# LOW CARBON DEVELOPMENT STRATEGIC MODEL FOR SUSTAINABLE TRANSPORT : A CASE STUDY OF MASS TRANSIT SYSTEM IN BANGKOK METROPOLITAN

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A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy Program in Environment Development and Sustainability
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# แบบจำลองเชิงยุทธศาสตร์เพื่อการพัฒนาแบบคาร์บอนต่ำสำหรับภาคการขนส่งที่ยั่งยืน : กรณีศึกษาระบบขนส่งมวลชนในกรุงเทพมหานคร

นางสาวขวัญวีร์ ทวีวัฒนเศรษฐ์



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรดุษฎีบัณฑิต
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ขวัญวีร์ ทวีวัฒนเศรษฐ์ : แบบจำลองเชิงยุทธศาสตร์เพื่อการพัฒนาแบบคาร์บอนต่ำสำหรับภาคการขนส่งที่ยั่งยืน : กรณีศึกษาระบบขนส่งมวลชนในกรุงเทพมหานคร (LOW CARBON DEVELOPMENT STRATEGIC MODEL FOR SUSTAINABLE TRANSPORT : A CASE STUDY OF MASS TRANSIT SYSTEM IN BANGKOK METROPOLITAN) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ดร.แสงจันทร์ ลิ้มจิรกาล, 232 หน้า.

การขนส่งที่ยั่งยืนเป็นหนึ่งในแกนหลักของกรอบการพัฒนาแบบคาร์บอนต่ำและเมืองที่ยั่งยืน ในเอกสาร Agenda 21 จากการประชุมสหประชาชาติว่าด้วยสิ่งแวดล้อมและการพัฒนาเมื่อปี ค.ศ. 1992 จนถึงปัจจุบัน การขนส่งที่ยั่งยืนเป็นกระบวนการหนึ่งที่สำคัญสำหรับเมืองใหญ่ต่างๆ ในการนำมาปรับใช้เพื่อการบรรลุเป้าหมายการพัฒนาอย่างยั่งยืน (SDGs) ในปี ค.ศ. 2030 กรุงเทพมหานครเป็นเมืองหนึ่งในภูมิภาคเอเชียที่มีความล่อแหลมจากผลกระทบของการเปลี่ยนแปลงสภาพภูมิอากาศและรูปแบบการพัฒนาเมืองที่ไม่ยั่งยืน ซึ่งเกิดจากการเจริญเติบโตทางเศรษฐกิจ การใช้พลังงานและการปล่อยก๊าซเรือนกระจกจากระบบขนส่งสาธารณะที่ไม่มีประสิทธิภาพ ขาดการวางแผนการใช้ประโยชน์ที่ดิน รวมถึงขาดการจัดการการเดินทางที่เหมาะสมในกรุงเทพมหานคร เป็นผลทำให้เกิดปัญหาด้านสิ่งแวดล้อม สังคม และเศรษฐกิจ ทั้งนี้ ประเทศไทยได้มีการพัฒนาแผนแม่บทภาคการขนส่งด้วยรถไฟฟ้าในการพัฒนากรุงเทพมหานครไปสู่เมืองคาร์บอนต่ำและเมืองที่ยั่งยืน อย่างไรก็ตามจากการศึกษาพบว่า ในระยะเริ่มต้นของการพัฒนาแผนแม่บทดังกล่าว ยังขาดการนำแนวคิดการขนส่งที่ยั่งยืนมาประยุกต์ใช้ การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อ ศึกษาสภาพปัจจุบันของระบบขนส่งและผลกระทบด้านต่างๆ ที่เกิดขึ้นในกรุงเทพมหานคร และเพื่อเสนอแบบจำลองเชิงยุทธศาสตร์เพื่อการพัฒนาแบบคาร์บอนต่ำสำหรับภาคการขนส่งที่ยั่งยืนและนำไปสู่เมืองคาร์บอนต่ำและยั่งยืน งานวิจัยนี้เป็นงานวิจัยเชิงสำรวจที่ใช้วิธีการวิจัยเชิงคุณภาพ ประกอบด้วย 1) การศึกษาทบทวนนโยบายทั้งในระดับระหว่างประเทศ ระดับชาติ และระดับท้องถิ่น รวมถึงศึกษาเอกสารต่างๆ ที่เกี่ยวข้องกับการพัฒนาอย่างยั่งยืน การขนส่งที่ยั่งยืน เมืองคาร์บอนต่ำ และระบบรถไฟฟ้าขนส่งมวลชน และ 2) การสัมภาษณ์เชิงลึกกับผู้มีส่วนได้ส่วนเสีย โดยใช้วิธีการสัมภาษณ์แบบกึ่งโครงสร้าง โดยมีการจัดกลุ่มผู้ให้สัมภาษณ์ออกเป็น 6 กลุ่ม ได้แก่ หน่วยงานภาครัฐ ผู้ประกอบการรถไฟฟ้าขนส่งมวลชน บริษัทที่ปรึกษา องค์กรระหว่างประเทศ องค์กรที่ไม่แสวงผลกำไร และผู้เชี่ยวชาญ ทั้งนี้ความหลากหลายในมุมมองจากแต่ละกลุ่มของผู้มีส่วนได้ส่วนเสีย ได้นำมาวิเคราะห์และนำเสนอในรูปแบบแผนภูมิใยแมงมุม ซึ่งเป็นรูปแบบที่เหมาะสมสำหรับกระบวนการวิเคราะห์เชิงอุปนัย

ผลการศึกษาวิจัยพบว่า ปัญหาด้านนโยบายและองค์ประกอบขององค์กรถือเป็นความท้าทายที่สำคัญสำหรับ การดำเนินงานยุทธศาสตร์การพัฒนาแบบคาร์บอนต่ำเพื่อการขนส่งที่ยั่งยืนและเมืองคาร์บอนต่ำ ซึ่งประกอบด้วย ความไม่สอดคล้องของนโยบายและแผนงาน การขาดการมีส่วนร่วมและการยอมรับเห็นชอบจากผู้มีส่วนได้ส่วนเสีย ความไม่พร้อมทางด้านข้อมูล ทรัพยากรมนุษย์ เทคโนโลยี และทางการเงิน ตลอดจนความไม่มีประสิทธิภาพในการบังคับใช้ระเบียบข้อบังคับต่างๆ ทั้งนี้ โมเดลจากการศึกษาครั้งนี้ได้นำเสนอปัจจัยหลัก และองค์ประกอบเสริมที่สำคัญต่างๆ อันประกอบด้วย การพัฒนาด้านขีดความสามารถของสถาบัน ด้านเทคนิค และความเชี่ยวชาญของบุคลากร กรอบโครงสร้างสถาบันและการบริหารผู้มีส่วนได้ส่วนเสีย การกำหนดนโยบายและการบูรณาการของกระบวนการและแผนงาน รวมทั้งแผนการดำเนินงานที่มีแผนปฏิบัติการและการดำเนินการอย่างเป็นรูปธรรมและต่อเนื่อง ทั้งนี้ เพื่อเป็นการสนับสนุนประสิทธิภาพของกระบวนการเชิงยุทธศาสตร์เพื่อการพัฒนาแบบคาร์บอนต่ำสำหรับภาคการขนส่งที่ยั่งยืนและเมืองคาร์บอนต่ำ ดังนั้น จึงได้แนะนำให้มีการเชื่อมต่อทั้งภายในเครือข่ายของระบบรถไฟฟ้า และการเชื่อมต่อระหว่างระบบรถไฟฟ้าไปยังระบบภาคการขนส่งอื่นๆ รวมถึงการพัฒนาพื้นที่รอบสถานีขนส่งมวลชน เพื่อเป็นการพัฒนาระบบขนส่งที่ครอบคลุมและมีประสิทธิภาพ นอกจากนี้ การมีส่วนร่วมของผู้บริหารระดับสูง และทิศทางที่ชัดเจนของนโยบายภาครัฐ จะเป็นการสนับสนุนที่สำคัญในการนำไปสู่กระบวนการพัฒนาภาคการขนส่งที่ยั่งยืนและการพัฒนาสู่เมืองคาร์บอนต่ำให้ประสบผลสำเร็จ

สาขาวิชา สิ่งแวดล้อม การพัฒนา และความยั่งยืน ลายมือชื่อนิสิต .....

ปีการศึกษา 2559 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

# # 5587760520 : MAJOR ENVIRONMENT DEVELOPMENT AND SUSTAINABILITY
KEYWORDS: LOW CARBON DEVELOPMENT STRATEGY / SUSTAINABLE TRANSPORT / LOW CARBON CITY

KWANYAWEE THAVEEWATANASETH: LOW CARBON DEVELOPMENT STRATEGIC MODEL FOR SUSTAINABLE TRANSPORT : A CASE STUDY OF MASS TRANSIT SYSTEM IN BANGKOK METROPOLITAN. ADVISOR: SANGCHAN LIMJIRAKAN, D.Tech.Sc., 232 pp.

Sustainable transportation has been raised up into the mainstreaming of low carbon development and sustainable city frameworks since first recognized at the United Nations Conference on Environment and Development (UNCED), in the outcome document namely the Agenda 21. Nowadays, sustainable transport is one of the major approaches for the mega cities to achieving Sustainable Development Goals (SDGs) as the 2030 Agenda for Sustainable Development. Bangkok Metropolitan is one of the cities in Asia where become more vulnerable areas to climate change impacts and unsustainable city patterns caused by urbanization, economic growth, high energy consumption and greenhouse gas (GHG) emissions. As results from inefficient public transport system, lack of land-use planning as well as lack of mobility management, Bangkok has more environmental, social and economic problems. In Thailand, the mass rapid transit (MRT) master plans have been developed as the key role in developing Bangkok Metropolitan toward low carbon and sustainable city, but there still lack of sustainable transportation concept applied in such plans. The objectives of the study are to study the current situation of transportation system and its impacts in Bangkok Metropolitan, and to propose low carbon development strategic model on sustainable transport toward sustainable and low carbon city. This research was designed as exploratory research applying a qualitative research methods consisting of 1) desk reviews of international, national, and local policies and relevant documents which related to sustainable development, sustainable transport, low carbon city, and mass rapid transit system; and 2) in-depth semi-structured stakeholder interviews were conducted with key respondents that classified into six stakeholder groups; namely governmental agencies, mass rapid transit operators, consulting companies, international organizations, non-profit organizations, and experts. Multiple viewpoints of different key stakeholder groups were analyzed and presented in the form spider charts which somewhat useful for the inductive analysis processes.

The research found that policy and institutional elements issues are major challenges for implementing low carbon development strategy for sustainable transport and low carbon city; including inconsistency of policy and plan, lack of stakeholder involvement and buy-in, lack of readiness in data, human resources, technology and finance, and ineffective regulations enforcement. The proposed model highlighted the major factors and supplemental key elements composing of institution, technical and human capacity development, institutional framework and stakeholder mapping, policy setting, process integration and inclusive plans, as well as plan of implementation with concrete and continuity action plan and implementation. These would support effective strategic process for low carbon development strategy on sustainable transport and low carbon city. The study would highly recommend that both inter- and intra-connecting networks of the MRT systems as well as the transit oriented development for developing inclusive and effective transport systems need to be strongly taken into account. In addition, a high-level participation and a clear direction of the governmental policies also need strongly support in achieving sustainable transport towards low carbon city development processes.

Field of Study: Environment Development and Sustainability Student's Signature .....
Academic Year: 2016 Advisor's Signature .....

