Development of a National Urban Mobility Programme for Thailand

An Inventory and Assessment of National Urban Mobility in Thailand

Final Report February 2019

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Background Information on the TRANSfer Project

The TRANSfer project is run by GIZ and funded by the International Climate Initiative (IKI)of the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Its objective is to support developing countries to develop and implement climate change mitigation strategies in the transport sector as "Nationally Appropriate Mitigation Actions" (NAMAs). The project follows a multi-level approach:

- At country level, TRANSfer supports selected partner countries in developing and implementing NAMAs in the transport sector. The NAMAs supported by the project cover a broad variety of approaches in the partner countries Indonesia, South Africa, Peru and Colombia.
- At international level and closely linked to the UNFCCC process, the project helps accelerate the learning process on transport NAMAs with a comprehensive set of measures (events, trainings, facilitation of expert groups, documents with guidance and lessons learned such as the transport NAMA handbook and a database, which is an interactive wiki-based portal that provides access to transport NAMAs).

Activities at country and international level are closely linked and designed in a mutually beneficial way. While specific country experience is brought to the international stage (bottom-up) to facilitate appropriate consideration of transport sector specifics in the climate change regime, recent developments in the climate change discussions are fed into the work in the partner countries (top-down).

For more information see: http://www.transferproject.org

Development of a National Urban Mobility Programme for Thailand

An Inventory and Assessment of National Urban Mobility in Thailand

This report is the final deliverable towards the development of a National Urban Mobility Programme in Thailand. It provides an inventory of urban mobility systems in Thailand and an inventory of national and urban mobility planning. This report acts a repository of data and information that sets out the existing national urban mobility situation. This report then presents a diagnostic assessment of urban mobility and how it is planned to identify an urban mobility programme that should overcome many of the urban mobility issues faced in Thailand today.

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Contents

List of Acronyms and Abbreviations

ADB	Asian Development Bank
AFD	Agence Française de Développement
ASEAN	Association of South East Asian Nations
BATS	Bangkok Area Transportation Study
BAU	Business as usual
BB	Bureau of Budget
B.E.	Buddhist Era
BEM	Bangkok Expressway and Metro Public Company Limited
BMA	Bangkok Metropolitan Administration
BMR	Bangkok Metropolitan Region
BMT	Bangkok Mass Transit Masterplan
BMTA	Bangkok Mass Transit Authority
BRT	Bus rapid transit
BTS	Bangkok Mass Transit System Public Company Limited
CLTC	Central Land Transport Committee
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CSEZ	Committee on Special Economic Development Zones
CTO	Common Ticketing Office
DLT	Department of Land Transport
DoH	Department of Highways
DPA	Department for Public Administration
DPT	Department of Public Works and Town and Country Planning
DRR	Department for Rural Roads
ENCON Fund	Energy Conservation Promotion Fund
EEC	Eastern Economic Corridor
EXAT	Expressway Authority of Thailand
GCF	Green Climate Fund
GDP	Gross domestic product
GHG	Greenhouse gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GNI	Gross National Income

GPP	Gross Private Product
LCV	Light commercial vehicles
LTC	Land Transport Committee
HFT	Heavy freight vehicles
HOV	High-occupancy vehicle
HSR	High Speed Railway
JICA	Japan International Cooperation Agency
LPG	Light petroleum gas
LRT	Light rapid transit
MC	Motorcycle
MFT	Medium freight vehicles
MYC	Mobilise Your City
M-Map	Mass Rapid Transit Masterplan for Bangkok Metropolitan Area
MoF	Ministry of Finance
MoI	Ministry of Interior
MoT	Ministry of Transport
MRTA	Mass Rapid Transit Authority
MRV	Measurement recording and verification
MTMP	Mass Rapid Transit Systems Masterplan
NAMA	Nationally Appropriate Mitigation Actions
NDA	National Designated Authority
NDC	Nationally determined contributions
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NO_2	Nitrogen Dioxide
NUMP	National Urban Mobility Programme
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development
OTP	Office of Transport and Traffic Policy and Planning
PAO	Provincial Administrative Organisation
PC	Private car
PCD	Pollution Control Department
PDMO	Public Debt Management Office
PPP	Public Private Partnership
PT	Public transport
SO_2	Sulphur Dioxide

SRT	State Railways of Thailand
SRTO	Single Rail Transfer Operator
SUMP	Sustainable Urban Mobility Plan
SWOT	Strengths, Weaknesses, Opportunities and Threats
TC	Transport Company
TDM	Travel demand management
THB	Thai Baht
TISI	Thai Industrial Standards Institute
TOD	Transit oriented development
TFF	Thailand Future Fund
UN	United Nations
URMAP	Urban Rail Transport Masterplan
VAT	Value added tax
VKM	Vehicle kilometres travelled
WHO	World Health Organisation

Executive Summary

This report provides an inventory of urban mobility systems in Thailand and an inventory of national and urban mobility planning. The report then presents a diagnostic assessment of urban mobility and how it is planned to identify an urban mobility programme that should overcome many of the urban mobility issues faced in Thailand today. The aim of this is to provide a basis upon which a National Urban Mobility Programme (NUMP) could be developed.

A NUMP is a framework to improve the capability of towns and cities to plan, finance and implement projects designed to improve the mobility of people in their areas. A NUMP supports the delivery of national policies (such as the NDC Action Plan) at the local level and empowers local governments to identify, plan for and deliver the optimal solutions to the issues they face.

There are two key demographic and population trends that will impact upon planning for urban mobility in coming decades.

- Nationally, the Thai population will decrease over coming decades. However, the population of Bangkok and surrounding areas is forecast to grow as the country continues to urbanise.
- The population is an aging one, requiring accessibility issues for older people to be considered in the design and delivery of urban transport systems

Transport infrastructure is developing and evolving all the time and has been a focus of government investment for several decades. However, it is evident that the development of road networks in particular have encouraged high levels of car use and this has impacted upon quality of life:

- There is high car and motorcycle ownership across the Kingdom, with more than one vehicle for every two people.
- The car ownership rate (the number of road motor vehicles per 1,000 inhabitants) of Bangkok (646) is higher than Singapore (170), Hong Kong (92) and London (320). That means that there is a higher dependency on a private car, lower utilisation of public transport despite a lower average income in Bangkok compared to these cities.
- Vehicle ownership continues to grow by 1.9% per year across Thailand, and by 3% in Bangkok.
- Vehicle occupancy rates (number of people in a car per trip) are low, exacerbating the impact of high car ownership. A major contributor to congestion.
- There is an increasing number of passengers using car hailing (e.g. UBER, Grab) that were public transport users before (data currently being collected) therefore contributing to congestion and GHG emissions.
- As a result of growth in vehicle use, transport is the second largest emitter of GHG.
- Air quality is impacted greatly by transport and in urban areas concentrations of particulate matter and other pollutants can exceed safe levels.
- There is a large number of road fatalities, with the second highest rate per head of population in the world - motorcycle riders make up nearly three quarters of fatalities on Thai roads.
- The cost of journey time delays, poor air quality and a high incidence of road fatalities is extremely high and, based on experience elsewhere, it manifests itself in, amongst other things, reduced economic performance.

Despite high motorisation rates, the bus continues to play a key role in moving the Thai population. 28% of passenger km travelled is by bus, compared to 26% by car and 24% by motorcycle. Building upon this

mode share provides an opportunity to strengthen the viability and sustainability of bus services in all urban areas. With buses emitting just 7.25% of greenhouse gas emissions but accounting for 28% of passenger km travelled, it is evident that encouraging any sort of modal shift from car to bus or other forms of public transport would have a notable impact on CO_2 and other greenhouse gas emissions. Strengthening public transport with additional operational funding and investments is therefore a key strategy in Thailand's NDC Action Plan.

There are some features of transport delivery in Thailand that support high levels of personal motorisation. A lack of, or incomplete, pedestrian and cycling infrastructure makes travelling on non-motorised modes more difficult. In addition, the cost of public transport and the need to pay twice when interchanging makes using public transport more expensive than car hailing services such as Grab.

As well as documenting urban mobility and the factors that affect it, this report has also presented the urban mobility planning framework and the governance structures currently in place. There are a variety of institutions involved in planning and delivering transport, most notably the Ministry of Transport (and its various departments), Ministry of Interior and the Royal Thai Police. Within the Ministry of Transport, there are various departments which have their differing roles. The Office of Transport and Traffic Policy and Planning (OTP) plays an essential role in planning transport systems, while the Department for Land Transport (DLT) plays a significant role in delivering and regulating public transport services.

Urban transport plans are developed by OTP in conjunction with the Department of Public Works and Town and Country Planning to ensure that land use planning and transport planning are co-ordinated. At present, plans are developed centrally, albeit with support and input from local consultancies and academics. The plans tend to be long term in nature and seek to overcome current transport problems. The plan for Phitsanulok reviewed as part of the preparation of this report suggest that there is a great deal of focus on infrastructure and vehicles, with less focus on non-motorised modes.

Public transport is regulated in Thailand. DLT controls public transport services (except rail mass transit, which is controlled by the Mass Rapid Transit Authority) in Bangkok through the issuing of operating permits to operators, while the provincial arms of the DLT performs this role in other municipalities and urban areas.

There is currently no mechanism for subsidising public transport services, thus all bus services should be self-funding through fare box revenue. This impacts upon the long-term viability of public transport services in all areas, and particularly where services are not commercially viable. When services cannot be sustained through fare box revenue alone, operators tend to reduce service levels to a point that revenues can sustain the service to generate a return on the investment. This in turn leads to a lack of investment in vehicles which has a negative knock-on effect on patronage – particularly as greater affluence allows bus users to be in a position to afford cars and motorcycles – air quality and greenhouse gas emissions. The situation gets worse in the absence of transport demand management measures that provide disincentives for the use of a private car or single occupancy hailing trips.

A review of the economics of bus services suggests that a lack of government subsidy, as well as constraining regulatory factors such as regulated fares, results in relatively low-quality service levels. There are plans to transform bus services into a network of feeder services once the rail mass transit network is developed further, although services are still likely to face the same issues without reforming the regulatory and legislative structures.

A diagnostic analysis using the SWOT framework elicited a variety of recommendations around the development of a NUMP:

While supply side measures are the focus of transport masterplans, demand management measures are an essential ingredient to shift behaviour. It is essential that in all urban areas, demand management measures such as road user charging, parking charging and parking availability constraints are considered alongside supply side improvements.

Opportunities should be given to local administrations to invest in public transport services in order to partially decentralise decision making and provide those administrations with the responsibility to enhance public transport services. One mechanism for this is to develop a fund that administrations could bid for (meeting specified criteria) in order to implement local projects.

Before any political decisions are taken on the fuel source of BMTA buses, a thorough evaluation of the optimal fuel source options should be carried out. There is a danger that decisions could be taken without a full understanding of the well-to-wheel emissions and how different fuel technologies will perform operationally across Bangkok.

It is necessary to support the work of the Common Ticketing Office (CTO) to implement a common ticket and common fare structure across Bangkok. It is essential that the CTO implements a product that meets the needs of users and overcomes the barriers to travel today, most notably the generalised user cost of travel.

It is evident that there is a significant opportunity to build upon the political desire to reduce PM2.5 levels by developing a formal travel demand management (TDM) strategy. This strategy should provide a mechanism for not only generating revenue from TDM measures but also for spending revenue generated i.e. how it should be spent, by which organisations, what the investment priorities are etc.

With the numerous plans for constructing mass transit across urban areas of Thailand, it is recommended that government considers whether funding for public transport could be more effective. At present, bus operators are completely reliant on fare revenue, yet fare levels are dictated by government and government subsidy of bus services is not permitted. Without changing this approach, bus services are likely to suffer from a lack of investment in the future.

It is recommended that OTP and other agencies continue to disseminate skills and knowledge. Only if the capacity exists at the local level can local administrations deliver urban mobility for their areas.

All transport projects should have a thorough process and outcome evaluation as a part of their delivery. Output monitoring is insufficient for the size and scale of many projects that are delivered, so delivering an effective monitoring and evaluation regime is paramount for long-term learning and skills development.

Following on from these recommendations, a framework for a National Urban Mobility Programme has been identified. Given the political priority to improve air quality, the 'Thailand Clean Mobility Programme' aligns with the findings of this study, while at the same time meeting the overarching objectives of OTP and government. There are three thematic areas for which 'action levers' can be developed:

- How to deliver transport demand management across urban areas, including Bangkok
- How to build upon and enhance bus services to improve urban mobility
- How to develop funding mechanisms to support local governments to implement urban mobility enhancing projects in their local areas

The targets for each of these three thematic areas are to:

- Reduce PM2.5 levels across specific urban areas

- Reduce CO_2 emissions by 2.17Mt per annual (p.a)
- Increase the number of bus passenger trips by approx. 5%

The action levers for each of the thematic areas are presented below:

In summary, the development of an inventory of urban mobility indicators and the diagnostic analysis of those indicators has led to the development of a NUMP framework. Implementing the NUMP in Thailand should significantly improve urban mobility systems and processes and allow for an improvement in air quality and a reduction in CO_2 emissions.

1 Introduction

1.1 Background

Globally transport accounts for 27% of energy-related CO_2 emissions and continues to remain a rapidly growing sector. According to the latest Transport Outlook CO_2 emissions could increase 60% by 2050 (OECD, 2018). GIZ was commissioned by BMU with the implementation of the project TRANSfer III - Facilitating the development of ambitious transport mitigation actions.

The objective of the project is to increase the efforts of developing countries and emerging economies to foster climate-friendly transport with international support. The project follows a multi-stakeholder approach and acts as a "mitigation action preparation facility".

In Thailand, the TRANSfer III project supports the Office of Transport and Traffic Policy and Planning (OTP) and its partners in the preparation of mitigation actions in urban transport in order to implement the NDC commitments (specified in the NDC Action Plan) in the transport sector. This includes the development of a National Urban Mobility (Investment) Programme (NUMP) for Thailand. Specifically, the NUMP aims to develop a support mechanism for cities to improve urban transport.

What is a National Urban Mobility Programme?

A NUMP is a framework developed by national governments to improve the capability of towns and cities to **plan, finance and implement projects** designed to improve the mobility of people in their areas.

A NUMP supports the delivery of national policies at the local level and empowers local governments to identify, plan for and deliver the optimal solution to the issues they face. A NUMP also empowers local governments to monitor and evaluate the solutions delivered to enhance learning and better manage urban mobility in future.

Examples of NUMPs include the currently developing **e-Mobility NUMP in Uruguay**. The national government is in the process of setting up a fund to invest in urban electric vehicles. In **France and Colombia** the NUMP supports investments in public transport infrastructure (e.g. bus stops, bus lines).

A NUMP can focus on infrastructure, technologies (e.g. electric vehicles) and is often supported by an investment (funding) and regulatory framework (e.g. planning guidelines). All NUMPs have in common that they provide additional funding for local planning measure (e.g. support through consultants in planning) and implementation (operational subsidies for bus operators, infrastructure investments, clean vehicle funds)

The primary focus for the NUMP should be secondary cities, i.e. those other than Bangkok. However, any national programme will, inevitably, impact upon Bangkok given the dominance of Bangkok and its surrounding areas on economic activity and on transport emissions. The NUMP supports the implementation of the Nationally Determined Contribution (NDC) Action Plan which aims to set out how the Thai government will reduce greenhouse gas emissions emanating from transport modes.

In its National Determined Contribution (NDC) Thailand has committed to a reduction of 20% of its CO_2 emissions compared to a business-as-usual scenario that amounts to 115.6 $MtCO_2$. The transport sector was assigned a total reduction of 41 $MtCO_2$. The substitution of biofuel in the transport sector

accounts for a 10 $MtCO_2$ reduction. The remaining target will be addressed in the NDC Action Plan for the transport sector with an additional potential of 35.41 $MtCO_2$ reduction in CO_2 emissions. Measures/policies under this action plan have been divided into three groups: the first group, which its budget is secured, is estimated to save 18.67 $MtCO_2$ and the second group, without budget allocation, reduce 16.74 $MtCO_2$. A third group of projects has been identified but the potential CO_2 savings have not yet been determined as baseline data collection is required. OTP has recently finalised the NDC Action Plan and the various projects that are required. It should be recognised that the NUMP for Thailand istherefore considered a helpful and complementary vehicle to deliver the NDC Action Plan measures.

The NUMP development in Thailand is supported by MobiliseYourCity (MYC). MobiliseYourCity is a globally operating partnership launched by the Governments of France and Germany and supported by the European Commission and implemented – among others- by GIZ. MobiliseYourCity supports national and local governments in emerging and developing countries in planning of sustainable urban mobility. Key tools promoted by MYC are National Urban Mobility Programs (NUMPs) and city-level Sustainable Urban Mobility Plans (SUMPs). Partner countries and partner cities of MobiliseYourCity have recognised the global challenges on urban transport and committed to tackle these through adoption of common principles of sustainable urban mobility in their national and local development planning. Partner countries and partner cities participate in the MobiliseYourCity Community of Practice and they can receive technical assistance as well as may take part in capacity-building activities.

1.2 Aims and Objectives

The core aims of the development of a NUMP are:

- Provide necessary groundwork that allows policy makers in the Thai government to make an informed decision on the implementation of the NDC action plan through a NUMP
- Develop a funding mechanism that supports the implementation of urban transport measures
- Provides a planning framework for urban transport planning (quality standards, clear guidance on roles and responsibilities, capacity development)

The development of the NUMP is a participatory process and requires several preparatory steps and discussions:

- Build on existing sector studies to assess current funding, financing and transport planning mechanisms and implementation of cities and national government
- Identify support needs for cities that are to be included in a NUMP (capacity, financial instruments, funding, planning procedures, institutional framework)
- Assess the current main barriers for low-carbon transport in Thailand
- Provide recommendations for "Vision & Goal setting" to:
    - draft a national vision for urban mobility (in line with the NDC action plan)
    - define the objectives of the National Urban Mobility Programme and
    - provide strategic direction on using the various levers of action available (governance, financing, funding, capacity building, technological choices, etc.) in Thailand

There are three core processes involved in the development of the NUMP, these are:

- Inventory
- Diagnosis
- Recommendations

The inventory documents the existing urban mobility systems and the factors that impact those systems, both now and in the future. It firstly considers the fundamental attributes that impact and influence how people live and travel. Population, density, urbanisation and motorisation rates help to set out the current and likely future factors that influence how people will move around Thailand and its urban areas. In addition, this report provides a thorough documentation of the existing urban mobility systems:

- Review of institutions involved in delivering and regulating urban mobility systems
- Review of relevant legislation governing urban mobility and systems
- Review of national and local urban mobility policies
- Financing and funding of urban mobility systems

This documentation allows for a diagnostic analysis of urban mobility systems which is carried out within the SWOT framework. This analysis is carried out with four specific areas of focus:

- Governance
- Budgeting and funding
- Capacity development
- Technology

Following the diagnostic analysis, a stakeholder engagement workshop was used to obtain the perceptions of decision makers within various government departments. This is presented within the diagnostic section. Using all of the findings presented, a National Urban Mobility Programme can then be defined.

1.3 Approach

The aim of this report is to document the urban mobility systems in place in Thailand, and analyse data to help inform of the key influences and impactors on urban mobility systems, now and in the future. The approach taken to compile this report has been to collect and collate existing datasets and information to provide a thorough documentation of the existing situation.

The first step was to collate existing official statistics and datasets collected by government departments and agencies. While not exhaustive, the key sources of data are listed below. In addition, a repository of documents and data sources reviewed to complete this report has been compiled.

- Office of the National Economic and Social Development Board (NESDB)
- Department of Provincial Administration, Ministry of Interior
- Department of Land Transport (DLT)
- Office of Transport and Traffic Policy and Planning (OTP)
- Asian Development Bank Transport Data
- World Health Organisation
- Various ministries across government, including interviews with officials

In addition, to collecting secondary data sources, interviews were carried out with numerous stakeholders across the country to document their roles and discuss the structures in which urban mobility is managed and provided. Interviews were carried out with the following organisations:

- Chiang Mai Municipality
- Chiang Mai Provincial DLT representative
- Bangkok Metropolitan Administration
- Hat Yai Public Works Department
- Office of Transport Traffic Policy and Planning
- Department of Land Transport
- Phuket Provincial Administration Organisation
- Phuket City Development Co., LTD.
- Public Debt Management Office – Ministry of Finance
- Nonthaburi Municipality

Following an analysis of all data and information collated, the SWOT analysis could be carried out. This was carried out independently by the team of consultants, and then presented to a workshop of key stakeholders and decision makers. The SWOT was then further refined through the discussion with stakeholders, and the final refined version is presented in this report.

Following the diagnosis of the key urban mobility issues in Thailand, a NUMP concept was developed by the team of consultants, GIZ officers, and OTP.

2 Urban Mobility Indicators

The aim of this chapter is to set the context within which the NUMP will be developed, describing the characteristics of Thailand and how these relate to and influence the requirements of the NUMP. This chapter provides an overview of the sociodemographic and economic characteristics of Thailand, and the state of transport, its energy consumption and emissions.

2.1 Socio-Economic and Demographic Metrics

2.1.1 Population and Demography

According to population forecasts based on the 2010 census, in 2017 Thailand had an estimated population of 67,653,000, with almost one quarter of this population residing within the Bangkok Metropolitan Region (BMR). Almost 16m people live within the BMR, while Nakhon Ratchasima, located to the north east of Bangkok and the second largest province, has a population of almost 2.5m. This is illustrated in Table 2-1 Population of Thailand including BMR and six major provinces 2017 below.

There are some potential weaknesses with how population data is collected. Registrations with the Ministry of Interior are often used to estimate populations. However, these can provide an inaccurate estimate due to residents registering in areas where they do not live - often residents of BMR registering in other provinces. Registered and unregistered immigrants may also be missing from official statistics. The population estimates presented below attempt to take account of the non-registered and immigrant population of each province.

Table 2-1 Population of Thailand including BMR and six major provinces 2017

Population	Thai + Non-Thai Registered Population	Non-Registered Population	Total Population	% Non-registered Population
Whole Kingdom	65,522,000	2,131,000	67,653,000	3.3%
BMR*	14,854,400	1,076,900	15,931,300	7.2%
Nakhonratchasima	2,482,600	9,668	2,492,268	0.4%
KhonKaen	1,721,200	15,118	1,736,318	0.9%
Chiang Mai	1,655,200	48,780	1,703,980	2.9%
Songkhla	1,529,000	18,810	1,547,810	1.2%
Phitsanulok	884,000	9,170	893,170	1.0%
Phuket	454,400	83,512	537,912	18.4%

Source: Office of the National Economic and Social Development Board

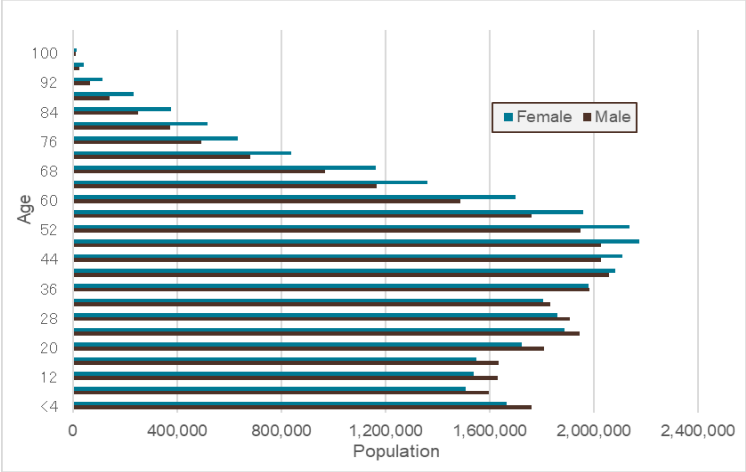
*BMR (Bangkok Metropolitan and Region Area) is Bangkok area and the 5 provinces of Bangkok including Nonthaburi, Pathumthani, Samutprakarn, Samutsakorn, and Nakhonprathom.

The population pyramid for Thailand is presented in Figure 2-1 Population pyramid by sex and age group 2017 below. This shows that there is a higher proportion of people within the middle-aged cohort than in the lower and upper age ranges. Those residents aged between 35 and 54 account for 32% of the population, while the mean average age is 37.

The United Nations Ageing Index (World Population Ageing 1950-2050), provides a metric on the number of people aged 60 or over for every 100 people under the age of 15. This shows that in 1975, there were 11.7 people aged over 60 for every 100 0-14 year olds. By 2000 this had increased to 30.5, and by 2025 it is forecast that there will be 87.3 people aged over 60 for every 100 people aged under 15. By 2050, the UN estimates that this will increase further to 158.1. This strongly suggests that Thailand is experiencing growth in the proportion of older people and will continue to experience an ageing

population in coming decades. This may reflect historic policies such as the family planning programme introduced in the 1970's which helped to reduce the population growth rate.

There is an apparent difference in the population of males and females. Within the cohort up to 35 years of age, there are more males than females, while in the cohort of those aged 40 and above, there are greater numbers of females than males.



Source: Department of Provincial Administration, Ministry of Interior

Figure 2-1 Population pyramid by sex and age group 2017

While Bangkok and its metropolitan region account for one quarter of Thailand's population, population density differs across the country. Notably, Bangkok has a population density of around 6,600 people per km² compared to over 7,583 people per km² in Hat Yai and 6,295 in Phuket. When taking account of the entire Bangkok Metropolitan Region however, the population density is around 4,219 people per km². This is an average density across the region, so may disguise areas of Bangkok where population density is much greater than the average. This is illustrated in Table 2-2.

Compared to other cities within the region, Bangkok isn't the most densely populated. Seoul and Taipei have the most densely populated areas with around 16,000 and 15,000 people per km² respectively (CityMayors.com), while Metro Manila and Jakarta have densities of around 10,500 people per km². More densely populated than Bangkok are also Ho Chi Minh City (9,450ppkm²) and Singapore (8,450ppkm²), showing that while Bangkok has a large population, it is not as densely populated as other comparable cities due to the large land area on which it sits. This has implications for planning urban mobility as public transport, and mass transit in particular, tends to perform better commercially in more densely populated areas - shorter distances and population density make delivering public transport services more efficient.

Alain Bertraud's work (2004) on comparing population densities and public transport use remains highly relevant today. Comparing Atlanta (US) and Barcelona (Spain), Bertraud noted that both cities had similar populations (between 2.5 and 3 million residents) Barcelona has a metro system with a total length of 99 km and Atlanta has a metro system with a total length of 74 km. Due to population densities, 60% of Barcelona's population lives within 600 m of a metro station while 4% of Atlanta's population live within 800 meters of one of its metro stations. In Atlanta, 4.5% of trips are made using the metro compared to 30% in Barcelona.

This example illustrates that transit supply is not the only factor that encourages high transit use, but that it needs to be accessible from where people live, and access those locations where people want to go to. Thailand has much to learn from this example, particularly Bangkok which is currently developing and

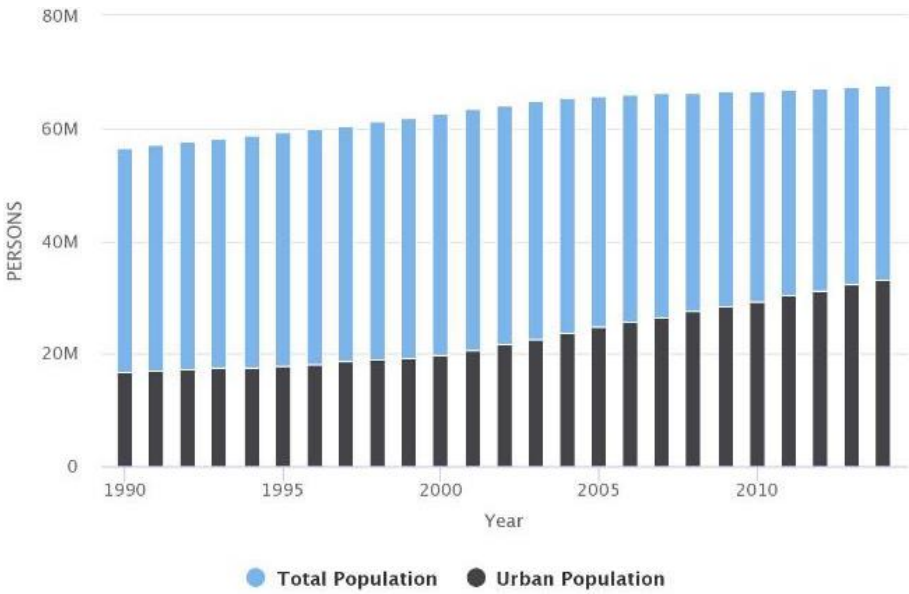
expanding its metro system. To encourage high levels of use, it is important to ensure there is easy access to the network of services for a maximum number of people to ensure it is well used. Alongside this, demand management techniques to encourage private vehicle users to use the metro network are likely to be required. The same is true of other Thai urban areas that are investing in mass transit networks.

Table 2-2 Population and density of urban areas in Thailand

City or Municipality (Urban Area)	Province	Population*	Area (km^2)**	Density [People/km^2]**
Bangkok Metropolitan Administration	Bangkok Metropolitan Administration	10,350,204	1,568	6,600
Total BMR in urban areas	BMR	12,586,200	2,871	4,384
Nakhon Ratchasima	Nakhon Ratchasima	174,332	39	4,470
Chiang Mai	Chiang Mai	174,235	47	3,707
Hat Yai	Songkhla	159,233	21	7,583
KhonKaen	KhonKaen	129,581	52	2,492
Phitsanulok	Phitsanulok	89,480	19	4,709
Phuket	Phuket	75,536	12	6,295

Source: Department of Provincial Administration, Ministry of Interior, Office of the National Economic and Social Development Board and Websites of each Municipalities
*Population can be found from Department of Provincial Administration, Ministry of Interior, and Office of the National Economic and Social Development Board and Population in each area consist of registered and non-registered population
**Area can be found from websites of each Municipalities
***Density can be calculated from population divided by area

The population of Thailand is becoming increasingly more urban, as illustrated in Figure 2-2 . In 2000, the urban population accounted for 31.4% of all residents, while in 2014 it accounted for 33.3million residents or 49.2% of the entire population. Of all urban dwellers, 48% live in BMR. This is highly relevant to the development of an urban mobility programme for Thailand as it shows that to reduce GHG emissions, then Bangkok will have to play a central role in any strategy.



Source: ADB Transport Data Bank

Figure 2-2 Changes to the urban population of Thailand since 1990

According to the Department of Provincial Administration, the nation's population has increased since 2007 at an average annual rate of 0.35%. The BMR, however, has seen its population increase by around 0.76% per year since 2007, as presented in Table 2-3.

Table 2-4 shows that the future population of Thailand is likely to continue increasing slightly up to 2027, but from 2032 onwards, the Government expects the population of the entire Kingdom to decrease. By contrast, the population of Bangkok will continue to increase up to 2037. This has implications for urban mobility planning in Bangkok as increasing demand will require new solutions over time to meet the mobility demands of residents and visitors. This highlights the need for constant monitoring of urban mobility as situations evolve and develop over time, and plans can quickly get out of date if demand changes.

Table 2-3 Population change by annual percentage between 2007 and 2017

Population Change	2007	2012	2017	Average Annual Percentage
Whole Kingdom	0.08%	0.45%	0.53%	0.35%
BMR	0.81%	0.76%	0.71%	0.76%

Source: Department of Provincial Administration, Ministry of Interior

Table 2-4 Population change forecasts 2022 - 2037

Population Forecast	2022	2027	2032	2037
Whole Kingdom	0.21%	0.05%	-0.13%	-0.33%
BMR	0.98%	0.68%	0.47%	0.23%

Source: Office of the National Economic and Social Development Board

In summary, a number of observations and conclusions can be drawn from this analysis of population data. Firstly, there is an ageing population in Thailand which may have implications on urban mobility in coming decades. For example, public transport may need to be more accessible for those with limited mobility.

A declining population, as well an ageing one, may have implications on future revenue generation for government, which may or may not impact upon the development of and maintenance of urban mobility systems. However, with the population of Bangkok continuing to increase, it highlights the need to ensure urban mobility systems in Bangkok continue to meet the existing and future demand placed upon it.

Finally, population density has a significant impact upon the design and development of urban mobility systems. Public transport, for example, tends to perform better in densely populated areas where large numbers of people can be served by a service along a single route or corridor. Hat Yai, in theory at least, has potential for good urban public transport services to meet the needs of its residents, when considering population density alone. In lower density areas further transport policies and land-use policies are usually required to ensure adequate access to public transport and reduce car dependency e.g. higher operational or infrastructure funding support, transit-oriented planning, parking management, congestion charging etc.

2.1.2 Economy

Thai Gross Domestic Product (GDP), in 2015, was measured at 13,673b Baht (US$420b), as illustrated in Table 2-5. This had grown from 6,317b Baht since 2003, an increase of 116% in 12 years. At the same time, BMR's GDP increased from 3,071b Baht to 6,397b Baht, so Bangkok's economy was greater in

2015 than the entire Kingdom's economy in 2003. In 2015, the construction and transport sector accounted for around 10.1% of national GDP and around 13% of BMR's GDP.

The size of the economies of other areas and provinces are significantly smaller than BMR, but have shown similar growth rates. Phuket is the slight anomaly with its GDP having more than trebled in the 12 years from 2003 to 2015.

Table 2-5 GDP between 2003 and 2015 (Billion Baht)

Area/Province	2003	2005	2007	2009	2011	2013	2015	Percentage in Construction and Transport Sector in 2015
Whole Kingdom	6,317	7,614	9,076	9,659	11,307	12,921	13,673	10
BMR	3,071	3,645	4,171	4,351	4,931	5,688	6,397	13
Nakhon Ratchasima	116	134	157	170	210	255	265	8
Chiang Mai	89	110	119	131	163	188	218	12
Songkhla	120	149	166	167	224	234	235	9
KhonKaen	78	88	115	142	161	184	187	7
Phitsanulok	38	44	49	57	67	90	82	9
Phuket	53	54	85	86	108	136	164	28

Source: Office of the National Economic and Social Development Board

GDP per capita showed similar growth levels to GDP, but there are some notable differences. While the Kingdom's residents grew richer between 2003 and 2015 with GDP per capita more than doubling from nearly 100,000Baht (US$3,000) to 203,356Baht (US$6,250), BMR's GDP per capita increased by just 54%. Despite this, BMR remains the most affluent region with GDP per capita of 410,617Baht, or US$12,500, double the national figure. This can be seen in Table 2-6below.

Table 2-6 GDP per capita 2003-2015 (Baht)

Area/Province	2003	2005	2007	2009	2011	2013	2015
Whole Kingdom	99,766	118,876	140,079	147,363	170,764	193,561	203,356
BMR	266,640	295,426	315,846	308,020	333,030	374,138	410,617
Nakhon Ratchasima	44,703	51,953	61,577	66,879	83,261	101,870	106,000
Chiang Mai	56,152	67,310	70,957	76,159	94,060	108,762	126,976
Songkhla	89,764	107,802	116,433	114,182	150,332	154,631	153,505
KhonKaen	44,246	49,914	65,487	81,453	92,176	105,683	107,607
Phitsanulok	45,820	50,657	56,314	63,376	73,099	99,837	91,577
Phuket	167,986	148,587	201,914	175,251	205,026	255,798	306,779

Source: Office of the National Economic and Social Development Board

GDP forecasts, using regression analysis, show that between 2017 and 2045, GDP will increase by 3% per year across the Kingdom. Bangkok's GDP, however, will increase by 2.6%, less than most other regions and provinces of the Kingdom. This is presented in Table 2-7.

