570	13.8%
		Bicycle	24	0.6%
		Motorcycle taxi	472	11.4%
		Motorised-three wheeler	228	5.5%
		Songthaew	383	9.3%
	Total		**1,677**	**40.7%**
Grand Total			**4,123**	**100%**

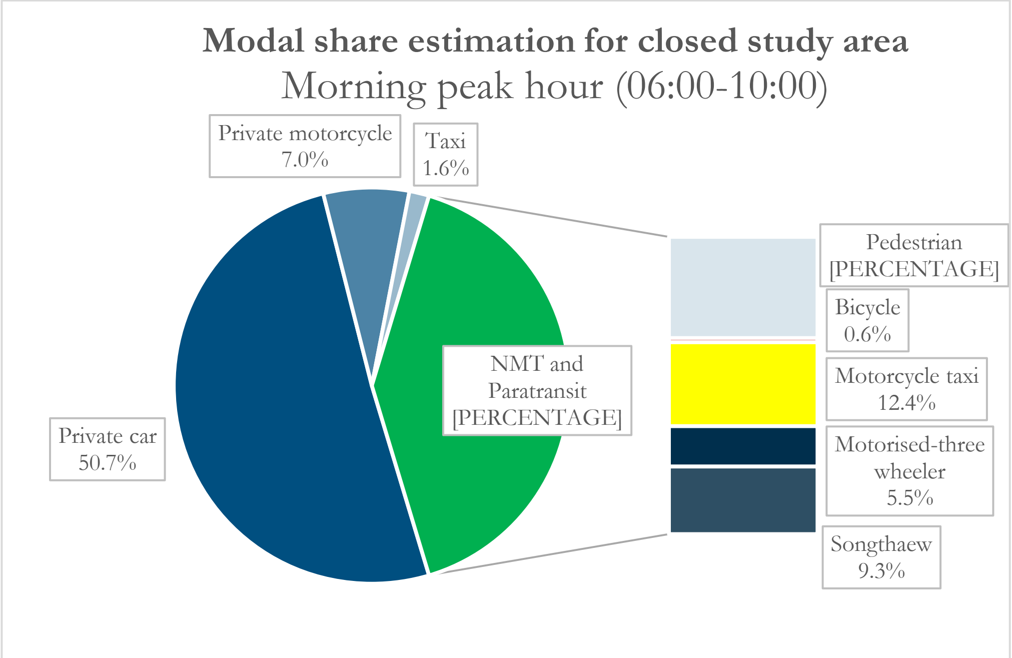


Figure 33: Morning peak hour arrival traffic count data for long distance modal share estimation (Source: Consultant, 2015)

From the assumption, the number of Fixed-route mass transit passengers who travel *into* Closed study area represents the number of NMT and Paratransit passenger who travel *from* beginning of Soi Ari *into* Closed study area at Location A which is 1,676 people.

According to the proportion of Fixed-route mass transit in Table 7, the percentage of Urban rail (BTS) is 51.4%, while that of Public bus 48.6%; therefore, the number of BTS and Public bus passengers who travel *into* Closed study area could be estimated 861 people and 815 people respectively. The Long distance modal share estimation is summarised in Table 7 and Figure 36.

Table 7 Long distance modal share estimation of closed study area based on Morning peak hour arrival

Type	Mode	Passenger Count	Percentage
Case 1: Door-to-Door ***(Enter to closed study area)***	Private car	2,091	50.7%
	Private motorcycle	288	7.0%
	Taxi	67	1.6%
	Total	**2,446**	**59.3%**
Case 2: Fixed-route Mass transit (*travel into Soi Ari*)	Urban rail (BTS)	862	20.9%
	Public bus	815	19.8%
	Total	**1,677**	**40.7%**
Total: Morning peak hour arrival		**4,123**	**100%**

The result concludes that the majority of current long distance travel modes to Governmental office district are private car at approximately half of all passengers, while the public transport share is at approximately 40%.

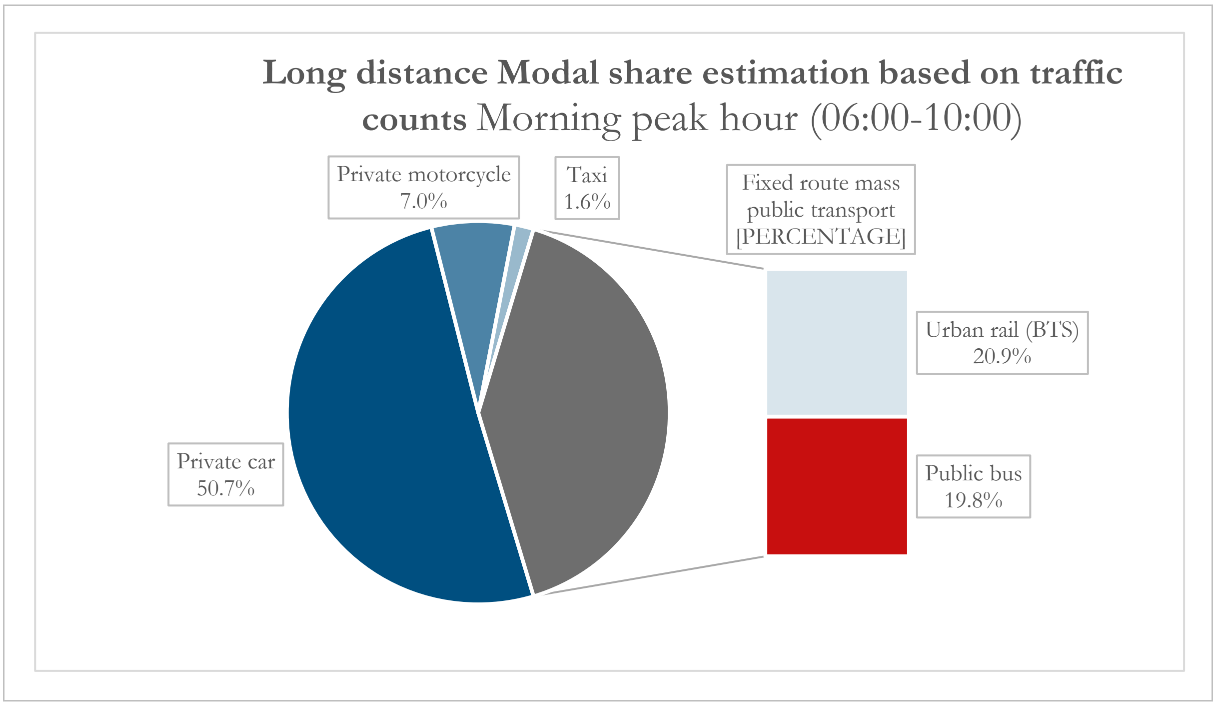


Figure 34: Long distance modal share estimation of closed study area (Source: Consultant, 2015)

3.2.3. Recommendations

- According to the current strategic plan from Ministry of Transport for expanding Urban-rail network and reforming public bus system, Fixed-route mass transit passengers in Ari are expected to increase substantially. People working and living in the Ari area will have more travel mode choice and the Door-to-door modes will be expected to have lower necessity, potentially resulting in lower modal share than presently. Therefore, NMT and intermodal transfer facilities (ITF) should be developed and expanded to accommodate the higher number of Fixed-route mass transit passengers who transfer to those modes and thereby making these modes more attractive.
- The guideline for designing NMT and ITF for paratransit in Soi Ari for accommodating future modal share will be illustrated in Chapter 4.
- The total number of Morning peak hour arrival in closed study area or 4,122 people is represented as a base-line for modal shift estimation and GHG emission reduction estimation in this report.
- Majority of people who travel into closed study area in morning peak by Door-to door transport for 59.3%, while the rest 40.7% travel by Fixed-route mass transit to Soi Ari then transfer to NMT and Paratransit to closed study area.
- The amount of Fixed-route mass transit passengers presented in this analysis is only for people who travel *into* a closed study area. The detail of actual total number Fixed-route mass transit passengers who travel to Ari station and its catchment area is shown further in Chapter 3.3.

Fixed-route mass transit travel behaviour

The fixed-route mass transit travel behaviour is analysed from the traffic count survey data, which is conducted in front of Soi Ari at Location 1, 2 and 3 as indicate in Figure 34. This includes all the Fixed-route mass transit passengers who travel to Ari station and its catchment area as shown in Figure 34. The Fixed-route mass transit mode is consist of 2 transport modes: 1) Urban-rail (BTS) and 2) Public Bus.

It was conducted on Tuesday 1 September 2015 which had a heavy rain in the evening during 17:15-19:00. The summary for 15-minute interval of arriving and departing passenger count for BTS passengers and public bus passengers result is presented in Figure 37, while the percentage of modal share for all-day arrival and departure in Ari area by BTS and public bus is illustrated in Figure 38 and 39. The full detail count data are presented in *Annex 3A Table 3A-1*.

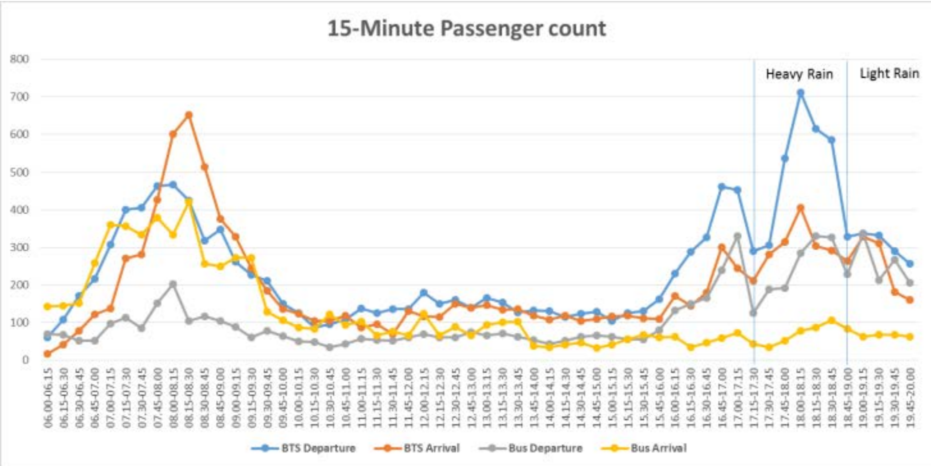


Figure 35: Passenger count of Fixed-route mass transit at Ari BTS station and bus stops (Source: Consultant, 2015)

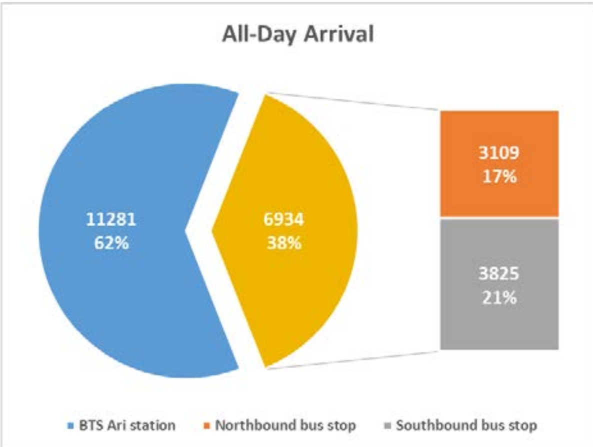


Figure 36: All-day arrival mode share (Source: Consultant, 2015)

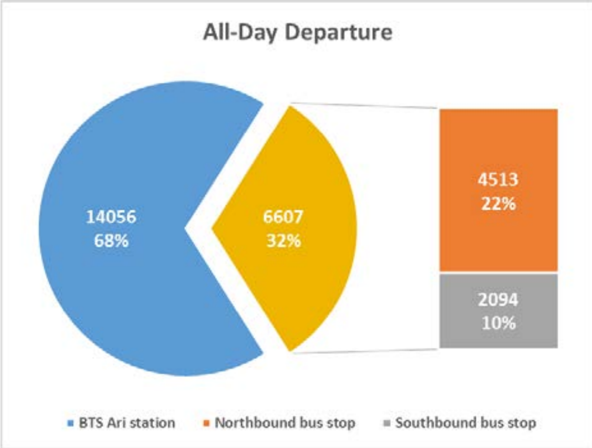


Figure 37: All-day departure modal share (Source: Consultant, 2015)

Result summary

- Total all-day arrival and departure of Fixed-route mass transit passengers is 18,215 and 20,663 people respectively. See detail in *Annex 3A*. The difference between arrival and departure rate for Fixed-route mass transit passengers occurs because of following assumptions: 1. Private vehicle sent the family member at workplace then he/she travel back home by himself/herself using public transport; 2. The survey period is only 6:00-20:00, while in the reality, there are passengers who travel before or after this period. 3. People who live in Ari area travel to other place and did not come back to Ari area yet.
- The number of passengers who use BTS to Ari area is approximately double of those public buses for all-day traffic count.
- Northbound bus stop (Outbound) has higher departure rate than South bound bus stop (Inbound), while Southbound bus stop (Inbound) has higher arrival rate than Northbound bus stop (Outbound). This implies that people who travel by public bus to work in Ari area in the morning are from North suburban area more than those from the city centre. Hence, this group of passenger also travel outbound to their home in North suburban in the evening.
- The morning peak hour spread between 06:45-09:30 and peaks during 08:00-08:30.
- From Figure 38, in the morning, BTS arrival rate peaks at approximately 2,600 passengers/hour, while public bus arrival rate peak at approximately 1,700 passengers/hour.
- The evening peak hour starts from 16:00 and afterward, and peaks during 18:00-18:30. The heavy rain affected the departure rate which instantly drop when it started to rain for 30 minutes, but rise to the peak afterward.
- From Figure 39, in the evening, BTS departure rate peaks at approximately 2,850 passengers/hour, while public bus departure rate is approximately 1,300 passengers/hour.
- In the evening, the public bus waiting area on each side of Phahonyothin road is overcrowded with more than 50 people who are waiting for the bus at the same time. Waiting area facilities is poor: no proper shelter and lighting, not enough amount of seating, vandalised bus stop signpost, no updated route number and route maps (see Figure 40).
- Footway and waiting area is encumbered by street vendors, which results in congestion and overcrowding on the footway near the waiting area (see 41).
- Structure of BTS station stairs and escalator are blocked the sight of people at public bus waiting area, resulting in safety issue as people have to stand on the road to see route number of the upcoming buses (see Figure 42).

- Some people avoided those problems by waiting at the end of BTS stairs, resulting in blocking the BTS passengers flow. Buses were forced to stop before the actual bus stop area which affects people who wait at the right place by peak for boarding or miss those buses (see Figure 43).

Figure 38: Overcrowded bus waiting area and poor facilities (Source: Consultant, 2015)

Figure 39: Street vendors encumbered the footways near public bus waiting area and block the pedestrian flows (Source: Consultant, 2015)

Figure 40: Structure of BTS station stairs blocked the sight of people at public bus waiting area (Source: Consultant, 2015)

Figure 41: Buses let people board before the actual bus stop (Source: Consultant, 2015)

Recommendations

- Public bus waiting area should be expanded or moved to more suitable and spacious location in order to accommodate the public bus passengers and pedestrian flow for the access route to waiting area. Since it is expected to have higher Public bus passengers after having NMT interventions and Public bus service improvement, therefore, public bus stop should be able accommodate the flow at more than 1,700 passengers/hour for 2 directions or 60 people per waiting area at the same time.
- Public bus waiting area facilities and surrounded footway access should be redeveloped, blocked street vendors should be relocated in order to increase the capacity of footways and accommodate pedestrian flow adequately.
- Intermodal transfer facilities (ITF) should be installed near waiting area for better pedestrian's accessibility and connectivity in order to promote NMT and public transport.
- Design guidelines for Public bus stop waiting area and ITF are described in Chapter 4.

NMT and Motorised paratransit travel behaviour

This survey uses a traffic count at data Location 4 and 5 for only NMT and paratransit as indicated in Figure 33 to investigate the modal share of egress mode from Fixed-route mass transit to Soi Ari**.** It was conducted on Wednesday 2 September 2015 without rain. The summary of all-day NMT and Paratransit modal share in Soi Ari is presented in Table 8 and Figure 44, while the 15 minute interval chart of NMT and Paratransit transfer count in Soi Ari by each side of the road are illustrated in Figure 45 and Figure 46. The full detail count data are presented in *Annex 3A* Table 3A-2.

Table 8 NMT and Paratransit transfer data at paratransit hub in Soi Ari

Mode	Passenger count	Average per hour	Percentage
Pedestrian	11,919	851	59.2%
Bicycle	57	4	0.3%
Motorcycle Taxi	4,742	339	23.6%
Motorised Three-wheeler	2,721	194	13.5%
Taxi	53	4	0.3%
Songtheaw	636	45	3.2%
Total	**20,128**[4]	**1,438**	**100%**

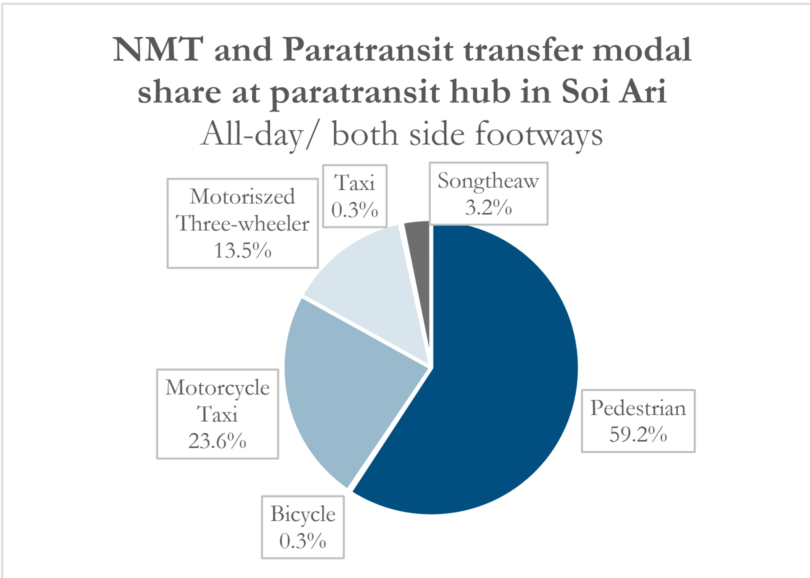


Figure 42: NMT and Paratransit all-day modal share in Soi Ari (Source: Consultant, 2015)

[4] The total passengers count for NMT and paratransit in **Table 3.3-5** at 20,128 passengers is higher than **Table 3.3-3** at 4,123 passengers because Table 3.3-5 accumulate all-day passengers for both in and out direction of Soi Ari.

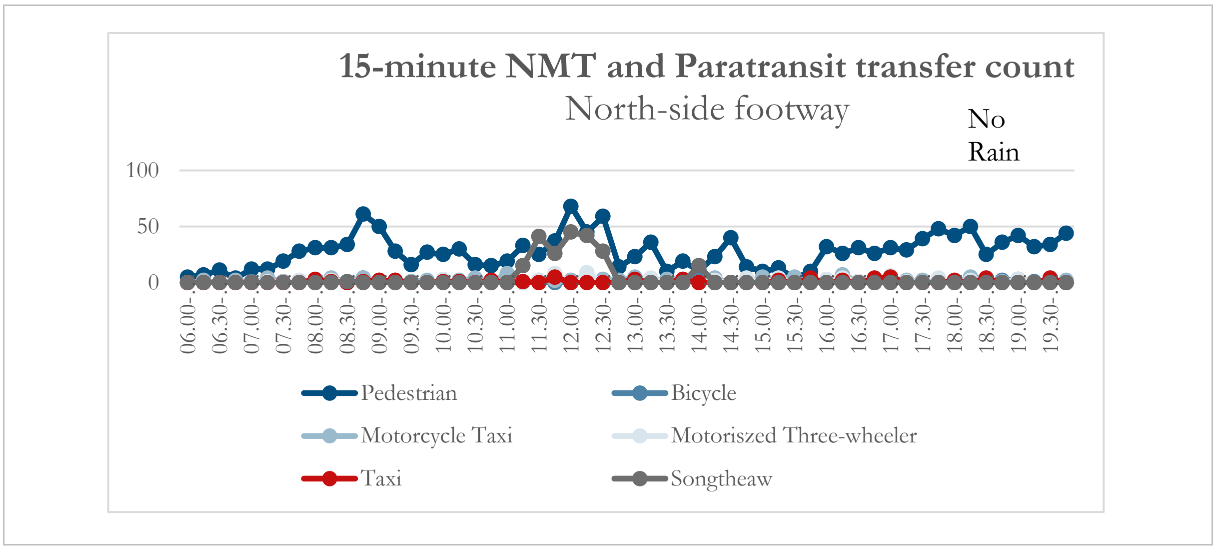


Figure 43: NMT and Paratransit Transfer count on North-side of Soi Ari (Source: Consultant, 2015)

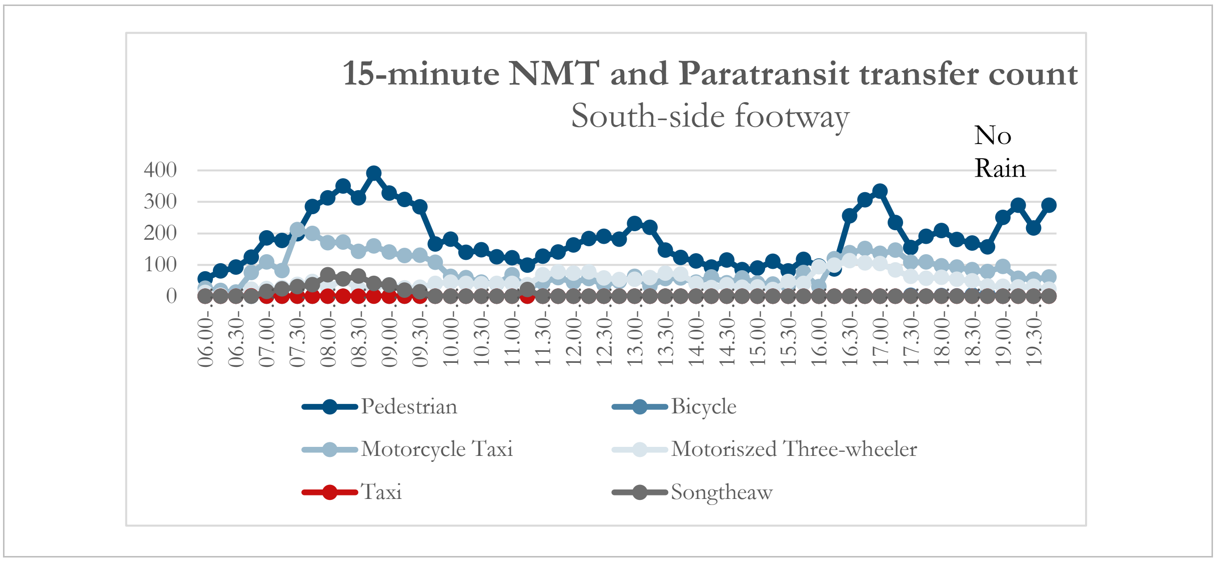


Figure 44: NMT and Paratransit Transfer count on South-side of Soi Ari (Source: Consultant, 2015)

Result summary

- The South-side footway has much more travellers than North-side footway (18,102 and 2,026 people respectively) because it is the main route for people to access to BTS station and bus stops located at the South of Soi Ari. Moreover, there are many restaurants and street vendors along the Southside footways and a market inside Soi Ari 1, which attracts people to walk in South-side footway rather than North-side.
- More than half of the traveller are pedestrians. The pedestrian flow peaks at approximately 1,800 and 1,400 pedestrians per hour in morning and evening peak hour respectively on South-side footway. Mid-day lunch break also has high pedestrian flow at nearly 1,000 pedestrians per hour.
- The second popular mode is motorcycle taxi which shared a quarter of the transport modes. The morning peak rate is 600-800 passengers per hour, while evening peak rate is 400-600 passengers per hour. During morning peak hour, sometimes there is a queue of people who are waiting for motorcycle taxi up to 30 people, which completely blocks the footway flow.

- Motorised-three wheeler passenger rate is approximately 200-300 passengers per hour during morning and mid-day, and peaks in the evening at 400 passengers per hour.
- Songthaew is operating only in the morning and lunch time break with approximately 100 passengers per hour.
- Initial observations from traffic counts show very small modal share of cycling in the Ari area. Most of bicycle users are residents, maids and market vendors.
- No pedestrian crossing along Soi Ari exists at present.

Recommendations

- South-side footway width should be extended to accommodate high pedestrian flow. Since it is expected to have higher Public bus passengers after having NMT interventions and Public bus service improvement, therefore, South-side footway should accommodate at least 1,600 pedestrians per hour, including space for street vendors and buyers queueing area in front of the stalls (see Figure 47).
- Proper location for paratransit transfer (both passengers queue on footways and street, and paratransit bay) should be allocated in order to reduce conflict activities on footways (queueing, walking, shopping) and conflict on the street (cycling, on-street parking, pedestrian crossing). The transfer area should be able to accommodate current queueing demand at 30 people (see Figure 48).
- Level-pedestrian crossing should be installed at high demand of crossing location (see Figure 49). The suggested location is explained in design guidelines for footway, paratransit transfer area and pedestrian crossing in Chapter 3.
- There is an opportunity to increase frequency and operating time of Songtheaw which has the lowest average GHG emission per passengers among all paratransit in Soi Ari. See occupancy rates below in Table 10.

Figure 45: Street vendors and buyers blocked the pedestrian flow (Source: Consultant, 2016)

Figure 46: Paratransit passenger queues blocked the pedestrian flow (Source: Consultant, 2015)

Figure 47: Lack of pedestrian crossing in Soi Ari (Source: Consultant, 2015)

Travel behaviour in closed study area

This survey is analysed from the traffic count survey data Location A, B, C and D as indicated in Figure 33**.** It was conducted on Tuesday 1 September 2015 with a heavy rain in the evening during 17:15-19:00. The closed study area modal share summary is presented in Table 10 and Figure 50. The total 15 minute interval chart of number of people that enter-exit at each gates Governmental offices district is illustrated in Figure 51. The full detail count data are presented in *Annex 3A Table A3*.

Note: This analysis is including through traffic that use the road inside Governmental Offices district as a shortcut.

Table 9 Closed study area All-day modal share passenger count

Mode	Passenger count	Average per hour	Percentage
Pedestrian	7,734	552	17.9%
Bicycle	444	32	1.0%
Motorcycle Taxi	5,362	383	12.4%
Motorised Three-wheeler	3,914	280	9.0%
Songtheaw	834	60	1.9%
Private Motorcycle	8,240	589	18.9%
Private car	14,942	1,067	34.5%
Taxi	1,876	134	4.3%
Total	**43,310**	**3,094**	**100%**

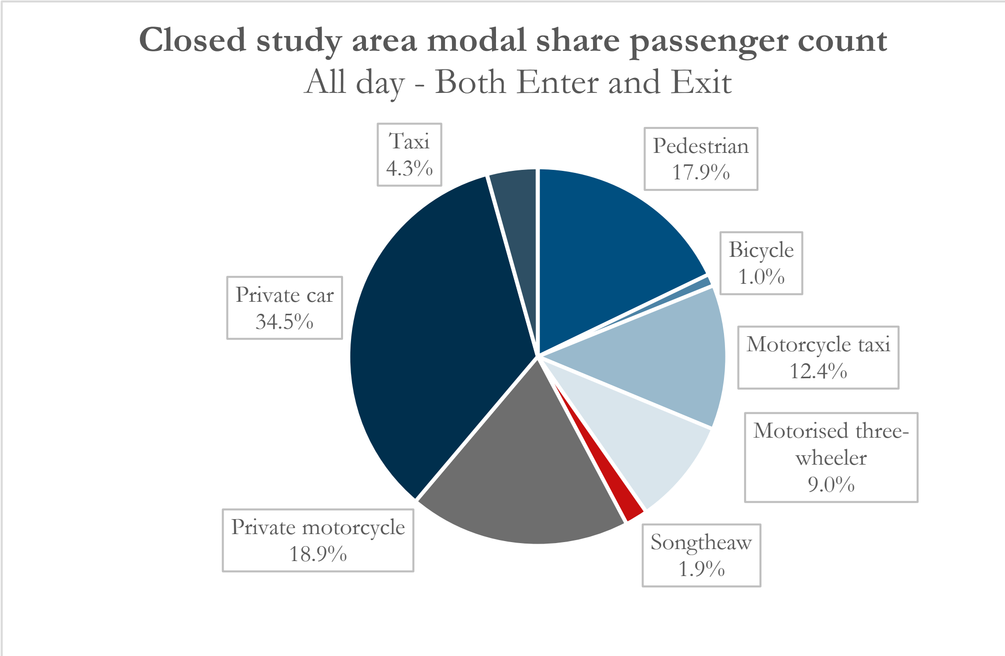


Figure 48: Closed study area modal share (Source: Consultant, 2015)

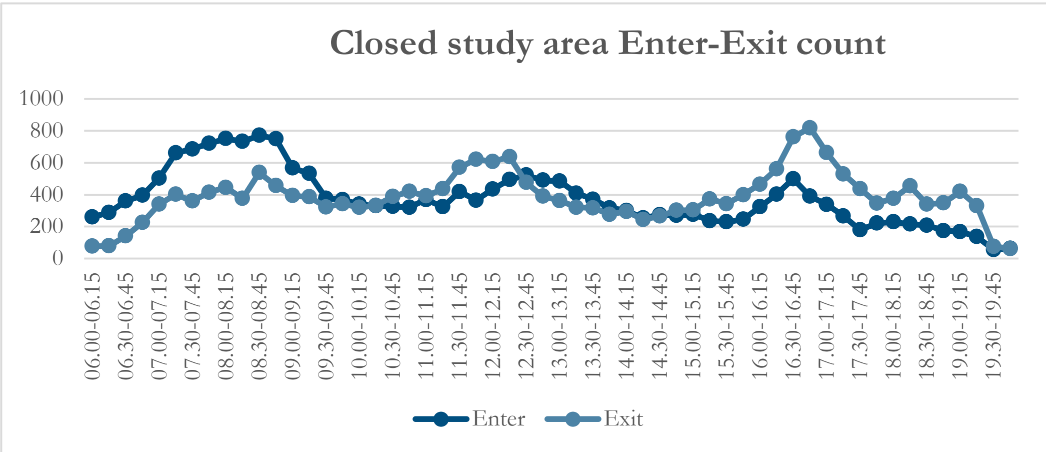


Figure 49: Closed study area Enter-Exit count (Source: Consultant, 2015)

Result summary

- The largest modal share for travel to/from Governmental offices district is private car with about one-third of all traffic count (compared to 50.7% for only the morning peak hour, see section 3.3.1 **Table 3.3-4**). Private motorcycle and walking are the second largest at around one-fifth.
- In the morning peak hour, the 15-min peak entry rate is higher than exit rate (approximately 3,100 and 2,100 people per hour respectively), which indicates that people come to governmental offices district and stay for working at the rate 1,000 people per hour approximately.
- During mid-day period, the result shows that people leave the governmental offices district for lunch break at round 12:00 and come back at 13:00-14:00.

- In the evening peak hour, the exit rate is higher than entry rate (approximately peak at 3,200 and 2,000 people per hour respectively), which indicates that people leave the governmental offices district after working hour at between 1,200 people per hour approximately.

3.3.1 Occupancy rate

This survey is conducted at Location A, B, C and D (closed study area) from traffic count survey as indicate in **Figure 3.2-1** on Tuesday 1 September 2015 which had a heavy rain in the evening during 17:15-19:00. The Occupancy rate of each transport mode of closed study area, Percentage of paratransit trip with passengers and maximum passenger per trip is presented in Table 11.

Table 10 Occupancy rate, Percentage of paratransit trip with passengers and Maximum passenger per trip

Type	Mode	Traffic count	Passenger count	Average occupancy rate	Percentage of trip with passengers	Percentage of trip without passengers	Total	Maximum passenger per trip
Paratransit (exclude driver)	Motorcycle Taxi	8,558	5,362	0.63	63%	37%	100%	1
	Motorised Three-wheeler	4,922	3,914	0.79	52%	48%	100%	5
	Songtheaw	93	834	8.97	82%	18%	100%	22
NMT	Bicycle	442	444	1.00				
Door-to-Door	Private Motorcycle	5,657	8,204	1.45				
	Private car	10,701	14,942	1.40				
	Taxi (exclude driver)	1,885	1,876	0.99				

Result summary

- Motorcycle taxi and Motorised Three-wheeler is having quite high Percentage of trip without passengers at 37% and 48% respectively, which means that those trip has GHG emission without any trip benefit of transporting passengers.
- Motorised Three-wheeler and Taxi have quite low average passengers per trip comparing to capacity of the vehicle.

Recommendations

- All Motorcycle taxi and Motorised Three-wheeler should be managed by a single system in order to reduce trips without passengers, especially in the morning peak hour that has high volume of Eastbound service for people to travel from the beginning of Soi Ari into Governmental Offices district.
- Transfer location of Motorcycle taxi and Motorised Three-wheeler bay should be located at more appropriate location in order to reduce the obstruction on the street.
- Songthaew services should be promoted for higher priority that motorcycle taxi and Motorised Three-wheeler as Songtheaws have the highest occupancy rate and have lower GHG emission per passenger.

3.3. Origin-Destination survey result and analysis

The Origin-Destination (O-D) survey result is based on questionnaire interview survey in *Annex 3C*. This aspect aims to investigate the travel behaviour of weekday trips by people who come to work in Governmental offices district. The respondents were asked for the origin of their home-based trip which varies across Bangkok metropolitan area. The trip destination is their workplace, which is fixed at closed study area.

For this O-D survey, Bangkok Metropolitan region is divided into the following 15 zones (as illustrated in Figure 52):

1. Bangkok province - Old centre
2. Bangkok province - New Centre West
3. Bangkok province - New Centre East
4. Bangkok province - Inner Suburban East
5. Bangkok province - Outer Suburban East
6. Bangkok province - Outer Suburban West
7. Samut Prakan Province - East
8. Samut Prakan Province - West
9. Nonthaburi Province - East
10. Nonthaburi Province - West
11. Pathumthani Province - East
12. Pathumthani Province - West
13. Nakon Pathom Province
14. Samut Sakon Province
15. Bangkok province - Phayathai district (Ari area and surrounding within 2km)

The number of trips originating from each zone is estimated by using following assumptions:

- The percentage of trip originate from each zone is based on the survey result.
- According to Chapter 3.3 long distance modal share estimation, the total trips of people who generally come to work every weekday morning in Soi Ari and closed study area per day is 4,122 trips. This number is used to estimate the trips originate from each zone.

The percentage of trip originating from each zone and estimated trips amount are presented in Table 11 and are summarised in Figure 53. There, the thickness of O-D lines represents the amount of trips from each zone. The blue and orange line represent the proportion of Case 1: Door-to-Door Motorised vehicle and Case 2: Fixed-route mass transit from each zone respectively.

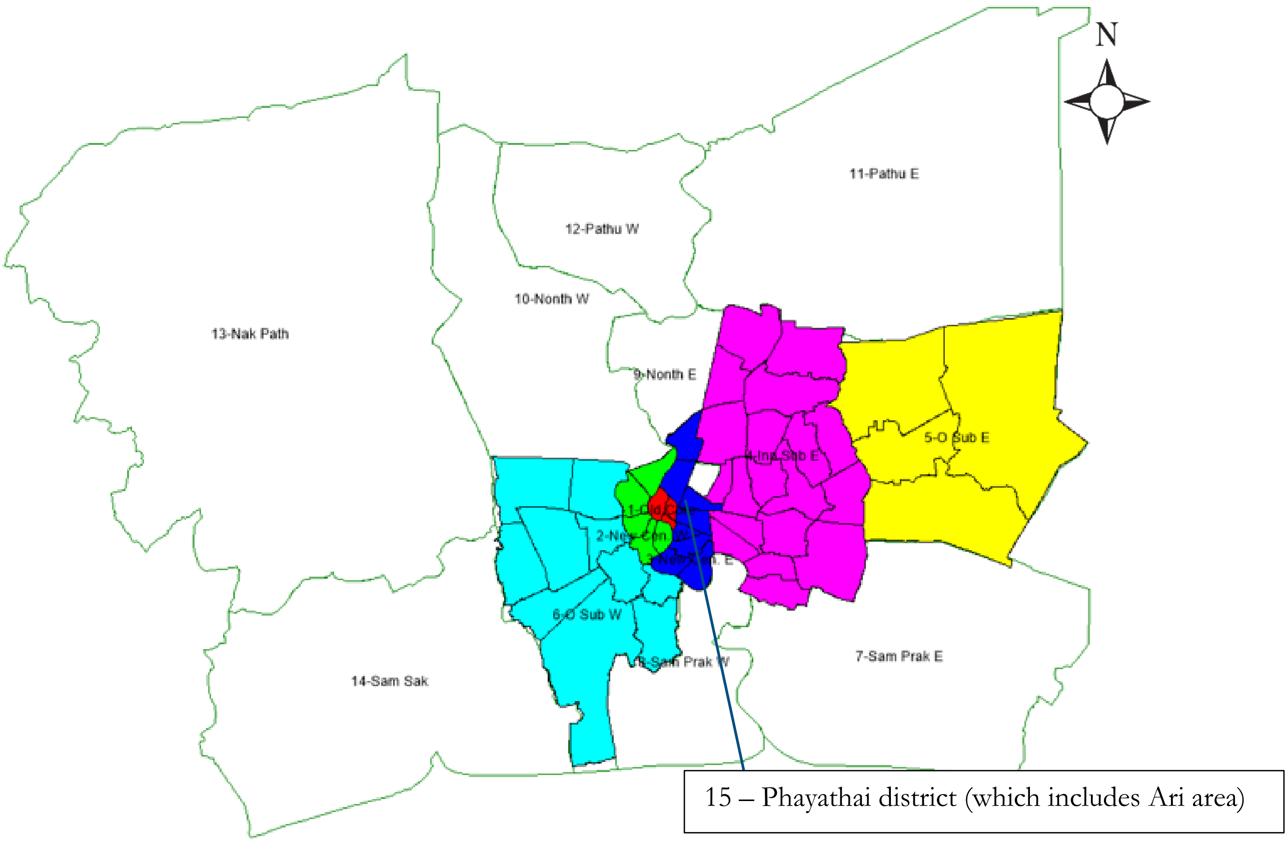


Figure 50: Zones for Origin-Destination survey (Source: Consultant, 2015)

Table 11 Trip percentage and estimated trip amount from each zone

Origin zone	Average distance to destination (Zone 15)	Case 1: Door-to-Door motorised vehicle		Case 2: Fixed-route Mass transit		Overall	
		Percent	Trip estimation	Percent	Trip estimation	Percent	Trip estimation
1: Old centre	5 km	0.0%	0	0.2%	3	0.2%	8
2: New Centre West	10 km	1.2%	29	2.1%	35	3.3%	136
3: New Centre East	6 km	4.4%	108	3.7%	62	8.1%	334
4: Inner Suburban East	14 km	19.0%	465	21.0%	352	40.0%	1649
5: Outer Suburban East	30 km	1.8%	44	1.1%	18	2.8%	115
6: Outer Suburban West	20 km	2.9%	71	1.5%	25	4.4%	181
7: Samut Prakan East	33 km	0.8%	20	1.0%	17	1.7%	70
8: Samut Prakan West	21 km	0.0%	0	0.0%	0	0.0%	0
9: Nonthaburi East	12 km	7.2%	176	3.0%	50	10.3%	425
10: Nonthaburi West	23 km	3.5%	86	0.8%	13	4.4%	181
11: Pathumthani East	42 km	2.6%	64	1.1%	18	3.7%	153
12: Pathumthani West	30 km	0.4%	10	1.1%	18	1.5%	62
13: Nakon Pathom	50 km	0.0%	0	0.4%	7	0.4%	16
14: Samut Sakon	42 km	0.0%	0	0.0%	0	0.0%	0
15: Phayathai district	0 km	10.7%	262	8.5%	142	19.2%	791
Total		**59.3%**	**2,446**	**40.7%**	**1,676**	**100.0%**	**4,122**

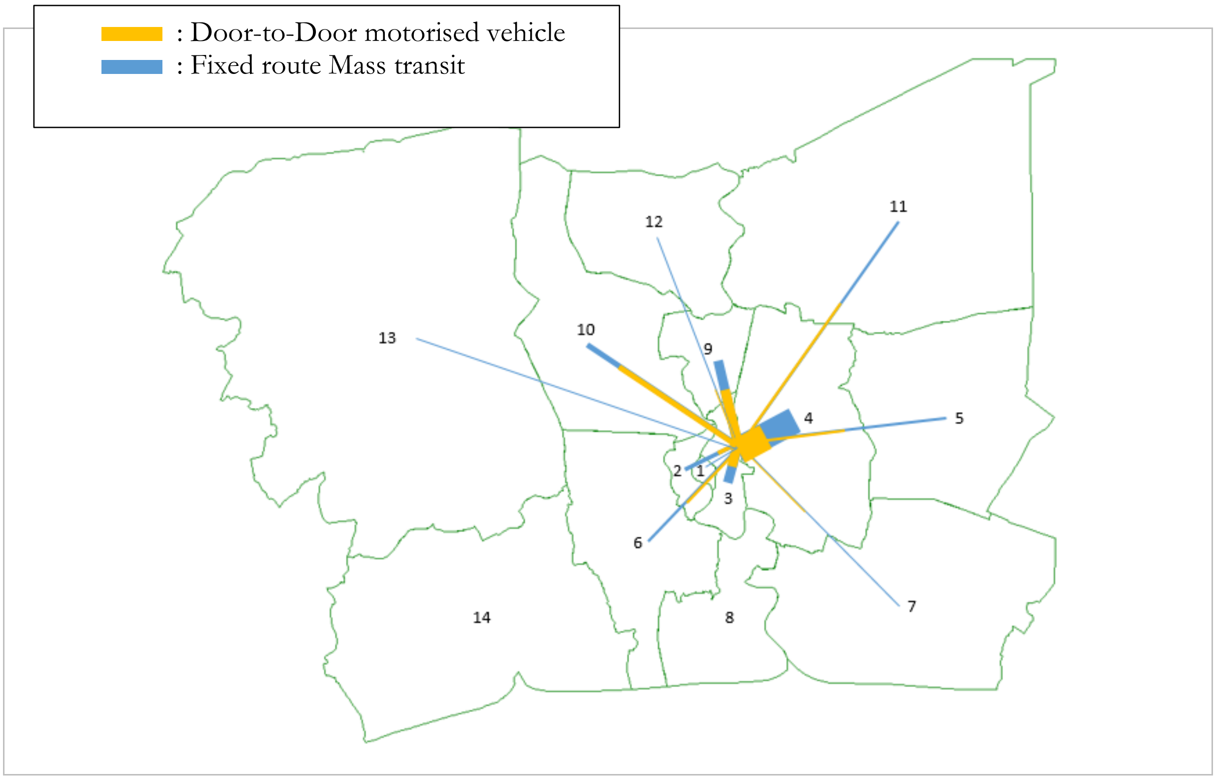


Figure 51: Origin-Destination survey result (Source: Consultant, 2015)

Result summary

- The highest trip generation zone is zone 4: Inner Suburban East at 40% of all trips. The second and third highest are zone 15: Phayathai district (study area) and zone 9: Nonthaburi East respectively.
- There is no significant difference between Case 1 and Case 2 in each zone; except zone 9: Nonthaburi East and zone 10: Nonthaburi West which private motorised vehicle and Taxi is significantly more popular.
- Though there are no respondents that come from zone 8 and 14, we cannot conclude that there is virtually zero trips generate from those area to Ari area.
- New development of Urban rail network may make changes of travel behaviour in the future and the Origin-Destination result also may differ from Figure 53.

3.4. General characteristics of target user

The general detail result of 458 respondents who is working in Governmental park their vehicle at offices in closed study area, which was collected from questionnaire interview survey, is presented in *Annex 3C.* Some selected aspects that impact to travel behaviour and current environment in Ari area is shown as follows.

3.4.1. Household vehicle ownership

Vehicle ownership amount

The household vehicle ownership of respondents in closed study area based on Case 1 and Case 2 is presented in **Figure 3.5-1.**

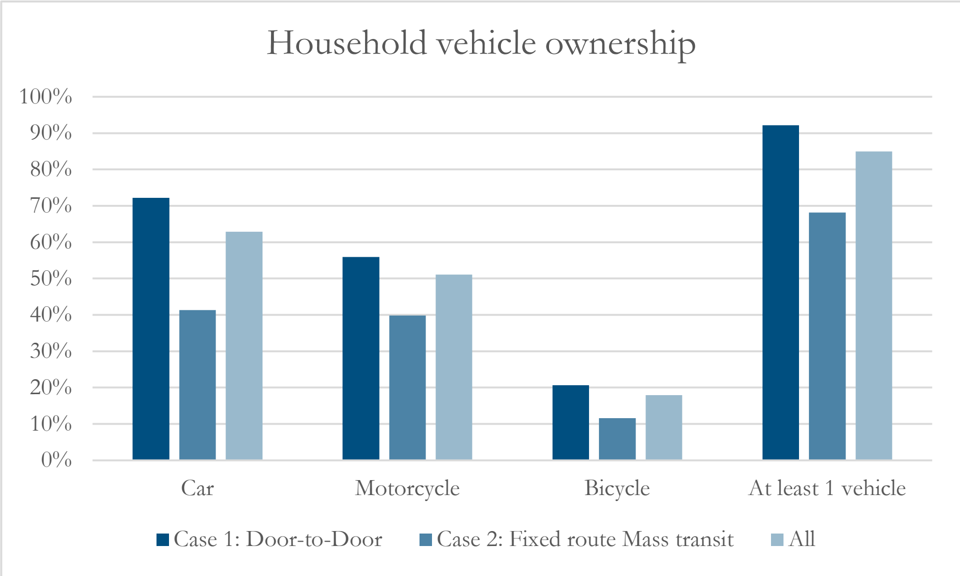


Figure 52: Household vehicle ownership of respondents in closed study area (Source: Consultant, 2015)

3.4.2. Parking location in Ari area

Where do you park your private vehicles?

The private vehicle parking location for people who is working in closed study area is presented in Figure 55.

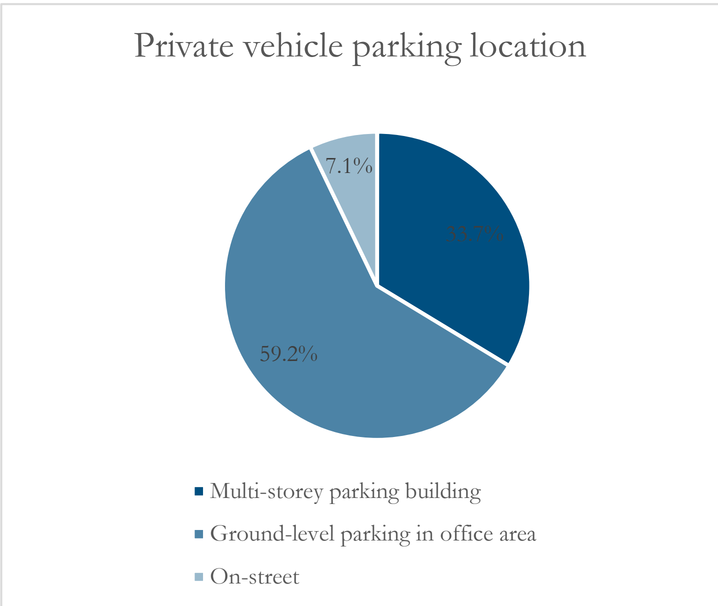


Figure 53: Location where respondents in closed study area parked their private vehicle (Source: Consultant, 2015)

Result summary

- In general, Case 1: Door-to-Door (private motorised vehicles or taxi passenger) has more percentage of household vehicle ownership than Case:2 Fixed-route mass transit
- More than 90% of Case 1 has at least a vehicle in their household
- Very low bicycle ownership at 10-20% in both cases
- Only 7.1% of people who drive to their office in closed study area that park the car on street

3.5. Current perception of Fixed-route mass transit and NMT

This aspect is analysed based on questionnaire interview survey results in *Annex 3C*. This analysis aims to investigate willingness to shift transport mode to Mass transit and its barriers, future modal share, current perception of people about walking and cycling as public transport access mode, and current perception of people about public bus facilities an service.

3.5.1. Willingness to shift transport mode

Future long distance modal share can be estimated by using the result of Willingness to shift from Case 1: Door-to-Door motorised vehicle to Case 2: Fixed-route mass transit for people in Soi Ari and closed study area who currently travel by Door-to-Door motorised vehicle.

The question asked in questionnaire is:

Are you willing to change your main travel mode to metro system/ public bus? (Currently, you do not change due to barriers)

☐ *Yes* ☐ *No*

The result is shown in Figure 56.

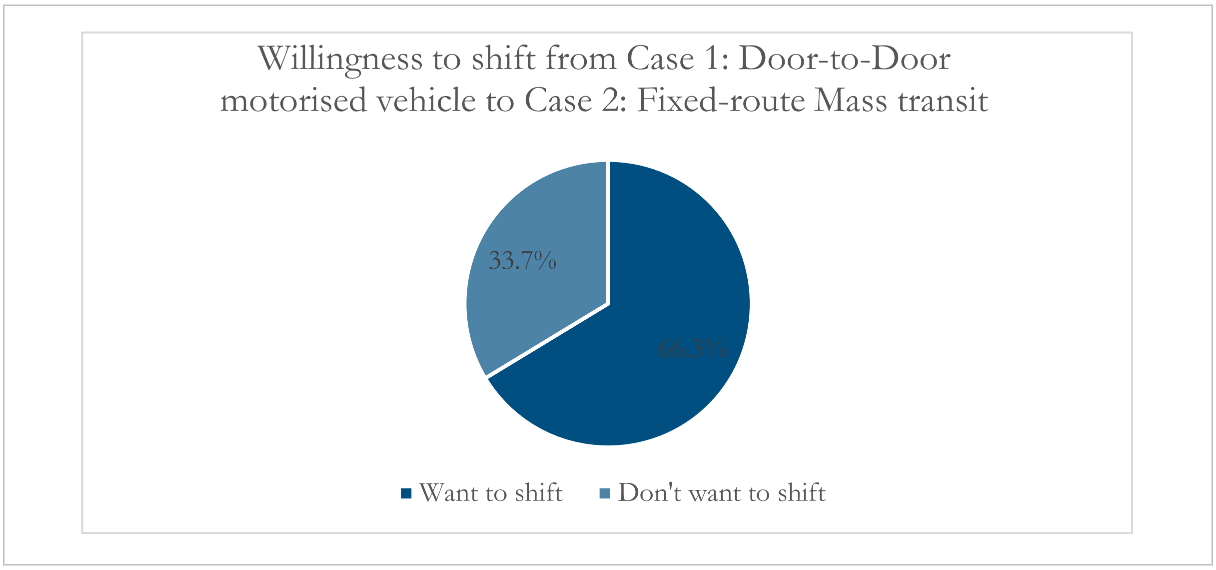


Figure 54: Willingness to shift from Private motorised vehicle to Fixed-route Mass transit (Source: Consultant, 2015)

Figure 56 indicates that if there are no barriers in Fixed-route mass transit, 66.3% of people who currently use Door-to-Door motorised vehicle to Ari area will potentially shift to Fixed-route Mass transit.

Note: This result may have optimistic uncertainty due to some respondents which are civil servants in Pollution Control Department and Department of Environmental Quality Promotion. These civil servants may reply optimistic answer due to their department vision to reduce pollution. So 66.3% is considered maximum possible percentage for this aspect.

From chapter 3.3 long distance modal share estimation, percentage of Case 1: Door-to-Door motorised vehicle and Case 2: Fixed-route mass transit will be used for estimate current and future modal share according to future maximum potential modal shift after having improvement to reduce barriers as in Figure 56 above.

Assuming that total number of people who travel into closed study area in morning peak hour is stable in the future, the estimation of maximum shift and future modal share is presented in Table 12.

Table 12 Estimated maximum shift and future modal share in Soi Ari for morning peak arrival

Case	**Scenario 1:** No improvement of Fixed-route mass transit barriers	**Modal shift**		**Scenario 2:** Fully improvement of Fixed-route mass transit barriers		
	Percent			**Percent**		**Passenger**
Total morning peak hour arrival	**100%**			**100%**		**4,122**
Case 1: Door-to-Door motorised vehicle	59.3%	**Not shift**	33.7% of **Case 1**	20.0%	**Case 1 reduce to 20.0%**	**824**
		Shift to Case 2	66.3% of **Case 1**	39.3%	**Case 2 increase to 80.0%**	**3,298**
Case 2: Fixed-route mass transit	40.7%			40.7%		

Result summary

- The highest possible modal share of Fixed-route mass transit is 80.0% or 3,298 people who come to work in closed study area in the future.
- This result can be used for preparing future transport facilities according to potential shift. However, the total passenger of whole Ari area is higher than 4,122 people and need more study for better forecast and facilities preparation.

3.6. Barriers for shifting transport mode

As mentioned in chapter 3.6.1 that there are Barriers for shifting main travel mode from Case 1: Door-to-Door motorised vehicle to Case 2: Fixed-route mass transit. These barriers are ranked from highest to lowest impact in people's perception from questionnaire results:

- Rank 1 - Metro system: not covered/ not attractive
- Rank 2 - Public bus system: not covered/ not attractive
- Rank 3 - Risk of accident/ risk of crime/ safety issue
- Rank 4 - Travel time use/ uncertainty of travel time

- Rank 5 - Footways and crossing not convenient/ not attractive
- Rank 6 - Total travel cost
- Rank 7 - Inconvenient/ weather issue

Result summary

- Apart from expanding and improving service of Metro and public bus system, safety and travel time are the key factors why people choose to travel by Private motorised vehicle and Taxi instead of Fixed-route Mass transit. If these major issues are improved, it is possible for more people to shift to Fixed-route Mass transit.

3.6.1. Current perception of Public bus

This survey aims to in investigate current perception in each component of NMT environment in Soi Ari and overall Public bus facilities and service, including;

- Public bus
    - Current condition of Public bus waiting area
    - Current condition of Public bus service
- Walking
    - Current condition of Footpath in Soi Ari and surrounding
    - Current condition of Pedestrian crossing in Soi Ari and surrounding
- Cycling
    - Current condition of cycling environment in Bangkok
    - Current condition of bike racks/ bike parking facilities
    - Current condition situation of bike sharing system (Pun Pun)

The question asked in questionnaire is:

Please rate current condition of … in your opinion (1 - poor/ large barrier, 5 – excellent/ not a barrier)

The result detail is presented in *Annex 3C* and the lowest scores condition of each component are highlighted in red. The average score of each component is summarised in Table 13 as follows:

Table 13 Average score of current perception in NMT environment

Condition	Case 1: Door-to-Door motorised vehicle	Case 2: Fixed-route mass transit	Average
Public bus waiting area	1.92	2.16	1.99
Public bus service	1.96	2.15	2.02
Footpath in Soi Ari and surrounding	1.82	1.93	1.85
Pedestrian crossing in Soi Ari and surrounding	1.86	1.95	1.88
Cycling environment in Bangkok	1.87	1.55	1.79
Bike racks/ bike parking facilities	1.81	1.62	1.76
Bike sharing system (Pun Pun)	1.92	1.81	1.89

Result summary

- The overall score of every component is less than 2.5 out of 5, which means that all components has low satisfaction and discourage people from using NMT and Public bus.

3.7. Current NMT characteristics and Future passenger estimation

This aspect is analysed based on questionnaire interview survey results in *Annex 3C*.

3.7.1. Walking characteristics

This aspect aims to investigate the main purpose of walking and the longest distance people are willing to walk for travel. The results of the summary are illustrated in Figure 57 - 59 and Table 14.

Note: The questionnaire has set an assumption that 1 minute walk equals to 80 metre; however, the current condition of footways seems to bring the average speed to be lower than the assumption.

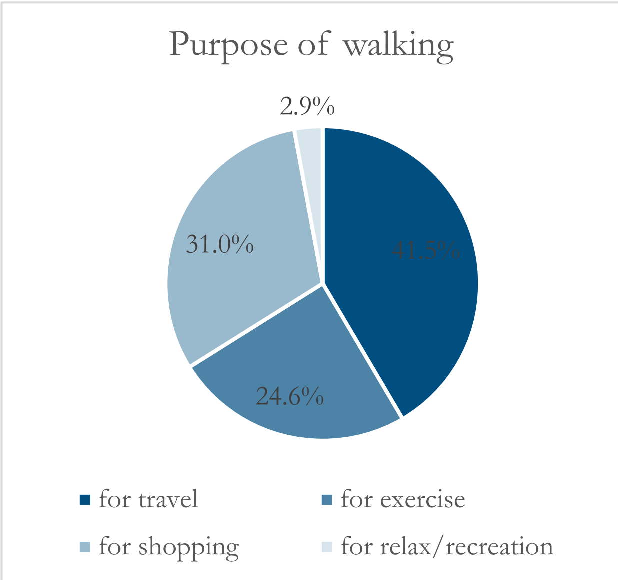


Figure 55: Main purpose of walkingMain purpose of walking (Source: Consultant, 2015Consultant, 2015)

How far will you willing to "walk for travel" to places (You will not walk longer than this)

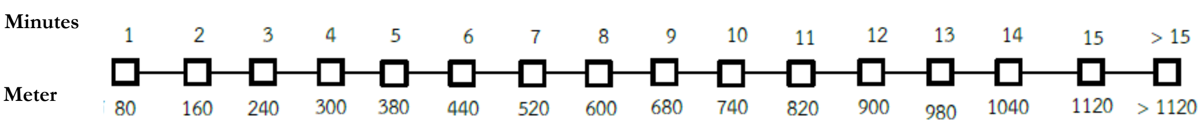


Table 14 Average of the longest distance that people are willing to "walk for travel"

Case	Average duration
Case 1: Door-to-Door motorised vehicle	8.93 minute
Case 2: Fixed-route Mass transit	9.90 minute
Overall	9.22 minute

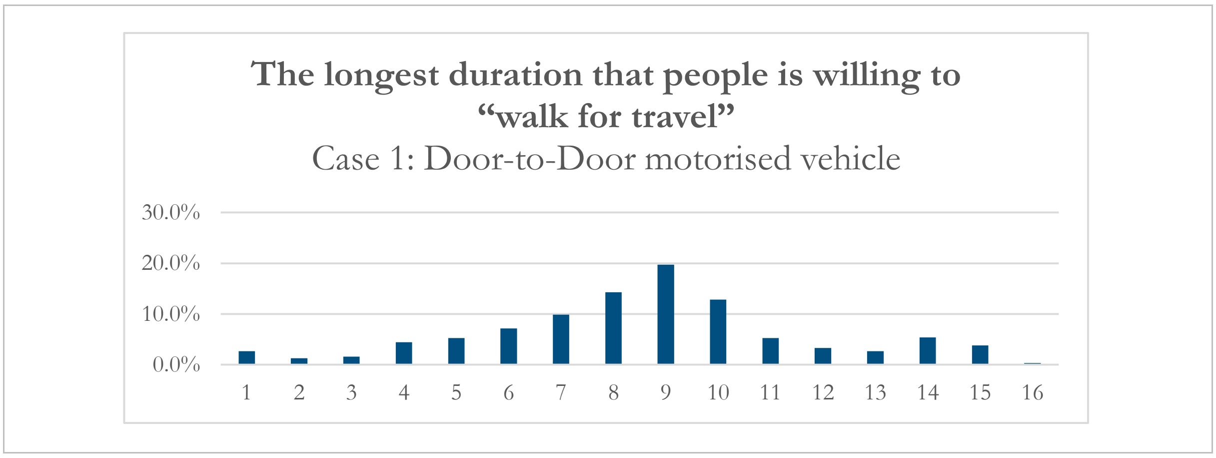


Figure 56: Willingness to "walk for travel" for Case 1Willingness to "walk for travel" for Case 1 (Source: Consultant, 2015Consultant, 2015)

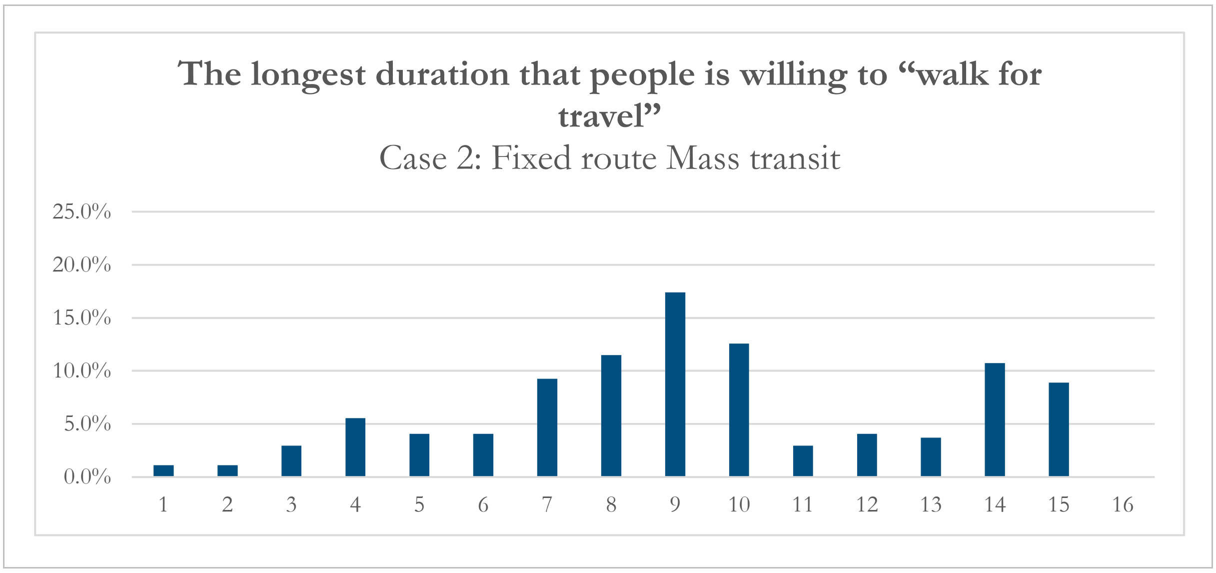


Figure 57: Willingness to "walk for travel" for Case 2 (Source: Consultant, 2015)

Result summary

- More than 70% of people usually walk for transport which are travel and buying things from convenient store or market nearby. The rest is walk for health and relaxation purpose.
- Overall, more than half of respondents accept walking for travel 9 minutes or more, which means that it is possible for them to walk along Soi Ari from BTS Ari station to the Location A of closed study area (approximately 700 metre or 9-minute walk).
- Average Private motorised vehicle and Taxi passenger (Case1) willingness to walk to 1 minute shorter than other transport mode passenger (Case 2).