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| | |
|---|---|
| ADB | Asian Development Bank |
| A-S-I | Avoid-Shift-Improve |
| BAU | Business-as-usual |
| B/C Ratio | Benefit/Cost Ratio |
| BEM | Bangkok Expressway and Metro Public Company Limited |
| BMA | Bangkok Metropolitan Administration |
| BMR | Bangkok Metropolitan Region |
| BMTA | Bangkok Mass Transit Authority |
| BRT | Bus Rapid Transit |
| BTS | Bangkok Mass Transit System |
| BTSC | Bangkok Mass Transit System Public Company Limited |
| CBDs | Central business districts |
| CO | Carbon monoxide |
| $CO_2$ | Carbon Dioxide |
| CPD | City Planning Department |
| CSD | United Nations Commission on Sustainable Development |
| CUTE | Comparative study on Urban Transport and the Environment |
| eBUM | Extended Bangkok Urban Model |
| EIA | Environmental Impact Assessment |
| ENV | Saving of environmental cost |
| EST | Environmentally Sustainable Transport |
| EQM | Environmental Quality Management |
| GHG | Greenhouse Gas |
| GIZ | German International Cooperation |
| GNI | Gross National Income |
| HDR | Human Development Report |
| IEA | International Energy Agency |
| IGES | Institute for Global Environmental Strategies |
| IPCC | Intergovernmental Panel on Climate Change |

| | |
|---|---|
| IRR | Internal Rate of Return |
| ISEAS | Institute of Southeast Asian Studies |
| ITF | International transport Forum |
| JICA | Japan International Cooperation Agency |
| JPOI | Johannesburg Plan of Implementation |
| KeTTHA | Kementerian Tenaga, Teknologi Hijau dan Air |
| km/hr | kilometers per hour |
| LCDS | Low Carbon Development Strategy |
| LCDSM | Low Carbon Development Strategic Model |
| MDGs | Millennium Development Goals |
| MOT | Ministry of Transport |
| MRT | Bangkok Metropolitan Rapid Transit |
| MRTA | Mass Rapid Transit Authority of Thailand |
| MRTC | Mass Rapid Transit Commission |
| MRV | Measurement, Reporting and Verification |
| M-Map | Mass Rapid Transit Master Plan in Bangkok Metropolitan Region |
| NAMAs | Nationally Appropriate Mitigation Actions |
| NESDB | Office of the National Economics and Social Development Board |
| NGOs | Non-governmental organizations |
| NGV | Natural Gas Vehicles |
| NIC | National Information Center |
| $NO_2$ | Nitrogen oxides |
| NPV | Net Present Value |
| NSO | National Statistical Office |
| NSTDA | National Science and Technology Development Agency |
| $O_3$ | Ozone |
| OECD | Organization for Economic Cooperation and Development |
| ONEP | Office of Natural Resources and Environmental Policy and Planning |
| OTP | Office of Transport and Traffic Policy and Planning |

| | |
|---|---|
| PCD | Pollution Control Department |
| $PM_{10}$ | Particulate matter sized smaller than 10 micrograms per cubic meter |
| PPP | Public Private Partnerships |
| PSUTA | Partnership for Sustainable Urban Transport in Asia |
| PV | personal vehicle |
| SEA | Strategic Environmental Assessment |
| SDGs | Sustainable Development Goals |
| Sida | Swedish International Development Cooperation Agency |
| $SO_2$ | Sulfur dioxides |
| SRT | State Railway of Thailand |
| TGO | Thailand Greenhouse Gas Organization |
| TOD | Transit-oriented development |
| TSP | Total suspended particulates |
| UITP | International Association of Public Transport |
| UN | United Nations |
| UNCED | United Nations Conference on Environment and Development |
| UNCSD | United Nations Conference on Sustainable Development |
| UNCRD | United Nations Centre for Regional Development |
| UN DESA | United Nations Department of Economic and Social Affair |
| UNDP | United Nation Development Programme |
| UN ESCAP | United Nations Economic and Social Commission for Asia and Pacific |
| UNGA | United Nations General Assembly |
| UN HABITAT | United Nations Human Settlements Programme |
| VHT | Vehicle hours of traveled |
| VKT | Vehicle kilometers travelled |
| VOC | Saving of vehicle operating cost |
| VOCs | Volatile organic compounds |
| VOT | Saving of road user's travel time |
| WHO | World Health Organization |

# CHAPTER I

# INTRODUCTION

## 1.1 Background and importance of the study

Cities are the first priority areas to concentrate in economic development, social activities, extensive infrastructures and governmental operations. They have a great potential for improving people's lives, economic, infrastructure, and accessibility in healthcare and education. However, urbanization process can cause several negative impacts on quality of life, natural resource, and environment. Consecutively, this would cause the changing of climate. The climate change has caused seasonal changes and more frequent and severe natural disasters including floods, storms and drought, coastal erosion and sea level rise. Moreover, the greater concentration of greenhouse gas (GHG) emissions and higher temperatures, variations in precipitation, and extreme natural disasters will affect human being in terms of socio-economic aspects such as quality of life and human security (Intergovernmental Panel on Climate Change (IPCC), 2007). In this regard, cities would become more vulnerable areas than others due to economic activities and high density of population.



Socio-economic development in many cities in Asia has been growing very rapidly such as economic growth, urbanization, production and consumption, urban employment, and motorization. As a result of these developments, Kainuma et al. noted that this region has the fastest producing GHG emissions in the world (Kainuma et al., 2012). Furthermore, they said that the region will generate GHG emissions up to 40-54 percent of global carbon dioxide ($CO_2$) emissions as of business-as-usual (BAU) scenario in 2050. Transport sector is considered as one of high energy consumption and $CO_2$ emission. This sector was the second largest contributor to global GHG emissions taking into account of 23 percent of global $CO_2$ emissions from fossil-fuel combustion in 2009 (Ang and Marchal, 2013). The International Energy Agency reported that the annual growth rate of $CO_2$ emissions in transport

sector would be 3 percent between 2009 and 2010 (International Energy Agency (IEA), 2012). Furthermore, almost three-quarters of the emissions from this sector came from road. In 2007, the IPCC reported that countries in Asia region had high vulnerable to the impacts of global climate change. Bangkok, a capital city of Thailand, is one of the top world port cities that have potential impact on climate change in 2070 under scenarios driving forces of population growth, economic growth and urbanization (Banister, 2011).

Bangkok would be counted as an unsustainable city because of high population density, rapid urbanization, unsustainable production and consumption patterns, pollutions, environmental degradation, health and mental insecurity and social or livelihood changes. In terms of GHG emission, Kennedy, et al. (2009) stated that Bangkok already has a relatively high carbon emission per capita compared to the leading developed cities in the world with the value of 10.7 t $CO_2$e/capita (World Bank, 2011). The Bangkok Metropolitan Administration (BMA) reported that transport sector is the highest GHG emission source in Bangkok (Bangkok Metropolitan Administration (BMA), 2007). Inefficient public transport system and land-use planning as well as lack of mobility management in Bangkok have made environmental, social and economic problems such as air pollution, higher fuel consumption, unsustainable livelihood, health and safety. In 2004, the World Health Organization (WHO) reported that road traffic injuries would be come up from the ninth in 1990 to the third leading cause of the global burden of disease or injury in 2020 (World Health Organization (WHO), 2004). In 2012, Bangkok had registered cars of about 7.5 million at an increasing rate of 27 percent between 2008 and 2012 (National Information Center (NIC), 2013) while the available road capacity is only for 1.6 million cars. This reflects that the number of car is fourfold of the road capacity. This unsustainable transport pattern of traffic congestion and car-dependency lifestyle would lead to unsustainable city which people would get low quality of living, pollutions, health insecurity and risk of car accident. Furthermore, this unsustainable transport would effect on the national energy insecurity of Thailand that is fuel import-dependency. Therefore, transportation system would be the first prioritize mission of the BMA to be a sustainable city.

Moving forward a sustainable city, a low carbon city is one of initiative approaches to combat climate change. For example, the Malaysian low carbon city framework essentially supports low carbon cities as a sub-set of sustainable cities (Kementerian Tenaga Teknologi Hijau dan Air (KeTTHA), 2011). The currently concept of low carbon city emphasizes on urban development and urban governance as cities become more vulnerable areas to global warming and climate change impacts causing by urbanization, economic growth, increasing of energy consumption and $CO_2$ emissions. Sustainable transportation is one of the sustainable city elements which has been remarkably raised into the low carbon city framework. For Malaysia, sustainable city refers to a city that is designed and developed with concern to environmental, social and economic development toward sustainable development and with responsibility for the future generation who will live in the city. While low carbon city refers to a city that consists of societies consuming and producing relatively low carbon emission to avoid the adverse impacts on climate change. Sustainable transport refers to transportation system including its policy and management practice that can contribute positive impacts on social, environmental and economic aspects for the society.

Regarding to the Eleventh National Economic and Social Development Plan, 2012-2016, Thailand aimed to protect natural resources, mitigate environmental damage and global climate change impacts, and improve living standard toward sustainable development. One of development strategies of this plan was to shift the development paradigm forward the country to a low carbon economy (National Economic and Social Development Board (NESDB), 2011). Importantly, the national strategies emphasized on energy efficiency in transportation sectors to enhance the reduction of greenhouse gas emissions. Effectively, low carbon city should include urban planning with an integration of social and ecological concerns. Furthermore, this plan aimed to modernize the public transportation network to cover Bangkok Metropolitan areas and to respond to the rapid urbanization. In addition, the plan pointed that a mass transit transportation network should be built in an efficient manner as well as an enhancement of the quality, standards, and equity of services.

All in all, one of the most potential solutions for the current public transport system is to promote a shift towards mass transit modes resulting in reduced $CO_2$ emission and cleaner environment. Many studies in megacities both in developed and developing countries support that public transportation in mass transit system plays the key role in $CO_2$ mitigation, efficient energy use and quality of life improvement through sustainable transport toward sustainable city (Kennedy et al., 2005; Zhao, 2010; Nakamura and Hayashi, 2012). This would provide co-benefit for all stakeholders in terms of socio-economic and environmental benefits. Therefore, the development of low carbon strategies model on sustainable transport would be toward sustainable and low carbon city.

## 1.2 Objectives of the study

The study aimed to:

- Study the current situation of transportation system and its impacts in Bangkok Metropolitan.
- Propose low carbon development strategic model on sustainable transport toward sustainable and low carbon city.

## 1.3 Research questions

The study mainly addressed the following these research questions:

1.3.1 What are the current situation of transportation system and its impacts on the selected studied city?

1.3.2 How can the current transportation system be proposed low carbon strategic model towards sustainable transport and leading to sustainable and low carbon city?

## 1.4 Scopes of the study

1.4.1 The study focused on the current state of transportation system and its impacts toward sustainable transportation leading to low carbon city in Bangkok Metropolitan.

1.4.2 The transportation system focused on mass transit system which is the Bangkok Metropolitan Rapid Transit (MRT), two lines selected.

1.4.3 The in-depth interview and discussion were conducted to the respondents selected by the specific sampling method to whom having responsibility and role dealing with the mass transit policy and planning, transport and traffic policy and planning in Bangkok Metropolitan.

1.4.4 The conceptual framework of Tilburg et al. (2011), data relevant on 1.4.2 and 1.4.3 were used to introduce to propose low carbon development strategic model.

1.4.5 The low carbon development strategic model proposed leading to the development on low carbon strategic plans taking into account on sustainable transport toward low carbon city in Bangkok Metropolitan.

## 1.5 Operational definitions

1.5.1 Low carbon city is referred to a city that consists of societies that consume and produce that emit relatively low carbon to avoid the adverse impacts on climate change (Kementerian Tenaga Teknologi Hijau dan Air (KeTTHA), 2011).

1.5.2 Low carbon development strategy is referred to an action plan which integrates the national low carbon and development policies which are related to mitigation action into the long-term policy framework (Tilburg et al., 2011)

1.5.3 Mass transit system is referred to public transport and rapid transit such as metros and sky train which is an electric transport system that may run underground, above street level, or at street level. It can commute a large number of passengers with high capacity and a high frequency of service

normally designed for local transit in a metropolitan area (The International Association of Public Transport (UITP), 2013).

1.5.4 Sustainable city is referred to a city where has a well plan and management with concerns that lifestyle and consumption would not adversely affect to city's environmental, social and economic development as well as can offer equality of opportunities and good urban services for all (KeTTHA, 2011).

1.5.5 Sustainable transport is referred to transportation which can enhance economic growth, accessibility, as well as health and safety of people by an integration of the economy to environmentally sound as part of efforts to achieve sustainable development (United Nations General Assembly (UNGA), 2012).

**1.6 Expected outcomes**

1.6.1 A better understanding of the current situation and impacts of transportation system in the studied city.

1.6.2 A conceptual model of low carbon development strategies on sustainable transport toward sustainable and low carbon city.

# CHAPTER II

# LITERATURE REVIEW

## 2.1 City, urban development, and climate change

Rapid urban development can cause high emissions especially in the city. Regarding to climate change mitigation, there has been increasing in research and study at local and city level. However, there is no one measure or solution framework that suitable for any city. The constraints of particular city are varying in both dimensions and level of impacts.