Table 2-7 Forecast GDP and GPP (Billion Baht) 2017 - 2045

Area/Province	Forecasted GDP and GPP (Billion Baht)						Annual GDP and GPP Growth Rate during 2017-2045
	2017	2025	2030	2035	2040	2045	
Whole Kingdom	15,167	20,179	23,312	26,444	29,577	32,710	3.0%
BMR	6,706	8,784	10,083	11,382	12,680	13,979	2.6%
Nakhon Ratchasima	291	396	461	526	591	656	3.1%
Chiang Mai	228	309	360	411	461	512	2.9%
Songkhla	268	350	401	452	503	554	2.9%
KhonKaen	219	301	352	403	454	506	3.4%
Phitsanulok	98	133	156	178	201	223	3.4%
Phuket	165	230	271	312	353	394	3.0%

Source: Analysed by the consultant using regression analysis

To put Thailand's economic performance into perspective, Thailand's GDP per capita in 2017 was US$6,595 compared to $9,952 in Malaysia, $2,989 in the Philippines and $3,847 in Indonesia (data.worldbank.org).

In summary, Thailand's economy has more than doubled in the past 12 years, with BMRs economy accounting for a little under half of the national economy. Per capita, Bangkok has not grown at quite the same rate as the rest of the Kingdom, but BMR residents produce 54% more in 2015 compared to 2003, and it continues to be the most affluent area in Thailand.

GDP forecasts suggest that, despite a declining population forecast, Thailand will continue to see growth, particularly in areas outside of BMR. This has implications for urban mobility planning because, as the country gets more affluent then the availability of private vehicles is likely to increase. This will be considered in more detail in the next section.

2.2 Transport in Thailand

This section examines some of the key attributes of the transport system in Thailand.

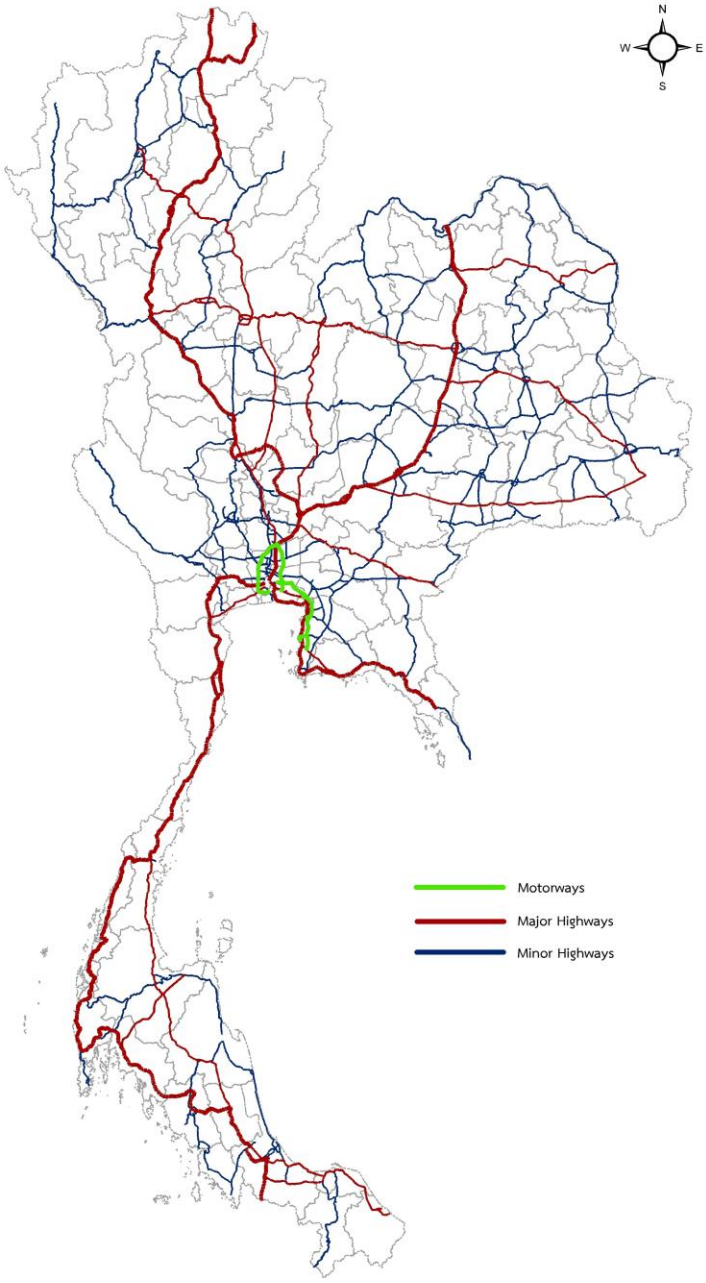
2.2.1 Existing transport infrastructure

There are five key motorised modes for which infrastructure is provided in Thailand:

1. Road
2. Rail
3. Air
4. Sea
5. River

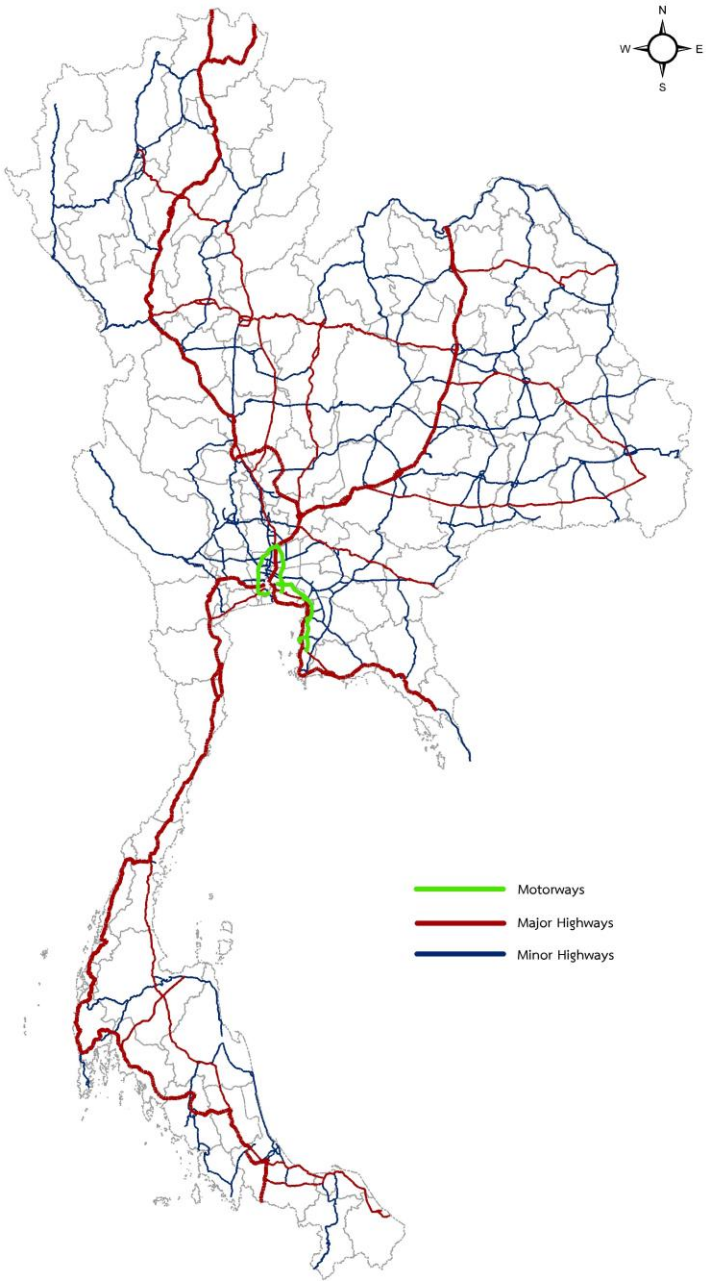
Thailand has a well-developed road network that spans across the country. Roads form the core of the transport network, with 180,053 km of road, 98.5% of which is paved. Paved roads in Thailand can be classified as:

- Motorways and general highways operated by Department of Highways – there are just 293 km of motorway including 125 km of route from Bangkok to Chonburi and Pattaya, and 168 km of outer ring road for Bangkok
- Expressways serving in BMR area operated by Expressway Authority of Thailand
- Local roads operated by Department of Rural Roads and other local administrations



Source: PSK consultants

Figure 2-3 illustrates the highway network for the entire country. This shows that the four major highways tend to radiate from Bangkok, serving all four corners of the Kingdom, while minor highways fill in the gaps to create a comprehensive national road network.



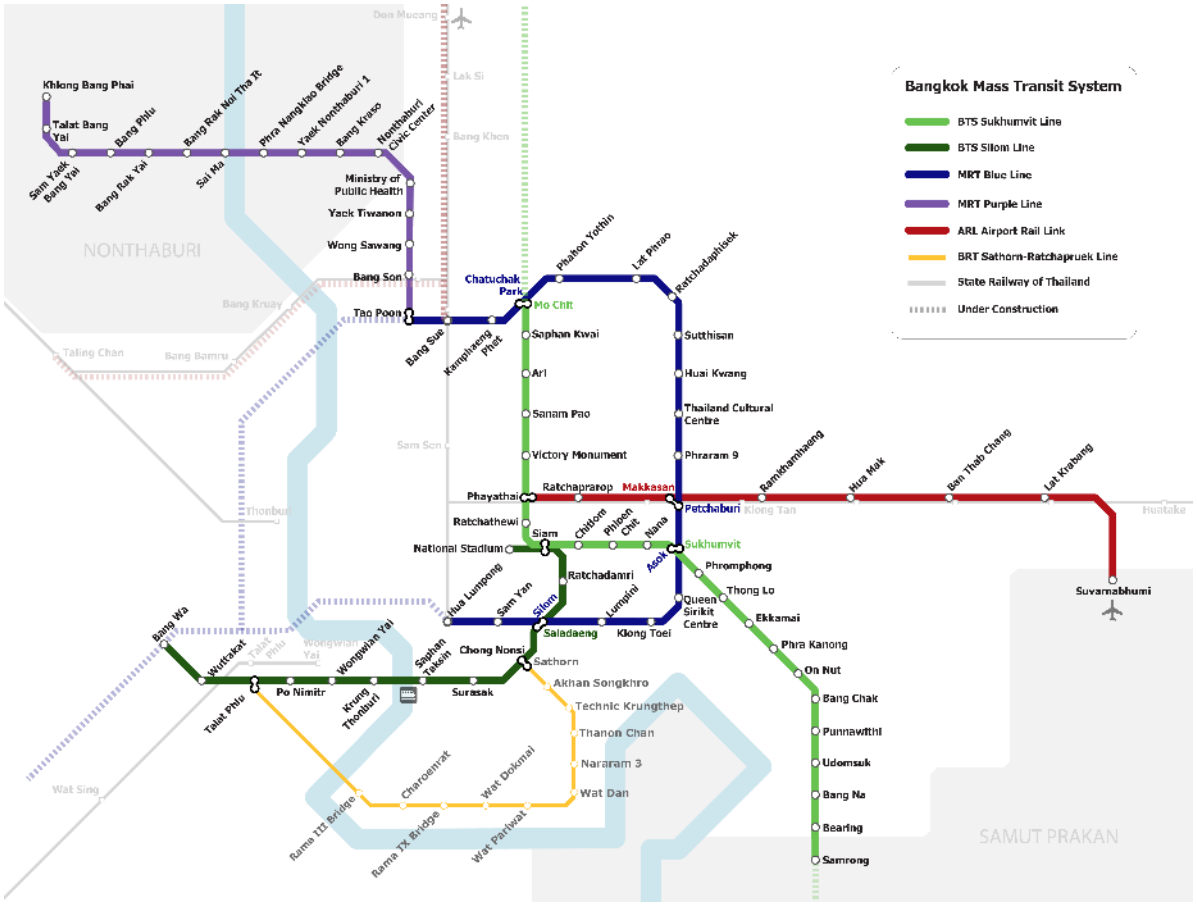
Source: PSK consultants

Figure 2-3 Existing highway and motorway network operated by DoH

The rail network can be divided into two groups: urban and inter-urban railways. Currently, the urban railway network consists of 112 km of track within the BMR area only, as illustrated in Figure 2-4 and discussed in detail in Section 3.1. There are four mass rapid transit lines and one airport rail link service. The services on these five lines are operated as follows:

- Bangkok Mass Transit System PCL (BTSC) under the concession granted by the Bangkok Metropolitan Administration (BMA) by operating two mass rapid transit lines consisted of Light Green line (Sukhumvit) and Dark Green (Silom) Line,

- Bangkok Expressway and Metro Public Company Limited (BEM) under the concession granted by the Mass Rapid Transit Authority of Thailand (MRTA) by operating two mass rapid transit lines consisted of Blue Line and Purple Line,
- SRT Electrified Train Co., DLT. (SRTET) under the State Railway of Thailand (SRT) by operating one airport rail link between downtown and Suvarnabhumi Airport.



Source: Wikipedia of Mass Rapid Transit Master Plan in Bangkok Metropolitan Region

Figure 2-4 Existing urban railway in BMR

The mass transit rail network in BMR is complemented by a network of bus services. Services are operated by the Bangkok Mass Transit Authority (BMTA) and private sector operators under contract to BMTA but this responsibility is being transferred to the department of land transport (DLT). There is one Bus Rapid Transit (BRT) corridor with dedicated running ways between Satorn and Ratchaplerk. Outside of BMR and in other urban areas, public transport mostly consists of buses, mini-buses and Songthaew.

In recent years there have been developments in public transport services in Chiang Mai and Phuket. Private bus operators and co-operatives have set up and use intelligent technologies and smartphone applications to make bus services more attractive to users.

The State Railway of Thailand (SRT) owns and operates inter-urban rail services. The system consists of 4,070 km of track with 16 different lines covering 47 (out of 77) of the Kingdom's provinces as presented in Figure 2-5. The vast majority of railway network is single track (3791 km) with 174 km of double track and 105 km length of triple track. The triple track lengths are found in and around BMR.

Source: State Railway of Thailand (SRT)

Figure 2-5 Existing inter-urban railway network BMR

There are 35 airports in Thailand consisted of 6 major international airports operated by the Airport of Thailand PCL including Suvarnabhumi, Don Muang, Chiang Mai, Chiang Rai, Phuket, and Hat Yai, 28 airports operated by Department of Airports, and U-Ta Pao international airport operated by Royal Thai Navy.

There are three major seaports in Thailand located in Bangkok and east coast of country for international freight transportation. They are consisted of (1) Bangkok (Klong Toei) seaport, (2) Laem Chabang (Chonburi Province), and (3) Map ta phut seaport (Rayong province). The first two seaports are operated

by Port Authority of Thailand (PAT) and the last one is operated by Industrial Estate Authority of Thailand.

There are 3,701 km of navigable inland waterways[1]. One of the most important of these waterways for freight transportation is along the Chao Phraya river from the rivers mouth, to 200 km north to Chai Nat Province. Passenger transport using inland waterways is confined to urban ferry services in and around Bangkok. Ferry or public boat services operate along the Chao Phraya river and the San Sab canal in BMR. The Marine Department within the Ministry of Transport issues concessions to private sector ferry or boat operators.

Non-motorised transport infrastructure in Thailand is poorly documented. In urban areas, often alongside highways, pedestrian footpaths exist along with skywalks to enable pedestrians to cross highways and intersections or to access elevated rail stations. In Bangkok, there are examples of cycle lanes having been implemented as part of a 2008 project to introduce 230 km of lanes throughout the capital. However, anecdotal evidence suggests that these are poorly used due to physical obstructions (and a lack of enforcement) such as:

- Cars parking in the cycle lane
- Road signs
- Street vendors
- Motorbikes using the lanes

2.2.2 Goods Transport

Road, rail, water and air account for all freight transportation. In terms of freight tonnage moved across the Kingdom, the vast majority, 86.9% is transported by road. Air accounts for very little freight movement, but does possess the greatest costs per km moved, as shown in Table 2-8.

Table 2-8 Demand for freight transportation and costs 2016

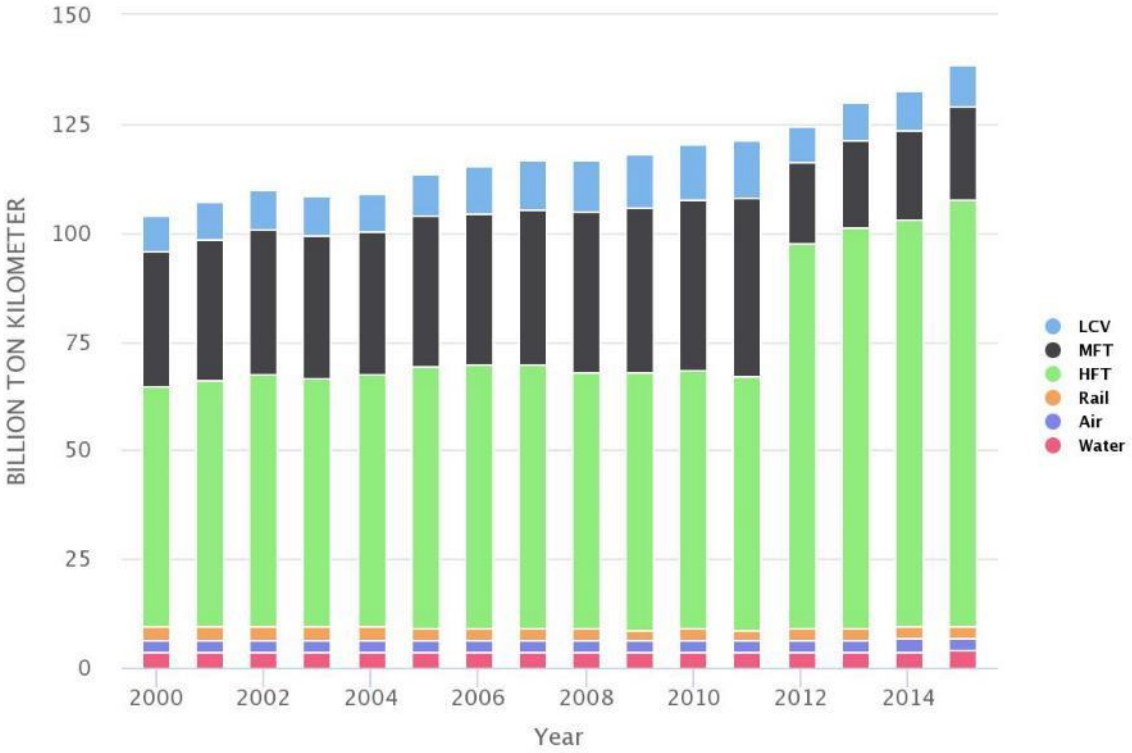
Mode	Demand of Freight Transportation (Tons/year)	Demand Percentage	Cost* (Baht/Tons-km.)
Road	699,743,964	86.9	1.69
Rail	9,678,384	1.2	0.71
Water	95,775,615	11.9	0.52
Air	60,784	0.008	20.00
Total	805,258,747	100.00	-

Source: Study on Travel Demand Survey and Freight Moving Database Improvement for Transport Planning Report in 2018, OTP
*Cost: consider only transportation fee without lifting fee

The distance that goods are moved across Thailand has grown by approximately 2% per year between 2000 and 2015. Roads have accommodated almost all of this growth, while rail, air and water movement distances have remained broadly stable since 2000.

Figure 2-6 shows that heavy freight trucks (HFT) have accounted for the greatest proportion of all freight distances since 2000, although medium freight trucks (MFT) accounted for 33% of all freight distances in 2010. Since 2011, MFT have more than halved the distance travelled each year while there was a shift to HFT. The reasons for this shift are unclear.

[1]http://transportdata.net/country_profile/main?c=Thailand&id=33#



Source: ADB Transport Data Bank
Remark: LCV = Light Commercial Vehicle, MFT = Medium freight truck, HFT = Heavy freight truck

Figure 2-6 KM travelled by freight mode since 2000

2.2.3 Motorisation rates

Motorisation rates for BMR and six provinces of Thailand (Nakhon Ratchasima, Chiang Mai, Songkhla, KhonKaen, Phitsanulok and Phuket) are presented in Table 2-9. Table 2-9 Motorisation rates per 1,000 people**Fehler! Verweisquelle konnte nicht gefunden werden.**Including motorcycles, for every 1,000 people in the Bangkok Metropolitan Administration area, there are 1,034 vehicles. In BMR as a whole region, the motorisation rate is 637 vehicles per 1,000 people. Notably, Phuket (821/1,000) and Chiang Mai (795/1,000) have higher motorisation rates than BMR. Excluding motorcycles, the motorisation rate in BMR (387/1,000) is higher than six major cities while Chiang Mai has the highest vehicle ownership rate of the six identified cities with 330 vehicles per 1000 people.

Table 2-9 Motorisation rates per 1,000 people (as of September 2018)

City or Municipality (Urban Area)	Province	Motorisation Rate (Veh/1000 People)	
		Include Motorcycles	Exclude Motorcycles
Bangkok Metropolitan Administration	Bangkok Metropolitan Administration	1,034	646
Total BMR	BMR	637	387
Nakhon Ratchasima	Nakhon Ratchasima	486	201
Chiang Mai	Chiang Mai	795	330
Hat Yai	Songkhla	517	232
KhonKaen	KhonKaen	465	216
Phitsanulok	Phitsanulok	522	220
Phuket	Phuket	821	291

Source: Department of Land Transport and Department of Provincial Administration, Ministry of Interior

In 2018, there were 39,551,789 registered vehicles (all vehicle types) in Thailand. 29% of these vehicles were registered in BMR. Given that less than a quarter of the Kingdom's population resides in BMR, the region accounts for disproportionately more vehicles than the rest of the country. This is perhaps unsurprising given that BMR is also the most affluent region of Thailand as identified in the previous section.

Between 2014 and 2018, the number of registered vehicles (all vehicle types) across Thailand increased by an average of 2.9% per year, as presented in

Table 2-10. In BMR, the number of registered vehicles increased by 4.4% however, growing faster than any other region. Notably, almost 1.3m newly registered cars appeared in BMR in just four years from 2014 to 2018 with ten vehicles (including motorcycles) for every 15 residents.

Table 2-10 also compares Thailand to two other middle-income countries within the ASEAN region – Malaysia and the Philippines. This shows that with a population of 67,654,000, there are 585 vehicles per 1,000 people, compared to 918 vehicles in Malaysia and 99 vehicles in the Philippines. Given that Malaysia is slightly more affluent that Thailand (Gross National Income (GNI) per capita in 2017 was US$9,650 compared to US$5,950 in Thailand), this highlights a potential risk that Thailand could follow Malaysia's example and continue to see greater motorisation rates as it becomes more affluent. Without policies to discourage greater levels of motorisation, the negative impacts of motorisation, congestion and its associated economic costs, road safety, air quality and CO_2 emissions could deteriorate further.

Car registration data in Bangkok shows that there are 6.1m registered private cars, or one car for every 2.6 residents. This compares to one car for every 10 residents in Singapore, one for every 7.5 residents in Hong Kong and one for every 3 people in London.

There were around 3m newly registered vehicles in 2018, accounting for around 8.2% of all vehicles, as presented in Table 2-11. Within BMR, new registered cars accounted for a slightly higher proportion of all registered cars, reflecting the greater affluence of BMR residents.

Table 2-10 Accumulated registered vehicles (all vehicle types)

Area/ Province	2014	2015	2016	2017	2018	Annual Growth Rate
Whole Kingdom	35,274,908	36,125,268	36,561,313	36,784,836	39,551,789	2.9%
Malaysia* Pop. 32.29m	N/A	25,719,247	26,877,430	28,456,097	29,666,187	4.9%
Philippines* Pop.104.9m	8,081,224	8,706,607	9,251,565	10,410,814	N/A	8.8%
BMR	9,662,241	10,060,300	10,328,106	10,458,848	11,478,006	4.4%
Nakhon Ratchasima	1,170,614	1,200,635	1,215,126	1,221,352	1,368,421	4.0%
Chiang Mai	1,269,063	1,317,170	1,348,578	1,363,205	1,457,217	3.5%
Songkhla	813,321	811,822	811,404	808,732	829,239	0.5%
KhonKaen	783,625	801,644	808,151	811,653	866,898	2.6%
Phitsanulok	450,788	461,587	465,259	467,881	509,673	3.1%
Phuket	436,014	446,087	453,054	456,631	488,366	2.9%

Source: Department of Land Transport
*Source: https://www.ceicdata.com/en/malaysia/motor-vehicles-registration/number-of-motor-vehicle-total

Table 2-11 New registered vehicles (all vehicle types)

Area/Province	2014	2015	2016	2017	2018	Annual Growth Rate
Whole Kingdom	2,831,728	2,711,820	2,816,441	3,011,274	3,093,791	2.2%
BMR	905,129	864,365	927,732	1,004,807	1,037,458	3.5%
Nakhon Ratchasima	78,773	72,622	71,528	75,201	83,686	1.5%
Chiang Mai	83,501	82,204	84,905	88,517	90,804	2.1%
Songkhla	48,804	49,477	50,705	53,633	49,501	0.4%
KhonKaen	71,836	66,540	64,941	69,763	76,166	1.5%
Phitsanulok	27,621	26,561	26,362	29,177	31,355	3.2%
Phuket	32,891	30,210	34,590	38,347	40,975	5.6%

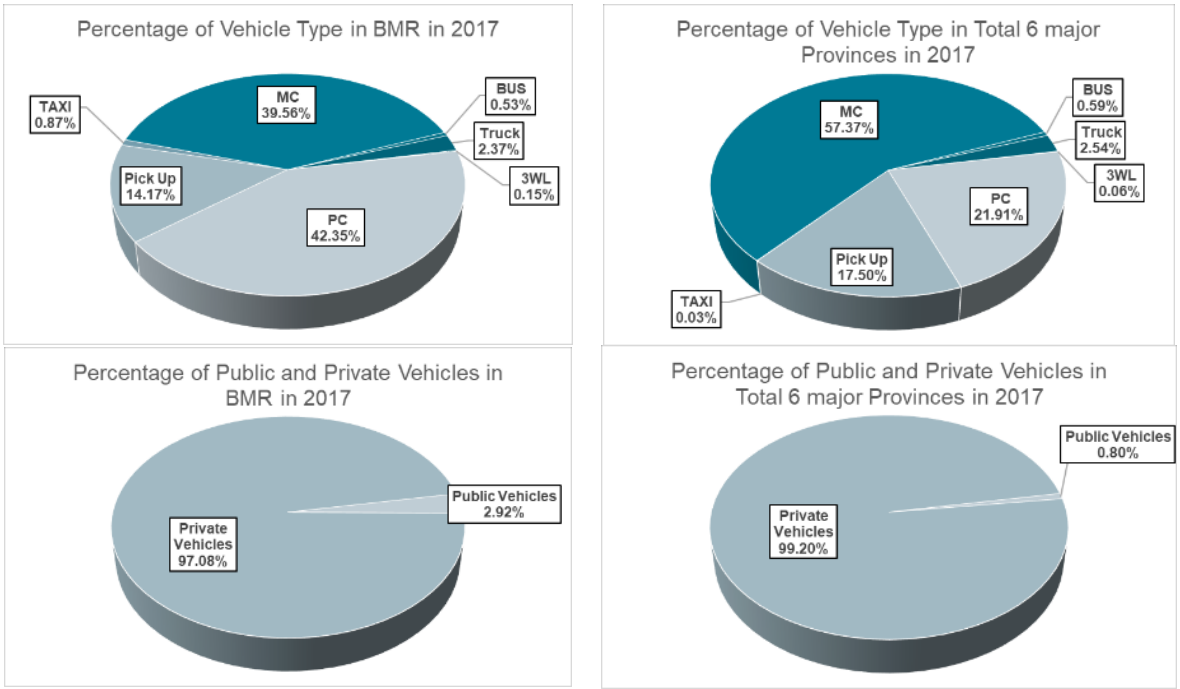
Source: Department of Land Transport

Figure 2-7 presents a disaggregation of vehicle types in BMR and six major provinces. In BMR, private cars account for the highest proportion of vehicles (42%) with motorcycles accounting for almost 40%. This contrasts with the six major provinces where motorcycles account for a much larger proportion (57%) compared to car (22%). Pick up vehicles also account for a higher share of vehicle types outside of BMR (17.5%) than within it (14%). It is also apparent that private vehicles account for the vast majority of vehicles in BMR and in provincial areas.

Vehicle types have greater implications for urban mobility planning. Firstly, the number and proportion of private cars and pickups in BMR makes it very difficult to provide adequate road space to meet demand. This undoubtedly leads to congestion, and with a growing number of private vehicles on the roads of BMR, this is likely to lead to growing congestion. Planning urban mobility systems needs to take account

of growth in these vehicles as demand management measures will be required to contain or restrict personal vehicle use alongside supply side improvements to the sustainable transport network.

The existence of a high proportion of motorcycles both in BMR and provincial areas provides comparatively low cost personal rapid transport for many people. However, experience in other motor cycle dominated cities such as Ho Chi Minh[2] suggests that once there is a high motorcycle ownership, this then leads to a growth in car ownership, which leads to congestion. Planning urban mobility in both BMR and other provincial areas must take account of motorcycle ownership levels and how this may shift towards greater car ownership in future. In addition, high levels of motorcycle use result in a high number of road fatalities, as discussed on page 27.



Source: Department of Land Transport

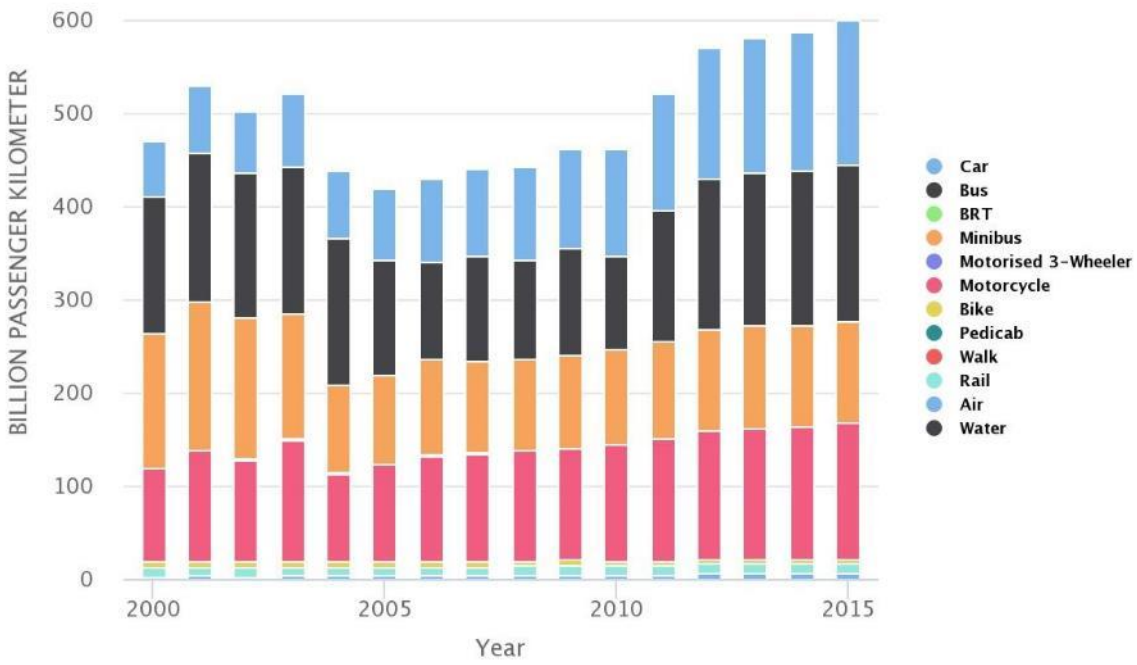
Figure 2-7 Disaggregation of vehicle types in BMR and provincial areas

2.2.4 Passenger Transport Demand

Across Thailand, in 2015, cars (26%) and motorcycles (24%) accounted for around half of all passenger-km travelled across all modes, as presented in Figure 2-8 Passenger km travelled by modeFigure 2-8. Buses accounted for the highest share of passenger-km travelled for a single mode (28%). This highlights that buses remain an important mode for a significant proportion of the population and should continue to be at the forefront of tackling congestion, poor air quality and reducing CO_2 emissions. There has been a steady increase in car-km travelled from 61billion passenger-km (2000) to 156billion passenger-km (2015). During the same period, motorcycle-km travelled have increased by 45% to 145billion passenger-km. This has coincided with greater numbers of passenger-km travelled suggesting that the population is becoming more mobile by either making more journeys or making longer distance journeys. During this same time, bus-passenger-km travelled has remained broadly stable which is counter intuitive to some of the

[2] Urban Accessibility in Motorcycle Dependent Cities – Case study in Ho Chi Minh City, Vietnam VAN, Nguyen Thi Cam; BOLTZE, Manfred; TUAN, Vu Anh ; 2013;

anecdotal findings from meetings with provincial governments which suggested that bus passenger numbers have declined over the past 15+ years.



Source: ADB Transport Data Bank

Figure 2-8 Passenger km travelled by mode

Travel demand in BMR has been forecast by the Office of Transport Policy and Planning and compared to demand in 2015 – this is illustrated in Table 2-12. It is forecast that travel demand will increase significantly up to 2021 from 19.8 million trips per day to 23.9million trips per day. Whether trip lengths, and therefore passenger-km, will vary is unclear from the evidence reviewed.

It is forecast that rail mass transit services will accommodate all of the increased demand, as well as facilitating a modal shift towards rail mass transit. Presumably this is because of the heavy investment in rail mass transit lines across BMR and the proposed re-organisation of the bus network to act as feeder services to the rail network. Whether the modal shift is from buses to rail or from private vehicles to rail is considered below.

Alongside this growth in trip demand, average vehicle speeds are forecast to reduce by around 5%. The construction of the rail mass transit lines is a possible reason for the reduction in travel speeds as it will disrupt and remove some existing road space.

Table 2-12 Travel demand in BMR

Data	2015		2021(Forecast)	
	BMR	BMA	BMR	BMA
Travel Demand (Million Trips/day)	19.8	12.02	23.9	13.92
Average Speed (Kph.)	21.20	14.91	20.25	14.74
Travel Demand of Railway Mass Transit(Million Trips/day)	0.97		7.89	

Source: Transport Model of Traffic Demand Management (TDM) Study in 2015, OTP

Looking more widely across other Thai urban areas, travel demand has also been modelled in Phitsanulok and Nakhon Ratchasima, as shown in Table 2-13. In Phitsanulok in 2017, 322,800 trips per day were recorded, while in 2022, demand forecasts suggest there will be 336,200 trips per day. In Nakhon Ratchasima, travel demand in 2017 accounted for 762,500 trips per day and is forecast to be 799,810 trips per day in 2022. This concludes that trip demand increases by 1.6% per year.[3] Forecasts for increases in travel demand in provincial areas assume a lower level of growth compared to BMR.

Table 2-13 Travel demand in Phitsanulok and Nakhon Ratchasima

Phitsanulok		**Nakhon Ratchasima**	
Year	**Travel Demand (Trips/day)**	**Year**	**Travel Demand (Trips/day)**
2017	322,800	2017	762,500
2022	336,200	2023	799,810
2026	345,000	2028	899,400
2031	356,400	2033	968,970
2036	382,500	2038	1,038,600
2041	410,500	2043	1,142,890
2046	440,500	2048	1,247,220
2051	472,800	2053	1,351,550
Annual Rate	1.1%	Annual Rate	1.6%

Source: The Study of Traffic Management and Public Transport Development Master Plan in Nakhon Ratchasima Urban Areas in 2017, OTP, The Feasibility Study and Preliminary Design of Phitsanulok Transit System in 2017, OTP

[3]The Study of Traffic Management and Public Transport Development Master Plan in Nakhon Ratchasima Urban Areas in 2017, OTP

Table 2-14 presents the modal split for the Bangkok area based on OTPs modelling. This shows that travel demand is forecast to increase by around 68% between 2015 and 2021. Demand is forecast to increase for all modes, although railway mass transit accounts for the most significant increase in demand – an increase of 713%. BMR will receive 10 elevated and expanded rail mass transit lines from 2019 onwards and this is expected to accommodate the majority of the increased travel demand across the region. Whether the modelling included travel demand management measures to encourage a shift towards rail mass transit is not clear (car and motorcycle trips are forecast to increase between 2015 and 2021), but it is important to note that the supply public transport is only part of the equation. Without demand management measures to discourage car use, achieving modal shift is likely to be limited.