3.7.2. Cycling characteristics and future user estimation

This aspect aims to investigate the ability of cycling, main purpose, frequency and the longest duration bicycle users are willing to go cycling for travel. The questions asked and the results are illustrated in Figure 60 - 64.

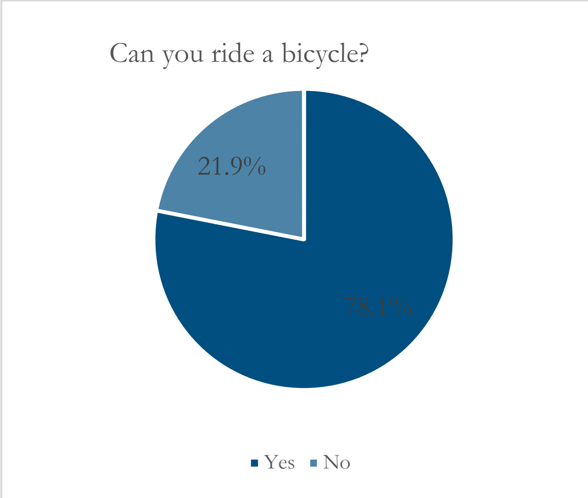


Figure 58: People who know how to ride a bicycle (Source: Consultant, 2015)

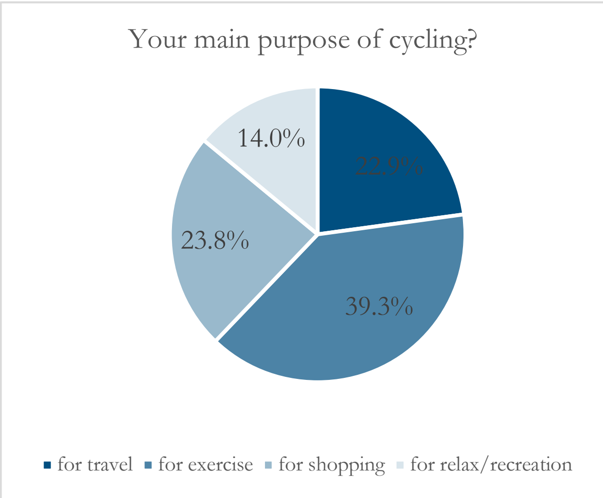


Figure 59: Main purpose of cycling (Source: Consultant, 2015)

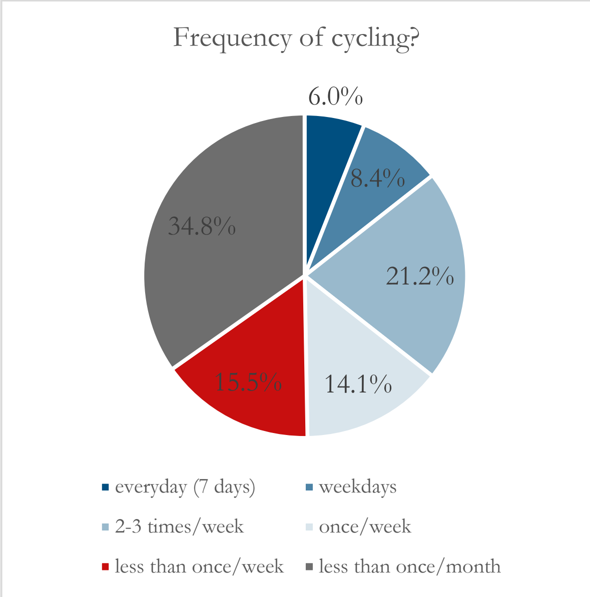


Figure 60: Frequency of cycling (Source: Consultant, 2015)

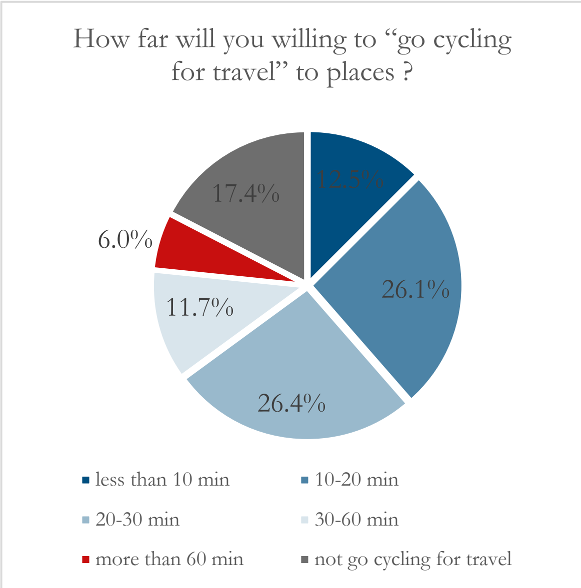


Figure 61: Longest duration of cycling for travel (Source: Consultant, 2015)

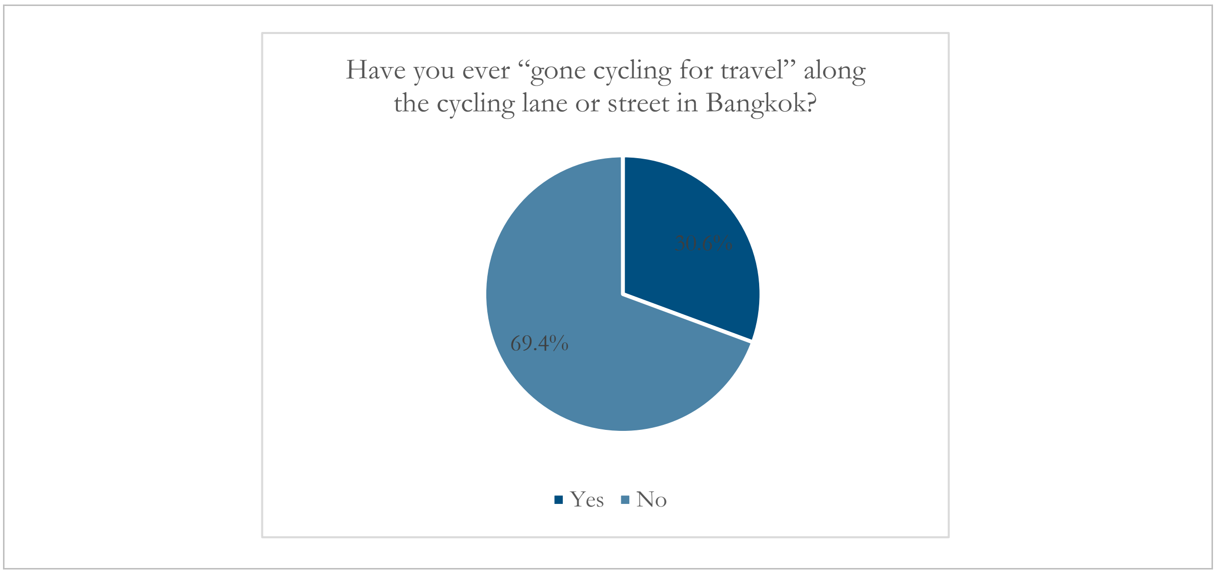


Figure 62: Bicycle user that has experience in cycling for travel in Bangkok (Source: Consultant, 2015)

Note: These results are based on the assumption that if the barrier of cycling in Ari area is reduced to meet the bicycle user’s expectation.

From the cycling characteristics results and the modal shift result in **Figure 3.6.1**, the potential bicycle user based on Morning peak hour arrival traveller in closed study area (which is equal to 4,122 people) can be estimated as shown in Table 15 and 16.

Table 15 Estimated maximum potential bicycle user for morning peak hour arrival in Soi Ari

Cycling ability	Percent	Estimated Passenger	Scenario	Percent	Maximum bicycle users
Total morning peak hour arrival	**100%**	**4,122**			
Don’t have ability to go cycling	21.9%	903			
Have ability to go cycling	78.1%	3,219	**Scenario 1:** No improvement of Fixed-route mass transit barriers	45.5% of have ability	1,465
			Scenario 2: Fully improvement of Fixed-route mass transit barriers	81.6% of have ability	2,553

Table 16 Estimated maximum potential bicycle user for morning peak hour arrival in Soi Ari

Scenario	**Estimated bicycle user**			
	Total	Have experience in "cycling for travel" in Bangkok **(Figure 3.7.6)**	Cycling more than 2 times a week **(Figure 3.7.4)**	Willing to "cycling for travel" more than 10 minutes **(Figure 3.7.5)**
Percentage	**100%**	**30.6%**	**35.6%**	**70.2%**
Scenario 1: No improvement of Fixed-route mass transit barriers	1,465	448	522	1,028
Scenario 2: Fully improvement of Fixed-route mass transit barriers	2,553	781	909	1,792

Result summary

- There are approximately 78% of respondents in the closed study area that have the ability to go cycling, or means that there are 356 bicycle user from total 458 respondents.
- Nearly half of respondents who have ability to cycling usually go cycling for travel and shopping purpose. Another half is for recreation and exercise purpose.
- From Table 16 scenario 1: No improvement of Fixed-route mass transit barriers, the estimated *maximum* number of people in Soi Ari and closed study area that currently able to go cycle from BTS Ari to Governmental offices districts in the morning peak hour at least 2 times a week is approximately 522 bicycle users. This number will be used as a reference for future potential NMT demand in Soi Ari and closed study area in pilot project in Chapter 3.9
- If the Mass transit system is fully extended and improved to meet traveller acceptable level as in scenario 2, the estimated *maximum* number of people who ready to use bicycle in Soi Ari could potentially increase to approximately 909 bicycle users in morning peak hours.
- It can be increased in the future up to the maximum at approximately 1,792 bicycle users due to the total number of people who able to go cycling for travel more than 10 minutes from BTS Ari station which covers all Governmental offices district in Soi Ari.
- Theoretically, the egress mode of cycling from BTS Ari station to closed study area is expected to be lower that mention in points above due to various travel mode choice; however, there may also have access trip from residents in Ari to BTS Ari station and intra trip in the area.

3.8. Level of intervention and potential of future modal shift

This aspect is analysed based on questionnaire interview survey results in *Annex 3C*. The survey aims to confirm whether NMT intervention can persuade people to shift transport mode to lower GHG emission mode or not. Also, it aims to investigate the most suitable level of NMT improvement intervention. Respondents are asked to select transport they are willing to use most at different levels of improvement intervention. The results are divided into Case 1: Door-to-Door motorised vehicle and Case 2: Fixed-route mass transit since the passengers of 2 cases have different mode choices preferences.

3.8.1. Modal share of access modes to Fixed-route Mass transit

This section aims to analyse transport mode choice before and after interventions and potential of modal shift from motorised paratransit to NMT as access modes to major public transit system in Ari area. The scenario used for this analysis is:

Question: If you have to travel from BTS Ari station to Governmental office district in Soi Ari with 700-1,000 metre distance every working day, which transport mode will you tend to use most?

The description and graphics for each level of intervention is shown in Questionnaire form in *Annex 3B*, including;

No intervention in any infrastructure

Option 1: Footways and Street

Reduce on-street parking to expand footways width/ Organise street vendors and para-transit area /Speed limit at 30kph/ road marking and signage of shared road with bicycle

Option 2: Footways, Pedestrian crossing and Bike lane

Reduce on-street parking for expand footways width /Organise street vendors and para-transit area /Level-pedestrian crossing and walking street/ Segregated bike lane with rubber bollards /Install bike rack and bike rental facilities around BTS Ari and in Soi Ari

Option 3 Footways, Pedestrian crossing, Bike lane and Shading cover

Reduce on-street parking for expand footways width /Organise street vendors and para-transit area /Level-pedestrian crossing and walking street/ Segregated bike lane with concreate kerb /Install bike rack and bike rental facilities around BTS Ari and in Soi Ari/ Install shading cover along footways and bike lane

Option 4 Footways, Pedestrian crossing, 2-side Bike lanes and Shading cover and one-way traffic

Reduce on-street parking for expand footways width /Organise street vendors and para-transit area /Level-pedestrian crossing and walking street/ Segregated bike lane with concreate kerb /Install bike rack and bike rental facilities around BTS Ari and in Soi Ari/ Install shading cover along footways and bike lane/ One-way traffic for motorised vehicle

The modal share results of each option for Case 1: Door-to-Door motorised vehicle and Case 2: Fixed-route mass transit are shown in Figure 65 and 66 respectively.

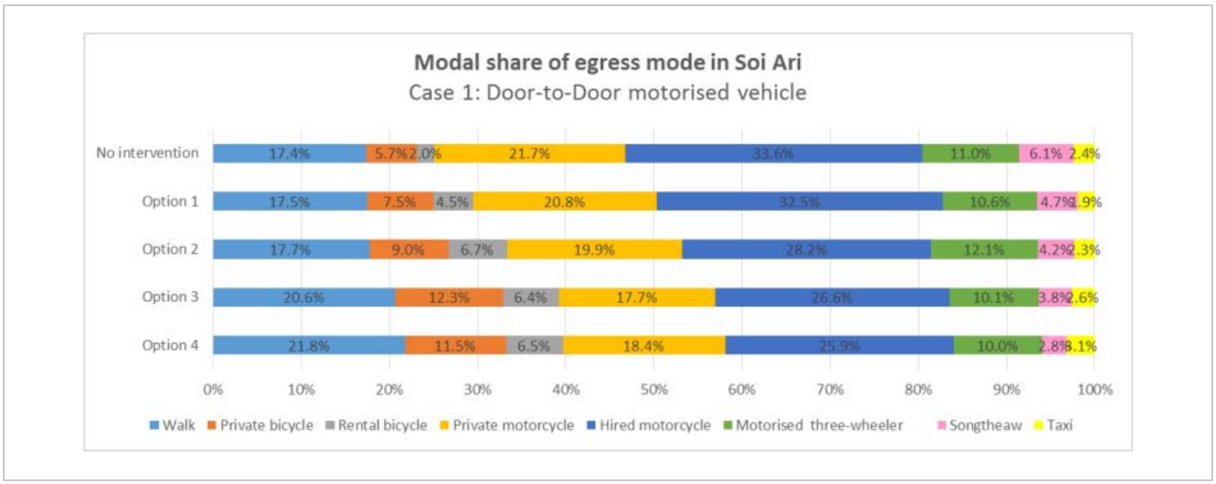


Figure 63: Modal share of egress modes in Soi Ari - Case 1: Door-to-Door motorised vehicle passenger (Source: Consultant, 2015)

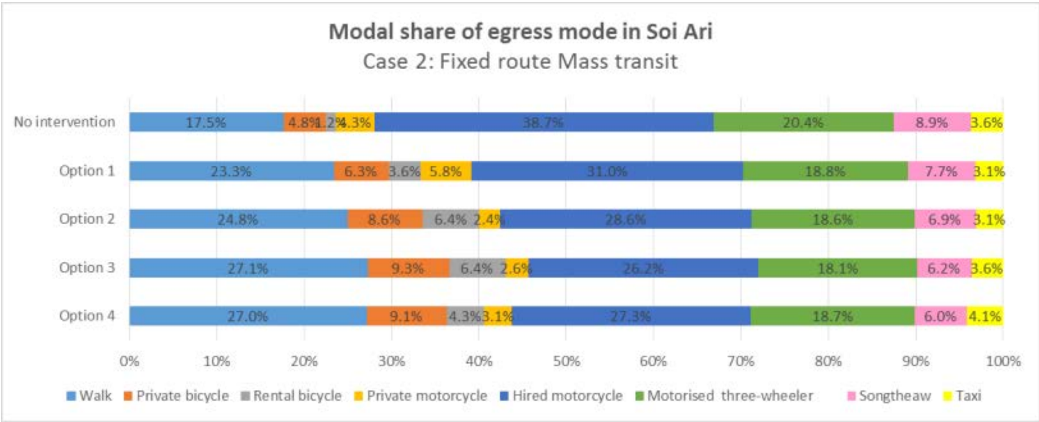


Figure 64: Modal share of egress modes in Soi Ari - Case 2: Fixed-route mass transit passenger (Source: Consultant, 2015)

The weighted average of Case 1 and Case is based on the percentage from Chapter 3.3 Long distance Modal share estimation, the total trips of people who generally come to work every weekday morning peak hour in Soi Ari and closed study area per day in Case 1 and Case 2 are 59.3% and 40.7% respectively.

The estimated NMT traveller and modal shift of each case and weighted average are presented in Table 17 and 18.

Table 17 Estimated NMT passenger modal shift for morning peak hour arrival

Level of intervention	Case 1: Door-to-Door motorised vehicle		Case 2: Fixed-route mass transit		Weighted average shift (Case1=59.3%; Case2=40.7%)
	Percent	Shift	Percent	Shift	Shift
No intervention	25.1%	Baseline	23.5%	Baseline	**Baseline**
Option 1	29.5%	+4.4%	33.2%	+9.7%	**+6.6%**
Option 2	33.4%	+8.3%	39.8%	+16.3%	**+11.6%**
Option 3	39.3%	+14.2%	42.8%	+19.3%	**+16.3%**
Option 4	39.8%	+14.7%	40.4%	+16.9%	**+15.6%**

Table 18 Estimated pedestrian modal shift for morning peak hour arrival

Level of intervention	Case 1: Door-to-Door motorised vehicle		Case 2: Fixed-route mass transit		Weighted average shift (Case1=59.3%; Case2=40.7%)
	Percent	Shift	Percent	Shift	Shift
No intervention	17.4%	Baseline	17.5%	Baseline	**Baseline**
Option 1	17.5%	+0.1%	22.3%	+4.8%	**+2.0%**
Option 2	17.7%	+0.3%	24.8%	+7.3%	**+3.1%**
Option 3	20.6%	+3.2%	27.1%	+9.6%	**+5.8%**
Option 4	21.8%	+4.4%	27.0%	+9.5%	**+6.5%**

Result summary

- NMT improvement interventions can encourage people to shift from Motorised paratransit to NMT
- Option 3 is the most appropriate intervention as it has the highest total NMT modal shift at approximately 16.3%
- For Option 3, pedestrian modal share increases by 5.8% from 17.8%, or equal to growth rate at 33.3% for future modal share. This 33.3% growth rate will be used in Chapter 3.9 for estimating future pedestrian demand.

3.8.2. Modal share for whole O-D trip

This section aims to analyse transport mode choice before and after interventions and potential for modal shift (or avoided future shift) from private vehicles to public transport if NMT and bus conditions are improved with fully extended MRT system in the future. The scenario used for this analysis is:

Question: In the next 5 years, if you have to travel from your new accommodation to Governmental office district in Soi Ari, which has 10 km distance, every working day. Your new house is next to bus stop and 5 km from Metro station. Which transport mode will you tend to use most?

The description and graphics for each level of intervention is shown in Questionnaire form in *Annex 3B*, including;

- Scenario 1: Without any infrastructure improvement
- Scenario 2: With Public bus service and waiting area improvement
    - New low-floor bus/ Direct route/ Provide waiting time and travel time information/ On-time/ Provide adequate route info and stop info/ not crowded/ Refurbish waiting area – wide, adequate seat, clean, light, good accessible, safe and easy to board and alight
- Scenario 3: With Public bus service, waiting area and street improvement Option 3
- Scenario 4: New metro station is built within 1 km from your accommodation, but no other infrastructure improvement
- Scenario 5: New metro station is built within 1 km from your accommodation, but no other infrastructure improvement
- Scenario 6: New metro station is built within 1 km from your accommodation, with Public bus service and waiting area and street improvement Option 3 in Soi Ari and from your home to metro station
    - The modal share results of each option for Case 1: Door-to-Door motorised vehicle and Case 2: Fixed-route mass transit are shown in Figure 67 and 68 respectively.

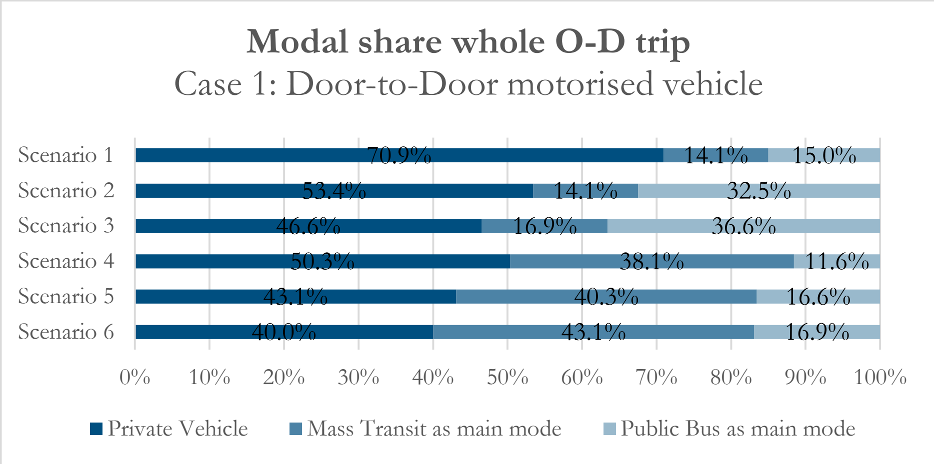


Figure 65: Modal share whole O-D trip - Case 1: Door-to-Door motorised vehicle passenger (Source: Consultant, 2015)

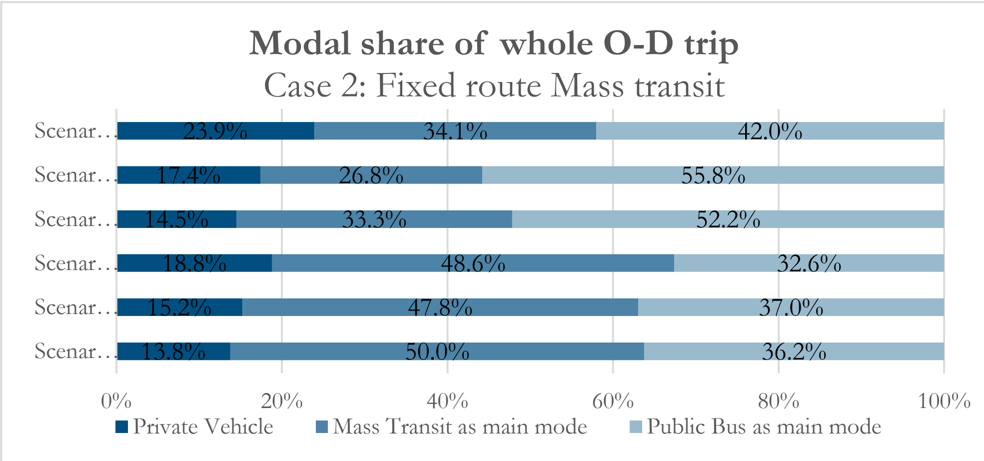


Figure 66: Modal share for whole O-D trip - Case 2: Fixed-route mass transit passenger (Source: Consultant, 2015)

The weighted average of Case 1 and Case is based on the percentage from Chapter 3.3 long distance modal share estimation, the total trips of people who generally come to work every weekday morning peak hour in Soi Ari and closed study area per day in Case 1 and Case 2 are 59.3% and 40.7% respectively.

According to *Annex 3A* in Table 3A-2 and Table 3A-3, the total of all modes in morning peak hour at the beginning of Soi Ari on South-side (Location 5) and Closed study area (Location A) are 6,373 and 1,771 people respectively. The estimated NMT traveller and modal shift of each case is presented in Table 19.

Table 19 Estimated Fixed-route mass transit passenger and Modal shift in weekday morning peak

Level of intervention	Case 1: Door-to-Door motorised vehicle		Case 2: Fixed-route mass transit		Weighted average shift (Case1=59.3%,Case2=40.7%)
	Percent	Shift	Percent	Shift	Shift
Scenario 1	21.1%	Based line		Baseline	Baseline
Scenario 2	46.6%	+25.5%	76.1%	+6.5%	**+17.8%**
Scenario 3	53.4%	+32.3%	82.6%	+9.4%	**+23.0%**
Scenario 4	49.7%	+28.6%	85.5%	+5.1%	**+19.0%**
Scenario 5	56.9%	+35.8%	81.2%	+8.7%	**+24.8%**
Scenario 6	60.0%	+38.9%	84.8%	+10.1%	**+27.2%**

Result summary

- Reforming public bus service and waiting area is a key factor to encourage people to shift transport mode from Private motorised vehicle to Fixed-route mass transit. In case 1, public bus passenger in *scenario 2* is doubled from no intervention in *scenario 1*.
- Extending the metro network also encourages people to shift transport mode as high as the public bus improvement. However, it takes most the share from public bus. (See *scenario 4* compare to *scenario 2*) and reduce the mode shift impact of public bus service and waiting area.
- Improving NMT conditions has a significant impact on modal shift in addition to other improvement. (See *scenario 3* compare to *scenario 2,* and *scenario 6* compare to *scenario 5*)
- NMT and public bus conditions intervention is highly recommend due to the modal shift impact expected.

3.9. Current and Future demand for NMT

The NMT demand for both pedestrians and bicycle users can be determined by using current peak flow rate and the future potential modal shift estimation. Therefore, the following data from survey is used to analyse for future NMT demand:

- The current peak flow rate of NMT at South side footway at the beginning of Soi Ari (Location 5) and Closed study area (Location A) from *Annex 3A* in Table 3A-2 and Table 3A-3
- The estimated future main transport mode from Chapter 3.8.2 Table 21 based on assumptions of <u>Scenario 3:</u> With public bus service, waiting area and street improvement Option 3 in Soi Ari.

3.9.1. Pedestrian potential demand

The current and future pedestrian peak flow rate estimation at the beginning of Soi Ari and closed study area are summarised in Table 20.

Table 20 Estimated current and future pedestrian peak flow rate of Soi Ari

	Current		**Future: Scenario 3**		
	Total morning peak passenger (From survey)	Peak flow rate (passengers/hr)	Growth rate	Total morning peak passenger	Peak 15 min flow rate (passengers/hr)
Beginning of Soi Ari	3,645	1,800 (converted from 450 passengers/ 15-minute peak)	33.3%	**4,859**	**2,400** (estimated from proportion from current situation)
Closed study area Gate A	756	480	33.3%	**1,008**	**640**

Result summary

- The peak flow rate (passengers/hour) is approximately half of total morning peak passenger
- The future potential morning peak flow rate at approximately 2,400 and 640 passengers per hour will be used as the referenced for designing NMT facilities for pilot area in Chapter 3.6.

3.9.2. Bicycle users potential demand

From Table 3A-2 and Table 3A-3 (in the *Annex*), the current demand of bicycle user in Soi Ari is presented in Table 12. The assumptions of forecasting the potential of future demand are explained as follow:

- The current bicycle users at the beginning of Soi Ari and closed study area Gate A is relatively low compared to all bicycle users in closed study area (see Table 12). Therefore, the future potential number of bicycle users who expect to travel from beginning of Soi Ari to closed study area Gate A will not use the growth rate from current users data, but will use the maximum potential bicycle users if there is no barrier in cycling from Chapter 3.7.2 instead, which is 522 passengers.
- The peak flow rate is assuming from pedestrian flow rate data in Chapter 3.9.1 that the peak flow rate is approximately half of total potential passenger.

Table 21 Estimated current and future bicycle user peak flow rate of Soi Ari

	Current		**Future: Scenario 3**	
	Total morning peak passenger (From survey)	Peak 15 min flow rate (passengers/hr)	Total maximum potential passenger	Peak 15 min flow rate (passengers/hr)
Beginning of Soi Ari	12	5	**522** (from beginning of Soi Ari to closed study area)	**250** (estimated from proportion from Table 3.9-2)
Closed study area Gate A	49	28		
All user in Closed study area	181	45		

Result summary

- The future potential morning peak flow rate at approximately 250 passengers per hour for one-way flow will be used as the referenced for designing NMT facilities for pilot area in Chapter 3.

4. Practical concept guidance note for public bus and NMT intervention design

This guidance note aims to provide potential integrated design solution for improving level of service of public bus system and for improving accessibility and connectivity of the walking environment around the urban rail stations and bus stops in Bangkok based on the survey results from this study, international guidelines and Thai regulations. The concepts presented in this guidance note is the ultimate results from intervention which rather far from the current reality in most location of Bangkok. The purpose of this is to provide guidance to the Ministry of Transport and relevant transport agencies to compare the good practises and current situation in Bangkok in order to encourage those agencies to see the potential of improvement intervention.

Note: The practical intervention for each location is required further study for passengers behaviour, infrastructure and detail design

This design guidance note in this chapter consists of 6 elements: Bus stop area (4.1); Intermodal transfer facilities (ITF) at bus stop (4.2); Bus station and interchange (4.3); Walking environment (4.4); Cycling environment (4.5); and Conceptual NMT design for study area (4.6).

4.1. Bus stop area

4.1.1. Bus stop layout

The bus stop design and layout should aim at the highest level of service to bus passengers and pedestrians.

The layout guidance for normal on-street bus bay is shown in Figure 69. The bus bay should provide at least 12 m which is the maximum length of a bus. The minimum clear width of boarding and alighting zone is 2 m., while the clear footway width after deduct shelter area should be at least 2 m. in order to accommodate the pedestrian flow adequately.

If there is on-street parking bays on both the approach and exit sides of the bus stop, the bus stop area length must be at least 37 m (as indicated in Figure 70), in order to provide sufficient taper for bus to enter and exit bus stop. The bus bay should also have clear road marking to prevent other vehicle to block or drive in the bus stop area.

Another option is to build bus boarder as shown in Figure 71. This will ease bus driver to stop on the kerbside bus stop that has on-street parking without taper distance needed. Bus boarders also provide a convenient platform for boarding and alighting passengers and wider waiting area. The bus boarder offers by far the best solution for both bus and passenger access whilst minimising the kerb length required; however, the effect of traffic lanes should take into consideration.

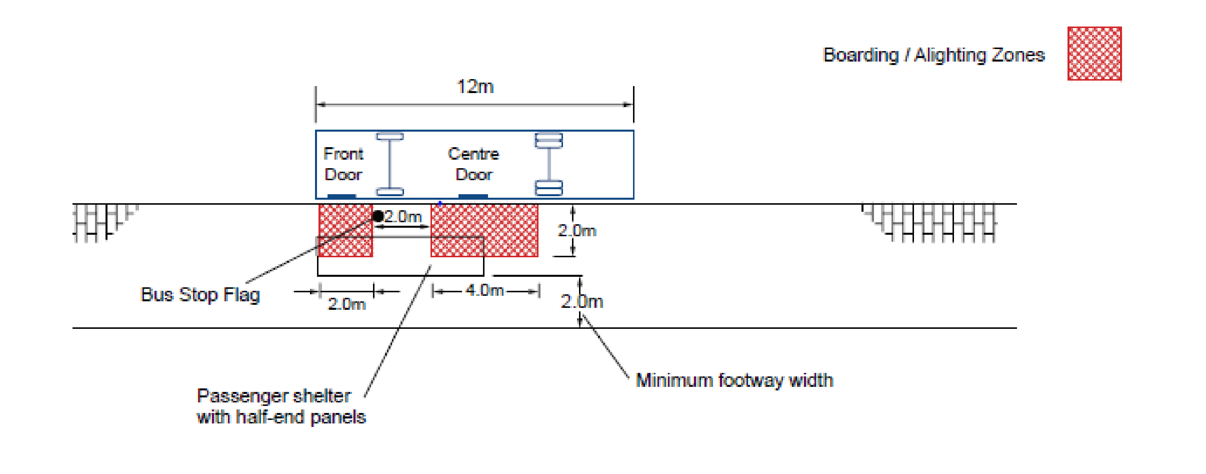


Figure 67: Normal on-street bus stop layout guidance (Source: Transport for London, 2006)

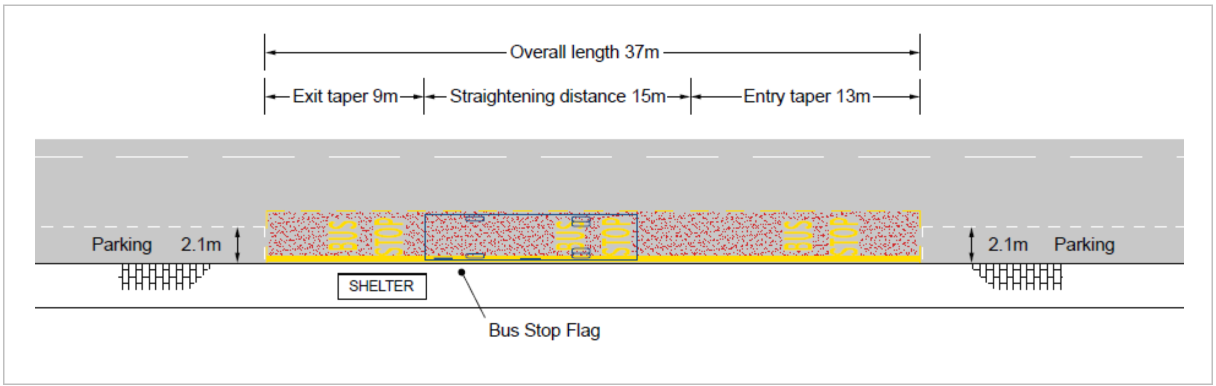


Figure 68: Kerbside bus stop with on-street parking on approach and exit layout guidance (Source: Transport for London, 2006)

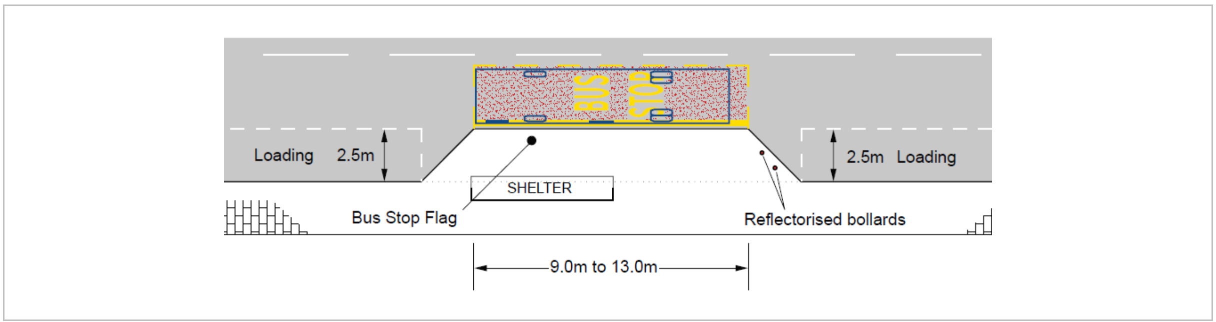


Figure 69: Bus border (Source: Transport for London, 2006)

4.1.2. Bus shelter

Bus waiting area should concern on safety issue and passenger's comfort as well as the accessibility of impaired people and wheelchair users, including:

- Provision and condition of waiting area
- Preferred clear area for boarding is 2 x 2 m
- Provision of shelter and seating

- Adequate width of shelter for wheelchair users to turn
- Adequate number of seating for elderly
- Preferred minimum width for accommodating pedestrian flow smoothly is 1.5 m
- Provision of bus route information

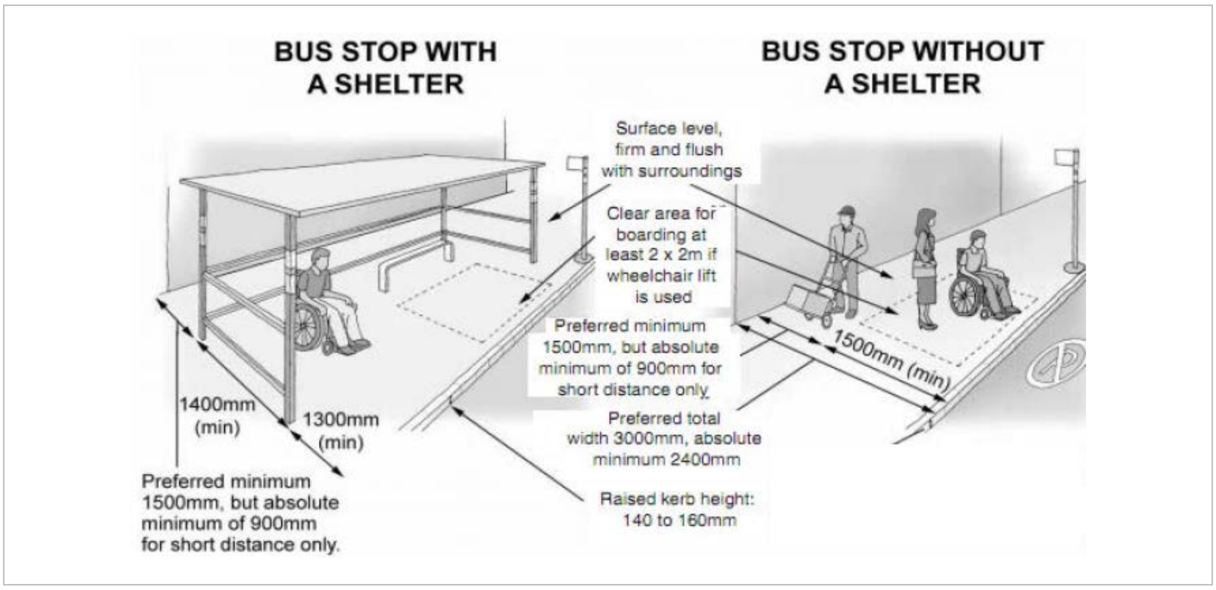


Figure 70: Bus stop accessibility best practice (Source: World Bank, 2013)

The design guidance of accessible bus shelter is presented in Figure 73 and 74.

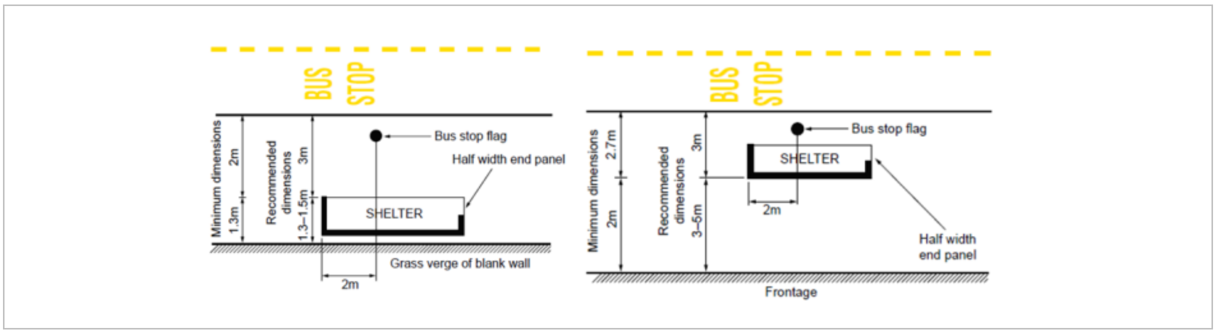


Figure 71: Accessible bus stop shelter dimension guidance (Source: World Bank, 2013)

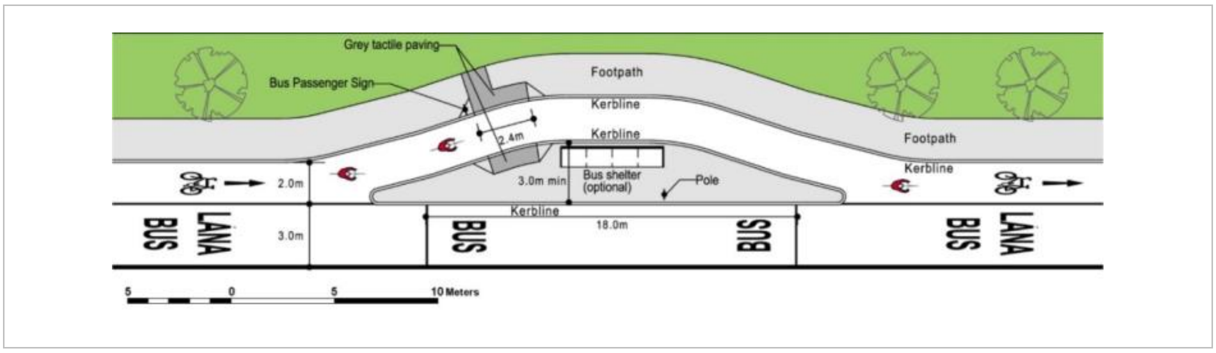


Figure 72: Practical design for bus stop with bicycle lane (Source: Transport for London, 2006)

4.1.3. Bus passenger's sightline

The bus stop should be located within 30 m from the entrance stairs and highly recommended to locate before the first set of entrance stairs in order to avoid sight obstruction problem for people who wait at waiting area. The example of this problem is shown in Figure 75 and the suggestion location is indicated in Figure 76.

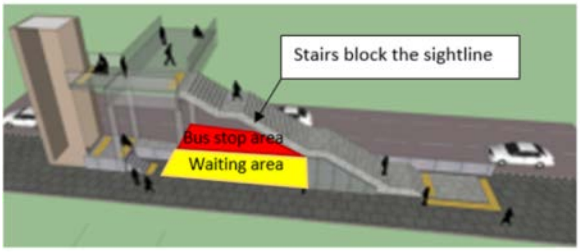


Figure 73: Bus stop location that has sightline blocking problem (Source: Consultant, 2015)

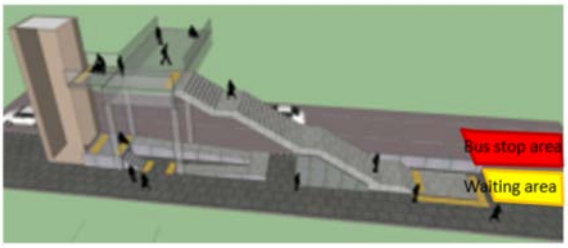


Figure 74: Suggestion for bus stop location (Source: Consultant, 2015)

4.1.4. Bus stop sign posts

The bus stop sign post design standard for Bangkok should be developed. It can be referenced from *Signing Standards Manual* (King County Metro, 2008) as the example in Figure 77. The characteristics of good bus stop sign post design are described as follows:

- The bus logo can clearly be seen by pedestrian on footway from distance
- All of the bus route numbers that operate at the bus stop can clearly be seen by pedestrian on footway from distance
- Name of the bus stop should be indicated
- Location does not block the pedestrian flow
- Height clearance from pedestrian (approximately 2.2 m)
- Route detail and area map fonts should be large enough for elderly to read
- Height of route detail and area map should be in the eyesight level for wheelchair user

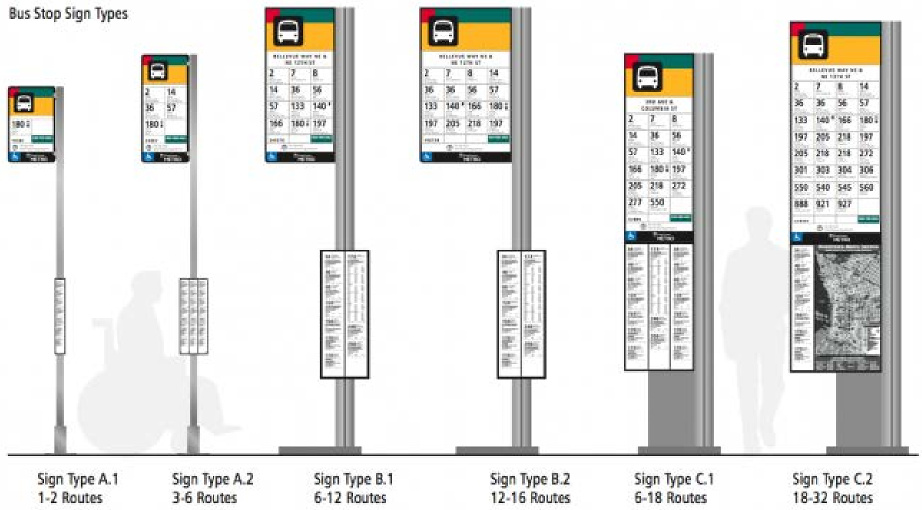


Figure 75: Example of bus stop sign post good practice (Source: King County Metro, 2008)

4.1.5. Bus stop real-time information display

The example of Real Time Information display at bus stops is shown in Figure 78. The main objective is to give the traveller some certainty about when a bus will arrive. Sometimes it provides them assurance about the service they had intended to take; other times they can use this information to make a choice about taking an alternative service.

Figure 76: Example of bus stop real-time information display good practice (Source: Wikimedia Commons, 2013)

Most at-stop real-time information systems are multi-line displays that display information about the next 2-4 buses expected to arrive at the stop. The information includes:

- For each forecast arrival at the stop, the most typical information is:
    - Route Number, and variant if applicable
    - Destination
    - Forecast arrival time at the bus stop; or
    - Number of minutes to the arrival

- Optionally, there may be additional symbols to indicate:
  - Whether the vehicle is in delay
  - Whether the vehicle is wheelchair accessible/low floor – this is used in cases where there is a mixed fleet
  - Indication of vehicle type, sometimes used when there are different door/boarding arrangements
- For stops with multiple routes, there are variants on which arrivals are displayed:
  - The next vehicles in order of arrival, regardless of route
  - The next vehicle to arrive on each route (subject to the maximum number of routes that can be displayed)
- To overcome the limitations of the number of lines on the display, the following methods are used to increase the amount of information available to the passenger
  - Both the next and subsequent arrival for the same route are shown on one line
  - The last line of the display scrolls through the subsequent 2-4 arrivals
- Traveller alerts
  - Current delays and disruptions
  - Events that are expected to happen later in the day (e.g. demonstration) or in the coming days (e.g. diversion due to construction/roadworks)
  - Forthcoming route and timetable changes
  - Specific messages initiated by the CAD/AVM dispatcher
- Safety and security messages
- Commercial advertising (still relatively rare)

Advantages and Cautions

The primary advantages of Real-time Information at Bus Stops are to:

- Provide information to travellers at their waiting area (waiting time is shown to have the highest negative value, and uncertainty causes anxiety)
- Increase travel choices for travellers
- Communicate directly to travellers while they are in transit

The principal cautions in relation to Real-time Information at Bus Stops are:

- The units are expensive, and this limits their deployment to the busier stops. Increasingly, transit authorities and operators are reflecting on the balance between information at bus stops and information via personal mobile devices.
- Due to their outdoor location, readability can be a problem in varying light conditions. This can be a real problem when there is not a bus shelter, as the display unit may be in full sunlight
- Units need to be robust and resistant to both weather and vandalism
- Communications and power supply can be a challenge, in part for availability, In part due to permissions required for works on public pavements and space. This is sometimes overcome by transferring the responsibility for the installation works to the local authority.

4.2. Intermodal transfer facilities (ITF) at bus stop

4.2.1. Cycle parking location

Bicycle parking facilities should be provided at the major bus stops, especially the ones that are connected to urban rail system which are expected to have high number of passengers. Sufficient bicycle parking should be installed at the closest area to the bus stop and the station entrance.

The suggested location for installing cycle parking racks is under the 4 urban rail station entrance stairs or escalator as indicated in blue area in Figure 79. Each set of stairs should have at least 10 slots of racks, total of 40 slots for beginning phase, and prepare the extension area for higher demand in the future. Bicycle parking facilities should also be considered to install at the attractions or building near the station that have high forecast number of bicycle user in the future i.e. shopping mall, university or Park and Ride building.

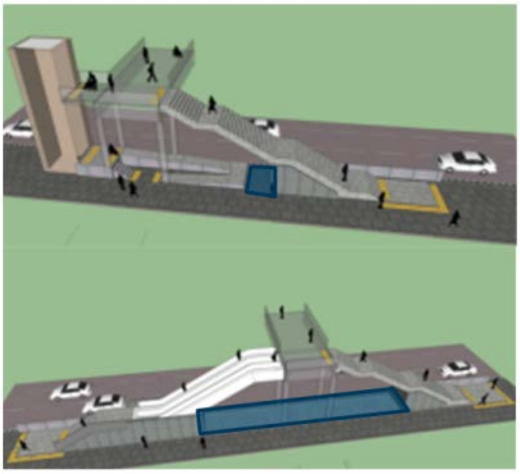


Figure 77: Suggested location for installing bicycle parking racks (Source: Consultant, 2015)

4.2.2. Drop-off bay and Waiting berth for other vehicles

The drop-off bay and waiting berth should be provided separately from bus stop area in order to avoid conflict with public bus or block the bus lane which leads to the delay of the public bus and passenger's safety issues.

The following suggestion is for the example of bus stops that connect to urban rail station. For taxi and private vehicle, the drop-off bay should be provided as off-street bay. It is suggested before or after the 2nd set of the stairs as indicate in green area in Figure 80.

For songthaew and public van, these vehicles need to stop by and wait for passengers; it should share the waiting berth with the taxi drop-off bay as indicate in green area in 80.

For motorcycle taxi, the waiting area should be located inside the beginning of Sois as indicate in grey area in Figure 80 in order to avoid the conflict on the main road.

The example of combined cycle parking and bus stop shelter is presented in Figure 81.

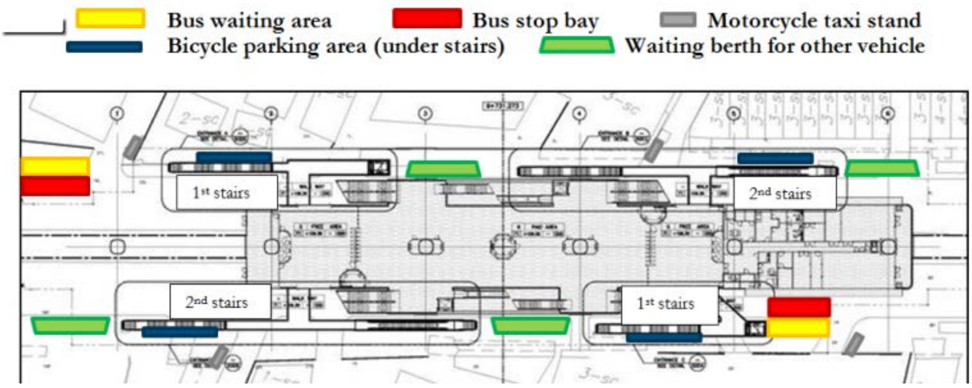


Figure 78: Suggested location for all ITF (Source: Consultant, 2015)

Figure 79: Example of combined bicycle and bus stop shelter (Source: Wig-Wag Trains, 2007)

4.3. Bus station and interchange

The bus station hub is suggested for main bus system interchanges or urban rail transit stations. The suggested locations for bus stations in Bangkok and vicinity from are presented in Figure 2A-11 in *Annex 2A: Bus re-route map* from previous study. The conceptual design example for bus station is illustrated in Figure 82.

Figure 80: Example of conceptual design for ITF hub (Source: PPIAF)

The example for bus station hub at the frontage of Park and Ride building at Phutthamonthon Sai 4 MRT station (West Bangkok) is shown in Figure 83. This ITF hub is expected to highly increase passengers' interchanging convenience and reduce the road conflict problems.

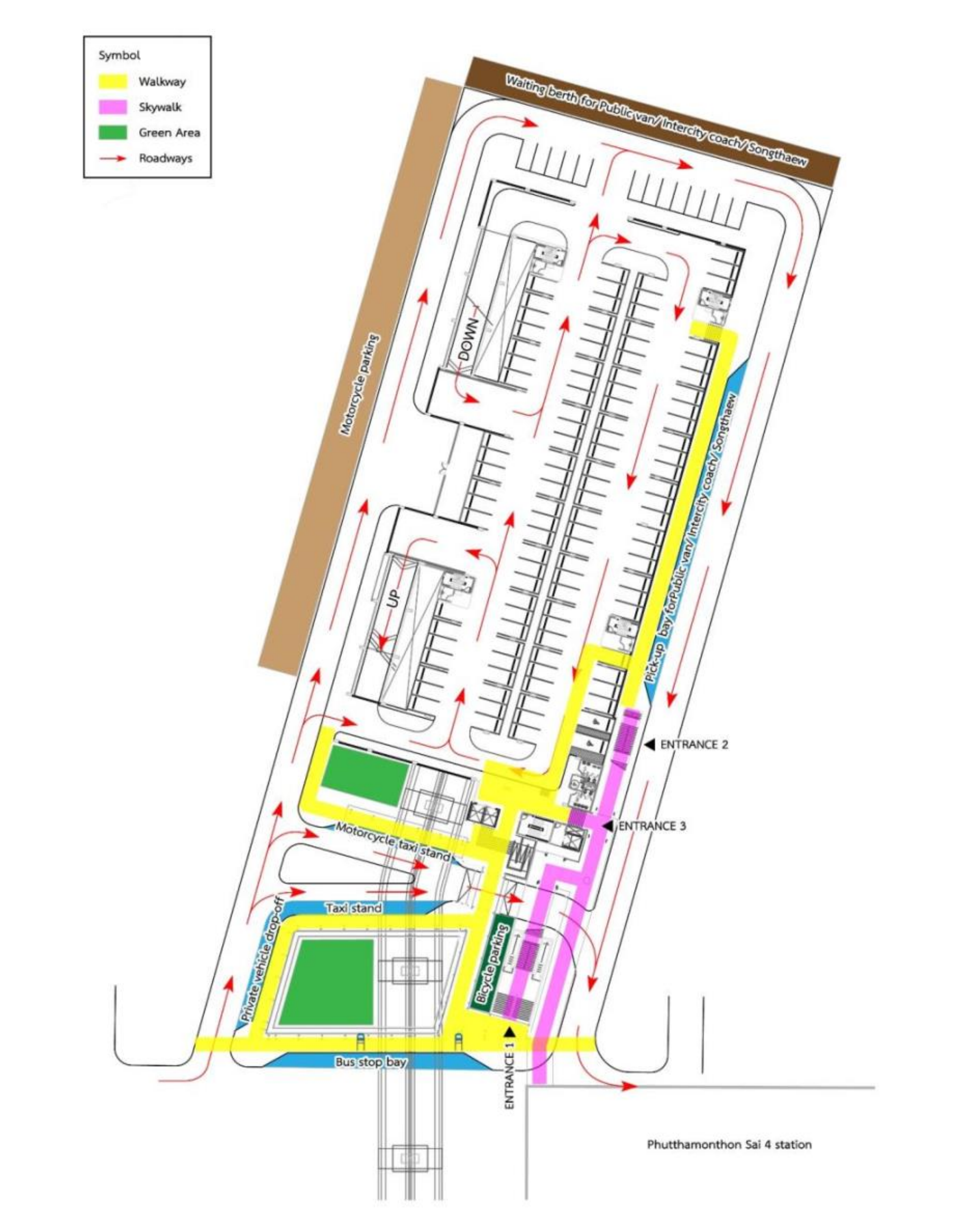


Figure 81: Example of ITF hub at Phutthamonthon Sai 4 station Park and Ride (Source: Consultant, 2015)

4.4. Walking environment

This walking environment guidance note is referenced from several selected international guidelines and Thai regulations, by adjusting criteria and concepts that are suitable and practical for the Bangkok and vicinity environment. The purpose of this guidance note is to suggest specifications, dimensions and solutions of footway and relevant facilities for better pedestrian comfort and to be inclusive for all kinds of people by introducing universal design. This guidance note consists of 3 parts: footway width design, intermodal connectivity and walking environment facilities.

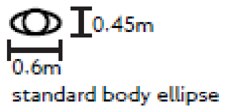
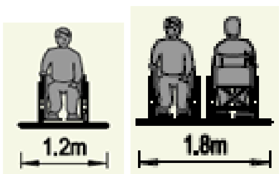
4.4.1. Footway width design criteria and its application

Criteria of footway width are based on pedestrian and space requirements from their activity on footway. These requirements and appropriate total footway width for such condition are described further in this section.

Pedestrian characteristics and dimensions

Different types of pedestrians have different footway width requirements for comfortable access, as explained in Table 22 (World Bank, 2013).