### 2.1.1 The urbanization trends and impacts

The Organization for Economic Cooperation and Development (OECD) defined urbanization as "an increase in the proportion of a population living in urban areas: or a process by which a large number of people becomes permanently concentrated in relatively small areas, forming cities" (OECD, 1997). Urban area can be defined by the population density, the percent of people on the provision of public utilities and services such as electricity, education, and healthcare. There are no global standards; it depends on each country which applies its own definition of urban areas. The United Nation Development Programme (UNDP), Asia-Pacific Human Development Report (HDR) 2012 also supported that the urban populations is not yet acceptable to a single definition to every countries even to the countries within a region. Moreover, UNDP (2012) clarified more about urbanization definition as "the conversion of land from a natural state or managed natural state (such as agriculture) to urban settlements or cities; a process driven by net rural-to-urban migration through which an increasing proportion of the population in any nation or region come to live in settlements".

Southeast Asia is massively urbanizing development with the percentage of population residing in urban areas 44.1 per cent in 2010 and projected to 65 per cent

in 2050 (United Nations Department of Economic and Social Affairs (UN DESA), 2012). A majority of the urban population of Southeast Asia lives in small cities and towns with less than 500,000 inhabitants (Institute of Southeast Asian Studies (ISEAS), 2009). In addition, ISEAS (2009) noted that small cities and lack of urban management capacity lead to difficulty in improving the local economy and develop infrastructure. Regarding to cities and environment, the effects of urbanization create unprecedented negative impacts upon quality of life, social stability, economic, and environment. Marcoux (1999) supported that there is a positive relationship between population density and the level of direct pressure on resources. For example, population growth and urbanization affect the volume of market demands, consumption pattern changes, and land use changes. Moreover, the concentration of human and economic activities place disproportionate pressure on the natural environment through the overexploitation of natural resources and the production of waste (ISEAS, 2009). With regarding to pollution and environment degradation, this will eventually result in instability of human well-being in the urban areas. Levels of urbanization in Southeast Asia vary widely between countries that rely on the linkage between urbanization and economic development. Table 2.1 presents the levels of urbanization, urban growth rate and Gross National Income (GNI) per capita in Southeast Asia in 2010. Thailand has the urban growth rate 34 per cent. Moreover, UN DESA (2012) reported that South-Eastern Asia countries have gradually increased in the proportions of urban population since 1950 and it is projected to increase to 65 per cent of the total region population by 2050.

### 2.1.2 The urban development toward climate change mitigation

Hoornweg et al. (2011) stated that global cities are critical areas in mitigate climate change. He argued that cities are responsible for two-thirds of global energy consumption, and the trend is expected to grow in the future. Because of their density, efficiency, high technological transfer, and innovation, cities can provide high potential in their urban development for reducing emissions. United Nations Human Settlements Programme (UN HABITAT) (2010) also noted that there is the interrelationship between climate change and development. While economic development under a business as usual scenario leads to higher GHG emissions

causing climate change, climate change results in development suffer. In order to facing of climate change, urban areas must improve planning and building capacities for adaptation and mitigation. There has been become more and more cities in developed and developing countries doing climate change mitigation policy and implementation (Hoornweg, 2010; Hoornweg et al., 2011).

Table 2.1 Urbanization, urban growth rate and GNI per capita in Southeast Asia.

| Country | Population in 2010 | | | Urban annual growth rate (2010-2015) | GDP per capita ($,2009)* |
|---|---|---|---|---|---|
| | Urban ('000) | Total ('000) | % Urban | | |
| Singapore | 4,837 | 4,837 | 100.0 | 0.9 | 52,840 |
| Brunei | 308 | 407 | 75.7 | 2.2 | 48,714 |
| Malaysia | 20,146 | 27,914 | 72.2 | 2.4 | 14,275 |
| Thailand | 23,142 | 68,139 | 34.0 | 1.8 | 8,479 |
| Indonesia | 102,960 | 232,517 | 44.3 | 1.7 | 4,380 |
| Philippines | 45,781 | 93,617 | 48.9 | 2.3 | 3,604 |
| Viet Nam | 27,046 | 89,029 | 30.4 | 3.0 | 3,104 |
| Timor-Leste | 329 | 1,171 | 28.1 | 5.0 | 2,677 |
| Laos | 2,136 | 6,436 | 33.2 | 4.9 | 2,401 |
| Cambodia | 3,027 | 15,053 | 20.1 | 3.2 | 2,084 |
| Myanmar | 16,990 | 50,496 | 33.6 | 3.0 | 1,244 |
| SEA | 246,701 | 589,615 | 41.8 | 2.2 | |
| * based on purchasing power parity (PPP); current international $ | | | | | |

Source: UNDP (2010) and World Bank (2010)

In 2010, Thailand population density was 127.6 persons per square kilometer while Bangkok was far high density in 5,258.6 persons per square kilometer (National Statistical Office (NSO), 2011). In 2012, with seven million residents in Bangkok, the urbanization is expected to continue. Although, there is a relatively low proportion of urban population living in slums, Bangkok still faces deteriorating water quality, inefficient waste management, and disaster management such as flooding in 2011 for example. Per capita carbon dioxide emissions in Bangkok, based on data in 2005, are already high compared to leading cities in the world as shown in Figure 2.1. The sources of emissions in Bangkok come from the power, waste and transport sectors (Kennedy et al., 2009).

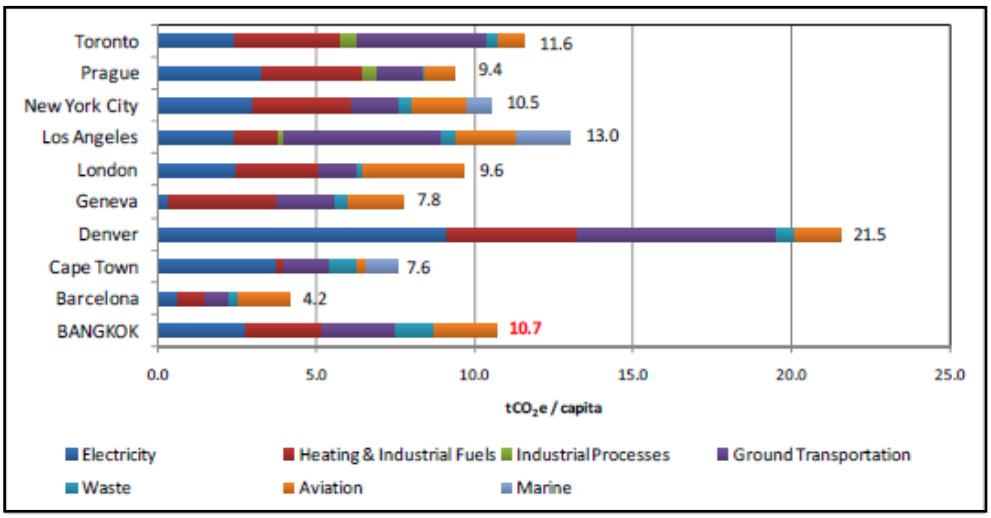



Figure 2.1 Per capita carbon dioxide ($CO_2$) emissions for selected cities.
Source: Kennedy et al. (2009) cited in World Bank (2011)

## 2.2 Low carbon city toward sustainable city

Regarding the impacts of urban development and climate change, these lead many cities concern on how to develop sustainable city. Low carbon city is one potential pathway to sustainable city that emissions at low levels as well as enhance quality of living (Kainuma et al., 2012). World Bank (2011) introduced the comprehensive approach for low carbon city which are based on four key dimensions which consists of compact urban form, efficient and cleaned energy, sustainable urban transport and efficient water and waste management, as shown in Figure 2.2. Compact urban form refers to smart planning-higher density, more spatially compact and more mixed-use urban design. Efficient and clean energy refers to renewable energy and green buildings. Sustainable urban transport refers to public transport infrastructure and clean vehicles. Efficient water and waste management refer to conserving water resources management efficiently and minimize waste generation on demand side and efficient wastewater treatment and waste recycling and disposing on the supply side.

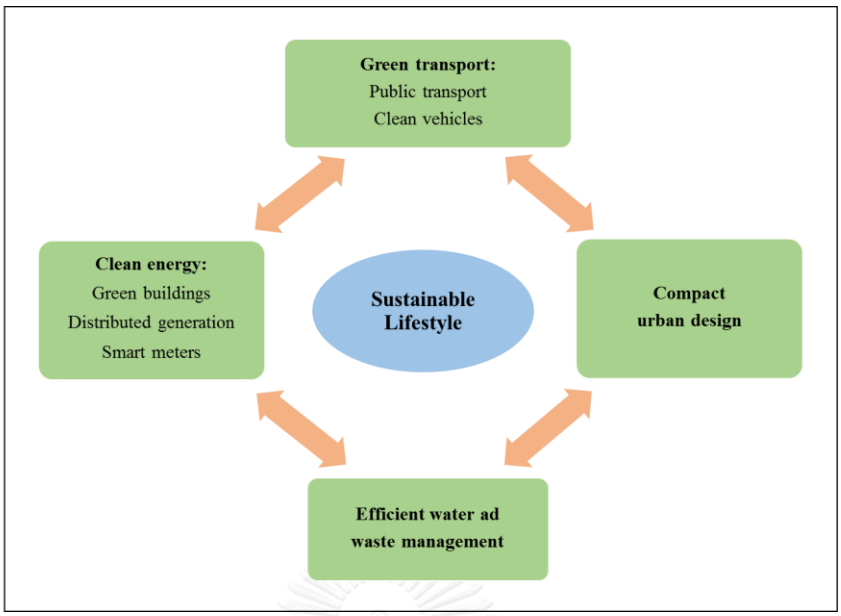



Figure 2.2 Comprehensive approaches for low carbon city

Source: World Bank (2011)

In the study of Baeumler et al. (2012), a strong alignment between low carbon and sustainable development strategies for cities is described on four areas with their development objectives as shown in Figure 2.3.

| Smart urban form and spatial development | Energy-efficient industry and building | Low-carbon vehicles and a public transport-oriented system | Low-carbon waste management and other services |
|---|---|---|---|
| • Preserved agricultural land<br>• Reduced contingent financial liabilities<br>• Improved rural land compensation and equity concerns<br>• Limited encroachment into sensitive sites | • Reduced air pollution<br>• Improved energy security<br>• Enhanced energy efficiency and industrial competitiveness<br>• Increased resource efficiency in buildings and heating | • Reduced congestion<br>• Reduced air pollution<br>• Improved traffic safety<br>• Increased urban livability | • Improved solid waste management<br>• Reduced air pollution<br>• Increased efficiency of water resource utilization and protection |

Figure 2.3 Alignment of low carbon city and sustainable urban development

Source: Baeumler et al. (2012)

In addition, Wang et al. (2012) presents the Chinese cities aim to become a low carbon city that need to focus on a comprehensive multi-sector approach toward

mitigating their GHG emissions. Figure 2.4 presents a roadmap with five components to help cities become low carbon as follow:

(1) Energy efficiency: particularly in the industrial, power, heating, and buildings sectors including use of clean, renewable sources of energy.

(2) Public transport: adoption of new technologies and the provision of high quality public and non-motorized transport.

(3) Spatial growth and urban form: higher densities emit less GHG, smarter link in public transport networks and compact urban forms.

(4) Low carbon lifestyle: less carbon-intensive households.

(5) Economic structure: lower-carbon industries, low carbon footprint.