Finally, it is unclear in the data source whether demand for car hailing services such as Grab or Uber are included within Taxi demand.

Table 2-14 Modal split of travel in Bangkok

Mode of Travel	2015		2021 (Forecasted)	
	Travel Demand (Million Trips/day)	Modal Split (%)	Travel Demand (Million Trips/day)	Modal Split (%)
Private Car (CAR)	4.89	38%	5.65	26%
Private Motorcycle (MC)	1.37	11%	1.48	7%
Taxi	0.58	4%	0.6	3%
Public Bus Transit (PT)	5.17	40%	6.19	28%
Railway Mass Transit*	0.97	7%	7.89	36%
Total	**12.98**	**100%**	**21.81**	**100%**

Source: Transport Model of Traffic Demand Management (TDM) Study in 2015, OTP
*Railway Mass Transit is considered travel demand in region area

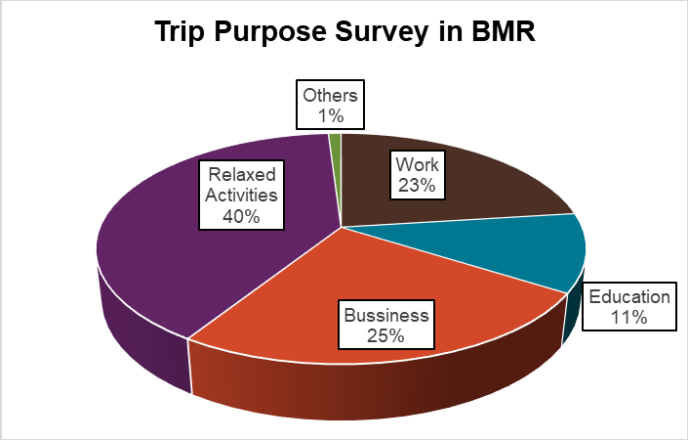
Feasibility and masterplan studies for the development of mass transit systems in Phitsanulok and Nakhon Ratchasima provide examples of modal split in provincial cities. Table 2-15 shows that if there are mass transit developments in these major urban areas, the mode share of private car (PC) and private motorcycle (MC) decrease while mode share of public transport (PT) increases when they are compared with BAU (without) case.

Table 2-15 Modal split of travel in Phitsanulok and Nakhon Ratchasima

Percentage of each mode in Phitsanulok						
Year	BAU			With Transit System Development		
	PC	MC	PT	PC	MC	PT
2017	38.2	60.3	1.5	38.2	60.3	1.5
2022	38.2	60.3	1.6	35.1	55.4	9.5
2031	38.1	60.2	1.7	33.3	52.6	14.1
2041	38.1	60.1	1.8	32.5	51.3	16.1
2051	38.0	60.1	1.9	32.2	50.8	17.1
Percentage of each mode in Nakhon Ratchasima						
Year	BAU			With Transit System Development		
	PC	MC	PT	PC	MC	PT
2017	54.2	33.9	11.9	54.2	33.9	11.9
2023	55.9	37.0	7.0	56.2	34.8	9.0
2033	57.5	35.7	6.8	55.0	33.7	11.3
2043	57.6	35.7	6.7	54.5	34.7	10.8
2053	57.7	35.8	6.5	53.6	36.2	10.2

Source: Source: The Study of Traffic Management and Public Transport Development Master Plan in Nakhon Ratchasima Urban Areas in 2017, OTP, The Feasibility Study and Preliminary Design of Phitsanulok Transit System in 2017, OTP

Within BMR, trips tend to be made for four key reasons as Figure 2-9 illustrates. Relaxed activities account for the greatest proportion (40%) while business (24%) and work (23%) account nearly half of all trips. Education trips account for just 11% of all trips. On the face of it, such a high proportion of leisure trips suggest that there are many discretionary trips taking place which can be targeted for modal shift – if that were a desired policy. However, more in-depth analysis is required to better understand these data and how it impacts upon urban mobility planning.



Source: Study on Monitoring Method to Reduce Energy Use from Transport Sector Measures in 2017, OTP

Figure 2-9 Trip purpose in BMR

With the high number of cars and motorcycles across Thailand, and particularly Bangkok, this impacts upon congestion and journey time delays. TomTom has developed a traffic index[4] measuring delays in journey times at different times of day. In Bangkok, it has evidence from its Satnav system, showing that travelling during peak periods in Bangkok requires 64 minutes of additional travel time per day compared with travelling at non-peak periods. During the morning peak (the busiest one-hour-long period in the morning in Bangkok based on real traffic measurements), travel times are typically 91% longer compared to uncongested free-flow conditions, while during the afternoon peak travel times are typically 118% longer compared to free flow conditions.

The BMR transport model requires inputs on vehicle occupancy rates across the region, and this data is presented in Table 2-16. Nearly two thirds of private cars and three-wheelers have just one person per vehicle, and over 57% of vans and pick-ups are also occupied by just one person. Private cars have a mean average occupancy of 1.51 people per vehicle, while all vehicles have an occupancy rate of less than two. This demonstrates an inefficient use of road space as all vehicles taking up a lot of space on a road are carrying, on average, less than two people.

Table 2-16 Vehicle occupancy of vehicles in Bangkok

Number of Passengers	Private Car	Private Van	Pick Up	Taxi	3 Wheel-motor Vehicle (TukTuk)	Motorcycle	Public Motorcycle
1Passenger/veh	64%	57%	57%	43%	64%	71%	53%
2Passengers/veh	25%	26%	28%	35%	24%	28%	47%
3Passengers/veh	7%	6%	8%	13%	7%	1%	1%
>4Passengers/veh	4%	11%	8%	9%	4%	0%	0%
Average(Passengers/veh)	**1.51**	**1.82**	**1.74**	**1.92**	**1.55**	**1.31**	**1.48**

Source: Transport Model of Traffic Demand Management (TDM) Study in 2015, OTP

In summary, this section provides an overview of the current situation in Thailand with regards to motorisation rates, vehicle ownership and future travel demand. It is evident that car registrations are

[4]https://www.tomtom.com/en_gb/trafficindex/city/bangkok

increasing and the motorisation rate in Bangkok in particular is high. Compared to other similar cities, Bangkok has a much higher car ownership rate than Singapore, Hong Kong and London.

It is forecast that travel demand will continue to increase in Bangkok and other provincial areas. While this increasing demand will lead to more vehicles and slower vehicle speeds on road, the vast majority of the increase in demand will be accommodated by rail mass transit services in BMR. What is not clear is whether this will lead to any sort of modal shift (it doesn't appear to), or whether rail mass transit will generate new trips from latent demand not being met at present.

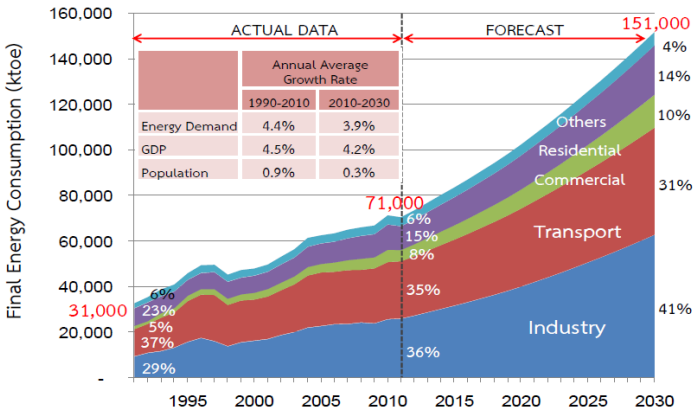
From an urban mobility perspective, Bangkok has in place a plan and a strategy to manage and accommodate travel demand in future. These measures include transit-oriented development in order to encourage higher density residential areas and discourage urban sprawl which can often result in longer trip lengths and greater pressure on the road network. However, with a continued growth in non-public transport modes, it will likely lead to greater levels of congestion and worsening journey times. There are various tools with which to encourage a more efficient use of road space and these should be considered to better manage urban mobility across the capital.

Outside of Bangkok, car ownership and motorisation rates are also increasing. This has implications on urban mobility planning as it will likely lead to worsening congestion and reduced journey speeds in other areas over time. In developing an urban mobility programme for Thailand, this needs to be considered carefully.

2.3 Transport impacts

2.3.1 Energy Consumption and Greenhouse Gas Emissions

In 1990, the transport sector accounted for the greatest proportion (37%) of energy consumption of any sector in Thailand, as illustrated in Figure 2-10. By 2011, the transport sector accounted for 35% of all energy consumed compared to industry accounting for 41%. The Ministry of Energy (MoE) estimates that the transport sector's share of energy demand will decrease to 31% by 2030 but will account for around 50,000 ktoe per year in 2030 in a no change scenario. Transport is therefore one of the most energy intense sectors, its use of energy has been growing since 1990 and without intervention, is forecast to continue growing in coming decades.



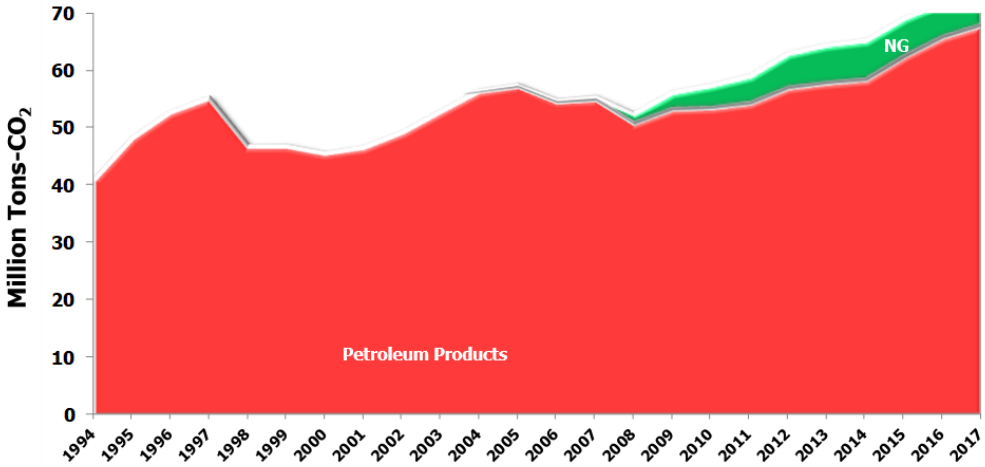
Source: http://www.eppo.go.th/images/POLICY/ENG/EEDP_Eng.pdf

Figure 2-10 Energy consumption in Thailand by sector under the 'Business as Usual' case

Transport CO_2 per capita has increased steadily since 2000, as illustrated in Figure 2-11. CO_2 emissions from the transport sector equated to 0.95 t per person in 2000, but in 2015 accounted for 1.17 t per

person, an increase of 23% in just 15 years. According to the MoE[5] GHG emissions from the transport sector totalled 61Mt CO_2eq in 2015 and 67Mt CO_2eq in 2017.

Petroleum products made up almost all of the fuel type in the transport sector up to 2000. Since 2000, natural gas has been introduced to the energy mix and in 2017 accounted for 6.5% of all fuel used in the transport sector. This helps to reduce GHG emissions compared to conventional petroleum products, while also providing air quality benefits. However, since 2014, there has been a marked reduction of CO_2 emissions from natural gas. While there are no empirical studies to substantiate this, it is noted that the price of natural gas increased from around 8.5THB per kg to 11.5THB per kg in 2014[6]. Since 2014, the price has continued to increase and in 2017 stood at over 13THB. The price increase is as a result of government choosing to reduce its subsidies towards natural gas. This could explain why natural gas use has therefore decreased during this time.



Unit: Million Tons-CO_2

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Petroleum Products	40.94	48.21	52.71	55.24	46.77	46.92	45.58	46.55	49.25	53.02	56.5	57.41
NG									0.01	0.01	0.06	0.14
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Petroleum Products	54.63	55.07	50.9	53.36	53.64	54.37	57.2	57.98	58.57	62.67	65.94	67.95
NG	0.23	0.5	1.65	3.03	3.85	4.9	5.92	6.52	6.73	6.46	5.92	4.74

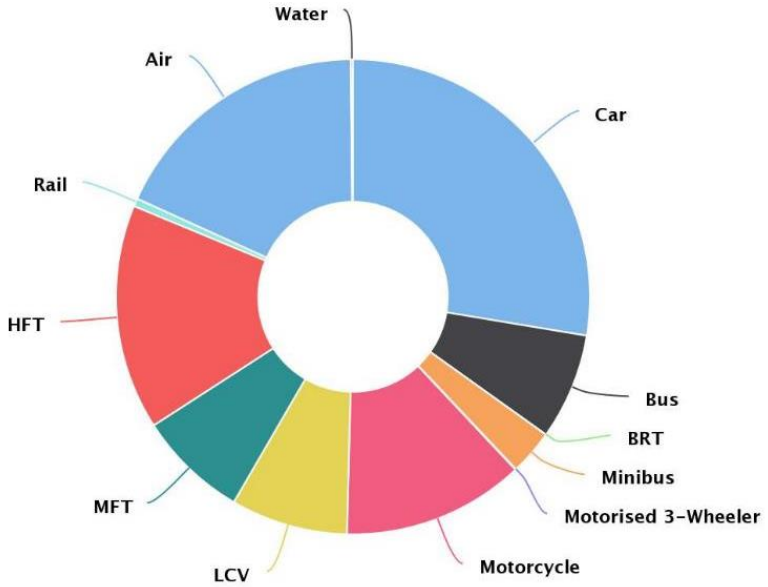
Source: Ministry of Energy

Figure 2-11 CO_2 emissions disaggregated by fuel type in the transport sector

A variety of modes account for CO_2 emissions across Thailand – as presented in Figure 2-12. Cars and motorcycles account for 40.1% of CO_2 emissions between them while freight vehicles, ranging from light commercial vans to heavy freight trucks, account for 30.8% of all CO_2 emissions. Air travel accounts for 17.1% of CO_2 emissions (although it is unclear whether this is from just domestic flights or international flights as well) while buses account for just 7.25% of emissions. Given that bus passenger miles are slightly greater than car passenger miles (see section 2.2.4), it is evident that encouraging any sort of modal shift from car to bus or other forms of public transport would have a notable positive impact on CO_2 and other GHG emissions.

[5] www.energy.go.th

[6] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26916.pdf



Source: ADB Transport Data Bank
LCV - Light Commercial Vehicle, MFT – Medium Freight Truck, HFT - Heavy Freight Truck, BRT - Bus Rapid Transport

Figure 2-12 CO_2 emissions by mode 2015

2.3.2 Air quality

There are five main constituents that contribute to air pollution, these are: sulphur dioxide (SO_2), nitrogen dioxide (NO2), carbon monoxide (CO), ozone (O_3) and particulate matter sized smaller than 10 microns (PM10) and 2.5 microns (PM2.5). These pollutants contribute to poorer air quality, which in turn can lead to a variety of health impacts on humans, including respiratory and cardio vascular diseases. PM2.5 is especially dangerous for humans and the main cause of its emission comes from combustion engine in transport sector. In Thailand, more than 50 μg/m^3 of PM2.5's intensity exceeds the acceptance criteria and negatively impacts upon human health.

Across 29 provinces, there are 61 air quality monitoring stations measuring the concentration of pollutants in the air. These show that in 2015, national air quality standards were breached in almost all areas during the course of the year. It was found that air pollution in Saraburi province can be measured as the most frequency of days that pollutant's intensity exceeds the acceptance criteria. In Saraburi, PM10 levels were breached during 105 days, PM2.5 levels were breached on 113 days and ozone breached on 36 days. However, that major cause of high air pollution in this province is not in transport sector, but in industrial sector from cement manufacturing plants.

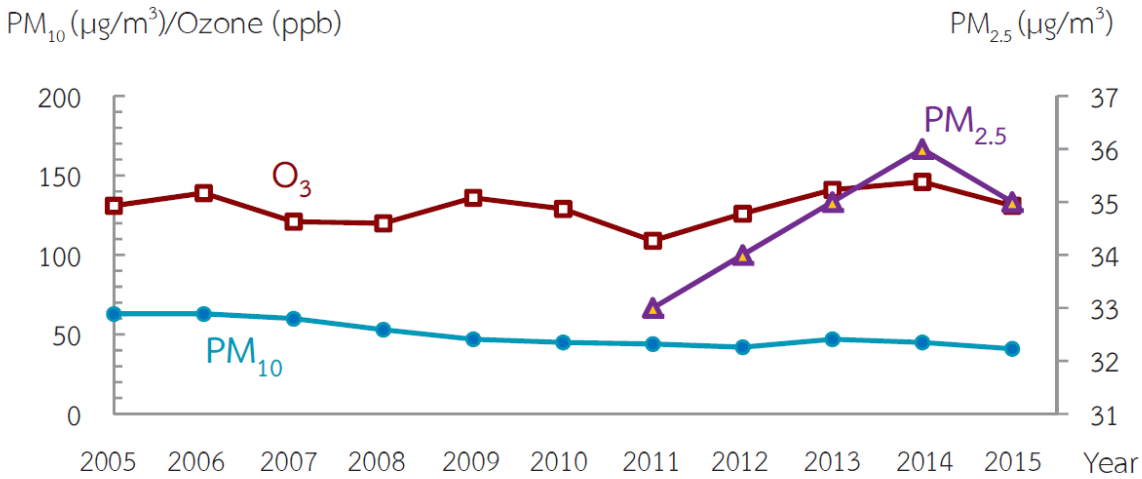
In metropolitan and major provinces like Bangkok and Chiang Mai, PM10 levels in Bangkok were breached on just 6 days, whereas PM2.5 levels were breached on 60 days, and ozone on 59 days[7]. Levels of pollutants in Chiang Mai were typically greater than in Bangkok, breaching safe levels on more days of the year, and with maximum concentrations far exceeding those in Bangkok. For example, PM2.5 concentrations in Bangkok were exceeded on 60 days, with a maximum recording of 101 ug/m^3. In Chiang Mai, these levels were exceeded 67 days of 2015, with a maximum recording of 266 ug/m^3. However,

[7]http://infofile.pcd.go.th/mgt/PollutionReport2015_en.pdf

major causes poor air quality in Chiang Mai are its topography surrounded by mountains where pollutants are not easy to vanish, and agriculture sector by burning the corn stalks in the field after harvesting in summer. Consequently, poor air quality in Bangkok is predominantly caused by the transport sector.

Considering air quality over time, Figure 2-13 presents annual average levels of PM10, PM2.5 and Ozone in Bangkok since 2005. This shows that concentrations of PM10 has reduced slightly but consistently over the ten-year period while ozone has fluctuated but remained broadly stable. PM2.5 increased significantly from 2011 to 2014 but reduced slightly in 2015. Reductions in PM10 in particular can be attributed to the increase in CNG powered vehicles across the metropolitan region.

January 2019 saw a significant increase in PM2.5 concentrations in Bangkok, of which transport was a major contributor. The Kasikorn Research Centre estimated the economic cost of this episode of high PM2.5 levels to have cost the economy THB 6.6billion (US$ 211m) due to health complaints and a reduction in the number of tourists visiting Bangkok.



Source: Thailand State of Pollution Report 2015, Pollution Control Department, Ministry of Natural Resources and Environment

Figure 2-13 Annual average levels of pollutants in Bangkok

The Pollution Control Department was established in 1992 to monitor a variety of pollution issues and develop policies to reduce pollution and its effects. There have been a variety of policies that contribute to improving air quality, these policies include:

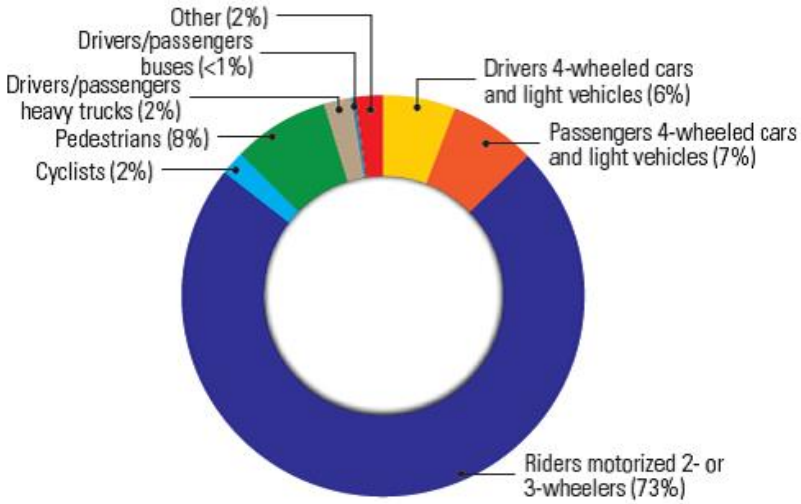
- Phasing out of leaded gasoline by 1995
- Phasing out of two-stroke motorcycle engines to four-stroke engines by 1997
- Encouragement of LPG use in taxis and other private vehicles and CNG for vans and buses, particularly in Bangkok
- Encouragement of public transport use in Bangkok through the development of mass transit systems

Overall, air quality is an issue in Thailand and while it is a problem for Bangkok, it is a greater issue in other parts of the Kingdom. There are active government policies that are attempting to improve air quality and these appear to be contributing to reducing levels of some air pollutants. However, safe levels are frequently exceeded and sometimes by several times the safe limit. It is evident that there is still more to be done across the country to improve air quality, and reducing the impact of transport on air quality appears to be a priority. This highlights the potential health benefits of encouraging sustainable travel across all urban areas in Thailand.

2.3.3 Road safety

According to the World Health Organisation (WHO), Thailand has the second highest road traffic fatality rate in the world. The WHO[8] reports the fatality rate at 36.2 deaths per 100,000 with over 24,000 deaths per year. This differs slightly from the Ministry of Public Health's record of 23.9 per 100,000 population. It is estimated that the cost of road traffic crashes to the Thai economy range between 3 and 5% of GDP, which suggests that road crashes, and particularly fatalities, are a significant issue for Thailand.

Figure 2-14 presents the proportion of road fatalities by road user category. It is evident that motorcycles account for by far the greatest proportion and a disproportionate amount of road fatalities. In most countries, road fatalities tend to be focussed on vulnerable road users such as pedestrians and cyclists and, in part, motorcyclists. But the overwhelming incidence of fatalities amongst motorcyclists highlights significant issues with that particular mode.



Source: World Health Organisation Global Status Report on Road Safety 2015

Figure 2-14 Road fatalities by road user type

Thailand has a variety of policies in place to reduce the severity of road crashes, these include:

- National speed limits
- Drink driving laws
- Motorcycle helmet wearing laws
- Seatbelt laws
- Driving while using a mobile phone law
- Drug driving laws

Despite these laws being in place, there are still low levels of law adherence. 26% of road crash fatalities involve alcohol, while the helmet wearing rate for motorcyclists is 52% for drivers and 20% for passengers. This is likely to contribute to the high fatality rate for motorcyclists illustrated above.

[8] http://www.searo.who.int/thailand/areas/roadsafety/en/

3 National and Urban Mobility Planning

3.1 Urban mobility plans – from past to present

There have been a variety of urban transport plans developed over a number of decades, mostly initiated by the central government. The early transport plans focussed solely on Bangkok and its surrounding areas due to its dominance as Thailand's primate city. It is only in more recent years that sustainable urban transport plans have been developed for cities other than Bangkok.

The first formal urban transport plan was the 1960 Bangkok land use plan, otherwise known as the Litchfield Plan, named after one of the American consultants who led the development of the plan. Shortly after this in 1962, the first National Economic and Social Development Plan (NESDP) was developed. The first NESDP considered some transport issues, but focussed on highway construction and improving rail infrastructure on the Kaeng Khoi – Buayai rail corridor. There appeared to be a lack of focus on urban transport issues within the first NESDP.

According to Jittrapirom et al. (2017) the Litchfield Plan was largely unsuccessful due to the ambiguity of laws relating to town planning at the time, as well as the fact that Bangkok expanded at a faster rate and in different ways to previously forecast. Despite attempts to make changes to the Litchfield Plan it was never delivered; so in the 1970's, the government sought the advice of German consultants to develop a transport plan for Bangkok.

The Bangkok Area Transportation Study (BATS) was the result of this support and it recommended developing expressways, mass transit lines and a road changing system. It also recommended that "Bangkok should be developed towards becoming a public transportation society". However, this ambition was not fully realised.

Due to the growing popularity of private motorised transport and the declining commercial viability of operating bus systems, the initial recommendations of providing bus priority infrastructure was modified to provide for the private car. For example, overpasses across 2-3 intersections along Petchaburi Road were modified and allowed for private cars to use as well as buses and later some buses were restricted from using some overpasses because of shorter distance for lane change from the bus stop to the flyover approach. From that point on, the use of private vehicles appears to have enjoyed greater priority over buses and other forms of public transport.

During the 1970s and 1980s, bus services across Thailand were typically loss making. The public transport focus of plans following BATS examined ways in which the commercial viability of bus services could be improved. However, these plans tended to focus on reducing operating losses – often through cutting services - as opposed to increasing operating revenues. This led to a deterioration in public transport provision.

The second NESDP (1967-71) identified the importance of investing in transport to aid the social and economic development of the country: "Transport and communications will continue as the largest sector of the Development Plan because of its success in stimulating private economic growth and its favourable impact on the social cohesiveness and security of the people". However, the plan then focussed primarily on the development of the highway network in order to have 11,300km of highway constructed by 1971 across Thailand.

The third NESDP (1972-76) followed a similar path, focussing on local and national highways in addition to enhancing existing rail services. Improved port facilities were also being invested in, as well as recognition that growth in air travel was placing pressure on the country's main airport – Don Muang.

The fourth NESDP for the period 1977-1981 recognised that the centralisation of goods and services in Bangkok had led to mass inward migration. The NESDP therefore had a clear policy to encourage urban growth outside of Bangkok Metropolitan Area to stem the flow of migrants and slow down the urban growth of the capital. It also suggested that the existing environment within Bangkok should be improved – a recognition of the mobility issues that were evident at that time. These improvements included the development of favourable conditions to establish a mass transit system as well as the encouragement of private investment in parking facilities.

Subsequent NESDPs have developed new goals and targets to tackle traffic congestion, but these initiatives continued to focus on providing highway infrastructure and while enhancing public transport was mentioned, it was not given the same level of priority.

Outside of the NESDP framework, urban transport planning has tended to focus on area-specific plans, of which Bangkok has been the recipient of the greatest number of plans. In 1984, the Bangkok Municipality Administration (BMA) proposed to construct the first mass transit system in Bangkok. This received some support from the central government through a commitment to provide a parcel of land for a depot. The system was initially planned during the study of the sixth NESDP (1987-91), but implementation of part of the plan did not occur for another 10-12 years. The system was known initially as the Skytrain and later BTS. Initially, the Skytrain system operated at a financial loss because of a lack of integration with bus services. Later the system gained greater levels of patronage once the travelling public recognised that journey times were more efficient compared to travel on-street.

Once the first mass transit line was in place, there soon became plans for developing the mass transit line into a network of services. The Mass Rapid Transit Systems Master Plan (MTMP) was approved in 1994 and involved extending the three existing mass transit lines between 1995 and 2011. This would have provided a network of 103 km of elevated rail. However, this plan was cancelled following the 1997 financial crisis.

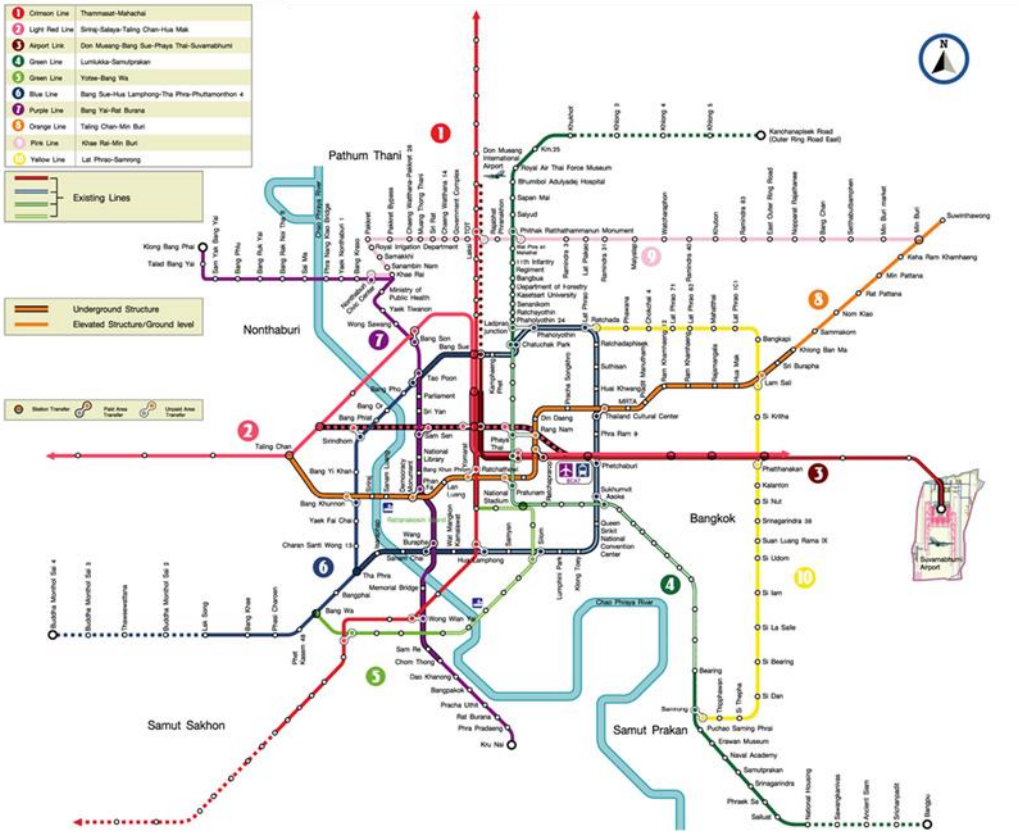
In place of MTMP, a second masterplan was developed: The Urban Rail Transportation Master Plan in Bangkok and Surrounding Areas (URMAP). This was a three-stage plan to implement 141.9 km of mass transit between 2001 and 2011, a further 158 km between 2012 and 2021 and finally 75 km from 2022 onwards. Unfortunately, the implementation of URMAP was slow, and so a third plan was developed – the BMT.

The Bangkok Mass Transit Master Plan (BMT) was a 19-year plan to be implemented from 2010 to 2029 involving 475 km of new rail mass transit, mostly as extensions to already developed and planned lines. These extensions were:

- Light Green Line: North-South extension of the BTS to KhuKhot and Samut Prakan
- Dark Green Line: West extension of the BTS to Yot Se
- Blue Line: Extension of the MRT Blue Line to complete a quasi circle line with a branch to Lak Song
- Purple Line: South extension to Rat Burana is under study
- Orange Line: Running east–west Min Buri to Bang Khun Non
- Dark Red Line: Running north–southwest from Rangsit to Bang Sue to Maha Chai

- Light Red Line: running east-west from Hua Mak to Sala Ya
- Airport Rail Link: North extension to Don Mueang

A fourth plan was developed by OTP and is the 20-year Mass Rapid Transit Master Plan for Bangkok Metropolitan (M-MAP) from 2010 to 2029, presented in **Fehler! Verweisquelle konnte nicht gefunden werden.** below. M-MAP consists of eight corridors which include two commuter rail lines, one airport rail link and five rapid transit lines which are a mixture of elevated, underground and at-grade rail.



Source: https://www.asia-city.com/newsletters/bk/images/map-eng.1.jpg

Figure 3-1 M-Map 2010-2029

M-MAP, while in the process of being implemented, has been developed further into a second masterplan: M-MAP2. This is a joint plan developed by OTP and JICA in 2018 and seeks to build upon the first M-MAP. This considers how at-grade rail lines can be developed as well as the potential for bus service enhancements.

In summary, there have been various masterplans developed for Bangkok's mass transit network. All the plans focus on rail mass transit except for M-MAP2 which seeks to examine non-rail modes, particularly buses. These plans are continually being developed today as evidenced by the work between OTP and JICA in developing M-MAP2. The NUMP can support both phases of M-Map by making recommendations on the suitable institutional management and investment plans or measures for mass transit development.

While most urban transport studies focussed on Bangkok, since the 1990's, plans have been developed for other urban areas. In 1994 Thailand's second city was the subject of the Chiang Mai Transport Master Plan. This plan was revised in 2007, and this had four key objectives:

- To reveal the past, present, and future trends of the city's transport system
- To ensure integrated, convenient, fast, and safe mobility
- To provide a transport management plan that accorded with the city's vision
- To provide a plan and program with sufficient details to support a budget proposal

This masterplan then developed 41 short, medium and long-term projects that if implemented, would contribute towards meeting the objectives as set out above. These projects ranged from the improvement and construction of new roads to sustainable measures including enhancing walking and cycling infrastructure and encouraging car sharing. In all, 24% of the allocated budget is for walking and cycling projects.

Alongside the Chiang Mai Transport Masterplan, the Chiang Mai Light Rail project has been developed by MRTA and OTP. Three LRT routes have been identified, providing 35 km of mixed underground and at-grade track. This plan received approval for final plans and is due to commence construction in 2018-19, with a budget of THB 28.9billion. The funding for this project will be provided from central government funds.

Other masterplan studies have been carried out for urban areas across Thailand. Si Sa Ket to the north east of the country was the subject of a masterplan in 2006 that sought to overcome the issues of low quality public transport services (leading to high use of private modes) and non-motorised infrastructure, high incidence of road traffic injuries, inappropriate traffic management and congestion.

The Si Sa Ket Masterplan proposed 41 separate projects, of which road development projects accounted for the largest individual cost. Only 1% of projects were allocated for non-motorised modes, despite the study that fed into the masterplan identifying non-motorised infrastructure as contributing to the various issues faced by local residents.

As well as urban area masterplans, there are currently plans to investigate investment in mass transit infrastructure across various urban areas. MRTA and OTP carried out a feasibility study for an LRT corridor in Phuket, linking Tha Nun in Phang Nga Province to Phuket airport and from the airport to Phuket City. The corridor would have 23 stops and is budgeted to cost THB 24billion.

In addition to LRT studies in Chiang Mai and Phuket, environmental impact assessments for an LRT line in KhonKaen were completed in 2018. A 22.6 km line has been identified along with 18 stops and is estimated to cost THB 15billion. It has also been reported that OTP are investigating mass transit studies in Nakhon Ratchasima, Phitsanulok and Udon Thani. Details of these studies are not available at the time of writing.