Table 22 Pedestrian requirement for walking environment

Pedestrian type	Clear width	Other requirements
Able-bodied person  	Minimum 0.6 m	
Elderly	Minimum 0.6 m	• No steep dropped kerbs/ ramps due to body balancing ability (preferred steps with handrail)
Parent with a pram/ People with luggage	Preferred 0.9 m	• Dropped kerbs and ramps with preferred maximum gradient 8%
Wheelchair user  	Minimum 0.9 m Preferred 1.2 m For two wheelchair user to pass 1.8 m	• Dropped kerbs and ramps with preferred maximum gradient 8% • Maximum crossfall 4% • Handrail at ramps • Accessible lifts/ wheelchair lifts • Accessible route signage • Ground level crossings
People with ambulant disability  	Minimum 0.9 m Preferred 1.0 m	• Ground level crossings
Visual impaired / Partial visual impaired	Minimum 0.6 m	• Tactile paving • Colour contrast paving/ signage • Large font/ Braille signage • Audible or tactile indicator for controlled crossings

Dimension measurement for Micro-level accessibility (infrastructure access)

Micro-level accessibility is the ease of action in using specific physical infrastructure (e.g. dropped kerb in crossing). This section aims to identify locations of potential physical infrastructure barriers during walking and interchanging from the perspective of people with limited mobility (e.g. elderly, mobility impaired, visual impaired, hearing impaired, people with luggage).

This is done by measuring the dimensions of potential barriers on links and crossings. Then compare them with minimum requirements in *Improving Accessibility to Transport for People with Limited Mobility (PLM) Practical Guidance Note* (World Bank, 2013), *Inclusive Mobility – Summary of dimensions* (Department for Transport, UK, 2002) and *Accessible bus stop design guidance* (Transport for London, 2006). The minimum clear width at any point of footway shall not be less than 0.9 m in order to accommodate all types of pedestrians in one direction, and this 0.9 m clear width segment shall not exceed 6 m long (World Bank, 2013).

Specify level of hazard and label them with different colours as following Table 23 (Consultant, 2015):

Table 23 Level of hazard in each dimension measurement

Facility dimension	Adequate	Risky	Dangerous
Clear footway width	**≥ 1.5 m**	**0.9-1.5 m**	**< 0.9 m**
Ramp and dropped kerb gradient	**≤ 8%**	**8-12%**	**> 12%**
Crossfall on footway	**≤ 4%**	**4-6%**	**> 6%**

Minimum footway width calculation

For bi-direction pedestrian flow, wider clear width footway should be provided to accommodate the flow. Thai regulations are just generally specifying that the typical footway width shall not be narrower than 1.5 m. Thai metro guideline also only suggests that minimum recommended width for bi-directional movement is 2 m (MRTA, 2013).

However, these guidelines did not take into account the actual traffic of pedestrian flow in order to find the appropriate clear footway width to accommodate such size of flow in each segment comfortably.

The Pedestrian Comfort Level (PCL) and pedestrian crowding can be adapted for that appropriate clear footway width calculation based on the PCL method from *Pedestrian Comfort Guidance for London* (Transport for London & Atkins, 2010).

From the pedestrian crowding formula:

Pedestrian crowding = People per hour ÷ 60 ÷ Clear footway width in m

To ensure the pleasant environment for pedestrian, the typical walking environment should have at least PCL B- which has the maximum pedestrian crowding at 17 ppmm (people per minute per metre) as indicated in Figure 84 (Transport for London & Atkins, 2010). Therefore, the required minimum clear footway width can be calculated from following formula:

Required minimum clear footway width = People per hour ÷ 60 ÷ 17 ppmm

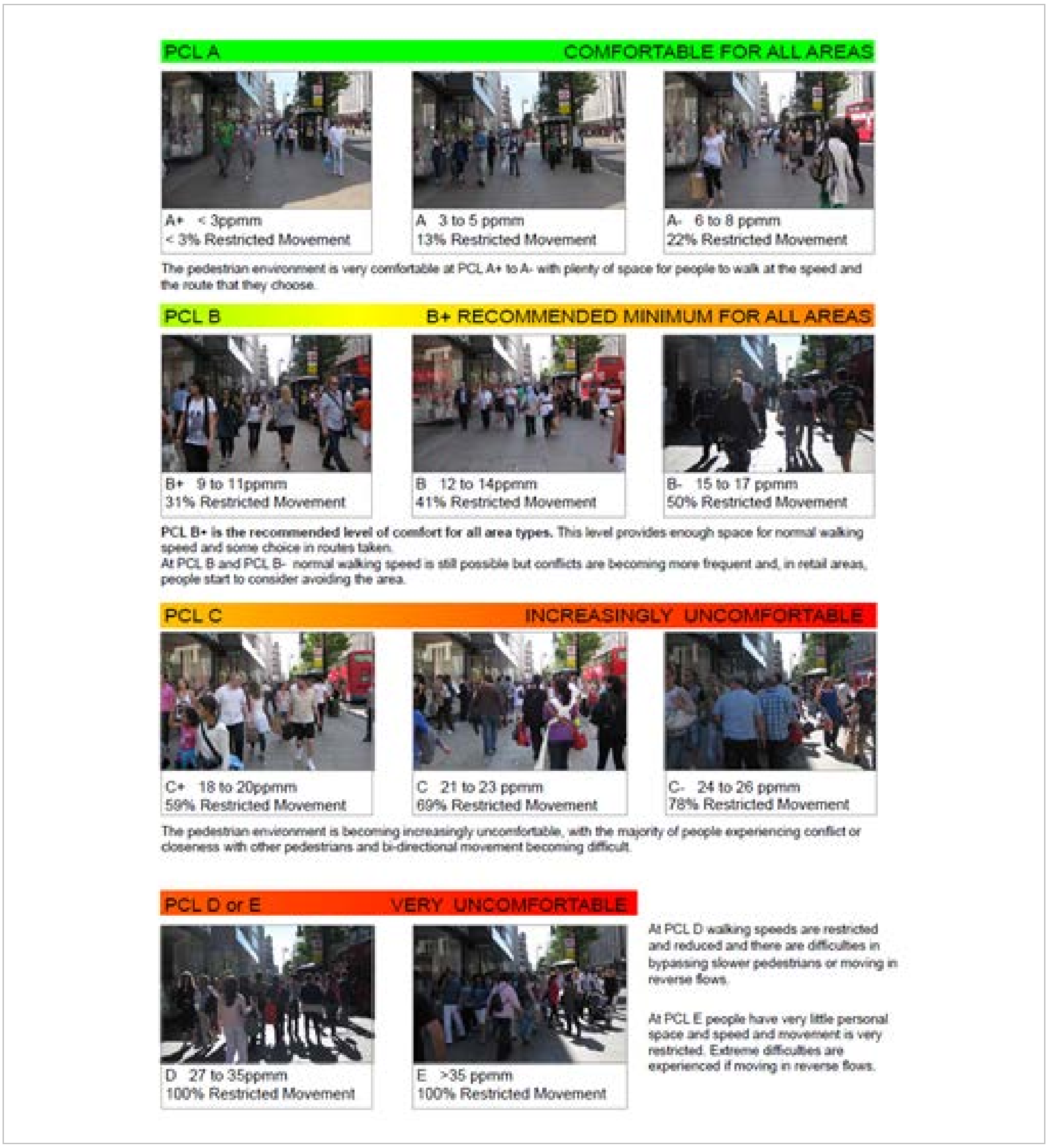


Figure 82: Classification of Pedestrian Comfort Level on footway (Source: Transport for London and Atkins, 2010)

Total footway width requirement

Public footway space is provided not only for the pedestrian use, but for street furniture, and other activities; such as public transport waiting area, street vendor area, café seating area etc. Each activity requires different width of footway space and different buffer for pedestrians to pass. According to Pedestrian Comfort Guidance for London (Transport for London and Atkins, 2010) and Indicators for Pedestrian-Friendly Footpath in City Centre of Bangkok: Patumwan case study (Pujinda,P. et al., 2010), the sample illustrations and the summary of suggested width requirement for each element are presented in following Figure 85 and Table 24, respectively.

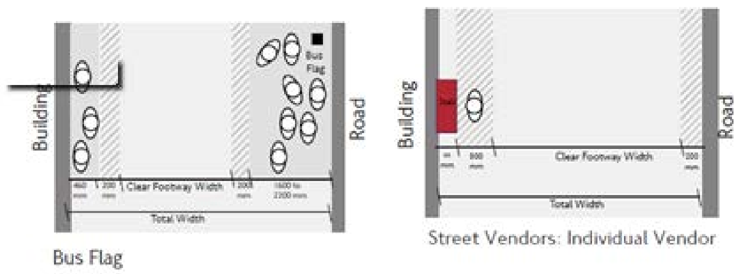


Figure 83: Bus stop with no shelter requirement and street vendor with customer queue requirement (Source: Transport for London and Atkins, 2010)

Table 24 Example of footway elements and required width

Element	Required clear width	Buffer
Footway for pedestrians	Minimum 1.5 m (including buffers) depends on flow and area type	0.2 m from roadside or guardrail
Utility and vegetation	0.6 m from kerbside	0.2 m
Street vendors	Minimum 0.6-1.0 m	0.5 m for shopper viewing area
Bus stops – no shelter	1.6-2.2 m from kerbside and 0.5 m from building edge	0.2 m 0.2 m
Bus stops – with shelter	Minimum 2.0 m depends on shelter size and set back	0.2 m
Footbridge/ tunnel entrances	At least 2.0 m	0.2 m
ATM	0.0 m if attached to the building	1.5-3.0 m for queuing
Bench	Depends on bench size	0.5 m for sitting
Perpendicular cycle parking	2.5 m	0.0 m

Therefore, the examples of calculated minimum clear footway width, and required total footway guidance are shown in Table 25 and Table 26, respectively.

Table 25 Examples of pedestrian flow and minimum width requirements

Condition	Flow	Required clear width	Criterion
Minimum allowance	900 pph	0.9 m	(Max length 6 m)
Thai regulations	1,500 pph	1.5 m	
Medium flow	1,800 pph	1.8 m	For 3 people to pass
High flow	2,700 pph	2.7 m	For 4.5 people to pass
Skywalk	3,000 pph	3.0 m	For 5 people to pass

Table 26 Examples of pedestrian flow and minimum width requirements

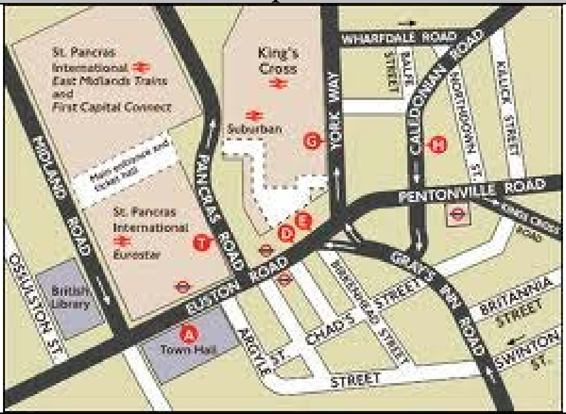
Condition	Required clear footway width)0.6 m per person(	Street vendors +shoppers	Utilities and vegetation	Buffer (0.2 m each)	Total width
Thai regulations minimum footway (<900 pph)	Clear footway 1.5 m (including buffers)	X	(0.6 m)	X	2.1 m
		1 side (1.5 m)	In line with street vendors	X	3.0 m
		2 sides (3.0 m)	In line with street vendors	X	4.5 m
Footway with standard flow (900-1,800 pph)	Clear footway for 3 people to pass (1.8 m)	X	(0.6 m)	2 sides (0.4 m)	2.8 m
		1 side (1.5 m)	In line with street vendors	1 side (0.2 m)	3.5 m
		2 sides (3.0 m)	In line with street vendors	X	4.8 m
Footway with crowded flow (1,800-2,700 pph)	Clear footway for 4.5 people to pass (2.7 m)	X	(0.6 m)	2 sides (0.4 m)	3.7 m
		1 side (1.5 m)	In line with street vendors	1 side (0.2 m)	4.4 m
		2 sides (3.0 m)	In line with street vendors	X	5.7 m
Bus stop with shelter	Clear footway for 3 people to pass (1.8 m)	*Should not have street vendors *	Bus stop shelter (2.0 m)	2 sides (0.4 m)	4.2 m
Footway adjacent to Skywalk or tunnel stairs	Clear footway for 3 people to pass (1.8 m)	*Should not have street vendors*	Stairs entrance (2.0 m)	2 sides (0.4 m)	4.2 m
Skywalk/ tunnel 3,000 pph	Clear footway for 5 people to pass (3.0 m)	X	X	2 sides (0.4 m)	3.4 m

This guidance can applied to each location of footway to find the minimum required width to accommodate current pedestrian flow, activities and infrastructure on the footway.

4.4.2. Intermodal connectivity direction signage

Direction signage is essential for improving connectivity of intermodal public transport. Direction signage should be unified for every public transport modes in a city. The design criteria for good direction signage and some good practice images are shown in Table 27.

Table 27 Direction signage design criteria and good practice images

Design criteria	Good practice
Indicate the location of all public transport waiting area in one local area map i.e. metro stations, bus stops, boat piers, taxi stands, and motorcycle taxi stands	
Indicate the direction to nearby public transport stations and walking distance in one signage	
Signage of accessible route to lifts/ramps for wheelchair users	
Logo of public transport waiting area that can be clearly seen from distance/ Route numbers on bus stop mark posts	
Transit map and route information at the public transport waiting area	

4.4.3. Walking environment facilities design solution

There are 3 categories of walking environment facilities included in this guidance note: crossing, dropped kerb and tactile paving, and street furniture and street vendor. The design criteria of these facilities are based on the problems found from street audits around Ari area and Ratchaprasong area in Bangkok. This guidance note, then, suggests the possible solutions in order to solve such difficulties.

Footway width and aesthetic

Problems:

- Too narrow footway width which allow pedestrian comfortably, especially inaccessible for wheelchair users (Figure 86)
- Cluttered, abandoned street furniture and vegetation area reduce clear footway width (Figure 87)
- Encroachment from street vendors reduce clear footway width (Figure 88)

Solutions:

- Convert parking lane or traffic lane for footway width expansion. (Figure 86) Parking space will be relocated to another space in proximity area.
- Relocate cluttered street furniture/ improve the aesthetic of abandoned street furniture (Figure 87)
- Reallocate street vendor area by using different paving to define street vendor areas and reduce encroachment/ reduce street vendor permitted area by specifying smaller stall size (Figure 88)

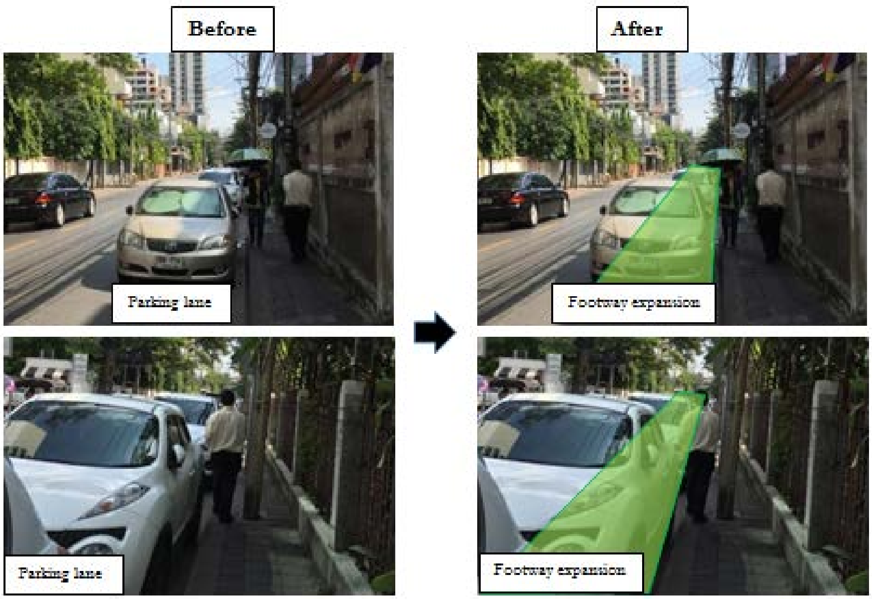


Figure 84: Concept of before and after convert parking lane space for footway expansion along Soi Phahonyothin 7 (Soi Ari) (Parking space will relocate to other Sois in proximity area) (Source: Consultant, 2015)

Figure 85: Concept of before and after relocate cluttered street furniture/ improve the aesthetic in Ratchaprasong area (Source: Thai Architecture Association and Thai Health Promotion Foundation, 2014; Consultant, 2015)

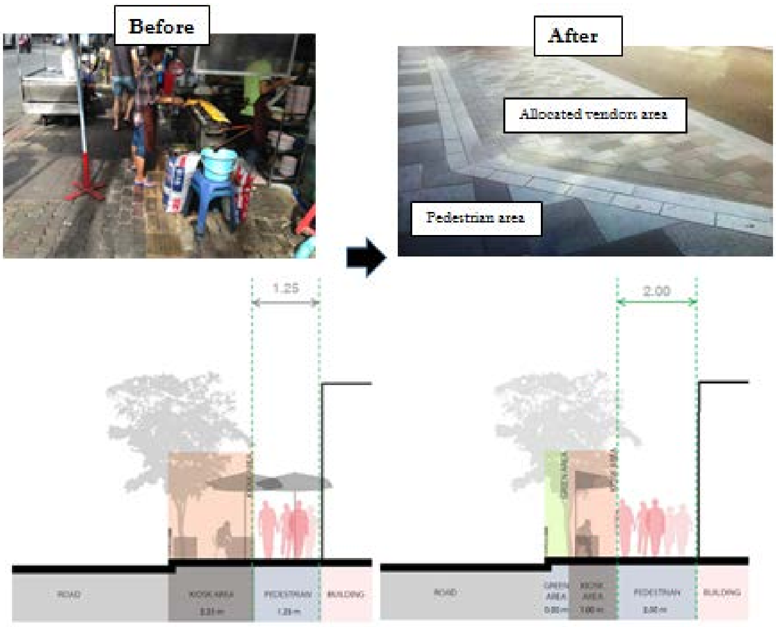


Figure 86: Concept of before and after reallocate street vendor area in Ratchaprasong area (Source: Consultant, 2015)

Crossing signal problems:

- Absence of signals /confusing signals
- Pedestrians not sure whether they have enough time to cross
- Not accessible for visual impaired

Solutions:

- Install signal at pedestrian crossing with the different signal figure for green and red man phase
- Install countdown sign for crossing (Figure 89)
- Install crossing indicator cone - spin in green man phase/ Install tactile arrow – more accurate and easier to find crossing direction (Figure 89)

Figure 87: Crossing signal solution examples (Source: Consultant, 2015)

Crossing safety problems:

- Allow vehicle to turn left in green man phase
- Steep dropped and high kerb at crossing with no gradient
- Small waiting area on the footway that adjacent to the crossing
- Motorcycles encroach the crossing area and obstruct the pedestrian flow
- Low priority of pedestrian at the crossing
- Crossing that far from the junction cannot be seen from the junction
- Not adequate lighting at crossing

Solutions:

- Redevelop crossing infrastructure by reducing corner radii/ partial narrowing of minor road/ build out and park on one side (Figure 90). This will help reduce the crossing distance, provide more waiting area space and increase driver awareness at crossings.
- Install the advance stop line for motorcycles and bicycles at the space between crossing and vehicle stop line (Figure 91).
- Paint the existing crossing with eye-catching colour or install new level pedestrian crossing (Figure 92)
- Install more lighting at crossings.

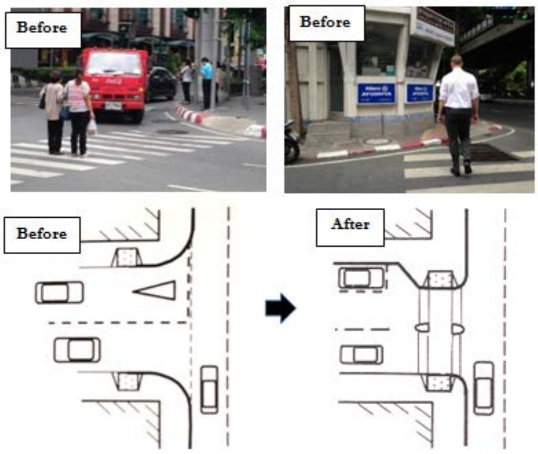


Figure 88: Concept of before and after crossing redevelopment (Source: : Schoon, 2010; Consultant, 2015)

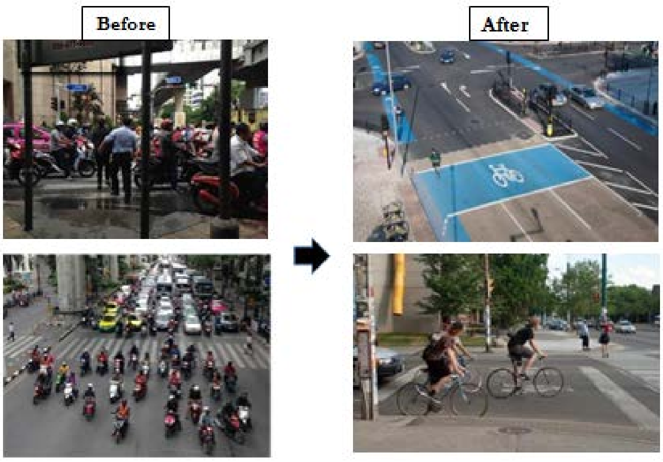


Figure 89: Concept of before and after installing advanced stop line (Source: iTS International, 2013; Consultant, 2015)

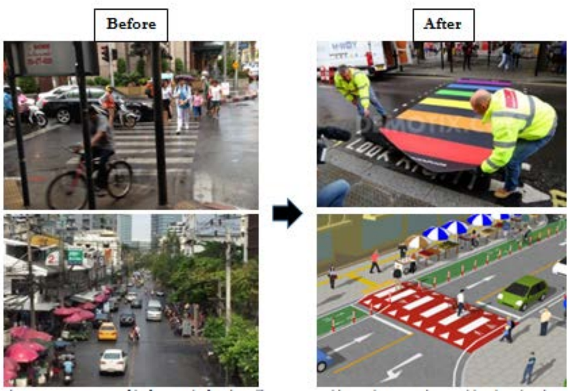


Figure 90: Concept of before and after installing eye-catching colour crossing and level pedestrian crossing (Source: Alamy, 2014; Consultant, 2015)

Dropped kerb and tactile paving problems:

- No gradient /steep gradient dropped kerbs along footway (Figure 93).
- Exiting footbridges do not have tactile paving (Figure 94).
- No warning tactile paving standard at dropped kerbs (Figure 95).
- Tactile blocks and dropped kerbs are damaged, encroached by street vendors and not practical (Figure 96).

Solutions:

- Increase the height of the minor roads to be equal or close to the height of adjacent footways (Figure 93).
- Attach the tactile sticker on the footbridges (Figure 94).
- Set the practical 'Universal Design' tactile paving standards that suit the Bangkok environment and apply the standard with the whole city (Figure 95).
- Remove the encroachment, and redevelop the tactile paving and dropped kerb that is suitable for pedestrian walking alignment and appropriate clear width (Figure 96).

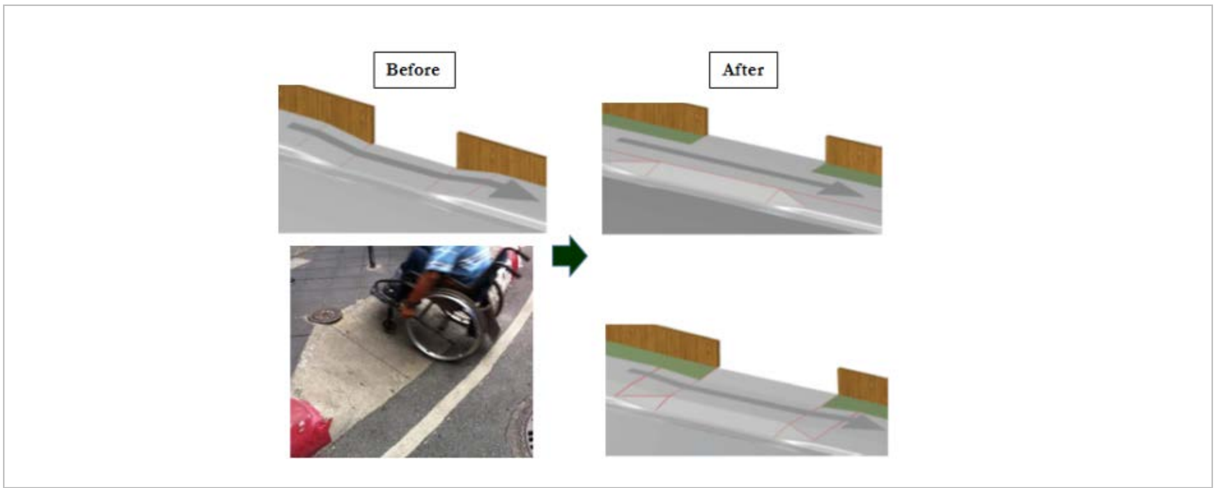


Figure 91: Concept of before and after increasing the height of the minor road (Source: Transport Scotland, 2014; Consultant, 2015)

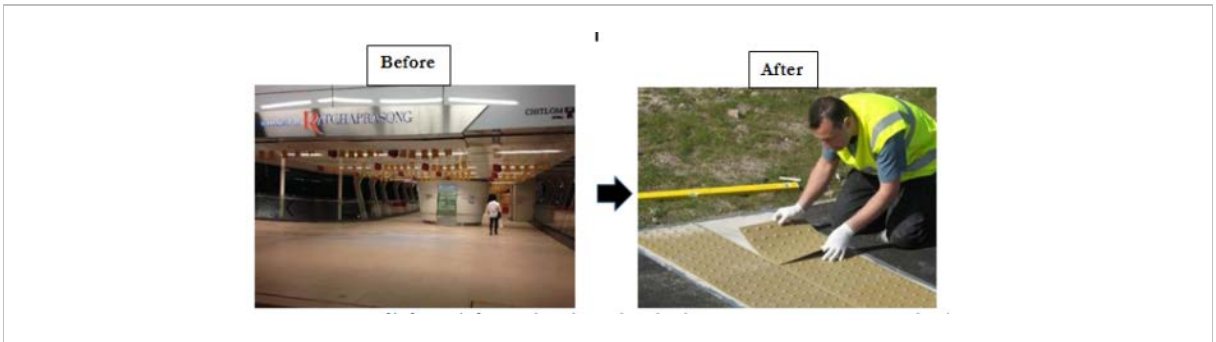


Figure 92: Concept of before and after attaching the tactile sticker (Source: Paving Expert, 2007)

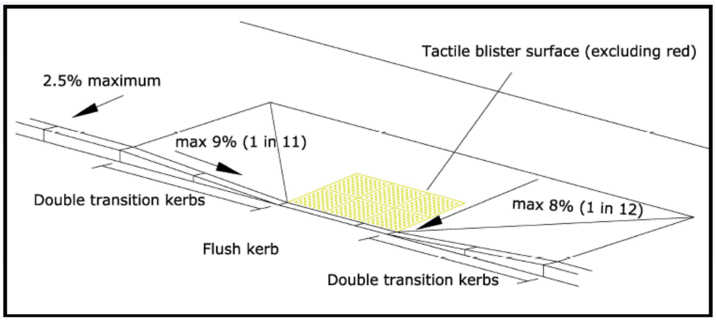


Figure 93: Example of the international 'Universal Design' standard (Source: Transport Scotland, 2014)

Figure 94: Concept of before and after redevelop the tactile paving and dropped kerb (Source: Consultant, 2015)

4.5. Cycling environment

This cycling environment guidance note is referenced from Thailand's first official *Cycling Lane Design Standards Manual* which was just launched in year 2015 by Department of Rural Highway, Ministry of Transport. The main aspects in this manual are:

- Geometric design of bikeway
- Surface material
- Traffic sign, road marking and safety system for cycling
- Cycle parking guidance

More details are presented in *Annex 4A: Standards for Bikeway Design and Construction in Thailand and full Cycling Lane Design Standards Manual* report. This manual contains basic criteria for constructing bikeways; however, it is lacking principles for bicycle user requirements for better level of service and safety.

Therefore, international guidance[5] is also reviewed and summarised for additional suggestions that is essential for cycling infrastructure:

- *London Cycling Design Standards* (Transport for London, 2014)
- *Focus on Cycling: Copenhagen guidelines for the design of road* project (City of Copenhagen,2013)
- *Cycle Infrastructure Design* (Department for Transport, UK, 2008)
- *Workplace cycle parking guide* (Transport for London, 2014)

The purpose of this guidance note is to suggest design principles, specifications and dimensions of cycling facilities for better bicycle users safety and comfort. This guidance note consists of 3 parts as follows.

4.5.1. Design outcomes, principles and master plan

According to *London Cycling Design Standards* (Transport for London, 2014), there are 6 core design outcomes, which together describe what good design for cycling should achieve, are: Safety, Directness, Comfort, Coherence, Attractiveness and Adaptability. Good design examples of each outcome are presented in Figure 97. Improvement therefore needs to be focused on the cycling experience: how safe and comfortable it feels, how direct and attractive a journey is to cycle, and whether cycle routes are coherent and easy-to-follow.

[5] UK and London are taken as examples as they are, just like Bangkok, only since relatively recently developing and investing in cycling infrastructure.

Figure 95: Good outcomes of cycling lane design (Source: Transport for London, 2014)

Figure 96: Proposed cycle routes in Central London for local engagement (Source: London Map, 360)

4.5.2. Cycling lane

Cycling lane classification

From the Thai *Cycling Lane Design Standards Manual* (Department of Rural Road, 2015) types of cycling intervention are categorised according to the average motorised traffic speed and volume as shown in Table 28 and Figure 99. See definition of each type of cycling lane in Figure 99.

Table 28 Type of cycling intervention based on Thai Cycling Lane Design Standards Manual

Average motorised traffic speed (km/hr) at 85 percentile	**Average traffic volume veh/day/yr (AADT)**		
	<3,000	3,000-5,000	>5,000
<30	Share lane	Wide kerb lane	See Nomo-Graph
30-50	Wide kerb lane	Bike lane	See Nomo-Graph
50-70	Bike lane or Median protected lane	Bike lane or Median path	See Nomo-Graph
>70	See Nomo-Graph	See Nomo-Graph	See Nomo-Graph

Note: AADT - annual average daily traffic

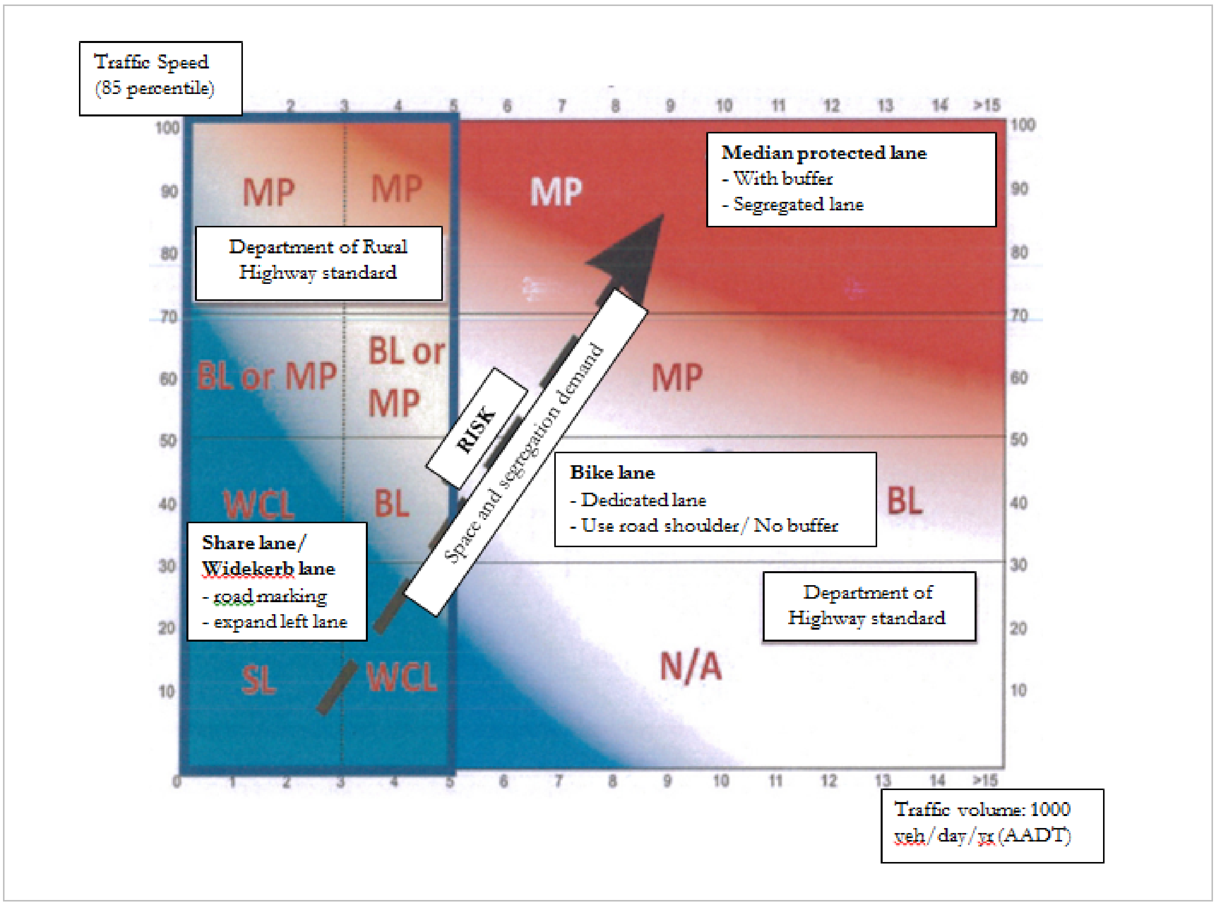
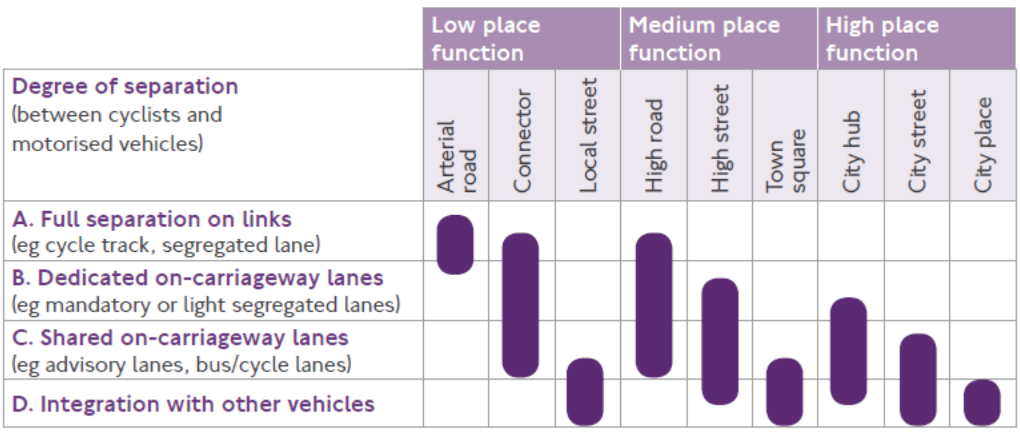


Figure 97: Nomo-graph in Thai Cycling lane Design Standards Manual (Source: Department of Rural Road, 2015; Consultant, 2015)

However, for practical design and use, the criteria of the intervention should also consider existing type of the road, place function and demand of cyclist as such from Transport for London (2014). Types of cycling interventions are categorised according to the ‘degree of separation’ they offer between cyclists and motor vehicles as shown in **Table 4.5.2**. Greater user separation is needed where the movement function of a street leads to higher motorised traffic speeds and volumes of traffic.

Table 29 Indicative range of cycling interventions by RFT street type



Additional key considerations from Thai standards are presented as follows:

- In case that the volume of motorised vehicles traffic is 10,000 vehicles per day or more, and an average speed of motorised vehicles is 80 km/h or more, bikeway must be constructed outside clear zone of roadway.
- In case that the volume of large motorised vehicles (i.e. 6-wheel truck and larger) is more than 30 vehicles per hour in the outermost lane, use of roadway embankment as bikeway should be considered. Or if another type of bikeway is used and an average speed of motorised vehicles traffic is high (80 km/h or more), an open space should be used to buffer between bicycles and motorised vehicles.
- In case that the volume of bicycle users is 50-200 users per hour, cycling lane type should be bike lane or median protected bike lane
- In case that the volume of bicycle users is more than 200 users per hour, cycling lane type should be median protected bike lane. The definition of this type of cycling lane is that there is the median space between normal traffic lane and bike lane which kerb, bollards, rubber cone or other protector elements installed in that median space to separate normal traffic and bicycle users.

Cycling lane width

The minimum recommended width for cycling lane is based on the clear space required by bicycle user in which to feel safe and comfortable. The requirement depends on:

- The cyclist's dynamic envelope, i.e. the space needed in motion, as shown in Figure 100
- The clearance when passing fixed objects
- The distance from, and speed of other traffic

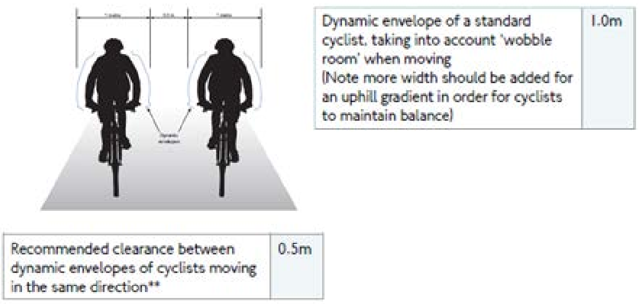


Figure 98: The cyclist's dynamic envelope (Source: UK Department of Transport, 2008)

The details can be found in *Cycle Infrastructure Design* (Department for Transport, UK, 2008) and *London Cycling Design Standard* (Transport for London, 2014).

According to Thai *Cycling Lane Design Standards Manual* (Department of Rural Highway, 2015), minimum width of cycling lane is classified by using motorised traffic speed and type of cycling lane which presented in Table 30 (Department of Rural Highway, 2015).

Table 30 Minimum width of cycling lane from Thai Cycling lane Design Standards Manual

Type of cycling lane	Parking	Avg. speed 50 km/hr	Avg. speed 70 km/hr
Wide curb lane	with parking	4.2 m	4.5 m
	without parking	4.2 m	4.8 m
Bike lane	with parking	1.7 m	2.2 m
	without parking	1.7 m	2.2 m
Median protected bike lane	One-way	2.0 m	2.0 m
	Two-way	3.0 m	3.0 m

In addition, international guidance also uses the flow rate of bicycle users as criteria to determine the minimum cycling lane width. The flow rate categories is presented in Table 31 (Transport for London, 2014), while Table 32 (ibid.) summarises the minimum and recommended absolute widths, which are described in more detail below. In all cases, consideration should be given to the impact of site-specific conditions on effective width, as described above, and the need to accommodate higher cycle flows over time.

Table 31 Cycling flow rate categories

	Peak hour	6am-8am	24-hour
Low	<200	<1,000	<1,600
Medium	200-800	1,000-4,000	1,600-5,500
High	800+	4,000+	5,500+

Table 32 Summary of width guidance on each type of cycling lane

Type of cycling lane	Absolute minimum	Preferred minimum
Cycle lanes (include contraflow lanes)	1.5 m	2.0 m
Bus/cycle lanes (share lane)	4.0 m	4.5 m
1-way cycle track (include segregated lanes)	1.5 m (low flow) 2.2 m (medium flow) 2.5+ (high flow)	
2-way cycle track	2.0 m (low flow) 3.0 m (medium flow) 4.0+ (high flow)	
Shared use – separated (two-way)	1.5 m each for cyclist and pedestrians (low flow) 3.0 m each for cyclist and pedestrians (high flow)	
Shared use – fully shared (two-way)	2.0 m (low flow) 3.0 m (high flow)	

These standards must be considered when planning and designing new cycling lane which appropriate for each specific roads in Bangkok.

4.5.3. Cycle parking

Secure cycle parking is an essential facility for people to decide to travel by bicycle. Most people are aware of theft and refuse to travel by their own bicycle if there is no secure parking. Therefore, secure cycle parking should be installed at major public transport areas and destination of travel i.e. office buildings, markets, shopping centres, residential buildings, schools, plazas etc.

A number of principles have been developed by Transport for London to explain best practice in the provision of cycle parking.

- **Visible** - Cycle parking should be easy to find and well-signed. Hiding it away in a corner of an underground car park may mean that staff doesn't know it is there - publicise it, if necessary, moving it might be better.
- **Accessible** - Cycle parking should be easy to get to and preferably within 20-30m of the final destination. Putting it close to the front door makes a positive statement to both staff and customers alike.
- **Safe and secure** - Not only should it be possible to securely lock the bike frame and wheels to something immovable, those using the parking should not feel that their personal security is at risk. Additional lighting or CCTV may also be needed. 'Natural' surveillance by passers-by or by being overlooked is usually the best form of security.
- **Easy to use, manage, maintain and regularly monitored** – Bike racks should be able to support all types of bicycle. Cycle lockers work best when they are assigned to individuals and have effective management systems. Surfaces under and around stands and lockers should be easy to sweep. It should be regularly monitored to realise the need to provide more cycle stands or to remove abandoned bicycle. These are everyday tasks for an efficient premises management team.
- **Consistently available** - Where parking is needed for short periods, for example in shopping areas, small clusters of stands at frequent intervals will often provide a better level of service than larger groupings at fewer sites. This is equally true of large employment sites where staff are based in different buildings.
- **Covered** - Covered long-stay parking at any site will make cycling a much more attractive option. This is especially important for employee parking and is very strongly recommended.
- **Connected** - Cycle parking should complement both the on-road and off-road cycle network and destinations along the way. There should be no barriers to its use caused by difficult road conditions or other safety hazards. Perhaps the site entrance could be improved for the benefit of cyclists
- **Linked to other services** - Where parking is provided at rail or bus stations, opportunities to combine parking with activities such as cycle hire, repair and tourist information should be exploited. If this doesn't appear to apply, just remember that visitors, customers and staff can all share the cycle parking if it is provided.
- **Attractive -** The design of cycle parking equipment should ensure it fits in visually with its surroundings. High quality always makes a statement about commitment.
- **Not a problem for others -** Cycle parking should not get in anyone's way. If located thoughtfully, the latter is unlikely to be an issue unless there is general public access. Keeping it clear of people and vehicles moving about a site will help meet the requirements of health and safety legislation.

The example of recommended cycle parking type from *Workplace cycle parking guide* (Transport for London, 2014) is presented in Table 33 (Transport for London, 2014).

The guidelines for cycle parking facilities location and amount standard is presented in *Annex 4A: Standards for Bikeway Design and Construction in Thailand*, while the suggestion for Thailand's environment is discussed in *Annex 4B: Cycle parking conference*.

Table 33 Examples of recommended cycle parking type

Type	Figure	Description
Sheffield stands	 Sheffield stand  'Toast rack' used for temporary parking	**Very strongly recommended** for most uses: they can park two bikes on one stand and are cheap to buy and install. Users like them as they support the frame of the bike and allow a range of locking positions. They can be bought as individual stands or in 'toast racks' that can be bolted-down in a number of locations. They are also available in a variety of finishes from stainless steel to coloured nylon, or simply galvanised to keep costs down. Maintenance costs for Sheffield stands, and other simple parking systems, are virtually nil. Always aim for a distance of at least 1m apart as cramming them together makes them harder to use and does not always increase capacity
Covered parking	  Parking under overhang	**Very strongly recommended** for employee parking and partnered with Sheffield stands. This can be achieved by the use of purpose-made shelters or by the use of existing building overhangs or covered areas. Please make sure that the roof gives adequate cover or site it so that the prevailing wind does not blow rain onto saddles. Clear roofing materials make for better surveillance, and therefore personal security, and reduce the need for additional lighting.
Two-tier racks		**Recommended** where extra capacity is needed. Each bike has its own 'space' so will not catch on adjacent bike when being inserted/removed. Best provided where instructions for use can be given as apparent effort needed to raise bikes may discourage some potential users. Can be angled at 45 degrees or more to minimise aisle width

4.5.4. Suggested infrastructure measures to promote the cycling safety and convenience[6]

Cyclist protective intersection

In any country, road intersections are where accidents happen the most. The first pioneer whom invented the physical measure or infrastructure to raise security at the intersection for the cyclists is the Netherlands. Currently, physical measures have been used in multiple countries across the globe, including:

- To have a small traffic island at the corner of intersection for a cyclist to avoid cars
- To have specific area for the cyclists to wait for the green light signal
- To have a separated area for the cyclists for preventing them from riding in same area as cars
- To have a specific traffic light system separated from the cars to facilitate the cyclists

Promotion for cycling for short trips

Most of people will use a bicycle for travelling short distance trips up to 5 km because people are not tired in that duration. Although hard figures are hard to come by for Bangkok, a comparison with Indian megacities, where 40-70% of trips are less than 5 km, shows the potential. Besides commuting trips for a certain share of the population, this includes trips to the market/local shops, running errands, visiting friends, going to restaurants or coffee shop, etc.

Promotion of cycling as a part of public transports system

For longer trips cycling can be combined with public transport, notably BTS/MRT. Therefore, there are multiple cities starting to pay attention on urban planning that will allow people to use a bicycle with public transportation system by parking a bicycle at the nearest urban rail or bus station, then continue their journey. For the last-mile or egress, bike sharing systems provides access to the final destination. Singapore's National Cycling Plan[7] has a particular focus of improving infrastructure (bike lanes, parking, bike sharing) around metro stations.

'NMT-only' streets

This measure has been activated for long time, and it attempts to encourage people not to use a car but a bicycle or walking. It can be permanently blocked for motorised private vehicles (common practice in European inner cities), part of the day (e.g. Hanoi's old town streets are NMT-only after 7 pm every day) or certain days a week or month (monthly car-free day in Jakarta). It leads people to realise the situation where a road is taken back for the community from crowded cars and provides for quality public space where street life thrives.

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[6] This section is based on PSK reports and Bakker et al. (2016). The latter provide additional policy options, beyond infrastructure, as well.

[7] https://www.ura.gov.sg/uol/master-plan/View-Master-Plan/master-plan-2014/master-plan/Key-focuses/transport/Transport

Creation of private sector's role in supporting the use of a bicycle

One issue or obstruction of a cycle track construction in city is the entrepreneur tend to oppose as this group of people is worried that a cycle track will affect their business performance. This happened with the cycle track on Koh Rattanakosin which the Bangkok governor had a policy to create following the government policy. During the construction, there was a lack of collaboration from the community in giving validation and opinion so it affects to performance of the business around Bang Lam Phu area. Thus, it is important, in any case of a cycle track construction, to gather collaboration among entrepreneur in the area in every process.

Public bicycle system

From the study all over the world on cycle use reveals that the more use of a bicycle of the people in the city, the more safe the traffic system will be, and one factor which involves in supporting people to use a bicycle is to have a public cycle system. This has been proven and this system is growing rapidly across the globe[8]. If this system is easy to access, convenient, capable to cover as much area as possible, and cheap, expanding the existing Pun-Pun system is likely to attract more riders.

Supporting budget allocation for projects of cycle infrastructure

German cities such as Hamburg and Berlin are increasing annual budget allocation to cycling and have set targets at 3 and 5 Euro/capita per year. Though this is still substantially below cities in The Netherlands and Denmark, the investments have led to growth in modal share of cycling by more than 2%-points (Lanzendorf and Busch-Geertsema, 2014).

Focus on integrated network of bike lanes

In this case, a good example is New York City. New York City has 616 kilometres of cycle track separated from the road and covers 5 districts in town. It has been planned to be built more in every year. Department of Transport, New York City reported that this cycle track does not only create safety for the cyclists, but the pedestrians, and the drivers are facilitated with security from cycle track construction too. The separated cycle track at Columbus Road makes an increase of the cyclist for 56 percent in week days and traffic accident is decreased for 34 percent with all roads remain the same condition. This report argues that the income of the retail shops along a cycle track is increased, if compared with other roads nearby. It implies a good sign of using a bicycle in enhancing economy.

Improve connectivity between sois

Sois and other small roads are already quite suitable for cycling, particularly the quieter ones. However most of these are dead-ends, effectively eliminating an excellent opportunity for creating cycling network. Cyclist are forced to take large detours and go on the unsafe larger streets. Strategically removing blockages is a low-cost, high benefit way to create a network. Even though politically difficult as it may require purchasing land from land-owners, this option should not be forgotten. A few trials of 1.5-2 m wide connections on strategic points could help building public interest and momentum.

Outskirts connectivity by cycling

Cycling lane and infrastructure construction at the outskirts where the accessibility of travelling by a bicycle is low will create tremendous effect to the central city because it means to the expansion of transportation system. Key areas include local train station, BTS/MRT stations and other public transport hubs.

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[8] https://www.google.com/maps/d/viewer?mid=zGPlSU9zZvZw.kmqv_ul1MfkI&hl=en

4.6. Conceptual design of study area

The chapter presents the proposed conceptual design of NMT and ITF for paratransit in Soi Ari for accommodating future modal share by focusing on the mode shift to NMT. The design is based on following information:

- Target group questionnaire survey result
- Traffic count survey result
- Street audit result
- Expert advice from Thai Cycling Club

This conceptual design aims to present the pilot project for NAMA study by visualising and suggesting the potential interventions that are suitable for existing environment of Bangkok and vicinity. The further detail design is planned to be studied and implement at a later stage.

The conceptual design is presented in 3 levels: Location of improvement intervention route and facilities (4.6.1); Dimension and quantity of facilities (4.6.2); Facilities requirement concept (4.6.3); Conceptual design (4.6.4).

4.6.1. Location of improvement intervention route and facilities

The intervention routes for NMT in Ari area are selected from the major access route of civil servant in Governmental office district which are the main target NMT users besides Ari residents and other workers. The proposed improvement NMT route suggested locations of each type of NMT facilities for Phase I are illustrated in Figure 101.

- Expanded covered footway with street vendors (Light blue line) – from Phahonyothin road West side footway from BTS Ari station, then turn left into Soi Ari and end at Soi Ari 2. Also, the market area inside Soi Ari 1.
- Expanded covered footway without street vendors (Dark blue line) – from Soi Ari 2 to the End of closed study area at Public Relations Department
- Covered median protected bike lane on kerbside (Brown line) - from the beginning of Soi Ari to the End of closed study area at Public Relations Department
- Two-way share lane- inside Soi Ari 1
- Cycle parking (Dark green rectangles) – install near BTS station, bus stops, along bike lane area and governmental office district
- Pun Pun bike sharing station (Purple rectangles) – install near BTS station, bus stops and governmental office district
- Pedestrian crossing (Red line) – level crossing for better accessibility and for traffic calming
- Bus stop (Blue circle) – relocate and expand the waiting area
- Other paratransit bay (Motorcycle taxi, Motorised three-wheeler, Songtheaw) should be remove from bike lane and footway, and relocated along parking lane area
- Signage and road marking for warning both bicycle users and normal traffic at critical location e.g. intersection ad pedestrian crossing

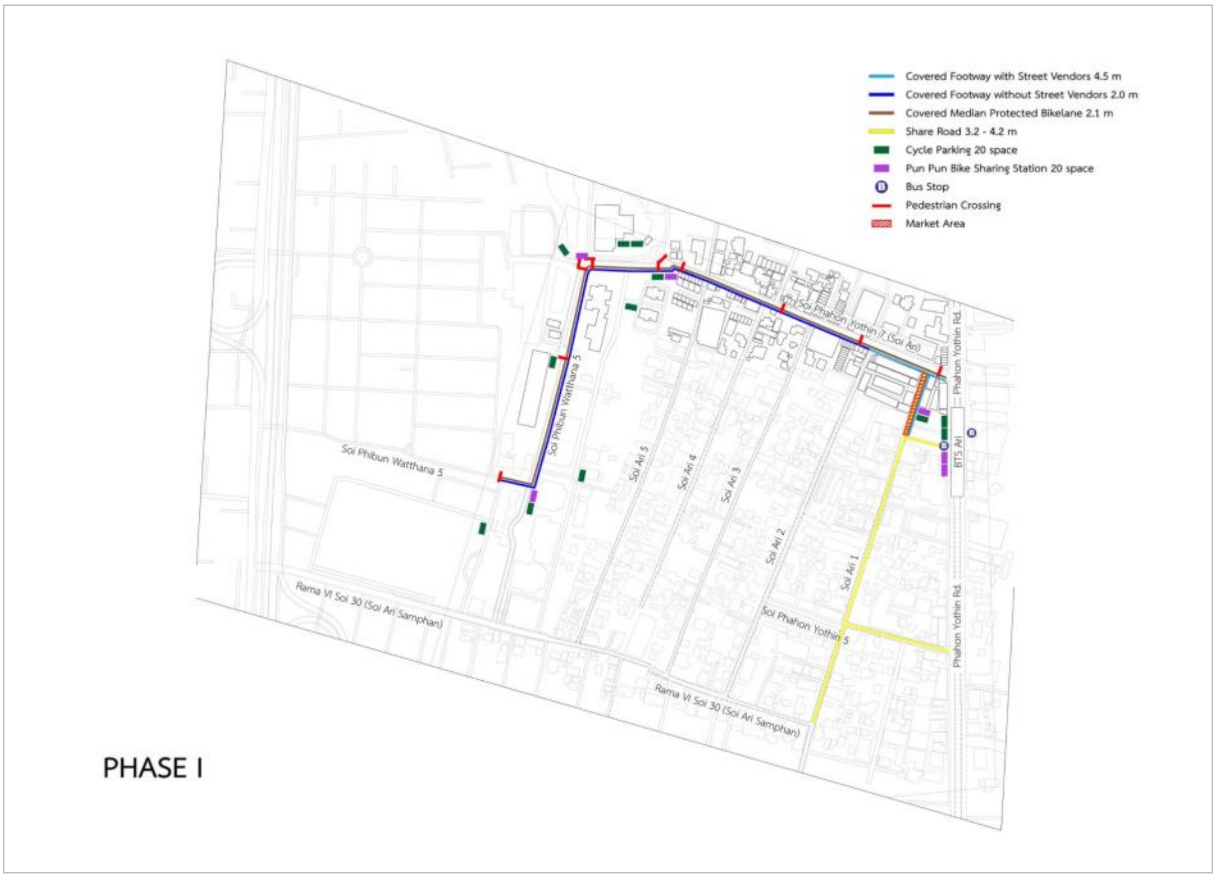


Figure 99: Improvement intervention route and facilities – Phase I (Source: Consultant, 2015)

The Phase II of intervention is suggested to extend the covered footway and bike lane to Soi Arisamphan and Rama VI road. Two-way share lanes with proper road marking and signage should extend to cover all Ari area. Cycle parking and Pun Pun bike sharing stations should be installed at new strategic area and increase amount at key ITF near Fix-routed mass transit station and inside Governmental district office buildings that have high volume of civil servants.

Figure 100: Improvement intervention route and facilities – Phase II (Source: Consultant, 2015)

4.6.2. Dimension and quantity of facilities

The recommended dimension and quantity of facilities for Phase I interventions are proposed for conceptual design by using following references:

- Forecast flow rate of pedestrian, bicycle user, motorised paratransit in future from Chapter 3.9.
- Footway width design guidance from Chapter 4.4 and Chapter 4.5
- Survey number of paratransit bay and number of paratransit passenger waiting in the queue

Footway width

According to peak pedestrian potential demand from Table 20 and the total width required for each footway condition which is determined from Table 28, the recommended footway width at each location of Ari area is presented in Table 34.

Table 34 Recommended footway width for NMT intervention

Location	Forecasted maximum flow rate	Function	Recommended footway width	Minimum allowance
Beginning of Soi Ari (Location A, B)	2,400 passengers/hr (crowded flow)	1-side street vendors	4.4 m	2.7 m (without street vendors)
Closed study area (Location E, F, G, H)	640 passengers/hr (minimum standard)	No street vendor	2.1 m	1.5 m

Bike lane width

According to peak bicycle user potential demand from Table 21 and physical survey of current infrastructure and other transport behaviour which is described as follow:

- Forecast potential peak hour flow is approximately 200 bicycle users per hour
- Street vendors and footways requirement at the beginning of Soi Ari (Location A and B)
- High demand of paratransit at the beginning of Soi Ari (Location A and B)
- Narrow lane width at end of Soi Ari area (Location E)
- Wide footway and road lane inside closed study area (Location F, G, H)
- Average motorised traffic speed is lower than 50 km/hr (The actual survey speed is approximately 30 km/hr)

The recommended cycle lane type and width of Ari area, based on cycle lanes type and width guidance in Chapter 4.5, is present in Table 35.

Table 35 Recommended cycling lane width for NMT intervention

Location	Forecasted maximum flow rate	Function	Recommended lane width	Minimum allowance	Conceptual Designed
Soi Ari (Location A, B, E)	200 users/hr (Low flow)	2-way median protected lane	2.0-3.0 m (buffer 0.5-1 m)	1.7 m (buffer 0.3 m)	1.7 m (buffer 0.3 m)
Closed study area (Location F, G, H)	200 users/hr (Low flow)	2-way median protected lane	2.0-3.0 m (buffer 0.5-1 m)	1.7 m (buffer 0.3 m)	2.7 m (buffer 0.3 m)

Due to limited lane width of Soi Ari and forecasted low non-peak hour flow rate, the cycling lane from beginning to the end of Soi Ari is designed to have minimum allowance width.

Cycle parking and Pun Pun bike sharing station

According to peak bicycle user potential demand in the morning peak hour at 216 bicycle users per hour, the initial phase facilities for cycle parking and bike sharing station should be provided at near BTS Ari are at least 50% of peak hour demand at approximate 100 spaces. The conceptual design proposed to have 60 cycle parking spaces and 40 Pun Pun bike sharing station space.

4.6.3. Facilities requirement concept

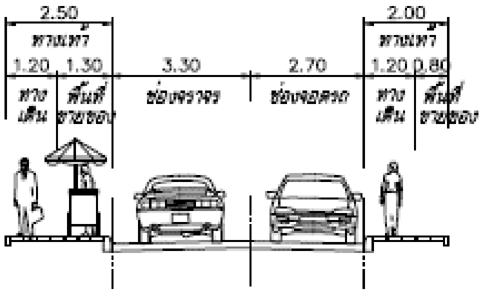
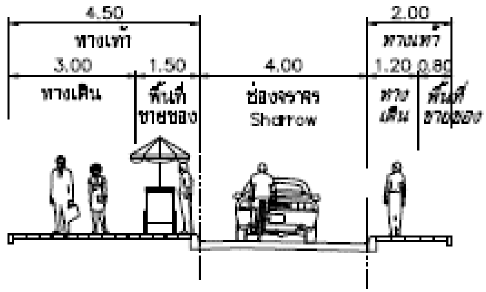
From the result summary in Chapter 3.8.1, the most appropriate intervention design is Option 3. The main design concept aspects are described as follows:

- Reduce on-street parking for expanding footways width and install bike lane. Extra on-street parking space with parking fee shall be provided inside other Sois in proximity Ari area. (Daytime should allow only temporary parking for loading on assigned loading bay and paratransit transfer hub along North side of Soi Ari)
- Relocate street vendors to step back further on expanded area of footway for wider clear footway width to accommodate future pedestrian flow. This includes the provision for customers queue in front of vendor stalls and better sightlines at crossing.
- Relocate para-transit passenger waiting area and para-transit bay in order to reduce blockage of pedestrian flow and for install the bike lane

- Install Level-pedestrian crossing at the location that has high demand of crossing pedestrians
- Install tactile paving for visual impaired people and seniors
- Increase the priority of pedestrian at the market area by changing the traffic lane to be share road and walking street
- Remove or relocate cluttered street furniture
- Install segregated 2-way bike lane with concrete kerb to separate normal traffic from cyclist
- Install shading cover along footways and bike lane, with lighting
- Install cycle parking and Pun Pun bike sharing station facilities around BTS Ari an Ari area, including inside governmental office building.
- Remove or relocate drainage cover in bike lane for cyclist safety

The detail of interventions at each specific location is presented in Table 36 - 43 by illustrating the perspective figures of existing environment and proposed concept environment.