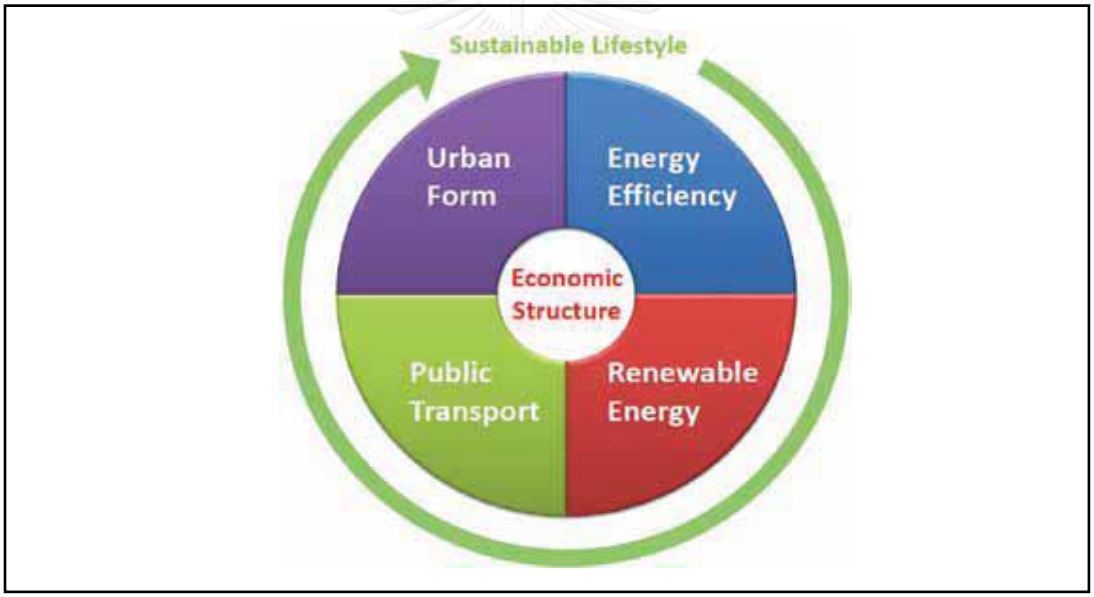



Figure 2.4 Low carbon city roadmap.
Source: Wang et al. (2012)

Table 2.2 summarizes the six key initiative areas on low carbon city approaches. It can be seen that in transport sector all approaches emphasized on public transport as the key element toward sustainable city. In addition, urban form, energy efficiency and water and waste management are basic areas in city development. Moreover, social and economic developments also are taken into account in terms of people lifestyle and economic structure of the city.

Table 2.2 Summary of key low carbon city initiative areas.

| Authors | Urban Form / Green Areas | Energy Efficiency / Renewal Energy | Public Transport | Water and Waste Management | Sustainable Lifestyle | Economic Structure |
|---|---|---|---|---|---|---|
| World Bank (2011) | • | • | • | • | • | |
| Baeumler et al. (2012) | • | • | • | • | | |
| Wang et al. (2012) | • | • | • | • | • | • |

Source: World Bank (2011), Baeumler et al. (2012), and Wang et al**.** (2012)

## 2.3 Sustainable transport

Many studies in megacities both in developed and developing countries support that public transportation in mass transit system will play the key role in $CO_2$ mitigation, efficient energy use and quality of life improvement through sustainable transport toward sustainable city (Kennedy et al., 2005; Zhao, 2010; Nakamura and Hayashi, 2012). Sustainable transport could contribute to enhancing the three pillars of sustainable development - environment, economic and social aspects to the city.



### 2.3.1 Sustainable transport concept

Sustainable transport has been concerned in many international agreements. Transport was considered in Agenda 21 in several chapters (United Nations Conference on Environment and Development (UNCED), 1992), for example, Chapter 4 - sustainable consumption mentioned transportation sector was one of the top high sectors in energy consumption. Chapter 7 suggested the transportation strategies to reduce car dependency while to promote public transportation in order to promoting sustainable energy and transport systems in human settlements. In addition, Chapter 9 remarked that the transport sector is a key role to play in economic and social development. However, the transport sector is also a source of atmospheric emissions that need for a review and a more effective design and management of

traffic and transport systems toward sustainable development. Furthermore, in Chapter 9 also suggested the governments to develop and promote more energy efficient, less polluting and safer transport systems, particularly integrated rural and urban mass transit.

The Millennium Development Goals (MDGs) considered transportation as one key role to achieve the MDG goals. United Nations Centre for Regional Development (UNCRD) studied the linkages between MDGs and Environmentally Sustainable Transport (EST) as shown in Table 2.3 (UNCRD, 2013). Also, UNCRD defines EST as transport that meets the needs of the present without preventing future generations from meeting their needs that is centered on the transportation system and transportation activity that meets social, economic and environmental objectives.

In addition, the future we want from Rio+20 has included sustainable transport in the section of framework for action and follow-up. Paragraph 132 stated that "… transportation and mobility are central to sustainable development. Sustainable transportation can enhance economic growth and improve accessibility. Sustainable transport achieves better integration of the economy while respecting the environment…" (United Nations General Assembly (UNGA), 2012). Also, paragraph 133 stated that "… to support the development of sustainable transport systems, including energy-efficient multimodal transport systems, notably public mass transportation systems, clean fuels and vehicles, as well as improved transportation systems in rural areas. We recognize the need to promote an integrated approach to policymaking at the national, regional and local levels for transport services and systems to promote sustainable development…" (UNGA, 2012).

Table 2.3 The linkages between Millennium Development Goals (MDGs) and Environmentally Sustainable Transport (EST)

| Millennium Development Goals (MDGs) | Environmentally Sustainable Transport (EST) Linkages |
|---|---|
| 1. Eradicate extreme poverty and hunger | EST promotes environmentally friendly and sustainable transport modalities, including increased mobility for the poor and the vulnerable groups through provision of adequate public transport and pedestrian facilities, which would ultimately help the poor to find employment and livelihood support. |
| 2. Achieve universal primary education | Through the provision of adequate public transport and pedestrian facilities, EST ensures affordable, reliable, and safe transportation for children, who may be deprived of opportunities for primary education, due to high fares or lack of adequate transport facilities to commute to school. |
| 3. Promote gender equality and empower women | Women are disproportionately affected by lack of affordable, safe, and adequate transport means, since they often carry out frequent and short trips during off-peak hours and off the main-routes for child care, household management activities, informal sector employment, etc. While female commuters are on the rise due to the increased female work force in many business and commercial sectors, they are vulnerable as pedestrians to traffic accidents and to personal violence when making trips on public transport. EST would encourage policy makers to take gender issues into consideration in sustainable transport planning, as well as to empower more women to be more socially and economic active, by providing them with affordable, reliable, and safer means of transportation. |
| 4. Reduce child mortality | Air pollution from the transport sector, in particular SPM ($PM_{10}$, $PM_{2.5}$) is associated with a broad range of acute and chronic health effects, ranging from minor physiologic disturbances to death from respiratory and cardiovascular diseases, exacerbating child mortality rates in many developing countries. Children are also vulnerable as victims of traffic accidents and mortalities, which are on the rise in many developing countries, due to increased motorization. Promotion of EST would contribute to reduction of air pollution levels, to introduction of cleaner fuels, to provision of environment and children friendly transport infrastructure, to improved and integrated land use planning, and to enforcement of adequate road safety standards and guidelines, which will collectively reduce the rate of child mortality worldwide. |
| 5. Improve maternal health | Air pollution from the transport sector contributes to poor maternal health conditions, while the lack of safe, affordable, and adequate transportation means for women pose risks to the well-being of mothers in many developing countries. Promotion of EST would contribute to reduction of air pollution levels, to introduction of cleaner fuels, and to provision of environment and women friendly transport infrastructure. |
| 6. Combat HIV/AIDS, malaria, and other diseases | Air pollution from the transport sector is associated with a broad range of acute and chronic health effects, ranging from minor physiologic disturbances to death from respiratory and cardiovascular diseases. Lack of affordable and adequate means of transportation also results in lack of access to appropriate medical services and medication in remote areas for the poor and the vulnerable groups, who have fewer resources to combat these diseases. Promotion of EST would contribute to a healthier living environment, and to the better likelihood of combating HIV/AIDS, malaria, and other diseases. |
| 7. Ensure environmental sustainability | Increased motorization trends and demand for transport facilities have given rise to a variety of transport related socio-economic and environmental problems. These include - vehicular air pollution and associated public health and environment impacts, noise pollution, traffic congestion and associated economic loss, inefficient use of energy resources, greater use of non-renewable fossil fuel, and loss of potential natural habitats and land resources. Therefore, strategic planning for promoting environmentally sustainable transport is needed to (a) improve quality of life for the present generation and (b) ensure environmental sustainability for the future. |
| 8. Develop a global partnership for development | Johannesburg Plan of Implementation (JPOI) adopted at 2002 WSSD has emphasized the critical need to promote an integrated approach to policy-making at the national, regional and local levels for transport services and systems to promote sustainable development, including policies and planning for land use, infrastructure, public transport systems and goods delivery networks, with a view to providing safe, affordable and efficient transportation, increasing energy efficiency, reducing pollution, congestion, and adverse health effects and limiting urban sprawl, taking into account national priorities and circumstances. The Plan calls upon countries to promote investment and partnerships among various stakeholders (central governments, local governments, the private sector, NGOs, and communities),for the development of sustainable, energy efficient multi-modal transportation systems, including public mass transportation systems and better transportation systems in rural areas, with technical and financial assistance for developing countries and countries with economies in transition. |

Source: UNCRD (2013)

### 2.3.2 Sustainable transport measures and indicators

Zhao (2010) mentioned that sustainable transport concept has four elements are high level of accessibility, efficient energy and low emissions, public transportation and social equity. Nakamura and Hayashi (2012) noted that the feasibility and effectiveness of transport measures depend on the different stages of city development and it patterns. In addition, they summarized the classification of typical examples of low carbon transport measures with the CUTE (Comparative study on Urban Transport and the Environment) matrix and A-S-I (Avoid-Shift-Improve) approach as shown in Table 2.4. A-S-I approach is the approach on demand-side which tries to achieve significant GHG emission mitigation, reduced energy consumption, less traffic congestion and improve livable cities.

Table 2.4 The classification of typical examples of low carbon transport measures with the CUTE matrix and A-S-I approach.

| | AVOID | SHIFT | IMPROVE |
|---|---|---|---|
| Technology | Transit corridor development<br>Transit oriented development (TOD) | Mass transit development | Low-emission vehicle (LEV) development |
| Regulation | Land-use control | Feeder Transport improvement<br>Traffic control | Emission standards |
| Information | | Advanced public transport systems | Advanced integrated transport systems |
| Economy | | Road pricing | Economic LEV promotion<br>The carbon market |

Source: Nakamura and Hayashi (2012)



The Institute for Global Environmental Strategies, IGES (2011) also described A-S-I approach in the synthesis report that avoid strategies aim to prevent high energy and emission intensive transport infrastructure; Shift strategies aim to shift towards low carbon modes such as building rail-road integrated network and enhancing multi-modal transport systems; Improve strategies aim to improving energy efficiency and other performance indicators such as high speed trains, upgrade of mass rapid transit (MRT) system, and improvement of safety features. Furthermore, this report suggested that to leverage the mass transit ridership the relevant indicators to measure low carbon transport should be clarified. Moreover, low carbon transport strategy needs to integrate with low carbon city design.

Kennedy et al (2005) mentioned the sustainable transport performance measures in three dimensions are social - accessibility, health and safety; economic - cost effectiveness, impacts on competitiveness and generation of wealth; environment - natural resource consumption and pollutions. Another study of Partnership for Sustainable Urban Transport in Asia (PSUTA) has studied in sustainable transport in Asia and summarized the elements of sustainable transport into main four aspects with twenty subtopics as shown in Figure 2.5.

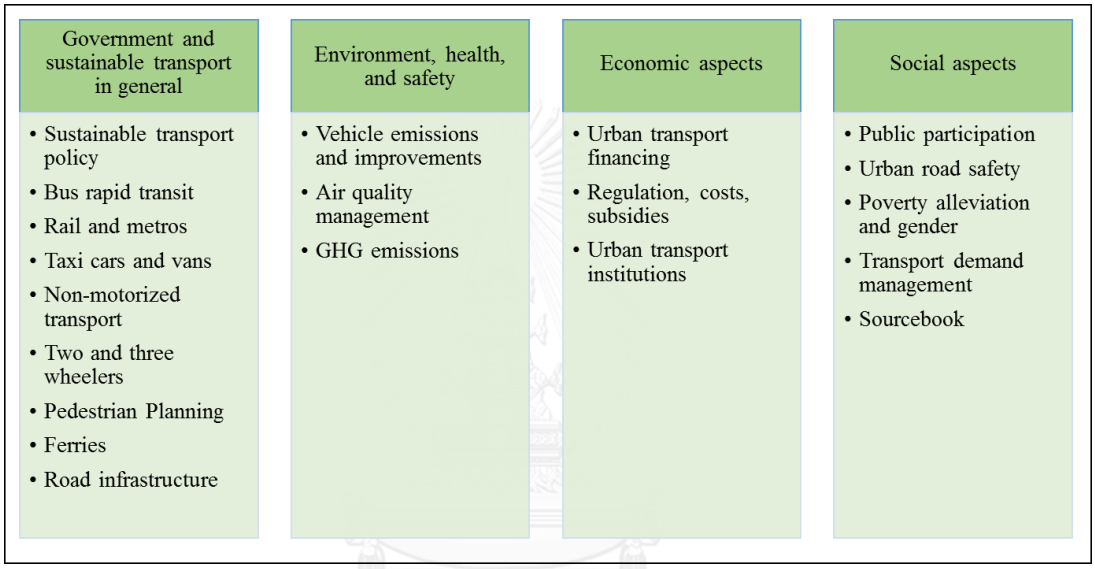



Figure 2.5 The elements of sustainable transport.