3.1.1 Other transport plans and policies

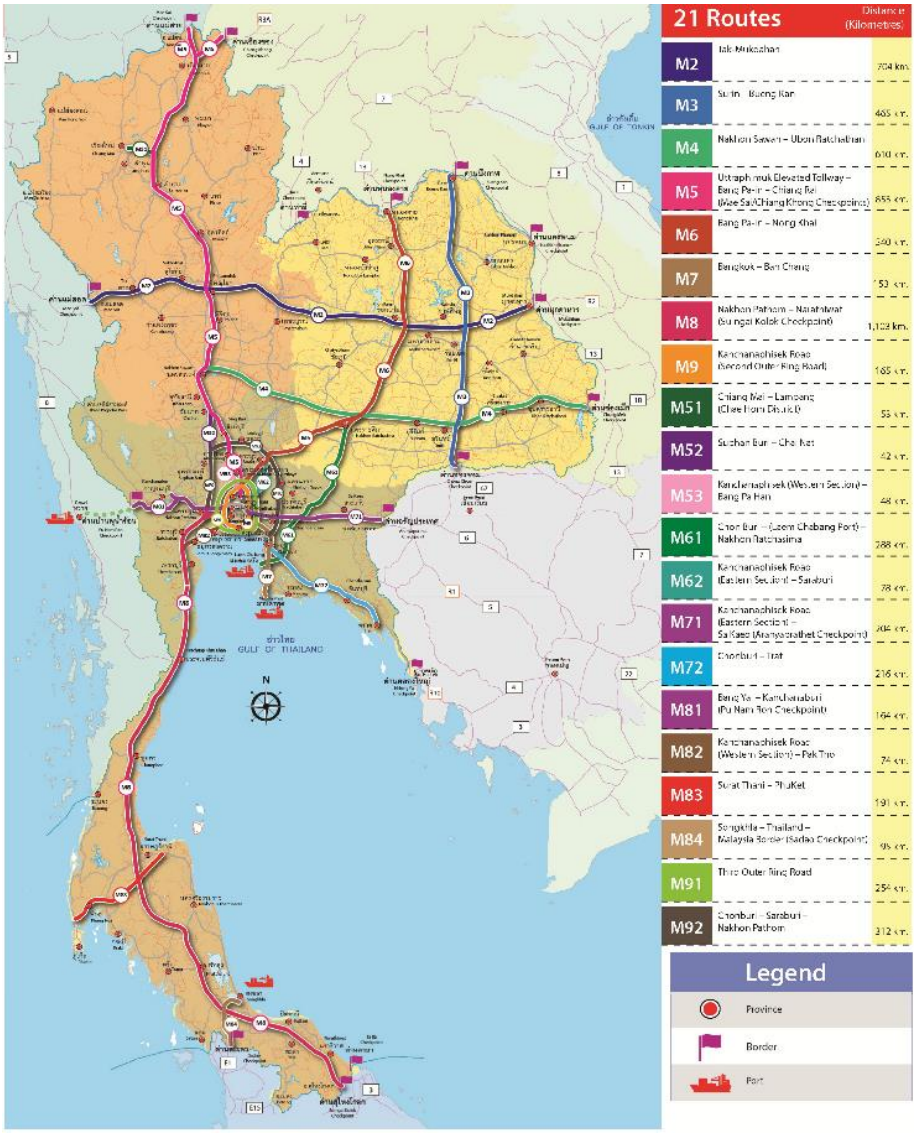
The Ministry of Transport has numerous plans to develop transport infrastructure across a variety of modes over coming years. The Transport Infrastructure Development Master Plan (2015 – 2022) aims to reduce transport and logistics costs to improve the competitiveness of the Thai economy. There are five key strands to this masterplan, and each one will be considered in turn:

- Highway network development to link with key areas in the country and with neighbouring countries
- Develop inter-city rail network
- Public transportation network development plan for Bangkok Metropolitan Region

- Air transport capacity enhancement
- Maritime transport development

The development of the highway network focusses on the Motorway Masterplan 2036 – as presented in Figure 3-2. This is part of a plan to develop the motorway network across Thailand to serve all regions, as well as neighbouring countries. When developed by 2036, the network will consist of 3,118 km of motorway across 21 different corridors.

The motorway network has been planned to link key urban areas with each other, provide key north-south and east-west links with a focus on motorways serving Bangkok. The network connects with corresponding motorways in Myanmar, Laos, Cambodia and Malaysia, while it also links strategic sea ports in the Gulf of Thailand to Bangkok.



Source: Department of Highways

Figure 3-2 Motorway masterplan 2017-2036

There are two strategic plans for the inter-city rail network. The first plan focuses on enhancing existing single track rail lines to double track. Six corridors and 767 km of track were identified as being urgent

with the doubling of existing track and are due for completion by 2020. A further eight corridors and 1,025 km of track has been identified for double track improvements and will be completed by 2026, while a third stage of 1,247 km of double track will be complete by 2030. These rail enhancements are shown in Figure 3-3.

Phase	Length (km.)	Completion (Year)
I	767	2020
II	1,025	2026
III	1,247	2030
New lines	678	N/A

Source: Office of Transport and Traffic Planning and Policy (OTP)

Figure 3-3 Development of double track and railway expansion

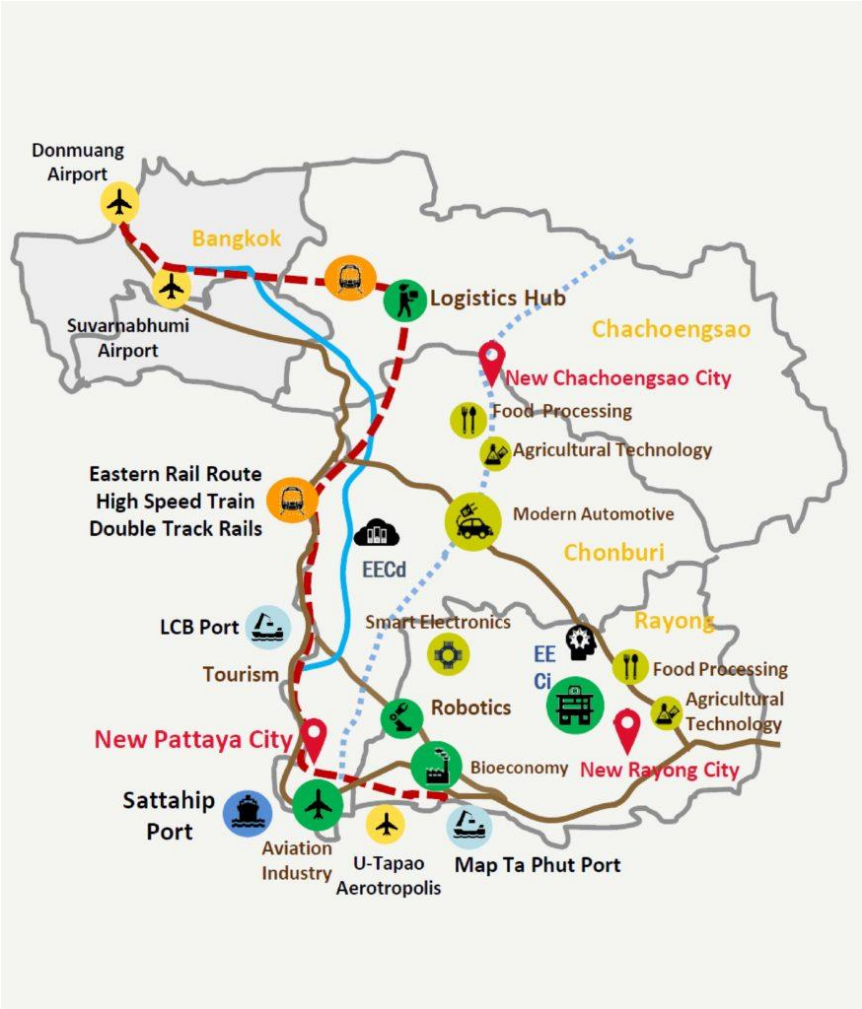
The second strategic plan for developing rail services in the Kingdom is the development of high-speed railway (HSR) network which is expected to be completed in 2036. There are three phases of development consisted of Phase I from 2017-2021 (Eastern HSR to U-Tapao Airport, North-eastern HSR to Nakhon Ratchasima, Southern HSR to Hua Hin), Phase II from 2021-2026 (Northern HSR to Phitsanulok, North-eastern HSR extension to NongKhai), and Phase III from 2027-2036 (Northern HSR extension to Chiang Mai, Southern HSR extension to Surat Thani, Southern HSR extension to Padang Besar, Eastern HSR extension to Trat).

Eastern Economic Corridor

There are plans to develop an Eastern Economic Corridor (EEC) in three provinces to the east of the Kingdom - Chachoengsao, Chonburi, and Rayong, as presented in Figure 3-4. The aim of this is to promote and support trade and investment in the area. The EEC will look to develop its transport infrastructure in two ways:

1) Linking the EEC to regional airways through the development of the Eastern Aviation Specialized Zone and the Eastern Airport City, which serves to raise Thailand to an unprecedented level as a central hub for aviation and air logistics industries. Upon completion, this will provide passengers with connections to major airports (Don Muang, Suvarnabhumi and U-Tapao international airports) via high-speed trains allowing for travel times between the EEC and Bangkok of less than 1 hour.

2) Linking transportation of Thai goods with other regions through the development of dual-track railways between China, Lao P.D.R., Thailand, and Cambodia, which is made possible through the implementation of automated transport and seamless operation systems housed at the new distribution centre located in Chachoengsao. It is from this point that goods can be seamlessly connected to Laem Chabang Port Phase III, or the Maptaput Industrial Port Phase III, with additional services aiming at placing the EEC in the spotlight as the global leader of tourism by developing a cruise port at the Sattahip Commercial Port.[9]



Source: Industrial Estate Authority of Thailand

Figure 3-4 Development of Eastern Economic Corridor

Air Transport Capacity Enhancement

There are plans to enhance airport capacity to accommodate greater numbers of people travelling to, from and within Thailand. Suvarnabhumi International Airport Bangkok is currently being expanded as part of a three-phase process. Phase I is complete, while Phase II consists of a secondary concourse and a new passenger terminal to the east side. The result of this development is that the airport will be able to

[9]https://www.eeco.or.th/en/content/infrastructure-overview

accommodate 60million passengers per year, compared to a design capacity of 45million at present. Phase II should be complete by 2019.

Phase III consists of a new south passenger terminal and two new runways. As a result, Phase II and Phase III, the airport should accommodate 90 million passengers per year. All expansion plans are expected to be completed by 2021 with the budget 64,000 million baht. In addition, there are also the expansion plans of Don Mueang, and U-Tapao international airport.

Maritime transport development

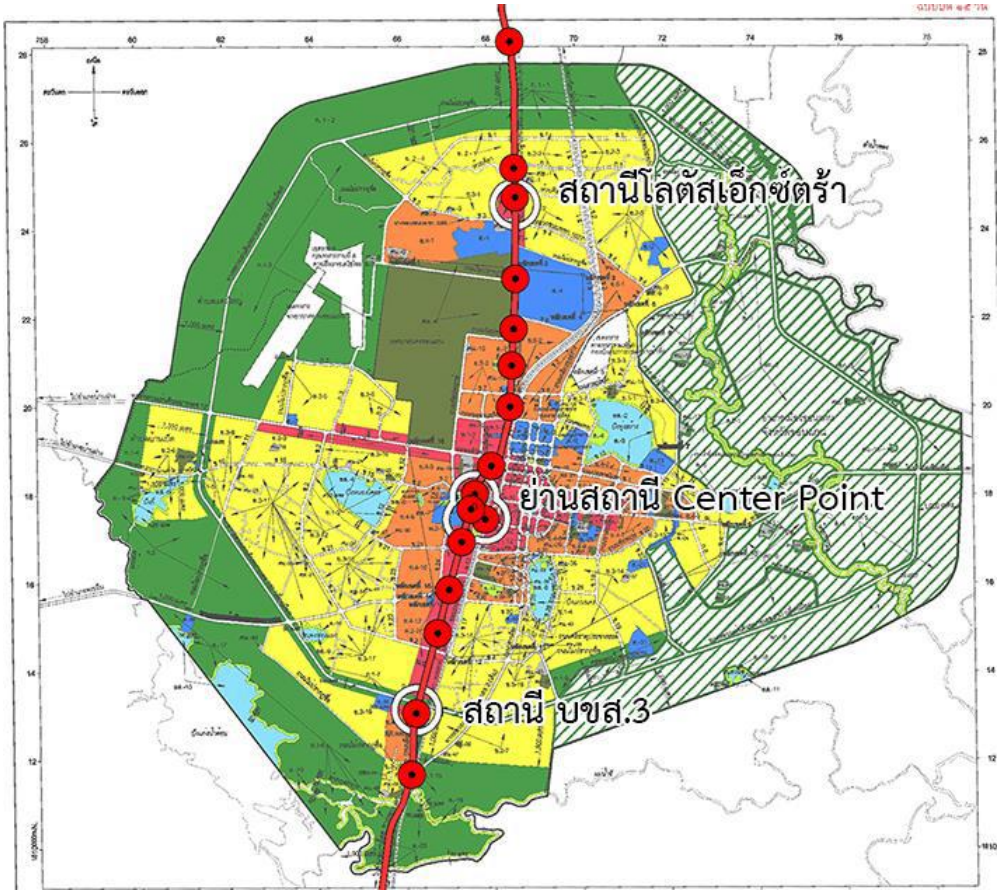
The most strategically important maritime transport development is Laem Chabang Port Phase III. This expansion will see the creation of a deep seaport and many other facilities including the implementation of a single rail transfer operator (SRTO), the construction of a larger Port A, and the renovation of many facilities to alleviate internal traffic problems. The renovations and expansions of the Laem Chabang port will provide better links to the transport network and allow the port to accommodate an increased volume of vessels. As a result, Phase III development can increase container throughput from 7.7 million containers per year to 18.1 million containers per year. The project has a budget of 155.834 billion baht and is expected to complete by 2025.

Other Developments and Plans

There are other transport developments and plans studied by OTP. These include a TOD study in Khon Kaen, a Traffic Demand Management (TDM) plan, and an Intelligent Transportation System (ITS) Master Plan for the whole of Thailand as well as BMR.

The feasibility study of a public transit corridor in Khon Kaen was completed in 2018 – an illustration of the planned public transport corridor is presented in Figure 3-5Figure 3-6. The project is now in a position where construction can start once funding is in place. The accompanying TOD study aims to support the new urban transit line (the Red Line) through developing land use plans around 16 stations. The process for developing a land use plan around each station involved the documentation and mapping of existing land use, building use, undeveloped land, and the street and pedestrian network within a 500 m radius of each station.

Following the documentation of the current situation, the development potential of the area surrounding each station is considered for its readiness, suitability, and optimal land use e.g. community, commercial, residential, health or educational use.



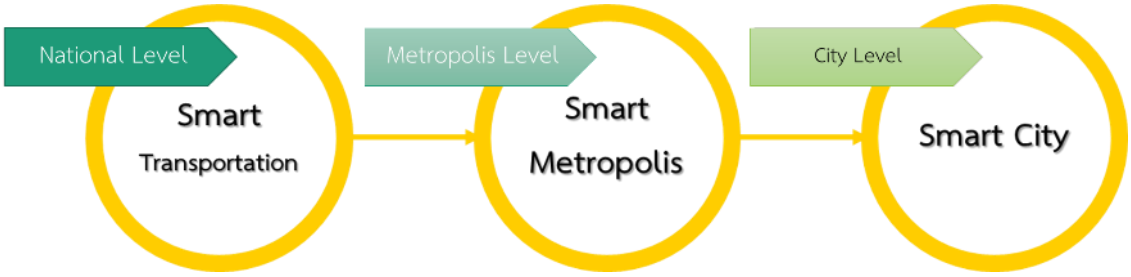
Source: Khon Kaen TOD Study, OTP

Figure 3-5 Proposed public transport corridor in Khon Kaen

The TDM plan proposes numerous infrastructural, financial, operational and organization measures:

- Infrastructural measures include ticketing management, public transport interchange development, park-and-ride development, road space reallocation, sky walk development, non-motorized transport support.
- Financial measures include public transport system support funds, road pricing, parking management, and vehicle tax changes.
- Operational and organization measures include travel plan support, aggressive driver elimination, flexible working support, information technology provision, car sharing and HOV lane support, bus efficiency enhancement, auto restricted zone provision, public campaign for using more public transport and traveling in off-peak periods, and more strict traffic regulation support.

The conceptual framework for ITS development seeks to turn BMR into a smart metropolis as shown in Figure 3-6 below. This involves using ITS to improve the performance of existing systems, as well as improving the user experience of using public transport.



Source: ITS Master Plan Report 2018, OTP

Figure 3-6 Concept of ITS development for Smart Metropolis Region

Encompassing many of the individual projects noted in this section, the Government developed a masterplan. The Transport Infrastructure Development Masterplan 2015-2022 has five key programmes – road, rail, mass transit, airports and seaports – which should enhance and upgrade all existing infrastructure to reduce the cost of logistics and transport across Thailand and make the country more competitive.

3.2 Transport governance

3.2.1 Institutions

The national institutions that govern transport matters across the Kingdom are presented in Figure 3-7. The three ministries that have direct responsibility are the Ministry of Transport (MoT), Ministry of Interior (MoI) and the Royal Thai Police.

There are other institutions that do have a responsibility relating to transport, but these tend to be for very specific reasons. Organisations such as the Eastern Economics Corridor (EEC) Committee or a Committee on Special Economic Development Zones (CSEZ) along the national borders are two examples. These special organizations/committees are either chaired by the prime minister or special committee are set up under the cabinet ordered with full cabinet support. Therefore, they have the authority to propose transport plans and strategies for the special development areas to stimulate economic growth in the area.

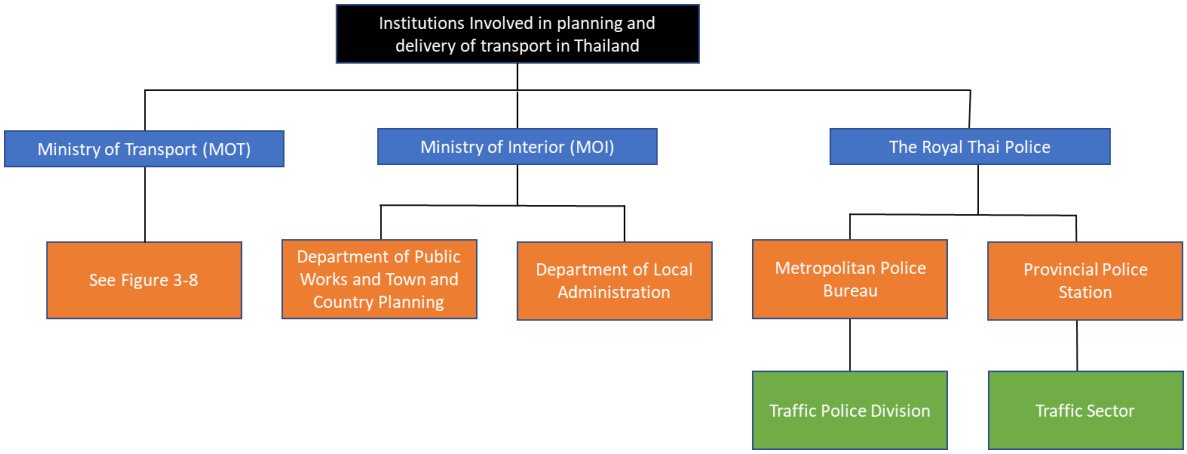


Figure 3-7 Key institutions involving transport in Thailand

The Ministry of Transport (MoT) is the main organization with direct responsibility to provide both infrastructure and services to accommodate mobility in both urban and rural areas across Thailand. Figure 3-8 presents the key departments within the MoT, with each department focusing on a specific area of

responsibility. For example, the Department of Highways is responsible for the planning, design, construction and maintenance of major highways and the motorway network, while the Department of Rural Road (DRR) is responsible for the same tasks but for minor highways and distributor roads. Local authorities such as municipalities, provincial administration organization are responsible for road network plan, construction and maintenance in urban and rural areas.

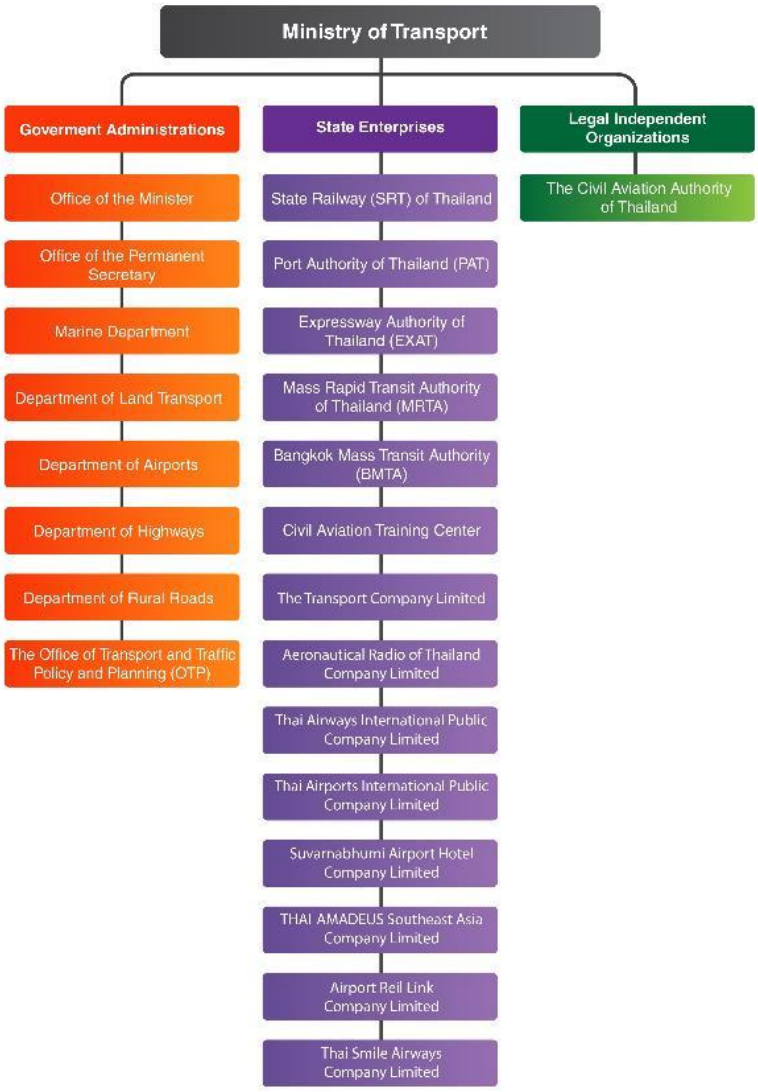


Figure 3-8 Organisation chart Ministry of Transport

Office of Transport and Traffic Policy and Planning

Within the MoT, the Office of Transport and Traffic Policy and Planning (OTP)is coordinating transport policies and plans as well as coordinating the management of public transport operations. It is OTPs responsibility to prepare transport plans that complement one another and are consistent with broader government policy. However, there is no law or regulation for departments within the MoT or local municipalities or provincial governments to rely on the planning and recommendations of OTP, unless directed to by the Cabinet.

There are nine divisions/bureaus within OTP. The bureau with responsibility for planning and overseeing urban mobility is the Bureau of Regional Transport & Traffic System Promotion. This bureau carries out

master plans urban areas across Thailand, carrying out a thorough analysis of existing datasets, modelling different options in order to improve the existing situation before developing a comprehensive transport plan with short-, medium-, and long-term measures that accord with other strategies and policies.

When OTP develops urban masterplans, it provides a set of recommendations for municipalities and delivery/operational agencies such as BMA (in Bangkok) or provincial DLT, to follow in order to deliver the masterplan. It is evident that OTP seeks to engage local consultants or academics when developing masterplans. For example, a 2016 masterplan developed for Phitsanulok (see Page 47 in lower Northern Thailand engaged Naresuan University to undertake the technical work. The involvement of local municipalities within the urban transport planning process is limited however, due to the centralised nature of the process. This creates a situation where municipal governments are expected to deliver plans prepared by a central agency without much little ownership over them. This is a potential factor that discourages implementation of those plans that are developed.

The same is true of the spatial planning process across Thailand which is delivered by the Department of Public Works and Town and Country Planning. There have been attempts to decentralise the planning process to local government levels, but due to a lack of capacity at the local level, it was determined that the function is best placed at the higher governmental level.

When developing masterplans for urban areas, traffic planning and the operational movement of highways requires engagement with the Royal Thai Police. It is necessary to obtain consent for any changes from either metropolitan/traffic police or provincial police, depending upon implementation location respectively. By law, metropolitan or provincial police including traffic and highway patrol police have full control and management of traffic in the field. Therefore, police approval is essential.

Department of Land Transport

The Department of Land Transport (DLT) is responsible for six key areas of transport delivery:

- To perform duties under land transport law, motor vehicle law, and other relevant laws
- To bring down the rate of accident and improve rail and road safety
- To promote and develop land transport networks
- To systematize land transport
- To establish cooperation with other relevant national and international agencies and organizations with regard to the land transport and international conventions and agreements
- To perform other duties as stipulated by law or delegated by the Minister of the Cabinet

The Land Transport Control Board is the regulatory body identified within the Land Transport Act that is responsible for planning and defining fixed route urban public transport services across Thailand. It defines the contractual basis within which bus services are provided, including the setting of fares (using a cost-plus formula – see Section 3.4), determining route alignments, peak vehicle requirement, bus stopping locations as well as other service requirements. It is unclear whether the urban transport masterplans contribute to the definition of service levels required by each operating licence.

While the DLT is supposed to be responsible for the planning <u>and</u> implementation of public transport services, the Department typically authorizes service providers (either private or government enterprises) to carry out some of these tasks. For example, BMTA (Bangkok Mass Transit Authority) provides bus services within the Bangkok Metropolitan Region, while the TC (the Transport Company) plans and provides intercity bus services.

For other urban areas, the DLT has provincial arms which help to deliver transport projects at a local level. The provincial DLT works closely with the local governments and the private sector to plan and provide public transport services, which usually consist of fixed route bus services or pick-up /modified medium truck for carrying passengers. The process for delivering public transport projects at a local level involves the provincial DLT office submitting the proposed bus route plan(s) and other operational requirements such as number of vehicles required, stopping locations, vehicle specification etc, to the Provincial Land Transport Control Board for approval. These plans can be for individual routes or for routes across an area. Subject to approval, DLT would provide permits to allow private bus operators to provide and operate these services. Each route must be operated by a single private service provider. However, the service provider may set up a cooperative and invite vehicle owners to be members (of the cooperative) and provide the services together. An example of public transport services provided in the Phuket area is discussed later in this chapter.

For the movement of goods, DLT regulates both private and public truck operators. Regulations mostly relate to ownership and operational safety. Although, DLT does provide permits for the private sector to carry out vehicle inspections and emission tests.

State-Owned Enterprises

Within the Ministry of Transport, there are numerous state-owned enterprises that play a key role in the delivery of transport services, as illustrated in Figure 3-8. In terms of urban transport, there are two key state-owned enterprises: Bangkok Mass Transit Authority (BMTA) and Mass Rapid Transit Authority (MRTA).

BMTA is the main operator of bus services in Bangkok. As of October 2017, BMTA operated 2,554 buses, of which 1,543 are standard buses and 1,011 are air-conditioned buses. BMTA sub-contracts the operation of some bus services to private operators, which (as of October 2017) operated 11,433 large and small vehicles. At the time of writing, BMTA is responsible for managing the private bus operators, but this responsibility is being transferred to the DLT, so that BMTA's sole focus is operating bus services.

The second state-owned enterprise is MRTA – Mass Rapid Transit Authority of Thailand. MRTA is responsible for providing mass transit systems, which currently exist in Bangkok only, but are being planned for other urban areas. MRTA is supposed to be an operational agency only with OTP responsible for planning. In practice however, OTP and MRTA work together to plan mass transit.

MRTA's primary purpose is to develop and integrate mass rapid transit systems in order to improve quality of life and enhance urban development across Thailand. In doing so, it aims to ensure that mass transit meets the needs or urban residents, uses technology and innovation to enhance urban mobility and improve quality of life through environmental and economic improvements.

Source: PSK Consultants

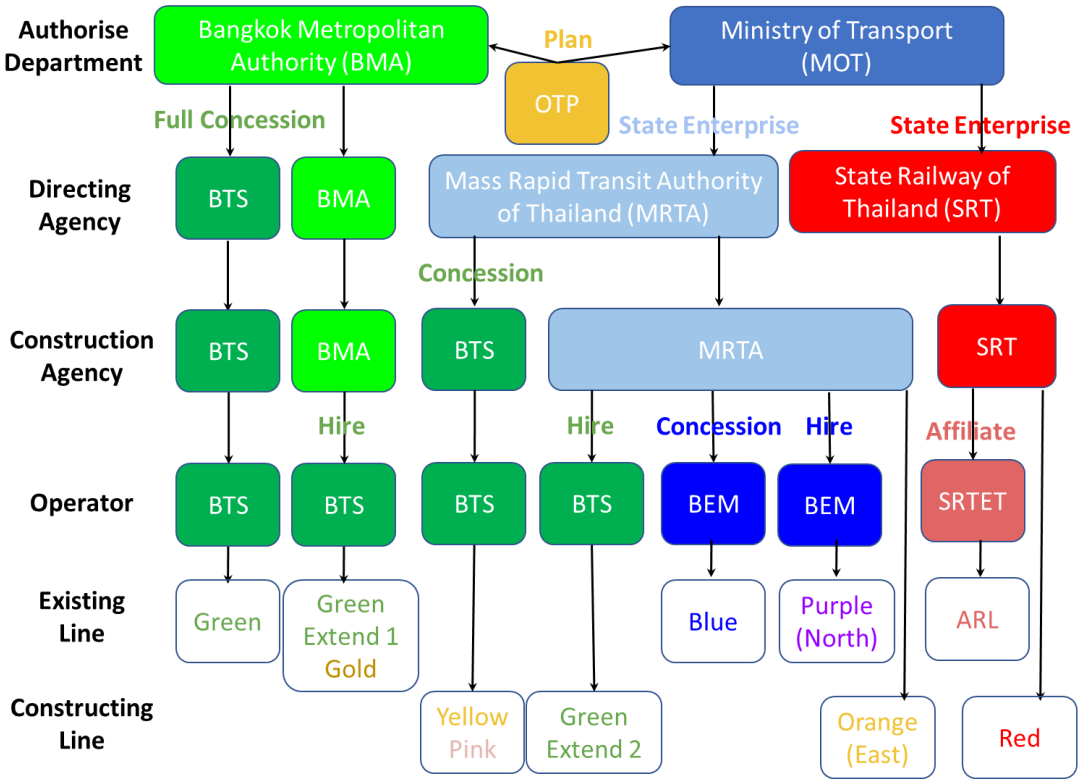
Figure 3-9 below presents the agencies involved in the construction and operation of existing and future mass transit lines in Bangkok. This shows two different approaches to delivering mass transit lines, the first where the Bangkok Metropolitan Authority was the authorising authority, the second with the MoT authorising and overseeing the delivery of lines through MRTA and the State Railway of Thailand.

The first metro line developed in Bangkok was the BTS Green Line in 1999. This was authorised by BMA, supposedly due to the Bangkok Governor's frustration with the government's lack of ability to develop a

mass transit system[10]. The system was designed and constructed without financial support from central government and was awarded a 30-year operating concession until 2029. In 2011, the Green Line was extended by 5.25 km and 5 stations, and this was funded by BMA with BTS awarded the operating contract. This highlights the difference between the 'full concession' and 'hire' agreement in Figure 3-9.

The second line to be implemented in Bangkok was the Blue Line in 2004. This was a project led by central government with MRTA being the directing and constructing agency. MRTA awarded a concession to BEM (formerly BMCL and BECL, Bangkok Expressway Public Company Limited) for operating and maintaining the line, as well as providing rolling stock and electrical systems.

There are numerous pros and cons of different contractual approaches will be considered in greater detail within the SWOT analysis.



Source: PSK Consultants

Figure 3-9 Agencies involved in the construction and operation of metro lines in Bangkok

Figure 3-10 presents the planning, delivery and financing process for delivering mass transit systems in Thailand. This is representative of the process now in place for new lines in Bangkok and systems being planned and developed in areas such as Chiang Mai and Phuket.

OTP continues to perform the main planning role in conjunction with MRTA, although OTP often uses consultants to do much of the technical work. Once approved, MRTA is then tasked with delivering mass transit. The construction of systems is funded through the 'Investment Budget' which are loans taken out

[10] https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/centre-for-transport-studies/rtsc/world-bank/OperatorsStory_Bangkok-BMCL_Final-060717.pdf

by MRTA, while ongoing costs are funded through farebox and other non-farebox revenues. These accounted for THB 145.52m in 2014 and were derived from parking charges and park and ride sites, kiosk renting, revenue from utilising land in and around MRT stations and developing land around MRT stations.

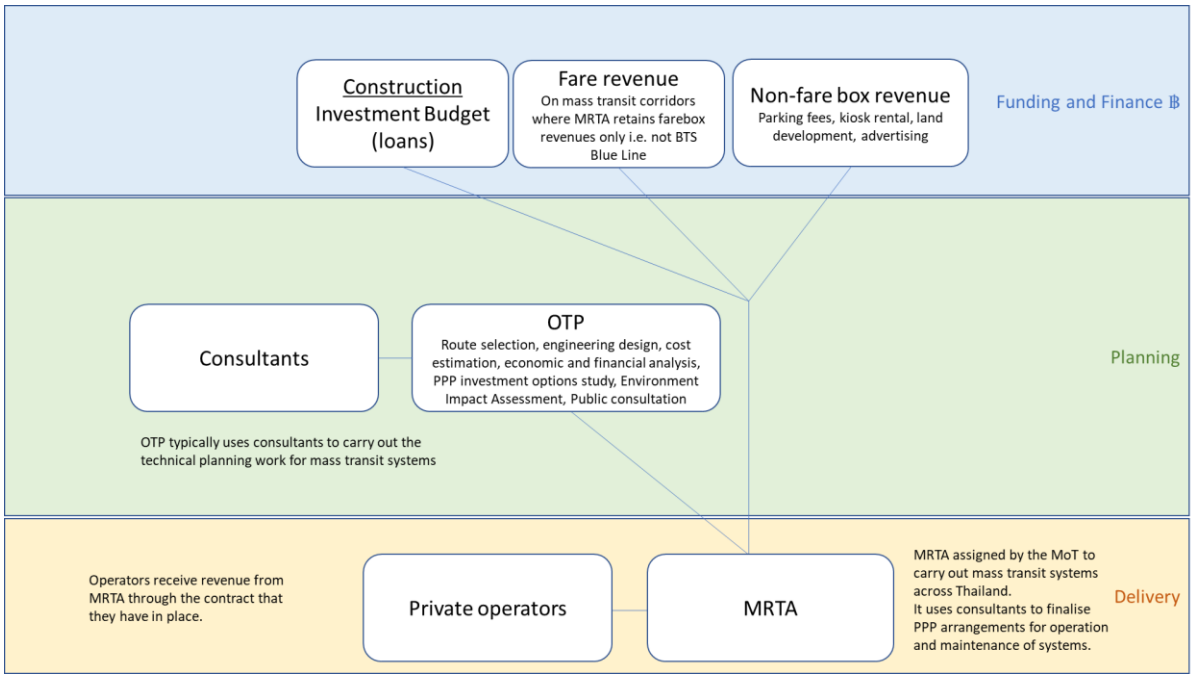


Figure 3-10 Process for the planning, delivery and financing of mass transit across Thailand

Ministry of Interior (MoI)

The MoI has numerous departments and offices that have a role in the delivery of transport facilities or services. One important transport responsibility lies with the Department of Public Works and Town and Country Planning (DPT). As traffic congestion has had an increasing impact on urban life, it has become necessary to consider land use and transport planning together. The Town Planning Act requires the DPT and OTP to collaborate and cooperate in the planning of urban and provincial land-use in conjunction with the transport masterplan in their areas. This requires close collaboration between DPT and OTP to ensure land use planning and transport planning is coordinated. Figure 3-11 and **Fehler! Verweisquelle konnte nicht gefunden werden.** show organization structure of the transport responsibilities that fall under the MoI.