Table 36 Location B- Soi Ari 1 intersection – Start point of market area (Source: consultant)

<table>
<tr><th>Existing</th><th>Proposed</th></tr>
<tr><td></td><td></td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">

- Relocate motorised three-wheeler bay and motorcycle taxi bay from along South-side footway and inside Soi Ari 1 to North-side
- Expand the South-side footway width and relocate street vendors the step back futher to newly expanded footway
- Install 2-way bike lane with concrete kerb next to South-side footway along Soi Ari
- Install shading cover along footways and bike lane, with lighting
- Install level pedestrian crossing at the beginning of Soi Ari 1
- Change parking lane in Soi Ari 1 to be market area but install 20-minute loading area instead
- Repave the street of Soi Ari 1 with difference surface or colour to indicate market area which has high number of pedestrians cross the street in Soi Ari 1 and for traffic calming
- Increase the height of road paving to be the same level as existing footway to increase the permeability and accessibility of the market area
- Install share-road marking in Soi Ari 1(1-way normal traffic but 2-way bicycle traffic by using share-road marking to mandate bicycle to keep left)

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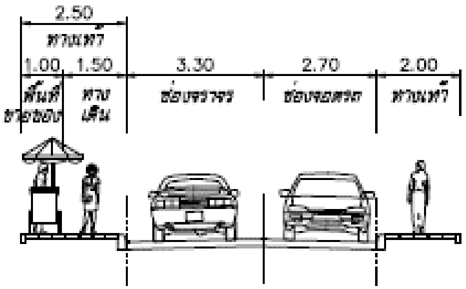
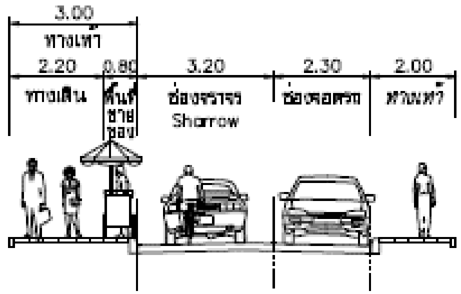
</table>

Table 4-32 Location C – Middle of Soi Ari 1 - End point of market area (Source: consultant)

Existing	Proposed
	
	

- Change parking lane in Soi Ari 1 to be market area
- Relocate motorcycle taxi bay to the end of market area
- Repave the street of Soi Ari 1 with difference texture or colour for indicate the walking street market area in Soi Ari 1 and for traffic calming
- Increase the height of road paving to be the same level as existing footway to increase the permeability and accessibility of the market area
- Install share-road marking in Soi Ari 1(1-way normal traffic but 2-way bicycle traffic by using share-road marking to mandate bicycle to keep left)

Table 4-33 Location D – Next to BTS Ari station – ITF hub (Source: consultant)

<table>
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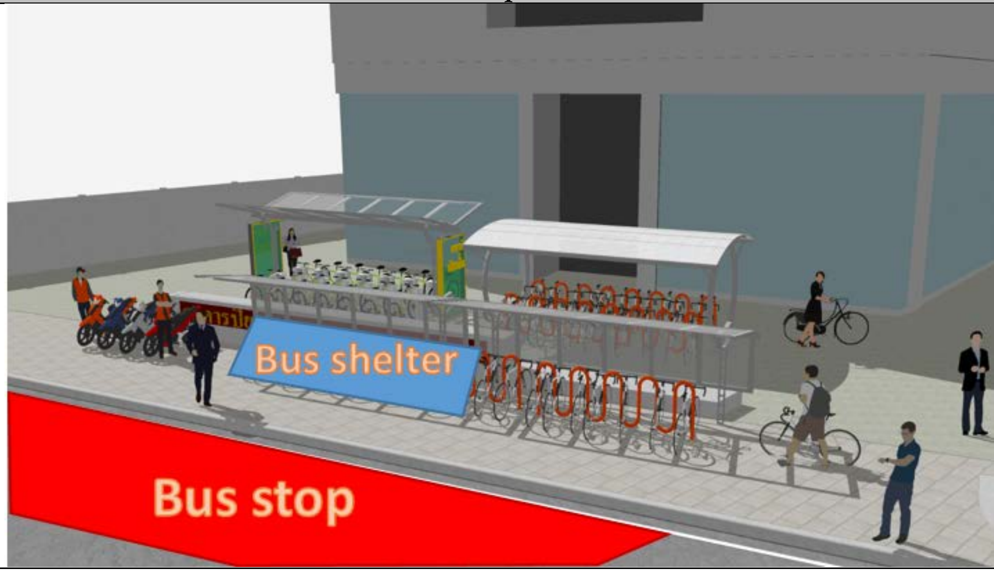
<tr><td></td><td>
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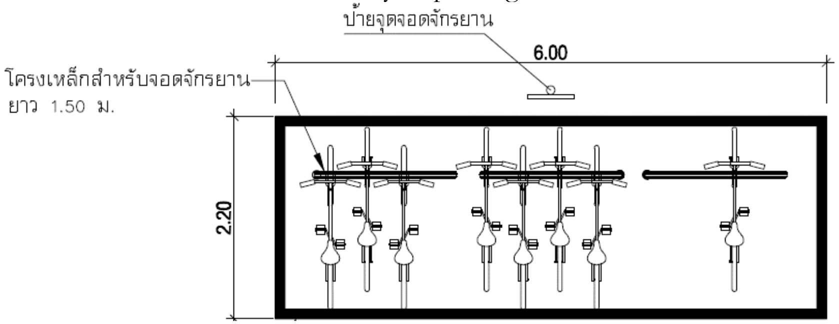
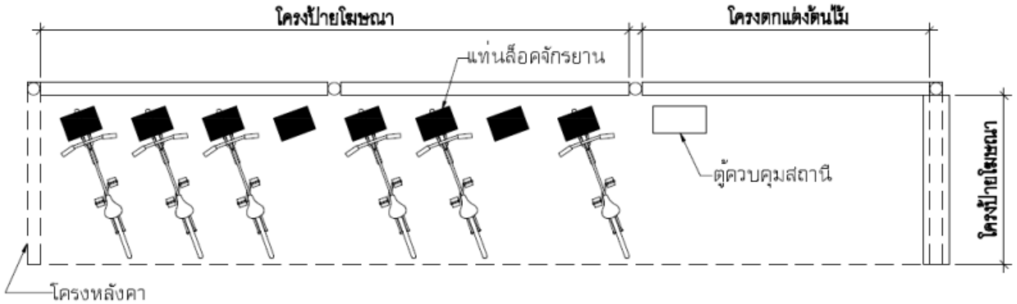
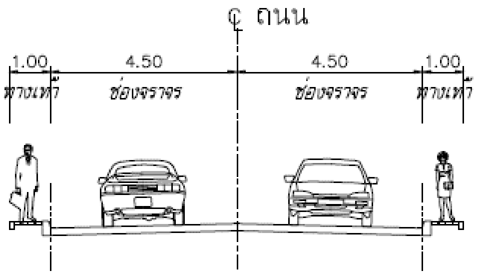
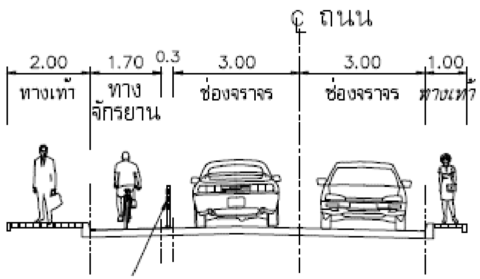
<tr><td>Cycle parking

</td><td>Pun Pun bike sharing station

</td></tr>
<tr><td colspan="2">

- Relocate West-side Ari bus stop from under BTS entrance stairs to in front of Piyawan building for better sightline for passengers at waiting area
- Install Pun Pun bike sharing station in front of Piyawan building
- Install secure cycle parking with roof cover in front of Piyawan building and under BTS entrance stairs

</td></tr>
</table>

Table 4-43 Location E – End of Soi Ari – Short share-road section (source: consultant)

Existing	Proposed
	
	

- Expand the South-side footway width
- Install 2-way bike lane with concrete kerb next to South-side footway along Soi Ari and end at the narrowest road section at the end of Soi Ari
- Install shading cover along footways and bike lane, with lighting
- Install level pedestrian crossing at the end of Soi Ari
- Repave the street from end of Soi Ari 1 to Department of Revenue gate with difference texture or colour for indicate the share road and for traffic calming
- Install share-road marking

Table 4-35 Location F – Department of Revenue gate – Cycle parking hub (source: consultant)

Existing	Proposed
	
▪ Expand the South-side footway width ▪ Change car parking space in front of Department of Revenue gate to be cycle parking and Pun Pun bike sharing station ▪ Install shading cover along footways and bike lane, with lighting ▪ Install level pedestrian crossing at the Department of Revenue gate ▪ Repave the street from end of Soi Ari 1 to Department of Revenue gate with difference texture or colour for indicate the share road and for traffic calming ▪ Install share-road marking	

Table 4-36 Location G – Inside Governmental office district (source: consultant)

<table>
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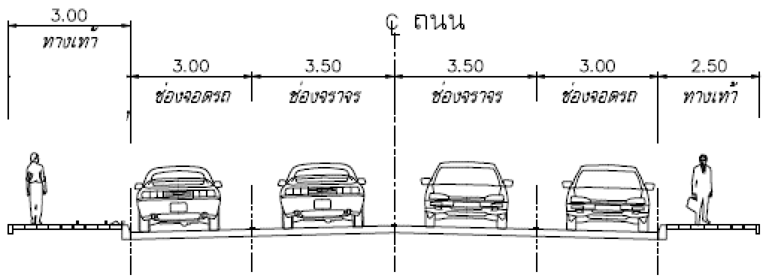
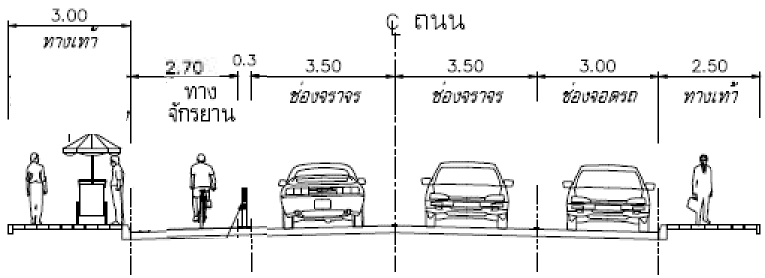
<tr><td>
</td><td>
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</table>

- Remove street vendors from the South corner of Soi Ari
- Relocate motorised three-wheeler bay from along South-side footway to North-side
- Expand the South-side footway width
- Expand the North corner footway width for pedestrian to wait before crossing and reduce crossing distance
- Install 2-way bike lane next to South-side footway starting from the South corner of Soi Ari
- Install concrete kerb for bike lane
- Install shading cover along footways and bike lane, with lighting
- Install level pedestrian crossing at the beginning of Soi Ari

Table 4-37 Location H – Pollution Control Department intersection (source: consultant)

<table>
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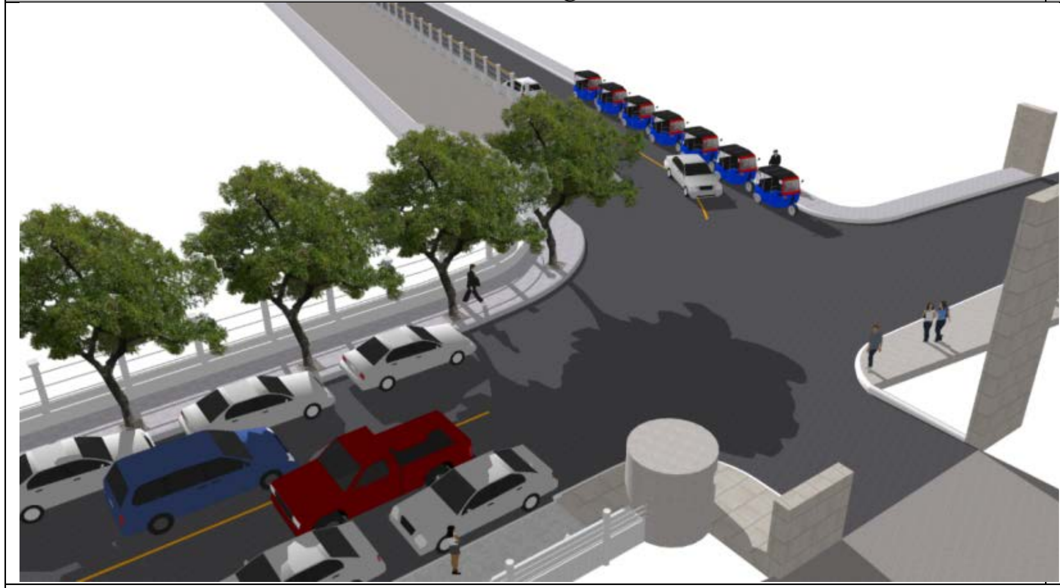
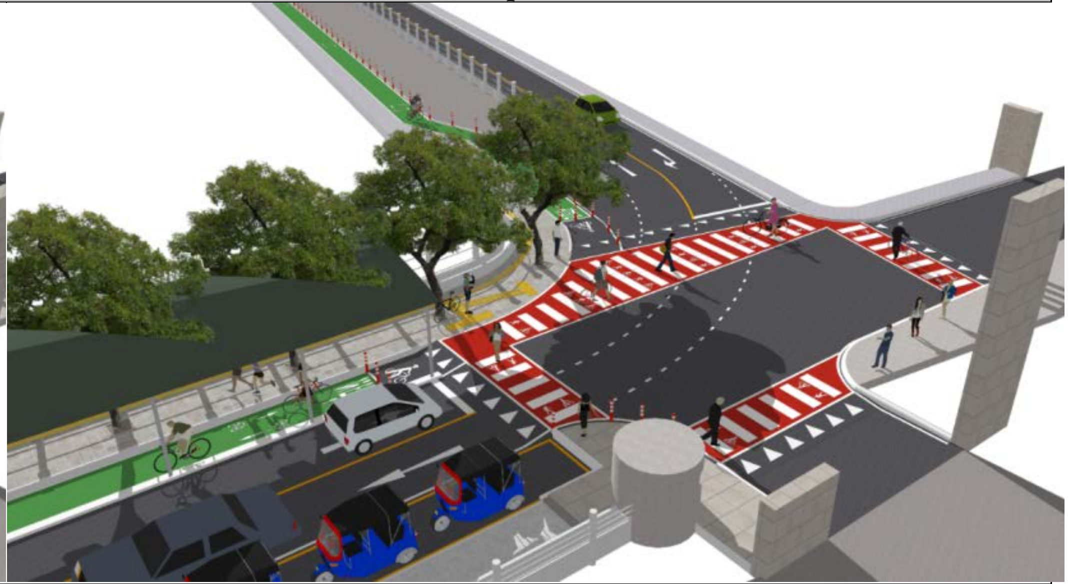
<tr><td></td><td></td></tr>
<tr><td colspan="2">

- Change parking lane along South-side footway to be bike lane
- Install shading cover along footways and bike lane, with lighting
- Install level pedestrian crossing table at the intersection in front of Pollution Control Department for traffic calming
- Install bike lane inside the Institute of Public Relations
- Relocate motorised three-wheeler and motorcycle taxi bay from the corner of intersection to along the North-side footway

</td></tr>
</table>

References

Bakker, S., M.D. Guillen, P. Nanthachatchavankul (2016) *Cycling in ASEAN megacities. Case studies on Bangkok and Metro Manila*. Forthcoming report, to be published by GIZ Thailand, www.transportandclimatechange.org

Department for Transport (2002) *Inclusive Mobility: A guide to best practice on access to pedestrian and transport infrastructure*, London.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3695/inclusive-mobility.pdf

Department for Transport (2003) *Traffic Signs Manual, Chapter 5: Road Markings*, London: The Stationary Office.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223667/traffic-signs-manual-chapter-05.pdf

Department for Transport (2008) *Traffic Signs Manual, Chapter 3: Regulartory Signs*, London: The Stationary Office.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223943/traffic-signs-manual-chapter-03.pdf

DLT (2015) *Draft Term of Reference: Bus system in Bangkok and vicinity development masterplan plan*, Bangkok.

GIZ (2011) *Avoid, shift, improve*, Germany.

http://www.transport2020.org/publicationitem/1027/factsheet-avoid-shift-improve-a-s-i

GIZ (2016) *People-centred Urban Mobility in Thailand, NAMA Concept Note*, Bangkok.

Grütter Consulting (2016). Assessment of Low Carbon Bus Technologies for Vietnam. Draft report, prepared for GIZ Vietnam, February 2016.

King County Metro (2008) *Signing Standards Manual*, Seattle.

http://seattletransitblog.com/wp-content/uploads/2011/09/MetroSigningStandardsManual.pdf

Lanzendorf, M., A. Busch-Geertsema (2014). The cycling boom in large German cities—Empirical evidence for successful cycling campaigns. *Transport Policy* 36 (2014) 26–33

Pike, N.P. and Rujopakarn, W. (1996) Finding a real solution to Bangkok's urban transport problems. *Urban Transport Asia'96 Conference*, June 24-26, Hilton Hotel Singapore.

Office of the Council of State (1979) *Land traffic Act, B.E. 2522*, Bangkok.

OmniTrans (2013) *Transit Design Guidelines*, California.

http://www.omnitrans.org/about/reports/files/Omnitrans-Transit-Design-Guidelines.pdf

OTP (2009) *Public bus system development in Bangkok and vicinity*, Bangkok: Prepared by PlanPro, Trans Consult, Somapa Information and Wichakorn.

OTP (2013) *Bus lanes in Bangkok and vicinity*, Bangkok. http://www.otp.go.th/index.php/pr-news/.5524html

Pujinda, P., Sanit, P. & Changklang, S. (2010) *Indicators for Pedestrian-Friendly Footpath in City Center of Bangkok: Patumwan case study*. Bangkok, Chulalongkorn University.

Rujopakarn, W. (2003) *Bangkok transport system development: What went wrong?*, Department of Civil Engineering, Faculty of Engineering, Kasetsart University, Bangkok.

http://pindex.ku.ac.th/file_research/657revised.pdf

Schoon, J.G., (2010) Pedestrian facilities: Engineering and geometric design. London, *Thomas Telford Limited.*

Thai Architecture Association and Thai Health Promotion Foundation (2014) *Si Yaek Jai Dee (Kind Junction)*, Bangkok.

Traffic and Transport Department, BMA (2015) *Traffic statistics 2014,* Bangkok. http://office.bangkok.go.th/dotat/StatBook/2557.pdf

Transport Canada (2012) *Improving Bus Service*, Public Works and Government Services Canada , Canada: Prepared by Gris Orange Consultant.

https://www.fcm.ca/Documents/tools/GMF/Transport_Canada/ImprovingBusService_EN.pdf

Transport for London (2006) *Accessible Bus Stop Design Guidance*, London.

http://content.tfl.gov.uk/ accessibile-bus-stop-design-guidance.pdf

Transport for London (2014) *Accessible Bus Stop Design Guidance – for consultation*, London. https://consultations.tfl.gov.uk/buses/accessible-bus-stop-design-guidance/supporting_documents/Accessible%20Bus%20Stop%20Design%20Guidance%20for%20public%20consultation%20290914.pdf

Transport for London (2015) *Pan London Red Routes (LoHAC)*, London. http://content.tfl.gov.uk/red-route-pan-london-lohac-map.pdf

Transport for London & Atkins (2010) Pedestrian Comfort Guidance for London. http://www.tfl.gov.uk/cdn/static/cms/documents/pedestrian-comfort-guidance-technical-guide.pdf

Transport Research Board of the National Academies (2013) *Transit Capacity and Quality of Service Manual – 3rd edition*, Washington, D.C.

http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_165fm.pdf

Transport Scotland (2009) Disability Discrimination Act: Good Practice Guide for Roads. http://www.transportscotland.gov.uk/report/j11185-06.htm

World Bank (2013) *Improve accessibility to transport for people with limited mobility (PLM).* https://openknowledge.worldbank.org/bitstream/handle/10986/17592/Accessibility0Report0Final.pdf?sequence=1

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Annex

Annex 2A: Bus re-route map from previous study

1st Full-scale bus re-route: BMTA route planning and scheduling project in Bangkok and vicinity (OTP, July 2004)
New bus route network covering 181 routes has been proposed which divided into 7 zones as shown in Figure 2A-1 to 2A-9

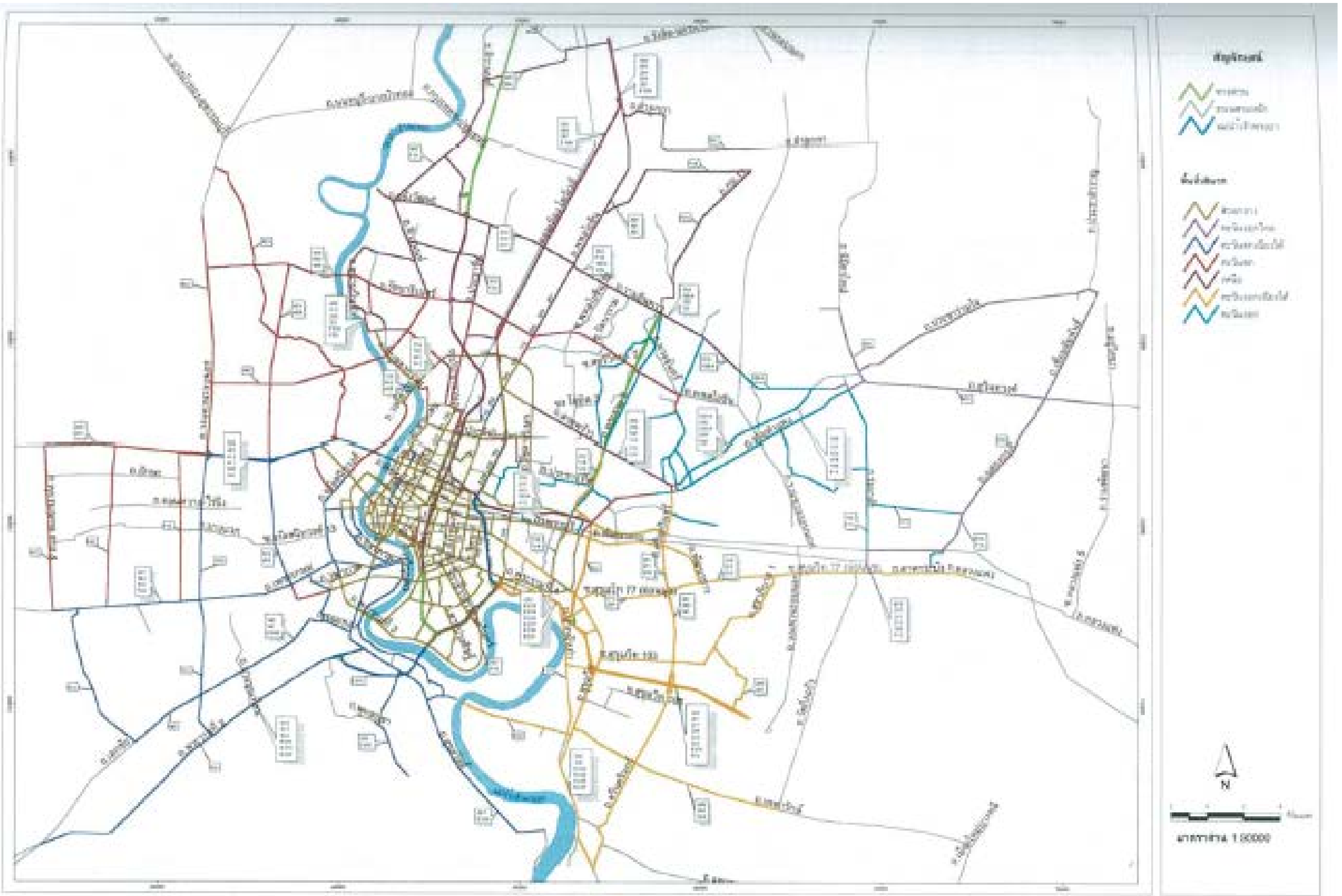


Figure 2A-4-101 All new Bus routes and BRT routes

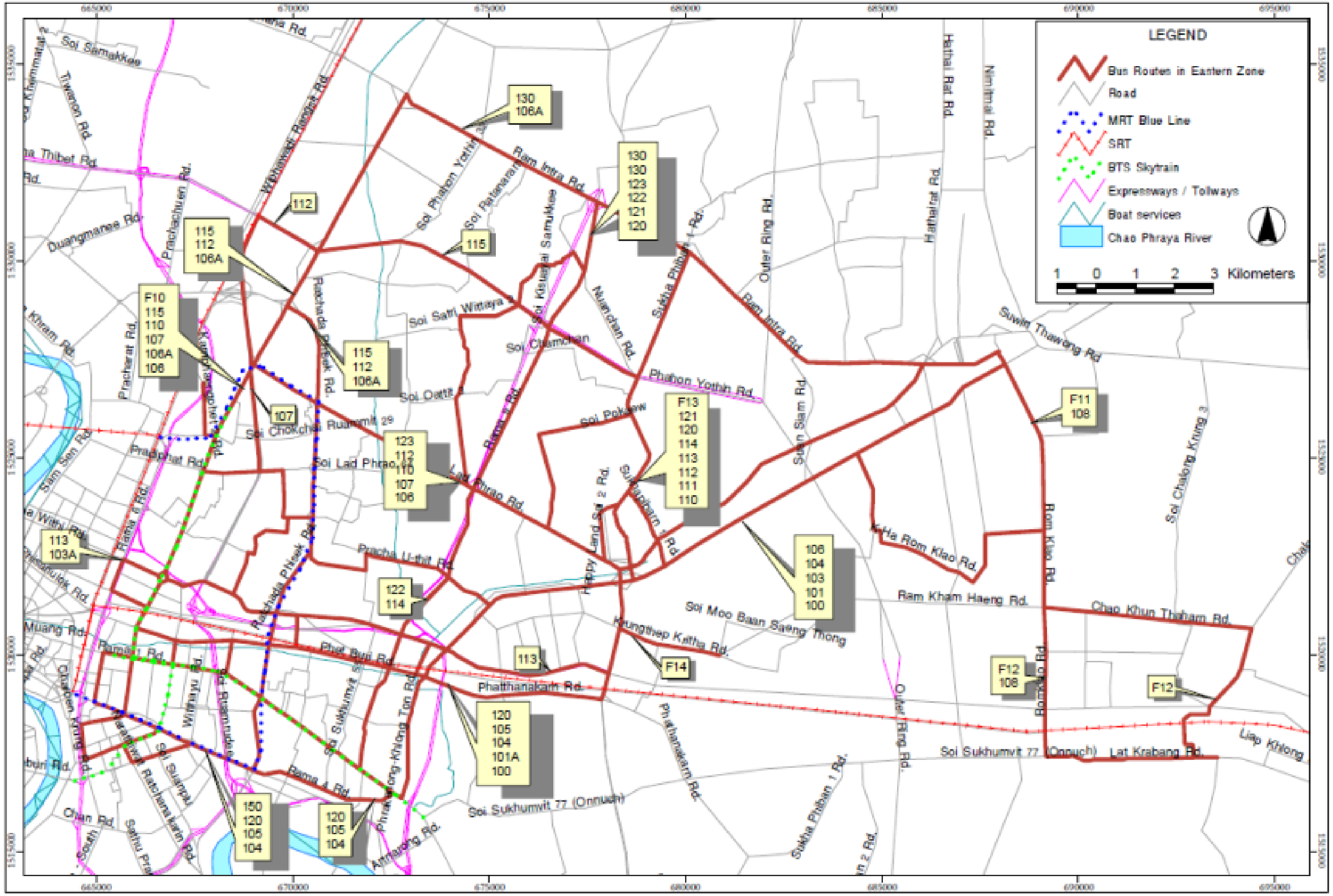


Figure 2A-4-102 New Bus routes in Eastern zone

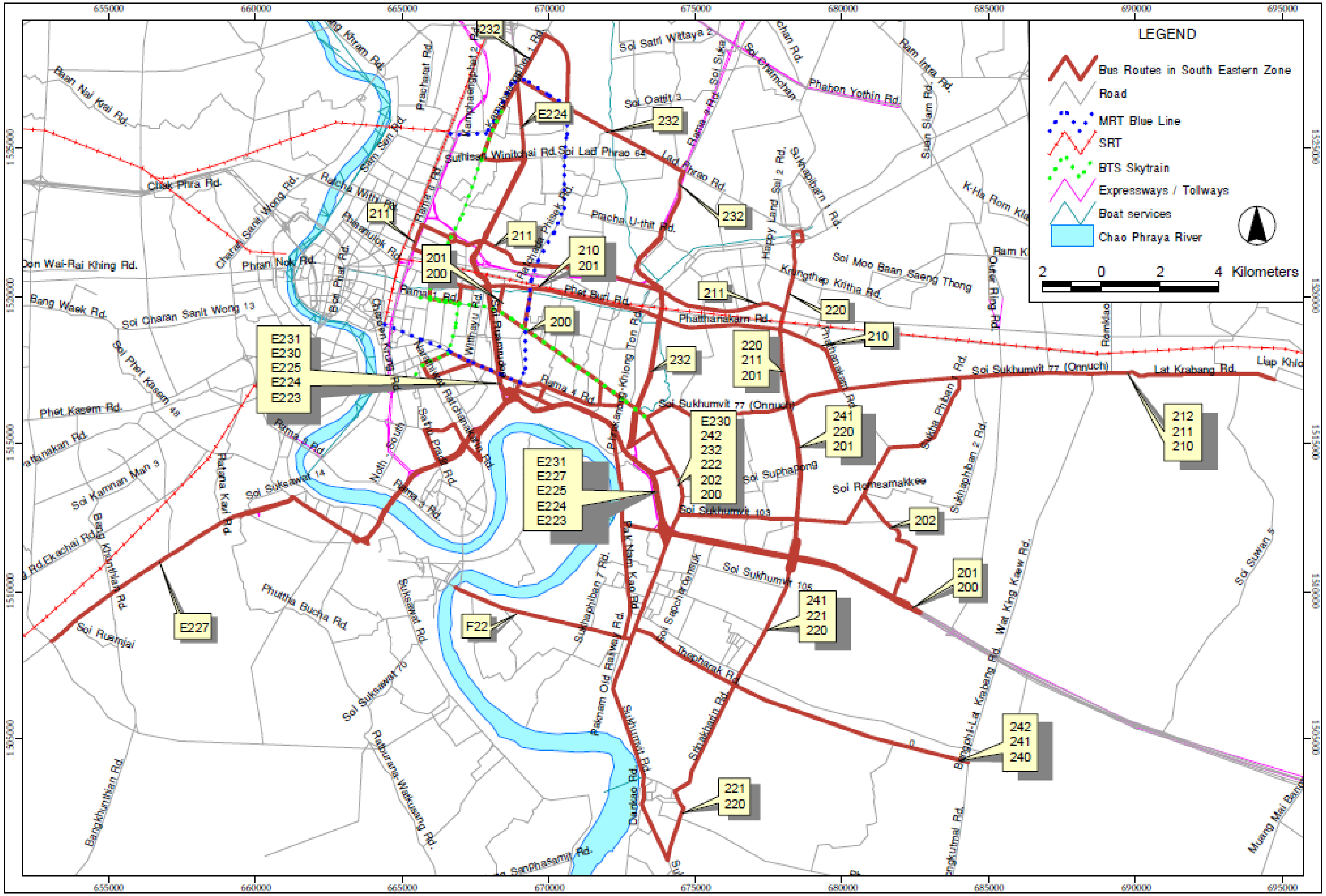


Figure 2A-4-103 New Bus routes in South Eastern zone

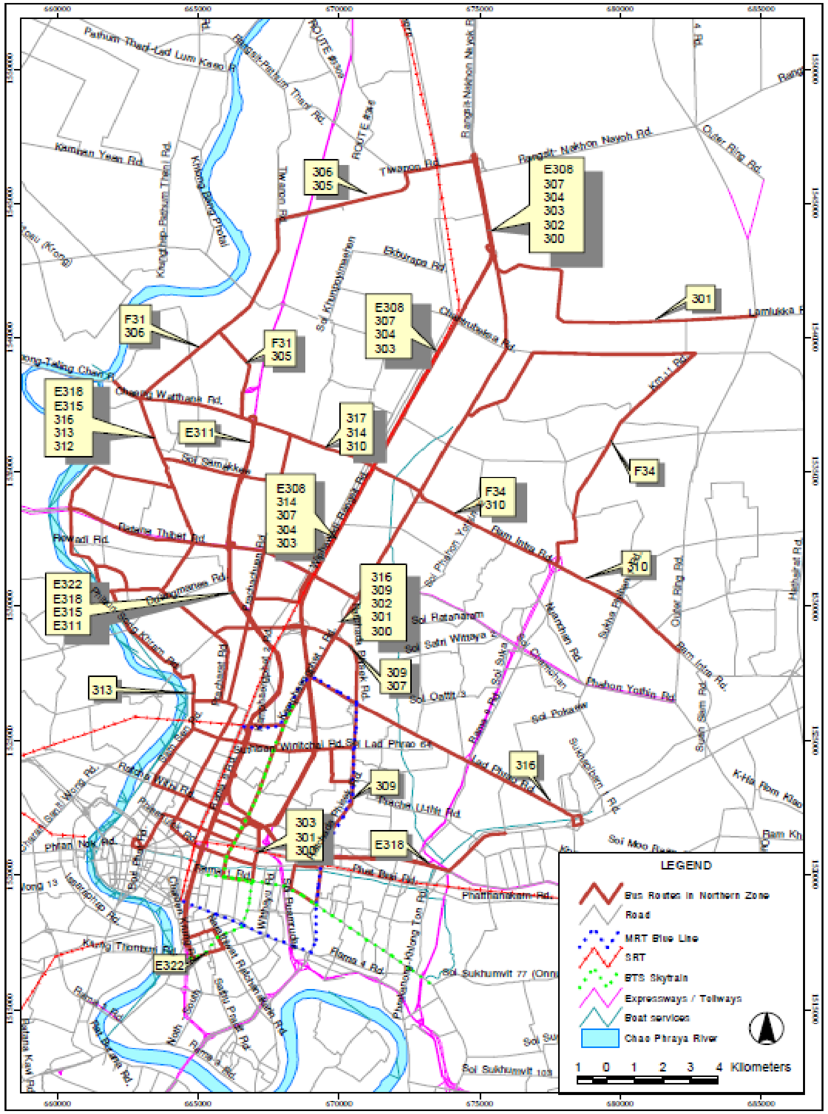


Figure 2A-4-104 New Bus routes in Northern zone

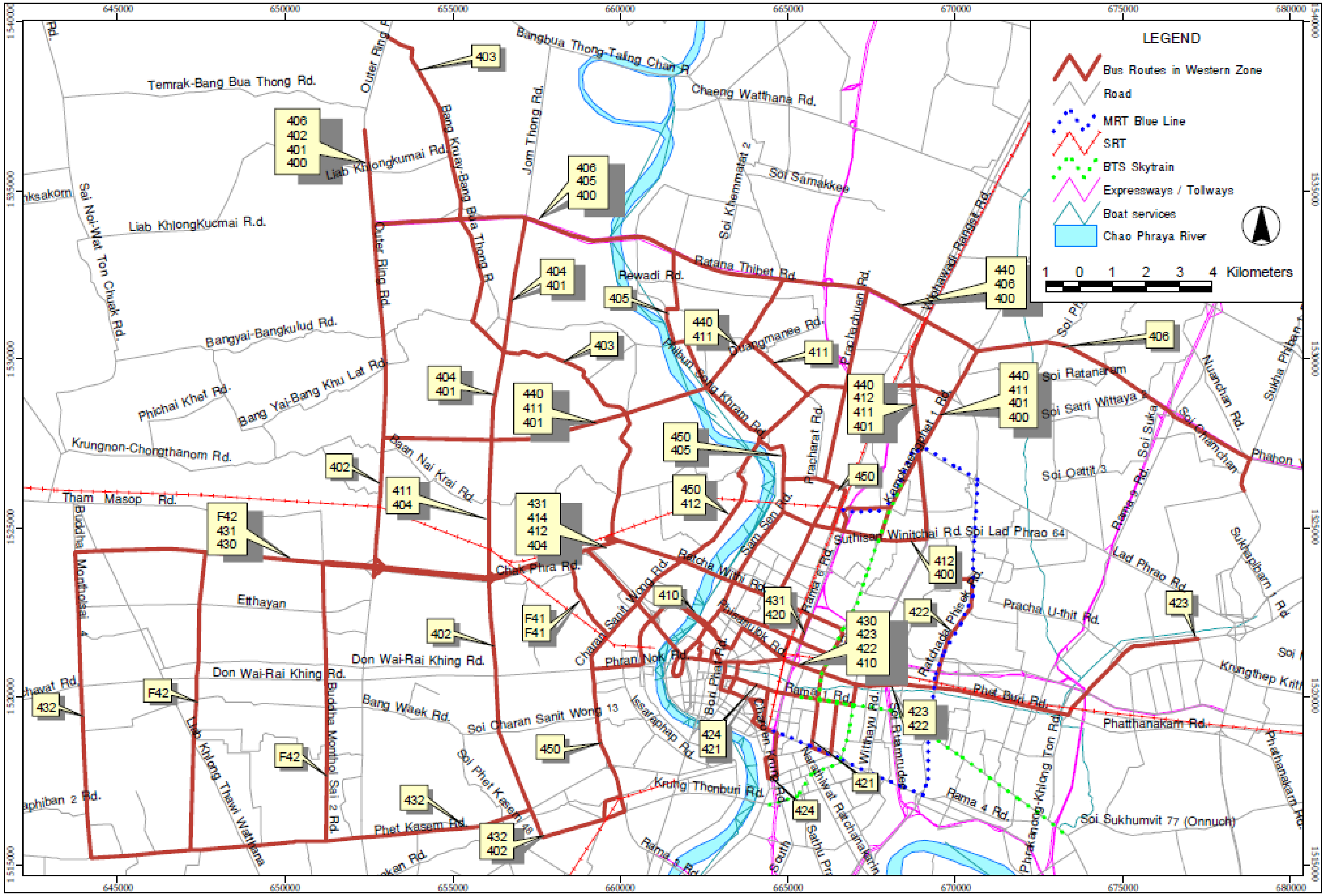


Figure 2A-4-105 New Bus routes in Western zone

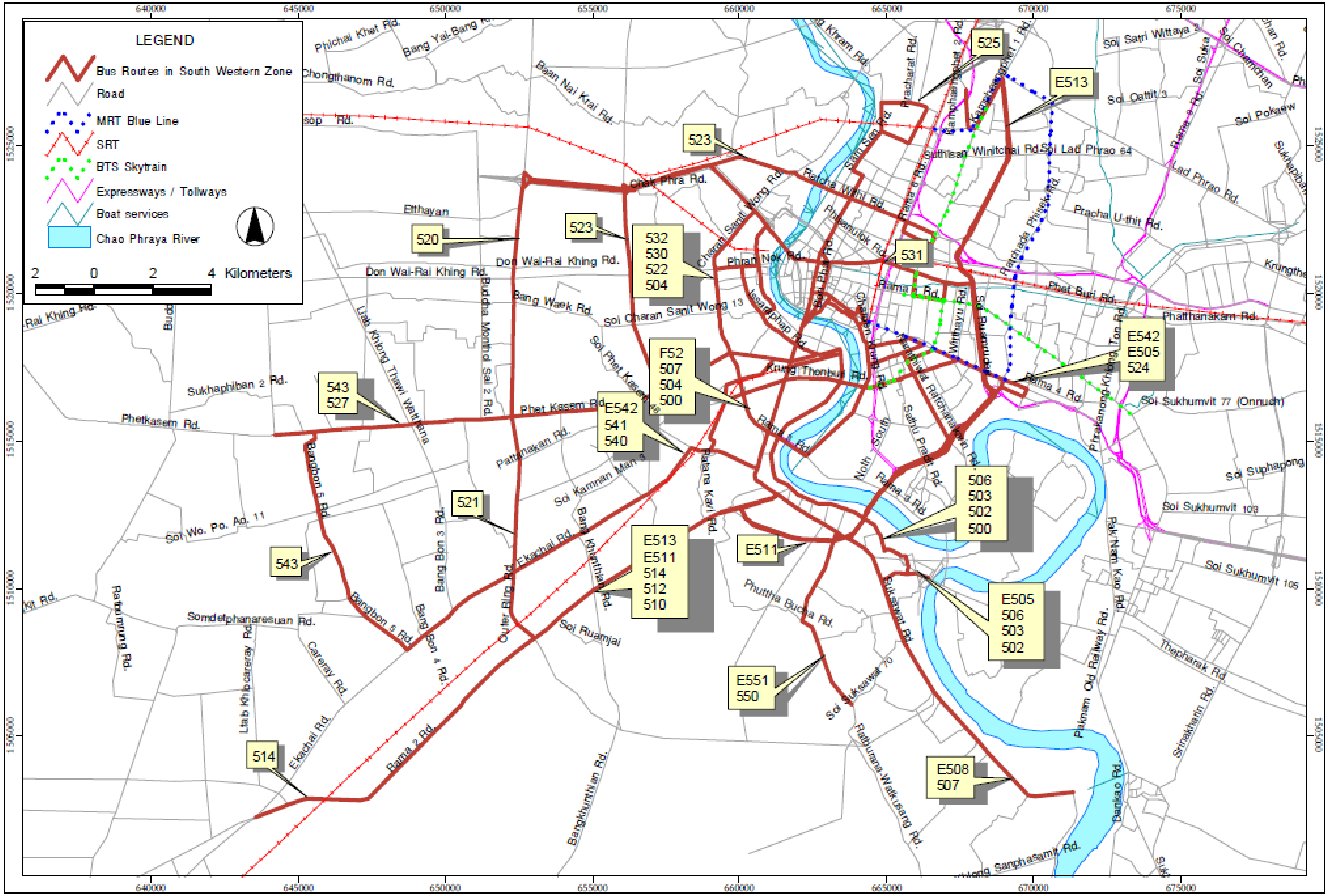


Figure 2A-4-106 New Bus routes in South Western zone

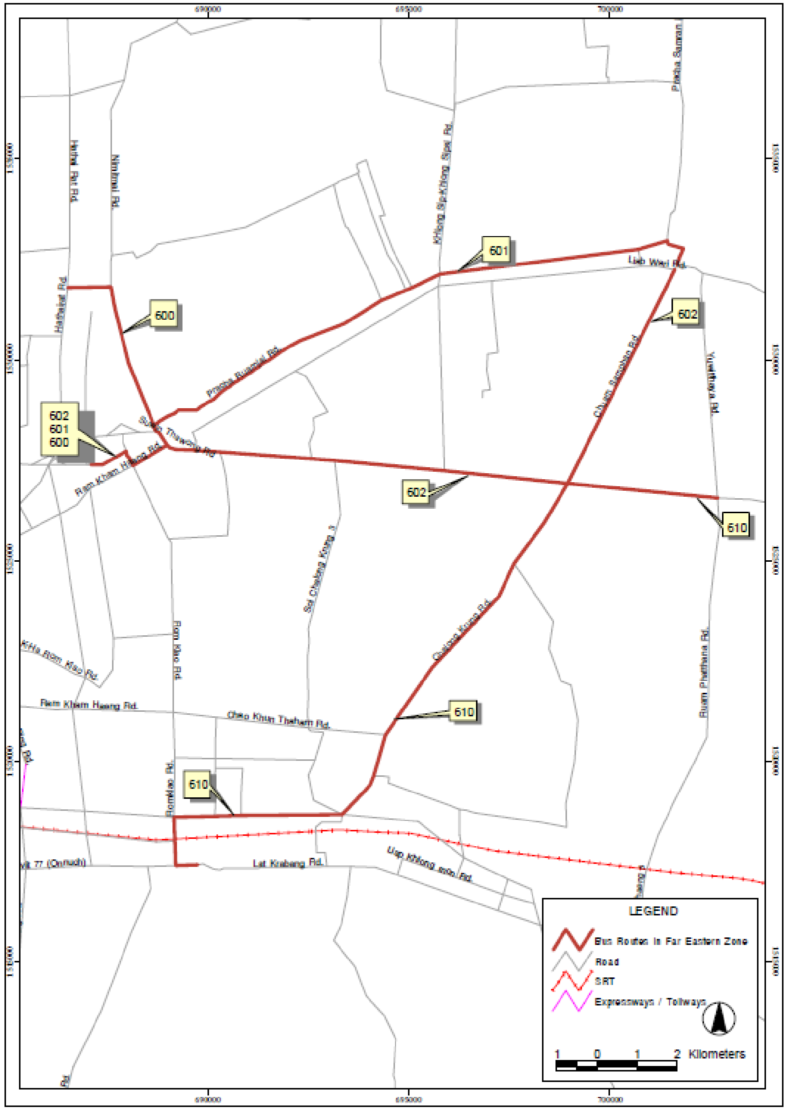


Figure 2A-4-107 New Bus routes in Far Eastern zone

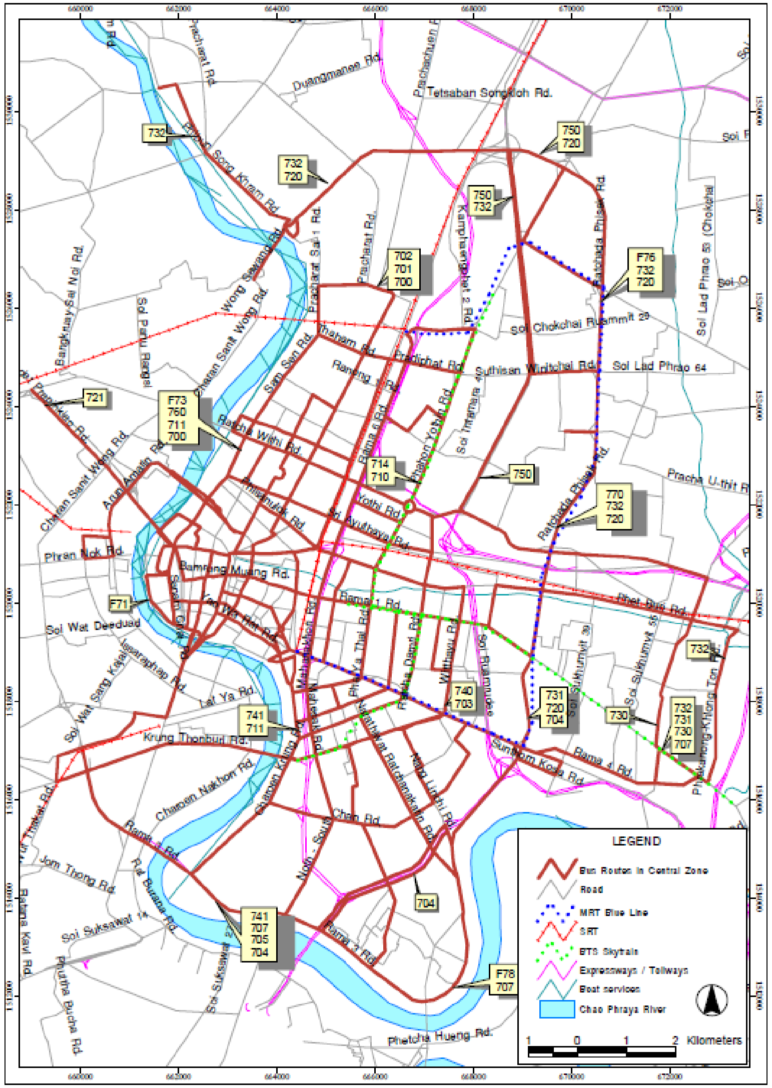


Figure 2A-4-108 New Bus routes in Central zone

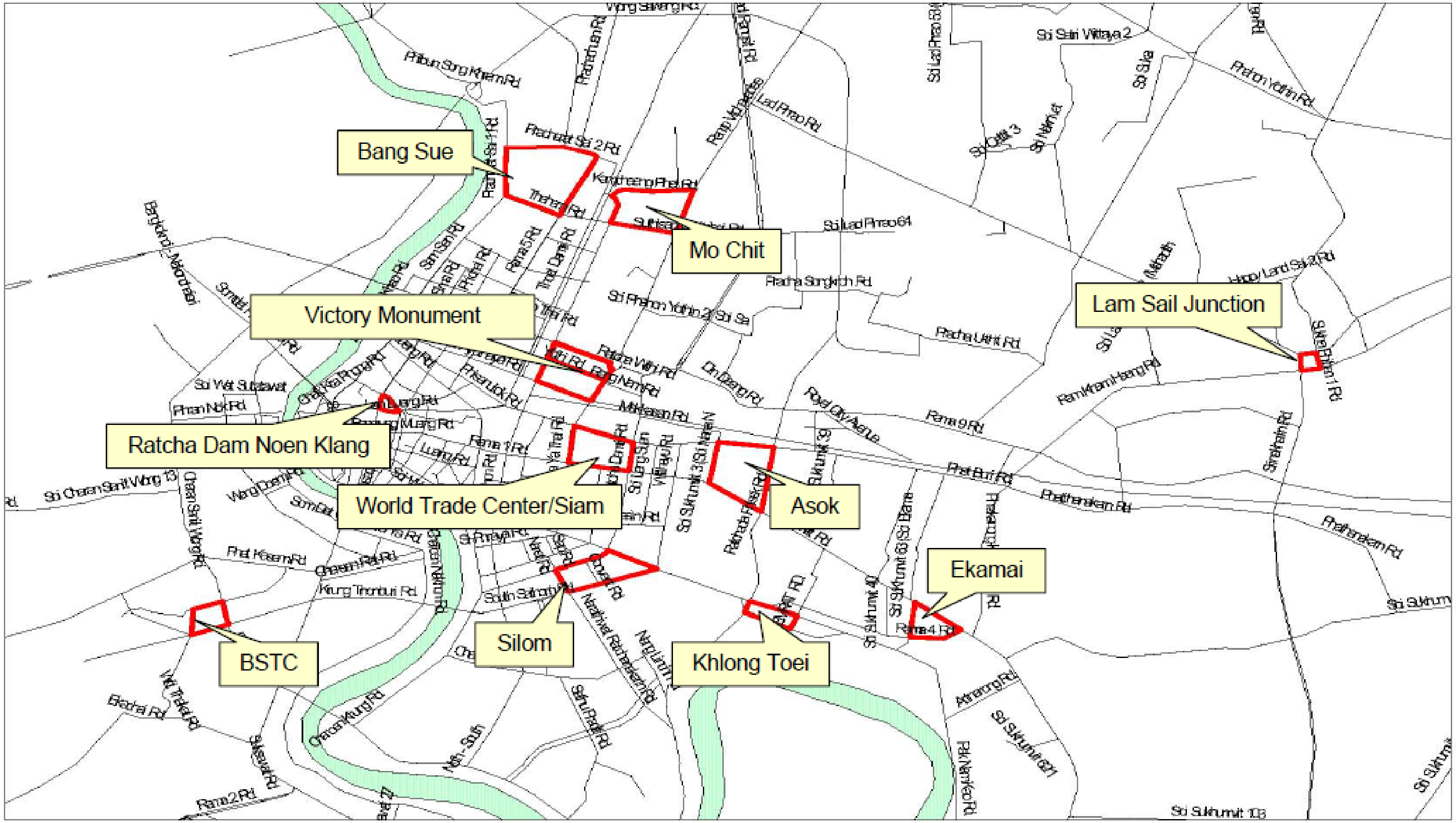


Figure 2A-4-109 New Major bus transfer station location in central Bangkok

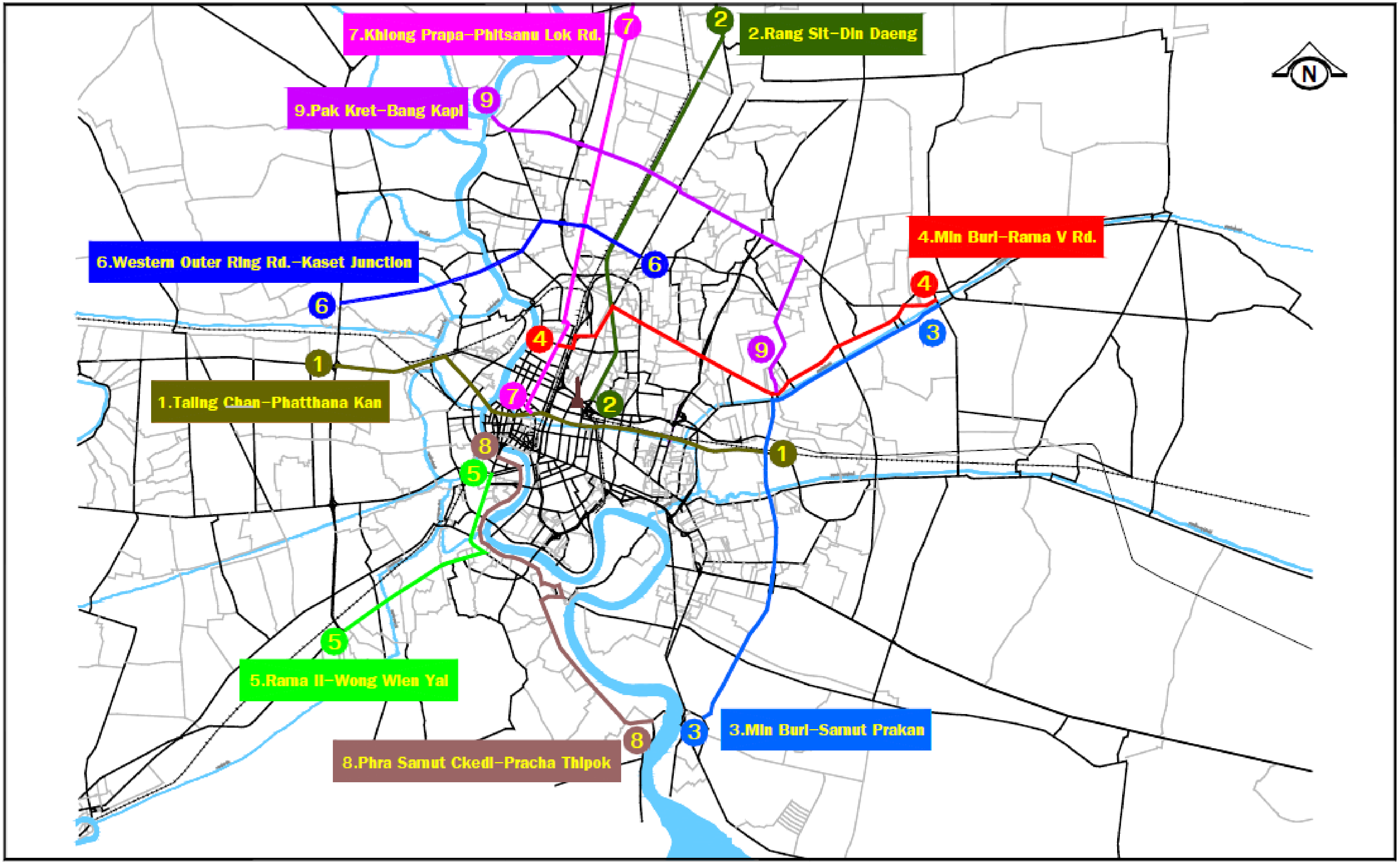


Figure 2A-4-110 Proposed BRT routes

1. **2nd Full-scale bus re-route: Public bus system development in Bangkok and vicinity** (OTP, Sep 2009)

   New bus route network covering 155 routes has been proposed which divided into 4 types: Radial 92 routes, Circumferential 26 routes, Cross town 18 routes, Expressway 19 routes. This study also proposed 30 essential bus transfer stations for interchange between routes in significant location. Route maps and stations location is illustrated in **Figure 2A-11** to **2A-16.**