Source: PSUTA* (2007)

* Partnership for Sustainable Urban Transport in Asia (PSUTA) is consisted of Asian Development Bank, Clean Air Initiative for Asian Cities, Swedish International Development Cooperation Agency (Sida), and World Resources Institute.

In addition, PSUTA (2007) also classified the sustainable transport indicators into the matrix of the four elements of sustainable transport as mentioned above as shown in Table 2.5.

Table 2.5 Sustainable transport elements and indicators.

| Externalities Pillar/roof | Clean air/air pollution | Safety/accidents | Access/congestion |
|---|---|---|---|
| Environment and safety | New car emission standards | Death and disease from polluted air | Excess pollution from congestion, circuitous routing |
| Equity/social | Different exposures by region, gender, group | Different accident rates for walkers, bikers, drivers, women/men | Different delays and travel times by gender, group |
| Economics | Health and property costs of pollution, costs of abatement (extra costs of vehicles and fuels) | Social and direct costs of accidents; expenditures on safety and driver training | Money value of losses of time, transport business profits |
| Governance | Clean air agency, enforcement laws monitoring stations | Seat belt laws, driver training requirements, new/existing vehicles safety standards | Emergency plans on polluted days |

Source: PSUTA (2007)

### 2.3.3 Co-benefits of sustainable transport

As mentioned before that sustainable transport could contribute to enhancing the three pillars of sustainable development - environment, economic and social aspects to the city. Ang and Marchal (2013) support that it would also provide the benefit to climate change mitigation and adaptation. Figure 2.6 illustrates the co-benefit of sustainable transport.

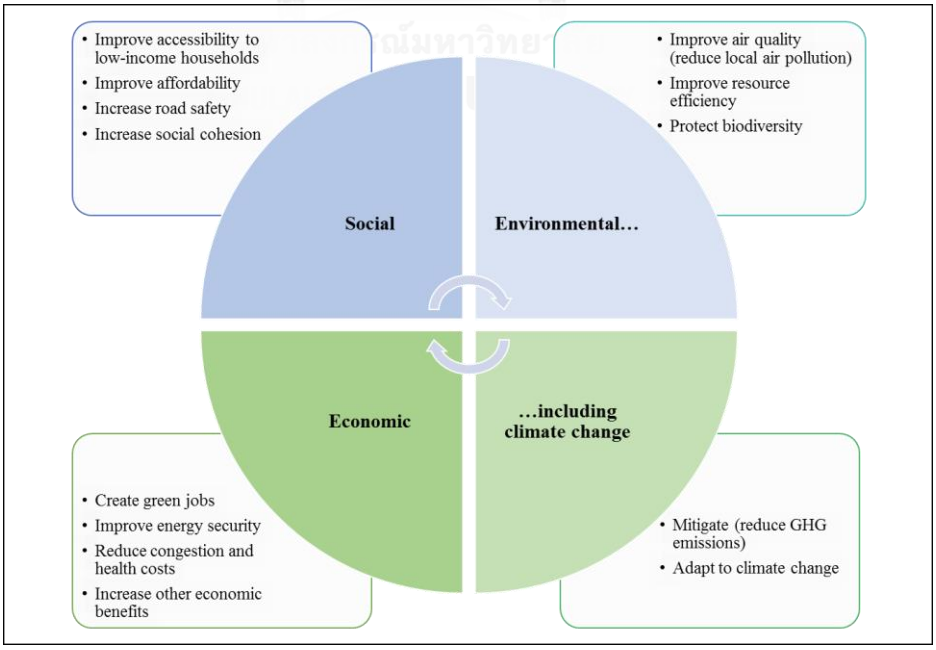



Figure 2.6 Co-benefit of sustainable transport.
Source: Ang and Marchal (2013)

### 2.3.4 Mass transit development

Mass transit modes are expected to decrease $CO_2$ emission in transport sector and are element towards sustainable transport (Khanna et al., 2011; Nakamura and Hayashi, 2012). Furthermore, Khanna et al. (2011) suggested that rail-based systems could achieve greater carbon mitigation than bus-based system because of electric-powered transport system. Also, rail-based systems can contain more passengers and higher speed. However, Mackett and Edwards (1998) argued that bus-based system would be more cost-effective than rail-based system since it used lower investment and lower operating costs.

There are many case studies on achievement in promoting the mass transit modes. For bus-based system, in Curitiba, Brazil, was the first city in successful implementation in Bus Rapid Transit (BRT). Then there are other cities applied the BRT such as Bogota, Colombia; Rio de Janeiro, Brazil and Guangzhou, China. For rail-based system, Japan is the earliest development in mass transit lines which took firstly took place in Tokyo and Osaka (Nakamura and Hayashi, 2012). Also, China has invested a huge amount of budget on railway development especially in underground to promote urban public transport such as Beijing and Shanghai.



## 2.4 Low carbon development strategies model of sustainable transport

Transport is the second largest contributor to global GHG emissions, which are 23 percent of global $CO_2$ emissions from fossil-fuel combustion as shown in Figure 2.7(a). Global passenger transport volumes in 2050 could be up to 2.5 times as large as in 2010 (International transport Forum (ITF), 2012). Road transport for passenger and freight accounts for 73 percent of transport-related $CO_2$ emissions as of 2009 as shown in Figure 2.7(b). However, current investment in fossil-fuel road transport has been continuing increase as economic growth (Ang and Marchal, 2013). Therefore, the government should control this growth and identify measures that would effectively reduce the level of GHG emissions from transport sector. On the other hand, the government could maintain the role of transport in generating

prosperity and mobility for the future generations. These are key challenges to be addressed at low carbon development strategies.

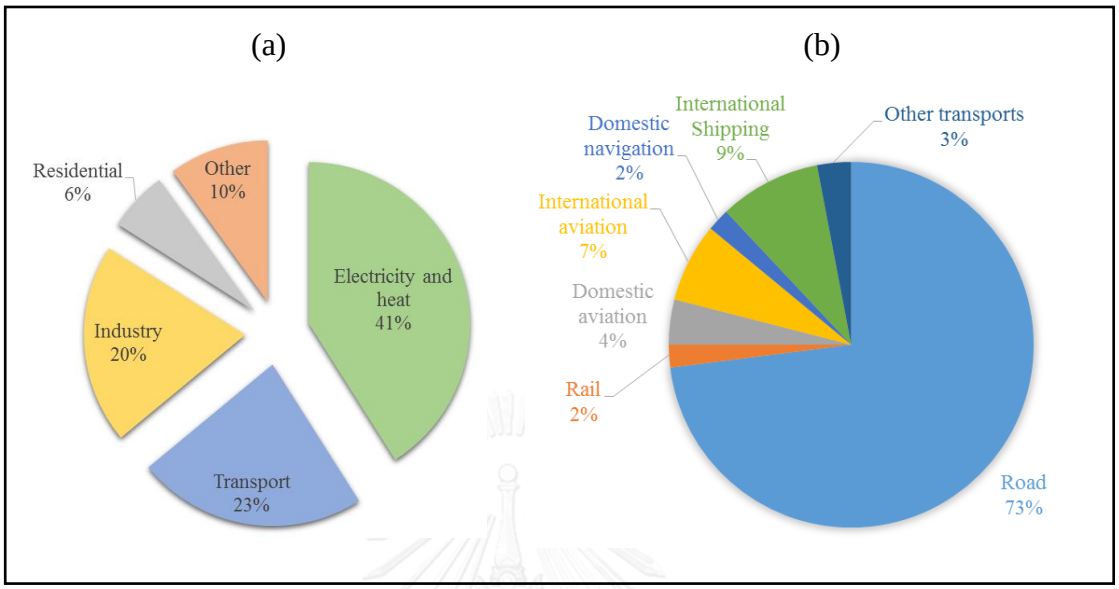



Figure 2.7 (a) World carbon dioxide emissions by sector, 2009 (IEA, 2011) and (b) Modal split of transport related carbon dioxide emissions, 2008 (OECD, 2010).

Source: Ang and Marchal (2013)

### 2.4.1 Low carbon development concepts

According to changing in a development model from treating environmental protection as an economic burden to a driver for global and national economic development, green low carbon growth concept has changed as essential for long-term economic and environmental sustainability (World Bank, 2011). OECD defines green growth as "Promoting economic growth while reducing pollution and GHG emissions, minimizing waste and inefficient use of natural resources, and maintaining biodiversity" (OECD, 2009 cited in World Bank, 2011). In addition, The United Nations Economic and Social Commission for Asia and Pacific (UN ESCAP) clarifies Green growth as "a policy focus for the Asia and Pacific region that emphasizes environmentally sustainable economic progress to foster low carbon, socially inclusive development to achieve real progress towards sustainable development and

poverty reduction. The green growth approach seeks to harmonize the two imperatives of economic growth and environmental sustainability by promoting "fundamental changes in the way societies produce and consume…" (UN ESCAP, 2006 cited in World Bank, 2011).

Low carbon development is a development paradigm that contributes to addressing the challenges in economic development and environmental sustainability by keeping greenhouse gas emissions low without intervention. Tilburg et al. (2011) presented the low carbon development at the intersection of development and mitigation as shown in Figure 2.8. This concept supports that the low carbon development is the interaction between development and mitigation.

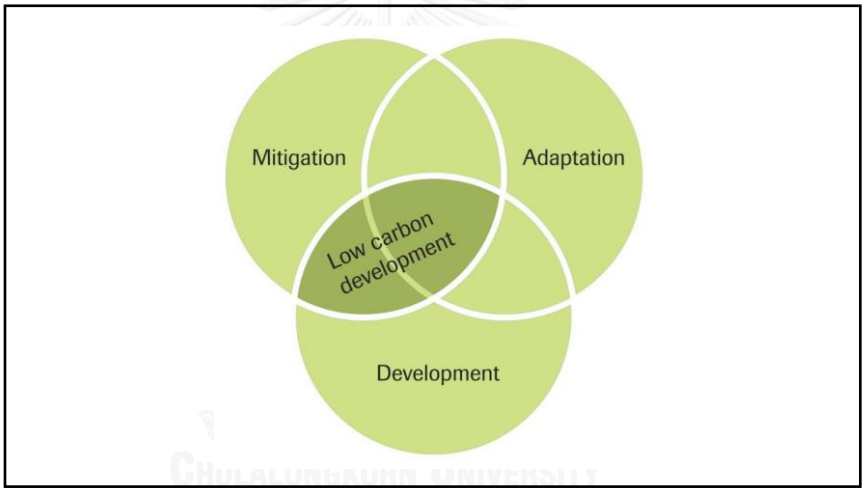



Figure 2.8 Low carbon development at the intersection of development and mitigation
Source: Tilburg et al. (2011)

### 2.4.2 Low carbon development strategies (LCDS)

Tilburg et al. (2011) suggested that the development of low carbon development planning needs six elements: readiness, building blocks, continuous process, technical and political alignment, purpose, and outcomes as shown in Figure 2.9. Tilburg et al. (2011) further introduced that the objective of Low Carbon Development Strategies (LCDS) is to motivate actions that support development without intervention. The study noted that the process of LCDS development should

be aligned towards this aim rather than focusing on producing a strategy document. These are the six elements for LCDS:

(1) **Readiness**: Each country has different condition and circumstance; therefore there are differences in their data availability, capacity and awareness. LCDS should be developed according to their situations in order to achieve realistic goal.