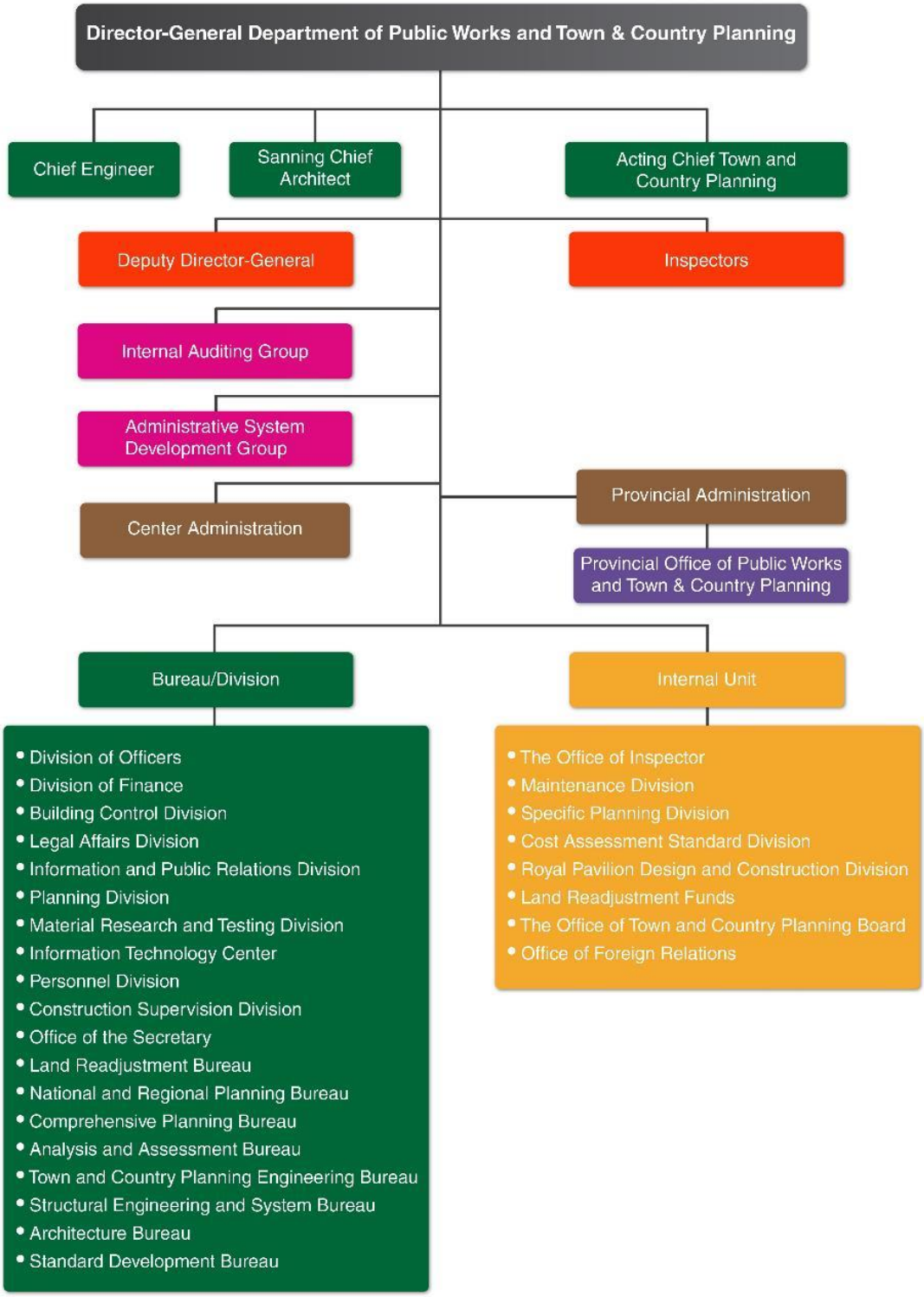


Figure 3-11 Organisational structure of Dept. of Public Works and Town and Country Planning

In the past, the DPT was responsible for producing land-use and transport plans, but this changed and it was then required to contribute to land use and transport plans through collaborations with the OTP. This caused some legal complications however. Until recently, the situation was that a five-year plan would be developed to coordinate land use and transport planning, but after the five-year period, if there was no new or continuous plan in place, then the existing plan will be discarded and neither the land use plan nor the transport plan could be enforced legally.

The Town Planning Act, 2015, was introduced and DPT is now responsible for issuing physical plans for controlling land-use and providing transport planning including traffic management in urban areas outside BMR. These plans will be effective at all times, whether there is a continuous land-use plan or not. The main reason for DPT's role with local planning is to assist local governments, to provide plans for land-use and transport and to be able to work closely with local people. For the case of Bangkok, BMA performs its own land-use and transport including implementing the plan and therefore DPT won't be working in BMR. An illustration of the urban transport planning process for areas outside of Bangkok is provided in Figure 3-12.

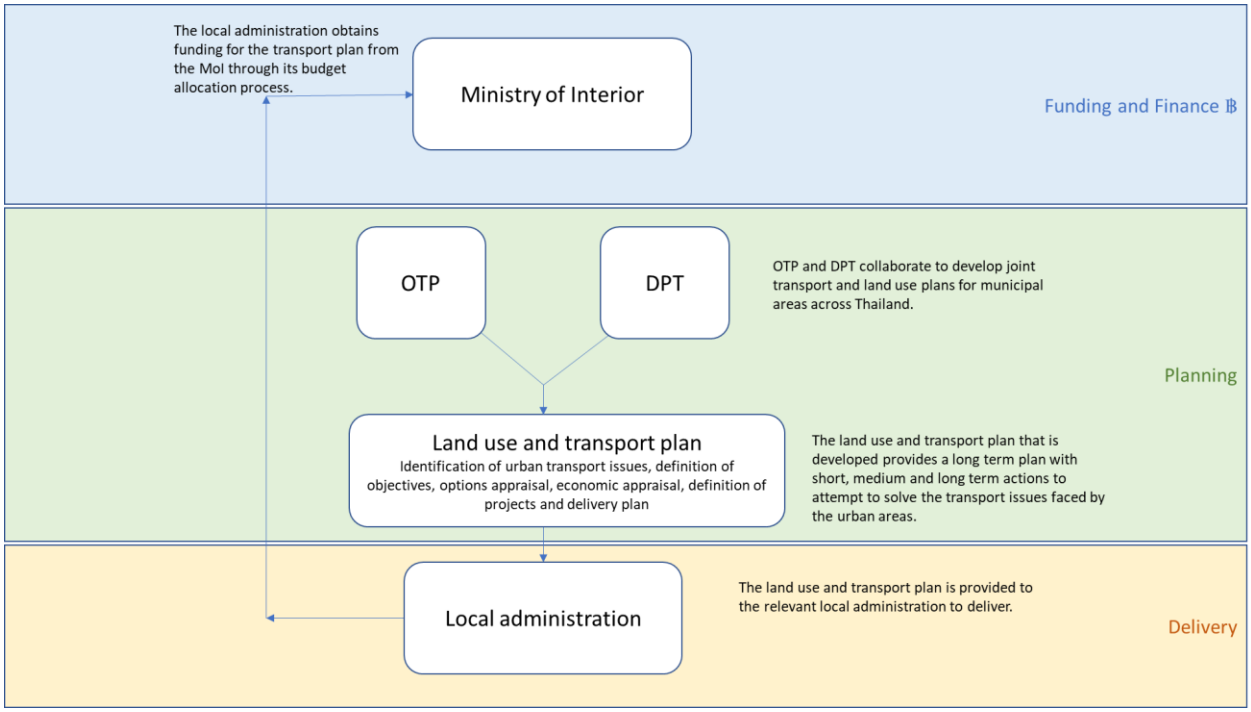


Figure 3-12 Illustration of the urban transport planning process

Local government

Provincial and municipal governments play a minor role in the preparation of urban transport plans, instead their role centres around obtaining funding for plans that are developed and delivering the plans prepared by other agencies. Local authorities are usually willing to follow transport plans put forward by OTP and DPT. In doing so, local authorities are required to carefully carry out an economic analysis and detailed design. The proposed projects in municipal areas will usually be submitted through the Department of Local Authority to the MoI. Funding for transport projects included within the land use and transport plan is received from the MoI and incorporated within the annual budget allocation for the municipality. The funding provided depends on the nature of the plan and the funding requested.

Phitsanulok Feasibility Study & Preliminary Design – an example of an urban transport plan

In 2016, OTP and Nerasuan University collaborated to develop a feasibility study for improving the transport system of Phitsanulok – an urban area in lower Northern Thailand. The aim of the study was to develop a 20-year masterplan to develop an efficient and effective transit system including non-motorised modes to reduce the use of private vehicles.

The plan initially considered the policy context and how the urban area fits into wider national and international strategies. It then reviews the existing situation in Phitsanulok, reviewing socio-economic data and travel demand.

The document then provided a conceptual public transport plan as well as an evaluation of suitable options. Once a suitable concept was concluded, a review of project costs was carried out alongside a 20-year revenue-cost model. There is a discussion around the potential for the introduction of a PPP project, and three PPP options were modelled by the consultant – net cost, gross cost and modified gross cost.

The investment model identified as being most suitable was one whereby 'the public sector is responsible for land expropriation, civil works, system works and initial bus purchase while the private sector is the sole investor in the construction of TOD areas, purchase of additional and replacement buses, initial investment, and the operation and maintenance'. The plan does not discuss how funding will be obtained and from where.

The plan then considered how the optimal transport plan would accord with land use planning principles, focussing on how TOD should be delivered across the area. Specifically, three areas were identified as optimal locations for developing land to ensure residents and businesses could benefit from high levels of accessibility using public transport. Two of these locations were near key public transport interchanges, the third close to a major retail centre.

Finally, the plan presents preliminary designs for new road layouts as well as bus routings, bus route alignments and park and ride sites. At the time of writing, this feasibility study had received approval to move to a more detailed design stage but had not yet been implemented.

When implementing public bus services (usually fixed route and schedule) for urban areas outside Bangkok, the Provincial DLT and Land Transport Committee (LTC) are the principal agencies responsible.

Other organizations can also plan and implement public bus or mass transit systems, for instance, Chiang Mai, Phuket or other major municipalities. These municipalities have recognised their own transport issues and have started working on plans to improve their transport networks. Once feasibility studies have been carried out locally with support from Provincial DLT, the proposals are passed on to government for approval for a more detailed design study (if necessary). Typically, impact assessments and public consultation exercises are required, while final decisions on scheme approval depend on the scale of the project and the deliverability at the local level.

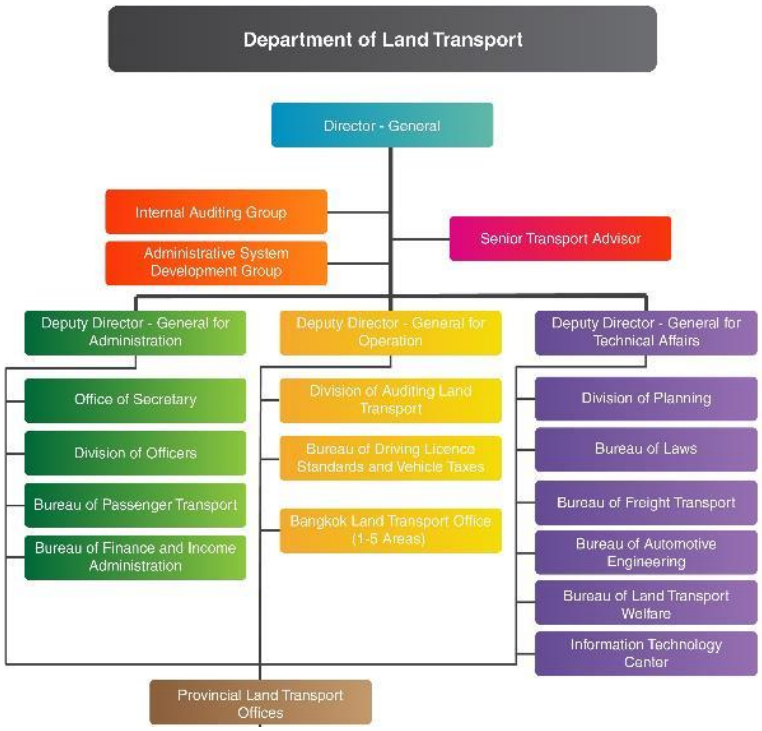


Figure 3-13 Organisational structure of transport responsibilities under Dept. for Land Transport

Within major municipalities, three organisations are responsible for the planning of traffic management controls, these are:

- Municipality public work division
- Municipality transport division
- Municipality traffic division

Not all municipalities have these three divisions, but they do exist within BMA, Pattaya, Chiang Mai and some other major municipalities. The operational responsibility for managing traffic rests with the Metropolitan Police Bureau (within BMA), traffic police of provincial police stations (in provincial areas), and Highway Police Division (has responsibility on all highways of DoH) under the Royal Thai Police. In these cases, the Royal Thai Police work closely with the municipalities.

When it comes to traffic management, municipalities are responsible for providing infrastructure, traffic management schemes, street signs, street furniture etc. to assist metropolitan/provincial/traffic police to manage signalised junctions. This type of arrangement has historically led to a misunderstanding about signal controls, which has led to U-turns being introduced along major urban streets becoming a common scheme to reduce congestion at major junctions. In addition, it is widely believed by most traffic police that manual control of signal controls is the only way to properly control flow of traffic. This is a weakness in existing traffic management practices in BMR and elsewhere.

Pollution Control Department and Thai Industrial Standards Institute

The Pollution Control Department (PCD) of the Ministry of Natural Resources and Environment and the Thai Industrial Standards Institute – TISI, part of the Ministry of Industry - are jointly responsible for setting and monitoring national standards for vehicle emissions. The PCD's role is to contribute to the

development of national policy to improve air quality, while it also administers the national standards for on-road vehicles. The TISI helps to ensure standards are standardised and consistent across the country and looks to cooperate with international standards organisations to ensure Thai standards are consistent on an international level.

Vehicle emission standards in Thailand are based on European standards while testing procedures are also consistent with European standards, which are illustrated in Table 3-1 below.

Table 3-1 European vehicle emission standards

Standard	Petrol engines	Diesel engines
Euro 1	CO: 2.72g/km HC + NOx: 0.97g/km	CO: 2.72g/km HC + NOx: 0.97g/km PM: 0.14g/km
Euro 2	CO: 2.2g/km HC + NOx: 0.5g/km	CO: 1.0g/km HC + NOx: 0.7g/km PM: 0.08g/km
Euro 3	CO: 2.3g/km THC: 0.20g/km NOx: 0.15g/km	CO: 0.66g/km HC + NOx: 0.56g/km NOx: 0.50g/km PM: 0.05g/km
Euro 4	CO: 1.0g/km THC: 0.10g/km NOx: 0.08g/km	CO: 0.50g/km HC + NOx: 0.30g/km NOx: 0.25g/km PM: 0.025g/km
Euro 5	CO: 1.0g/km THC: 0.10g/km NMHC: 0.068g/km NOx: 0.06g/km PM: 0.005g/km (direct injection only)	CO: 0.50g/km HC + NOx: 0.23g/km NOx: 0.18g/km PM: 0.005g/km PN [#/km]: 6.0x10 ^11/km
Euro 6	CO: 1.0g/km THC: 0.10g/km NMHC: 0.068g/km NOx: 0.06g/km PM: 0.005g/km (direct injection only) PN [#/km]: 6.0x10 ^11/km (direct injection only)	CO: 0.50g/km HC + NOx: 0.17g/km NOx: 0.08g/km PM: 0.005g/km PN [#/km]: 6.0x10 ^11/km

Source: https://www.rac.co.uk/drive/advice/emissions/euro-emissions-standards

National Economic and Social Development Board (NESDB)

The Strategic Unit of the NESDB is responsible for "formulating development strategies at the national level and other levels, providing recommendations and suggestions to the government, putting policies and strategies of the government into practice and monitoring and evaluating the government policies"[11]. One of the key deliverables from the NESDB is the National Economic and Development Plan, which it produces every five years and has done since the 1960s. This plan sets out the national policy framework and direction for all government departments to follow in order to contribute towards the economic and social development of the country. While the NESDB does not determine transport policy itself, it does provide an overarching national policy direction and ensures that transport policy aligns with and complements other government policies.

3.2.2 Legislation

Legislation in the field of transport in Thailand may be roughly divided into two types:

1. General laws for specific modes or organisations
2. Laws for specific components of the transport system

The first type of legislation provides general laws for specific modes or specific organization such as Highway Legislation, Land Transport Legislation, Motorways Law, Mass Transit legislation, etc. This type of legislation is typically structured as follows:

- Name of the law
- Statements about the responsible organisations including organisation structure including committees, divisions, specification of tasks etc.
- Definitions for the technical terms stated in the law

All transport organizations in Thailand have legislations to specify their responsibility and tasks to follow closely.

The second type is a legislation specifying involvement of components of the system such as traffic legislation, Navigation in Territorial Waters of Thailand Act, B.E. 2546 (2003), etc.

The most relevant legislation that governs land transport across the Kingdom are as follows:

- Vehicle Act, B.E. 2546 (2003)
- Railway and Roadway Alignment and Management Act, B.E. 2464 (1921)
- State Railway of Thailand Act, B.E. 2494 (1951)
- Highway and Bridge Toll Fee Regulation Act, B.E. 2497 (1954)
- Highway Act, B.E. 2535 (1992) (Improvement in 2006)
- Concession Highway Act, B.E.2542 (1999)
- Mass Rapid Transit Authority of Thailand Act, B.E.2543 (2000)
- Expressway Authority of Thailand Act, B.E.2550 (2007)
- Providing Properties for Public Transport Act, B.E. 2540 (1997)

[11]http://www.nesdb.go.th/nesdb_en/ewt_news.php?nid=4258

More detail of these laws is provided in Table 3-2 below.

There are other laws that are not directly related to transport but do potentially impact upon the provision of transport services and the ability for local governments to improve and enhance mobility in their local areas. One such law is the Decentralization Plan and Process Act of 1999. This Act seeks to decentralise the delivery of all government functions from central government to local governments. One of the public services that municipalities are required to systemise for the benefit of local communities is 'transportation and traffic engineering'.

Table 3-2 Overview of transport-related legislation

Legislation	Overview of legislation	Role for sustainable travel
Land Transport Act B.E. 2522 (1979)	Requirement to have a Land Transport Policy Commission. Setting up of the Land Transport Control Board as well as a provincial Land Transport Control Board in every province. LTCB has power to 1) Prescribe nature of fixed route transport services, 2) Fix routes, number of operators and vehicles in Bangkok, 3) Fix fares, 4) Prescribe bus stop locations. All operators must be licensed by the registrar before they can provide services – the Central Registrar issues licences in Bangkok, the provincial registrar issues licences in the provinces. When fixed route operating licences are granted, these are valid for 7 years. Non-fixed route and small vehicle licences are valid for 5 years from issue. Licences issued dictate the number of vehicles, their nature, size, type, colour, seats, route, stop locations, timetable, daily working hours, depot location etc. All vehicles used for public transport services must be strong, firm and well equipped with defined accessories. Drivers, conductors, inspectors, and service providers must be registered with the Registrar. Licensing process sets out requirements of all personnel.	The Land Transport Act sets out the regulatory basis upon which public transport services are provided. The enhancement of any public transport services through NUMP or any other programme would need to ensure it meets the requirements of this legislation or amend its content accordingly in a legislative process.
Vehicle Act, B.E. 2546 (2003)	Vehicles must be registered with a licence plate. A road safety fund should be established to promote road safety, using revenue from sales of licence plates. Taxis & motorcycle taxis must be registered as public vehicles. Vehicles should be safe and undergo regular safety checks. Annual vehicle tax shall be collected. Drivers must have a driving licence. Penalties for driving under the influence of alcohol/drugs etc.	Legislation sets out how vehicles are taxed. This process could be amended so that annual vehicle tax is linked to CO_2 emissions – as excise tax is already – so that additional tax revenue can be obtained alongside a reduction in CO_2 emissions. Additional tax revenues can be used for funding sustainable modes.
State Railway of Thailand Act, B.E. 2494 (1951)	Origin of State Railway of Thailand (SRT) and the Railway Commission of Thailand. Legislation sets out the governance structure for SRT, and its responsibilities in terms of performance and capacity.	Sets out mechanism by which railways are managed and delivered in Thailand.
Highway Act, B.E. 2535 (1992) (Improvement in 2006)	Defines highways into five categories: special, national, rural, local, and concession highways. Legislation sets out the governance structure whereby a Highways Director assumes responsibility for supervision, inspection and control of the highway network.	The definition of highways is useful. What the Act doesn't provide detail on is the re-classification of parts of roads for priority for other road users, such as cyclists, buses etc.

	The Act also sets out the process by which highways are constructed and expanded.	
Concession Highway Act, B.E. 2542 (1999)	Defines process for awarding a concession to build and/or maintain highways as well as the process once a concession has been awarded.	Law is important for the development of highways across Thailand. Its relevance to sustainable travel is not clear.
Mass Rapid Transit Authority of Thailand Act, B.E. 2543 (2000)	MRTA will be the authority for mass transit routes and systems across Thailand. It will carry out all mass transit business in Bangkok and surrounding provinces, and will study, analyse and prepare projects for introducing and/or improving mass rapid transit services. Legislation sets out the board and governance structure. The planning survey and design process is set out. Maintenance and safety mechanisms are detailed. Licence to grant concessions to operating companies. MRTA will provide facilities appropriate for all users.	Mass rapid transit does, and will continue to, play a key role in moving people around Bangkok sustainably. MRTA has been involved in the planning of other mass transit systems in Chiang Mai, Phuket and elsewhere, so it is a key agency for ensuring appropriate and sustainable modes of travel are provided for Thai urban residents.
Expressway Authority of Thailand Act, B.E. 2550 (2007)	EXAT will be the authority for expressways across Thailand. EXAT will construct and provide expressway and maintain expressways. It will also collect toll fees. The legislation sets out the governance structure and responsibilities of the board.	Toll fees can be redirected to invest in sustainable transport. The Thailand Future Fund illustrates this mechanism, where a proportion of expressway toll fees are directed transport infrastructure projects in order to generate more revenue.
Procurement of Immovable Property for Public Transportation Enterprises Act, B.E. 2540 (1997)	Law sets out the land acquisition, resettlement and compensation process when land acquisition is required for public transport projects.	Should sustainable travel projects require land acquisition, this legislation provides the basis for doing so.
Town Planning Act B.E. 2518 (1975) & 2558 (2015)	Law sets out the process for developing general and specific land use plans.	A part of all general and specific town plans include the documentation of communications and transport.
Persons with Disabilities Empowerment Act B.E. 2550 (2007)	Sets out requirement of all public bodies to provide access to essential goods and services for Persons with disabilities. The Minister of Transport must be on a National Committee for Empowerment of Persons with Disabilities. Minister of Transport must issue Ministerial Regulations to prescribe aspects, specifications or the provision of equipment, facilities or services in the buildings, places, vehicles, transportation services and other public services to ascertain that they can be accessed and utilized by persons with disabilities	The aim of the legislation is to encourage and ensure that Persons with disabilities are provided with access to essential goods and services. This has implications on sustainable travel as any new services are accessible for all.

3.2.3 Nationally Determined Contributions (NDC) Action Plan

In the lead up to 2016, Thailand committed to reducing GHG emissions, including a pledge in 2014 to reduce CO_2 emissions by 7-20% by 2020 as part of the Thailand NAMA. In 2016, as part of the COP21 in Paris, Thailand pledged to reduce its greenhouse gas emissions by 20% (and up to 25%) or 115.6 Mt CO_2e from the projected business as usual level by 2030. The timeframe for achieving the reduction in GHG emissions is to plan and prepare from 2017 to 2021, and then implement the defined measures from 2021 to 2030.

The development of the NDC roadmap involves line ministries and agencies contributing to a working group on mitigation planning. Following public consultation, a 1st and 2nd draft of the NDC roadmap is prepared. This is then considered by the Sub-National Board on Policy Integration, the National Board of Climate Change Policy and, finally, the Cabinet is responsible for finalising and formally ratifying the NDC Roadmap on Mitigation.

Of the 115.6 Mt CO_2e reduction, transport has been identified as a sector that should reduce emissions by 41 Mt CO_2e, these are:

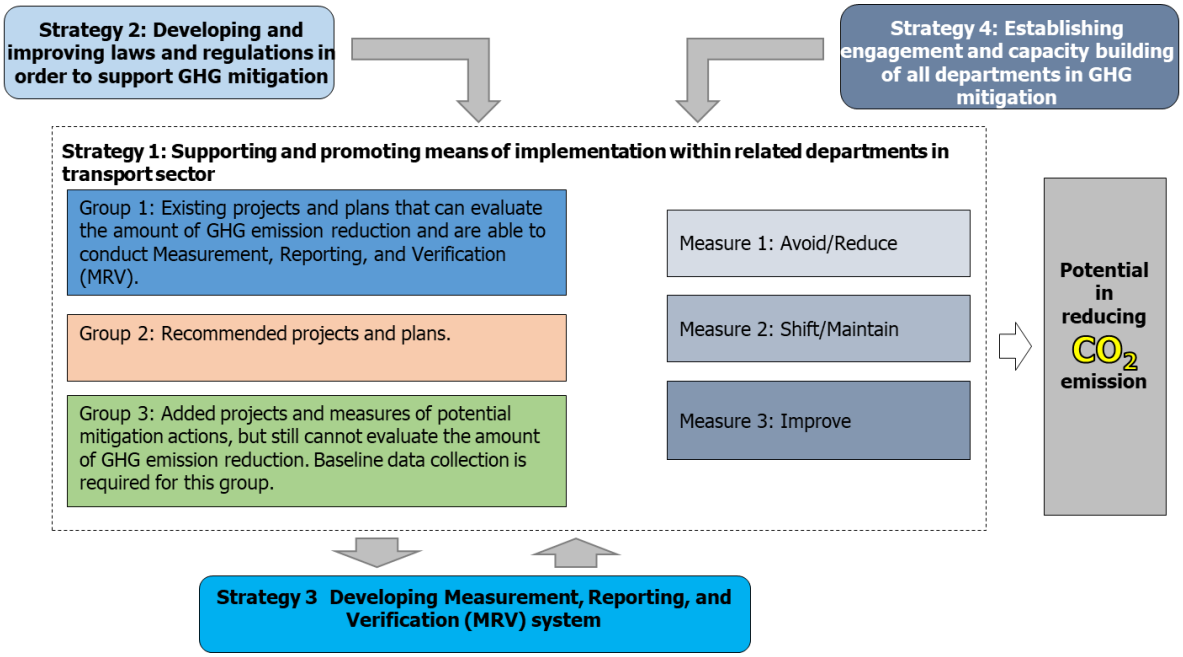
- Biogas fuels for vehicles = 10 Mt CO_2e
- Increased energy efficiency = 8 Mt CO_2e
- Mode change of mobility = 23 Mt CO_2e

Except biogas fuels for vehicles responsible by the Ministry of Energy, direct efforts by the Ministry of Transport (MoT) in other two key areas will result in a total reduction of 31 Mt CO_2e. Therefore, the MoT prepared a NDC action plan for the transport sector aiming to mitigate at least 31 $MtCO_{2e}$. There are four strategies that have been agreed upon in order to meet this CO_2 emission reduction target:

1. Supporting and promoting means of implementation within related departments in transport sector
2. Developing and improving laws and regulations in order to support GHG mitigation
3. Developing Measurement, Reporting and Verification (MRV) system
4. Establishing engagement and capacity building of all departments in GHG mitigation

These four strategies feed into a strategic map to support the identification and delivery of measures to 'avoid/reduce', 'shift/maintain' or 'improve' in order to reduce CO_2 emissions, illustrated in Source: The Office of Transport and Traffic Policy and Planning

Figure 3-14 below. For the three measures, a host of projects have been identified and modelled to understand their impact on CO_2 emissions. The identified projects are estimated to reduce CO_2 emissions by 35.42 $MtCO_2e$.



Source: The Office of Transport and Traffic Policy and Planning

Figure 3-14 Draft NDC Action Plan in the transport sector

The mechanism for delivering the NDC Action Plan has three key strands:

- Institutional management appropriate and related to the NDC Action Plan
- Funding mechanism and source of budget to implement the NDC Action Plan
- Linkage of NDC to other institutions and bridge to implementation

3.2.4 Public Transport Service Regulation

The Department of Land Transport (DLT) is the main organization responsible for providing public transport services in urban and rural areas, as well as between urban areas. Presently, DLT classifies public bus services into four types:

1. Public bus with service routes within Bangkok Metropolitan Region (BMR): DLT provides permits to Bangkok Mass Transit Authority (BMTA) to provide the services for this area. These services can have different bus types including large, medium, small, air condition and double deck buses.
2. Public intercity bus routes that have on one end (origin or destination) in Bangkok (intercity bus terminal) and the other end in another province such as Bangkok – Chiang Mai, Bangkok – Nakhon Ratchasima, etc. This service can have fewer bus types including large single/double deck bus and van.
3. Public inter-provincial bus routes that have on one end (origin or destination) in any province, except Bangkok and the other end on any province, except Bangkok. The bus types for this service is similar to type 1. Example of the service such as Chantaburi-Udon Thani, Nakhon Phanom-Chiang Mai, Nakhon Ratchasima-Chonburi.
4. Public bus routes that are within a province connecting the major urban area with suburbs and villages. The bus type can be modified pick-up, modified 6-wheel truck, van and small bus.

For services types 1 and 2 (above), BMTA and the Transport Company (TC – a state enterprise that provides inter-urban bus services) would propose the routes and services to the DLT. Using guidelines provided by the Land Transport Committee (LTC), the route proposal will be presented to the LTC for final authorisation and the issuing of a route operating licence. In the proposal both the BMTA and TC would have to specify whether the service would be provided by the organization itself or private service provider. If the service is to be provided by a private sector provider, LTC would require detail operating characteristics such as location of the terminal, bus stops on both ends, bus schedule and driver experience, etc.

For service types 3 and 4, the provincial DLT is the organization responsible for planning and providing the services. Typically, the provincial DLT office would issue permit to the private organization to provide services on a route by route basis. The permit would be issued to the service provider/s that followed LTC guidelines and adhere to the standards within the guidelines. The process is quite similar to a technical proposal bidding, but no profit return is necessary. Usually, this starts with a public announcement to any interested parties registered with the provincial DLT. These parties would prepare a proposal with certain requirements such as the number of buses available, termini and its location, bus stops, bus frequency during peak and off-peak periods, etc. These proposals will be submitted to LTC through provincial DLT and DLT. Usually LTC would request the division of public transport under DLT to provide initial technical evaluation. The final selection of the best proposal will be made by the LTC and later DLT would issue permit/s to the selected service provider(s).

Regulations are in place to ensure operators meet their public service obligations once it has been awarded an operating contract. If the operator does not meet the basic requirements set out in its proposal, for example, if it did not meet the operating frequency or if it changed the fare it charges, then the DLT has an ability to carry out a field evaluation. This involves the DLT assessing what service the operator is delivering and whether this meets its obligations. In all cases where a field evaluation is carried out, the DLT submits a report to the LTC. Where an operator does not meet its contractual requirements, the contract can be removed.

There is currently no mechanism to subsidise public transport services. When operating contracts are awarded by DLT, they require the operator to cover costs through farebox revenue while fares are capped at a level determined by the regulator, which in Thailand's case is the Land Transport Committee.

Figure 3-15 illustrates the process for planning, delivering and financing public transport services across Thailand as described in the paragraphs above.

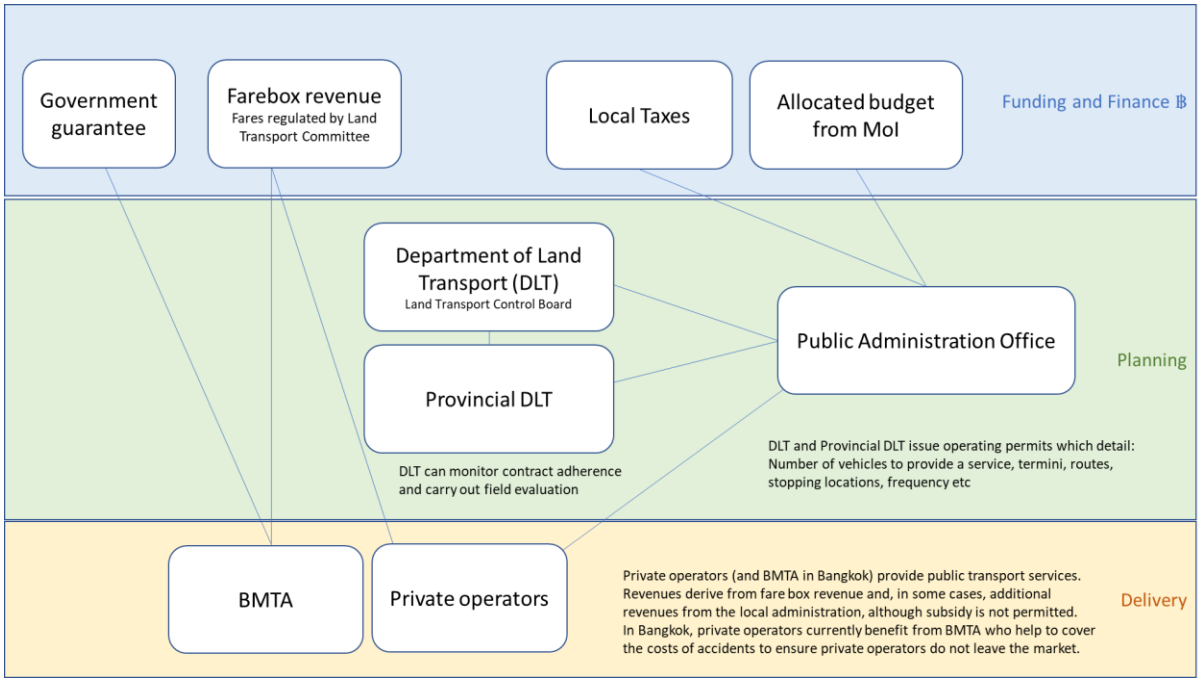


Figure 3-15 Illustration of the planning, delivery and financing of public transport services

3.3 Funding and Financing Transport

Funding for transport is specific for investments for infrastructure (such as railway infrastructure, bus stops and lanes etc.) and operations (rolling stock, maintenance costs, etc.). The following sections describe funding practices in Thailand for both purposes.

3.3.1 Central Government

Central government play a key role in the funding and delivery of transport networks and services. Central government obtains most of its revenues through taxation and the issuing of bonds. Full disclosure of government revenue sources was not available at the time of writing.

Central government allocates revenue to all departments, of which the MoT is one of the beneficiaries. The central government budget for 2018 is THB 3.04trillion[12] (approx. US$94billion) of which the MoT is allocated THB 168.77billion (US$5.22billion). This accounts for 5.5% of the overall national budget. By comparison to neighbouring countries, it is notable that in Singapore, 12.25%[13]of central government budget is spent on transport whereas in Malaysia, 2.8%[14] of the government budget is directed towards transport. Allocating 5.5% of total government spending is high compared to the UK which allocated around 3.75% of all government spending towards transport in 2019[15].

Figure 3-16highlights the funding received by government departments receiving more than THB100b per year. Transport receives the seventh largest annual funding behind the central fund, revolving fund,

[12] http://dataservices.mof.go.th/Dataservices/GovernmentExpenditureEconomyMinistry?language=EN

[13] https://www.singaporebudget.gov.sg/data/budget_2017/download/FY2017_Analysis_of_Revenue_and_Expenditure.pdf

[14] http://www.treasury.gov.my/index.php/en/economy/economic-data.html

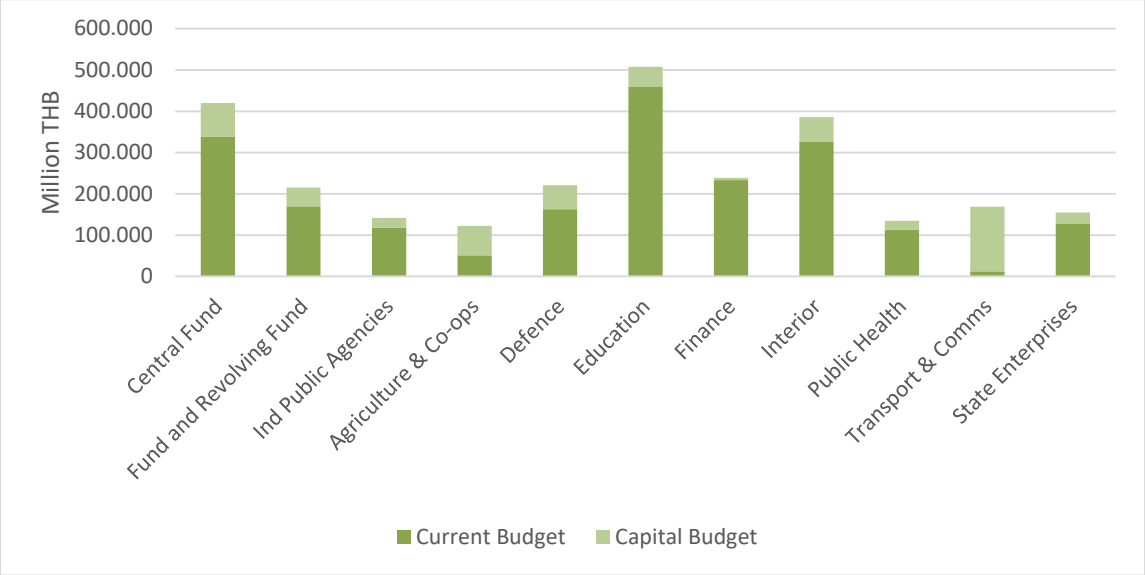
[15] https://www.ukpublicspending.co.uk/uk_transport_spending_60.html

defence, education, finance and MoI. Notably for the Ministry of Transport, just 7.25% of its budget is 'current budget' (which includes maintenance) whereas over 90% of the budget is 'capital budget' to fund the investment in infrastructure. No other ministries receive such a high proportion of funding as capital budget, and conversely, such a low proportion on 'current' spending. This highlights the focus on investing in transport infrastructure across the Kingdom but also illustrates an area of weakness in that such a small proportion of the transport budget is allocated towards operating transport services.