Figure 2A-4-111 All new Bus routes and Tranfer Stations locations

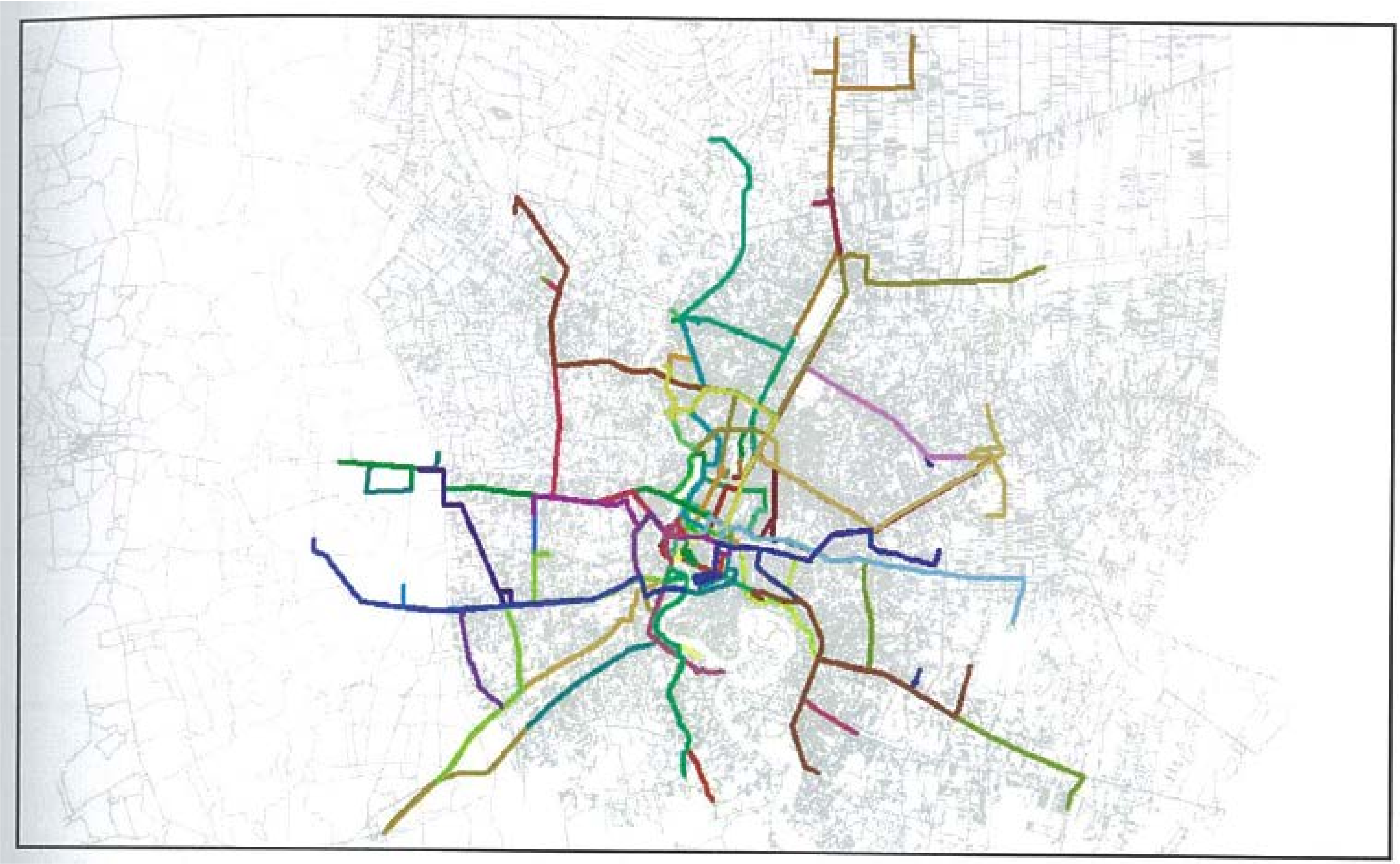


Figure 2A-4-112 New Bus routes in Radial type

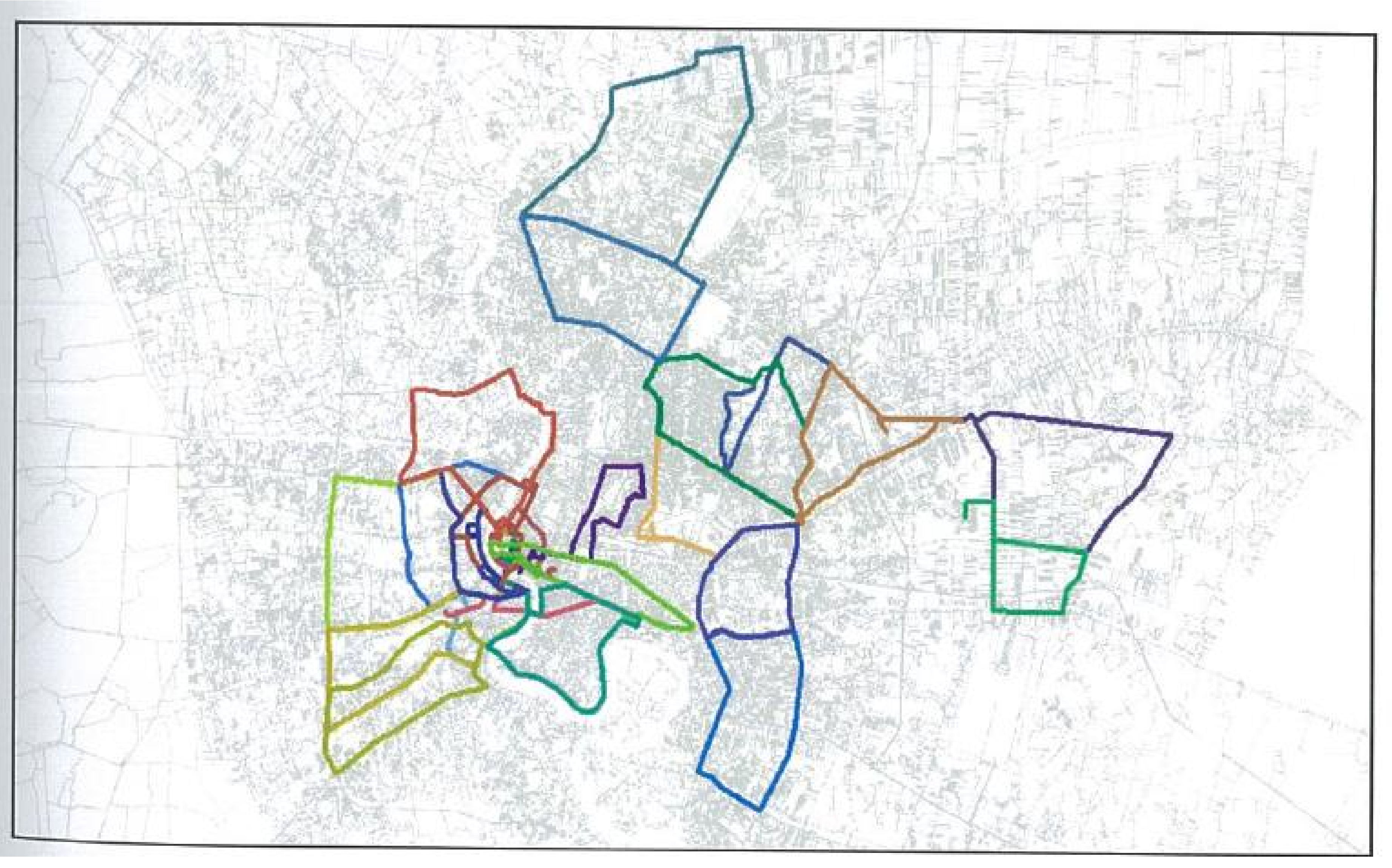


Figure 2A-4-113 New Bus routes in Circumferential type

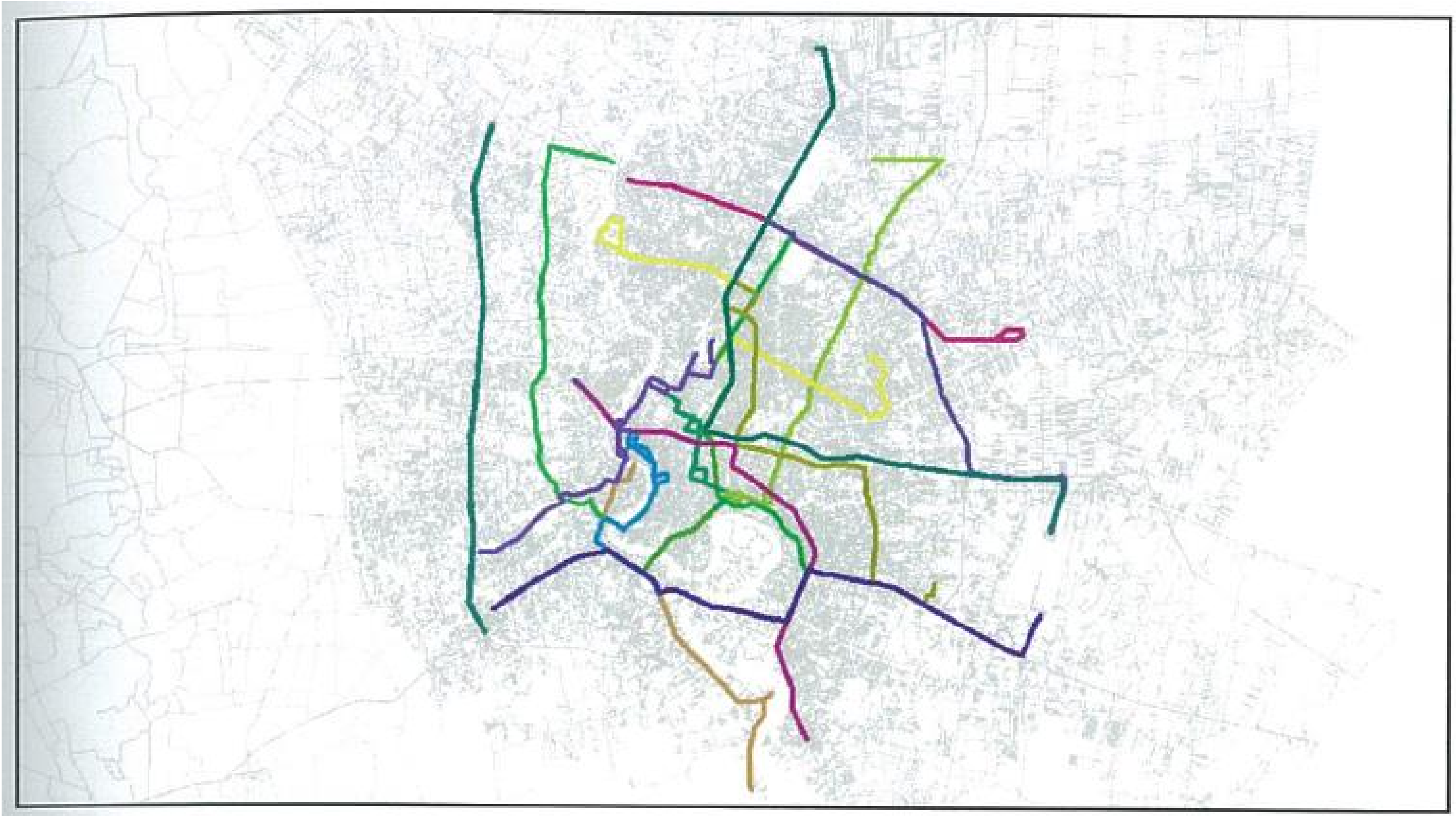


Figure 2A-4-114 New Bus routes in Cross Town type

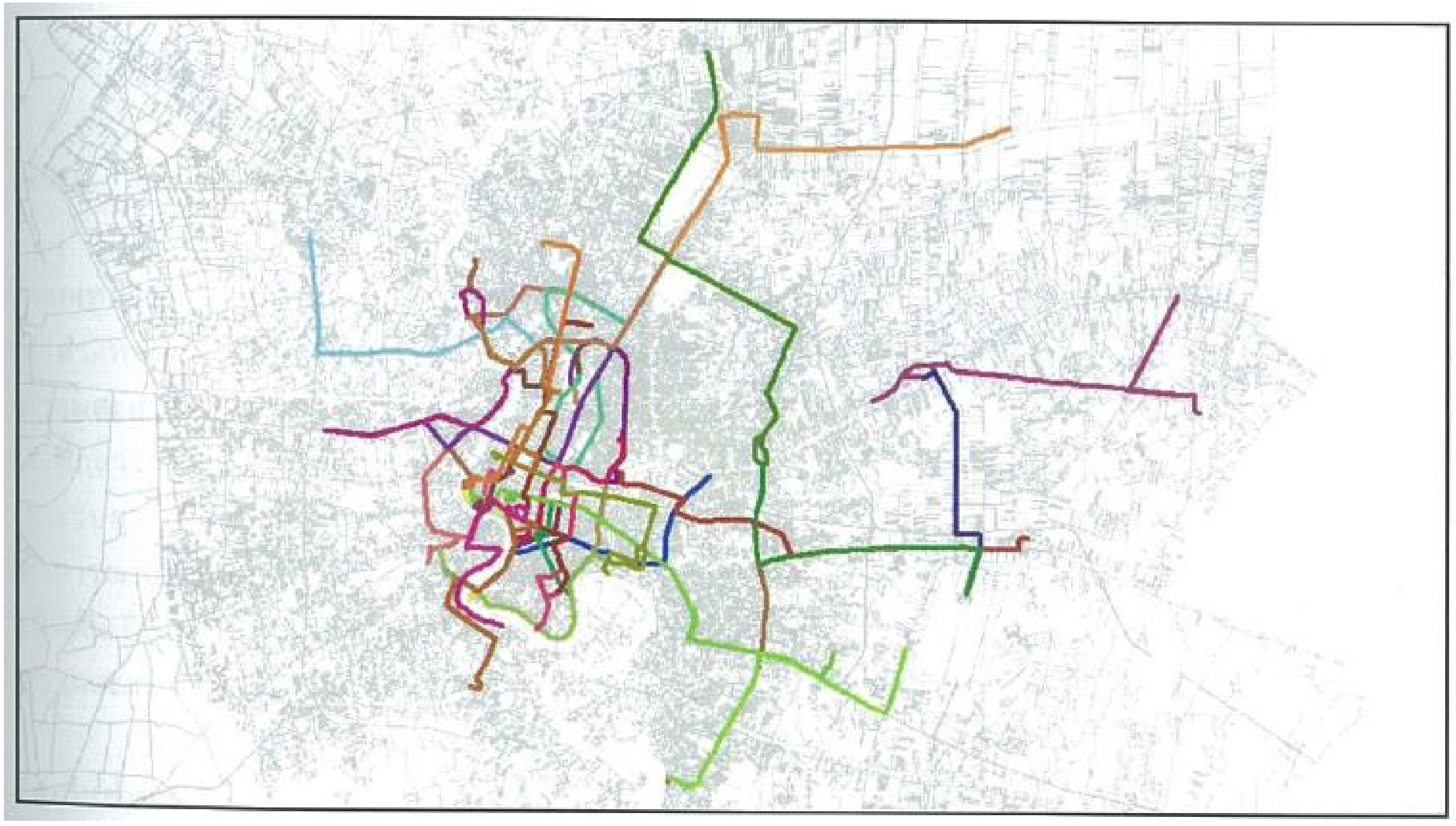


Figure 2A-4-115 New Bus routes in Feeder type

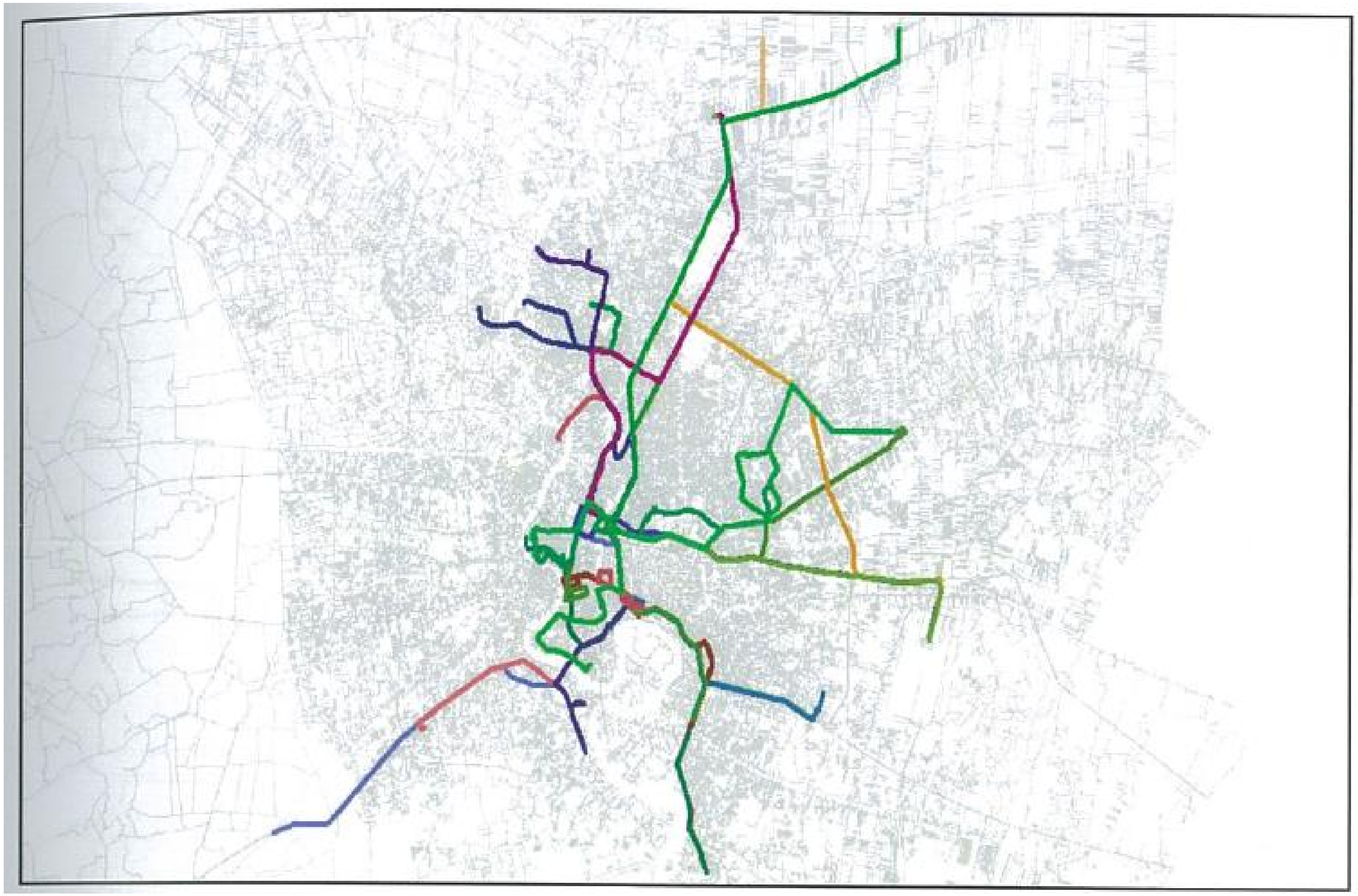


Figure 2A-4-116 New Bus routes in Expressway type

2. **Upcoming Full-scale bus re-route: Public bus system in Bangkok and vicinity development masterplan plan** (DLT, 2016) - Initial Route network is illustrated in **Figure 2A-17** to **2A-12.**

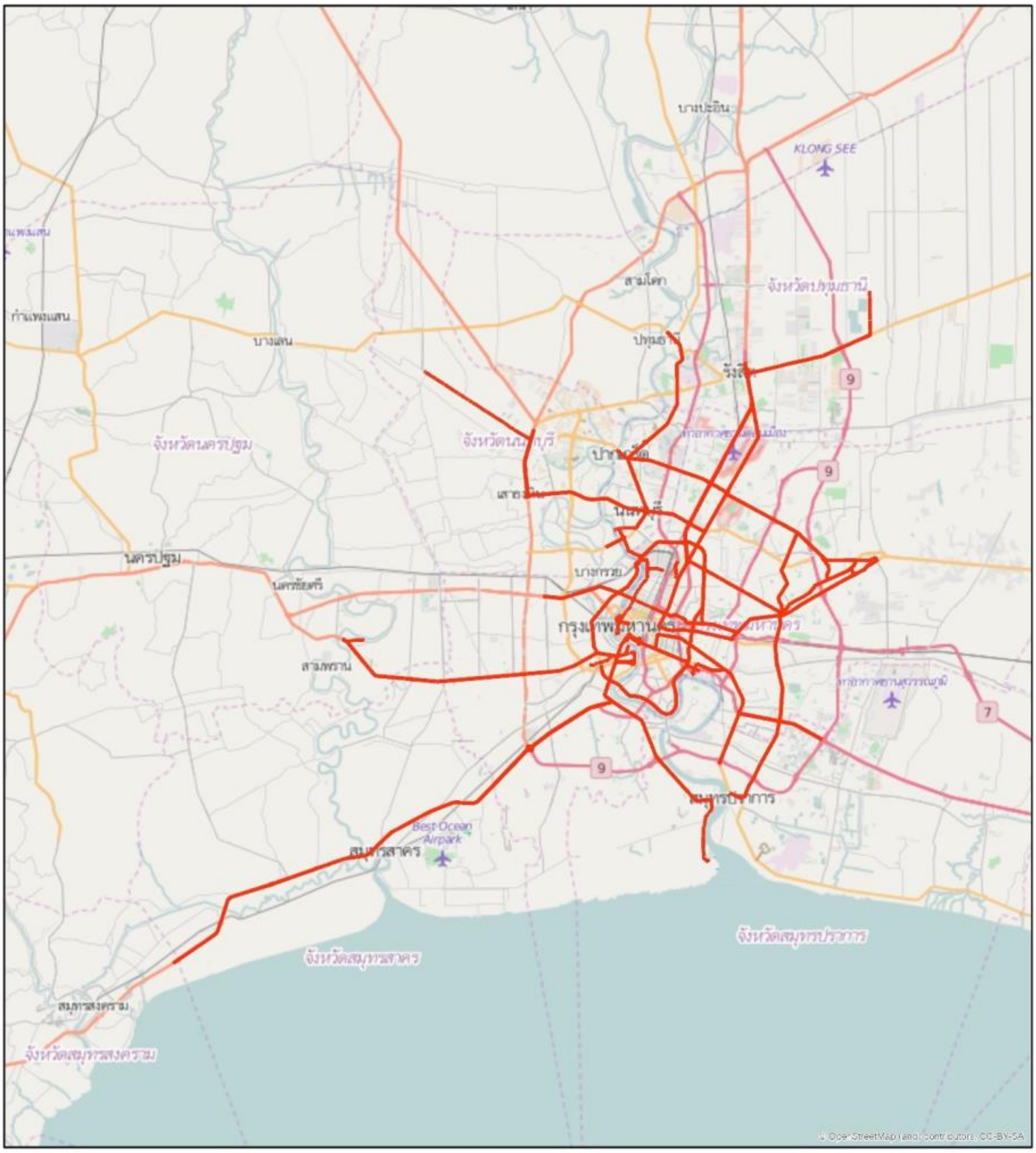


Figure 2A-4-117 New Bus routes No. 801-825 (Main)

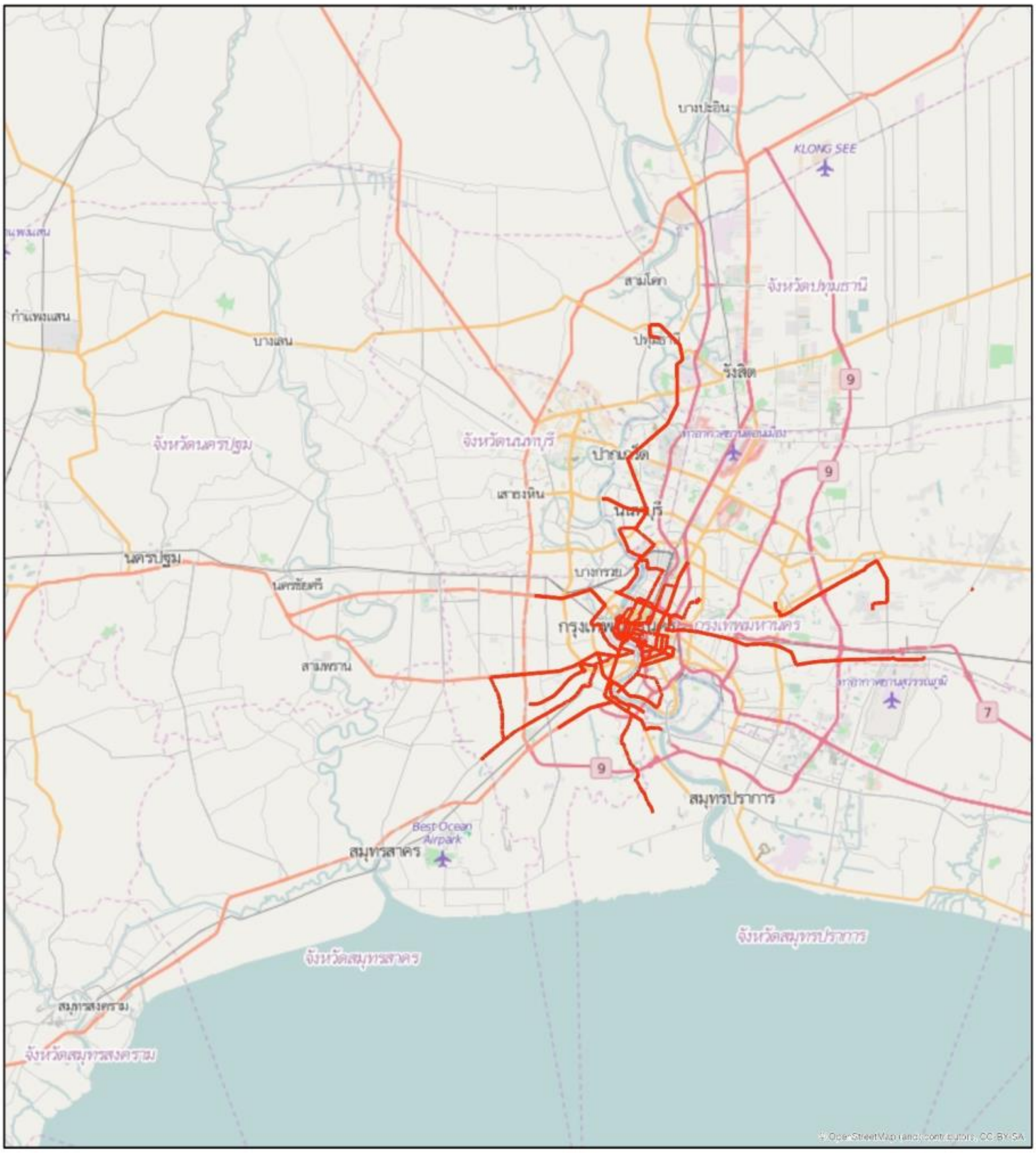


Figure 2A-4-118 New Bus routes No. 826-845 (Feeder1)

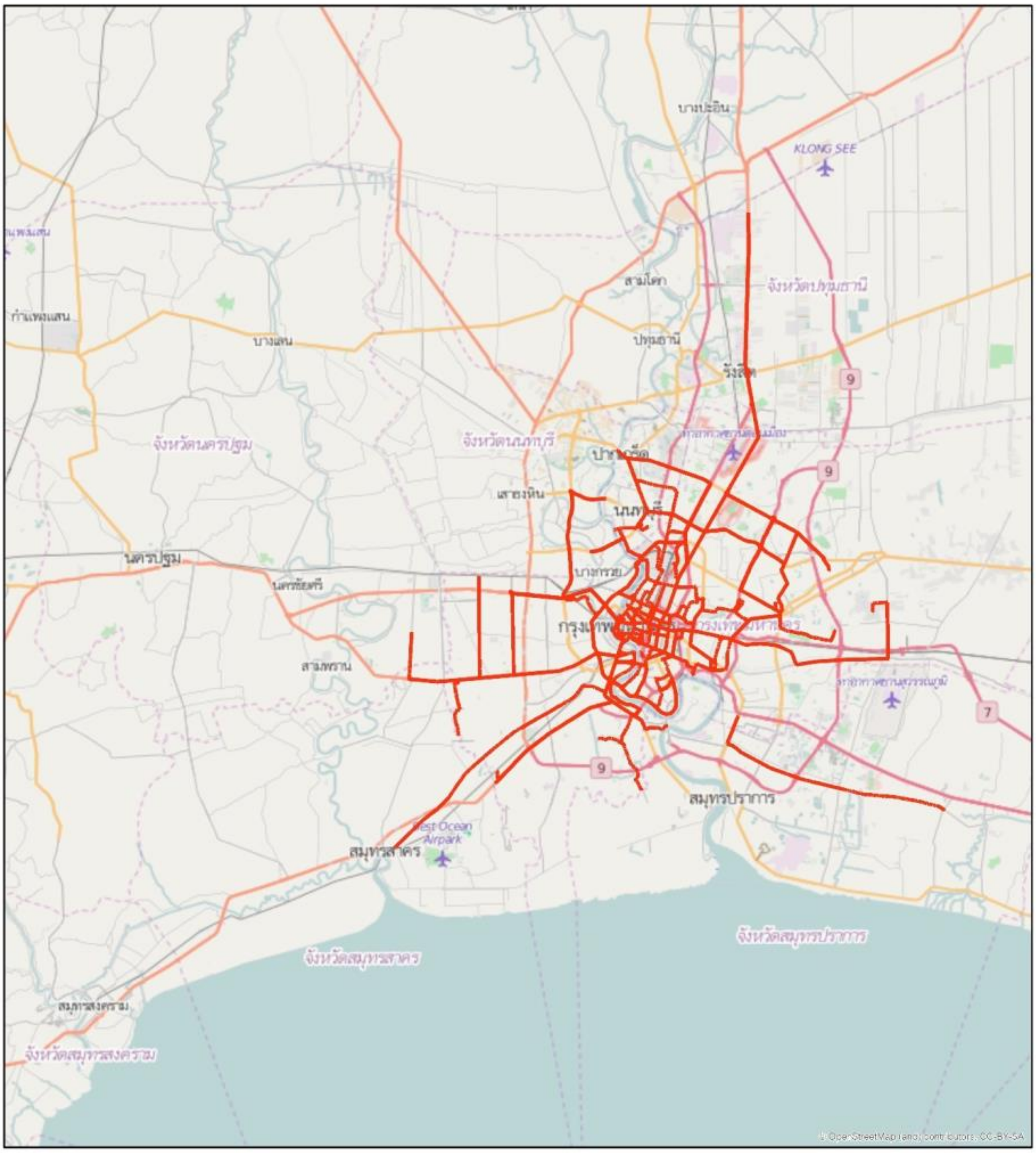


Figure 2A-4-119 New Bus routes No. 846-885 (Feeder2)

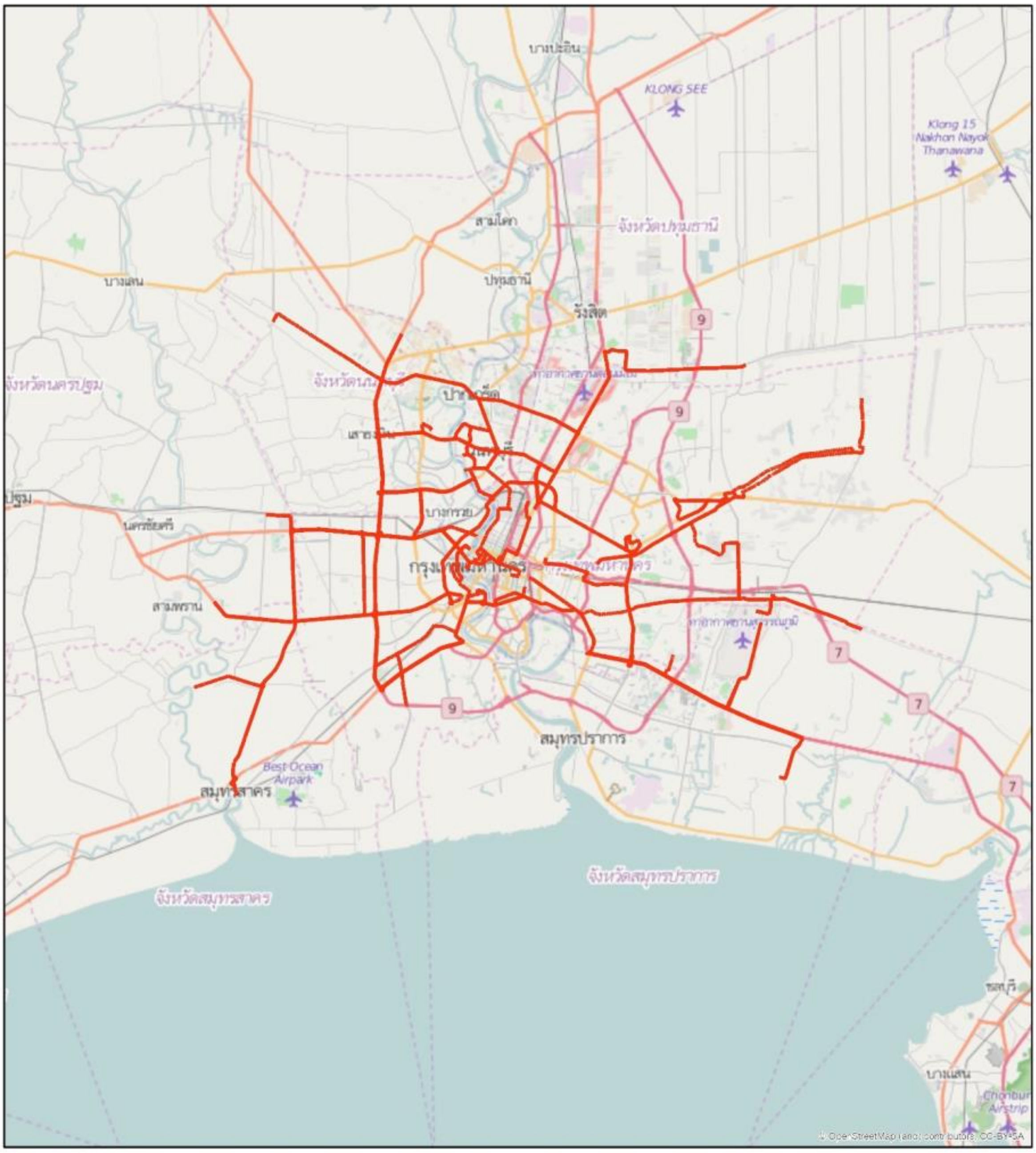


Figure 2A-4-120 New Bus routes No. 886-925 (Feeder3)

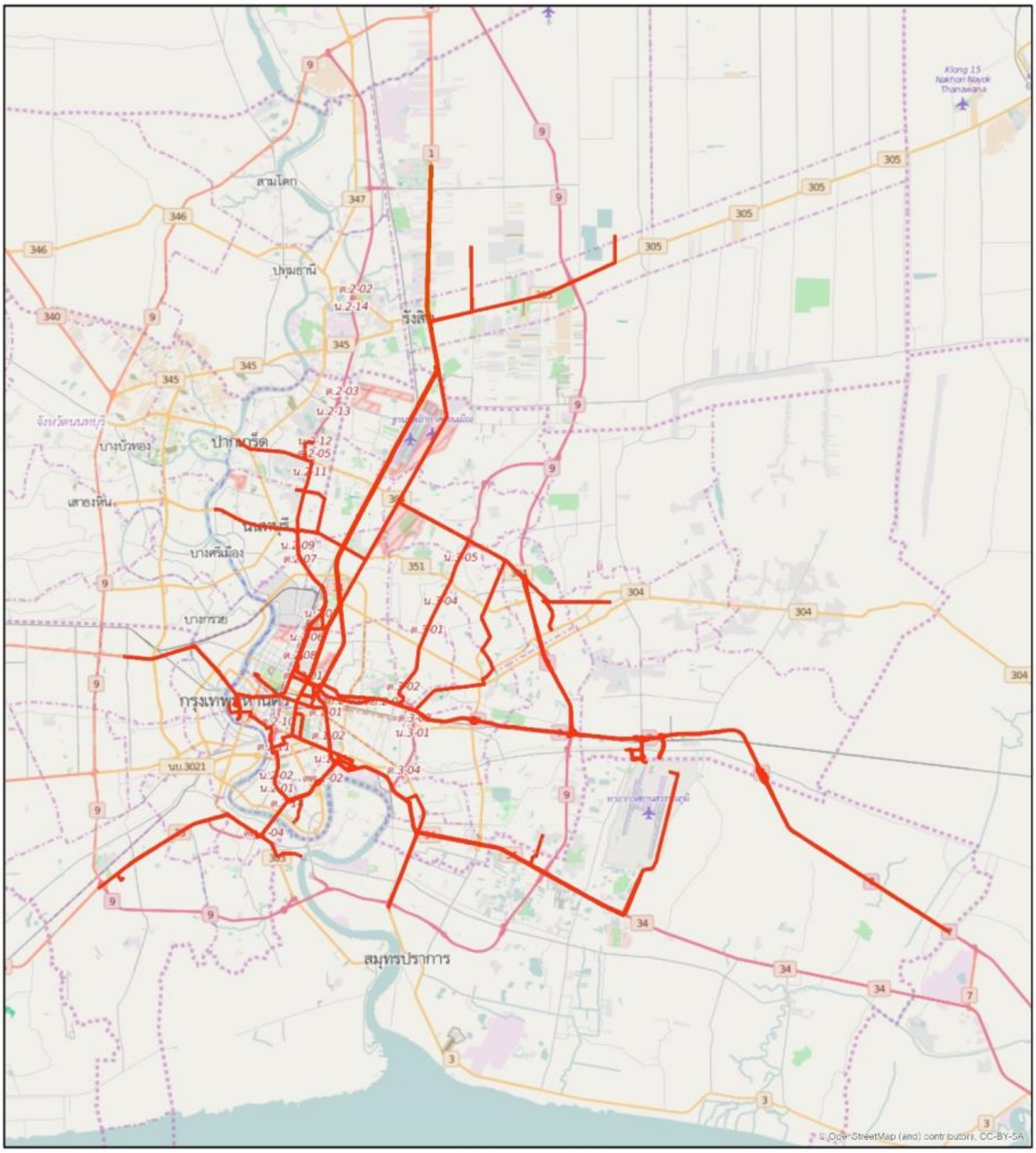


Figure 2A-4-121 New Bus routes No. 926-954 (Expressway)

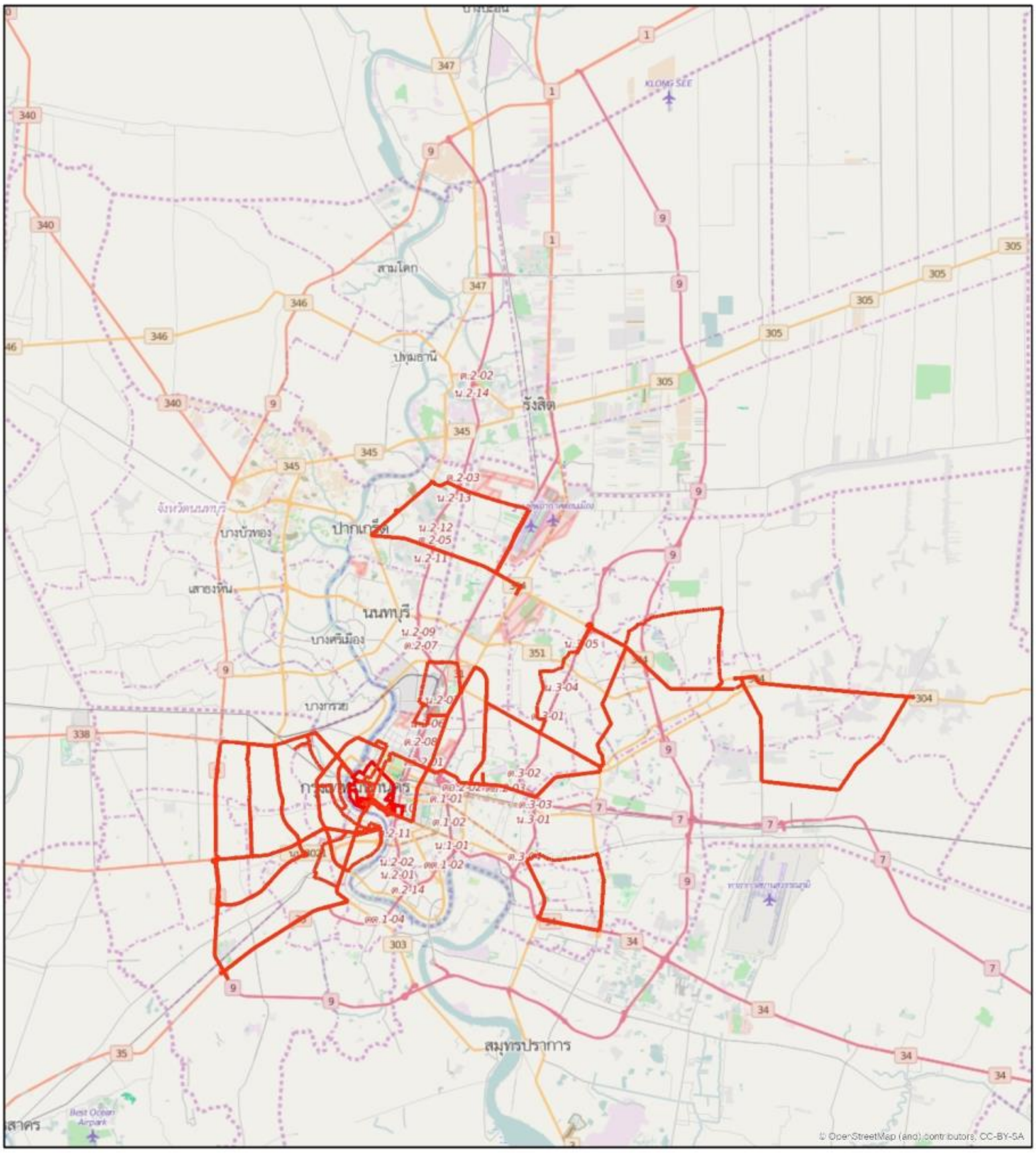


Figure 2A-4-122 New Bus routes No. 955-972 (Circumferential)

Annex 2B: Bus route number

Table 2B-4-37: Example of public bus route number that indicated by route characteristics

Route Characteristics	Route number
Airport	A01 - A10
Main	M01 - M25
Expressway	X01 - X29
Loop	L01 - L18
Feeder 1 (North)	N01 - Nxx
Feeder 2 (East)	E01 - Exx
Feeder 3 (South)	S01 - Sxx
Feeder 4 (West)	W01 - Wxx
Feeder 5 (Centre)	C01 - Cxx
Other	O01 - Oxx
BRT	B01 - Bxx

Table 2B-4-38 Example of public bus route number that indicated by depot

Depot	Route number
Depot 1	A01-Axx
Depot 1	B01-Bxx

Note: This suggested route number is the guideline for helping passengers to remember the rote number and direction easier. The internal document for government can still use the approved 801-972.

Annex 2C: Bus stop location regulation

Source: Office of Traffic and Transportation, Tang Sa-duak Journal, Year 13, Volume 1, p.24-27
http://office.bangkok.go.th/dotat/media/journal/13-2.pdf

Consideration of the bus stop sign placement is an authority of "Bangkok Bus Stop Consideration Sub-Committee" by taking the convenience and security of waiting passengers, bus operators, drivers, and pedestrians as a priority into consideration. The sign shall be positioned at least 300 meters beyond urban area and approximately placed 500 meters away from outskirts. The following standards form BMA must be met for bus stop placement;

- **Appropriate area for bus stop placement**
  - For the area which has a pedestrian crossing, a bus stop sign ideally shall be placed beyond a pedestrian crossing for 30 meters which otherwise before the cross walk for 30 meters if necessary.
  - For the single and dual carriageway which has a bus stop set on both sides, the bus stop signed shall be set at apart from each other at approximately 60 meters in order to facilitate the traffic also to space out for a pedestrian crossing.
  - For the road with bus bay on kerbside, a bus stop shall be placed at the exit taper of bus bay.
  - In case if there is a public bus passenger shelter located in appropriate area, a bus stop sign shall be placed beyond the shelter for 3 meters.

- If a bus stop sign must be placed at the area where a railroad passes through, the sign must be positioned not less than 15 meters before or 30 meters beyond a railroad.
- In case the ideal placement of bus stop sign is nearby a canal bridge or river bridge, it should be placed not less than 80 meters before the bridge ramp and 100 meters beyond the bridge
- For a crossroad with No-stopping marking (red-white) on the kerb, a bus stop sign shall be positioned 10 meters before the markings. In case there is no marking, it otherwise shall be placed not less than 50 meters before the crossroad.
- For the area of roundabout or traffic circle, a bus stop should be places not less than 50 meters before the corner of entering and existing of roundabout.
- For the area which is an entrance or exit of a building, a bus stop shall be placed not less than 5 meters before and 20 meters beyond that entrance or exit.
- For an intersection with an alley (Soi), a bus stop shall be placed not less than 10 meters before or 25 meters beyond the intersection.
- In case if there is an footbridge, a bus stop shall be set not less than 5 meters before or otherwise 30 meters beyond the stairs in order to encourage people to use the overpass.

- **Prohibited area for bus stop placement**
  - The bus stop placement should not located closed to postbox, fire hose, petrol station, bank, and public phone box area. In case the construction is necessary to be set in these locations, a bus stop shall be placed not less than 3 meters before and 30 meters beyond the areas.
  - The bus stop placement should not located closed to the traffic isle which the corner is used to be a turning point. In case if necessary, a bus stop sign must be located not less than 15 meters before and 30 meters beyond the turning point
  - A bus stop sign should not be placed in the radius of a roundabout or traffic circle. If the setting has to be done, the proposal should be submitted to the subcommittee
  - A bus stop must not be placed at a curve, crossroad, and turning point. In case a curve does not bother the vision of driver, the placement could be done under the subcommittee's consideration.

Annex 2D: Bus shelters maintenance concession argument

Source: http://www.dailynews.co.th/bangkok/375560

Mr. Polsak Chareonsiri, CEO (TSF) ThreeSixtyFive Public Company Limited, disclosed that despite the fact that the company has won the bidding competition and owned the three contracts of authority in advertisement and in maintenance of the bus stop waiting area, there are problems found in the two contracts consisting of the contract "A" and "C". Contract "A" group is stated to cover the bus stop shelters in the area of Klong Sam Wa, Kan Na Yao, Chatuchak, Don Muaeng, Dusit, Bang Sue, Min Buri, Lat Phrao, Wang Thong Larng, Huay Kwang, Bang Kean, Sai Mai, Nong Chok, Lak Si, 516 shelters whereas contract "C" group covers the area of Din Daeng, Bang Ko Laem, Bang Rak, Bueng Kum, Pathumwan, Phayathai, Yannawa, Ratchathewi, Lat Krabang, Sathorn, 538 shelters, and 1054 shelters in total. Due to BMA announced the order to restrain the advertising board construction for six months, from August 2013 until March 2014, the order impacted to the business performance. At all events, there was an approach to sceptical query for the compensation but did not receive any answer. The company then considered to repeal the both contracts by sending a formal notice informing to offer the maintenance until the end of 2015. As of 1st January 2016, the maintenance and the electricity set were terminated because the company could not bear the costs anymore. However, the company affirms that the formal notice has been sent, and an approach was arranged with the governor for multiple times as the company had to encounter with crucial impacts and was unable to proceed the plan. Those events the company had to encounter affects to the reliability of the company. All in all, the company informs consent of electric meters to be transferred to BMA in order to find a new company to response further. The other compensations will further be reviewed under jurisdiction.

Mr. Taweesak Lertprapan, Director at Traffic and Transportation Department states that the project is during the stage of requesting for an approval from the governor, Mr. Sukumpan Boripat, to repeal the contract which is now has not been finished. Therefore, it is still the company's responsibility if there is a case of decadence found and maintenance needed. BMA is still capable to inform the company and receive maintenance. In case the company does not follow what states in the contract, BMA will arrange discussion with The Metropolitan Electricity Authority for electric connects since the two have mutual agreement.

Annex 2E: Reviewing summary of consultancy for public bus stop design report

From Consultancy for public bus stop design report (KMITL and BMTA, 2014), there are 9 main topics of analysis as follows:

- Concepts of public bus stop in Thailand and foreign countries

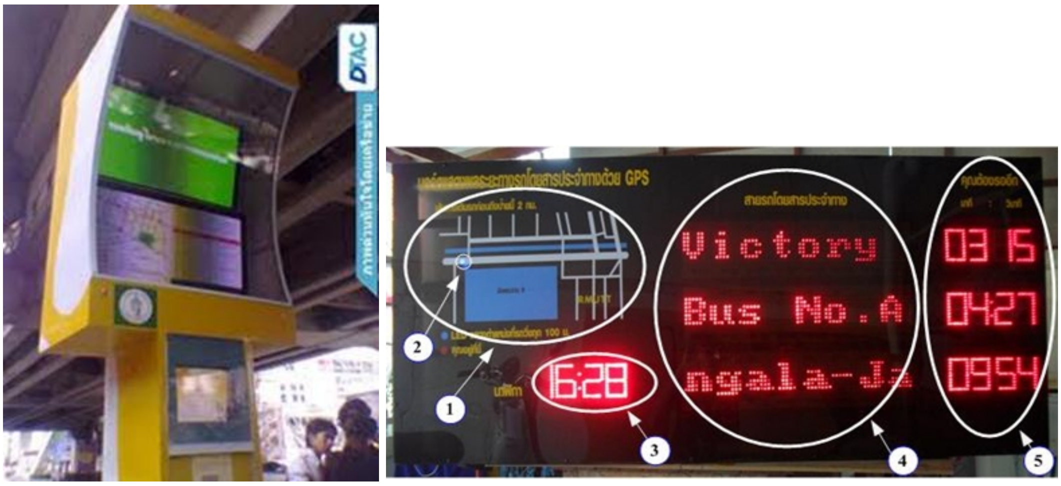


Figure 2E-1 Prototype real-time bus information from previous pilot project

- Comparisons between public bus stop in Thailand and foreign countries
- Prototype design of public bus stop in small, medium and large size

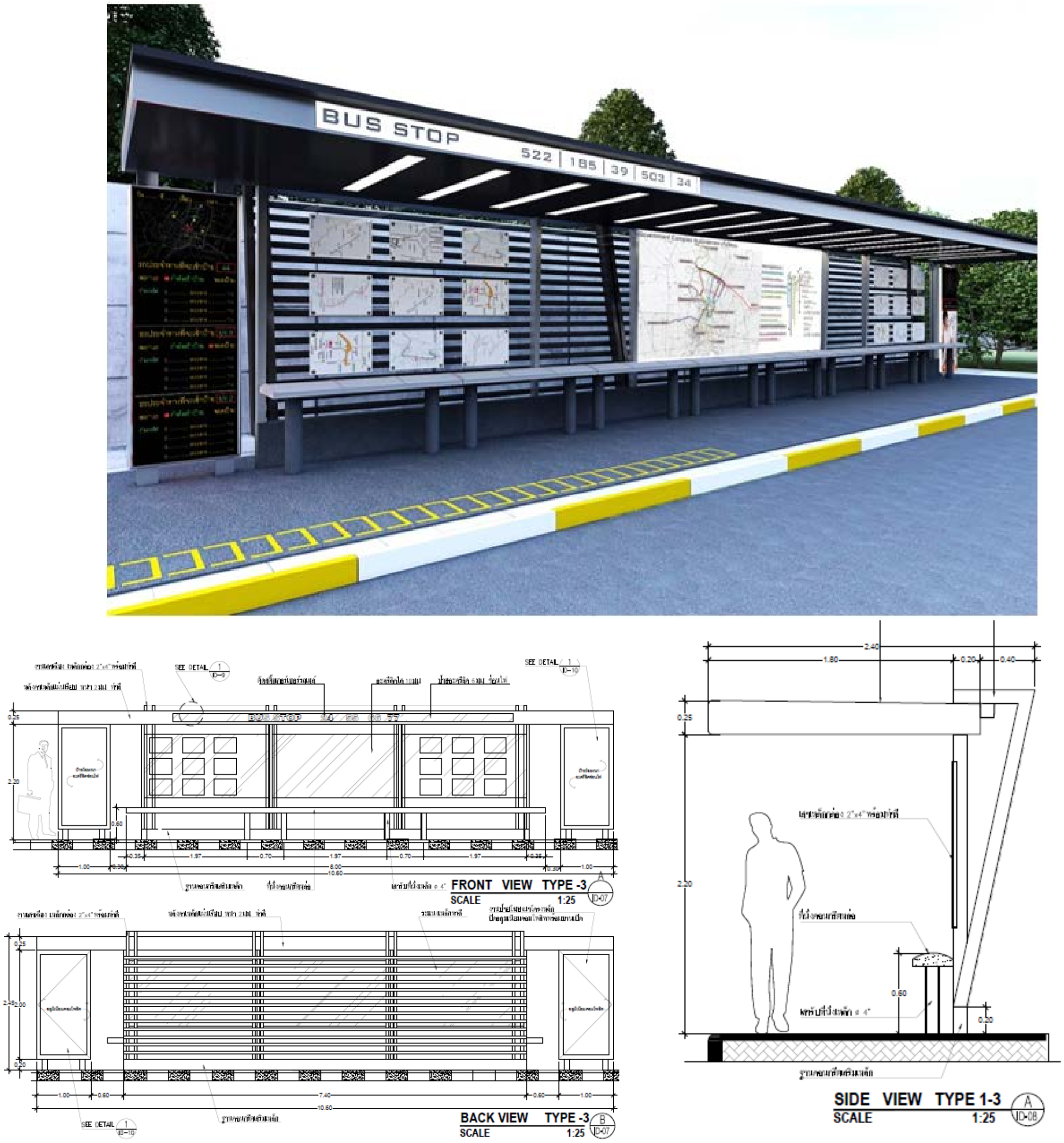


Figure 2-E2 Prototype design of large public bus stop

- Prototype design of route map and stop map board

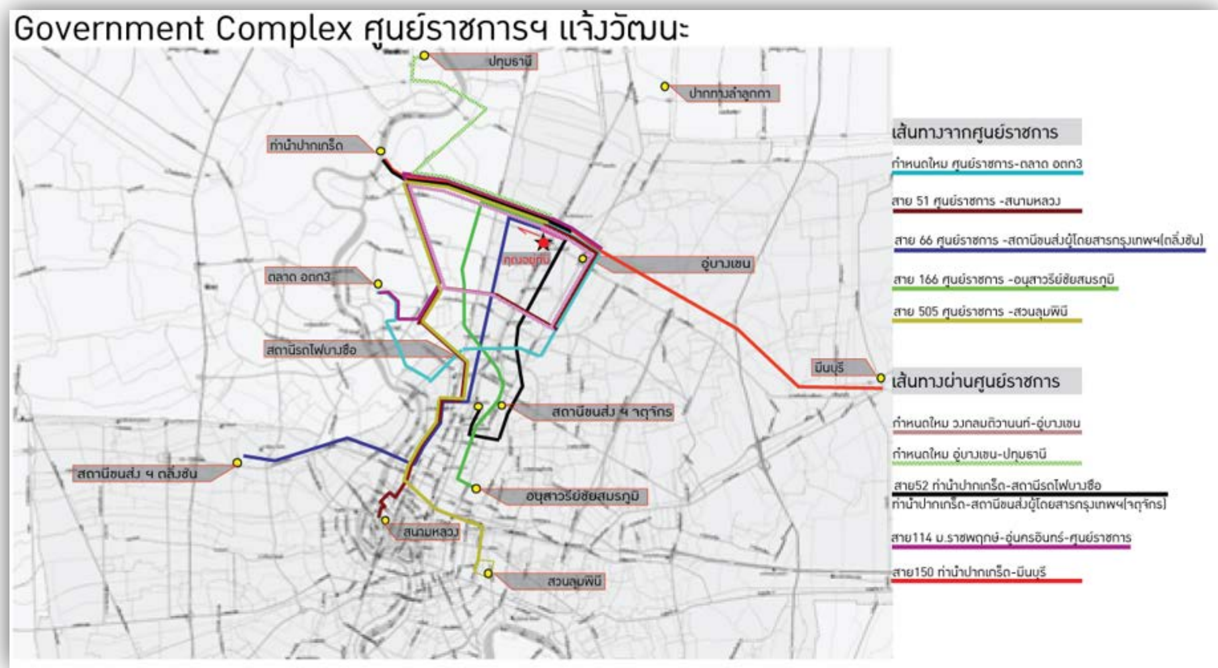


Figure 2E-4-123 Prototype design of route map

Figure 2E-4-124 : Prototype design of stop map of a bus route

- Prototype design of bus stop information board and intelligent sign board

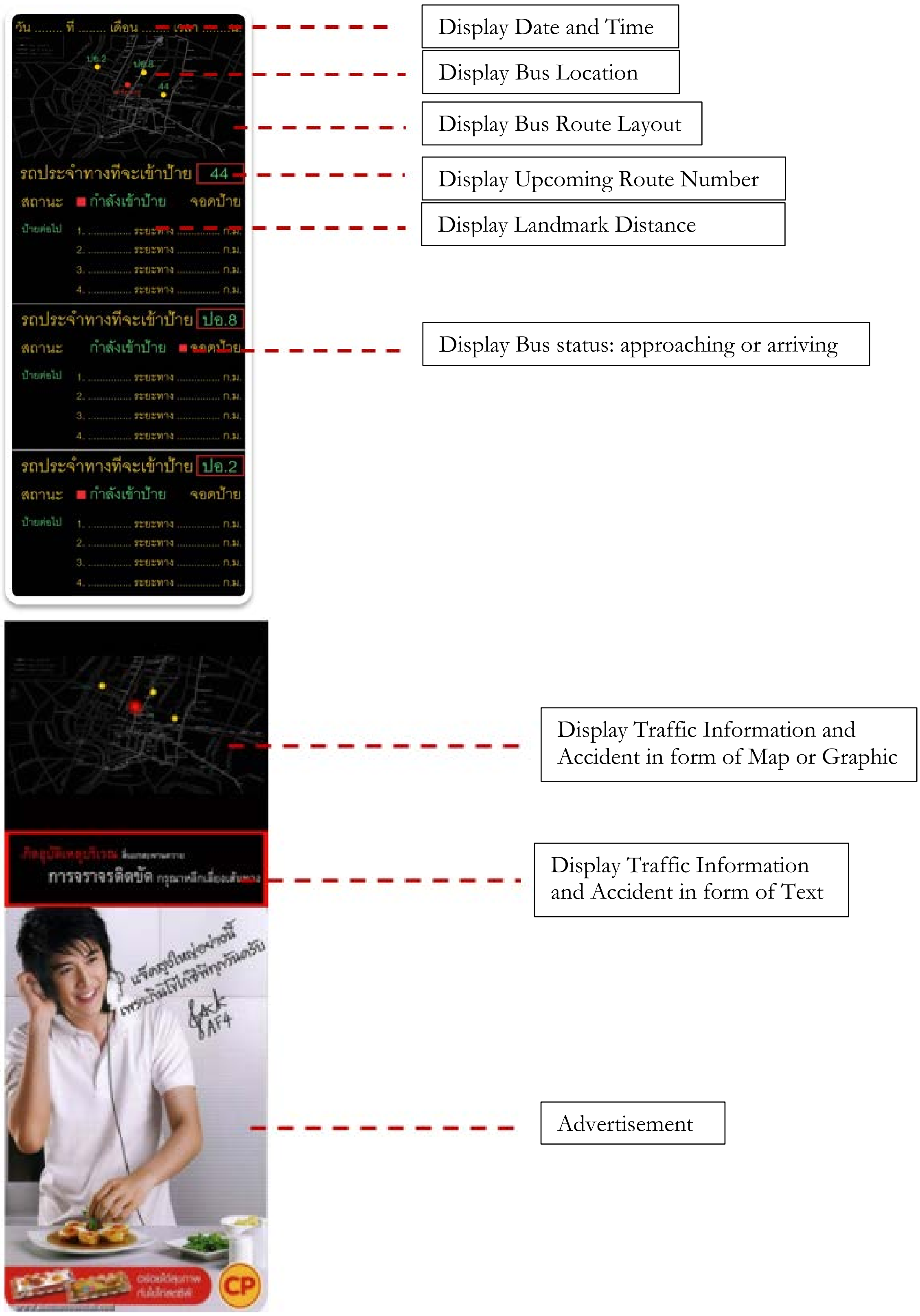


Figure 2E-4-125 Information board and intelligent real-time information board

- Prototype design of special route map for Victory monument area

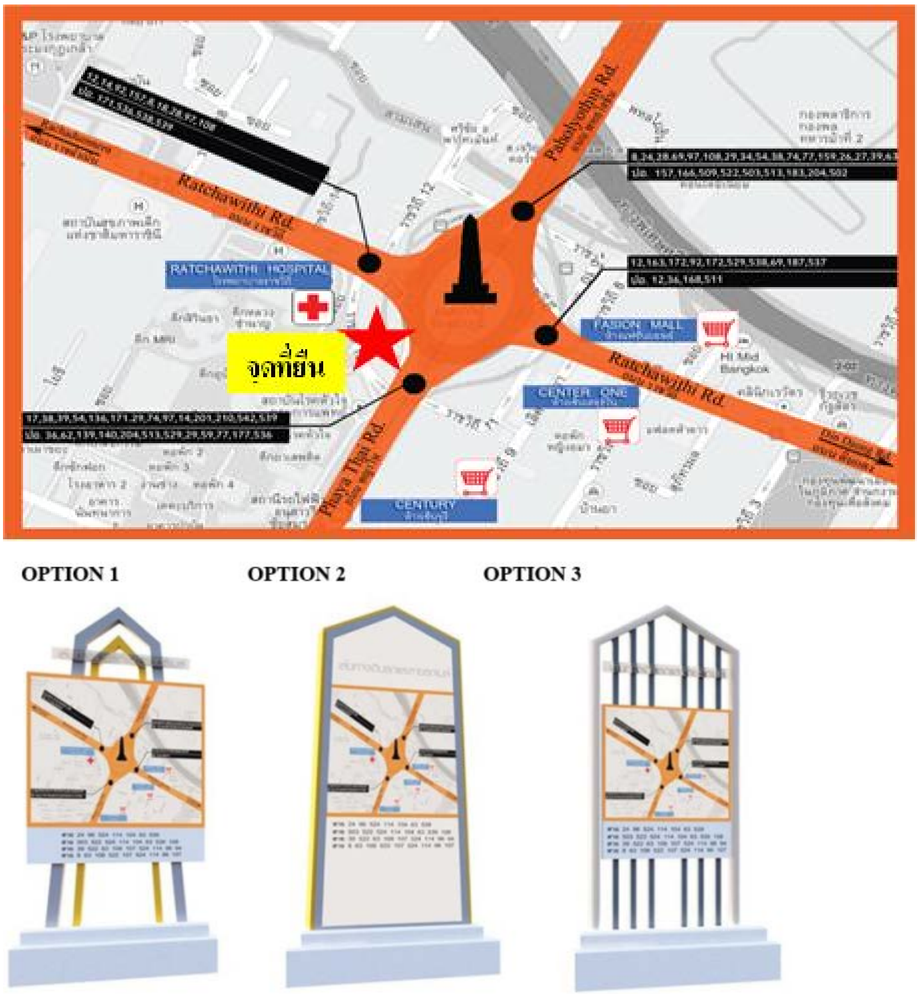


Figure 2E-4-126 Victory monument special route map board

- Prototype design of bus stop mark post

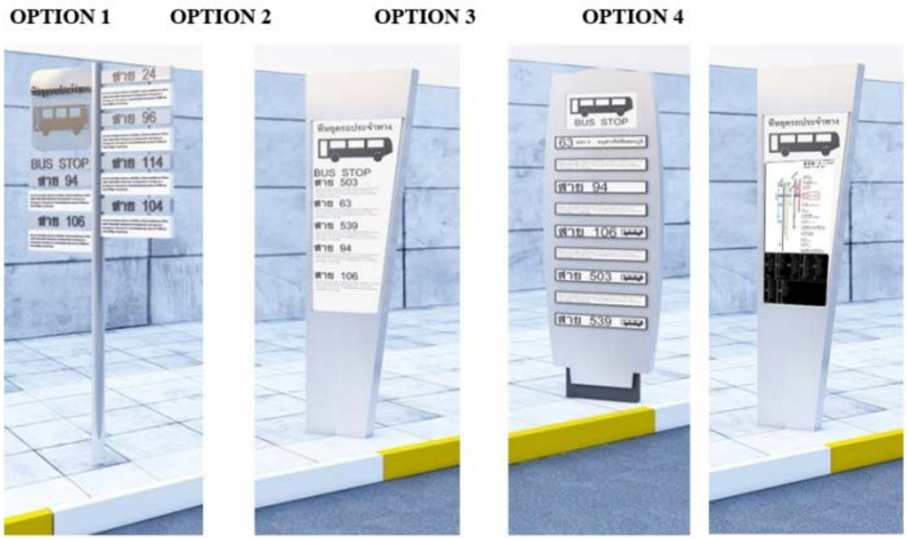


Figure 2E-4-127 Bus stop mark post

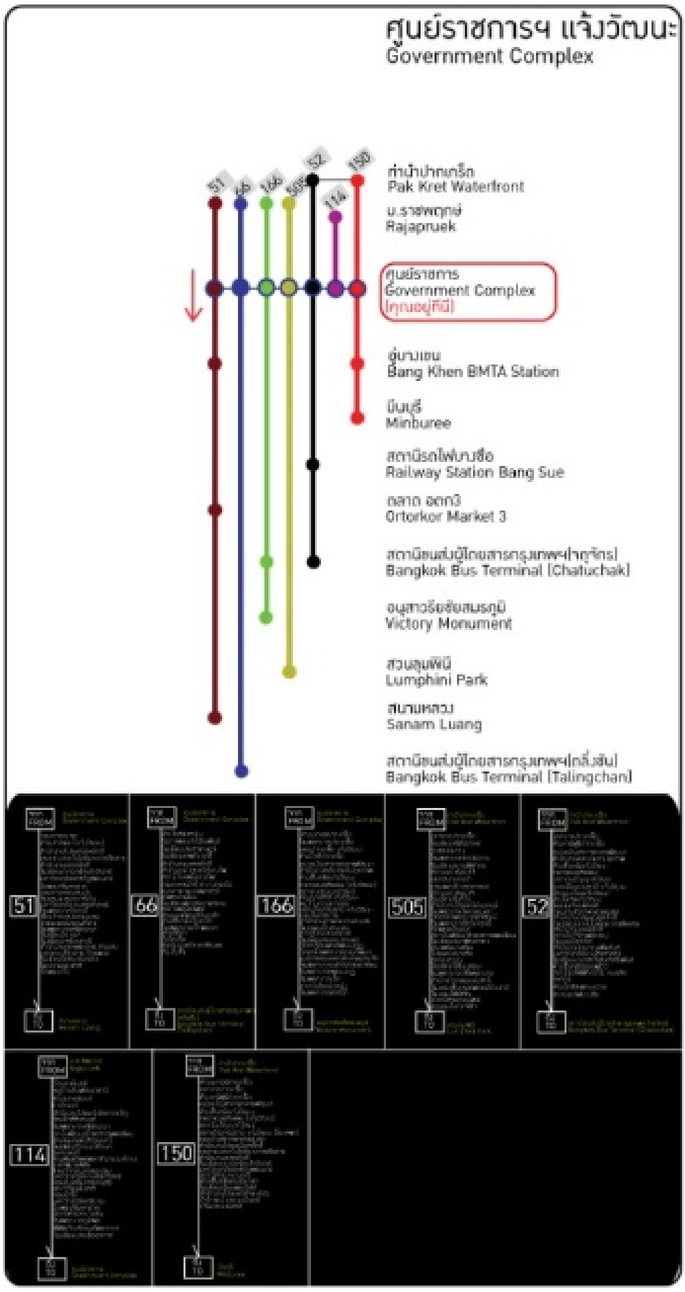


Figure 2E-4-128 Route information on the mark post option 4

Annex 3A: Traffic count survey data

Figure 3A-1 Survey location map (Source: Consultant)