(2) **Building blocks**: As mentioned in readiness that the specific country has their own context. LCDS process would also have different determinants and prioritize criteria.

(3) **Technical and political**: LCDS should ensure to align with technical and policy process for confirming that the strategy could be implemented properly.

(4) **Continuous process**: LCDS is a continuous system which cannot be a discrete process. There three main steps which are assessing the current situation, identifying low carbon alternatives, and identification of policy aims, actions and interventions.

(5) **Purpose**: LCDS is a document which has different purposes. The readers can apply its information to their different purposes.

(6) **Outcomes**: LCDS could be changed or adjusted along the process in order to ensure that it would generate the optimal outcomes.

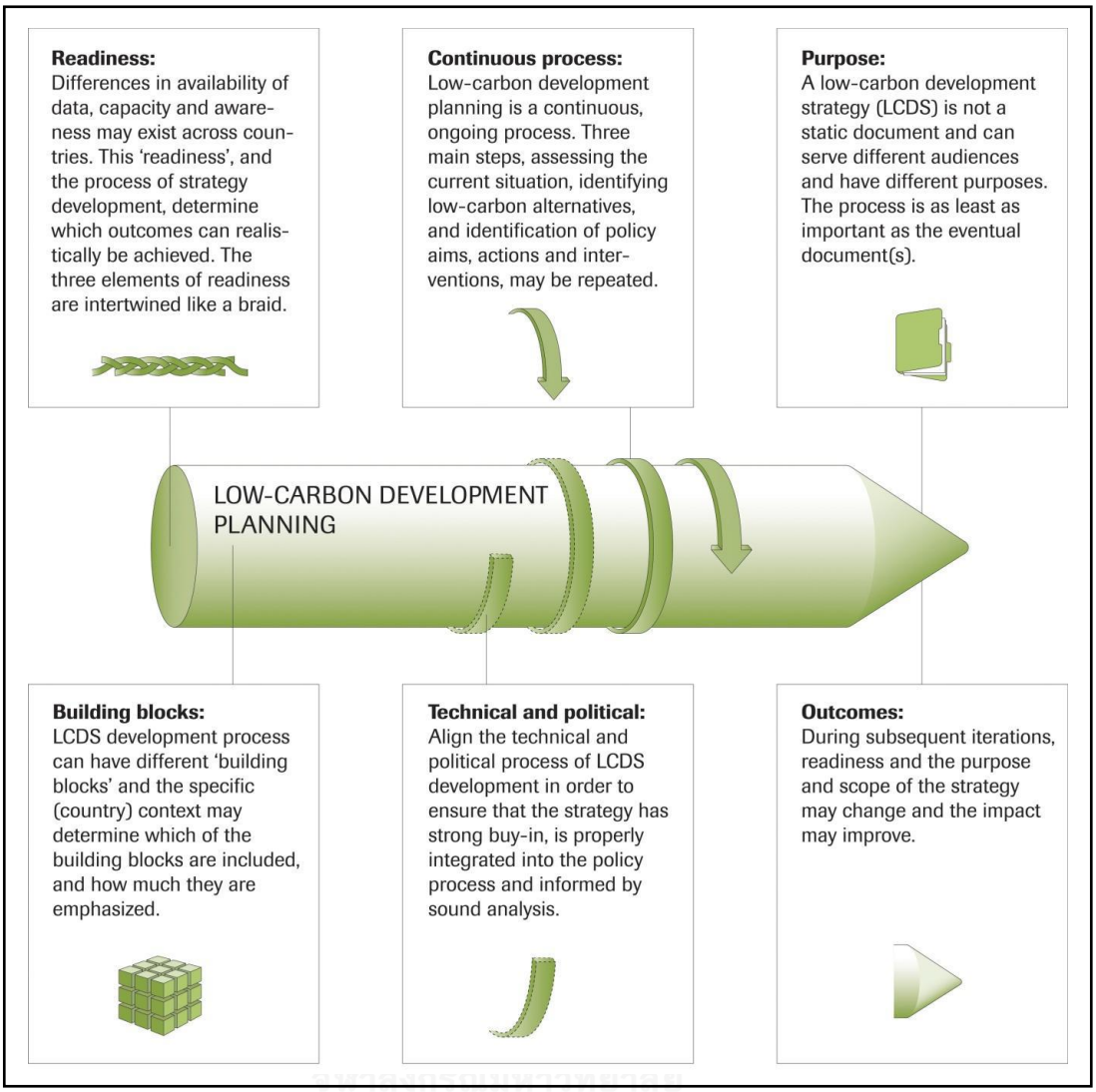



Figure 2.9 The approach to developing low carbon development strategies.
Source: Tilburg et al. (2011)

In addition, Tilburg et al. (2011) mentioned that there are additional three elements for LCDS with regarding to stakeholder involvement and capacity, inter-ministerial committee and aligning technical and political process are as following:

(1) Strengthening stakeholder involvement and capacity

With regarding to the national context, Tilburg et al. (2011) stated LCDS can serve different stakeholders and have different purposes. Thus, it implied that the different building blocks and readiness of LCDS may not need to be the same detailed but based on case-by-case. In the study found that creating an effective LCDS needs

to be a participatory process under strong senior leadership within the government. In addition, stakeholders' involvement is need from the start of the process to enable the creation of ownership of the outcomes. However, this report argued that differences in readiness and in the process of strategy development will determine which outcomes can realistically be achieved. The differences in the readiness among countries rely on to strengths and weaknesses in three categories: the fact base, analytical and institutional capacity, and the awareness and engagement of all relevant stakeholders (Tilburg et al., 2011). Strengthening the stakeholders' capacity can contribute efficiently to the development at every level. In the study in Institute for Global Environmental Strategies (IGES) (2011) supported that multi-level approach toward low-carbon society is essential. It is expected to promote citizen awareness and grass roots action that is the effective combination of top-down and bottom-up approaches to gain public support for the policies. Moreover, the potential of all stakeholders should be empowered to strengthen their responsiveness and adaptability toward any changes. For example, citizens should be encouraged to participate in the public agenda, with efficiency and transparency. Databases at provincial and local levels should be developed and linked with central databases and any others that all stakeholders have equality in accessibility.

(2) Inter-ministerial committee

Beside of stakeholder involvement and their readiness, a dedicated inter-ministerial body also the essential support in developing LCDS. Tilburg et al. (2011) noted that the development LCDS process is the government takes the lead include aligning the LCDS to other national plans and strategies, defining a package of policy interventions across sectors and ministries, and integrating into the national budget. The study gave an example in Indonesia, a lack of coordination between different ministries, departments and agencies emerged led to the major barriers to the development of one national LCDS. In the study of World Bank (2011) supported the strengthening of national and institutional coordination as a key successful implementation. An inter-ministerial committee could be set up with effectively coordinate with key sector ministries such as the Ministries of Energy, Environment, Finance, Interior, and Transport. Furthermore, this report noted that clear roles and

responsibilities should be assigned across the key sectors and between the central and local governments. IGES (2011) stated that innovative political and economic incentives and institutional arrangements, including inter-ministerial arrangements, are called for to induce transition toward low carbon society.

(3) Aligning technical and political process

Tilburg et al. (2011) mentioned the alignment of technical and political aspects of the low carbon development process is one essential element. Part of the input to the LCDS process, such as assessments of development benefits and costs is an analytical aspect with normally need technical experts outside of government. For developing countries, expert support is mostly made available by international technical assistance in cooperation with local experts from within or outside government (Tilburg et al., 2011). IGES (2011) supported that external collaborations are needed for technology transfer, gaining technical knowhow to support localization in technology, as well as infrastructure changes for the development.

In terms of financial support, IGES (2011) stated that international mechanisms for financing the investments required political collaborations, as in various multilateral and bilateral mechanisms. In addition, involvement of private sector for financing in Thailand can be attained by public private partnerships (PPP) as a funding model for public infrastructure and service projects such as a new telecommunications system. Also, it can be business venture which is funded and operated through a partnership of government and one or more private sector companies. However, in implementing process, IGES (2011) noted that different policies and technical measures need to be designed for each different city taking into account specific conditions of each city. For example, Bangkok needs highly effective options including expansion of mass transit transportation system, growing of trees in large spaces, improving efficiency of electricity use in buildings, and solid waste management. While other urban areas municipality might need the appropriate options include local waste management practices and local natural resource management.

## 2.5 Existing transport situation of the Bangkok Metropolitan

Bangkok metropolitan occupies 1,568.7 square kilometers and consists of 50 districts with high density in 5,258.6 persons per square kilometer (National Statistical Office (NSO), 2011). The inner city of Bangkok has high density and located by official places and commercial business areas as shown in Figure 2.10.

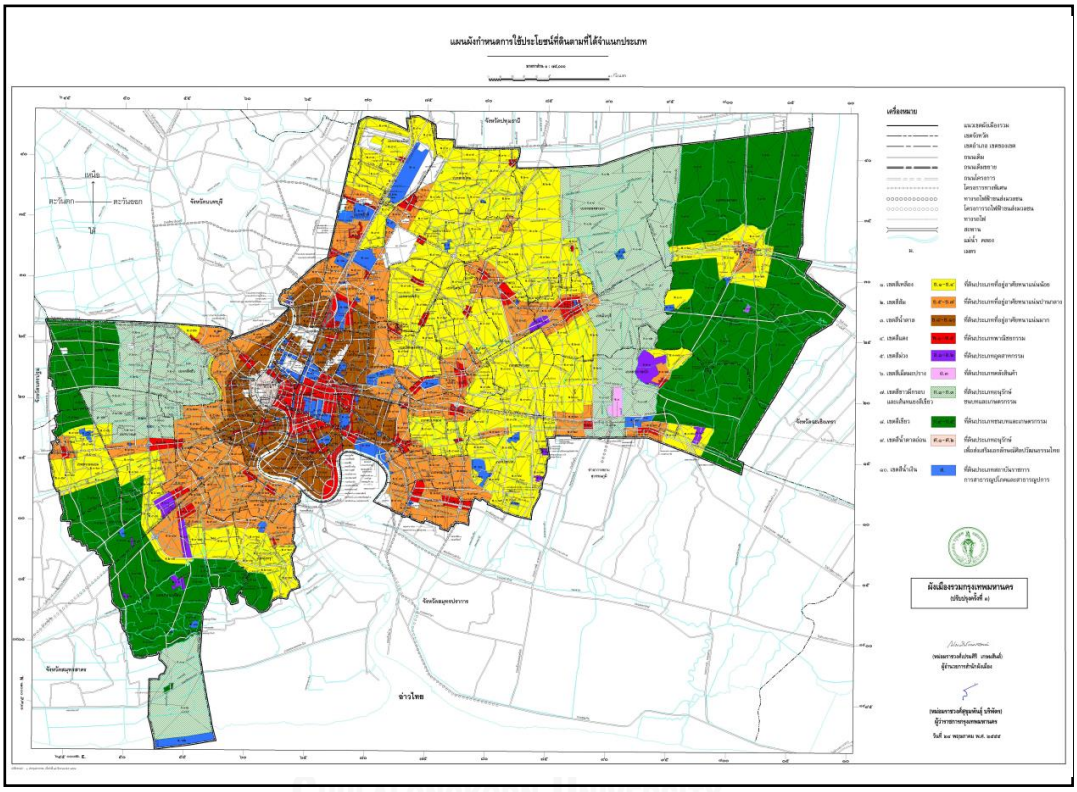




Figure 2.10 Land uses in Bangkok Metropolitan, 2012

Source: City Planning Department, BMA (2012)

Regarding to environmental aspect, per capita carbon dioxide ($CO_2$) emissions in Bangkok, based on data in 2005, are already high and the major sources of emissions in Bangkok came from transport sectors as shown in Table 2.6. Department of Energy Business reported that the fuel consumptions per day in Thailand are high for example Benzene 22 million ton, Gasohol 13 million ton and Natural Gas Vehicles (NGV) 8 million kilograms (data as of November 2012). Inefficient public transport system and land-use planning as well as lack of mobility management in Bangkok have created many environmental, social and economic problems. For

example, air pollution, fuel overconsumption, unsustainable livelihood, health and safety. Unsustainable transport likes traffic congestion and car-dependency lifestyle can lead to unsustainable city which people will get low quality of living, pollutions, health insecurity and risk of car accident. Furthermore, this unsustainable transport would effect to the national energy security that Thailand is fuel import-dependency.