For the MoI, funding is the opposite of that for the MoT. The majority of MoI's funding stems from the current budget with less than 20% of its budget allocated for capital spending. As existing public transport services are delivered by local governments using funding from the general budget allocation and/or local taxes, this partly overcomes the issue of the MoT having a high proportion of its budget for capital projects.

For clarification on Source: Ministry of Finance

Figure 3-16 below, the Central Fund is a discretionary fund allocated to the Prime Minister to meet new priorities during the year. The Fund and Revolving Fund is not clearly described by the Ministry of Finance, but it is understood it refers to several priorities including energy efficiency revolving fund and a community development fund.



Source: Ministry of Finance

Figure 3-16 Central government spending by ministry

Generally, funding for transport project are derived from tax (both the general tax and dedicated tax) and loans. Three organizations in the Ministry of Finance (MOF) are responsible for the general tax collection: the Revenue department, the Excise department, and the Customs department. There are other departments in the MOF that also obtain funds for transport including the Public Debt Management Office (PDMO). Specifically, the PDMO can submit a transport loan proposal to receive approval from the cabinet to find loans from national or international banks or other funding agencies.

Every year the Bureau of Budget (BB) under the Ministry of Prime Minister's Office sets about preparing the transport budget with each transport department of the MOT and MOI. The share of funding dedicated to urban transport is unclear. After thorough discussion between each department and the BB, the BB will discuss the total budget with the Office of the Permanent Secretary of the ministry again and

if the total budget exceeds the proposed transport budget initially planned for (and received approval from the cabinet) by the BB, a round of budget cutting is necessary. At this stage some projects would be taken out or pending for cabinet approval again. The criteria for removing projects from the budgeting process is not publicly available, although decisions are likely to be political. This process is

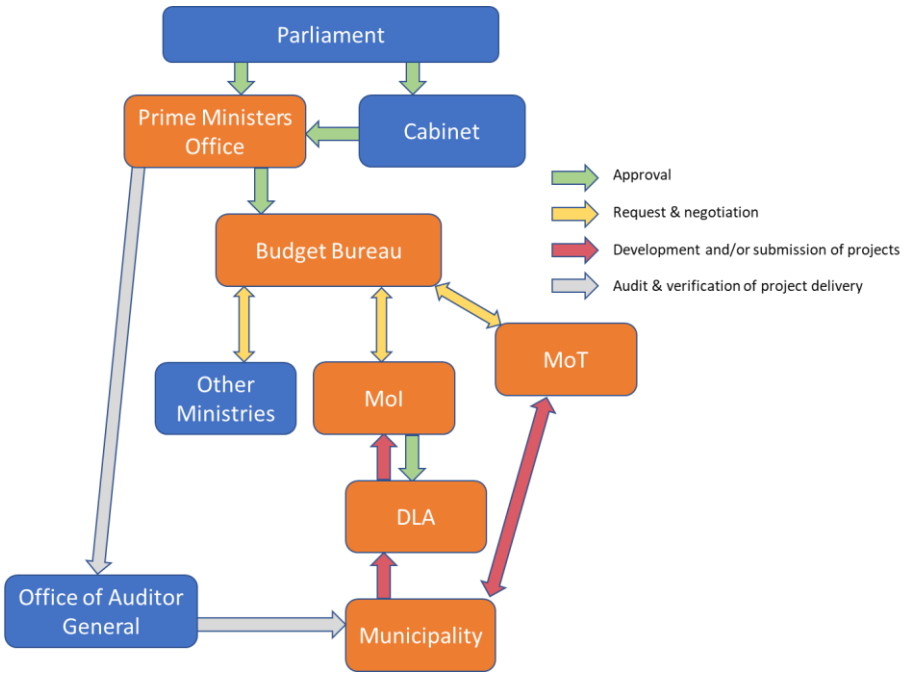


Figure 3-17 Illustration of decision-making process for transport funding

For the MoI, the Department of Local Administration (DLA) is responsible for gathering transport projects proposed by the municipality and submitting them to the BB. The transport projects proposed by the municipality (including those projects planned by OTP and DPT as part of the urban transport planning process) will be gathered by the office of the Governor and submitted to the DLA. Generally, if the budget is less than THB50 million, the mayor would assume responsibility and approve the project. If the project is between THB50-100 million, the Governor is responsible. If it is higher, the Governor and the director of the DLA are responsible. For large (budget >THB100 million) or extraordinary projects, the proposing organisation would need to discuss detail of the project with the BB. At the time of writing, it was not clear if there was any mechanism for joint funding of projects between the MoT, MoI or other departments or agencies.

Once Parliament has agreed the relevant budgets, then for the MoI budget will be transferred to the provincial office of the Controller General. Each provincial department and municipality would need to contact this office to receive funding for transport projects. Project implementation is generally carried out via bidding process.

For the MoT, the budget approved by Parliament is transferred to the department office of the Controller General. This office will contact the departments that receive funding and work together to go through the bidding process. The budget spending process must follow rules and regulations issued by the Office of Prime Minister. At the end of the year, the Office of the Auditor General would review the proposed projects and check whether the projects had been carried out as stated in the budget proposal.

Aside from funding transport, central and local government benefits from taxation and charges on transport services. The vehicle licence registration fee is collected by DLT each year, and the amount paid depends on the engine size (cc), vehicle type, age, weight, and fuel type. According to PDMO, the revenue generated by all existing transport related taxes are allocated to a dedicated area of spending. For example, expressway road tolls are dedicated for the operation and maintenance of existing toll roads and the construction of future toll roads.

Revenue is also generated through fuel taxes. These are levied upon consumers when they purchase fuel for vehicles. The retail price structure of oil is shown in Table 3-3, but briefly consists of:

Refinery oil price – the summation of the crude oil price, refinery costs and transportation costs

Taxes – these include:

- Excise tax collected by the Excise Department (MoF) which contributes to the general budget. This ranges between 0.975THB/litre for gasohol 95 E85 and 6.6THB/litre for unleaded gasoline
- Municipality tax collected by each municipality in which petrol stations are located for local developments and range from 0.0975THB/litre to 0.65THB/litre.
- 7% of Value Added Tax (VAT) collected by Revenue Department (MoF)

Funds – there are two funds that fuel taxes contribute to:

1. The Fuel Fund is used for to help stabilize prices during periods of price fluctuations. For example, when the oil prices are high, this fund is used to subsidise the domestic retail price, whereas when oil prices are lower, the tax is used to build the fuel fund reserves The fuel fund is also used to subsidise the price of some fuel types such as Gasohol 95 E85, as shown in Table 3-3. Each oil type has different rates to collect into this fund ranging from -6.38TBH/litre for Gasogol 95 E85 to 8.08THB/litre for unleaded gasoline.
2. Energy Conservation Fund is used for renewable energy promotion in the country. All oil types are taxed in the same rate of 0.10 Baht/liter.

Marketing margin – this denotes the retailers profit margin which typically varies between 2.07THB/litre and 3.46THB/litre

According to the Ministry of Energy, fuel taxes are used for generating tax for general spending with no evident ring fencing of transport revenue for funding transport projects.

Table 3-3 Example of Retail price structure of oil in Thailand

UNIT:BAHT/LITRE	Refinery oil Price	Excise Tax	Municipality Tax	Fuel Fund	Energy Conservation Fund	WHOLESALE PRICE(WS)	VAT 7%	WHOLESALE + VAT	MARKETING MARGIN	VAT 7%	RETAIL (Wholesale+ Marketing+Vat)
ULG	13.1384	6.5000	0.6500	8.0800	0.1000	28.4684	1.9928	30.4612	3.4568	0.2420	34.16
GASOHOL95 E10	13.9656	5.8500	0.5850	2.1200	0.1000	22.6206	1.5834	24.2041	2.3794	0.1666	26.75
GASOHOL91	13.5702	5.8500	0.5850	2.1200	0.1000	22.2252	1.5558	23.7809	2.5225	0.1766	26.48
GASOHOL95 E20	14.8848	5.2000	0.5200	-0.7800	0.1000	19.9248	1.3947	21.3195	2.2621	0.1583	23.74
GASOHOL95 E85	20.0321	0.9750	0.0975	-6.3800	0.1000	14.8246	1.0377	15.8623	3.4371	0.2406	19.54
H-DIESEL	15.4336	5.9800	0.5980	0.2000	0.1000	22.3116	1.5618	23.8734	2.0716	0.1450	26.09
H-DIESEL B20	16.1963	5.1520	0.5152	-4.5000	0.1000	17.4635	1.2224	18.6859	2.2468	0.1573	21.09
LPG (UNIT:BAHT/KILO)	14.8635	2.1700	0.2170	-0.0710	0.0000	17.1795	1.2026	18.3821	3.2566	0.2280	21.87

Government also receives revenue through PPP concessions as well as toll charges. When charges are made on toll roads, some of this revenue is ring fenced to cover construction and maintenance costs, other revenue is used to cover the concessionaire fee. This is discussed in more detail below.

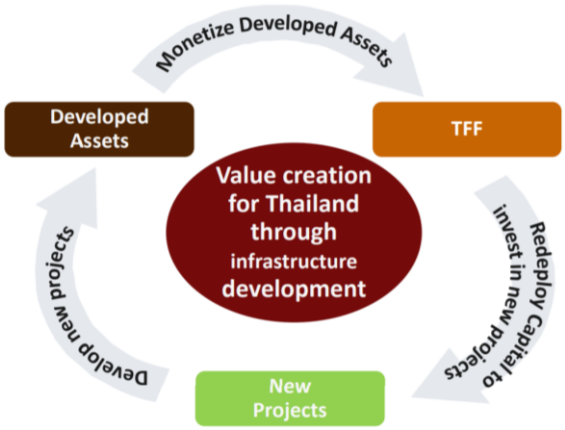
3.3.2 Thailand Future Fund (TFFIF)

In 2016, the Thailand Future Fund was set up in an attempt to overcome the limitations of central government funding. Limitations include:

- Competing needs for current expenditure from the central government budget
- The need for government borrowing to be kept below 60% of GDP, thus there is a limit to the amount that can be borrowed (2017: 41.8%)
- The annual cash flow of state-owned enterprises, such as EXAT, is not sufficient to meet investment needs
- Some sectors and projects are not suited to a PPP funding arrangement

To overcome some of these limitations, the TFFIF attempts to use private investment, through the sale of 'units', to be directed towards revenue generating projects such as expressways. To start the TFFIF process, the government sold part of its concession rights in two Expressway projects in order to raise approximately $1.4b which is then re-invested in new revenue generating projects. The intention is to continually reinvest in new projects that generate revenue for investors and government, as illustrated in Figure 3-18

According to the State Enterprise Policy Office, the TFFIF aims to invest in value-enhancing state agencies' infrastructure assets/projects to create long-term distribution growth potential – including expressways or toll roads, railways, electricity generation and distribution, airports, deep seaport, and other infrastructure businesses.

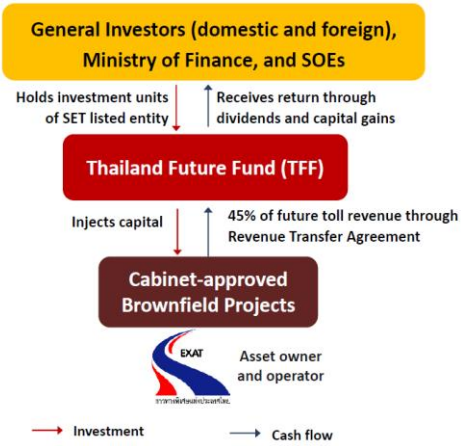


Source: State Enterprise Policy Office[16]

Figure 3-18 Value creation model for TFFIF

Figure 3-19 TFFIF financing model presents the flow of funding for the initial stage of TFFIF where funding is provided for two toll ways owned and operated by the Expressway Authority of Thailand (EXAT).

[16]https://www.set.or.th/thailandfocus/2018/files/THFocus2018Day1_1530-1615_Prapas.pdf



Source: State Enterprise Policy Office

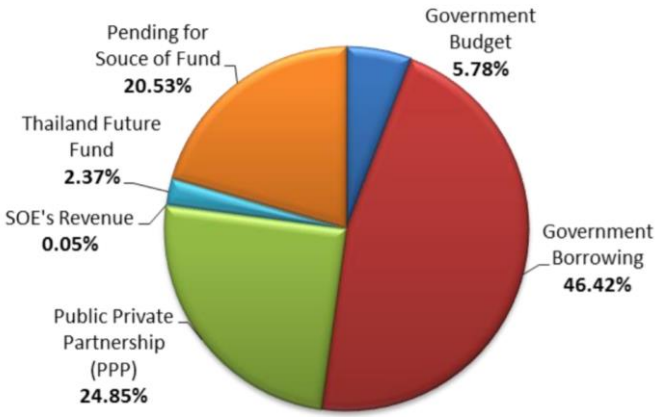
Figure 3-19 TFFIF financing model

November 2018 saw the initial public offering of the sale of TFFIF 'units'. The units are traded on the Stock Exchange of Thailand, so are available for retail and institutional investors to acquire.

The benefit of TFFIF is that it allows the government to accelerate infrastructure spending, but use revenue generated for funding future projects. In summary, it is selling the future revenues from revenue generating infrastructure projects now in order to fund more infrastructure development in the short term. This approach puts less pressure on the Government's annual budget and on public debt to fund infrastructure projects. It also provides investment opportunities for private investors and benefits capital markets through attracting foreign investment.

The fund is not suitable for projects that have economic benefits but no financial return, otherwise the fund would not produce the revenue sources to support continued infrastructure funding or profit distribution. The TFFIF is therefore not suitable for investment in walking and cycling infrastructure which typically does not generate financial returns.

The TFFIF has been identified as one source of funding, albeit a small proportion, for the delivery of the Transport Infrastructure Development Masterplan (2015-2022), as discussed in paragraph 3.1.1. The THB2,021.3b cost for delivering 44 infrastructure projects will be funded as illustrated in Figure 3-20.



Source: Ministry of Transport

Figure 3-20 Funding sources for Transport Infrastructure Development Masterplan

3.3.3 Local Government

Local government receives funding from a variety of sources. 'Shared tax income' is derived from:

- VAT collected in its province (11.1% of all VAT collected within the province)
- Specific business tax collected in its province (10% of tax collected)
- Excise and alcohol tax (10%)
- Real estate registration (100%)
- Mineral and petroleum taxes (unknown %)

In addition to shared tax revenue, local governments collect:

- Property and building taxes
- A local development tax based on the median appraisal value of occupied land
- Signage tax

Local governments also collect revenues from other sources, such as animal slaughter fees, waste collection fees, driving licence deliverance and building permit deliverance. Local governments can collect car parking charges as Bangkok Metropolitan Authority does on some streets in Bangkok. In other urban areas, local governments appear not to implement charges to any great extent.

In addition to tax revenue, local governments receive general operation grants and block sectoral grants dedicated to the improvement of a specific public service obligation. According to the OECD[17] 94.1% of grants are current grants, to cover revenue spending, whereas 5.9% of grants received by local government are capital grants. It is from these sources of revenue that local governments can fund day to day transport services. However, it is unclear which government departments provide which grants and what share of a municipality's transport budget is made up of grants from the MoT, MoI or other departments.

3.3.4 National development banks

The Small and Medium Enterprise Development Bank of Thailand acts as a national development bank to support small and medium enterprises to grow and support the Thai economy. The bank aims to support private sector organisations and entrepreneurs, rather than provide funding for large scale projects, such as the role of international development banks and donor agencies.

Commercial Thai banks do play a role in financing and investing in projects, often playing a role in scrutinising and the financing of PPP projects. The PPP process requires a thorough financial investigation with statements of approval from banks and other investors. Most national banks can participate in joint ventures for the bidding of projects, for example, Bangkok Bank is partnering with BTS to invest in the BTS train and will fund most of the land development projects carried out by BTS around stations.

3.3.5 Donor agencies and partners

Historically, Thailand has received funding from a broad range of donor agencies. However, as the country has become an upper middle-income economy (as designated by the World Bank), it receives increasingly less funding from donor agencies. The following provides a list of agencies and how they support (or used to support) transport related projects.

[17]https://www.oecd.org/regional/regional-policy/profile-Thailand.pdf

World Bank

The World Bank has not funded a transport-related project since 2011 when it provided US$740,000 towards the Chiang Mai Sustainable Urban Transport Project. Since then, the World Bank has provided little direct funding as Thailand has become an upper middle-income country.

Asian Development Bank (ADB)

The ADB has historically supported Thailand to aid its economic and social development. In the 1980's, ADB supported the country with a loan to upgrade and strengthen more than 1,200 kilometres of roads. The loan also sought to improve road safety, contribute towards maintenance, as well as other policies needed to maintain a modern national road system.

Since 1966, ADB has invested more than US$6.7 billion in 275 loans, grants, and technical assistance projects focused primarily on energy, and transport and communication. ADB has provided no new public sector loans to Thailand since 2010 since it became an upper middle-income country. Instead, ADB has provided policy advice, capacity building, and knowledge support for infrastructure development, social sector reform, financial sector improvement, and regional cooperation.

GIZ

GIZ has been supporting the government on a variety of sustainable transport related projects. GIZ is currently supporting the development of this National Sustainable Urban Mobility Program or so-called Thailand Clean Mobility Programme (TCMP), as well as providing technical advice on the delivery of multi-operator ticketing schemes. GIZ's main focus in Thailand is to support the Kingdom to reduce its GHG emissions.

GCF

The Green Climate Fund (GCF) has invested in several climate-readiness projects implemented by GIZ and the Global Green Growth Institute. UNDP has submitted a concept note for resilience projects. No transport project has been submitted to the GCF for Thailand so far. It is unlikely that the GCF board approves a grant project given the middle-income status. Whether Thailand seeks a conditional loan for transport infrastructure projects is not clear. The Ministry of Natural Resources and Environment acts as the National Designated Authority (NDA) in Thailand.

AFD

Agence Française de Développement supports the Thai government in a number of ways, including in providing advice and expertise in transport planning. In 2016, it led workshops and seminars to share knowledge and support the development of sustainable urban mobility.

JICA

Thailand is now considered by JICA as a non-category country for general grant aid. This is because it is an upper middle-income country. However, JICA does provide loans to Thailand for transport projects. JICA currently provides funds for rail mass transit lines in Bangkok, notably purple lines I and II, as well as the red line. In total, Yen 1,421,000,000,000 is being loaned to the Thai government for these two metro lines. These loans are targeted at supporting the country with reducing GHG emissions to reduce the Kingdom's impact on climate change.

3.3.6 Private sector

The private sector plays an important role in the funding and delivery of transport projects. Private bus operators are involved in the delivery of public transport services under contract to DLT or BMTA – as discussed elsewhere in this report. They don't however, play any role in funding transport services, merely operating them and receiving revenue as contractually obliged.

At present, there are no laws or regulations that require private sector employers or developers to contribute towards transport infrastructure or services. There have been examples where businesses have looked to contribute towards infrastructure costs. For example, Nava Nakorn industrial park was facing access issues due to traffic congestion and OTP carried out a study to identify solutions to overcome the congestion. It was agreed that an overpass will be built and that the industrial park should fund the work, although in the end the Department of Highways took responsibility for the construction.

For large infrastructure projects, Public Private Partnerships (PPPs) are encouraged by the Thai government. PPPs are governed by the Private Investments in State Undertakings Act 2013, superseding the Public Participation in State Undertakings Act 1992. The Act sets out a framework for the comprehensive planning and quality of PPP projects which includes the development of a PPP policy committee, a PPP fund, a PPP strategic plan and rules on the use of experts and consultants.

The PPP Strategic Plan is prepared every five years for the purpose of determining a policy framework around which projects can be delivered. The plan provides the governments priorities for PPP projects, identifies where investment is required and sets targets and timeframes for the planning and delivery of PPP projects. The purpose of this plan is to encourage participation and investment from the private sector. The plan suggests that allowing the private sector to participate and jointly invest in major infrastructure projects not only helps reduce financial restrictions based on the government budget and decrease the need for government loans, but involving the private sector helps to improve the efficiency of delivering such projects.

The 2015-2019 Strategic Plan identified six priority infrastructural project types where private sector investment is required:

- Development of Urban Rail Transit System for the Population
- Development of Toll Roads in Major Metropolitan Urban Areas
- Development of Port Logistics
- Development of High Speed Rail
- Development of Telecommunication Network and Assets
- Development of High Speed Internet

Alongside these six sectors, a further 14 project types are identified where government encourages private sector investment, of which the following represent those that affect transport projects:

- Development of Toll Roads between Major Metropolitan Urban Areas
- Development of Packaging Stations
- Development of a Common Ticketing System
- Development and Management of Airport Ground

Finally, the PPP Strategic Plan requires the responsible ministries and/or agencies to co-operate through the planning of PPP projects so that where synergies between projects exist, these are identified and planned for so the benefits of projects can be maximised.

In 2017, a second PPP Strategic plan was introduced that covered the period from 2017 to 2021. This aligned the PPP strategy with the newly developed NESDP. The priorities changed slightly from 2015, with just the following four subsectors which require private investment, and with 19 subsectors where private investment is encouraged:

- Development of Urban Rail Transit Lines
- Development of Toll Roads in Metropolitan Areas
- Development of Public Logistics Ports
- Development of High-speed Rail Lines

In 2019, another Act is due to be passed that helps to speed up the process of delivering PPP projects. The PISU Promotion Act 2019 is currently planned in an attempt to reduce the average project approval time. There are three key stages to the development of a PPP project. The first stage is the development of a feasibility study while this is followed by a project appraisal process. The third and final step is the tender evaluation and contract award. The impact of the PISU Promotion Act 2019 aims to reduce the time of these three steps from an average of 25 months to just 9 months.

Examples of transport PPP projects in Thailand include:

MRTA has recently approved a project for two monorail lines: Yellow Line and Pink Line, both of which are included in MRT master plan for Bangkok. Even though each line is separately studied and designed during the feasibility study phase, they are combined for the PPP net cost bidding process. Both MRTA and the operator (service provider company) from the private sector accept joint financial risk. In the net cost agreement, the government pays for all civil works as well as the station and depot facility while the private sector funds rolling stock, M&E, communication and management facilities. The operator collects fares to be used for operation, maintenance and management and apportion part of the rest to MRTA as part of a concession fee. The monorails are scheduled to be complete and open for service by 2024.

A 6-lane 196 km motorway arrangement has recently been agreed from Bang Pa-in interchange in Ayutthaya province where the current motorway 9 (Bang Phlee-Bang Pa-in motorway) meets with Highway 1 (Phahonyothin highway). Motorway 6 will be built parallel to Phahonyothin highway and Highway 2 (Friendship highway), passing Saraburi province and ending at Kilometre 2 on the Nakhon Ratchasima bypass road. The motorway is scheduled to be completed by 2020.

3.4 Economics of public transport

3.4.1 Bus operating revenues

Bus operating revenues derive from two main sources: farebox revenues and non-farebox revenues. For operators in Thailand, farebox revenues account for most, if not all, of bus operating revenues. Non-farebox revenues can include advertising (on vehicle, at stops/stations, etc), commercial development, land value capture, and consultancy and advisory services.

Farebox revenue is an essential element of a bus operators' revenues in Thailand. The price of fares, however, is regulated by the DLT. Prices are based on a 'cost-plus formula' where a rate calculated in Baht per km is established on a sliding scale based on the price of diesel. The final decision on any changes in bus fares is made by the cabinet – neither the DLT nor the operator.

The cost-plus formula is a methodology adopted by Central Land Transport Committee (CLTC) to assess the request for a fare increase by the operator or the operator association. The CLTC firstly considers

operating costs and these are assessed in three parts: variable, semi variable and fixed costs. Variable costs are fuel, labour, tyres, and other parts that require regular changing. Semi variable costs include maintenance and depreciation, while fixed costs include management, vehicles, taxes and back office functions.

Once the operating costs have been determined, between 10% and 14% is added to provide reasonable profit, hence the 'cost-plus' formula. Following this, occupancy rates are estimated to understand the amount of passengers travelling on a service. This allows for the estimation of operating revenues which in turn determine whether there is justification for changing the price of fares. The cost-plus formula does not take into account fuel consumption of the vehicle, nor does it take account of the quality of vehicle used.

3.4.2 Current Bus Fares

Using the cost-plus formula, bus fares are derived for the local area which can vary based on the vehicle type, service type and/or distance travelled. In Bangkok, for services operated by BMTA or under contract to BMTA, the following fares are charged (as of April 2019):

Bus type	**Colour**	**Fare**
Regular bus	Cream-Red	8 baht
Regular bus	White-Blue	9 baht
Regular Overnight	Cream-Red	9.50 baht
Air Condition(White - Blue)	Cream-Blue	12 - 20 baht (depending on the distance travelled)
Air Condition(Euro 2)	Yellow-Orange	13 - 25 baht (depending on the distance travelled)
Air Condition(NGV rental)	White	13 – 25 baht (depending on the distance travelled)
Air Condition(new NGV)	Blue	15 – 25 baht (depending on the distance travelled)

There are a range of fare concessions provided to different groups of travellers on BMTA services. The following travellers are exempt from paying bus fares:

1. Buddhist monks and novices
2. Mailmen in uniform while on duty
3. Holders of BMTA employee ID cards& bus inspectors
4. Holders of official certificates or medals specified in the Regulation on Bus Fare Exemptions

The following travellers receive a half fare exemption when travelling on regular buses:

1. The blind with a certificate from the Association of the Blind
2. Soldiers and policemen in uniform
3. Holders of official certificates or medals (Victory medal, European Royal War medal, Border Service medal, Free Man Protection medal, non-active War Veterans Classes 1,2,3 and 4) as specified by the Regulation on Bus Fare Concession at the exact rates specified by the Transport Control

The following travellers receive bus fare reductions on airconditioned buses:

1. Victory Medal (Off-spring of holders of this medal are also entitled.)
2. Border Service Medal
3. Free-Man Protection Medal
4. European Royal War Medal
5. Non- active War Veterans Classes 1 2 3 4 and 6.
6. BMTA Employee with ID Cards

3.4.3 Bus operating cost characteristics

There are two sides to the equation to ensure public transport services are financially sustainable: income versus expenditure, or, revenue versus operating costs. This section will examine bus operating costs across Thailand and consider two case studies for bus operations.

	Licence-holding Bus Operating Firm		Joint bus operating firm	
Types of Costs	**Amount (B1,000)**	**%**	**Amount (B1,000)**	**%**
Wages	8999.5	19.6	181.9	12.4
Tyres	233	0.5	25.5	1.7
Battery	38	0.1	5.6	0.4
Fuel	7117.6	15.5	290.6	19.8
Lubricants	131.7	0.3	11.4	0.8
Bus repairs	3326.9	7.3	72.2	4.9
Replacement parts	1985.1	4.3	8	0.5
Office expenses	12514.4	27.3	101.4	6.9
Taxes and fees	363.1	0.8	24.4	1.7
Depreciation	11178.8	24.4	745.7	50.8

Source: Ongkittul and Thongpat (2018)

Figure 3-21 Bus operating costs in Thailand

Ongkittikul and Thongpat (2018) analysed bus operating costs for operating companies – their data is presented in **Fehler! Verweisquelle konnte nicht gefunden werden.**. This shows that for licence holding bus operating firms, back office functions account for the greatest proportion of operating costs (27.3%), and alongside depreciation (24.4%), wages (19.6%) and fuel (15.5%), these account for 87% of all bus operating costs. For joint operating firms, back office functions account for a much lower proportion of costs (6.9% although depreciation accounts for over half of all operating costs.

To put these costs into context, Source CPT, 2018

Figure 3-22 presents bus operating costs in the UK. This shows that driver wages and on-costs (tax, pension contributions etc) account for 45.9% of all costs while fuel accounts for 15.9% - which is comparable to licence holding bus firms in Thailand. Notably, vehicle depreciation accounts for just 6.3% of costs, significantly less than in Thailand. This is somewhat intriguing given that the average age of a bus in the UK is 7.6 years old[18] compared to more than 16 years[19] in Thailand, so logic would suggest that vehicle depreciation would be less in Thailand given that vehicles are older.

As another comparator, in Naya Raipur, India[20], operating costs are reported to be approximately 45% fuel costs, 24% operation and maintenance, 19% driver costs and 12% capital costs.

Overall, operating costs in Thailand appear different to those in the UK and India. In the UK, driver costs account for the greatest proportion of costs because the UK is a high-income country, whereas in India, fuel accounts for the greatest proportion. In Thailand, the greatest costs appear counter intuitive as back office functions and vehicle depreciation appear to account for the majority of costs.

[18]https://www.statista.com/statistics/468341/average-age-of-local-buses-fleet-england/

[19]http://siteresources.worldbank.org/THAILANDEXTN/Resources/333295-1253072771677/TH_MakingTransportMoreEnergyEfficient_fullreport.pdf

[20]http://wricitieshub.org/online-publications/71-costs-and-revenues-understanding-bus-operations

CPT Cost Index

Summary of results: change in bus & coach industry costs for the 12 months to 30 June 2018

	Overall national result	Regional indices: Greater London bus	Home Counties	Midlands	Northern England	South West England	England (all regions)	Wales	Scotland	Percentage that each category represents of total costs
Overall change in operating costs	3.1%	3.7%	2.7%	1.6%	2.5%	3.8%	**2.9%**	1.3%	4.6%	
Change in individual cost categories:										
1 Drivers wages and on costs	4.0%	3.2%	3.9%	2.7%	3.4%	5.9%	3.6%	2.7%	6.4%	45.9%
2 Other labour and staff costs	2.4%	5.6%	2.9%	0.0%	1.9%	-0.7%	2.5%	1.4%	2.0%	13.9%
3 Insurance and claims	-3.1%	-2.9%	-3.3%	-1.0%	-5.1%	-1.5%	-3.6%	5.5%	-4.1%	2.4%
4 Fuel	-4.9%	-5.3%	-4.4%	-3.2%	-6.6%	-5.1%	-5.4%	-5.4%	-2.4%	15.9%
5 Maintenance materials	8.5%	5.7%	4.5%	7.3%	12.5%	9.3%	8.5%	8.4%	8.1%	4.4%
6 Vehicle depreciation	8.8%	17.0%	4.9%	4.7%	5.2%	1.0%	7.7%	4.3%	15.1%	6.3%
7 Other operating costs	7.8%	11.6%	8.0%	2.7%	7.8%	13.4%	8.7%	-1.4%	5.3%	11.2%
Sample size:										
Representing operating costs of:	£3,190,300,000	£706,800,000	£342,900,000	£291,000,000	£945,500,000	£287,000,000	£2,573,500,000	£123,300,000	£493,800,000	

Source CPT, 2018

Figure 3-22 Bus operating costs in the UK

3.4.4 Case Study 1 – Phuket PAO

Officers from the Phuket Provincial Administration Organisation (PAO) met with the project team to discuss their experiences of operating bus services in and around Phuket. The PAO officers provided their experiences of operating bus services in and around Phuket.

Local bus services in Phuket are mostly provided by Songthaew (modified pick-up trucks). In recent years, there has been a reduction in the number of people using Songthaew to get around Phuket Town and a noticeable shift to more people using private cars and motorcycles. This has led to the commercially viability of services deteriorating over a number of years.

Phuket PAO obtains revenue from central government funding, as well as local taxes. As Phuket has many hotels which are subject to local taxes, it is one of the more affluent PAO's in Thailand.

Phuket PAO operates a fleet of 38 Songthaews along four routes – as shown in Figure 3-23. The four routes are numbered and coloured and operate intensively during the day:

Line 1 – yellow – 84 one-way trips per day

Line 2a – red – 84 one-way trips per day

Line 2b – blue – 80 one-way trips per day

Line 3 – green – 72 one-way trips per day

A flat fare is charged across all services – 15 Baht per trip. However, no fare is charged to students, monks and blind people.

Table 2.1 presents passenger numbers and fare revenues from operating each of the four Songthaew services between October 2017 and July 2018. It also illustrates the revenue that the operators receive from non-farebox sources.

There are around 40,000 passengers using the four services per month. Routes 1 and 2A are the most popular services carrying around two thirds of all passengers and revenue. This is intuitive given that they operate more one-way trips per day than the other two services. Route 3 generates just 13% of revenues.

Figure 3-23 Songthaew routes in Phuket Town

On average, each one-way trip carries around six passengers. This fluctuates each month and by each service. It would be necessary to monitor passenger loadings and specifically peak time loadings to be able to assess whether services are operating with lots of spare capacity, or whether service levels accord with demand.

A final point to note from Table 3-4 is that advertising label rental generates 10.7% of all revenues. This is positive as it reduces slightly the importance of farebox revenue. The reasons for the fluctuations in advertising revenue each month is unclear as December, March and June appear to generate significantly more revenue than other months.

Table 3-4 Songthaew operating revenues in Phuket town

Month	Fare Operation				Number of passengers	Total Fare Operation	Advertising Label Rental	Total Revenue
	Route 1	Route 2A	Route 2B	Route 3				
Oct-17	205,905	202,665	117,165	79,365	40,340	605,100	5,000	610,100
Nov-17	191,625	180,360	112,710	72,060	37,117	556,755	10,000	566,755
Dec-17	233,880	206,985	138,540	85,560	44,331	664,965	109,900	774,865
Jan-18	214,065	191,565	146,520	82,815	42,331	634,965	43,000	677,965
Feb-18	195,720	163,515	141,285	74,820	38,356	575,340	82,000	657,340
Mar-18	213,690	181,740	140,055	84,630	41,341	620,115	150,000	770,115
Apr-18	197,490	174,180	140,865	92,160	40,313	604,695	60,000	664,695
May-18	198,195	188,190	113,715	79,365	38,631	579,465	65,000	644,465
Jun-18	152,580	137,700	84,405	56,520	28,747	431,205	120,000	551,205
Jul-18	190,500	182,145	108,090	74,310	37,003	555,045	52,000	607,045
Total	1,993,650	1,809,045	1,243,350	781,605	388,510	5,827,650	696,900	6,524,550

Table 3-5 presents operating costs for the four Songthaew services in Phuket by month. This shows that for the 10-month period to July 2018 operating costs totalled THB 17,433,091. There are various aspects of operating costs. The operating costs incurred by private operators are fixed each month, but account for 55% of all costs. Fuel accounts for 31% of costs while all other costs are comparatively insignificant. This profile of operating costs is more aligned with the experience of UK bus operators who find that driver and fuel costs account for the majority of the cost of operating bus services.