Group 1: Fixed-route mass transit passenger from/to Ari area

Collect from 3 major public transport station on Phahonyothai road, next to the beginning of Soi Ari, which is indicated in **red square** in **Figure 3A-1**

Location 1: BTS Ari station – North Exit

- collect **enter and exit** number of **BTS passengers** at fare collection gate

Figure 3A-2: BTS Ari station – North Exit (Source: Consultant)

Location 2: Ari bus stop – Northbound

- collect **board and alight** number of **public bus passengers** at bus stop

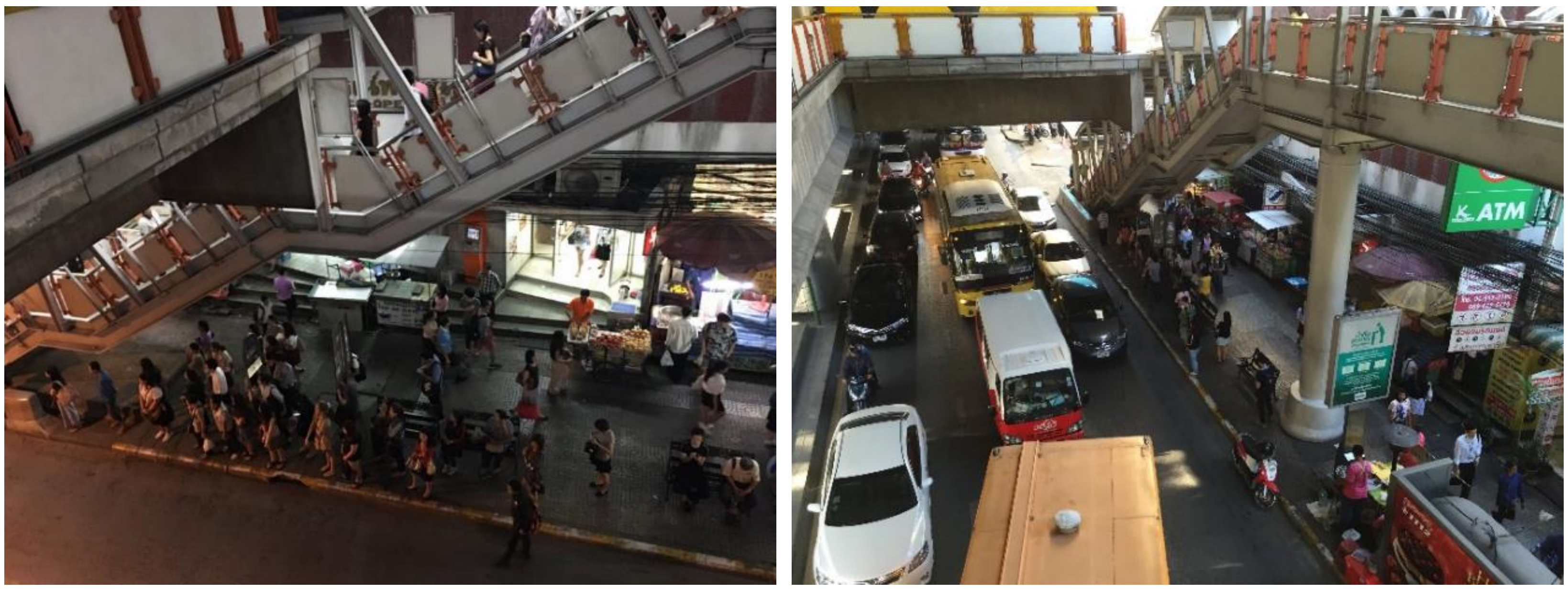


Figure 3A-3 Location 2: Ari bus stop – Northbound (Source: Consultant)

Location 3: Ari bus stop – Southbound

- collect **board and alight** number of **public bus passengers** at bus stop

Figure 3A-4 Location 3: Ari bus stop – Southbound (Source: Consultant)

Table 3A-1 Fixed route Mass transit passengers traffic count data

	BTS Ari station		Northbound bus stop		Southbound bus stop		Bus stop total		Total	
Time	Enter	Exit	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Departure	Arrival
06.00-06.15	60	17	21	56	48	87	69	143	129	160
06.15-06.30	107	41	23	40	44	104	67	144	174	185
06.30-06.45	171	78	20	71	31	80	51	151	222	229
06.45-07.00	217	121	25	83	27	175	52	258	269	379
07.00-07.15	308	138	59	141	38	219	97	360	405	498
07.15-07.30	400	270	79	131	34	225	113	356	513	626
07.30-07.45	406	281	56	114	29	219	85	333	491	614
07.45-08.00	463	426	94	193	57	187	151	380	614	806
08.00-08.15	467	601	173	145	29	188	202	333	669	934
08.15-08.30	425	652	77	221	27	200	104	421	529	1073
08.30-08.45	317	514	94	113	23	144	117	257	434	771
08.45-09.00	347	376	79	99	25	150	104	249	451	625
09.00-09.15	261	328	57	135	32	137	89	272	350	600
09.15-09.30	226	245	48	135	13	138	61	273	287	518
09.30-09.45	211	184	46	63	32	65	78	128	289	312
09.45-10.00	149	135	41	41	23	65	64	106	213	241
10.00-10.15	126	123	36	35	14	52	50	87	176	210
10.15-10.30	87	104	34	30	14	53	48	83	135	187
10.30-10.45	95	104	27	48	8	73	35	121	130	225
10.45-11.00	107	119	29	25	14	68	43	93	150	212
11.00-11.15	138	86	33	29	24	73	57	102	195	188
11.15-11.30	126	95	41	33	13	33	54	66	180	161
11.30-11.45	136	69	30	33	21	44	51	77	187	146
11.45-12.00	136	131	40	42	20	24	60	66	196	197
12.00-12.15	179	117	53	43	17	80	70	123	249	240
12.15-12.30	149	114	43	27	18	39	61	66	210	180
12.30-12.45	160	150	47	43	13	46	60	89	220	239
12.45-13.00	140	139	53	27	21	38	74	65	214	204
13.00-13.15	165	146	44	46	22	47	66	93	231	239
13.15-13.30	154	134	36	41	35	59	71	100	225	234
13.30-13.45	127	135	50	46	13	56	63	102	190	237
13.45-14.00	133	118	43	17	10	20	53	37	186	155
14.00-14.15	131	108	26	13	17	22	43	35	174	143
14.15-14.30	114	119	34	18	18	24	52	42	166	161
14.30-14.45	123	105	50	13	13	33	63	46	186	151
14.45-15.00	128	110	38	13	27	20	65	33	193	143
15.00-15.15	105	116	48	27	14	15	62	42	167	158
15.15-15.30	125	118	41	25	14	31	55	56	180	174
15.30-15.45	131	112	42	27	13	40	55	67	186	179
15.45-16.00	162	110	65	22	14	39	79	61	241	171

	BTS Ari station		Northbound bus stop		Southbound bus stop		Bus stop total		Total	
Time	Enter	Exit	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Departure	Arrival
16.00-16.15	230	171	100	15	32	48	132	63	362	234
16.15-16.30	288	144	102	7	47	27	149	34	437	178
16.30-16.45	326	180	144	28	21	19	165	47	491	227
16.45-17.00	462	301	135	17	104	41	239	58	701	359
17.00-17.15	453	245	219	28	111	45	330	73	783	318
17.15-17.30	289	211	93	27	32	16	125	43	414	254
17.30-17.45	305	281	115	16	73	18	188	34	493	315
17.45-18.00	536	314	132	23	59	29	191	52	727	366
18.00-18.15	711	405	187	55	97	23	284	78	995	483
18.15-18.30	615	304	224	64	107	23	331	87	946	391
18.30-18.45	585	292	241	83	85	23	326	106	911	398
18.45-19.00	329	263	182	61	47	23	229	84	558	347
19.00-19.15	337	328	215	41	123	21	338	62	675	390
19.15-19.30	332	310	137	43	76	24	213	67	545	377
19.30-19.45	289	182	171	48	96	20	267	68	556	250
19.45-20.00	257	161	141	49	65	13	206	62	463	223
Count total	14056	11281	4513	3109	2094	3825	6607	6934	20663	18215

Summary (Source: Consultant)

Summary		BTS Ari		Northbound bus stop		Southbound bus stop		Bus stop total		Total	
Period		Enter	Exit	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Departure	Arrival
Morning	Total	4535	4407	992	1781	512	2383	1504	4164	6039	8571
06.00-10.00	per hour	1134	1102	248	445	128	596	376	1041	1510	2143
Mid-day	Total	3177	2782	983	723	407	1029	1390	1752	4567	4534
10.00-16.00	per hour	530	464	164	121	68	172	232	292	761	756
Evening	Total	6344	4092	2538	605	1175	413	3713	1018	10057	5110
16.00-20.00	per hour	1586	1023	635	151	294	103	928	255	2514	1278
All-day	Total	14056	11281	4513	3109	2094	3825	6607	6934	20663	18215
06.00-20.00	per hour	1004	806	322	222	150	273	472	495	1476	1301
Peak 15 min	Total	711	652	241	221	123	225	338	421	995	1073
	per hour	2844	2608	964	884	492	900	1352	1684	3980	4292

Group 2: NMT passenger and Motorised-paratransit passenger in Soi Ari

Collect from 2 locations at the beginning of Soi which is indicated by **yellow square** in **Figure 3A-1**, including:

Location 4: Beginning of Soi Ai– North side footway

- collect **inbound and outbound** number of **NMT passenger**: pedestrian and bicycle users
- collect **inbound and outbound** number of **Paratransit transfer passengers** (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw

Figure 3-4-129 Location 4: Beginning of Soi Ai– North side footway (Source: Consultant)

Location 5: Beginning of Soi Ai– South side footway (Paratransit hub)

- collect **inbound and outbound** number of **NMT passenger**: pedestrian and bicycle users
- collect **inbound and outbound** number of **Paratransit transfer passengers** (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw

Note: Street vending is restricted on Monday

Figure 3A-6 Location 5: Ari bus stop – Southbound (Off-peak Monday: Street vending is restricted) (Source: Consultant)

Figure 3A-7 Location 5: Ari bus stop – Southbound (Morning-peak Tuesday-Friday: Street vending is allowed) (Source: Consultant)

Table 3A-2 NMT-passengers and paratransit-passengers traffic count data

Period	Pedestrian			Bicycle			Motorcycle Taxi			Motorised Three-wheeler			Taxi			Songtheaw		
	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum
06.00-06.15	5	55	60	0	0	0	0	25	25	0	12	12	0	0	0	0	0	0
06.15-06.30	7	80	87	0	0	0	2	18	20	0	3	3	0	0	0	0	0	0
06.30-06.45	11	92	103	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0
06.45-07.00	4	124	128	0	0	0	2	75	77	0	22	22	0	1	1	0	0	0
07.00-07.15	12	185	197	1	0	1	0	109	109	0	24	24	0	0	0	0	15	15
07.15-07.30	12	177	189	1	0	1	4	81	85	1	27	28	0	0	0	0	23	23
07.30-07.45	19	198	217	0	0	0	1	212	213	0	38	38	0	0	0	0	30	30
07.45-08.00	28	285	313	1	0	1	1	199	200	2	47	49	0	0	0	0	37	37
08.00-08.15	31	312	343	0	0	0	0	170	170	0	28	28	3	0	3	0	68	68
08.15-08.30	31	350	381	3	0	3	4	172	176	2	54	56	1	0	1	0	55	55
08.30-08.45	34	312	346	0	0	0	1	142	143	1	24	25	0	0	0	1	64	65
08.45-09.00	61	391	452	4	1	5	4	160	164	1	30	31	1	0	1	0	41	41
09.00-09.15	50	327	377	1	0	1	2	140	142	1	37	38	2	0	2	0	36	36
09.15-09.30	28	307	335	0	0	0	2	129	131	0	26	26	2	0	2	0	19	19
09.30-09.45	16	284	300	0	0	0	1	130	131	0	28	28	0	0	0	0	14	14
09.45-10.00	27	166	193	0	0	0	2	108	110	0	41	41	0	0	0	0	0	0
10.00-10.15	25	181	206	1	0	1	2	63	65	3	45	48	1	0	1	0	0	0
10.15-10.30	30	139	169	0	0	0	2	59	61	0	41	41	1	0	1	0	0	0
10.30-10.45	16	147	163	0	0	0	4	45	49	0	40	40	0	0	0	0	0	0
10.45-11.00	15	125	140	0	0	0	1	40	41	0	41	41	2	0	2	0	0	0
11.00-11.15	19	122	141	2	1	3	8	68	76	0	41	41	0	0	0	0	0	0
11.15-11.30	33	99	132	0	0	0	0	26	26	0	37	37	1	0	1	15	21	36
11.30-11.45	25	127	152	1	0	1	2	44	46	2	68	70	0	0	0	41	0	41
11.45-12.00	37	140	177	0	0	0	2	59	61	8	77	85	5	0	5	26	0	26
12.00-12.15	68	163	231	0	0	0	2	45	47	0	73	73	0	0	0	45	0	45
12.15-12.30	45	183	228	2	0	2	2	56	58	9	77	86	0	0	0	42	0	42
12.30-12.45	59	190	249	0	0	0	3	38	41	0	58	58	0	0	0	28	0	28
12.45-13.00	14	181	195	0	0	0	2	47	49	0	53	53	0	0	0	0	0	0
13.00-13.15	23	231	254	0	0	0	5	63	68	0	54	54	3	0	3	0	0	0
13.15-13.30	36	219	255	1	0	1	2	33	35	4	59	63	0	0	0	0	0	0
13.30-13.45	10	146	156	0	0	0	3	56	59	0	73	73	0	0	0	0	0	0
13.45-14.00	19	123	142	0	0	0	3	58	61	2	70	72	3	0	3	0	0	0
14.00-14.15	11	112	123	3	0	3	0	45	45	0	41	41	0	0	0	15	0	15
14.15-14.30	23	93	116	0	0	0	4	61	65	2	27	29	0	0	0	0	0	0
14.30-14.45	40	115	155	0	0	0	0	43	43	0	37	37	0	0	0	0	0	0
14.45-15.00	14	84	98	0	0	0	0	58	58	4	28	32	0	0	0	0	0	0
15.00-15.15	10	89	99	2	0	2	5	42	47	0	29	29	0	0	0	0	0	0
15.15-15.30	13	111	124	0	0	0	3	39	42	4	21	25	2	0	2	0	0	0
15.30-15.45	4	80	84	0	0	0	5	32	37	0	47	47	0	0	0	0	0	0
15.45-16.00	10	117	127	1	0	1	0	75	75	2	41	43	4	0	4	0	0	0

Period	Pedestrian			Bicycle			Motorcycle Taxi			Motorised Three-wheeler			Taxi			Songtheaw		
	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum
16.00-16.15	32	96	128	0	0	0	0	30	30	3	94	97	0	0	0	0	0	0
16.15-16.30	26	86	112	2	0	2	7	119	126	4	99	103	2	0	2	0	0	0
16.30-16.45	31	255	286	0	0	0	1	138	139	1	113	114	0	0	0	0	0	0
16.45-17.00	26	306	332	0	0	0	0	151	151	2	106	108	4	0	4	0	0	0
17.00-17.15	31	334	365	2	0	2	0	136	136	6	104	110	5	0	5	0	0	0
17.15-17.30	29	234	263	0	0	0	2	146	148	1	83	84	0	0	0	0	0	0
17.30-17.45	39	155	194	1	3	4	2	108	110	0	63	63	0	0	0	0	0	0
17.45-18.00	48	190	238	1	0	1	0	109	109	4	57	61	0	0	0	0	0	0
18.00-18.15	42	208	250	0	2	2	0	97	97	0	60	60	2	0	2	0	0	0
18.15-18.30	50	180	230	0	1	1	5	92	97	2	54	56	0	0	0	0	0	0
18.30-18.45	25	169	194	0	4	4	3	84	87	0	49	49	4	0	4	0	0	0
18.45-19.00	36	157	193	2	7	9	1	78	79	0	33	33	0	0	0	0	0	0
19.00-19.15	42	250	292	3	0	3	0	95	95	3	31	34	0	0	0	0	0	0
19.15-19.30	32	289	321	1	1	2	0	57	57	0	29	29	0	0	0	0	0	0
19.30-19.45	34	217	251	0	0	0	0	54	54	0	31	31	4	0	4	0	0	0
19.45-20.00	44	289	333	0	1	1	2	61	63	0	22	22	0	0	0	0	0	0
Count total	**1542**	**10377**	**11919**	**36**	**21**	**57**	**109**	**4633**	**4742**	**74**	**2647**	**2721**	**52**	**1**	**53**	**213**	**423**	**636**

Table 3A-2 Summary

Summary		Pedestrian			Bicycle			Motorcycle Taxi			Motorised Three-wheeler			Taxi			Songtheaw			Total		
Period		North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum	North	South	Sum
Morning	Total	376	3645	4021	11	1	12	26	1883	1909	8	441	449	9	1	10	1	402	403	431	6373	6804
06.00-10.00	per hour	94	911	1005	3	0	3	7	471	477	2	110	112	2	0	3	0	101	101	108	1593	1701
Mid-day	Total	599	3317	3916	13	1	14	60	1195	1255	40	1178	1218	22	0	22	212	21	233	946	5712	6658
10.00-16.00	per hour	100	553	653	2	0	2	10	199	209	7	196	203	4	0	4	35	4	39	158	952	1110
Evening	Total	567	3415	3982	12	19	31	23	1555	1578	26	1028	1054	21	0	21	0	0	0	649	6017	6666
16.00-20.00	per hour	142	854	996	3	5	8	6	389	395	7	257	264	5	0	5	0	0	0	162	1504	1667
All-day	Total	1542	10377	11919	36	21	57	109	4633	4742	74	2647	2721	52	1	53	213	423	636	2026	18102	20128
06.00-20.00	per hour	110	741	851	3	2	4	8	331	339	5	189	194	4	0	4	15	30	45	145	1293	1438
Peak 15 min	Total	68	391	452	4	7	9	8	212	213	9	113	114	5	1	5	45	68	68	139	792	861
	per hour	272	1564	1808	16	28	36	32	848	852	36	452	456	20	4	20	180	272	272	556	3168	3444

Source: Consultant

Group 3: All traffic to/from indicated closed study area of governmental offices district

Collect from 4 main entrance gates of a "**closed study area"** as indicate by blue boundary in **Figure 3.2-1.** This **closed study area** is only one part of Governmental offices district in Soi Ari. This area is suitable for collect traffic count data since it has only 4 main gates that the traffic get through. The other area of Governmental offices district has large amount of gates which is difficult to monitor and collect traffic data.

The selected traffic survey locations at 4 gates, which is indicated by **blue circle** in **Figure 3.2-1**, including:

Location A: Revenue Department gate

- collect **enter and exit** number of **NMT passenger**: pedestrian, and bicycle users
- collect **enter and exit** number of **paratransit vehicle and passengers** (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw
- collect **enter and exit** number of **private vehicle and passengers**: private car and private motorcycle

Figure 3A-8 Revenue Department gate (Source: Consultant)

Location B: Department of Water Resources gate

- collect **enter and exit** number of **NMT passenger**: pedestrian, and bicycle users
- collect **enter and exit** number of **paratransit vehicle and passengers** (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw
- collect **enter and exit** number of **private vehicle and passengers**: private car and private motorcycle

Figure 3A-9 Location B: Department of Water Resources gate (Source: Consultant)

Location C: Soi Phibunwatthana 5 gate

- collect **enter and exit** number of **NMT passenger**: pedestrian, and bicycle users
- collect **enter and exit** number of **Paratransit vehicle and passengers** (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw
- collect **enter and exit** number of **Private vehicle and passengers**: private car and private motorcycle

Figure 3A-4-130 Location C: Soi Phibunwatthana 5 gate (Source: Consultant)

Location D: The Government Public Relations Department gate

- collect **enter and exit** number of **NMT passenger**: pedestrian, and bicycle users
- collect **enter and exit** number of **paratransit vehicle and passengers** (exclude drivers): motorcycle taxi, motorised three-wheeler, and songtheaw
- collect **enter and exit** number of **private vehicle and passengers**: private car and private motorcycle

Figure 3A-4-131 Location D: The Government Public Relations Department gate (Source: Consultant)

Table 3A-4 Closed study area all mode traffic count data

1) Pedestrian

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	29	9	2	2	2	5	4	4	38	4	7	8	57	37	20
06.15-06.30	18	2	3	3	5	4	8	8	20	6	9	16	51	34	17
06.30-06.45	22	7	8	4	5	6	14	8	29	12	11	22	74	49	25
06.45-07.00	34	9	2	2	16	7	8	3	43	4	23	11	81	60	21
07.00-07.15	37	10	7	3	8	9	17	4	47	10	17	21	95	69	26
07.15-07.30	35	16	5	3	27	9	19	9	51	8	36	28	123	86	37
07.30-07.45	58	13	5	9	30	6	11	9	71	14	36	20	141	104	37
07.45-08.00	59	26	5	11	28	23	19	16	85	16	51	35	187	111	76
08.00-08.15	60	19	16	2	33	27	21	14	79	18	60	35	192	130	62
08.15-08.30	53	16	18	6	37	21	34	18	69	24	58	52	203	142	61
08.30-08.45	40	14	12	3	42	29	27	20	54	15	71	47	187	121	66
08.45-09.00	38	8	13	4	58	35	18	14	46	17	93	32	188	127	61
09.00-09.15	31	7	4	4	83	58	13	13	38	8	141	26	213	131	82
09.15-09.30	30	15	9	2	57	42	10	26	45	11	99	36	191	106	85
09.30-09.45	14	11	3	2	51	29	7	10	25	5	80	17	127	75	52
09.45-10.00	12	4	6	3	23	32	7	9	16	9	55	16	96	48	48
10.00-10.15	14	6	6	2	17	11	15	10	20	8	28	25	81	52	29
10.15-10.30	30	26	1	0	18	8	15	8	56	1	26	23	106	64	42
10.30-10.45	12	16	2	3	18	14	9	11	28	5	32	20	85	41	44
10.45-11.00	8	10	1	4	16	33	11	20	18	5	49	31	103	36	67
11.00-11.15	17	15	2	8	25	46	15	16	32	10	71	31	144	59	85
11.15-11.30	6	10	4	8	30	62	28	24	16	12	92	52	172	68	104
11.30-11.45	26	41	1	13	54	105	20	28	67	14	159	48	288	101	187
11.45-12.00	20	57	2	18	58	142	29	17	77	20	200	46	343	109	234
12.00-12.15	19	29	0	21	70	219	25	31	48	21	289	56	414	114	300
12.15-12.30	54	56	2	7	107	127	22	29	110	9	234	51	404	185	219
12.30-12.45	60	57	8	15	119	104	18	32	117	23	223	50	413	205	208
12.45-13.00	64	56	9	6	107	48	14	28	120	15	155	42	332	194	138
13.00-13.15	30	30	26	3	124	27	12	8	60	29	151	20	260	192	68
13.15-13.30	55	26	11	10	46	21	16	13	81	21	67	29	198	128	70
13.30-13.45	41	26	11	1	27	16	10	25	67	12	43	35	157	89	68
13.45-14.00	29	27	8	1	30	10	13	19	56	9	40	32	137	80	57
14.00-14.15	13	8	2	1	9	7	10	8	21	3	16	18	58	34	24
14.15-14.30	13	10	4	2	4	11	18	18	23	6	15	36	80	39	41
14.30-14.45	28	20	5	1	5	2	22	11	48	6	7	33	94	60	34
14.45-15.00	16	12	0	3	9	4	21	29	28	3	13	50	94	46	48
15.00-15.15	27	30	0	6	10	6	8	18	57	6	16	26	105	45	60
15.15-15.30	25	59	4	8	5	3	4	20	84	12	8	24	128	38	90
15.30-15.45	17	21	7	5	7	3	10	18	38	12	10	28	88	41	47
15.45-16.00	11	21	3	7	13	3	10	12	32	10	16	22	80	37	43
16.00-16.15	10	42	7	11	12	14	8	5	52	18	26	13	109	37	72
16.15-16.30	18	58	11	16	42	4	7	9	76	27	46	16	165	78	87
16.30-16.45	22	83	7	27	31	8	63	46	105	34	39	109	287	123	164
16.45-17.00	10	90	3	21	17	9	28	24	100	24	26	52	202	58	144
17.00-17.15	7	52	4	5	1	18	7	3	59	9	19	10	97	19	78
17.15-17.30	12	13	1	2	2	2	0	2	25	3	4	2	34	15	19
17.30-17.45	5	10	0	0	5	0	4	3	15	0	5	7	27	14	13
17.45-18.00	5	10	0	1	6	9	8	4	15	1	15	12	43	19	24
18.00-18.15	5	10	13	0	4	6	4	2	15	13	10	6	44	26	18
18.15-18.30	5	10	0	5	2	7	3	4	15	5	9	7	36	10	26
18.30-18.45	5	10	1	5	3	2	5	6	15	6	5	11	37	14	23
18.45-19.00	5	10	0	0	8	2	3	7	15	0	10	10	35	16	19
19.00-19.15	3	4	0	0	4	2	6	3	7	0	6	9	22	13	9
19.15-19.30	5	0	0	0	4	3	2	2	5	0	7	4	16	11	5
19.30-19.45	2	3	0	1	0	0	0	0	5	1	0	0	6	2	4
19.45-20.00	4	0	0	0	0	0	0	0	4	0	0	0	4	4	0
Count Total	1328	1260	284	310	1574	1460	760	758	2588	594	3034	1518	7734	3946	3788

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	**Total**	570	186	118	63	505	342	237	185	756	181	847	422	2206	1430	776
06.00-10.00	**per hour**	143	47	30	16	126	86	59	46	189	45	212	106	552	358	194
Mid-day	**Total**	635	669	119	153	928	1032	375	453	1304	272	1960	828	4364	2057	2307
10.00-16.00	**per hour**	106	112	20	26	155	172	63	76	217	45	327	138	727	343	385
Evening	**Total**	123	405	47	94	141	86	148	120	528	141	227	268	1164	459	705
16.00-20.00	**per hour**	31	101	12	24	35	22	37	30	132	35	57	67	291	115	176
All-day	**Total**	1328	1260	284	310	1574	1460	760	758	2588	594	3034	1518	7734	**3946**	**3788**
06.00-20.00	**per hour**	95	90	20	22	112	104	54	54	185	42	217	108	552	282	271
Peak 15 min	**Total**	64	90	26	27	124	219	63	46	120	34	289	109	414		
	per hour	256	360	104	108	496	876	252	184	480	136	1156	436	1656		

2) Bicycle

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit		A	B	C	D	Total		Enter	Exit
06.00-06.15	1	1	1		2		1	1		2	1	2	2	7		5	2
06.15-06.30	7		1	1	3	1				7	2	4	0	13		11	2
06.30-06.45	1		1	1	10	5	3			1	2	15	3	21		15	6
06.45-07.00		4	1	3	2	2	1	5		4	4	4	6	18		4	14
07.00-07.15	1	4			5	6	2	2		5	0	11	4	20		8	12
07.15-07.30		1				2	3			1	0	2	3	6		3	3
07.30-07.45		1			2	1		2		1	0	3	2	6		2	4
07.45-08.00	4			1		3	1	2		4	1	3	3	11		5	6
08.00-08.15	2	3	1		3	2	3	1		5	1	5	4	15		9	6
08.15-08.30	1	1	1		1	1	2	1		2	1	2	3	8		5	3
08.30-08.45	2	1	1		4	2	3	3		3	1	6	6	16		10	6
08.45-09.00	1				1	2	2			1	0	3	2	6		4	2
09.00-09.15	2	2			4	1	1	3		4	0	5	4	13		7	6
09.15-09.30		3	1		3	1	1			3	1	4	1	9		5	4
09.30-09.45	1	2	1					2		3	1	0	2	6		2	4
09.45-10.00	1	2			1		1	1		3	0	1	2	6		3	3
10.00-10.15					1			1		0	0	1	1	2		1	1
10.15-10.30	1	3		1	2					4	1	2	0	7		3	4
10.30-10.45		3		1	2	2		3		3	1	4	3	11		2	9
10.45-11.00		1				1		2		1	0	1	2	4		0	4
11.00-11.15	1		1			5	1			1	1	5	1	8		3	5
11.15-11.30			1		4	1		4		0	1	5	4	10		5	5
11.30-11.45		1			2	1	1	3		1	0	3	4	8		3	5
11.45-12.00					3	2		1		0	0	5	1	6		3	3
12.00-12.15	1	2			2		1			3	0	2	1	6		4	2
12.15-12.30	1	4			1					5	0	1	0	6		2	4
12.30-12.45	1				3	1	4			1	0	4	4	9		8	1
12.45-13.00							1			0	0	0	1	1		1	0
13.00-13.15	2				2	4				2	0	6	0	8		4	4
13.15-13.30			1		1	1		1		0	1	2	1	4		2	2
13.30-13.45	1	2			2	1				3	0	3	0	6		3	3
13.45-14.00				1		1				0	1	1	0	2		0	2
14.00-14.15		1	2		2			1		1	2	2	1	6		4	2
14.15-14.30					2					0	0	2	0	2		2	0
14.30-14.45	1	1			1					2	0	1	0	3		2	1
14.45-15.00	2	1			1	4				3	0	5	0	8		3	5
15.00-15.15		1			4	5		1		1	0	9	1	11		4	7
15.15-15.30	1				2	1				1	0	3	0	4		3	1
15.30-15.45	3	1			5	4				4	0	9	0	13		8	5
15.45-16.00	2	1			3	3				3	0	6	0	9		5	4
16.00-16.15	4	1			3	2				5	0	5	0	10		7	3
16.15-16.30	2	2			2		1	1		4	0	2	2	8		5	3
16.30-16.45	1	2			5	2		5		3	0	7	5	15		6	9
16.45-17.00		1			4	1		10		1	0	5	10	16		4	12
17.00-17.15					1		1			0	0	1	1	2		2	0
17.15-17.30	1				1					1	0	1	0	2		2	0
17.30-17.45						1				0	0	1	0	1		0	1
17.45-18.00					1	3	1	1		0	0	4	2	6		2	4
18.00-18.15		2			2	1		4		2	0	3	4	9		2	7
18.15-18.30	1	3	1		4	2				4	1	6	0	11		6	5
18.30-18.45				1		2		3		0	1	2	3	6		0	6
18.45-19.00	1					1				1	0	1	0	2		1	1
19.00-19.15	3	2			1	2				5	0	3	0	8		4	4
19.15-19.30	1		1		1	2		2		1	1	3	2	7		3	4
19.30-19.45	1	1								2	0	0	0	2		1	1
19.45-20.00	3			1						3	1	0	0	4		3	1
Count Total	**59**	**61**	**16**	**11**	**111**	**85**	**35**	**66**		**120**	**27**	**196**	**101**	**444**		**221**	**223**

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit		A	B	C	D	Total		Enter	Exit
Morning	**Total**	24	25	9	6	41	29	24	23		49	15	70	47	181		98	83
06.00-10.00	**per hour**	6	6	2	2	10	7	6	6		12	4	18	12	45		25	21
Mid-day	**Total**	17	22	5	3	45	37	8	17		39	8	82	25	154		75	79
10.00-16.00	**per hour**	3	4	1	1	8	6	1	3		7	1	14	4	26		13	13
Evening	**Total**	18	14	2	2	25	19	3	26		32	4	44	29	109		48	61
16.00-20.00	**per hour**	5	4	1	1	6	5	1	7		8	1	11	7	27		12	15
All-day	**Total**	59	61	16	11	111	85	35	66		120	27	196	101	444		**221**	**223**
06.00-20.00	**per hour**	4	4	1	1	8	6	3	5		9	2	14	7	32		16	16
Peak 15 min	**Total**	7	4	2	3	10	6	4	10		7	4	15	10	21			
	per hour	28	16	8	12	40	24	16	40		28	16	60	40	84			

3) Private motorcycle

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	9	5	1	1	6	4	0	4	14	2	10	4	30	16	14
06.15-06.30	4	4	2	2	8	4	1	0	8	4	12	1	25	15	10
06.30-06.45	11	7	4	1	10	26	4	2	18	5	36	6	65	29	36
06.45-07.00	10	16	2	0	30	40	8	0	26	2	70	8	106	50	56
07.00-07.15	11	22	5	6	44	68	9	2	33	11	112	11	167	69	98
07.15-07.30	17	36	12	2	61	70	5	3	53	14	131	8	206	95	111
07.30-07.45	11	41	6	2	68	40	10	9	52	8	108	19	187	95	92
07.45-08.00	17	51	6	0	60	50	9	4	68	6	110	13	197	92	105
08.00-08.15	12	51	12	0	60	68	14	4	63	12	128	18	221	98	123
08.15-08.30	11	38	16	3	71	41	13	7	49	19	112	20	200	111	89
08.30-08.45	12	39	12	2	52	100	18	5	51	14	152	23	240	94	146
08.45-09.00	10	40	7	4	52	61	19	1	50	11	113	20	194	88	106
09.00-09.15	19	30	6	10	32	51	12	6	49	16	83	18	166	69	97
09.15-09.30	11	26	3	7	36	58	13	4	37	10	94	17	158	63	95
09.30-09.45	9	27	6	2	47	48	5	5	36	8	95	10	149	67	82
09.45-10.00	11	19	6	7	23	50	6	7	30	13	73	13	129	46	83
10.00-10.15	28	21	8	2	39	44	4	12	49	10	83	16	158	79	79
10.15-10.30	25	27	4	6	24	34	6	20	52	10	58	26	146	59	87
10.30-10.45	27	43	5	7	30	64	5	13	70	12	94	18	194	67	127
10.45-11.00	21	35	3	4	46	100	3	2	56	7	146	5	214	73	141
11.00-11.15	20	31	10	10	32	60	6	12	51	20	92	18	181	68	113
11.15-11.30	16	30	4	7	17	42	4	6	46	11	59	10	126	41	85
11.30-11.45	17	40	7	5	28	52	7	10	57	12	80	17	166	59	107
11.45-12.00	19	24	7	8	23	50	8	19	43	15	73	27	158	57	101
12.00-12.15	22	22	10	8	30	70	5	8	44	18	100	13	175	67	108
12.15-12.30	23	26	8	4	20	76	6	9	49	12	96	15	172	57	115
12.30-12.45	13	37	6	2	30	52	8	7	50	8	82	15	155	57	98
12.45-13.00	23	32	9	6	26	35	5	7	55	15	61	12	143	63	80
13.00-13.15	29	24	8	8	21	40	9	9	53	16	61	18	148	67	81
13.15-13.30	15	25	5	2	26	23	3	5	40	7	49	8	104	49	55
13.30-13.45	20	25	4	8	35	20	6	6	45	12	55	12	124	65	59
13.45-14.00	31	24	4	4	25	26	8	5	55	8	51	13	127	68	59
14.00-14.15	21	29	4	0	16	36	9	8	50	4	52	17	123	50	73
14.15-14.30	15	38	4	2	24	38	15	10	53	6	62	25	146	58	88
14.30-14.45	19	22	3	3	31	35	9	22	41	6	66	31	144	62	82
14.45-15.00	14	19	4	5	16	42	20	20	33	9	58	40	140	54	86
15.00-15.15	16	21	2	2	26	35	13	22	37	4	61	35	137	57	80
15.15-15.30	13	18	6	6	13	33	17	20	31	12	46	37	126	49	77
15.30-15.45	19	26	3	4	21	36	7	12	45	7	57	19	128	50	78
15.45-16.00	22	21	0	2	12	56	10	8	43	2	68	18	131	44	87
16.00-16.15	29	26	6	8	34	48	12	6	55	14	82	18	169	81	88
16.15-16.30	33	35	4	9	39	50	6	10	68	13	89	16	186	82	104
16.30-16.45	41	50	6	10	36	54	20	23	91	16	90	43	240	103	137
16.45-17.00	45	77	6	8	31	48	15	30	122	14	79	45	260	97	163
17.00-17.15	35	89	6	8	38	34	9	25	124	14	72	34	244	88	156
17.15-17.30	41	46	4	4	25	28	7	30	87	8	53	37	185	77	108
17.30-17.45	0	42	0	1	6	24	5	4	42	1	30	9	82	11	71
17.45-18.00	4	38	0	3	10	30	6	4	42	3	40	10	95	20	75
18.00-18.15	12	26	2	4	22	48	11	8	38	6	70	19	133	47	86
18.15-18.30	13	22	2	6	31	56	5	5	35	8	87	10	140	51	89
18.30-18.45	15	16	0	4	29	43	5	2	31	4	72	7	114	49	65
18.45-19.00	17	13	3	4	16	28	4	7	30	7	44	11	92	40	52
19.00-19.15	23	10	2	5	15	52	5	9	33	7	67	14	121	45	76
19.15-19.30	18	7	0	1	26	30	3	2	25	1	56	5	87	47	40
19.30-19.45	17	4	3	1	0	0	3	0	21	4	0	3	28	23	5
19.45-20.00	13	6	2	1	0	0	0	0	19	3	0	0	22	15	7
Count Total	**1029**	**1619**	**280**	**241**	**1629**	**2451**	**455**	**500**	**2648**	**521**	**4080**	**955**	**8204**	**3393**	**4811**

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	**Total**	185	452	106	49	660	779	146	63	637	155	1439	209	2440	1097	1343
06.00-10.00	**per hour**	46	113	27	12	165	195	37	16	159	39	360	52	610	274	336
Mid-day	**Total**	488	660	128	115	611	1099	193	272	1148	243	1710	465	3566	1420	2146
10.00-16.00	**per hour**	81	110	21	19	102	183	32	45	191	41	285	78	594	237	358
Evening	**Total**	356	507	46	77	358	573	116	165	863	123	931	281	2198	876	1322
16.00-20.00	**per hour**	89	127	12	19	90	143	29	41	216	31	233	70	550	219	331
All-day	**Total**	1029	1619	280	241	1629	2451	455	500	2648	521	4080	955	8204	**3393**	**4811**
06.00-20.00	**per hour**	74	116	20	17	116	175	33	36	189	37	291	68	586	242	344
Peak 15 min	**Total**	45	89	16	10	71	100	20	30	124	20	152	45	260		
	per hour	180	356	64	40	284	400	80	120	496	80	608	180	1040		

4) Motorcycle taxi

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	0	2	0	1	10	6	0	0	2	1	16	0	19	10	9
06.15-06.30	0	10	0	0	13	4	0	1	10	0	17	1	28	13	15
06.30-06.45	0	15	1	2	15	11	1	1	15	3	26	2	46	17	29
06.45-07.00	0	27	1	0	7	24	2	0	27	1	31	2	61	10	51
07.00-07.15	4	16	0	0	5	52	2	1	20	0	57	3	80	11	69
07.15-07.30	12	20	3	1	29	54	13	1	32	4	83	14	133	57	76
07.30-07.45	31	28	3	1	39	40	15	2	59	4	79	17	159	88	71
07.45-08.00	27	49	1	0	32	39	10	0	76	1	71	10	158	70	88
08.00-08.15	37	46	1	2	35	49	19	3	83	3	84	22	192	92	100
08.15-08.30	31	38	3	2	35	45	20	3	69	5	80	23	177	89	88
08.30-08.45	43	30	4	4	52	45	33	0	73	8	97	33	211	132	79
08.45-09.00	35	25	8	4	54	60	22	0	60	12	114	22	208	119	89
09.00-09.15	89	14	2	9	7	50	3	0	103	11	57	3	174	101	73
09.15-09.30	70	28	2	4	27	48	5	0	98	6	75	5	184	104	80
09.30-09.45	38	21	1	6	6	40	10	0	59	7	46	10	122	55	67
09.45-10.00	55	19	2	2	28	38	9	0	74	4	66	9	153	94	59
10.00-10.15	31	15	1	5	19	32	10	3	46	6	51	13	116	61	55
10.15-10.30	25	12	3	4	9	28	13	5	37	7	37	18	99	50	49
10.30-10.45	21	9	2	0	8	30	5	4	30	2	38	9	79	36	43
10.45-11.00	19	9	1	2	23	39	4	0	28	3	62	4	97	47	50
11.00-11.15	27	10	1	1	15	30	5	5	37	2	45	10	94	48	46
11.15-11.30	20	10	5	2	8	30	6	6	30	7	38	12	87	39	48
11.30-11.45	29	25	1	0	24	28	0	0	54	1	52	0	107	54	53
11.45-12.00	21	32	4	3	20	30	0	4	53	7	50	4	114	45	69
12.00-12.15	30	14	1	6	26	27	8	0	44	7	53	8	112	65	47
12.15-12.30	38	22	0	2	25	24	0	7	60	2	49	7	118	63	55
12.30-12.45	24	14	2	0	18	25	4	4	38	2	43	8	91	48	43
12.45-13.00	25	10	2	0	24	24	2	0	35	2	48	2	87	53	34
13.00-13.15	16	9	2	3	19	26	4	1	25	5	45	5	80	41	39
13.15-13.30	19	26	1	1	26	33	2	0	45	2	59	2	108	48	60
13.30-13.45	29	20	1	0	12	25	4	0	49	1	37	4	91	46	45
13.45-14.00	13	15	0	2	13	20	6	0	28	2	33	6	69	32	37
14.00-14.15	15	20	2	0	8	29	5	3	35	2	37	8	82	30	52
14.15-14.30	11	13	0	0	4	20	4	2	24	0	24	6	54	19	35
14.30-14.45	11	18	2	0	15	20	3	3	29	2	35	6	72	31	41
14.45-15.00	12	15	1	3	2	22	5	3	27	4	24	8	63	20	43
15.00-15.15	5	11	3	4	13	25	8	3	16	7	38	11	72	29	43
15.15-15.30	16	21	0	0	14	26	10	10	37	0	40	20	97	40	57
15.30-15.45	11	29	0	0	15	21	7	0	40	0	36	7	83	33	50
15.45-16.00	12	36	4	1	17	27	5	4	48	5	44	9	106	38	68
16.00-16.15	8	34	1	1	20	28	7	10	42	2	48	17	109	36	73
16.15-16.30	4	48	3	4	26	24	3	10	52	7	50	13	122	36	86
16.30-16.45	12	61	0	1	35	26	0	0	73	1	61	0	135	47	88
16.45-17.00	8	59	2	5	24	17	0	0	67	7	41	0	115	34	81
17.00-17.15	2	83	3	0	13	24	1	0	85	3	37	1	126	19	107
17.15-17.30	3	36	3	3	10	23	0	4	39	6	33	4	82	16	66
17.30-17.45	10	23	0	0	4	15	2	0	33	0	19	2	54	16	38
17.45-18.00	6	16	1	0	11	4	0	0	22	1	15	0	38	18	20
18.00-18.15	7	11	0	0	12	6	4	7	18	0	18	11	47	23	24
18.15-18.30	9	10	0	0	18	19	3	4	19	0	37	7	63	30	33
18.30-18.45	8	8	0	0	11	5	1	0	16	0	16	1	33	20	13
18.45-19.00	8	8	0	0	3	23	0	7	16	0	26	7	49	11	38
19.00-19.15	8	8	0	0	1	28	0	2	16	0	29	2	47	9	38
19.15-19.30	6	5	0	0	7	21	0	2	11	0	28	2	41	13	28
19.30-19.45	5	4	0	0	0	0	0	0	9	0	0	0	9	5	4
19.45-20.00	5	4	0	0	0	0	0	0	9	0	0	0	9	5	4
Count Total	1061	1221	84	91	966	1509	305	125	2282	175	2475	430	5362	2416	2946

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	Total	472	388	32	38	394	605	164	12	860	70	999	176	2105	1062	1043
06.00-10.00	per hour	118	97	8	10	99	151	41	3	215	18	250	44	526	266	261
Mid-day	Total	480	415	39	39	377	641	120	67	895	78	1018	187	2178	1016	1162
10.00-16.00	per hour	80	69	7	7	63	107	20	11	149	13	170	31	363	169	194
Evening	Total	109	418	13	14	195	263	21	46	527	27	458	67	1079	338	741
16.00-20.00	per hour	27	105	3	4	49	66	5	12	132	7	115	17	270	85	185
All-day	Total	1061	1221	84	91	966	1509	305	125	2282	175	2475	430	5362	**2416**	**2946**
06.00-20.00	per hour	76	87	6	7	69	108	22	9	163	13	177	31	383	173	210
Peak 15 min	Total	89	83	8	9	54	60	33	10	103	12	114	33	211		
	per hour	356	332	32	36	216	240	132	40	412	48	456	132	844		

5) Motorised Three-wheeler

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	0	0	0	0	10	6	0	0	0	0	16	0	16	10	6
06.15-06.30	1	0	0	0	8	6	0	0	1	0	14	0	15	9	6
06.30-06.45	5	2	0	0	11	9	0	0	7	0	20	0	27	16	11
06.45-07.00	5	8	0	0	14	10	0	0	13	0	24	0	37	19	18
07.00-07.15	19	2	0	0	29	13	0	0	21	0	42	0	63	48	15
07.15-07.30	7	3	0	0	33	20	0	0	10	0	53	0	63	40	23
07.30-07.45	7	3	4	3	30	33	0	0	10	7	63	0	80	41	39
07.45-08.00	17	5	0	0	21	23	0	0	22	0	44	0	66	38	28
08.00-08.15	9	1	0	3	20	43	0	0	10	3	63	0	76	29	47
08.15-08.30	17	2	3	6	20	11	0	0	19	9	31	0	59	40	19
08.30-08.45	23	5	3	4	30	52	0	0	28	7	82	0	117	56	61
08.45-09.00	25	6	0	2	23	39	0	0	31	2	62	0	95	48	47
09.00-09.15	20	3	3	6	10	16	0	0	23	9	26	0	58	33	25
09.15-09.30	35	0	0	0	15	11	0	1	35	0	26	1	62	50	12
09.30-09.45	13	0	0	0	3	6	0	0	13	0	9	0	22	16	6
09.45-10.00	25	1	0	0	0	5	0	0	26	0	5	0	31	25	6
10.00-10.15	15	0	0	0	4	9	0	0	15	0	13	0	28	19	9
10.15-10.30	4	6	0	0	11	10	0	0	10	0	21	0	31	15	16
10.30-10.45	10	3	0	0	15	20	0	0	13	0	35	0	48	25	23
10.45-11.00	5	1	0	0	9	28	0	0	6	0	37	0	43	14	29
11.00-11.15	17	5	0	0	21	15	0	0	22	0	36	0	58	38	20
11.15-11.30	14	12	0	0	16	16	0	0	26	0	32	0	58	30	28
11.30-11.45	5	22	3	1	23	25	0	3	27	4	48	3	82	31	51
11.45-12.00	8	29	3	2	22	30	0	2	37	5	52	2	96	33	63
12.00-12.15	27	14	5	0	30	34	0	0	41	5	64	0	110	62	48
12.15-12.30	43	98	1	4	37	38	0	0	141	5	75	0	221	81	140
12.30-12.45	23	10	3	3	47	44	3	0	33	6	91	3	133	76	57
12.45-13.00	29	16	8	5	44	38	0	0	45	13	82	0	140	81	59
13.00-13.15	45	14	6	5	32	26	0	0	59	11	58	0	128	83	45
13.15-13.30	0	0	6	3	36	28	0	0	0	9	64	0	73	42	31
13.30-13.45	2	22	0	0	53	22	0	0	24	0	75	0	99	55	44
13.45-14.00	13	3	0	0	40	15	0	0	16	0	55	0	71	53	18
14.00-14.15	29	0	0	0	33	6	0	0	29	0	39	0	68	62	6
14.15-14.30	4	0	2	2	19	14	0	0	4	4	33	0	41	25	16
14.30-14.45	6	0	0	0	2	14	0	0	6	0	16	0	22	8	14
14.45-15.00	9	0	0	0	16	18	0	0	9	0	34	0	43	25	18
15.00-15.15	14	1	0	0	9	19	0	0	15	0	28	0	43	23	20
15.15-15.30	14	3	0	0	13	20	0	0	17	0	33	0	50	27	23
15.30-15.45	5	0	0	0	10	4	0	0	5	0	14	0	19	15	4
15.45-16.00	2	22	0	0	17	6	0	0	24	0	23	0	47	19	28
16.00-16.15	10	25	0	0	15	10	0	0	35	0	25	0	60	25	35
16.15-16.30	28	10	0	0	65	18	0	0	38	0	83	0	121	93	28
16.30-16.45	16	35	1	2	45	16	2	9	51	3	61	11	126	64	62
16.45-17.00	8	58	1	3	28	44	0	12	66	4	72	12	154	37	117
17.00-17.15	21	39	0	0	14	22	0	0	60	0	36	0	96	35	61
17.15-17.30	29	11	3	0	5	34	0	0	40	3	39	0	82	37	45
17.30-17.45	14	9	0	0	14	29	2	6	23	0	43	8	74	30	44
17.45-18.00	15	7	0	0	30	13	2	4	22	0	43	6	71	47	24
18.00-18.15	11	5	0	0	26	31	0	3	16	0	57	3	76	37	39
18.15-18.30	27	7	0	0	8	52	0	0	34	0	60	0	94	35	59
18.30-18.45	20	5	1	2	28	30	0	0	25	3	58	0	86	49	37
18.45-19.00	13	5	0	0	14	23	0	0	18	0	37	0	55	27	28
19.00-19.15	16	9	0	0	13	35	0	0	25	0	48	0	73	29	44
19.15-19.30	16	7	0	0	6	32	0	2	23	0	38	2	63	22	41
19.30-19.45	18	5	0	0	0	0	0	0	23	0	0	0	23	18	5
19.45-20.00	17	4	0	0	0	0	0	0	21	0	0	0	21	17	4
Count Total	**850**	**563**	**56**	**56**	**1147**	**1191**	**9**	**42**	**1413**	**112**	**2338**	**51**	**3914**	**2062**	**1852**

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	Total	228	41	13	24	277	303	0	1	269	37	580	1	887	518	369
06.00-10.00	per hour	57	10	3	6	69	76	0	0	67	9	145	0	222	130	92
Mid-day	Total	343	281	37	25	559	499	3	5	624	62	1058	8	1752	942	810
10.00-16.00	per hour	57	47	6	4	93	83	1	1	104	10	176	1	292	157	135
Evening	Total	279	241	6	7	311	389	6	36	520	13	700	42	1275	602	673
16.00-20.00	per hour	70	60	2	2	78	97	2	9	130	3	175	11	319	151	168
All-day	Total	850	563	56	56	1147	1191	9	42	1413	112	2338	51	3914	**2062**	**1852**
06.00-20.00	per hour	61	40	4	4	82	85	1	3	101	8	167	4	280	147	132
Peak 15 min	Total	45	98	8	6	65	52	3	12	141	13	91	12	221		
	per hour	180	392	32	24	260	208	12	48	564	52	364	48	884		