Table 2.6 GHG emissions in Bangkok (2007-2012)

| Sector | $CO_2$ Equivalent, Million Tons | | |
|---|---|---|---|
| | GHG emissions 2007 | GHG emissions 2012*, BAU | GHG emissons 2012*, Under BMA action plan |
| Transportation | 21.18 | 25.3 | 19.77 |
| Electricity generation | 14.86 | 16.00 | 13.75 |
| Waste production | 1.13 | 1.13 | 0.95 |
| Others, methane from rice production, etc. | 5.58 | 6.36 | 6.36 |
| Reduction of GHG emissions from bio-fuel energy | | | (0.61) |
| Reduction of GHG emissions from improved waste disposal | | | (0.28) |
| Reduction of GHG emissions from expanded parks and green areas | | | (1.00) |
| Total | 42.75 | 48.79 | 38.94 |

*Forecasting number

Source: BMA (2007) cited in UN HABITAT (2010)

BMA launched its Action Plans on Global Warming Mitigation (BMA, 2007) with a target of reducing the city's emission by 15 percent below the projected emission level in 2012. The Action Plan contains the following five initiatives.

Initiative 1: Expand Mass Transit and Improve Traffic Systems

Initiative 2: Promote the Use of Renewable Energy

Initiative 3: Improve Electricity Consumption Efficiency

Initiative 4: Improve Solid Waste Management and Wastewater Treatment Efficiency

Initiative 5: Expand Park Areas

According to the first initiative on expand mass transit, the aim is to reduce the number of private car used in the city by promote people to model shift to mass transit. Also, the plan estimated that $CO_2$ emission in Bangkok would be decreased by 2.4 t $CO_2$e/year in 2012. Mass transit system includes the Bangkok Mass Transit System (BTS), the Bangkok Metropolitan Rapid Transit (MRT) and Airport Rail

Link. Regarding to the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (2010-2029) or called M-Map is one of Thai government plans for the development of urban rail transit network serving the Bangkok Metropolitan Region. The Bangkok Metropolitan Region (BMR) is consisted of Bangkok Metropolitan and the five adjacent provinces of Nakhon Pathom, Pathum Thani, Nonthaburi, Samut Prakan and Samut Sakhon. The plan was drafted under the Office of Transport and Traffic Policy and Planning (OTP) of the Ministry of Transport. Table 2.7 shows the twelve routes of the mass rapid transit master plan with the totaling 508 kilometers has been constructed within a development period of twenty-year plan (2010–2029).

Table 2.7 The route of the mass rapid transit master plan in Bangkok Metropolitan Region (2010-2029).

| No. | Lines | Distance (kilometers) |
|---|---|---|
| | Primary lines | |
| | Commuter rail | |
| 1 | Dark Red Line (Thammasat - Maha Chai) | 80.8 |
| 2 | SRT Light Red Line (Sala Ya - Taling Chan - Hua Mak) | 58.5 |
| 3 | Airport Link (Phaya Thai - Makkasan - Suvarnabhumi) and Airport Link extension (Phaya Thai - Bang Sue - Don Mueang) | 49.5 |
| | Mass rapid transit | |
| 4 | Dark Green Line (Lam Luk Ka - Saphan Mai - Mo Chit - On Nut - Bearing - Samut Prakan - Bang Pu), extension of the BTS Sukhumvit Line | 66.5 |
| 5 | Light Green Line (Yot Se - Taksin Bridge - Bang Wa), extension of the BTS Silom Line | 15.5 |
| 6 | Blue Line (Bang Sue - Tha Phra, Hua Lamphong - Bang Khae - Phutthamonthon 4), extension of the MRT Blue Line | 55.0 |
| 7 | Purple Line (Bang Yai - Rat Burana) | 42.8 |
| 8 | Orange Line (Taling Chan - Min Buri) | 37.5 |
| | Feeder lines | |
| 9 | Pink Line (Khae Rai - Pak Kret - Min Buri) | 36.0 |
| 10 | Yellow Line (Lat Phrao - Samrong) | 30.4 |
| 11 | Grey Line (Watcharaphon - Rama IX Bridge) | 26.0 |
| 12 | Light Blue Line (Din Daeng - Sathon) | 9.5 |
| | Total | 508.0 |

Source: OTP (2010a)

## 2.6 Future transportation policy of Thailand toward sustainable transport

Recently, Thailand has developed the study in a Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts which aims to provide the direction for the transportation system development in Thailand along with to mitigate the impacts of climate change. The main objectives of the study are to prepare a Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts for a short-term program (2013-2017) and a long-term plan (2018-2030) and to promote the integration of planning and implementing processes for the environmentally sustainable transport systems and mitigation of climate change impacts. From the study, the Master Plan has initiative six strategies as following:

**Strategy1**: Upgrade capability of agencies and personnel for the development of an environmentally sustainable transport system.

**Strategy2**: Establish appropriate plans and mechanisms for interfacing and monitoring of transport and traffic work plans/measures/ projects; and to move them forward to implementation.

**Strategy3**: Establish comprehensive and inter-connected transport infrastructure.

**Strategy4**: Efficient transport management for sustainability and greenhouse gas reduction.

**Strategy5**: Promote transport research and development as well as adoption of environment-friendly innovations and technologies.

**Strategy 6**: Promote public awareness of the environment.

Based on the Master Plan, Thailand should be able to reduce GHG emissions by 15-16 million tons of $CO_2$ in 2020 or around 20-22 percent of the 2020 BAU (OTP, 2013a).

# CHAPTER III

# RESEARCH METHODOLOGY

## 3.1 Research Framework

This research aimed to study the current states of transportation and its impacts in Bangkok Metropolitan in order to develop low carbon development strategic model for sustainable city transport. The research would enhance sustainable transportation toward sustainable and low carbon city. The rapid increasing in urbanization and highly consumption would lead to high dependency on car. Furthermore, the current traffic situation and city planning, has made current states of transportation mode in the city to be more traffic congestion, more $CO_2$ emission, and less quality standard of living. Therefore, a national sustainable development plan, relevant in low carbon development strategies needs to be developed, particularly in transportation sector. The mass public transportation is considered as a mean of sustainable transport leading to low carbon city. The conceptual framework of study is shown in Figure 3.1.



The conceptual framework of the study was consisted of the three key parts namely low carbon development strategy (LCDS), sustainable transport and low carbon city. According to the study of Partnership for Sustainable Urban Transport in Asia (PSUTA, 2007), four elements of sustainable transport concepts were included as follows;

(1) Environment - air quality and Greenhouse Gas (GHG) emissions
(2) Economic - urban transport financing
(3) Social - road safety and public participation
(4) Governance and policy aspects - sustainable transport policy, public transportation mode, and Environmental Impact Assessment (EIA)

These elements were studied using indicators and measures. The current transportation policy focusing on mass rapid transit master plan was also studied and analyzed in order to know the co-benefit, gaps and barriers of such plan toward sustainable transport and low carbon city.

Low carbon city approaches developed by Baeumler et al. in 2012 were studied. The study focuses only on public transport and low carbon vehicles via reducing traffic congestion, air pollution and GHG emissions, and improving road safety. This approach was studied based on available data and information relevant the sustainable transport.

Regarding low carbon development strategy, the study was conducted based on the study of Tilburg et al. (2011), composed of

(1) Readiness
- Available in data of the current situation
- Experts
- Process and policy

(2) Building blocks
- Assessing the current situation
  - Data collection: GHG emissions, existing policies and regulation.
  - Capacity assessment: the available capacity to analyze the data
  - Stakeholder mapping: who and what are their roles and responsibilities
  - Institutional setup: government ministries, departments and agencies who are involved and what are their roles and mandates
- Identification of policy aims, actions, and interventions
  - Long term vision, targets and actions of the policy
  - Finance: financial sources, private sector investments
  - Government intervention: which policies and regulations to support low-carbon development
  - Plan for implementation: the roles and responsibilities of all stakeholders

(3) Technical and political

- Technical assessments e.g. input data, potentials, costs and benefits
- National political process and decision-makers

(4) Continuous process

- Iterative development model - planning, analysis and design, implementation, and evaluation

(5) Purpose

- Different purposes depending on the stakeholders.

(6) Outcomes

- Strategy could be changed or adjusted along the process in order to ensure that it would generate the optimal outcomes

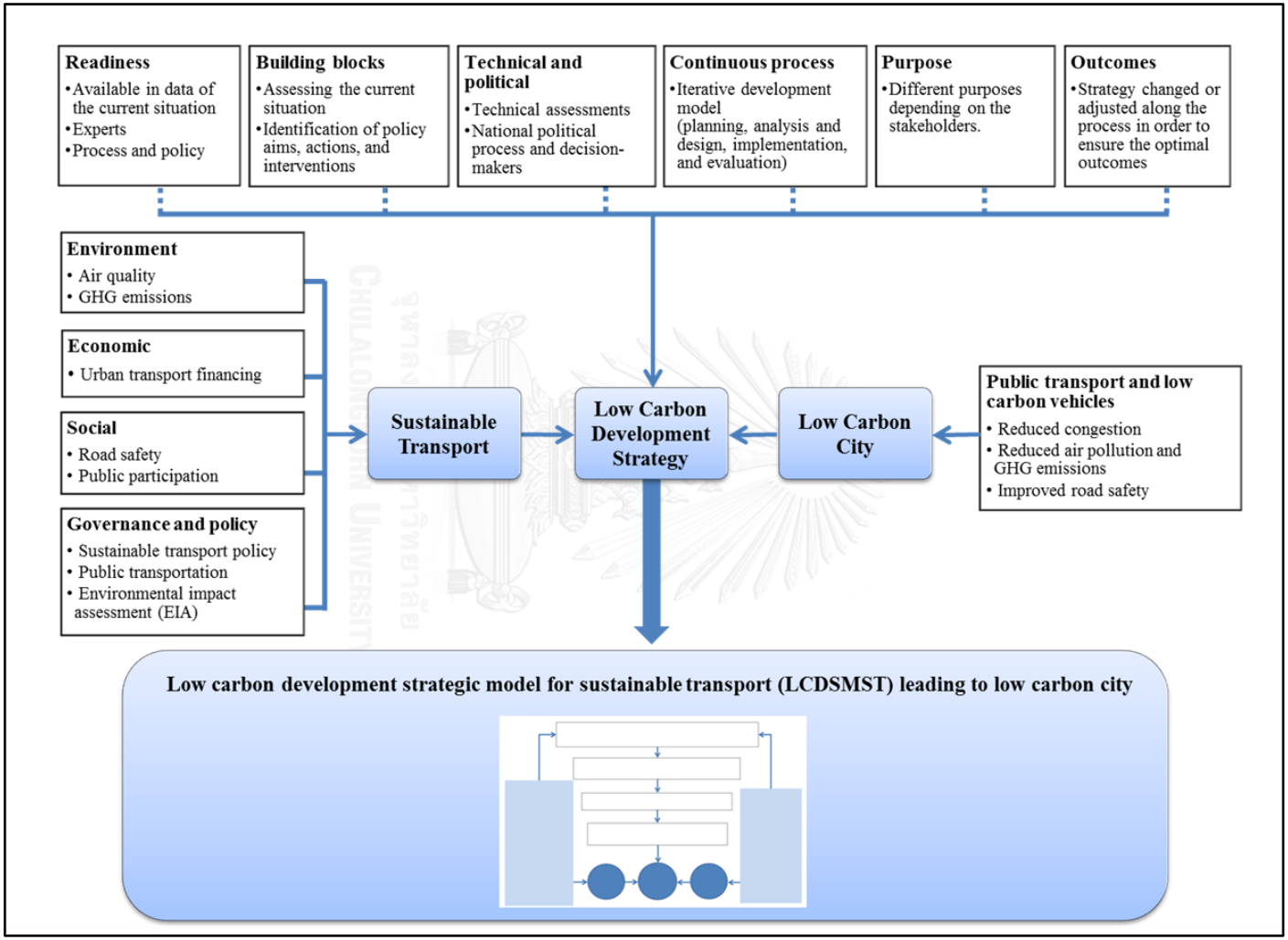



Figure 3.1 The conceptual framework of low carbon development strategy for sustainable transport

## 3.2 Research Design

The nature of this research was designed as exploratory and descriptive researches. The exploratory research aims to identify key issues and key variables that can help the researcher for better understanding or may determine the optimal methods to be used in a subsequent study (Stebbins, 2001) while the descriptive research provides a range of descriptive map to the perspective of a specific phenomenon.