Table 3-5 Operating costs in Phuket Town

Month	Operating wage by Private Sector	Maintenance	Fuel	Engine Oil	Office Materials	Vehicle Materials	Insurances and Taxes	GPS Connecting Service	Overtime Operation	Other Costs	Total
Oct-17	£ 965,000	£ 4,450	£ 505,373	£ -	£ -	£ 4,214	£ -	£ 28,462	£ 25,130	£ 1,873	£ 1,534,501
Nov-17	£ 965,000	£ 14,520	£ 509,076	£ -	£ -	£ 60,765	£ -	£ 28,462	£ 23,900	£ 24,500	£ 1,626,223
Dec-17	£ 965,000	£ 35,000	£ 517,840	£ 68,800	£ -	£ 327,987	£ 63,380	£ 28,462	£ 28,270	£ 23,052	£ 2,057,791
Jan-18	£ 965,000	£ 12,170	£ 531,369	£ -	£ 94,160	£ 28,640	£ -	£ 28,462	£ 24,690	£ -	£ 1,684,491
Feb-18	£ 965,000	£ 12,500	£ 486,718	£ -	£ 107	£ 62,060	£ -	£ 28,462	£ 24,050	£ 1,156	£ 1,580,053
Mar-18	£ 965,000	£ 13,710	£ 543,618	£ -	£ -	£ 288,791	£ 278,180	£ 28,462	£ 28,810	£ 4,922	£ 2,151,493
Apr-18	£ 965,000	£ 5,635	£ 527,276	£ 17,100	£ -	£ 31,477	£ 102,346	£ 28,462	£ 20,760	£ 3,050	£ 1,701,105
May-18	£ 965,000	£ 1,330	£ 577,756	£ 17,100	£ -	£ 31,514	£ -	£ 28,462	£ 22,120	£ -	£ 1,643,281
Jun-18	£ 965,000	£ 1,480	£ 548,657	£ -	£ -	£ 180,754	£ -	£ 28,462	£ 19,910	£ 1,338	£ 1,745,601
Jul-18	£ 965,000	£ 6,430	£ 585,978	£ -	£ -	£ 101,361	£ -	£ 28,462	£ 21,320	£ -	£ 1,708,551
Total	**£ 9,650,000.00**	**£107,225.00**	**£5,333,662.35**	**£103,000.00**	**£94,267.00**	**£1,117,562.00**	**£443,905.01**	**£ 284,620.00**	**£238,960.00**	**£59,889.68**	**£17,433,091.04**

While the operating costs from the private sector operators are fixed, it is possible to understand the costs that they incur in more detail, as shown in Table 3-6 Private operator costsTable 3-6. Of the THB 965,000 monthly cost, it appears that, including VAT at 7%, the operators incur a small loss of THB 11,910 per month. Of the total cost, drivers, ticket officers and route chiefs account for 78%.

Table 3-6 Private operator costs

Rank	Detail	Number of Person	Wage per Person (Baht)	Total Budget (Baht)
	Office Sector			
1	Manager	1	25,000	25,000
2	Accountant	1	11,000	11,000
3	Admistrative Officer	1	10,000	10,000
	Operating Sector			
1	Route Chef	4	16,000	64,000
2	Driver	28	14,000	392,000
3	Ticket Officer	28	11,000	308,000
4	Guard	3	11,000	33,000
5	Parking Fee for Route No.1	-	-	5,000
6	Parking Fee for Route No.2	-	-	5,000
7	Management Cost and Other Costs	-	-	60,000
Total Cost				913,000
Vat (7%)				63,910
Total Monthly Budget				976,910
	Total Budget in 12 Months			11,722,920

Taking account of all costs and revenues,

Table 3-7 illustrates the net result. It is apparent that operating Songthaew services generates a loss of around THB 1million per month with revenues accounting for just 37.4% of total costs.

Table 3-7 Net profit of Songthaew services in Phuket Town

Month	Total Fare Operation	Advertising Label Rental	Total Cost	Profit
Oct-17	605,100.00	5,000.00	1,534,501.30	-924,401.30
Nov-17	556,755.00	10,000.00	1,626,223.12	-1,059,468.12
Dec-17	664,965.00	109,900.00	2,057,791.21	-1,282,926.21
Jan-18	634,965.00	43,000.00	1,684,491.26	-1,006,526.26
Feb-18	575,340.00	82,000.00	1,580,052.79	-922,712.79
Mar-18	620,115.00	150,000.00	2,151,493.17	-1,381,378.17
Apr-18	604,695.00	60,000.00	1,701,105.17	-1,036,410.17
May-18	579,465.00	65,000.00	1,643,281.22	-998,816.22
Jun-18	431,205.00	120,000.00	1,745,600.90	-1,194,395.90
Jul-18	555,045.00	52,000.00	1,708,550.90	-1,101,505.90
Total	5,827,650.00	696,900.00	17,433,091.04	-10,908,541.04

With operating revenues accounting for just 37.4% of costs, it is necessary to question whether there is more that could be done to make services more commercially viable in terms of increasing revenues or reducing costs. To this extent, it is necessary to consider why private modes are becoming more attractive and what public transport operators can do to encourage greater levels of ridership.

One obvious aspect is to improve service quality. Service quality includes many aspects including, but not limited to:

- Frequency of service
- Operating hours
- Geographic extent of service provision
- Facilitated interchange
- Journey time
- Journey time reliability
- Vehicle quality
- Passenger comfort and facilities
- Vehicle accessibility

Improving any of these service quality attributes requires a targeted approach depending on the objectives. Improving the frequency of a service for example, requires a consideration of the number of vehicles required to operate at that headway or frequency, plus fuel and driver costs. Enhancing operating hours requires using existing vehicles for longer periods of time, reducing the opportunities for routine maintenance unless additional vehicles are provided, which provides an additional cost. Improving vehicle quality requires initial capital investment and/or leasing costs. In short, all attempts at improving service quality requires additional investment being made which, within the current regulatory framework, is difficult for private operators due to the deteriorating financial outlook for public transport services. To improve public transport services therefore, requires either government support to ensure it is commercially viable which allows investment in services or support to either increase revenues or reduce operating costs.

Some areas of service improvement are within the control of an operator. Other areas, however, are within the control of local or national government. Improving journey times and journey time reliability, for example, may require dedicated bus priority such as bus lanes so that cars and other road users do not impact upon bus journey times. Alongside this, facilitating interchange in order to maximise the network effects of different public transport services requires co-ordination with other modes such as mass transit

and/or rail. This cross-mode co-operation may not be within the influence of bus operators, thus the role of local and national government is important.

To increase revenues, there are two main options: either increase the fare that existing passengers pay (which is likely to be met with some resistance from passengers) or encourage more passengers to use the service. Of the two options and based on anecdotal evidence that these services have lost passengers to private modes in recent years, it would seem that there is sufficient capacity to encourage more users to use the services (there is an average of around six passengers per one-way service) rather than increase fares. To improve the financial viability of services in Phuket alone, a separate study would need to be carried out (if it hasn't already) to identify the most appropriate measures to increase patronage and revenues. To compete with private modes, there are numerous options available. Firstly, the supply of services could be enhanced through greater investment in services to better meet the needs of existing and potential users. This could include improved quality of service i.e. frequent services, more attractive vehicles, lower fares etc.

One mechanism to invest in improved service quality is to support a reduction in operating costs. One mechanism may be to use technology to better align supply with demand. Mayday, a non-profit organisation has been testing an app-based technology in Khon Kpaen that allows bus services to be more responsive to demand. This is something that Phuket PAO and bus operators could consider when and where a more flexible route could improve service levels for users and, hopefully, improve demand.

It doesn't appear that there is any significant profiteering from the private operators, in fact, it appears that they make a small loss. The other costs are incurred by the Phuket administration directly, and these costs do not appear unusual. It is possible that if fuel was cheaper through some form of subsidy, this would result in lower operating costs, but this is unlikely to be sufficient to cover the net financial loss of operating services in Phuket.

Alongside enhancing the supply of services, demand measures also need to be considered carefully. There are numerous demand management measures that could be considered, and these should be targeted at meeting local policy aims.

Overall, Phuket PAO can afford to accept a loss due to local taxes etc. But other provinces and urban areas are likely to be less able to afford to subsidise public transport services in the same way. This is therefore a risk to public transport provision across urban areas of Thailand, something that a national urban mobility programme could help to overcome as it does in many countries worldwide.

3.4.5 Case Study 2 - BMTA

The largest operator of bus services in Thailand is the Bangkok Mass Transit Authority. The BMTA is a state enterprise in the public utility category under the Ministry of Transportation and was established in 1976. BMTAs primary function is to operate mass transportation of passengers in Bangkok and between Bangkok with the provinces of Nakhon Pathom, Nonthaburi, Pathum Thani, SamutPrakan, and SamutSakhon. All data referred to in this section derives from the BMTA 2016 Annual Report.

In 2016, BMTA operated 2,774 buses, of which 1,562 were regular buses and 1,212 were air-conditioned buses. The following sets out the key statistics from BMTA's bus operations in 2016:

- 2,615 buses used – 94% of the fleet
- 114 routes
- 218,990,664 km travelled by BMTA buses (1.23% less than in 2015)
- 68,290,484 litres of diesel oil/year
- 28,204,625 kg. of gas/year
- Ticket sales totalled 307,407,402 tickets/year

- Total revenue of 3,321,714,894 baht/year

Fare revenues can be split into two main parts: on-bus revenue and off-bus revenue. In 2016, BMTA generated THB 3.18b of revenue from on-bus sales and THB 145.4m from advanced tickets, coupons and monthly cards. Just 4.4% of revenues are therefore collected off-bus, while over 95% of revenues are collected on bus. There has been an increase in off-bus sales, as these sales increased from THB 136.7m in 2014 and THB 141.6m in 2015 to THB 145.4m in 2016. The rate of growth, however, is some way from impacting upon on-bus fare revenues. As a consequence, the role of fare collectors on board buses remains essential.

Fare revenue appears to be on a downward trend. Compared to 2015, fare revenues were 2.2% lower in 2016. BMTA suggest that this reduction is the result of a reduced bus fleet, thus fewer kilometres operated. BMTA does obtain other sources of revenue. All revenue sources and amounts for 2016 are below. It is evident that government subsidy is almost the same amount as bus fares (including season product sales), and between them, these two revenue sources account for around 90% of all bus operation revenues. Other revenues are mostly derived from private bus operators who operate services on behalf of BMTA.

Bus fare	฿ 3,176,345,647.50
Happy family income	฿ 32,276,933.00
Government subsidy	฿ 3,189,458,612.00
Monthly pass revenue	฿ 15,500,005.00
Coupon sales	฿ 129,868,242.00
Share from fares of private joint bus	฿ 472,883,101.00
Share from fare of minibus	฿ 23,679,800.00
Share from shuttles in Sois	฿ 7,794,184.00
Share from fare of vans	฿ 73,861,433.00
Bus rental	฿ 28,238,144.00
Revenue from public service subsidy	฿ 886,020,283.00
Other	฿ 273,031,782.00
Total	**฿ 8,308,958,166.50**

Operating costs are summarised by BMTA as bus operation overheads, administration overheads, other costs and financial costs. These amounts are shown below, along with a calculation of profit/loss. It is evident that BMTA made a financial loss of THB 4.8b in 2016 (US$147m), which was slightly greater than the loss incurred in 2015 of THB 4.79b. Despite the various revenue sources, including significant government subsidy, BMTA continues to make a significant loss each year.

Bus operation overhead	฿ 8,060,346,783.00
Administration overhead	฿ 2,171,368,583.00
Others	฿ 1,949,310.00
Financial cost	฿ 2,877,519,652.00
Revenue	฿ 8,308,958,166.50
Net profit/loss	-฿ 4,802,226,161.50

BMTA, in their 2016 annual report, carried out an appraisal of their own performance and provided various reasons why they continue to incur financial losses. The first point they highlight is that fares are deliberately below the cost of operations as most bus users have 'low to middle incomes. With a reducing income from farebox revenues, this issue is likely to deteriorate in coming years.

BMTA has a large organisational and bureaucratic structure which is aging. This has resulted in a lack of innovation, new ideas and desire to embrace new technologies to drive more efficient working practices.

Two other deficiencies that BMTA recognises in their internal practices are poor depot facilities for vehicles, as well as the poor condition of buses. On average, 320 buses per day break down, which makes operating bus services very inefficient, and a very poor level of service for the user. Unreliable services typically result in declining patronage and therefore farebox revenues which results in a cycle of decline in bus services. It is apparent that this cycle needs to change if private motorists are to be encouraged to shift towards public transport.

While the above factors are things that BMTA has come control over, it is also impacted from external influences that it has little control over. The first of these is traffic congestion and infrastructure construction works impacting upon long and unreliable headways. This encourages people to seek to use elevated rail services and other private modes.

Despite operating a large number of services, BMTA services continue to see competition from unregistered and unregulated public transport services. These services do not have a permit to operate and are therefore illegal. Due to the nature of these illegal services, they do not follow rules with regards to passengers boarding and alighting, which can impact upon greater levels of traffic congestion which buses must sit in.

Finally, the current bus services are considered on a route by route basis as opposed to a network of services. This has led to repetitive services and a complex collection of routes. This is a result of a lack of central planning of bus services and integration of services with mass transit corridors. Thus, the DLT as the public bus service regulator plans to propose reorganisation of bus services to ensure their primary role is that of feeder services to rail mass transit.

BMTAs self-appraisal appears honest and highlights a number of ways in which it can improve and in which government or other agencies could make improvements to improve the economics of operating bus services in Bangkok. In fact, many of the same issues are likely to be relevant to other urban areas in Thailand which helps to highlight some of the weaknesses and threats that a NUMP could help to alleviate.

3.4.6 Summary of the case studies

This section has provided a review of the economics of operating bus services in Thailand, most notably in Phuket and Bangkok. Both case studies have shown that public transport services are loss making, and for both urban areas, these losses are growing as fewer passengers use the available services. Both areas are relatively fortunate as they receive alternative sources of revenue that help to fund these losses – in Phuket the local administration is able to use local taxes levied on the tourism industry to subsidise public transport, while in Bangkok central government provides significant subsidy (as much as BMTA receives through the farebox) to help fund the loss making BMTA. This is positive for both of the case study areas, but other areas in Thailand may not be so lucky to access to such funds. This potentially creates an inequitable outcome as more affluent urban areas and provinces can afford to subsidise bus services, whereas the less affluent may struggle. In addition, despite being heavily subsidised, they continue to lose passengers to other modes – notably private modes – suggesting that the current model for funding public transport could be improved.

One notable revenue source that is capped are fares. These are regulated by government using a 'cost plus' formula. Controlling the price of something can often lead to a shortfall in revenues as customers pay less than the cost of delivering a service – a point highlighted by BMTA. Price controls can typically have two effects; either excess demand, or shortage of commodity. In relation to bus services in Thailand, excess demand doesn't seem to be the issue, but the shortage of commodity is, as services cannot be operated to cover their costs.

There are two sides to the equation to assess the economic viability of bus services. Fares and revenue rest on one side and the fact that fares are regulated does inhibit an operator's ability to generate the revenue it needs/wants. However, on the other side of the equation are costs. This chapter has identified that, for BMTA at least, there are inefficiencies in how bus services are managed. Without a streamlined and efficient back office and management structure that acts like any other business to maximise revenues and minimise costs, BMTA is likely to always make a financial loss and require significant government subsidy.

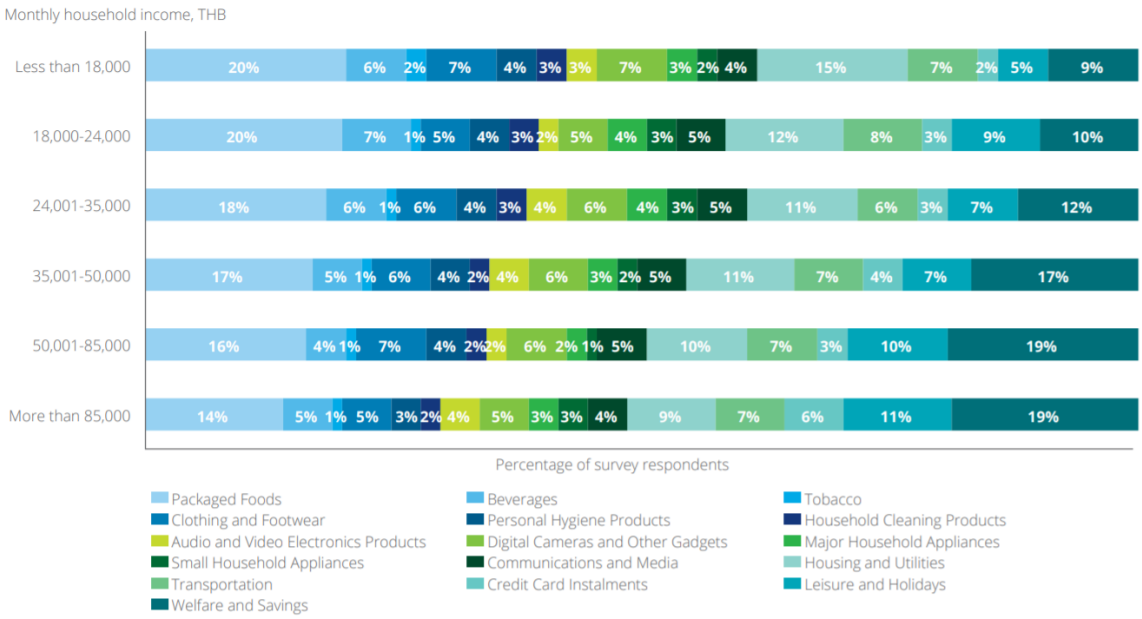
Finally, it is apparent that bus services are also hampered by factors that are outside of its control. Congestion is a major issue that increases journey times, fuel usage and driver and fare collector costs. One way of supporting bus services in Bangkok, Phuket and elsewhere, would be to provide greater levels of priority over private modes, so that journey times are at least comparable to car journey times. This priority can come in many forms, and should be focussed on overcoming the issues faced by buses in specific areas. This would require greater study on the specific characteristics of issues that buses face in different cities, areas and even isolated corridors.

3.4.7 Household transport spending

The users of transport services help to contribute towards the cost of providing those services. It is necessary to consider the impact of these costs on household budget.

Transport spend as a proportion of household income is consistent across all income groups, according to Deloitte[21]. For those households with THB 18,000 or less per month (US$545/month), transport accounts for approximately 7%. Those in the THB 18,000-24,000 bracket spend slightly more (8%) of household income, while those households with the highest income spend around 7% of income on transport. This is shown in **Fehler! Verweisquelle konnte nicht gefunden werden.** below.

[21]https://www2.deloitte.com/content/dam/Deloitte/jp/Documents/consumer-business/cp/jp-cp-ci2016tl-eng.pdf



Source: Deloitte, 2016

Figure 3-24 Transport spending as a proportion of household income

The Deloitte report is slightly at odds with official government statistics. According to the National Statistics Office and based on a household survey carried out in 2015, households spend between 16% and 20% of their household income in vehicles and transportation. This varies slightly by region as follows:

- In Bangkok metropolitan area including Nonthaburi, Pathum Thani and SamutPrakan 18.9% of monthly household income is spent on vehicles and transport
- In the northern region, 16.4% of household spend is on transport
- In central and north eastern regions, 18.3% of household spend is on transport
- In the south, 19.4% of household spend is on transport

Comparing Thailand with Europe, the European Environment Agency[22] reported on the proportion of household income spent on transport across all European countries. In 2008, French households spent an average of 14.6% of household income on transport, of which around 3.5% was on purchasing vehicles, around 9% on operating personal vehicles and around 2.1% on other transport services (public transport). Households in the Netherlands and Belgium both spent around 12% of income on transport. Therefore, if Thai households are spending between 16% and 20% of household income on transport, as per the Deloitte report, then this would be in line with expectations.

Comparing income directly to the price of bus fares, the following is noted. The minimum daily wage in Bangkok is THB 325 per day (US$10/day), elsewhere the minimum wage ranges from THB 308 to THB 330 per day. As discussed in paragraph 3.4.2, bus fares range from THB8 to THB25for a single journey, depending on the type of vehicles used and distance travelled. Assuming two bus trips per day, travelling by bus accounts for between 4% and 14% of the daily minimum wage.

While bus users typically only face the cost of bus fares, car users face a variety of costs, taxes, tolls and charges. Excise tax is levied on the purchase of new cars, with a scale that attempts to encourage less polluting (or CO_2 emission) models by setting the new tax scheme according to their CO_2 emission levels, e.g. below 100, 101-150, 151-200 and above 200 g CO_2/km, as well as a rather high CO_2 emission ceiling

[22] https://www.eea.europa.eu/data-and-maps/indicators/expenditure-on-personal-mobility-2/assessment

of 200 g CO_2/km. Motorcycles are taxed at between 3% and 20% depending on the cylindrical volume but will use CO_2 emission per km as criteria for setting its excise tax level starting from 2020 onwards.

Excise tax is also levied on petroleum products at rates that differ based on the fuel type. Excise tax on gasoline is THB 7/litre, while gasohol with varying concentrations of ethanol are taxed at THB 1.05/litre for E85, THB 5.60/litre for E20 and THB 6.30/litre for ethanol concentrations of not less than 9%.

'Domestic transportation by way of land' is exempt from VAT.

There is an annual vehicle tax levied on motorised vehicles, and these vary based on vehicle category. For motorcycles, annual tax costs are around THB 300-400, while for cars and pick-ups, costs range from THB 1000 to THB 7000.

Car users are charged for using toll roads. Each toll road operator has varying prices depending on journey length and these are set in the original concession agreement and updated on a pre-agreed timetable. For example, on the Utraphimuk Expressway in Bangkok, toll charges are reviewed every five years. Car users also pay parking charges where they are in place. At locations such as airports and central shopping malls, land owners charge for car parking.

4 Review of Inventory and Diagnostic Analysis of Status Quo

The inventory analysis provided a thorough review of the existing urban mobility planning and regulatory framework as well as the societal impacts of urban mobility systems. This chapter initially presents some of the key findings from the inventory phase, before developing a SWOT analysis of urban mobility planning and processes across Thailand. Specifically, this chapter will consider the strengths, weaknesses, opportunities and threats of:

- Existing governance structures
- Budgeting and funding
- Capacity building
- Use of technology

General observations on present arrangement within each of these categories are drawn before considering in turn how these relate to the main areas of urban transport provision, with individual consideration of:

- Non-motorized transport
- Public transport
- Freight

4.1 Governance

4.1.1 Institutional and regulatory framework

The institutional and regulatory structure that governs urban mobility is led by numerous stakeholder agencies. Figure 4-1 highlights the key government departments that have a key role in the planning and delivery of urban mobility systems. The allocation of roles identified as part of the inventory analysis shows the following:

- The Department of Land Transport (DLT) is responsible for the delivery and planning of public transport services at a provincial level but not including the responsibility for mass transit services which belongs to MRTA.
- The DLT licences operators and monitors adherence to the licence conditions, while it plays a role in determining fare levels which are regulated based on a cost-plus formula.
- The Office of Transport and Traffic Policy and Planning (OTP) is responsible for the planning for all transport and works closely with all relevant agencies to develop optimal plans. In particular, it collaborates with the Department of Public Works, Town and Country Planning to ensure an integrated transport and land use planning process.
- Where the planning and delivery of specific functions is specialist, the Ministry of Transport has dedicated state enterprises that focus on those aspects. For example, the planning and delivery of mass rapid transit systems is carried out by MRTA, a specialist agency that focus on the effective planning and delivery of rapid transit systems. BMTA, the biggest bus operator in Bangkok, is wholly owned by government while SRT manage state railways and EXAT manage expressways.

Various observations can be made when considering the institutional structure of urban mobility planning and delivery:

- Highly centralised planning functions across government departments. The DPT has attempted to decentralise planning functions to local areas but found a lack of capacity at the local level to plan effectively.

- There are various agencies involved in the delivery of urban mobility. At times it appears that there is a lack of clarity around the planning functions – agencies are not legally obliged to follow the advice of OTP. And there appear to be some inconsistencies with the role of the police in managing traffic. With effective planning and traffic management technologies, there theoretically should not be a need for the police to direct traffic manually, instead they could focus that time and resource on monitoring adherence to traffic and vehicle regulations.
- The strong link between the agencies that plan land use plan transport is encouraging. Both disciplines are integral to the efficient functioning of urban areas so having this mechanism in place should benefit future urban mobility planning.
- Separate agencies have specialist functions. This helps to define planning and delivery roles.

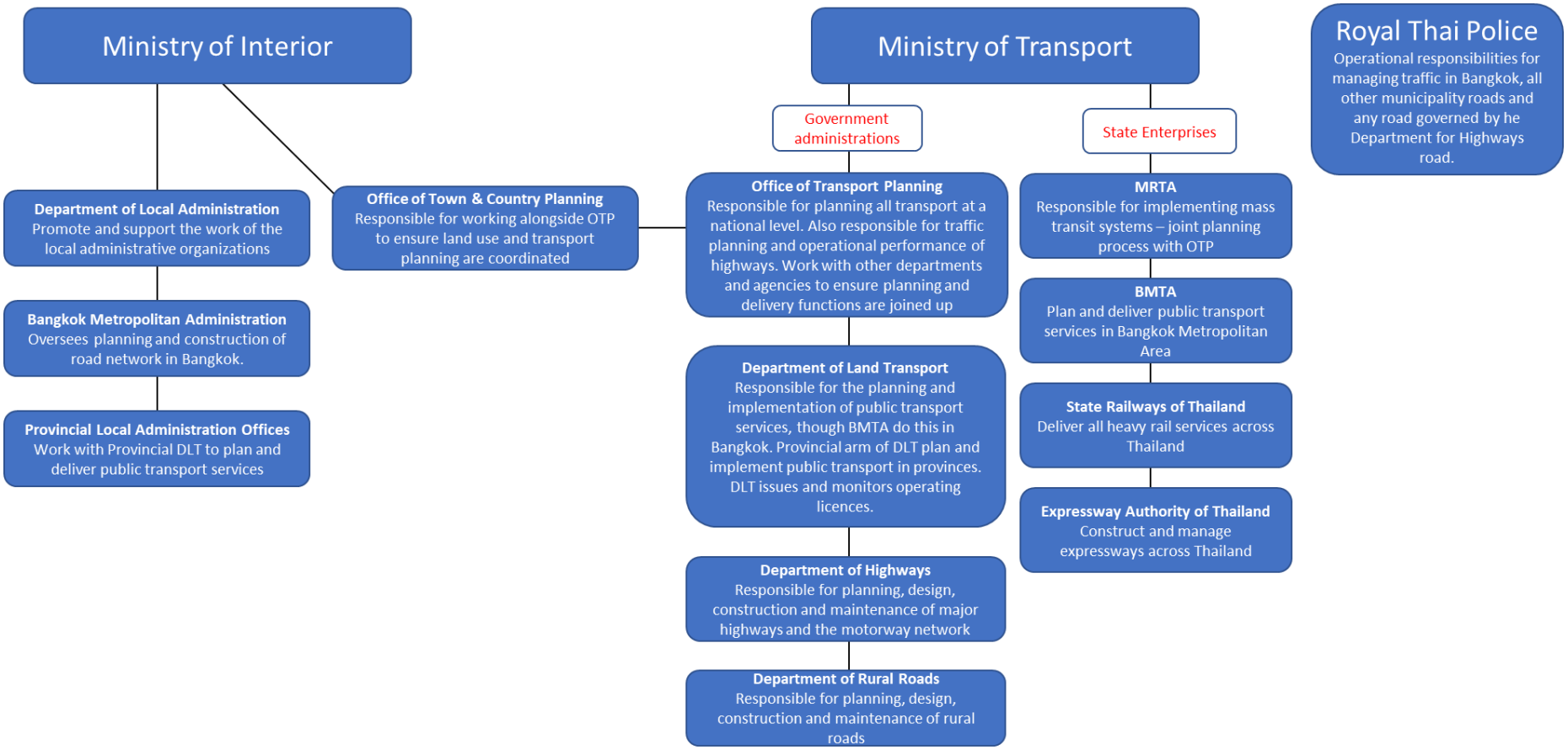


Figure 4-1 Key agencies involved in planning and delivering urban mobility

4.1.2 Current Government policy framework

The overarching government policy framework is provided by the National Economic and Social Development Plan (NESDP), the current Plan being for the period 2017 – 2021. The Plan sets out 10 development strategies for the five-year period, each spanning across a variety of sectors and Ministries. One of these strategies is for 'Advancing Infrastructure and Logistics' for which transport is a central component.

The transport-related targets which the NESDP put forward are to:

- Increase the proportion of freight transportation that uses the railways and waterways;
- Raise the proportion of passengers using public transportation systems in urban areas
- Expand the capacity of the Bangkok airports and of regional airports to meet increasing demand from passengers.

The NESDP goes on to detail four ways in which urban transport should be improved:

1. Develop urban public transport systems consistent with the economic and social conditions of urban areas. The country should accelerate the construction of mass-transit city-rail projects in Bangkok and develop appropriate systems in Khon Kaen, Chiang Mai, Songkhla, Hat Yai, and Phuket.
2. Improving the quality of bus services and rerouting bus lines to connect passengers to the core public transport network and increase the use of public transportation. Local government organisations should be encouraged to increase their role in improving public transportation in order to accelerate the development of public transportation in regional areas.
3. Develop land around transport stations to encourage and maximise public transport use. In addition, stricter enforcement of urban planning regulations should be led by each city's local government.
4. Expanding infrastructure to support non–motorised modes in urban areas by improving crosswalks, footpaths, and bicycle lanes along local routes leading to the city's public transportation network. In addition, infrastructure must consider the universal design concept.

The NESDP therefore provides a framework and policy direction around which urban areas can enhance mobility for its residents. In fact, several of the projects identified within the NESDP have been planned for or are being implemented. The development of urban rail mass transit corridors in Bangkok is continuing with 555 km of new rail lines being implemented by 2029 in line with the M-Map and M-Map2 plans. Outside of BMR, OTP has developed transport masterplans for Nakhon Ratchasima, Khon Kaen, and Chiang Mai.

The development of a NUMP must complement this national framework and strategy to deliver the changes needed to enhance urban mobility. However, the framework does focus largely around supply side measures which is sub-optimal as the demand for travel (use of private modes in particular) also needs to be managed.

A review of the present status of the existing governance structures is considered below, within the SWOT framework.

4.1.3 Strengths

The transport governance structure appears relatively clear, with distinct planning, regulatory, and delivery functions. Dedicated state enterprises focus on specific areas of delivery, such as railways (SRT), mass transit (MRTA) or bus services in Bangkok (BMTA) which helps to focus their remit.

There is a recognition by national government, in particular, of the need to invest in sustainable transport, as evidenced by the NESDP and various urban transport plans that are in place or being developed. Investment in public transport infrastructure in Bangkok is evident, and there are efforts to speed up the infrastructure building process through the Transport Future Fund to lever public and private sector funding to enhance infrastructure in the short term.

Whether mass transit is appropriate is dependent on the prevailing conditions in each area and this report does not attempt to appraise the benefits or disbenefits of the plans in place. However, the fact that OTP, DLT, MRTA, and other agencies are involved in planning improved transport networks is a strength.

Urban transport masterplans are developed by OTP with support from regional academics and experts. These plans typically use evidence-based transport planning to overcome issues found in local areas. OTP develops and proposes strategic development plans and identifies the delivery body within the MoT. For added scrutiny, the Office of the Permanent Secretary examines and screens OTPs plans, whilst also proposing an appropriate budget to the minister directly.

The collaboration between OTP and the DPT ensures land use and transport planning is coordinated. This is essential for the development of all urban areas to allow for the efficient movement of people and goods. It is unknown what impact this collaboration has had in practice, but the theory suggests that the governance structure of planning for urban mobility is in place.

4.1.4 Weaknesses

A variety of weaknesses with governance structures and planning have been identified both by the study team and by stakeholders. A key weakness relates to the highly centralised planning functions that exist within the government. As all land use and urban transport masterplans are developed by DPT and OTP, this means that local governments do not develop their own plans and deliver those based on local priorities. There have been attempts, notably by the DPT, to devolve planning responsibilities to local governments, but this process has stalled as local governments were not seen to have the required capacity and skills to develop their own plans.

Urban masterplans tend to focus on a long period of time – up to 20 years with short, medium, and long-term actions. What the plans do not do is monitor and evolve as situations and priorities change. This is a potential weakness in the planning process.

A further weakness in the urban master planning process is the fact that plans do not have to be implemented. As the delivery agency (the municipal government in most cases) has not been at the heart of planning urban mobility improvements, it is not obliged to implement the plans developed for it.

Urban masterplans tend to focus on heavy infrastructure and making largescale changes. While non-motorised modes are mentioned, there is little in the way of NMT investment, despite the NESDP identifying NMT as a key recipient of investment and important link in the overall urban mobility system. This may provide an opportunity however, to place the responsibility for NMT planning & delivery on local governments (with appropriate funding).

Weak integration of modes is a result of a lack of joint planning processes between government agencies. This was identified within the February workshop by participants who stated that as departments and organisations have their own goals and targets, the implementation of projects can be sub-optimal when it involves multiple agencies.

There is a focus on major infrastructure projects that generate revenue, which favours mass transit, rail & expressway projects over NMT projects where revenue is not generated. Funds such as the Transport Future

Fund have been developed to 'fast track' private sector funding into revenue generating projects that can be delivered in the short term. This approach risks the delivery of large-scale projects, with sub-optimal access to that infrastructure.

There is a focus on supply side measures, most notably mass transit requiring investment in heavy infrastructure. This appears to be the focus instead of improving bus services. Buses will still perform an essential role in moving people around Bangkok, Chiang Mai, Phuket and many other urban areas, even with more rail mass transit lines. Plans to re-organise bus services are positive, but to just use buses as a feeder service to mass transit lines is not necessarily the most effective way of enhancing urban mobility around the capital city. In fact, it is a potentially regressive step if the generalised cost and actual cost of travel for those on lower incomes increases as a result of proposed changes.

Along with enhancing existing services, demand side measures are important to consider and current plans do not make clear how this could happen in urban areas across Thailand. Governments appear not to have much control over car parking in urban areas as the private sector has historically been encouraged to provide it when developing residential and commercial properties. This constrains demand management tools available to urban areas to manage their transport system.

Regulated bus fares, while minimising the cost to users, do have weaknesses. As noted by Ongkittikul and Thongpat (2018), the fare calculation mechanism makes assumptions on load factors, but without adjusting those load factors when there are new licences issued to new operators. It has been observed that regulated bus services have a lower load factor and therefore a lower profit margin than assumed by DLT. This reduced profit disincentivises investment in services and vehicles and has a knock-on effect on the maintenance of vehicles, which in turn reduces the reliability and attractiveness of public transport. With a deteriorating level of service, this will only encourage people to shift towards more attractive personal modes of transport, which is what has happened in recent decades. The effect of this can be seen in declining bus patronage and increasing car ownership.

The government guarantees BMTA debts and funds interest costs to allow BMTA to provide bus services. This does not encourage BMTA to make their services more efficient, nor does it encourage BMTA to streamline their management and back office functions. It is not clear whether measures have been put in place to encourage BMTA to streamline processes, but the 2016-17 annual report suggests that the back-office function at BMTA is inefficient.

In the current regulatory and governance structure, some private operators are unwilling to follow timetables and formal scheduling for fear of making an operating loss. If operators do not adhere to schedules, then this makes networks less efficient and therefore a poorer service for users. If operators are permitted to not follow schedules, then this highlights an issue in the monitoring of contract adherence.

The lack of enforcement and contract adherence was identified by workshop participants as a key weakness in the governance structures in Thailand. There was a perception that while Thailand has many plans and attempts to deliver some of these, the lack of enforcement in some of the regulations it attempts to implement means that the benefits of the plans are constrained.

Finally, a major weakness relates to the lack of controls to acquiring a private car. At present, there are no controls to discourage purchasing cars. On the contrary, the first car buyer incentive scheme introduced in 2011 actively encouraged people to purchase a car for the first time and offered a generous tax rebate ($350-$3,250 for a mid-sized car) for doing so. The reasons for the policy was to encourage a shift from motorcycle to car, whilst also boosting car sales to boost economic growth. By encouraging car ownership in this way means that people have invested in private cars so will be harder to shift onto public transport.