6) Taxi

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	4	0	0	0	2	3	0	0	4	0	5	0	9	6	3
06.15-06.30	0	0	0	0	11	6	0	0	0	0	17	0	17	11	6
06.30-06.45	0	0	0	0	13	3	0	0	0	0	16	0	16	13	3
06.45-07.00	6	0	0	0	3	5	0	1	6	0	8	1	15	9	6
07.00-07.15	2	2	0	0	0	3	4	0	4	0	3	4	11	6	5
07.15-07.30	1	2	0	0	15	13	4	0	3	0	28	4	35	20	15
07.30-07.45	1	1	0	0	6	3	0	0	2	0	9	0	11	7	4
07.45-08.00	0	3	3	2	11	7	0	0	3	5	18	0	26	14	12
08.00-08.15	5	0	2	0	9	8	0	0	5	2	17	0	24	16	8
08.15-08.30	3	0	0	0	13	14	0	0	3	0	27	0	30	16	14
08.30-08.45	5	0	2	1	17	12	0	2	5	3	29	2	39	24	15
08.45-09.00	10	0	3	3	15	16	2	1	10	6	31	3	50	30	20
09.00-09.15	7	0	11	3	7	33	5	0	7	14	40	5	66	30	36
09.15-09.30	16	0	6	4	6	22	4	0	16	10	28	4	58	32	26
09.30-09.45	19	0	0	2	11	27	1	0	19	2	38	1	60	31	29
09.45-10.00	16	0	3	6	9	20	2	0	16	9	29	2	56	30	26
10.00-10.15	13	3	1	0	5	18	1	0	16	1	23	1	41	20	21
10.15-10.30	14	0	0	0	10	24	2	0	14	0	34	2	50	26	24
10.30-10.45	12	7	0	5	9	22	2	2	19	5	31	4	59	23	36
10.45-11.00	5	4	6	3	2	20	0	0	9	9	22	0	40	13	27
11.00-11.15	18	1	3	0	8	12	6	0	19	3	20	6	48	35	13
11.15-11.30	4	3	0	0	1	23	2	0	7	0	24	2	33	7	26
11.30-11.45	20	2	0	4	8	10	2	10	22	4	18	12	56	30	26
11.45-12.00	2	2	2	0	3	20	2	0	4	2	23	2	31	9	22
12.00-12.15	22	2	0	0	2	11	3	0	24	0	13	3	40	27	13
12.15-12.30	3	1	0	0	13	23	1	0	4	0	36	1	41	17	24
12.30-12.45	20	0	0	0	2	22	3	1	20	0	24	4	48	25	23
12.45-13.00	8	1	0	0	7	3	2	0	9	0	10	2	21	17	4
13.00-13.15	20	3	2	4	3	6	8	1	23	6	9	9	47	33	14
13.15-13.30	31	3	1	1	10	24	4	4	34	2	34	8	78	46	32
13.30-13.45	18	1	1	4	1	9	5	2	19	5	10	7	41	25	16
13.45-14.00	6	2	0	0	1	22	6	0	8	0	23	6	37	13	24
14.00-14.15	9	7	4	3	14	34	4	0	16	7	48	4	75	31	44
14.15-14.30	6	2	0	0	4	4	4	2	8	0	8	6	22	14	8
14.30-14.45	6	0	0	0	6	4	8	1	6	0	10	9	25	20	5
14.45-15.00	3	2	0	0	0	19	9	1	5	0	19	10	34	12	22
15.00-15.15	11	2	0	0	1	2	11	1	13	0	3	12	28	23	5
15.15-15.30	0	5	0	0	0	17	3	2	5	0	17	5	27	3	24
15.30-15.45	3	6	0	0	3	6	3	0	9	0	9	3	21	9	12
15.45-16.00	1	1	0	0	2	17	2	0	2	0	19	2	23	5	18
16.00-16.15	4	1	0	0	9	9	7	2	5	0	18	9	32	20	12
16.15-16.30	5	1	0	0	14	9	4	6	6	0	23	10	39	23	16
16.30-16.45	2	6	0	0	18	9	4	6	8	0	27	10	45	24	21
16.45-17.00	2	6	3	0	8	10	2	10	8	3	18	12	41	15	26
17.00-17.15	7	6	0	0	4	7	0	4	13	0	11	4	28	11	17
17.15-17.30	10	1	0	0	1	8	0	2	11	0	9	2	22	11	11
17.30-17.45	4	2	0	1	1	12	1	0	6	1	13	1	21	6	15
17.45-18.00	8	2	0	0	3	14	1	0	10	0	17	1	28	12	16
18.00-18.15	7	1	0	0	0	19	0	2	8	0	19	2	29	7	22
18.15-18.30	9	1	0	0	5	12	1	0	10	0	17	1	28	15	13
18.30-18.45	6	0	0	0	0	14	0	4	6	0	14	4	24	6	18
18.45-19.00	0	0	0	0	1	4	0	4	0	0	5	4	9	1	8
19.00-19.15	1	0	0	0	4	19	0	4	1	0	23	4	28	5	23
19.15-19.30	0	0	0	0	0	12	0	0	0	0	12	0	12	0	12
19.30-19.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.45-20.00	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0
Count Total	**416**	**95**	**53**	**46**	**331**	**725**	**135**	**75**	**511**	**99**	**1056**	**210**	**1876**	**935**	**941**

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	Total	95	8	30	21	148	195	22	4	103	51	343	26	523	295	228
06.00-10.00	per hour	24	2	8	5	37	49	6	1	26	13	86	7	131	74	57
Mid-day	Total	255	60	20	24	115	372	93	27	315	44	487	120	966	483	483
10.00-16.00	per hour	43	10	3	4	19	62	16	5	53	7	81	20	161	81	81
Evening	Total	66	27	3	1	68	158	20	44	93	4	226	64	387	157	230
16.00-20.00	per hour	17	7	1	0	17	40	5	11	23	1	57	16	97	39	58
All-day	Total	416	95	53	46	331	725	135	75	511	99	1056	210	1876	**935**	**941**
06.00-20.00	per hour	30	7	4	3	24	52	10	5	37	7	75	15	134	67	67
Peak 15 min	Total	31	7	11	6	18	34	11	10	34	14	48	12	78		
	per hour	124	28	44	24	72	136	44	40	136	56	192	48	312		

7) Private car

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	140	1	1	0	35	17	3	0	141	1	52	3	197	179	18
06.15-06.30	125	6	1	2	59	14	10	0	131	3	73	10	217	195	22
06.30-06.45	152	6	0	3	63	18	10	0	158	3	81	10	252	225	27
06.45-07.00	119	16	2	0	89	46	16	3	135	2	135	19	291	226	65
07.00-07.15	159	24	3	2	88	89	20	10	183	5	177	30	395	270	125
07.15-07.30	140	43	10	2	158	102	24	9	183	12	260	33	488	332	156
07.30-07.45	103	45	14	3	167	89	16	6	148	17	256	22	443	300	143
07.45-08.00	142	59	18	4	155	67	20	4	201	22	222	24	469	335	134
08.00-08.15	120	44	15	3	167	81	25	10	164	18	248	35	465	327	138
08.15-08.30	101	39	24	3	145	83	27	4	140	27	228	31	426	297	129
08.30-08.45	99	41	20	2	149	134	29	15	140	22	283	44	489	297	192
08.45-09.00	89	47	25	5	153	98	25	11	136	30	251	36	453	292	161
09.00-09.15	69	33	21	5	56	40	25	8	102	26	96	33	257	171	86
09.15-09.30	59	20	19	7	54	67	6	5	79	26	121	11	237	138	99
09.30-09.45	53	19	22	6	33	69	5	6	72	28	102	11	213	113	100
09.45-10.00	50	25	18	4	38	89	9	8	75	22	127	17	241	115	126
10.00-10.15	49	25	14	3	42	80	9	10	74	17	122	19	232	114	118
10.15-10.30	54	37	12	4	29	64	15	7	91	16	93	22	222	110	112
10.30-10.45	49	34	7	6	49	70	10	12	83	13	119	22	237	115	122
10.45-11.00	50	31	14	5	52	67	3	13	81	19	119	16	235	119	116
11.00-11.15	42	37	8	0	46	72	11	12	79	8	118	23	228	107	121
11.15-11.30	51	46	7	7	39	82	15	19	97	14	121	34	266	112	154
11.30-11.45	41	33	3	8	58	99	16	24	74	11	157	40	282	118	164
11.45-12.00	49	35	4	2	36	72	15	26	84	6	108	41	239	104	135
12.00-12.15	40	20	5	5	31	45	20	19	60	10	76	39	185	96	89
12.15-12.30	38	13	8	8	28	45	12	18	51	16	73	30	170	86	84
12.30-12.45	42	20	0	6	21	34	3	10	62	6	55	13	136	66	70
12.45-13.00	45	17	5	3	19	53	3	11	62	8	72	14	156	72	84
13.00-13.15	40	18	3	9	13	65	8	15	58	12	78	23	171	64	107
13.15-13.30	51	28	4	6	26	42	3	4	79	10	68	7	164	84	80
13.30-13.45	53	21	3	7	21	53	6	5	74	10	74	11	169	83	86
13.45-14.00	45	26	7	10	18	29	7	7	71	17	47	14	149	77	72
14.00-14.15	39	41	6	6	32	49	4	5	80	12	81	9	182	81	101
14.15-14.30	35	34	4	4	26	32	8	9	69	8	58	17	152	73	79
14.30-14.45	35	27	6	9	36	41	11	14	62	15	77	25	179	88	91
14.45-15.00	49	32	4	12	33	30	18	10	81	16	63	28	188	104	84
15.00-15.15	40	22	6	18	29	41	15	12	62	24	70	27	183	90	93
15.15-15.30	29	32	8	19	17	45	17	10	61	27	62	27	177	71	106
15.30-15.45	32	56	5	17	15	62	14	19	88	22	77	33	220	66	154
15.45-16.00	49	62	6	18	31	51	12	19	111	24	82	31	248	98	150
16.00-16.15	52	77	7	19	42	60	19	23	129	26	102	42	299	120	179
16.15-16.30	43	95	9	28	27	88	4	27	138	37	115	31	321	83	238
16.30-16.45	51	120	7	30	53	101	12	38	171	37	154	50	412	123	289
16.45-17.00	53	134	7	40	49	92	4	42	187	47	141	46	421	113	308
17.00-17.15	56	143	5	33	43	84	6	38	199	38	127	44	408	110	298
17.15-17.30	50	119	7	26	43	110	3	30	169	33	153	33	388	103	285
17.30-17.45	14	91	5	21	35	167	6	18	105	26	202	24	357	60	297
17.45-18.00	22	42	2	17	39	143	6	16	64	19	182	22	287	69	218
18.00-18.15	22	44	0	22	39	110	12	18	66	22	149	30	267	73	194
18.15-18.30	27	80	2	14	28	134	2	10	107	16	162	12	297	59	238
18.30-18.45	36	54	4	23	27	94	2	8	90	27	121	10	248	69	179
18.45-19.00	46	48	4	6	28	134	4	10	94	10	162	14	280	82	198
19.00-19.15	34	43	2	10	36	144	4	16	77	12	180	20	289	76	213
19.15-19.30	25	50	2	2	23	129	2	8	75	4	152	10	241	52	189
19.30-19.45	18	38	1	5	0	0	0	0	56	6	0	0	62	19	43
19.45-20.00	22	34	2	4	0	0	0	0	56	6	0	0	62	24	38
Count Total	3338	2427	428	543	2868	4016	611	711	5765	971	6884	1322	14942	7245	7697

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	Total	1720	468	213	51	1609	1103	270	99	2188	264	2712	369	5533	3812	1721
06.00-10.00	per hour	430	117	53	13	402	276	68	25	547	66	678	92	1383	953	430
Mid-day	Total	1047	747	149	192	747	1323	255	310	1794	341	2070	565	4770	2198	2572
10.00-16.00	per hour	175	125	25	32	125	221	43	52	299	57	345	94	795	366	429
Evening	Total	571	1212	66	300	512	1590	86	302	1783	366	2102	388	4639	1235	3404
16.00-20.00	per hour	143	303	17	75	128	398	22	76	446	92	526	97	1160	309	851
All-day	Total	3338	2427	428	543	2868	4016	611	711	5765	971	6884	1322	14942	7245	7697
06.00-20.00	per hour	238	173	31	39	205	287	44	51	412	69	492	94	1067	518	550
Peak 15 min	Total	159	143	25	40	167	167	29	42	201	47	283	50	489		
	per hour	636	572	100	160	668	668	116	168	804	188	1132	200	1956		

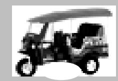
8) Songtheaw

	A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
06.00-06.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06.15-06.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06.30-06.45	2	0	0	0	0	0	0	0	2	0	0	0	2	2	0
06.45-07.00	12	12	0	0	0	0	0	0	24	0	0	0	24	12	12
07.00-07.15	12	11	0	0	0	0	0	0	23	0	0	0	23	12	11
07.15-07.30	14	9	0	0	0	0	0	0	23	0	0	0	23	14	9
07.30-07.45	14	19	0	0	0	0	0	0	33	0	0	0	33	14	19
07.45-08.00	29	14	0	8	0	0	0	0	43	8	0	0	51	29	22
08.00-08.15	35	11	0	0	0	0	0	0	46	0	0	0	46	35	11
08.15-08.30	54	6	0	0	1	0	0	0	60	0	1	0	61	55	6
08.30-08.45	43	10	0	0	0	0	0	0	53	0	0	0	53	43	10
08.45-09.00	41	12	0	0	0	0	0	0	53	0	0	0	53	41	12
09.00-09.15	20	14	0	0	0	0	0	0	34	0	0	0	34	20	14
09.15-09.30	39	19	0	0	0	0	0	0	58	0	0	0	58	39	19
09.30-09.45	30	0	0	0	0	0	0	0	30	0	0	0	30	30	0
09.45-10.00	37	0	0	0	0	0	0	0	37	0	0	0	37	37	0
10.00-10.15	33	0	0	0	0	0	0	0	33	0	0	0	33	33	0
10.15-10.30	46	0	0	0	1	0	0	0	46	0	1	0	47	47	0
10.30-10.45	22	0	0	0	1	0	0	0	22	0	1	0	23	23	0
10.45-11.00	37	0	0	0	0	4	0	0	37	0	4	0	41	37	4
11.00-11.15	18	0	0	0	0	0	0	0	18	0	0	0	18	18	0
11.15-11.30	13	0	0	0	0	7	0	0	13	0	7	0	20	13	7
11.30-11.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.45-12.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.00-12.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.15-12.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.30-12.45	0	0	0	0	0	13	0	0	0	0	13	0	13	0	13
12.45-13.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13.00-13.15	0	0	0	0	0	5	0	0	0	0	5	0	5	0	5
13.15-13.30	12	0	0	0	0	0	0	0	12	0	0	0	12	12	0
13.30-13.45	17	0	0	0	0	0	0	0	17	0	0	0	17	17	0
13.45-14.00	11	0	0	0	0	0	0	0	11	0	0	0	11	11	0
14.00-14.15	15	0	0	0	0	0	0	0	15	0	0	0	15	15	0
14.15-14.30	28	0	0	0	0	0	0	0	28	0	0	0	28	28	0
14.30-14.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.45-15.00	9	0	0	0	1	0	0	0	9	0	1	0	10	10	0
15.00-15.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.15-15.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.30-15.45	11	0	0	0	0	0	0	0	11	0	0	0	11	11	0
15.45-16.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.00-16.15	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0
16.15-16.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.30-16.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.45-17.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.00-17.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.15-17.30	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0
17.30-17.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17.45-18.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.00-18.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.15-18.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.30-18.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.45-19.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.00-19.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.15-19.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.30-19.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19.45-20.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	**654**	**137**	**0**	**8**	**6**	**29**	**0**	**0**	**791**	**8**	**35**	**0**	**834**	**660**	**174**

Summary (Source: Consultant)

Period		A - Enter	A -Exit	B - Enter	B -Exit	C - Enter	C -Exit	D - Enter	D - Exit	A	B	C	D	Total	Enter	Exit
Morning	**Total**	382	137	0	8	1	0	0	0	519	8	1	0	528	383	145
06.00-10.00	**per hour**	96	34	0	2	0	0	0	0	130	2	0	0	132	96	36
Mid-day	**Total**	272	0	0	0	3	29	0	0	272	0	32	0	304	275	29
10.00-16.00	**per hour**	45	0	0	0	1	5	0	0	45	0	5	0	51	46	5
Evening	**Total**	0	0	0	0	2	0	0	0	0	0	2	0	2	2	0
16.00-20.00	**per hour**	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0
All-day	**Total**	654	137	0	8	6	29	0	0	791	8	35	0	834	**660**	**174**
06.00-20.00	**per hour**	47	10	0	1	0	2	0	0	57	1	3	0	60	47	12
Peak 15 min	**Total**	54	19	0	8	1	13	0	0	60	8	13	0	61		
	per hour	216	76	0	32	4	52	0	0	240	32	52	0	244		

9) All mode summary (Source: Consultant)

Survey Location		Pedestrian 			Bicycle 			Motorcycle taxi 			Motorised three-wheeler 			Songtheaw 			Private motorcycle 			Private car 			Taxi 			Total		
		Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay	Enter	Exit	Stay
Morning	Total	1430	776	654	98	83	15	1062	1043	19	518	369	149	383	145	238	1364	1076	288	3812	1721	2091	295	228	67	8962	5441	3521
06.00-10.00	per hour	358	194	164	25	21	4	266	261	5	130	92	37	96	36	60	341	269	72	953	430	523	74	57	17	2241	1360	880
Mid-day	Total	2057	2307	-250	75	79	-4	1016	1162	-146	942	810	132	275	29	246	1592	1974	-382	2198	2572	-374	483	483	0	8638	9416	-778
10.00-16.00	per hour	343	385	-42	13	13	-1	169	194	-24	157	135	22	46	5	41	265	329	-64	366	429	-62	81	81	0	1440	1569	-130
Evening	Total	459	705	-246	48	61	-13	338	741	-403	602	673	-71	2	0	2	1027	1171	-144	1235	3404	-2169	157	230	-73	3868	6985	-3117
16.00-20.00	per hour	115	176	-62	12	15	-3	85	185	-101	151	168	-18	1	0	1	257	293	-36	309	851	-542	39	58	-18	967	1746	-779
All-day	Total	3946	3788	158	221	223	-2	2416	2946	-530	2062	1852	210	660	174	486	3983	4221	-238	7245	7697	-452	935	941	-6	21468	21842	-374
06.00-20.00	per hour	282	271	11	16	16	0	173	210	-38	147	132	15	47	12	35	285	302	-17	518	550	-32	67	67	0	1533	1560	-27

Annex 3B: Questionnaire form

QUESTIONAIRE SURVEY FOR TRAVEL PATTERNS/ SATISFACTION/ FACTORS FOR TRAVEL MODE CHOICE

Study of appropriate improvement intervention for promoting Pubic Bus /Footways and Cycling lane in daily life travel

Date __/___/___ Survey Location____________________ Surveyor____________________ Questionnaire No.________

Respondent's main travel mode to Ari area ☐ Only Private car/ Private motorcycle/ Taxi for whole trip ☐ Other modes included

Section 1: Basic information

1.1 Sex ☐ male ☐ female 1.2 Status ☐ single ☐ married ☐ divorced/ widow

1.3 Age ☐ below 15 years ☐ 15-22 years ☐ 23-29 years ☐ 30-39 years ☐ 40-49 years ☐ 50-59 years ☐ 60 years or above

1.4 Education ☐ junior high school ☐ senior high school ☐ diploma / high vocational certificate ☐ bachelor ☐higher than bachelor

1.5 Occupation ☐ student ☐ private company employee ☐ retailer/ business owner ☐ civil servant/ government official
☐ freelance ☐ housewife/househusband /retired ☐ unemployed ☐ other (please specify) ________

1.6 Disability ☐ mobility) please specify(__________ ☐ visual) please specify(_________ ☐ hearing) please specify(_________☐ none

1.7 Personal monthly income) baht(☐ 10,000 or less ☐ 10,001 – 20,000 ☐ 20,001 – 30,000 ☐ 30,001 – 40,000 ☐ higher than 40,000

1.8 Driving license ☐ car ☐ motorcycle ☐ none

Section 2: Household information

2.1 Current address Village/Soi ________________________________ Road ____________________________
Sub-district________________________________ District ___________________________
Province___________________________

2.2 Type of accommodation ☐ detached house ☐ commercial building ☐ town house ☐ rental apartment/ dorm ☐ condo ☐ other_________

2.3 Number of household member ___________ persons Number of juvenile below 15 years ___________ persons

2.4 Vehicle ownership amount car/pick-up truck/van _________ motorcycle _________ bicycle_________ other _______)please specify(_________

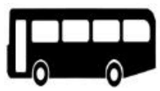
2.5 Household monthly income) baht(☐ 2 0,000or lower ☐ 20,001 – 4 0,000 ☐ 40,001– 60,000
☐ 60,001– 80,000 ☐ 80,001 -100,000 ☐ higher than 100,000

SECTION 3: ORIGIN-DESTINATION DAILY JOURNEY

(Case: go/ return from workplace with other activities in a typical working day in this week)

Answers for fill in following table

3.1 Travel Mode

 A) walking	 B) cycling	 C) private motorcycle	 D) motorcycle taxi	 E) motorised three-wheeler	 F) taxi
 G) songtheaw	 H) public bus	 I) public van	 J) metro	 K) canal boat	 L) private car

3.4 Trip Purpose A) go/ return from workplace B) go/ return from school C) personal business D) leisure E) other)please specify(

3.5 Frequency A) everyday) 7 days (B) weekdays (5 days/week) C) 2-3 times/week D) once per week E) less than once per week

Please fill out the table the step of travel in <u>every stage</u> from departing from home in the morning until go back home in the evening

Stage	3.1 Travel Mode	3.2 **Origin of stage** (Speciify: home/ bus stop /metro station/ workplace /school /shopping mall /etc.)	3.3 **Destination of stage** (Speciify: home/ bus stop /metro station/ workplace /school /shopping mall /etc.)	3.4 Trip Purpose	3.5 Frequency	3.6 Depart time)am/pm(	3.7 Time use (min(	3.8 Cost)baht(
Out 1		Place ___________Home_________________________ Road _______________ Sub-district_____________ District ______________ Province_______________	Place ____ Road _______________ Sub-district_____________ District ______________ Province_______________					
Out 2 (if		Place ____	Place ____					

has)		Road ______________ Sub-district____________ District _____________ Province______________	Road ______________ Sub-district____________ District _____________ Province______________					
Stage	3.1 Travel Mode	3.2 **Origin of stage** (Speciify: home/ bus stop /metro station/ workplace /school /shopping mall /etc.)	3.3 **Destination of stage** (Speciify: home/ bus stop /metro station/ workplace /school /shopping mall /etc.)	3.4 Trip Purpose	3.5 Frequency	3.6 Depart time)am/pm(	3.7 Time use (min(	3.8 Cost)baht(
Out 3 (if has)		Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________					
Out 4 (if has)		Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________					
Out 5 (if has)		Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________					
Return 1		Place ________**Office**____________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ____________________________________ Road ______________ Sub-district____________ District _____________ Province______________					

Return 2 (if has)		Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________						
Return 3 (if has)		Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________						
Return 4 (if has)		Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________						
Return 5 (if has)		Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________	Place ___________________________________ Road ______________ Sub-district____________ District _____________ Province______________						

SECTION 4: BARRIERS IN CHANGING TRAVEL BEHAVIOR FOR PRIVATE CAR USER/ TAXI USER

4.1 Normally, you use private car or motorcycle/ taxi as the main travel mode to workplace? ☐ Yes ☐ No) If answer **No**, Please skip to **Section 5**)

4.2 Where do you park your private vehicles? ☐ Parking building ☐ Ground-level Parking area in Office area ☐ On-street ☐Use taxi

4.3 Are you willing to change your main travel mode to metro system/ public bus? (Currently, you are still not change due to barriers) ☐ Yes ☐ No

4.4 Please **Sort** 7 barriers in your opinion from largest to smallest for changing travel behavior from private car/ taxi to metro system/ public bus system

) 1 largest barrier – 7 smallest barrier(

_____ Metro system: not covered/ not attractive
_____ Public bus system: not covered/ not attractive
_____ Footways and crossing not convenient/ not attractive
_____ Risk of accident/ risk of crime/ safety issue
_____ Inconvenient/ weather issue
_____ Travel time use/ uncertainty of travel time
_____ Total travel cost

SECTION 5: CONDITION OF TRAVEL COMPONENT

5.1 Please **Rate** current condition of **Public bus waiting area** in general in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) Waiting area space	☐	☐	☐	☐	☐	6) Waiting time/ travel time info	☐	☐	☐	☐	☐
2) Seating amount / comfort	☐	☐	☐	☐	☐	7) Map link to other transport	☐	☐	☐	☐	☐
3) Shelter/ weather protection	☐	☐	☐	☐	☐	8) Environment/ cleanliness	☐	☐	☐	☐	☐
4) Convenient to access the area	☐	☐	☐	☐	☐	9) Feel safe when use	☐	☐	☐	☐	☐
5) Bus route info	☐	☐	☐	☐	☐	10) Adequate lighting	☐	☐	☐	☐	☐

5.2 Please **Rate** current condition of **Public bus service** in general in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) Waiting time use	☐	☐	☐	☐	☐	5) Location information	☐	☐	☐	☐	☐
2) Indirectness of route/time use	☐	☐	☐	☐	☐	6) Waiting time/ travel time info	☐	☐	☐	☐	☐
3) Convenient to board/ alight	☐	☐	☐	☐	☐	7) Environment/ cleanliness	☐	☐	☐	☐	☐
4) Fare collection system	☐	☐	☐	☐	☐	8) Feel safe when use	☐	☐	☐	☐	☐

5.3 Please **Rate** current condition of **Footways <u>in Soi Ari</u> and surrounding** in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) Footways width	☐	☐	☐	☐	☐	7) Protection from weather	☐	☐	☐	☐	☐
2) Street furniture condition	☐	☐	☐	☐	☐	8) Street vendors position	☐	☐	☐	☐	☐

(broken? abandoned?)						)blocked?(					
3) Street furniture position)blocked?(	☐	☐	☐	☐	☐	9) Ramp from footways to street) too steep? not exist? blocked?)	☐	☐	☐	☐	☐
4) Parked vehicles on footways /on-street)blocked?(	☐	☐	☐	☐	☐	10) Feel safe when use	☐	☐	☐	☐	☐
5) Environment/ cleanliness	☐	☐	☐	☐	☐	11) Adequate lighting	☐	☐	☐	☐	☐
6) Footways smoothness	☐	☐	☐	☐	☐						

5.4 Please <u>**Rate**</u> current condition of **Pedestrian crossing <u>in Soi Ari</u> and surrounding** in your opinion **(1 - poor/ large barrier, 5 – excellent/ no barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) appropriate location/ amount	☐	☐	☐	☐	☐	5) Adequate crossing time given	☐	☐	☐	☐	☐
2) Ramp from footways to street) too steep? not exist? blocked?)	☐	☐	☐	☐	☐	6) Ramp from footways to street) too steep? not exist? blocked?)	☐	☐	☐	☐	☐
3) Width/ waiting area space	☐	☐	☐	☐	☐	7) Feel safe when use	☐	☐	☐	☐	☐
4) Reliability of crossing signal	☐	☐	☐	☐	☐	8) Adequate lighting	☐	☐	☐	☐	☐

5.5 Your purpose of walking (Can answer more than 1 choice) ☐ for travel ☐for exercise ☐ for shopping ☐for relax/recreation

5.6 How far will you willing to **"walk for travel"** to places (You will not walk longer than this)

Minutes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	> 15
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Metres	80	160	240	300	380	440	520	600	680	740	820	900	980	1040	1120	> 1120

5.7 Do you have ability to cycling? ☐ Yes ☐ No (If answer **No**, Please skip to **Section 6**)

5.8 Your purpose of cycling (Can answer more than 1 choice) ☐ for travel ☐for exercise ☐ for shopping ☐for relax/recreation

5.9 Frequency of cycling ☐ everyday) 7 days (☐weekdays ☐ 2-3 times/week ☐ once/week ☐ less than once/week ☐ less than once/month

5.10 How far will you willing to **"go cycling for travel"** to places (You will not go cycling longer than this)

☐ less than 10 min ☐ 20-10min ☐ 30-20min ☐ 60-30min ☐ more than 60 min ☐ not go cycling

5.11 Have you ever "**go cycling for travel**" along the cycling lane or street in Bangkok? ☐ Yes ☐ No (If answer **No**, Please skip to **Section 6**)

5.12 Please **Rate** current condition of **cycling environment in Bangkok** in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) Appropriateness of existing route	☐	☐	☐	☐	☐	6) Feel safe when turn right/ crossing at intersection	☐	☐	☐	☐	☐
2) Width/ direction	☐	☐	☐	☐	☐	7) Obstacle along the route (parked car?)	☐	☐	☐	☐	☐
3) Smoothness (have pothole?)	☐	☐	☐	☐	☐	8) Weather/ shading	☐	☐	☐	☐	☐
4) Connectivity with other mode	☐	☐	☐	☐	☐	9) Route maps and information	☐	☐	☐	☐	☐
5) Feel safe from other vehicles	☐	☐	☐	☐	☐	(10Adequate lighting	☐	☐	☐	☐	☐

5.13 Please **Rate** current condition of **bike racks/ bike parking facilities** in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) Location and proximity (appropriate/accessible?)	☐	☐	☐	☐	☐	3) Feel safe when use	☐	☐	☐	☐	☐
2) Amount of slot per location	☐	☐	☐	☐	☐	4) Protection from weather	☐	☐	☐	☐	☐

5.14 Please **Rate** current condition of **bike sharing system (Pun Pun)** in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**

Condition	1	2	3	4	5	Condition	1	2	3	4	5
1) Convenient for renting	☐	☐	☐	☐	☐	3) Adequate amount of bike	☐	☐	☐	☐	☐
2) Rental fee	☐	☐	☐	☐	☐	4) Quality of bike	☐	☐	☐	☐	☐

SECTION 6: TRAVEL MODE CHOICE

Please see the intervention improvement of **street and footways in Soi Ari** **Option 1, 2 and 3**, figures in **Section 7** then answer the following Scenarios

Choice for fill in Scenario 1 table

A) Walk	B) Private bicycle	C) Rent Rental bicycle	D) Private motorcycle	E) Hired motorcycle	F) Motorised three-wheeler	G) Songtheaw	H) Taxi
0 baht 10-15 min	0 baht 5 min	0-10 baht 5 min	10-20 baht 5 min	15-30 baht 5-10 min (incl. wait)	25-40 baht 10 min(incl.traffic)	5-10 baht 15 min (incl. wait)	35-45 baht 15 min (incl. wait)

Scenario 1 If you have to travel from **BTS Ari station** to **Governmental office district in Soi Ari** with **700-1,000 metre** distance **every working day**, which transport mode will you tend to use most?

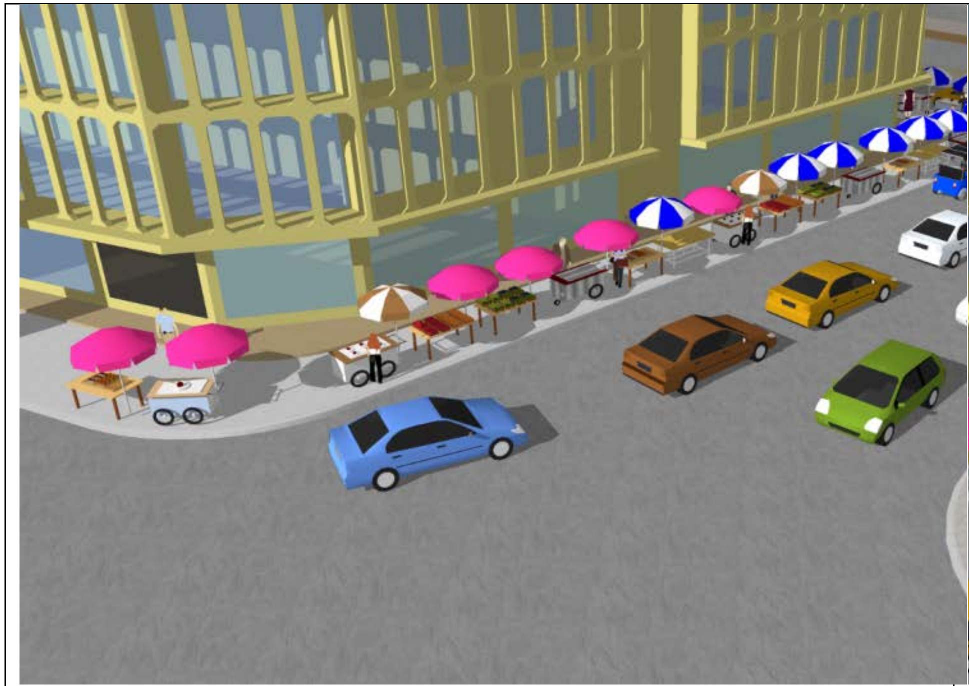
Scenario 1	**Travel mode**
6.1 **No** intervention or improvement in any infrastructure	Rank 1 Rank 2
6.2 **With** improvement in Soi Ari in **Option 1** of **Footways and Street** along the route: Reduce on-street parking for expand footways width / Organise street vendors and para-transit area /Speed limit at 30kph/ road marking and signage of shared road with bicycle	Rank 1 Rank 2
6.3 **With** improvement in Soi Ari in **Option 2** of **Footways, Pedestrian crossing and Bike lane** along the route: Reduce on-street parking for expand footways width /Organise street vendors and para-transit area /Level-pedestrian crossing and walking street/ Segregated bike lane with rubber bollards /Install bike rack and bike rental facilities around BTS Ari and in Soi Ari	Rank 1 Rank 2
6.4 **With** improvement in Soi Ari in **Option 3** of **Footways, Pedestrian crossing, Bike lane and shading cover** along the route: Reduce on-street parking for expand footways width /Organise street vendors and para-transit area /Level-pedestrian crossing and walking street/ Segregated bike lane with concrete kerb /Install bike rack and bike rental facilities around BTS Ari and in Soi Ari/ Install shading cover along footways and bike lane	Rank 1 Rank 2
Scenario 1	**Travel**

	mode
6.4 **With** improvement in Soi Ari in **Option 4** of **Wide footways, Pedestrian crossing, 2-side Bike lane, shading cover and one-way traffic** along the route: Reduce on-street parking and traffic lane for expand wide footways /Organise street vendors and para-transit area /Level-pedestrian crossing and walking street/ One-way Segregated bike lane with concrete kerb on both side of the street /Install bike rack and bike rental facilities around BTS Ari and in Soi Ari/ Install shading cover along footways and bike lane /One-way traffic for motorised vehicle	Rank 1 Rank 2

Scenario 2 In the next 5 years, if you have to travel from **your new accomodation** to **Governmental office district in Soi Ari,** which has **10 km** distance, **every working day**. Your new house is **next to bus stop** and **5 km from Metro station.** Which transport mode will you tend to use most?

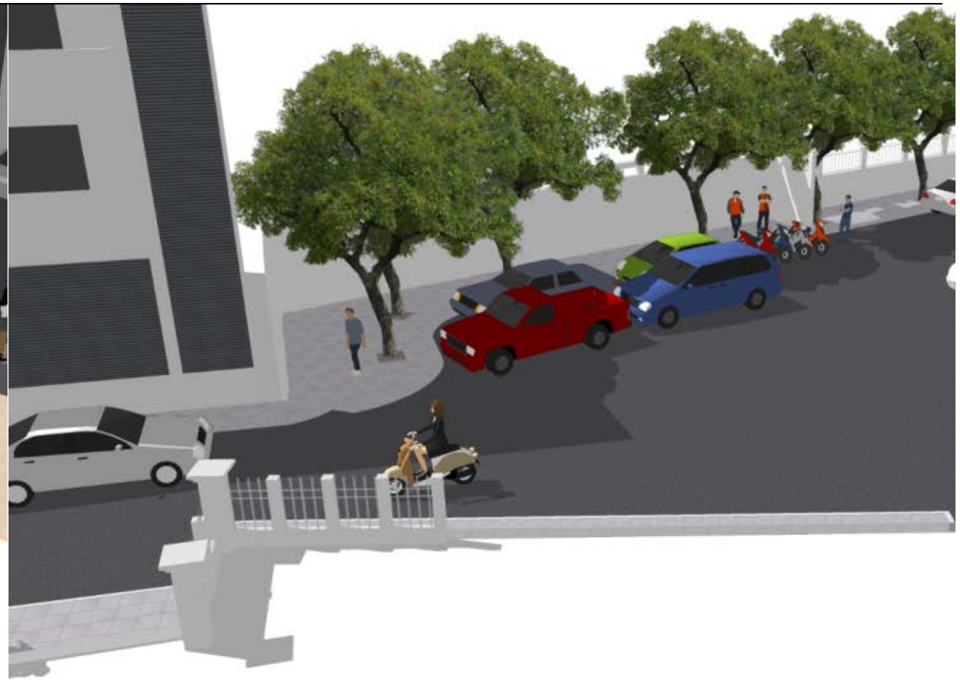
Scenario 2	**Mode 1** **Use Private car/ Private motorcycle/ Taxi**	**Mode 2** **Use Metro to Soi Ari then do the Scenario 1**	**Mode 3** **Use Public bus to Soi Ari then then do the Scenario 1**
6.5 **Without** any infrastructure improvement			
6.6 **With Public bus service and waiting area** improvement: New low-floor bus / Direct route/ Provide waiting time and travel time information/ On-time/ Provide adequate route info and stop info/ not crowded/ Refurbish waiting area – wide, adequate seat, clean, light, good accessible, safe and easy to board and alight			
6.7 **With Public bus service and waiting area** and street improvement **Option 3** in Soi Ari			
6.8 New metro station is built **within 1 km** from your accommodation**,** but **no** other infrastructure improvement			
6.9 New metro station is built **within 1 km** from your accommodation, **with Public bus service and waiting area** improvement			
6.10 New metro station is built **within 1 km** from your accommodation, **with Public bus service and waiting area** and street improvement **Option 3** in Soi Ari and from your home to metro station			

SECTION 7: TRAVEL MODE CHOICE

 Existing – Location A	 Existing – Location B

	
Existing – Location C	Existing – Location D

Existing – Location E



Existing – Location F

Existing – Location G

Existing – Location H

.

	
Option 1 – Location A	Option 1 – Location B

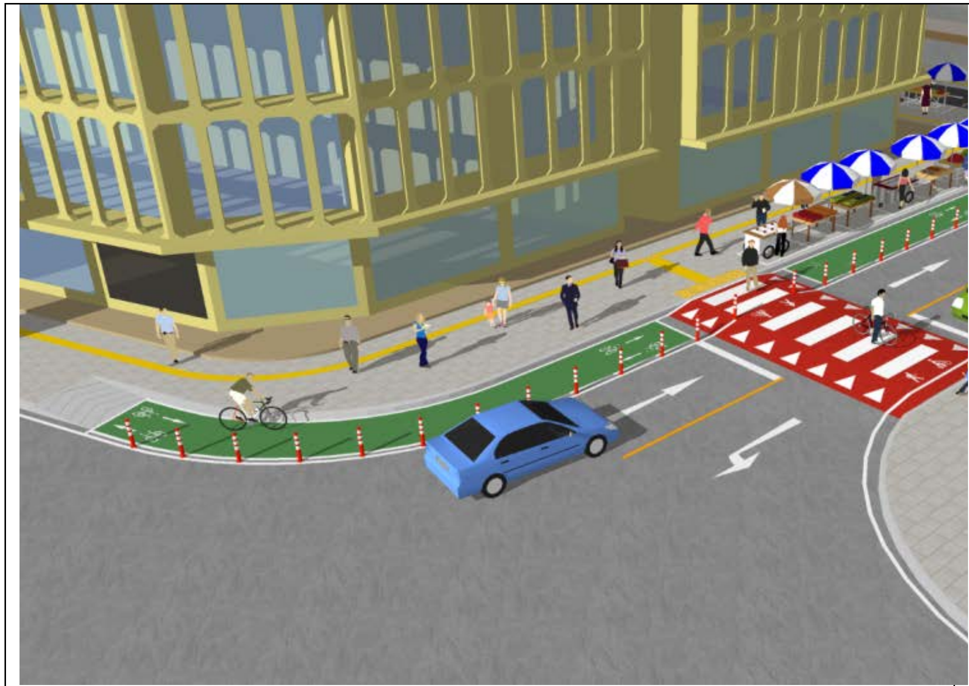
Option 1 – Location C

Option 1 – Location D

Option 1 – Location E

Option 1 – Location F

	
Option 1 – Location G	Option 1 – Location H



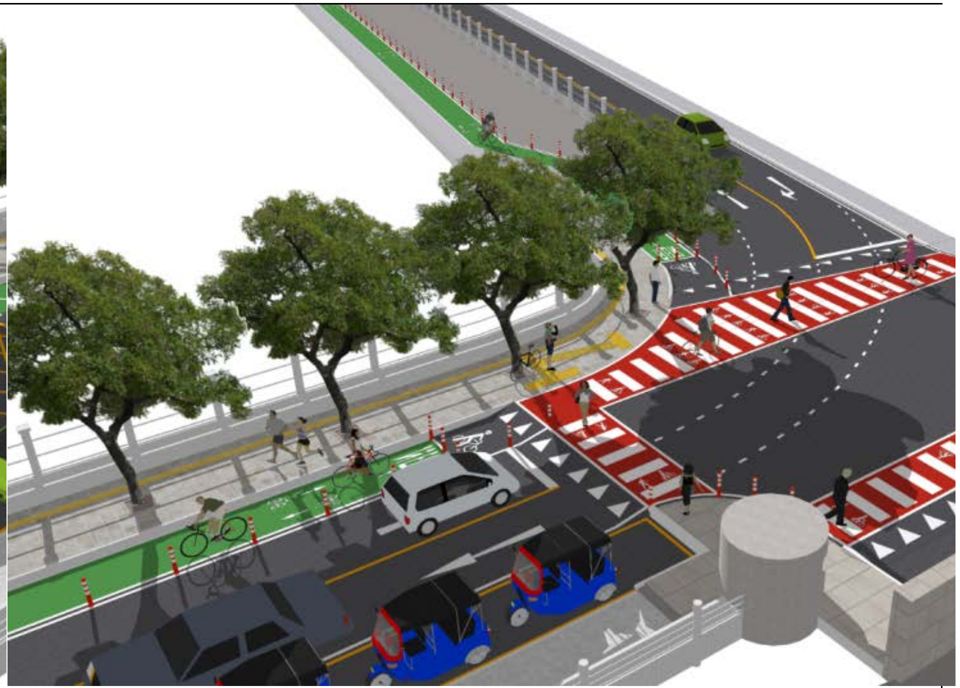
Option 2 – Location A

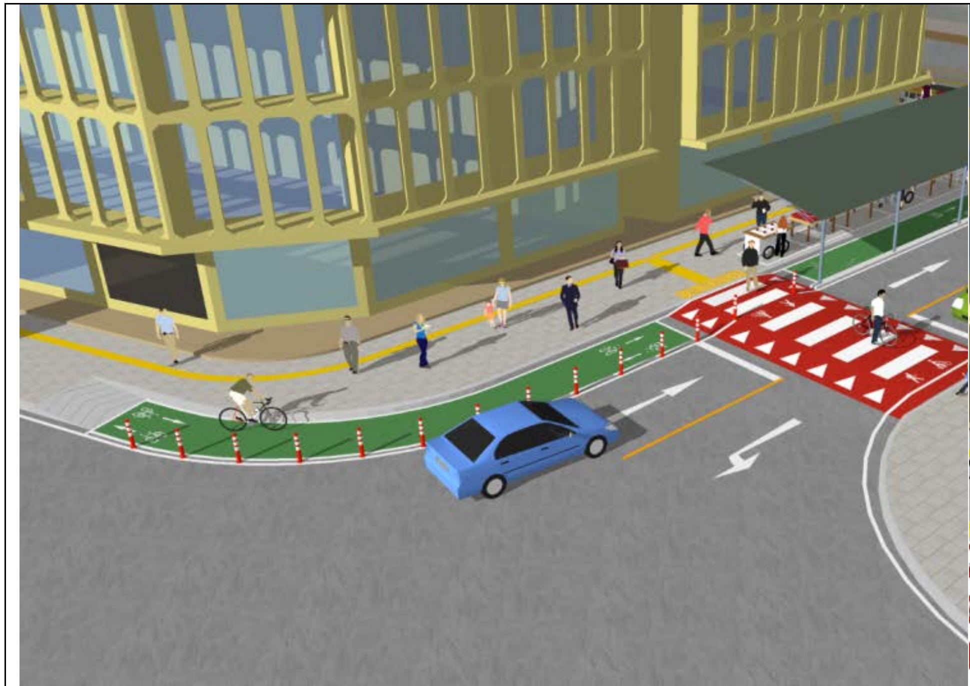
Option 2 – Location B

	
Option 2 – Location C	Option 2 – Location D

Option 2 – Location E

Option 2 – Location F

	
Option 2 – Location G	Option 2 – Location H

	
Option 3 – Location A	Option 3 – Location B

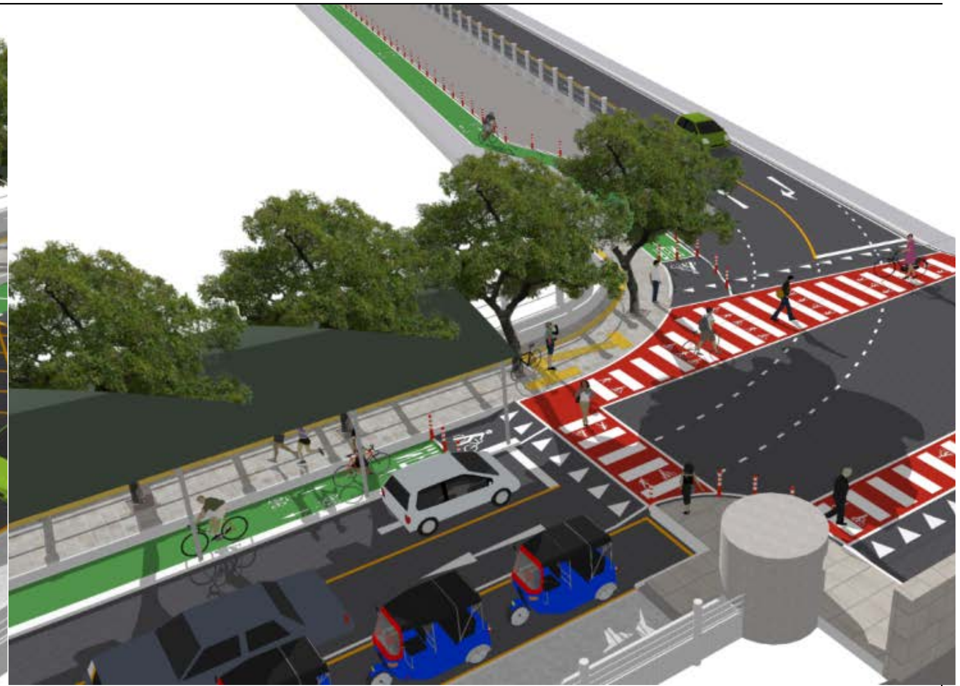
Option 3 – Location C

Option 3 – Location D

Option 3 – Location E

Option 3 – Location F

Option 3 – Location G

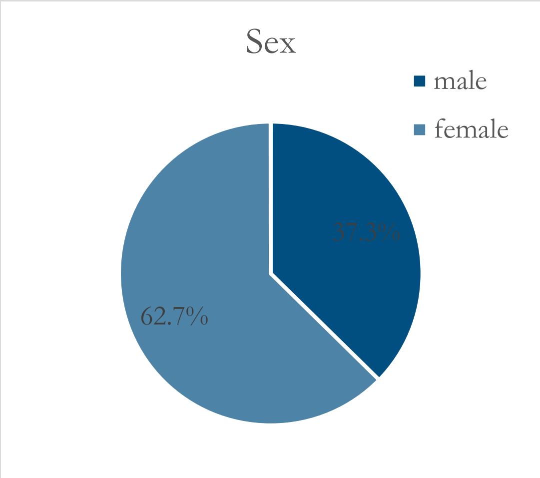


Option 3 – Location H

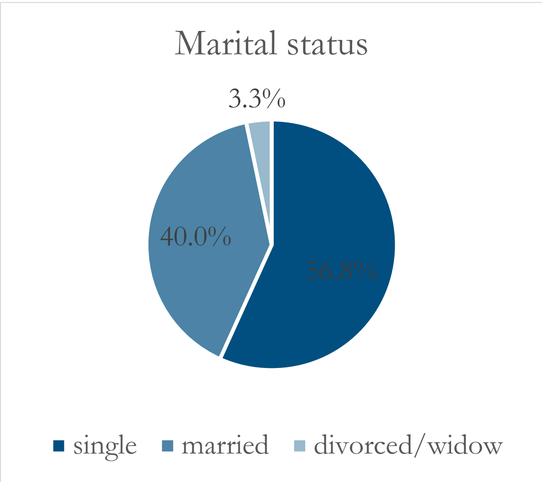
Annex 3C: Questionnaire result summary

<u>Section 1: Basic information</u>

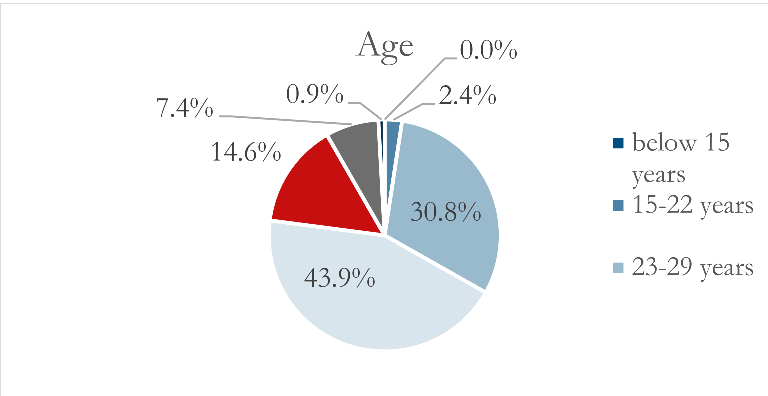
1.1 Sex



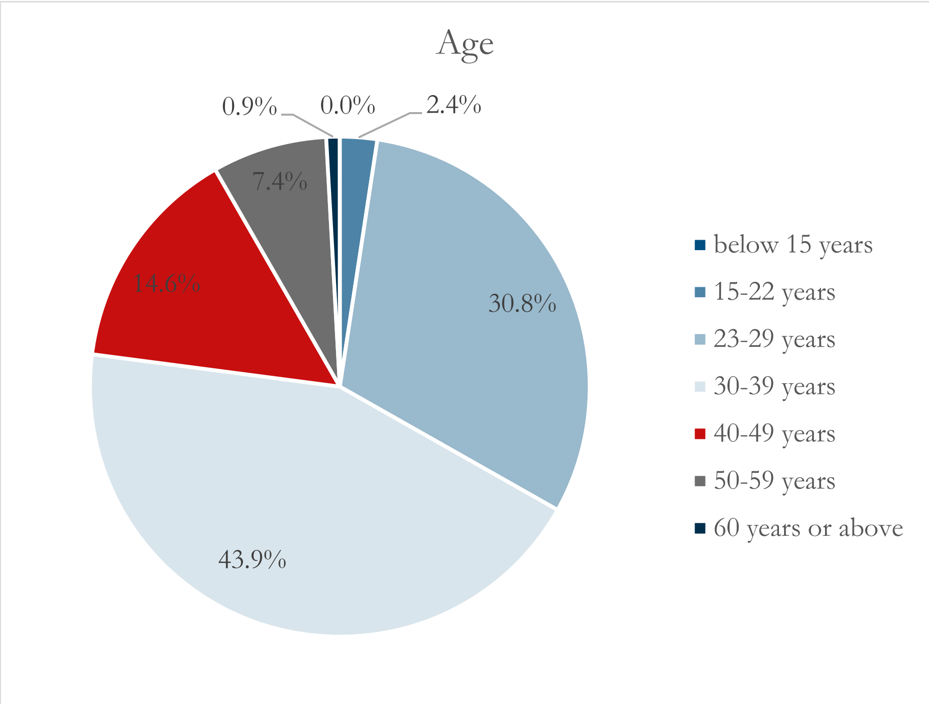
1.2 Marital status



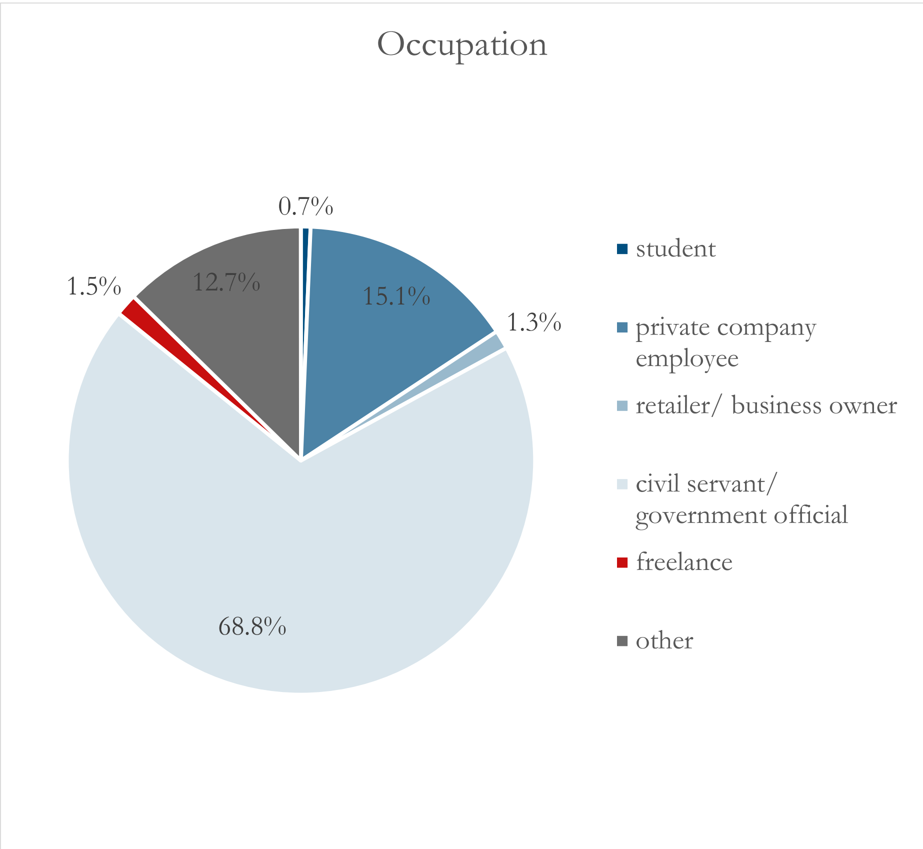
1.3 Age



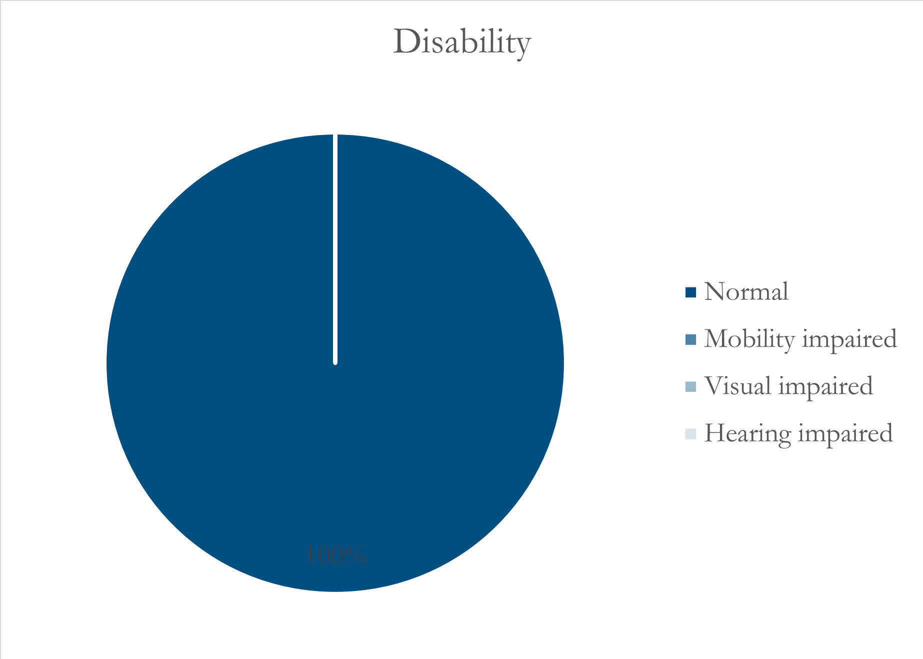
1.4 Education



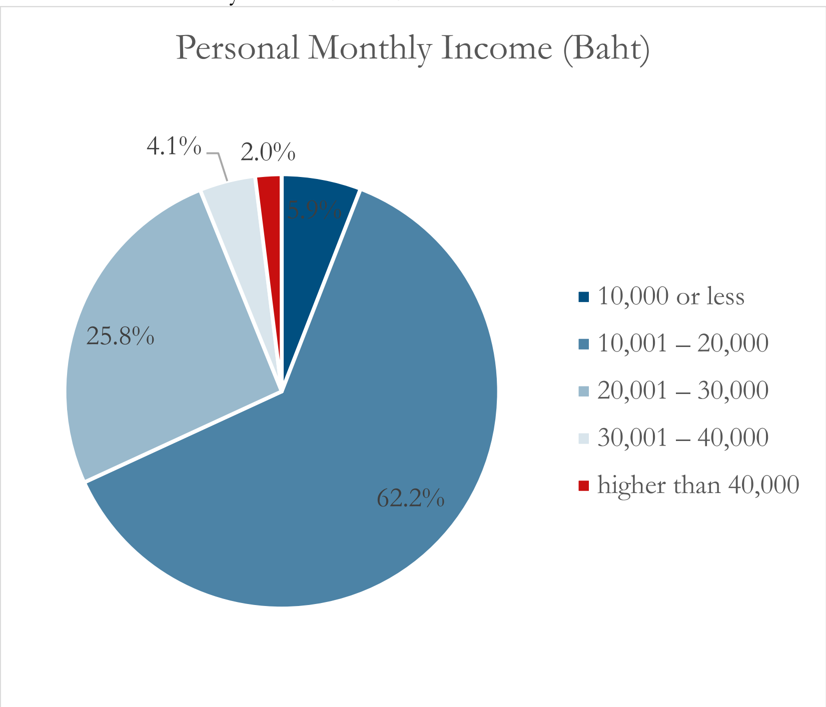
1.5 Occupation



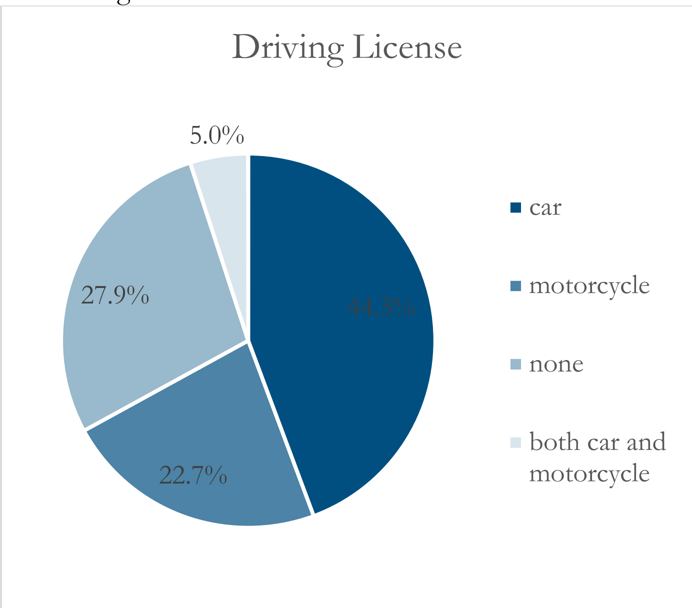
1.6 Disability

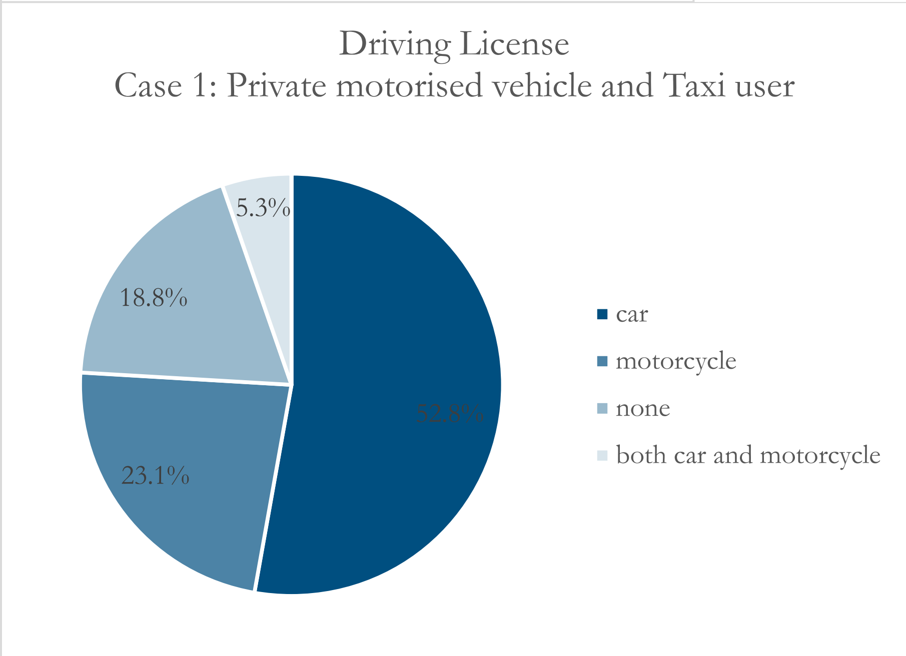


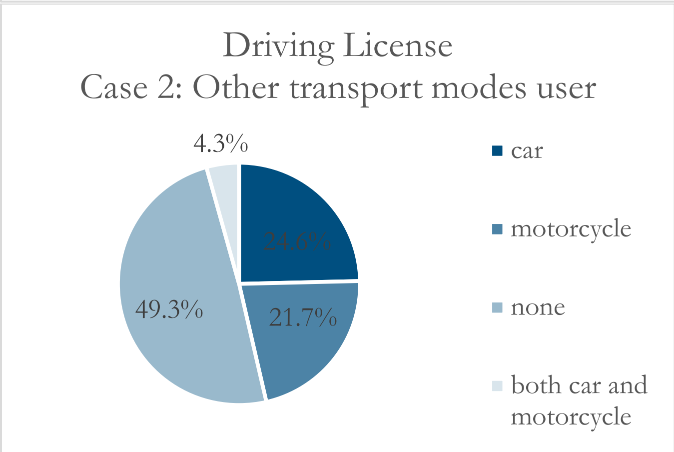
1.7 Personal monthly income) baht(



1.8 Driving license

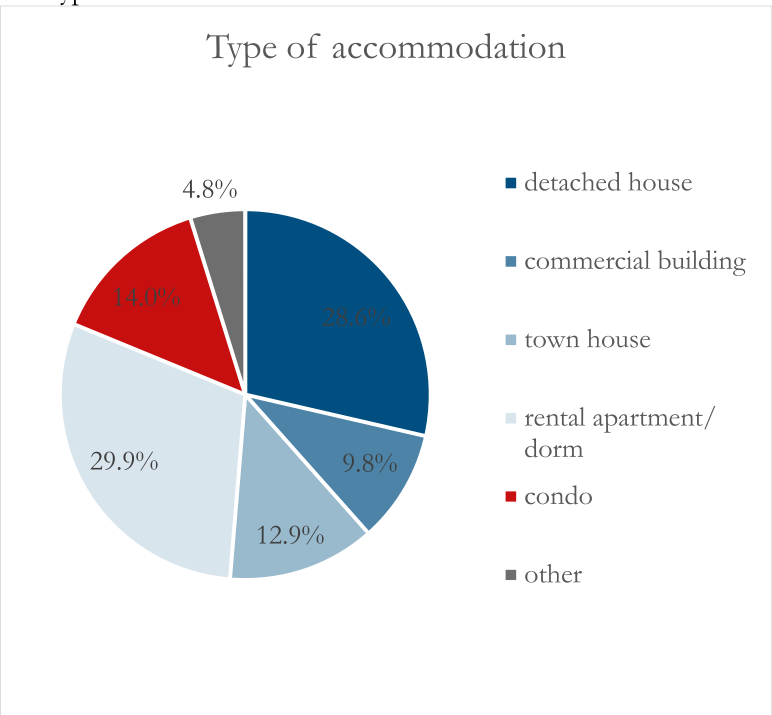




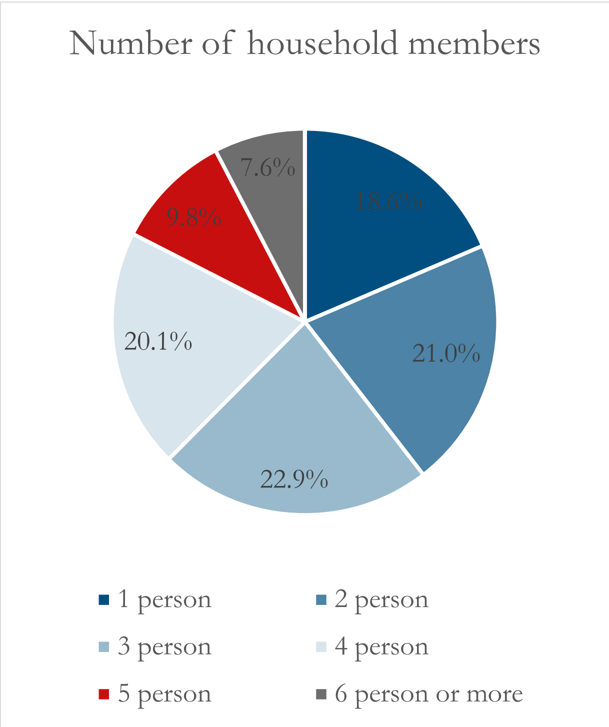


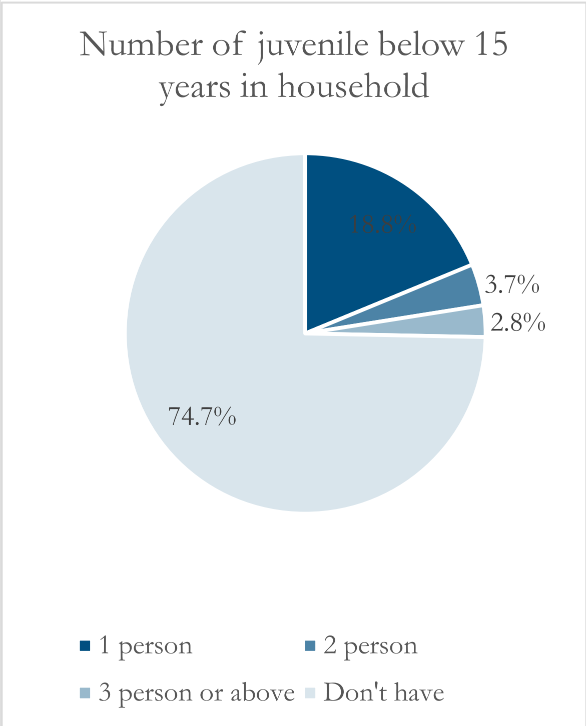
Section 2: household information

2.2 Type of accommodation

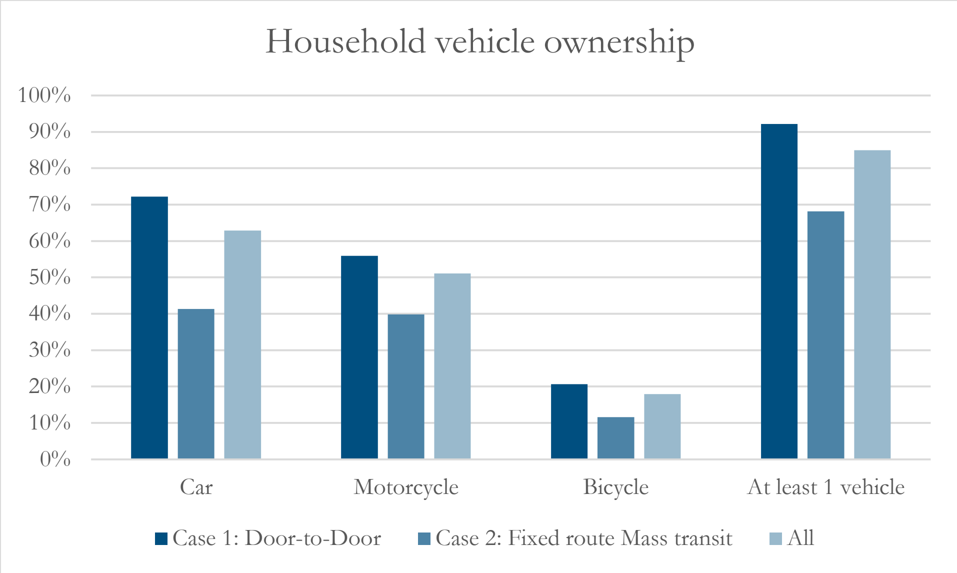


2.3 Number of household members

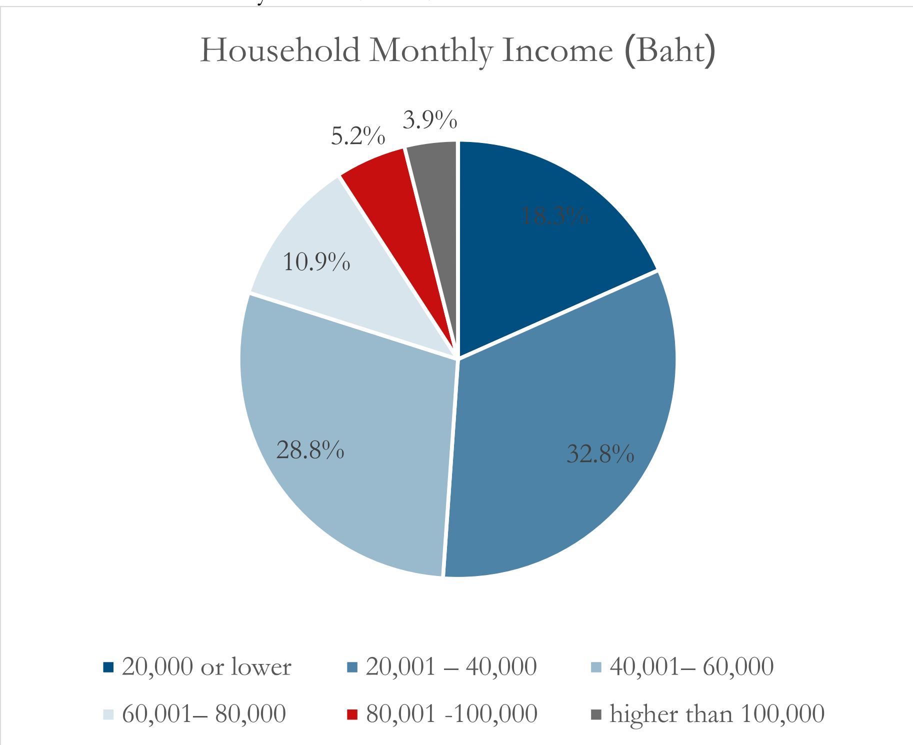




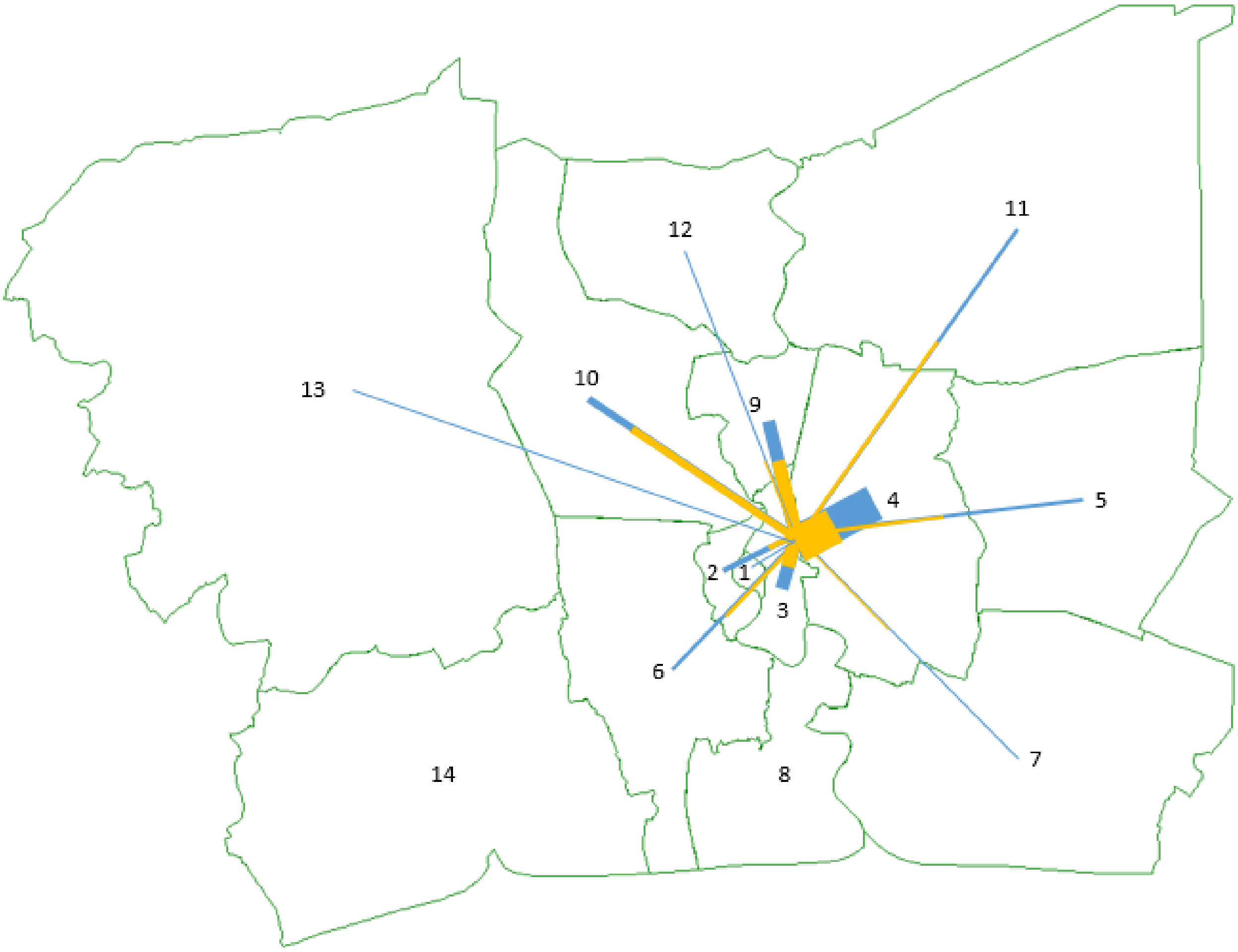
2.4 Household vehicle ownership



2.5 Household monthly income) Baht(



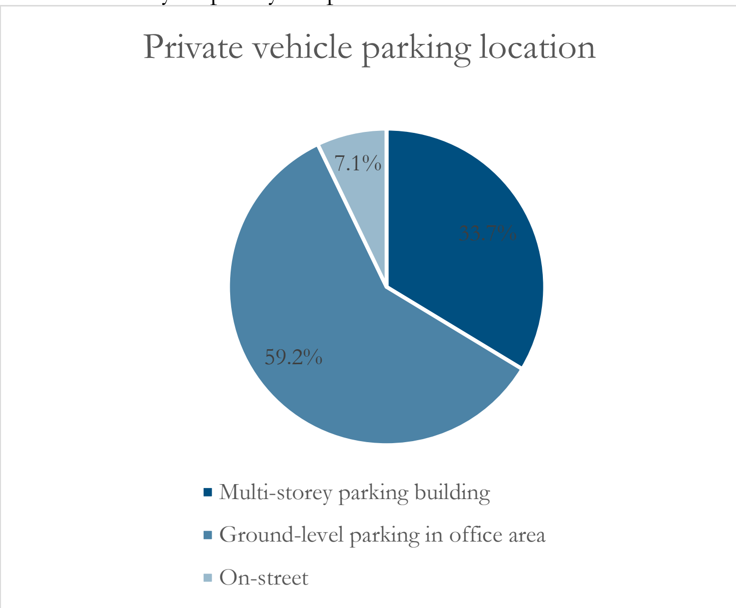
Section 3: Origin-destination daily journey



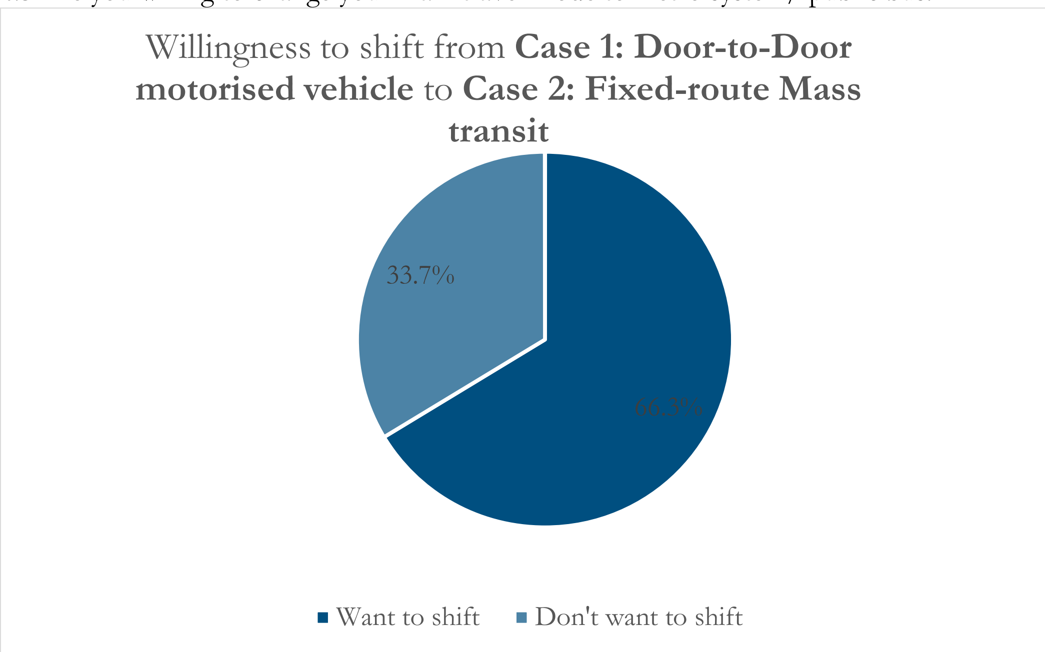
Origin zone	Case 1: Door-to-Door motorised vehicle		Case 2: Fixed-route Mass transit		Overall	
	Percent	Trip estimation	Percent	Trip estimation	Percent	Trip estimation
1: Old centre	0.0%	0	0.2%	3	0.2%	8
2: New Centre West	1.2%	29	2.1%	35	3.3%	136
3: New Centre East	4.4%	108	3.7%	62	8.1%	334
4: Inner Suburban East	19.0%	465	21.0%	352	40.0%	1649
5: Outer Suburban East	1.8%	44	1.1%	18	2.8%	115
6: Outer Suburban West	2.9%	71	1.5%	25	4.4%	181
7: Samut Prakan East	0.8%	20	1.0%	17	1.7%	70
8: Samut Prakan West	0.0%	0	0.0%	0	0.0%	0
9: Nonthaburi East	7.2%	176	3.0%	50	10.3%	425
10: Nonthaburi West	3.5%	86	0.8%	13	4.4%	181
11: Pathumthani East	2.6%	64	1.1%	18	3.7%	153
12: Pathumthani West	0.4%	10	1.1%	18	1.5%	62
13: Nakon Pathom	0.0%	0	0.4%	7	0.4%	16
14: Samut Sakon	0.0%	0	0.0%	0	0.0%	0
15: Phayathai district	10.7%	262	8.5%	142	19.2%	791
Total	**59.3%**	**2,446**	**40.7%**	**1,676**	**100.0%**	**4,122**

SECTION 4: BARRIERS IN CHANGING TRAVEL BEHAVIOR FOR PRIVATE CAR USER/ TAXI USER

4.2 Where do you park your private vehicles?



4.3 Are you willing to change your main travel mode to metro system/ public bus?



4.4 Barriers for shifting main travel mode from private vehicle to fixed-route mass public transport (from highest to lowest impact in people's opinion)

Rank 1 - Metro system: not covered/ not attractive
Rank 2 - Public bus system: not covered/ not attractive
Rank 3 - Risk of accident/ risk of crime/ safety issue
Rank 4 - Travel time use/ uncertainty of travel time
Rank 5 - Footways and crossing not convenient/ not attractive
Rank 6 - Total travel cost
Rank 7 - Inconvenient/ weather issue

SECTION 5: CONDITION OF TRAVEL COMPONENT

Case 1: Private motorised vehicle and Taxi user
Case 2: Other transport modes user

5.1 Current condition of **Public bus waiting area** in general
Average score (out of 5.00)

Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) Waiting area space	1.88	2.20	1.98	6) Waiting time/ travel time info	1.88	2.03	1.92
2) Seating amount / comfort	1.73	1.95	1.80	7) Map link to other transport	1.96	2.19	2.03
3) Shelter/ weather protection	1.87	2.02	1.92	8) Environment/ cleanliness	1.93	2.17	2.00
4) Convenient to access the area	2.01	2.31	2.10	9) Feel safe when use	1.93	2.20	2.01
5) Bus route info	2.01	2.22	2.07	10) Adequate lighting	2.03	2.29	2.11
				Average	1.92	2.16	1.99

5.2 Current condition of **Public bus service** in general
Average score (out of 5.00)

Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) Waiting time use	1.89	2.02	1.93	5) Location information	2.03	2.22	2.09
2) Indirectness of route/time use	1.95	2.20	2.02	6) Waiting time/ travel time info	1.75	2.01	1.83
3) Convenient to board/ alight	2.00	2.20	2.06	7) Environment/ cleanliness	1.88	2.14	1.96
4) Fare collection system	2.21	2.30	2.24	8) Feel safe when use	1.95	2.11	2.00
				Average	1.96	2.15	2.02

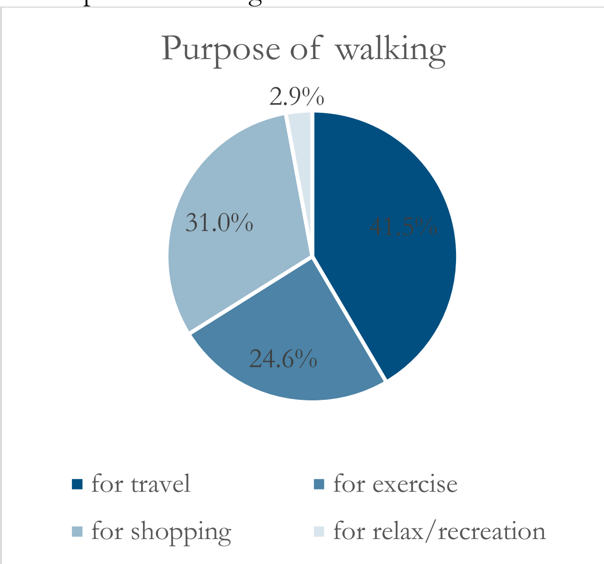
5.3 Please <u>**Rate**</u> current condition of **Footpath <u>in Soi Ari</u> and surrounding** in your opinion **(1 - poor/ large barrier, 5 – excellent/ not a barrier)**
Average score (out of 5.00)

Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) Footpath width	1.87	1.84	1.86	7) Protection from weather	1.78	1.84	1.80
2) Street furniture condition (broken? abandoned?)	1.83	1.88	1.84	8) Street vendors position)blocked?(	1.76	1.84	1.78
3) Street furniture position)blocked?(	1.85	1.91	1.87	9) Ramp from footpath to street)too steep? not exist? blocked?)	1.80	1.99	1.86
4) Parked vehicles on footpath / on-street)blocked?(	1.80	2.04	1.87	10) Feel safe when use	1.82	2.01	1.88
5) Environment/ cleanliness	1.78	1.79	1.78	11) Adequate lighting	1.88	2.06	1.93
6) Footpath smoothness	1.89	1.99	1.92				
				Average	1.82	1.93	1.85

5.4 Current condition of **Pedestrian crossing** **in Soi Ari** **and surrounding**
Average score (out of 5.00)

Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) appropriate location/ amount	1.96	2.03	1.98	5) Adequate crossing time given	1.93	2.03	1.96
2) Ramp from footpath to street)too steep? not exist? blocked?)	1.92	2.07	1.96	6) Ramp from footpath to street)too steep? not exist? blocked?)	1.72	1.81	1.74
3) Width/ waiting area space	1.94	2.08	1.98	7) Feel safe when use	1.76	1.77	1.76
4) Reliability of crossing signal	1.73	1.83	1.76	8) Adequate lighting	1.90	1.94	1.91
				Average	1.86	1.95	1.88

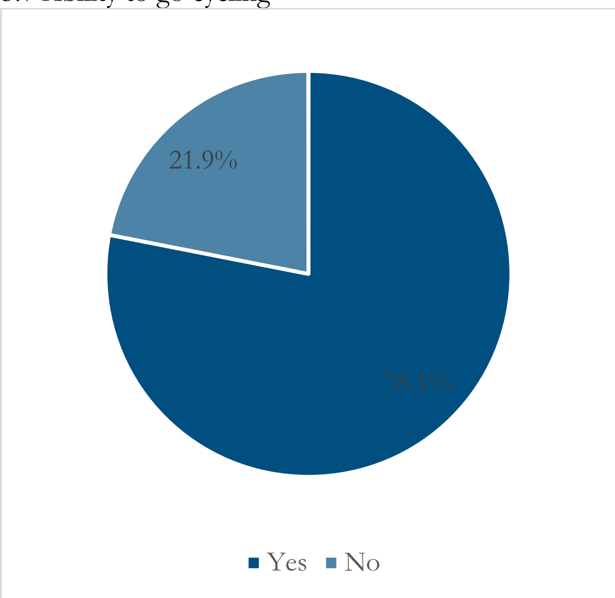
5.5 Purpose of walking



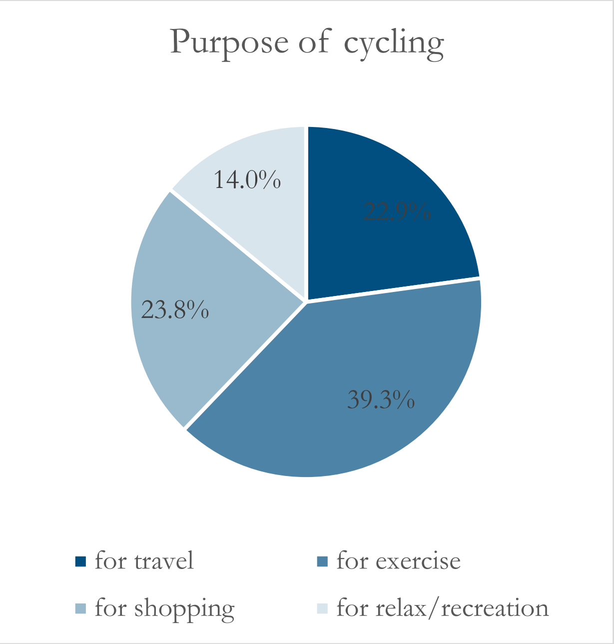
5.6 Longest duration people willing to **"walk for travel"**

Case	Time	Distance
Case 1: Private motorised vehicle and Taxi user	8.93 minute	714 meter
Case 2: Other transport mode user	9.90 minute	792 meter
Case 3: All	9.22 minute	738 meter

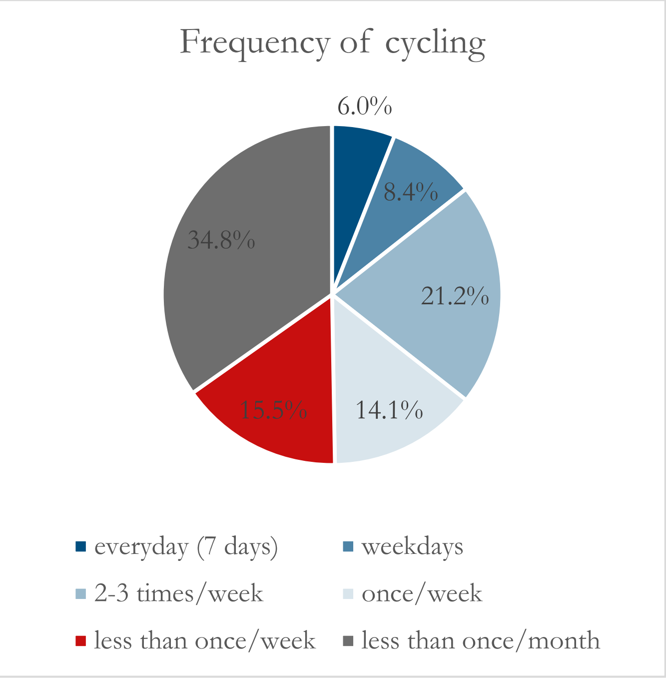
5.7 Ability to go cycling



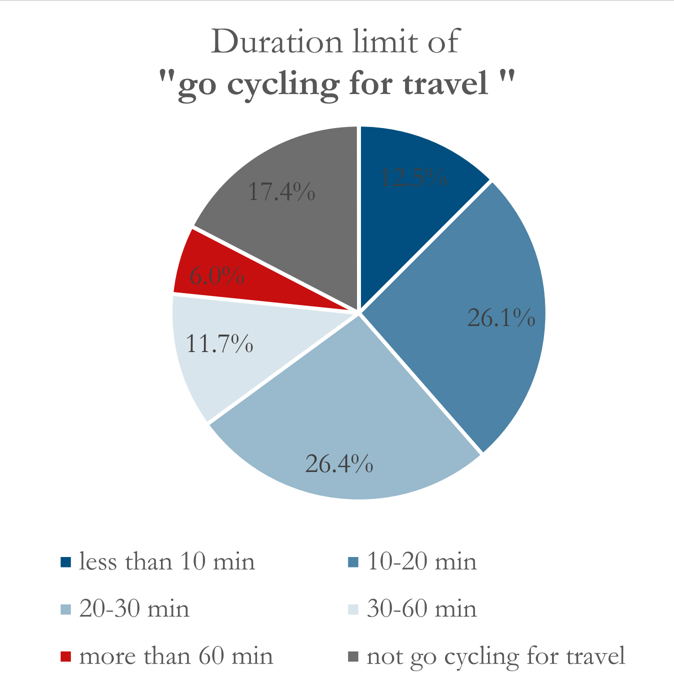
5.8 Purpose of cycling



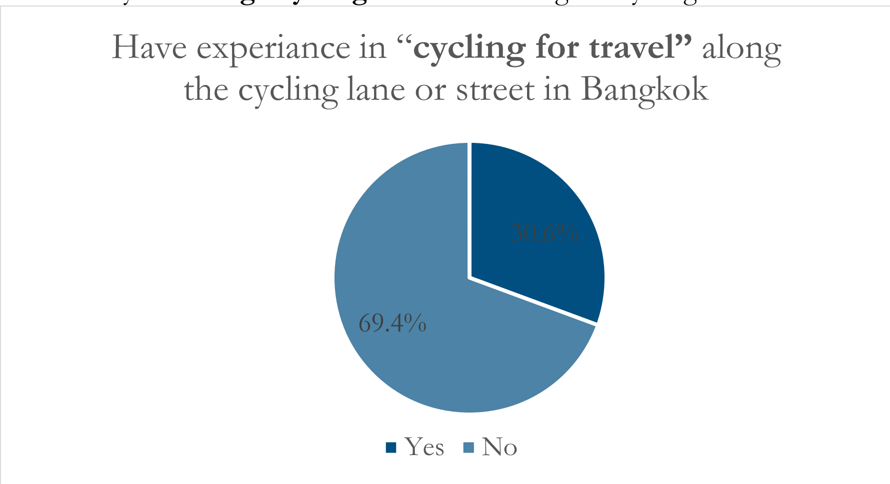
5.9 Frequency of cycling



5.10 Longest duration people willing to **“go cycling for travel”**



5.11 Have you ever “**go cycling for travel”** along the cycling lane or street in Bangkok?



5.12 Current condition of **cycling environment in Bangkok** in your opinion

Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) Appropriateness of existing route	1.82	1.39	1.72	6) Feel safe when turn right/ crossing at intersection	1.79	1.42	1.70
2) Width/ direction	1.81	1.55	1.75	7) Obstacle along the route (parked car?)	1.72	1.48	1.66
3) Smoothness (have pothole?)	1.86	1.55	1.79	8) Weather/ shading	1.84	1.58	1.78
4) Connectivity with other mode	1.94	1.77	1.90	9) Route maps and information	1.91	1.58	1.83
5) Feel safe from other vehicles	1.95	1.48	1.83	(10Adequate lighting	2.01	1.68	1.93
				Average	1.87	1.55	1.79

5.13 Current condition of **bike racks/ bike parking facilities**

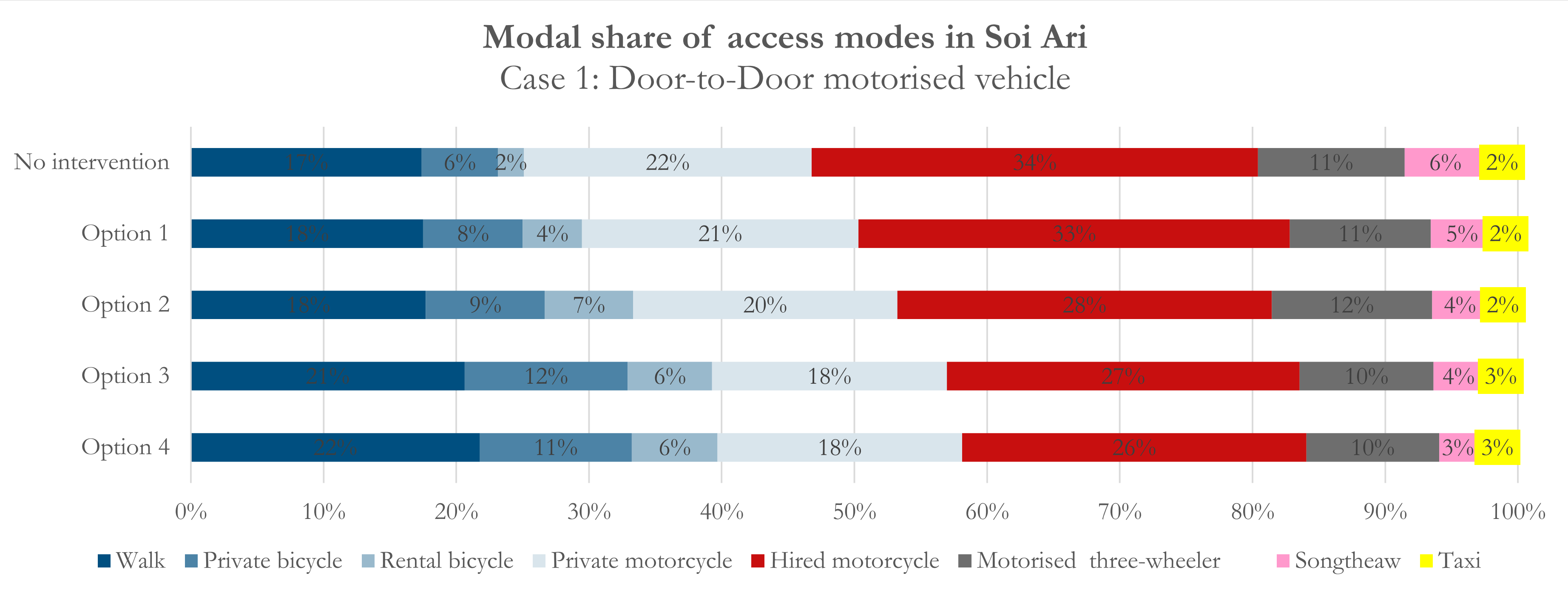
Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) Location and proximity (appropriate/accessible?)	1.79	1.61	1.75	3) Feel safe when use	1.79	1.61	1.75
2) Amount of slot per location	1.87	1.65	1.82	4) Protection from weather	1.78	1.61	1.74
				Average	1.81	1.62	1.76

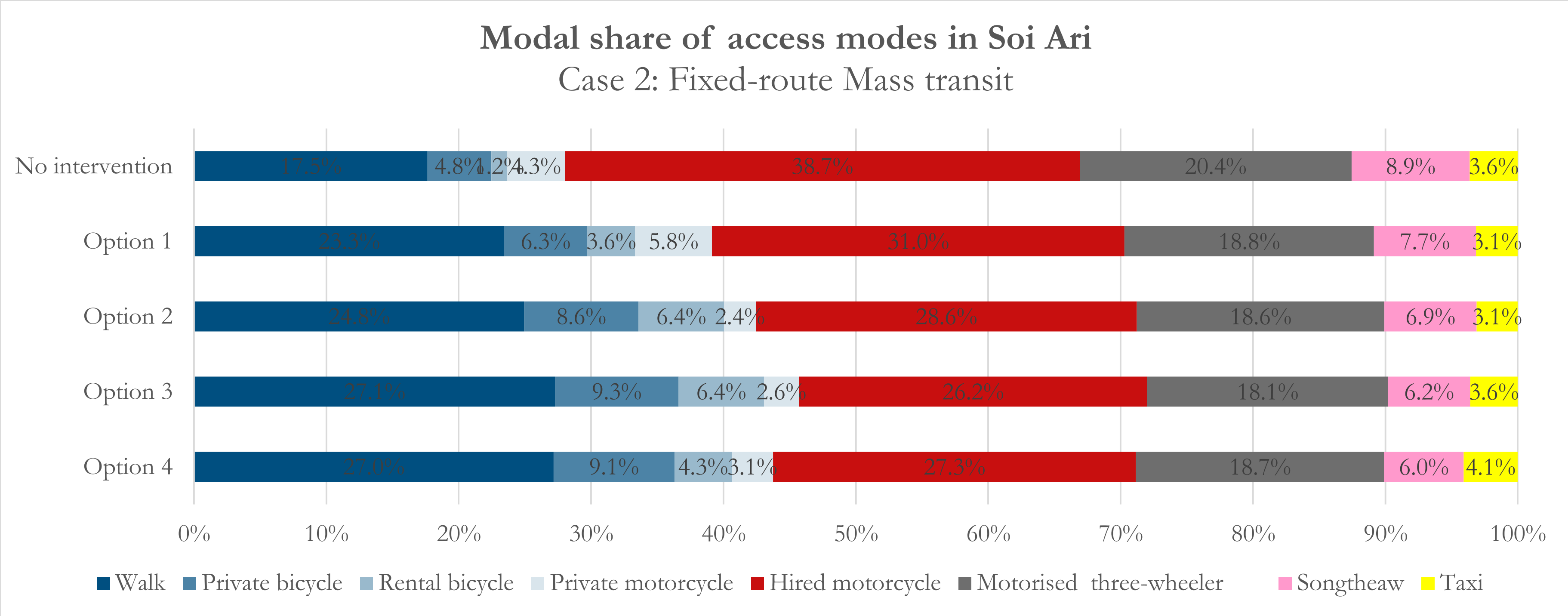
5.14 Current condition situation of **bike sharing system (Pun Pun)**

Condition	Case 1	Case 2	All	Condition	Case 1	Case 2	All
1) Convenient for renting	1.94	1.77	1.90	3) Adequate amount of bike	1.80	1.71	1.78
2) Rental fee	2.07	1.90	2.03	4) Quality of bike	1.87	1.87	1.87
				Average	1.92	1.81	1.89

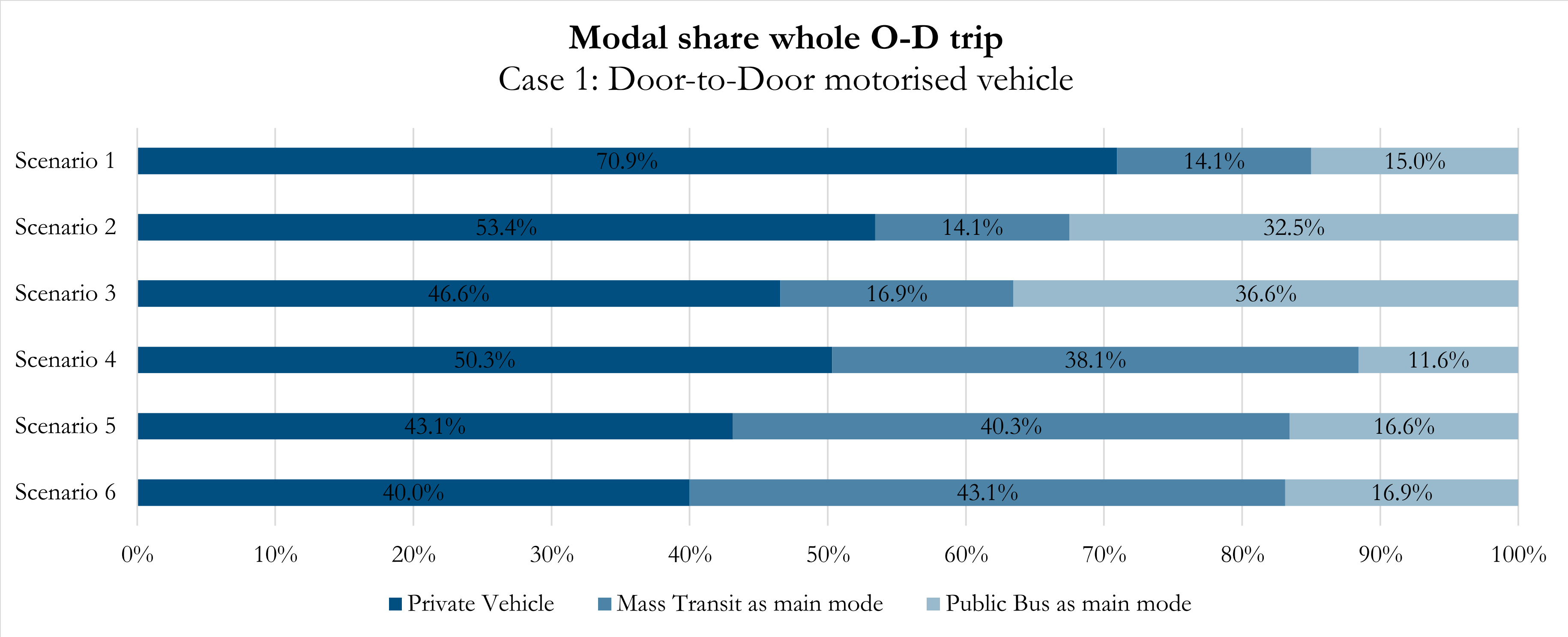
SECTION 6: TRAVEL MODE CHOICE

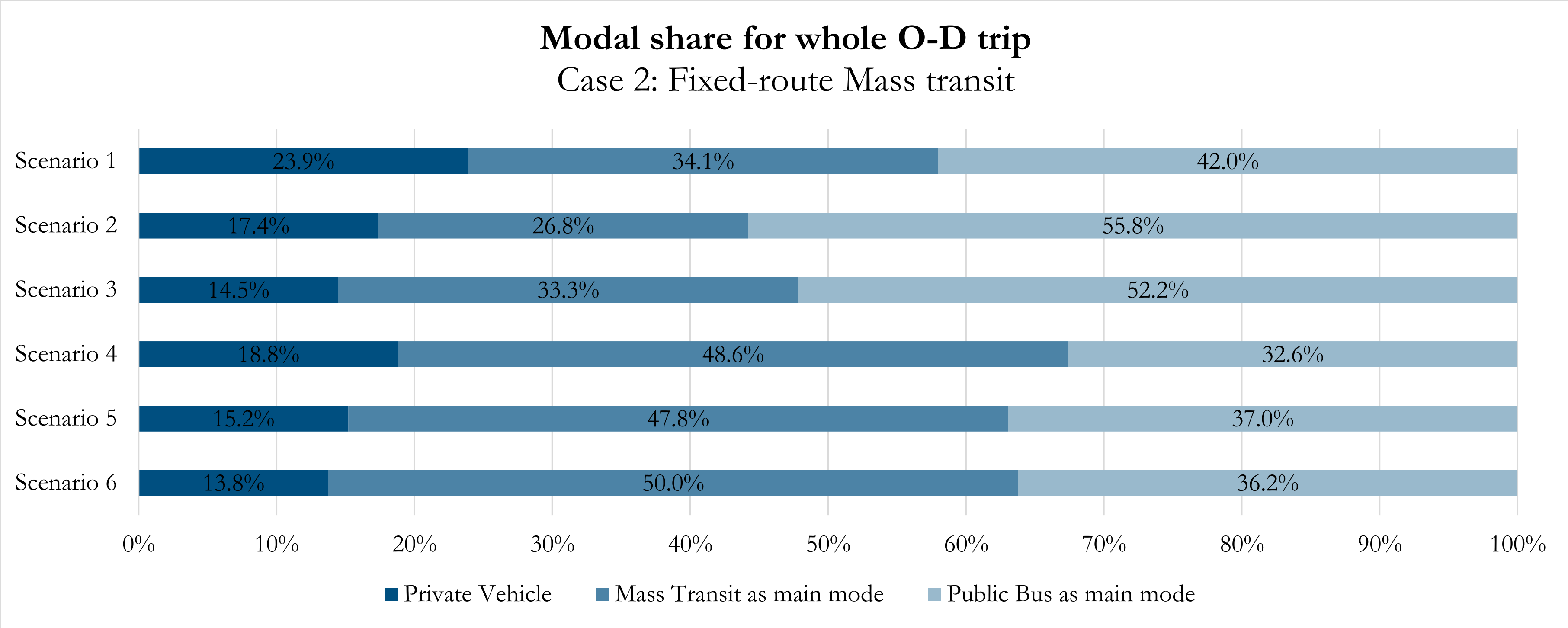
Scenario 1 If you have to travel from BTS Ari station to Governmental office district in Soi Ari with 700-1,000 metre distance **every working day**, which transport mode will you tend to use most?




Modal share of access modes in Soi Ari
Case 2: Fixed-route Mass transit
No intervention
Option 1
Option 2
Option 3
Option 4
17.5%
4.8%
1.2%
4.3%
38.7%
20.4%
8.9%
3.6%
23.3%
6.3%
3.6%
5.8%
31.0%
18.8%
7.7%
3.1%
24.8%
8.6%
6.4%
2.4%
28.6%
18.6%
6.9%
3.1%
27.1%
9.3%
6.4%
2.6%
26.2%
18.1%
6.2%
3.6%
27.0%
9.1%
4.3%
3.1%
27.3%
18.7%
6.0%
4.1%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Walk
Private bicycle
Rental bicycle
Private motorcycle
Hired motorcycle
Motorised three-wheeler
Songtheaw
Taxi

Scenario 2 **In the next 5 years,** if you have to travel from **your new house** to **Governmental office district in Soi Ari,** which has **10 km** distance, **every working day**. Your new house is **next to bus stop** and **5 km from Metro station.** Which transport mode will you tend to use most?





Modal share for whole O-D trip
Case 2: Fixed-route Mass transit
Scenario 1
23.9%
34.1%
42.0%
Scenario 2
17.4%
26.8%
55.8%
Scenario 3
14.5%
33.3%
52.2%
Scenario 4
18.8%
48.6%
32.6%
Scenario 5
15.2%
47.8%
37.0%
Scenario 6
13.8%
50.0%
36.2%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Private Vehicle
Mass Transit as main mode
Public Bus as main mode

Annex 4A: Standards for bikeway design and construction in Thailand

Source: Thailand Cycling Club - http://www.thaicyclingclub.org/sites/default/files/05-standards_for_bikeway_design_and_construction_in_ thailand.pdf

On 19th January 2016, the government cabinet passed a resolution agreeing to proposals made by the Ministry of Transport (MoT) as follows:

1. Agreed that standards should be set up for bikeway design and construction in Thailand that all government agencies would be referring to in the construction of bikeways, so that they would have the same forms and standards all over the country.

2. Agreed that MoT, Ministry of Interior (MoI), Ministry of Tourism and Sports (MoTS), Prime Minister Office (PMO), Ministry of Education (MoE), Royal Thai Police (RTP) and Thai Health Promotion Foundation give cooperation and supports to develop and promote transportation of the people with bicycle a to their mandates, duties and responsibilities by using a Manual of Standards for Bikeway Design and Construction in Thailand for reference, so that bikeways would be constructed in the same forms and standards all over the country.

3. Agreed that responsible agencies were to make an agreement in details with Bureau of the Budget to allocate budget for annual expenditure to implement measures to promote and support transportation of the people by bicycle according to related legal procedure and regulations.

Manual of Standards for Bikeway Design and Construction in Thailand has key contents consisting of Bikeway Classification, Geometric Design of Bikeway, Pavement Design, Traffic Signs Design, Bikeway's Pavement Markings and Safety Facilities, Traffic Safety System, and Guidelines for Bicycle Parking Facilities, which developed from bikeway standards of the **American Association of State Highway and Transportation Officials (AASHTO)** which are recognised worldwide and the **Manual on Uniform Traffic Control Devices (MUTCD)** with details as follows:

1. Bikeway Classification uses speed and volume of motorised vehicles traffic as the control factor for classification of bikeways (adapted to make it appropriate for Thailand) as follows:

1) For roadways where an average speed of motorised vehicles is lower than 30 kilometre per hour (km/h) and a yearly average volume of motorised vehicles traffic is less than 3,000 vehicles per day, bicycles can use traffic lanes together with other vehicles in ordinary traffic lanes. If volume of motorised vehicles traffic is more than 3,000 but no more than 5,000 vehicles per day, bicycles can use traffic lanes together with other vehicles, such as the traffic lane next to roadway kerb or roadside car parking spaces. In case that volume of motorised vehicles traffic is more than 5,000 vehicles per day, bike lanes cannot be implemented.
2) For roadways where an average speed of motorised vehicles is between 30 to 50 kilometre per hour (km/h) and a yearly average traffic volume is less than 3,000 vehicles per day, bicycles can use traffic lanes together with other vehicles, such as the traffic lane next to roadway curb or roadside car parking spaces. If traffic volume is more than 3,000 but no more than 5,000 vehicles per day, bike lane is to be specifically designated with markings on pavement clearly separating bike lane from other traffic lanes and safety facilities on road shoulder and main lanes. In case that volume of motorised vehicles traffic is more than 5,000 vehicles per day, specifically designated bikeway is to be provided with markings on pavement clearly separating bikeway from traffic lanes.
3) For roadways where an average speed of motorised vehicles is between 50 to 70 kilometre per hour (km/h), specifically designated bikeway is to be provided with markings on pavement clearly separating bikeway from traffic lanes and safety facilities on road shoulder and main lanes, or a bikeway is to be provided separated from general traffic lanes, such as bikeway newly constructed with concrete barrier to separate main traffic lanes from footpaths and bikeway.
4) For roadways where an average speed of motorised vehicles is higher than 70 kilometre per hour (km/h), specifically designated bikeway, such as on road shoulder with divider or barrier to separate it from motorised vehicles traffic, is to be provided.

5) In case that the volume of motorised vehicles traffic is 10,000 vehicles per day or more, and an average speed of motorised vehicles is 80 kilometre per hour (km/h) or more, bike way must be constructed outside clear zone of roadway.
6) In case that the volume of large motorised vehicles is more than 30 vehicles per hour in the outermost lane, use of roadway embankment as bikeway should be considered. Or if another type of bikeway is used and an average speed of motorised vehicles traffic is high (80 km/h or more), an open space should be used to buffer between bicycles and motorised vehicles.
7) In areas where bicycle users are expected to be children or those who have little experience riding bicycle, such as areas near school, in community or public park, for example, specific areas must be provided for bicycles to separate bike way from roadway.

2. Geometric design of bikeway has design standards as follows:
1) Speed and Safety Stop Distance
2) Traffic Sign System
3) Horizontal Curve Design
4) Vertical Curve Design
5) Lateral Clearance Design under Safe Bicycle Stop Distance
6) Crossroad Design

3. Pavement design of bikeway

Bikeway infrastructure Design according to AASHTO standards is as follows:
1) Where road shoulder is used as bike lane, existing pavement of the route is adopted.
2) Design for Multi Use Path-type of traffic lanes or where bike way is separated from general traffic lanes, such as when a new bike way is constructed with concrete ridge or road island dividing traffic lanes. Structure of pavement is required to be as follows:
   2.1) 5 cm. asphalt pavement, 15 cm. ground, 15-30 cm. foundation
   2.2) Double Surface Treatment pavement, 15 cm. ground, 15-30 cm. foundation
   2.3) 10 cm. concrete pavement, 5 cm. sandy ground, 10 cm. foundation

4. Design of Traffic Signs, pavement markings, and safety system for bikeways consist of design of legends on traffic signs and installing locations, and design of markings on pavement.

5. Traffic Safety System consists of blinking light system on signs placed at bikeways and lighting system.

6. Guidelines for Bicycle Parking Facilities

Specification for Bicycle Parking Facilities by the U.S. Department of Transportation, Federal Highway Administration (2006), provides recommendations that to specify standards for bicycle parking facilities, details must be taken into consideration. The guidelines is presented in **Table 4B-1**. Designers and users must use their discretion to determine what point of these guidelines would be used for a concerned area.

Table 4A-1 Suggested cycle parking location and amount standard

Areas that cycle parking facilities need to be considered	Standards for cycle parking facilities
1. Residential buildings	(1) 1 bicycle per 3 residential units
2. Club houses (that are used for doing activities) or sport clubs	(2) 1 bicycle per activity room (plus 3 per cent of maximum capacity)
3. Society buildings or places used for social gatherings of various faculties	(3) 1 bicycle per social function room
4. Hotels or apartments	(4) 1 bicycle per 20 staff
5. Libraries, museum, exhibition halls and galleries	(5) 1 bicycle per 10 parking lots for motorised vehicles
6. Schools, colleges and universities	(6) 1 bicycle for 4 staff
7. Kindergartens and primary schools	(7) 1 bicycle for 4 students
8. Rehabilitation facilities, clinics and institutions	(8) 1 bicycle for 10 staff
9. Hospitals	(9) 1 bicycle for 20 staff
10. Shopping malls, cinema theaters – complexes and avenue	(10) 1 bicycle for 20 staff
11. Business districts and industrial estates	(11) 1 bicycle per 10 parking lots for motorised vehicles
12. Other areas	(12) 1 bicycle per 10 parking lots for motorised vehicles

Annex 4B: Cycle parking for Thailand's environment suggestions

Source: Translated from Thailand Cycling Club - http://www.thaicyclingclub.org/article/detail/6845

The Thailand's Cycle Parking Standards round table conference held at 6 March 2015 by Thai Cycling Club (TCC) in which relevant public sectors specialised in the fields of urban planning and transports system, other related sectors, and specialists participated, has its content of awareness as below;

"Most of the regular cyclists will realize the importance of having a cycle parking especially for those who do cycling for daily basis or traveling. The cycle parking is considered to be even more essential than the cycling track or bike lane. In case that not having a cycling track, the cycling journey is not obstructed, but lacking a secure cycle parking concerns the people on the loss of bicycle. This leads to the reason of non-popularity of the cycling in Bangkok and vicinity. Therefore, the thing the Thai Cycling Club has coherently attempted to require is "To have the sufficient, convenient, and secure cycle parkings" which finally is appeared as a subordinate content beneath the 5th National Health assembly 5.1 System and Construction designation supporting pedestrian and cyclist."

Department of Public Works and Town and Country Planning (DPT), with their authority in Thai building control act, established the working group by selecting the cyclists to be the committees in order to study on application of the global standards with Thai context. The committees are ordered to outline the primarily draft to purpose with the department in order for the working group to corporate in cycle parking standards formulation. By this case, uses scale of the area and number of the room in each building as criteria.

According to the study of cycle parking standards in the five organisations in the USA and Canada, it has been noticed that the cycle parking can be classified into two types consisting of short-term parking and long-term parking. Short-term parking is a temporary parking not exceed than two hours using rack to lock a bicycle. This parking has designation and construction standards such as the rack has to lock at least two parts of a bicycle and other additional facilities such as roof must be provided. Long term parking is a parking where the cyclists are able to park exceed two hours and has more securities such as a bicycle locker, a bicycle cage, and should be placed in a suitable location. There are other additional facilities such as a bathroom and a changing room. The long term parking includes multiple innovations, for example, an automatic underground parking in Japan, a cycle parking building of Netherlands. Regarding the study, thus there is primarily standards formulation in terms of facility's quantity occurred. In order to meet standards, a cycle parking is required to have capacity for ten cars. Also, at least 2 types of structure of a cycle parking are required to be designed for proposal.

Moreover, there are 6 aspects that discussed in the conference as follow;

1. "The bike lane is more necessary than the cycle parking" which against the research's result which has been found that 69.4 percent of the people remarked that a cycle parking is more necessary.
2. "Every area has similar demand for cycle parking" is found to be different depending on a characteristic of a citizen, behaviours, activities and physical environment, route's attraction, and a daily use of a bike lane whether is in urban or in rural area.
3. "A cycle parking can be easily designed and capable to be placed at anywhere". In fact, there are 12 criteria required. For example, a space should not be wasted, but approachable. Thus, a construction is not as easy as it seems.
4. "A builder and a user have the same opinion on a cycle parking". However, there are 5 different opinions between a builder and a user.
5. "On-Street parking is safer than Off-Street parking". In fact, it is the opposite.

6. "It is not a time yet to develop a standard for parking inside a public building in Thailand", but the truth is that there are more people using bicycle, so the needs of a cycle parking standard has been obviously increased.

The participants suggested that, apart from the framework done by DPT which covers three aspects those are; minimum standards, basic equipment, and sufficiency capacity inside a building, there should be other aspects those could not be overlooked;

- Type of a cycle parking may be categorised based on type of a building rather than parking duration.
- A cycle parking should be located closer to building entrance than car parking spaces.
- A number of parking slots should match a size of a building to support an increase of users
- Rules and regulation should be flexible and adjustable because of the frequent changes of situation.
- There should be a study of European and Japanese cycle parking standards invented because they are considered to be ahead of USA standards which is currently used by DPT
- The committees should question whether, ideally, the cycle park is constructed for the town or the cyclists
- The study of the cyclist's behaviour should be invented. According to the observation, it can be noticed that a cycle park where the cyclists tend to use is located close to the entrance of a building, has a rack in order to lock a bicycle, and roof. At the primary stage, it should be located nearby a motorbike park and has the same parking card system with a motorcycle. In this case, for safety concerns.
- A cycle parking should be located nearby urban rail stations.
- The committees should pay attention on cycle parking system as it supports the public transports system and the quantity of the cycle parking should conform to transports system.
- Quantity of the cycle parking should be estimated based on number of cyclist rather than size of area and the quantity of car parking space.
- The location of the cycle parking is as much important as the quantity of parking space as the cyclist considers safety and convenience as the first priorities, for example, if the parking is located at the high story or the underground, it would not attract people to use it.
- There should be a study on why people give up using a cycle. The study by King Mongkut's University of Technology Thonburi has shown the cyclist has lost for 23%
- The committees should widen their perspective as the cycle park is not only constructed to support the use of bicycle, but also other reasons such as to reduce the car use. Therefore, pavement and public parking cannot be overlooked.
- A bathroom and a changing room is essentially important for the people those use a bicycle as daily basis. To have these facilities must be a regulation of the cycle parking. In fact, a locker should be provided.
- Office of Transport and Traffic of BMA has a policy enforcement on a cycle parking construction beneath BTS station stairs which is increasing every year.
- The construction should consider for both expensive and cheap bicycle, and should provide the rack which can lock, at least, two parts of a bicycle.
- Housing criteria should be based on number of people rather than size of area
- There should be a code of the length between a parking area and a fire sprinkler.
- The purposed standards does not cover all details of building and area such as a market, a convenience store, all types of public transport station, a governmental office, a park.
- It might not work if the target is set beyond capability. Therefore, it is better to start from creating guideline, then can be a code and standard.
- The quantity of a cycle parking should be slightly increased based from the actual usage and forecast result.

Publishedby
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Lake Rajada Office Complex
(16th floor)
New Ratchadapisek Road, Klongtoey,
10110 Bangkok

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Picture credits / Sources
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Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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