4.1.5 Opportunities

Despite the weaknesses, there are numerous opportunities to develop current practices and enhance governance and planning processes. Firstly, there is the potential to decentralise planning capabilities to local governments, so they can develop their own urban transport plans, with support and guidance from OTP. This provides a greater level of autonomy and ownership at the local level and means that plans can be monitored and can evolve over time as the challenges evolve. OTP should play a supervisory and overseeing role, providing expert technical advice, developing national guidance etc.

A further opportunity within the transport planning process is to place greater emphasis on non-motorised modes in order to prioritise non-CO_2 emitting modes and enhance connectivity to public transport services. This is identified as a priority within the NESDP, but heavy infrastructure features more prominently within masterplans.

Co-operation between land use and urban transport master-planning is a major strength and continuing this level of cross-agency collaboration continues to be a major opportunity. This will help encourage urban areas develop to in a sustainable manner, promote the use of sustainable modes and potentially discourage private vehicle ownership and use.

Bus services do exist in urban areas across Thailand which provides an opportunity to enhance existing services to make services more attractive. National policy encourages local governments to support bus services and build upon existing networks. There are a variety of ways in which this can be done but providing greater levels of priority on congested roads could support the financial viability of bus services and encourage modal shift.

There are opportunities around the introduction of the Common Ticket Administration to help change the nature of funding public transport services. Within Bangkok, the development of a common ticket and a common fare structure could allow for differing financial models to support public transport. There is an opportunity to apportion revenue for common ticket use in a manner that encourages patronage growth and therefore greater levels of service sustainability.

Outside of Bangkok, there are opportunities to review the contractual basis upon which bus services are provided. This could encourage and incentivise investment in vehicles and service levels, but it requires a complete shift from existing institutional arrangements.

4.1.6 Threats

A significant threat to urban mobility is a growing rate of motorisation, particularly amongst motorcycles, and particularly in areas away from Bangkok. Growing motorisation rates tend to correspond with economic growth suggesting that continued economic growth is a threat to urban mobility. Ensuring non-motorised modes and public transport meet the needs of residents in urban areas is essential.

Workshop participants suggested that each government department and agency has defined aims, objectives and targets. Unfortunately, the clarity of roles for each department discourages cross department and cross agency co-operation.

The urban master planning process is a threat if plans are not updated based on evolving circumstances. Regular monitoring and local input to plan development is essential if the plans are to overcome issues today and tomorrow.

The 'First Car Buyer Programme', which ended in 2016, has encouraged car ownership for a number of years. Despite that this programme has now ceased, it makes it politically difficult for government to introduce demand management measures or any other measures perceived to be 'anti-car' any time in the near future. This threatens attempts to reduce CO_2 emissions, improve air quality and reduce congestion.

A further threat to reducing CO_2 emissions and improving air quality are the existence of fuel subsidies. The Thai government uses a state oil fund to limit the impact from increases in the global oil price. Continuing with such a policy is a major threat to sustainable travel as it encourages private mode use.

In Bangkok and other major urban areas, the urban transport masterplans developed tend to focus on mass transit. While this may or may not be optimal, focussing on just mass transit is a threat if connectivity is not provided through complementary public transport services, integrated ticketing and non-motorised access.

4.1.7 Recommendations

In order to improve air quality (and specifically PM2.5 levels) and reduce CO_2 emissions, a number of recommendations are made:

While supply side measures are the focus of transport masterplans, demand management measures are an essential ingredient to shift behaviour and should be considered equally as important as mass transit projects or bus service improvements. It is essential that in all urban areas, demand management measures such as road user charging, parking charging, and parking availability constraints are considered at the same time as supply side improvements.

Opportunities should be given to local administrations to invest in public transport services in order to partially decentralise decision making and provide those administrations with the responsibility to enhance public transport services. One mechanism for this could be to develop a fund that administrations could bid for (meeting specified criteria) in order to implement local projects.

It is recommended that before political decisions are taken on the fuel source of BMTA buses, a thorough evaluation of the optimal fuel source options is carried out. There is a danger that decisions could be taken without a full understanding of the well-to-wheel emissions and how different fuel technologies will perform operationally across Bangkok.

A final recommendation is to support the work of the Common Ticketing Office (CTO) to implement a common ticket and common fare structure across Bangkok. It is essential that the CTO implements a product that meets the needs of users and overcomes many of the barriers to travel today, most notably the generalised user cost of travel.

4.2 Budgeting and Funding

The nature of the financing of urban transport has important implications over its planning and delivery. The inventory analysis showed how government allocated funding towards transport and for what purposes.

4.2.1 Government Funding

Naturally, central government plays a key role in funding and financing transport across Thailand. The Ministry of Transport received THB 168.77b in 2018, accounting for 5.5% of all government spending. Compared to other countries, 5.5% of spending allocated towards transport is reasonable. Both Malaysia (2.8%) and the UK (3.75%) allocate a lower proportion of funding. However, Singapore allocates 12.25% of its government budget towards transport, which highlights the need to invest in transport if there is a desire for high quality public transport and NMT infrastructure.

The budget that the Ministry of Transport receives is dedicated towards both capital and revenue (day to day) spending. For the MoT, 90% of the budget is specifically for capital spending with just 10% for day to day spending and services. This demonstrates the government's priority to develop transport infrastructure in urban areas which is well documented within the inventory analysis. It also highlights the lack of focus on developing and improving existing bus services.

Local government budgets typically derive from the Ministry of Interior and local tax revenue. It is from these revenue sources that they are expected to support public transport services in their administrative areas. The inventory analysis showed how the Phuket Public Administration Organisation (PAO) supports the delivery of a small number of services in and around Phuket Town, yet services consistently make an operating loss, forcing the PAO to fund these losses from their own budget. This is something that is possible in Phuket due to local tax revenue from the tourist industry but is less possible elsewhere. Therefore, the funding of essential public transport services in urban areas can be dependent upon income levels, which benefits more affluent areas but not poorer areas.

Central government generates tax revenue from transport related activities. Fuel tax is commonplace across the world, and Thailand also has its own fuel taxes. There are various elements to fuel tax:

- Excise tax - collected by the Excise Department (MoF)
- Municipality tax collected by each municipality in which petrol stations are located
- 7% of Value Added tax collected by Revenue Department (MoF)

In addition to this, there is a fuel fund that acts as a fuel price stabiliser to dampen fluctuations in the oil price and an energy conservation fund which collects 0.1THB/litre from sales of all oil-based fuel types to invest in renewable energy promotion across Thailand. According to the Public Debt Management Office, many transport related taxes such as the that on fuel have a dedicated purpose. This means that they do not go towards 'general taxation', instead these revenue sources are destined for specific funds that have specific objectives.

4.2.2 Private sector funding

Government has used private sector funding in the past to construct transport infrastructure and looks set to continue involving the private sector in current and future projects. The Thailand Future Fund (TFFIF) has been set up to fund revenue-generating infrastructure projects and reinvest some of that revenue in more projects in future. The fund was only introduced in 2018 and initially focussed on two expressway projects, but the potential for the TFFIF to invest in other urban mobility enhancing projects is significant.

Government is seeking to speed up the process of encouraging private sector investment in developing transport infrastructure. In 2019 it is intended that the PISU Promotion Act will lead to shorter lead-in times for PPP projects provided they meet governments priorities for such projects. At the current time, rail mass transit projects appear to be the sole focus for urban mobility projects while other priorities include high speed rail, port infrastructure and expressways.

4.2.3 Strengths

Government is investing in infrastructure and has identified funding sources for rail mass transit across Bangkok. The recognition that for Bangkok to function efficiently requires mass transit that is segregated from other modes is positive and having the funding sources in place for this investment is a major strength. The same can be said of proposals to invest in mass transit in Chiang Mai, Phuket, and elsewhere. Recognising the problem and developing costed proposals to move people quickly and efficiently using mass transit is a key strength.

On the whole, transport does receive a reasonable allocation of the national budget (5.5%), including receiving more than Ministry of Health. What proportion of the budget is allocated towards sustainable modes is not known.

Fuel taxation is already in place to not only generate revenue, but to act as a disincentive to use private vehicles. Fuel tax is also levied to create the ENCON fund to reduce energy consumption from the transport

sector. More could be done with this form of taxation so that it is a part of a suite of demand management measures but having the tax mechanism in place is a strength.

Funding mechanisms based on future operating revenues being rolled out through the Thailand Future Fund (TFFIF). This helps fund major transport infrastructure in the short term while recycling funding to re-invest in other infrastructure projects without the need for solely central government funding.

4.2.4 Weaknesses

A key weakness identified by workshop participants is that funding of urban mobility planning outside of Bangkok is limited. A lack of direct funding for public transport - without financial support, local administrations are limited in the public transport services that they can provide. Without realistic alternatives, private modes will remain popular.

What funding is allocated towards transport, only a small proportion is reserved for operational spending with preference made for capital spending. While this is good for large infrastructure projects, it leaves little revenue to be spent on improving and enhancing existing bus services and/or encouraging non-motorised modes.

The historic use of PPPs has led to complexities in delivering projects. The contractual obligations of BTS and the Sukhumvit Line are such that it now makes it very difficult to develop common ticketing in Bangkok. This is a weakness that is not easily overcome within the existing concession timeframe. The lack of legislation around the introduction of common ticketing also inhibits the ability to develop an integrated public transport network in Bangkok.

Regulated bus fares limit revenue raising potential, which forces a focus on limiting costs, resulting in a lack of investment in vehicles as well as delivering a poorer quality service. Private operators also focus their efforts on the more profitable routes and at the more profitable times in order to generate a return on investment.

Finally, when funding is provided for urban transport projects, there is no ex-post analysis of the funding and what it achieved. A thorough evaluation of all projects should be carried out as a matter of course in order to develop a robust evidence base of what works and what doesn't, and how future projects can be delivered based on the experiences gained.

4.2.5 Opportunities

January 2019 saw an increase in PM2.5 levels over and above safe limits. This led to significant public concern, particularly in Bangkok, which has led to political desire to combat PM2.5 and other pollutants predominantly caused by vehicles. This provides a significant opportunity to use air quality as a justification for implementing travel demand management measures which may have been too politically difficult to implement without the PM2.5 issues.

The 12th NESDP 2017-21 recognised the need to reform urban transport and identified the potential for a public transportation fund to be set up to replace current Public Service Obligation. This is an opportunity to develop a fund that could be available to all provincial and municipal governments to bid for money to implement public transport projects locally.

A further opportunity to build on the air quality concerns and on the NESDP reform proposal is to consider a 'polluter pays' mechanism to generate revenue that can be invested in sustainable transport. There are various ways in which this can be done, and these should be considered carefully. If revenue can be retained locally, this could give local administrations with funds to invest locally in sustainable modes which could complement a public transport fund, discussed above.

Existing transport masterplans tend to focus on supply side measures in an attempt to resolve mobility issues. An opportunity therefore exists for local administrations to develop and implement demand-side measures that can help generate revenue to fund the supply-side projects and encouraging sustainable travel modes. There is value in considering giving local governments the power to introduce revenue generating powers whilst encouraging sustainable modes – parking restrictions, business parking levies etc.

A growing and stable economy increases re-financing opportunities on capital markets to help reduce borrowing costs for investment in transport infrastructure and services – a significant opportunity.

The final opportunity identified relates to the 2018 Fiscal Discipline Act. This Act aims to reduce opportunity of politicians to use state funding to implement populist policies in the future. Instead it places controls over members of the Cabinet to comply with strict financial and fiscal disciplines of the state. This provides an opportunity for the development of a NUMP to follow these guidelines and ensure political decisions are taken for the benefit of all residents.

4.2.6 Threats

Several threats have been identified to the funding and financing of transport in Thailand. First is the identification that Thailand spends just 5.5% of its budget on transport. Compared to Singapore (12.5%) this is low, and if Thailand wants to have urban mobility akin to Singapore then it may need to consider investing to a similar scale. High-quality transport options require sufficient funding.

The source of additional revenue for local administrations to invest in sustainable transport modes is a potential threat. There is a perception that it is easier to use indirect measures to change travel behaviour than it is to rely on the government budget for funding. If government does not put in place more accessible funds for administrations to invest in sustainable modes, then there is a danger that urban mobility will not improve.

The funding of major infrastructure projects could come from the Thailand Future Fund. While this is a strength overall and allows for the fast tracking of private sector funding to construct major projects in the short term, it does so by selling the future revenue generating ability of the projects. The threats are therefore two-fold: Firstly, it means that future revenues will go to the private sector as opposed to government revenues, and secondly it encourages the focus on high profile, revenue-generating infrastructure projects when optimal solutions may not require this.

Finally, due to Thailand becoming a middle-income country, it is no longer possible to benefit from donor agencies such as the World Bank, requiring the Thai government to find transport funding from other sources. While this is mostly positive, it does place the responsibility of funding urban mobility on the Thai government.

4.2.7 Recommendations

It is evident that there is a significant opportunity to build upon the political desire to reduce PM2.5 levels by developing a formal travel demand management (TDM) strategy. This strategy should provide a mechanism for not only generating revenue from TDM measures but also for spending revenue generated i.e. how it should be spent, by which organisations, what the investment priorities are etc.

With the numerous plans for constructing mass transit across urban areas of Thailand, it is recommended that government considers whether funding for public transport could be more effective. At present, bus operators are completely reliant on fare revenue, yet fare levels are dictated by government and government subsidy of bus services is not permitted. Without changing this approach, bus services are likely to suffer from a lack of investment in the future. It is therefore recommended that public transport funding is reviewed during the development phase of the common ticket and common fare.

4.3 Capacity Development

Strengthening and recognising the potential of human capital is at the heart of the 12th National Economic and Social Development Plan 2017-21. It states that Thai citizens still lack the knowledge, skills, qualities and attitudes needed to realise the country's development potential. It also states that Thailand's transportation and logistics infrastructure have remained inefficient and lack systematic connectivity and require to become more efficient.

In terms of the skills and capacity of Thailand to overcome the issues that it faces, the plan recognises that 'manpower in the field of transportation and logistics should be developed'. It goes on, 'infrastructure for science, technology and innovation remains limited, and there is a shortage of researchers both in terms of quantity and quality'. To overcome these issues identified, there are several initiatives that the government is focussing on.

Firstly, there is an aim to support the 'research and development of transportation related technology and innovation along with human resources to raise the capacity of the country to provide world-class transportation services, and for its transportation workforce to be equipped with up-to-date skills and be adaptable to changing technology and standards'. The NESDP goes on to state that 'human resource development should especially be emphasized in the aviation industry. Related agencies and academic institutions should collaborate in designing curricula and training tools that match the standards required by the International Civil Aviation Organization (ICAO), the European Aviation Safety Agency (EASA), the Federal Aviation Administration (FAA), and the Japan Civil Aviation Bureau (JCAB).

For railway, increasing knowledge transfer into and between Thailand's public and private operators, as well as academic institutions is a priority for the NESDP, in addition to increasing the capacity of railway-related human resources in Thailand. The plan also wants to encourage more railway related research, development, and innovation.

Collaborating with neighbouring countries is also thought to be an appropriate mechanism for the government to address skill deficiencies. The Indonesia-Malaysia-Thailand Growth Triangle has been set up with a number of actions, one of which is to enhance human resources development to strengthen human skills in all sectors.

OTP also recognises the importance of sharing skills and enhancing the capacity of the country to improve urban public transport. In its 2016 annual report, it set out how it will develop public transport in the city region. As part of this strategy, it seeks to prepare a 'handbook of public transportation in urban areas of the region'. This handbook seeks to set out the principles for collecting, storing and analysing data in order to identify issues with existing public transport provision and solutions to those issues.

4.3.1 Strengths

When it comes to capacity development, Thailand has numerous strengths. There is a recognition that skills play an important role in the future development of urban mobility across Thailand and that at present, Thailand lacks the necessary skills in a variety of industries, not just transport. There are strategies in place to try and bridge these skills gaps, although it is not entirely clear from published materials how some of the strategies will be delivered in practice.

Transport planning skills do exist in organisations such as OTP and MRTA and these can be built upon. That OTP has developed six research centres and a 'handbook for public transportation in urban areas of the region' illustrates its desire to share and disseminate this expertise with other organisations, particularly local administrations.

The skills developed within MRTA has provided the organisation with consulting capacity for mass transit planning. MRTA has a reasonably qualified workforce with officers who are certificated in railway engineering and planning and also financial analysis.

This can not only benefit urban areas of Thailand but can also become an 'export' when supporting other urban areas across the region and further afield.

4.3.2 Weaknesses

The National Economic and Social Development Plan 2017-21 identifies a lack of skills as a weakness in transport systems development. In its plans to alleviate these weaknesses however, it identifies the need to improve skills in aviation and railway. While skills in these industries are necessary, it overlooks the skills needed to plan and operate urban public transport systems as well as planning non-motorised transport networks. Urban mobility requires a specific skill set to be able to understand travel demand and accommodate that through efficient transport networks that do not rely on private modes in order to function.

At the local government level, there appears to be a lack of drive, confidence and/or awareness to deliver transport projects independently, instead relying on OTP to tell them what to do. The roles and responsibilities of OTP and local government officers is not clear. A similar issue is also evident at BMTA where the operator is regulated what to do by central government. This lack of autonomy and centralisation of decision-making powers weakens the role of local administrations in the delivery of transport services that are optimal for local areas.

BMTA is aging with few new ideas being adopted. To improve the financial position, it is necessary to ensure the management structure is streamlined and fit for purpose. BMTA should be run like a business, not the civil service in order to maintain (and enhance) services for all users.

The evaluation of the delivery of transport projects tends to focus on project outputs. Instead, greater focus on outcomes and the process undertaken to achieve those outcomes is required in order to build an evidence base of successful and unsuccessful transport projects.

4.3.3 Opportunities

The development of six research centres by OTP is an opportunity to broaden skills and capability at the local level to plan and deliver transport projects. Building on this example could help ensure all local governments have the necessary skills to plan and manage their own transport systems.

OTP's development of a 'handbook of public transportation in urban areas of the region' could significantly enhance the capacity of local municipal and provincial governments to identify their own transport issues and solutions. Working alongside OTP, DLT and other agencies could then transfer some of that knowledge and skills to a local level where projects that meet the needs of local people can be developed and delivered.

Effective monitoring and evaluation of outputs and outcomes of transport projects provides an understanding of the impact of different projects and builds up a local evidence base to aid future decision making. Evaluating project outcomes and processes against clear indicators is essential for understanding the successes and failures so that future projects can benefit from this knowledge.

4.3.4 Threats

The NESDP identifies a lack of skills as a weakness in transport system development. It identifies the need to improve skills in aviation and railway but overlooks the skills needed to plan and operate urban public transport systems and planning non-motorised transport networks, particularly at the local level. This is a

threat to urban mobility in the long term if decisions are taken by central government that may not be suitable over the long term for local areas.

While some agencies lack some skills, there is a broader threat when agencies such as BMTA cannot ensure that the people with the skills required are in the relevant positions. As identified by BMTA themselves, if they cannot put in place the best personnel with the capacity and skills to improve the financial performance of BMTA, then there is a risk that mistakes will continue to be made and services struggle.

The financial state of operators (especially BMTA) does not allow them to hire sufficiently educated and skilled personnel for the planning and delivery of bus services. Without reform of how public transport services are paid for and funded, bus services are likely to suffer a period of decline given how convenient and widespread personal transport modes have become.

4.3.5 Recommendations

It is recommended that OTP and other agencies continue to disseminate skills and knowledge through the six research centres. Only if the capacity exists at the local level can local administrations deliver urban mobility for their respective areas.

A second recommendation is to ensure all transport projects have a thorough process and outcome evaluation as a key part of their delivery. Output monitoring is insufficient for the size and scale of many projects that are delivered, so focussing on an effective monitoring and evaluation regime is paramount for long-term learning and skills development.

4.4 Technology

4.4.1 Strategic direction

There has been a recognition in Thailand that new technologies will help alleviate some of the negative impacts of transport and enhance urban mobility. More recently the Ministry of Transport, as part of its 2017-2021 strategic plan, identified digital technology development in the transport sector as a key priority, including:

- Digital Development Plan for Economy and Society of MOT
- Intelligent Transportation System (ITS) Master Plan for the whole of Thailand as well as BMR
- Master plan for Promoting the Use of Intelligent Transportation System (ITS) in the Development of Transportation System in Regional Area.
- Development of Application for Information Services and Travel Planning on Mobile Phone for Disables, Elders. and Everyone
- Improvement of Information Technology System to Support the Land Transport Act
- Development of Train Monitoring System

The MOT hopes that these strategies can help to develop technology and innovation in transport within Thailand and reduce reliance on importing technologies in order to reach for the target of Thailand 4.0 which aims to transform the Thai economy into an innovation-driven one.

OTP's 2016 annual report illustrates how it will look to use intelligent transport system (ITS) technology to integrate all transport data in the Bangkok Metropolitan Area in order to monitor and control traffic in real time and be able to provide travellers with information to plan their commute. A superior traffic management system will increase overall efficiency and safety, as well as help related agencies better manage crisis situations and make more-informed policy decisions regarding transportation development.

4.4.2 Fuel technologies

The country has looked at technology to minimise negative impacts of transport in the past. The inventory analysis identified that fuel technologies have been used to improve air quality – encouraging Liquefied Petroleum Gas (LPG) and Compressed natural gas (CNG) use in taxis and other private vehicles and CNG for vans and buses in Bangkok has had a positive impact on air quality. The country has also been successful in phasing out other technologies to improve air quality, most notably leaded gasoline by 1995 and 2-stroke motorcycle engines by 1997.

Fuel economy standards are something that Government has been developing over recent years. From 2015, it became incumbent upon vehicle manufacturers to display an 'Eco-sticker' on windscreens to inform buyers of the CO_2emissions and fuel consumption that vehicle is likely to emit and consume. This project complements the Eco Car Phase II program to encourage manufacturers to produce more efficient cars in Thailand.

Cars are not the only focus for the use of clean fuel technologies. BMTA has also been tasked with acquiring new buses to operate across Bangkok, and the issue of the optimal fuel technology to power these buses is being discussed at the time of writing. The inventory analysis identified that there appear to be decisions being taken, without considering all possible fuel options.

4.4.3 Innovation in transport technologies

ITS is increasingly emerging as a solution to some urban mobility issues. Thailand 4.0 identifies ITS as important to the country to realise its ambitions. In addition, an ITS masterplan (2018) aims to use ITS to improve the performance of existing systems, as well as improving the user experience of using public transport.

There are numerous examples of how ITS is being rolled out to enhance urban mobility. The Phuket City Development Company is a private sector organization which operates a bus service on one route between Patong beach and Phuket International Airport. The service consists of real time passenger information at each bus-stop via smartphone application and an electronic fare payment by using IC card. That is one example for other bus operators to apply this company's models in investment and high technology to develop their services.

Mayday has been developing its technologies to improve services and passenger information. In Khon Kaen, Mayday – a not for profit organisation – has been testing an app-based technology that allows bus services to be more responsive to demand. In Bangkok, the same organisation has been supporting an effort to provide better information to bus users at bus stops, creating metro-style bus stop maps – see image.

There has been much focus in Bangkok on the development of common ticketing. The Mangmoom smartcard is currently in use, with three elevated rail lines accepting the card in 2019. The means of payment is just one aspect to integrating ticketing and reducing barriers to travel, and much effort is currently being focussed on creating a common fare. The Common Ticket Office is exploring all options throughout 2019 and seeks to implement a Bangkok-wide product that provides a common ticket and a common fare in coming years.

The freight industry has also been subject to attempts to reduce emissions. The GMS Green Freight Initiative (2013-2017) sought to encourage industry to improve logistics management and fuel efficiency measures in order to reduce emissions and lower freight company fuel costs. This involved working with small to medium sized freight companies to finance and test different fuel technologies and provide eco-driver training.

4.4.4 Strengths

A key strength is the recognition of government to improve air quality, reduce CO_2 emissions and support urban mobility. Based on stated policies and strategies – Thailand 4.0 being the driving force behind the development of different technologies - technology is going to play a key role in supporting government objectives. Not only on the development of fuel technologies, but the role of technology in allowing for a more efficient use of the transport network and its performance has been identified.

The capacity of Thailand to benefit from developing technologies is a major strength. The large vehicle manufacturing base in the country allows the country to influence manufacturers to improve fuel and emission standards. In addition, the capacity to build on recent experience in delivering high quality engineering projects – such as rail mass transit projects – helps to roll out the technologies in Bangkok to other urban areas.

Thailand has a recent track record in implementing technologies to enhance air quality. The adoption of LPG and CNG for the taxi and bus fleets has had a noticeable impact on air quality, although the number of these vehicles is significantly outweighed by private cars, motorcycles and pick-ups.

Thailand has worked with countries across ASEAN to reduce the impact of freight on air quality and CO_2 emissions. Green freight initiatives have been implemented to develop fuel technologies to improve fuel efficiency to benefit the environment and operating costs.

4.4.5 Weaknesses

There are several weaknesses in the development of transport technologies in Thailand. Many technologies are imported and not developed locally. This means that there can be a high cost for some technological developments which can limit implementation. Thailand 4.0 attempts to put in place a framework to encourage more home-grown businesses to develop technologies to support the transport sector.

Where technologies do exist, they are not always used effectively. The police manually take over from signals, particularly during peak periods. Whether this is an improvement compared to mathematically calculated junction capacity optimisation techniques that are in use across the world is worth investigating further.

While BMTA has invested in some technologies, it is suggested that it does not use vehicle scheduling software for its services. If there is a process that could improve the delivery of bus services, it would be prudent to adopt these.

Some private bus operators appear unwilling to adopt new technologies due to high costs and not knowing if they would make a return on their investment. Given the marginal nature of the economics of bus services across the Kingdom, it is difficult for operators to invest in services given the current regulatory environment. While the Phuket City Development Corporation has invested in technology to support its business, it is being financially supported by hotel owners in Phuket which allows it to invest. The same cannot be said for many other bus operations.

4.4.6 Opportunities

There are opportunities to build upon the technological developments being developed in the Kingdom today. The Smart Bus concept in Phuket and the projects being developed by Mayday in Khon Kaen have the potential to be adopted elsewhere to enhance transport services. As technologies are introduced, capturing and analysing data outputs from those technologies provide a significant opportunity to improve transport services.

Various opportunities lie in developing government policy to encourage less polluting fuel technologies. For example, subsidising or reducing the price of electric vehicles might allow for their more widespread introduction in mid-term across all urban areas.

Technology should be used to reduce barriers to public transport use. Investing in ticketing equipment that allows for smartcard, mobile and EMV (Europay, Mastercard and Visa) payments, as well as cash, will remove any payment barriers to using public transport. Investing in technologies (and commercial arrangements) that allow simplified ticketing, including period products, should provide users with the confidence that they are paying the best value fares for the journeys they make. Concepts such as Mobility as A Service could be considered if such systems are implemented, and this could significantly enhance urban mobility.

4.4.7 Threats

A significant threat to adopting emerging vehicle and fuel technologies lies with private bus operators. As they struggle to invest in their own vehicles and services, any investment in technology would need to demonstrate that it will generate a return on investment, otherwise investment may not happen.

Very low investment in infrastructure for bus services (bus lanes, terminals, priority signalling) while infrastructure investment tends to be focussed on mass transit, inter-urban rail and expressways. This is a threat to bus services as well as NMT modes.

While public transport operators have stalled in implementing technologies to support the operation of their own services, competing modes have used technology to encourage a shift in travel behaviour. The high penetration of convenient car hailing services is a strong competitor to public transport, which could be a threat to the long-term sustainability and development of sustainable transport.

Understanding how people move is an essential tool for developing robust policies to develop urban transport networks and encourage sustainable travel. A significant threat to the urban areas of Thailand is if technologies are not used to record and analyse people movements. Stakeholders suggested that there is a lack of data and evidence upon which to develop sound policy and deliver sustainable transport projects.

4.4.8 Recommendations

It is evident that a thorough appraisal of the environmental, economic and financial impacts of BMTA new bus fleet should be carried out. BMTA suggested that decisions taken around fuel technologies are heavily influenced by government and not necessarily following a thorough assessment of options. It is imperative that this appraisal of vehicle fuel source options be carried out to determine the best solution for BMTA at the earliest opportunity so decisions are taken that best meet the needs of the operator and, ultimately, the user.

A second recommendation is for government to actively encourage the adoption of new technologies and evaluate the impact that they have and develop an understanding of how best to utilise different technologies across the Kingdom, whether they be ITS, fuel technologies etc.

5 Development of a National Urban Mobility Programme

This report has built upon the documentation of the transport planning and delivery framework that exists, as well as the impact that transport has on society, and provided a thorough SWOT analysis to diagnose solutions to some of the urban mobility issues faced. These recommendations have been collated and moulded into a coherent and complementary programme of projects that will help the Thai government to better meet its stated objectives to enhance urban mobility and reduce the external impacts of transport. This chapter presents a programme and provides some detail around projects that should be carried out at the earliest opportunity.

5.1 NUMP Structure

The objective of a NUMP is to put in place a 'strategic, action-oriented framework for urban mobility, developed by national governments, enacted to enhance the capability of cities to plan, finance and implement projects and measures designed to fulfil the mobility needs of people and businesses in cities and their surroundings in a sustainable manner'.

Transport plans, whether national, regional or local, typically follow a similar structure, namely:

- Outlining the vision of the plan/strategy
- Defining the objectives and targets
- Setting out the thematic areas/components which will aid the delivery of the vision and objectives
- Specifying the action levers to implement the plan

This process of developing the NUMP has identified that the Government's priorities are to reduce greenhouse gas emissions and improve air quality. The PM2.5 'crisis' in January 2019 brought into focus the need to improve air quality, particularly in Bangkok. The vision for the NUMP should therefore be to significantly improve air quality whilst at the same time developing a programme of projects to enhance urban mobility. The 'Thailand Clean Mobility Programme' therefore aligns with the findings of this study, while at the same time meeting the overarching objectives of OTP and government.

There are three thematic areas which 'action levers' can be developed. Based on the analysis with this report, these should be:

- How to deliver transport demand management across urban areas, including Bangkok
- How to build upon and enhance bus services to improve urban mobility
- How to develop funding mechanisms to support local governments to implement urban mobility enhancing projects in their local areas

The targets for each of these three thematic areas are:

- Reduce PM2.5 levels across specific urban areas
- Reduce CO_2 emissions by 2.17Mt p.a
- Increase the number of bus passenger trips by approx. 5%

The action levers for each of the thematic areas are presented in the next section, while further detail of the proposed NUMP can be seen in Appendix A. These set out the individual tasks that will help meet the objectives and targets set out above.

5.2 NUMP – The Thailand Clean Mobility Programme

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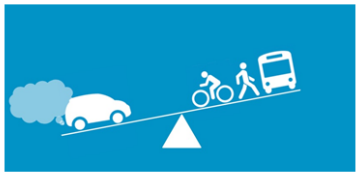
Thailand Clean Mobility Programme

PM 2.5 emissions from **road transport** in Bangkok, Nakhon Pathom, Pathum Thani, Nonthaburi, Samut Prakan, and Samut Sakhon reduced	**Reduction of CO_2** emissions by 2.17 Mt p.a. (see NDC action plan, from year of introduction)	No of **bus passenger increased** from 211 to 222 million trips p.a.

Transport Demand Management

- Traffic, environmental and economic impact modelling
- Policy design options (Preliminary April/May, Full Policy Design)
- Public communication strategy development
- Roadmap for congestion charge implementation
- Support congestion charging development process
- Develop a mechanism for the usage of transport demand management revenue



Bus Improvements

- Environmental, Economc and Financial Impact assessment of bus fleet in Bangkok
- Procurement standard for public fleets including background studies
  (-> Partner MoF)
- Communication strategy on fleet renewal
- Revision of fare structure and subsidy system for Bangkok
  (-> Common Ticket Office)

Seeking for additional funding

Upscaling: Planning and Funding

- Support the development of Public Transport Fund (develop White List of eligible projects and refunding options
  (-> Partner MoF)
- Integration of economic and environmental indicators in project prioritization
  (-> Partner DPT)

Seeking for additional funding

6 Summary and Conclusions

This report has built upon the foundations of the inventory analysis to identify the strengths and weaknesses of transport governance, funding, capacity and technology. Taking account of both reports numerous conclusions have been drawn, a selection of which are:

- Alongside a requirement to reduce CO_2 emissions, air quality, particularly PM2.5 levels, is a high priority for politicians to tackle in Bangkok and other urban areas across the Kingdom – this should be the central focus of any NUMP as it would likely obtain greatest political support at this time.
- The government's focus to improve urban mobility centred around road building for a number of decades, but in recent times rail mass transit has been a particular focus in Bangkok, Phuket, Chiang Mai and elsewhere. This assumes that to improve urban mobility, improvements to transport supply is required. Urban areas with efficient public transport networks combine transport supply alongside demand management measures to encourage sustainable travel. It is therefore essential that urban areas in Thailand develop plans and strategies for managing demand.
- In developing demand management measures, it is necessary to define how demand will be managed, but also how the revenue generated from the measures can be re-invested in supporting sustainable travel.
- A review of the economics of public transport highlighted a host of issues related to operating bus services in Bangkok and elsewhere. While government policy focuses on rail mass transit, bus services will continue to play a key role across the Kingdom and support should be given to enhancing the service they can provide in the following ways:
    - Funding for local governments to implement bus service enhancing projects
    - Support for BMTA to appraise options for fleet renewal to maximise environmental, economic, financial and operational benefits
    - Support the common ticket office to develop a suitable regulatory structure to enable a common ticket and a common fare to reduce barriers to public transport use in Bangkok

It is on these conclusions that a National Urban Mobility Programme has been developed and presented. The programme is intended to meet government priorities on air quality and CO_2 emissions yet also be deliverable in the short to medium term, and measurable. Monitoring the impact of any measures implemented is essential, and would support future policy development and decision making to further enhance urban mobility in the future.

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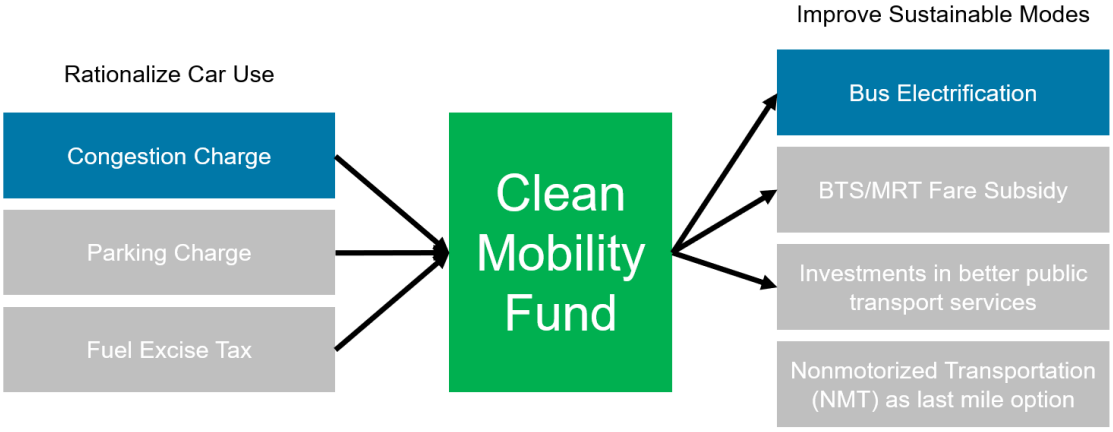
Appendix A – Thailand Clean Mobility Programme

Thailand Clean Mobility Programme



Objectives: Decrease PM2.5 emissions and improve air quality and quality of life, decrease CO2 emissions to comply with Thailand's NDC Action Plan, achieve equitable access to mobility for all income-groups, improve traffic safety