### 3.2.1 Research Approach

A qualitative research method was used in the study. The qualitative research is normally explained as allowing a detailed exploration of a topic of interest in which information that is collected by a researcher through case studies, ethnographic work, interviews, and so on (Harwell, 2011). Its method also described as an inductive that a researcher may construct theories or hypotheses, explanations as well as conceptualizations from details provided by respondents. In order to gain a better understanding and develop a more comprehensive conceptual framework, the process of inductive analysis through the use of qualitative approach would be an appropriate method for exploratory research.



### 3.2.2 The Study Area

Bangkok Metropolitan is located in the central part of Thailand which occupies 1,568.737 square kilometers. In 2010, Bangkok had total population 8,249,117 persons with population density 5,258.6 persons per square kilometer, and the population growth rate during 2000-2010 was 2.61 (National Statistic Office (NSO), 2011). Bangkok has fifty districts which had high density in the inner city areas where were located by official places and commercial business areas. However, the suburban areas of Bangkok, particularly in the East and the West had high population growth rate as shown in Figure 3.2. The dark green areas show the districts where have population growth rate more than 2.0 (BMA, 2011). For the Bangkok metropolitan and its vicinity areas including Nakhon Pathom, Pathum Thani, Nonthaburi, Samut Prakan and Samut Sakhon provinces had faced of urbanization

issue where had high population density as representing in Figure 3.3. In addition, City Planning Department (CPD) mentioned that the population growth rate has continuously increased in residential and commercial areas in Bangkok.

In terms of motorization, Bangkok has registered cars of about 7.5 million at an increasing rate of 27 percent between 2008 and 2012 while the road capacity available is only for 1.6 million cars (National Information Center, 2013). The evidence was supported by the Office of Transport and Traffic Policy and Planning (OTP) reported that the traffic speed performance indicator (km/hr.) in the peak hour in the Bangkok metropolitan and its vicinity areas during 2008-2011 had decreased from 19.9 to 16.2 km/hr. in the morning and from 23.3 to 19.6 km/hr. in the evening (OTP, 2013b).

Urbanization and motorization lead the traffic tended to be more traffic congestion crisis which is an unsustainable transport pattern. It can impact to people in many aspects as follow;

- environment e.g. air and noise pollution, GHG emissions
- society e.g. health insecurity, stress, and road safety
- economic e.g. fossil fuel overconsumption, transportation cost and time consuming



Regarding to mitigate this problem issue and its impact, the mass transit plans had been reviewed and developed through the decades but there still lack of sustainable transportation concept applied in such plans. In 2010, the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region or M-Map (OTP,2010a) developed by the OTP is the current master plan to develop an urban rail transit network serving in Bangkok Metropolitan Region. It has been implemented in order to develop the transportation system towards sustainable transport and low carbon city. In addition, this plan aims to achieving the national low carbon development plan which also focuses on transport sector.

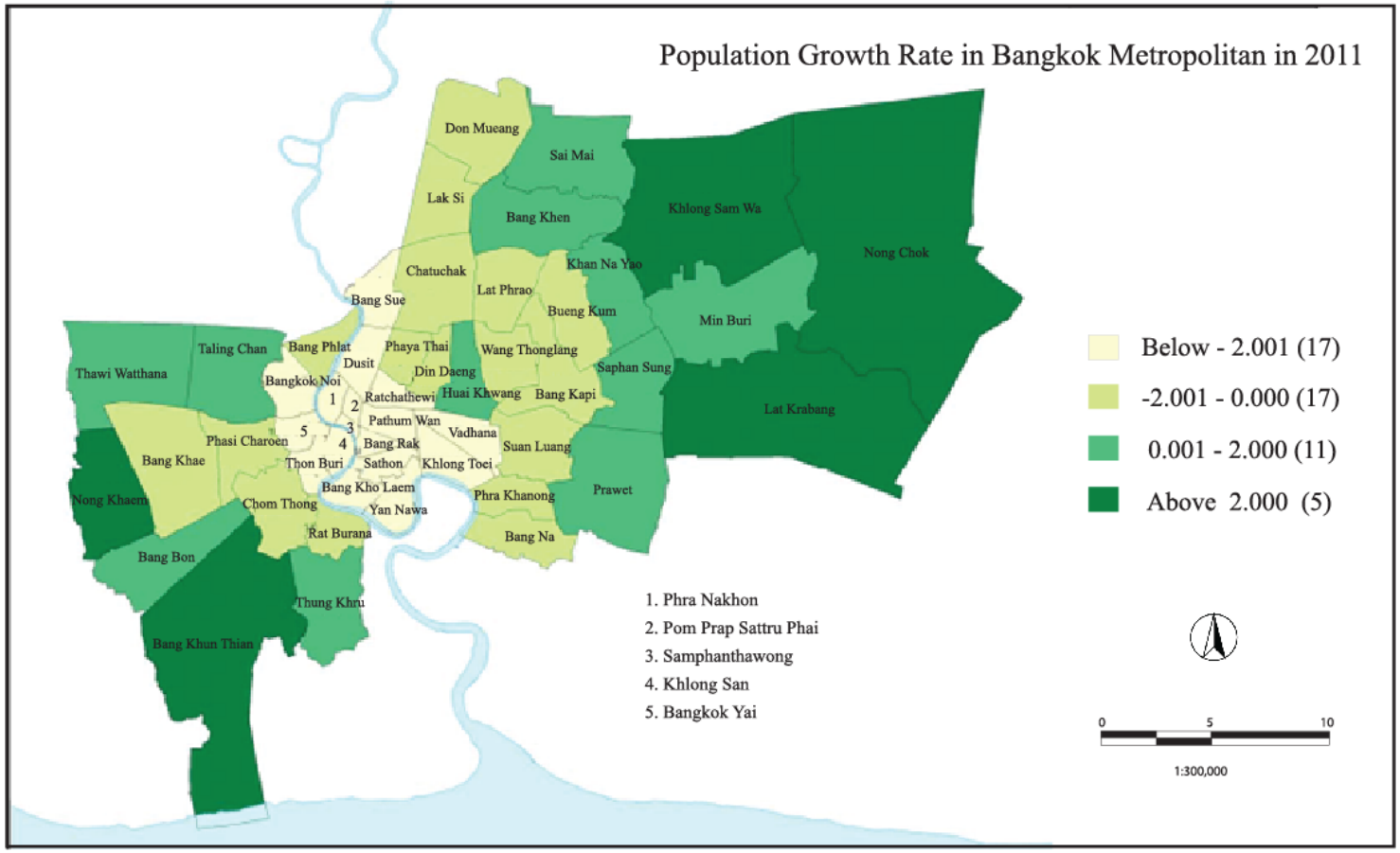



Figure 3.2 Population growth rate in Bangkok Metropolitan in 2011
Source: Modified from City Planning Department, BMA (2011)

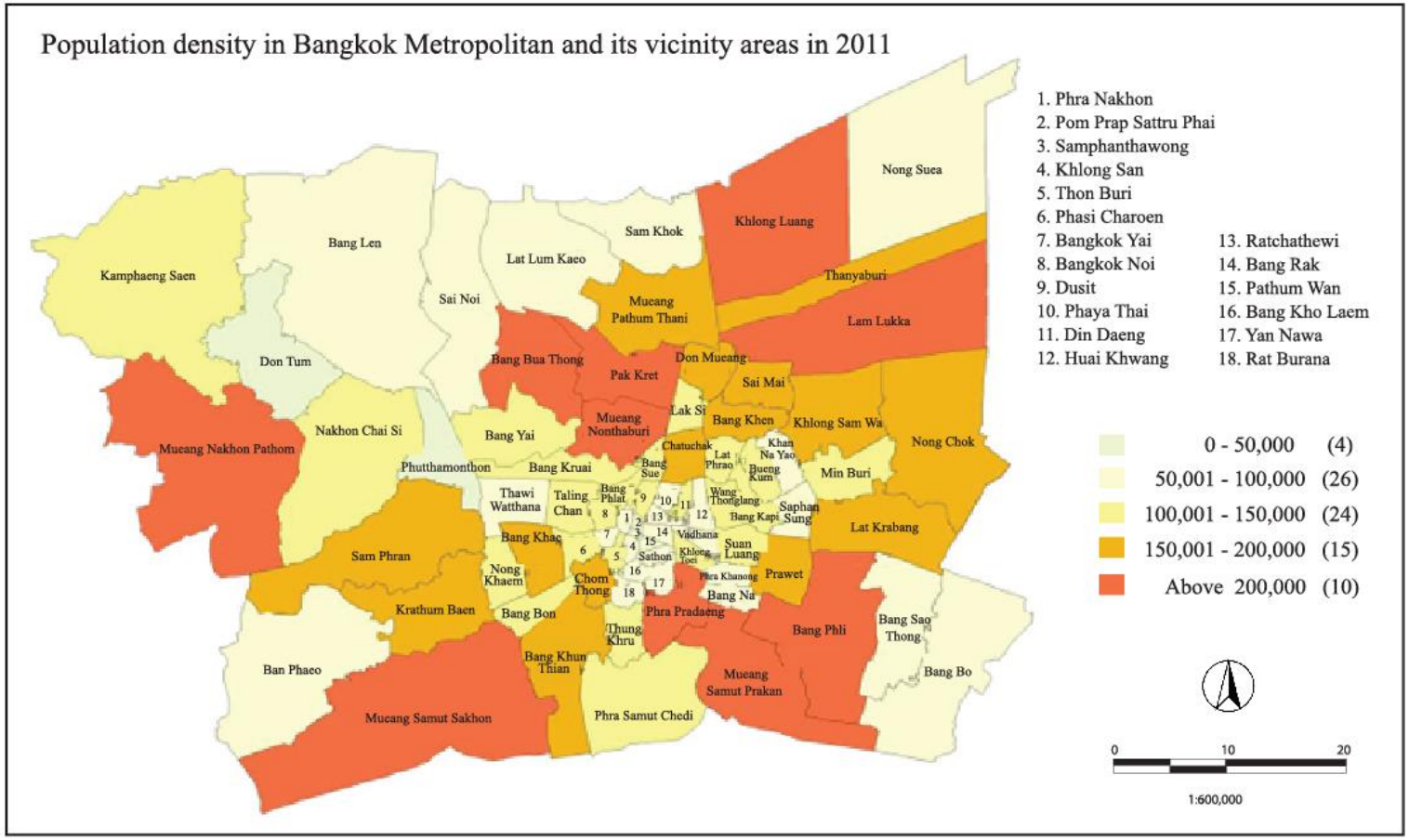



Figure 3.3 Population densities in Bangkok Metropolitan and its vicinity areas in 2011
Source: Modified from City Planning Department, BMA (2011)

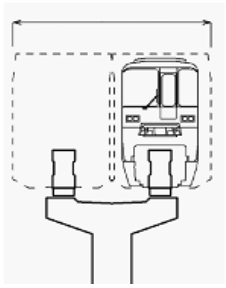
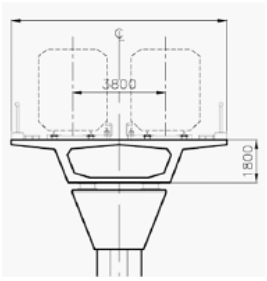
Regarding the M-Map (OTP, 2010a), it designates eight primary routes and four feeder lines. The routes have a totaling 508 km and plan to be constructed within a development period of twenty years (2010–2029). In this study, the Pink and the Orange mass transit lines are selected as the interesting cases. Yin (1994) described selection of the cases that cases should reflect characteristics and problems identified in the underlying theoretical propositions and conceptual framework. In addition, they should have the relevance to other current and future projects as well as the availability and quality of existing information.

There are criteria which using to select these two lines:

1. Location: Line alignments of these two lines are reconciled to urbanization pattern. Pink line is the Northwest-East route while Orange line is the West-East route. These routes cross over the residence, office and business areas where also high urban sprawls.
2. System and function: Their system can represent in both primary line – Orange line and feeder line – Pink line.
3. Time period: These two lines are in the same timeline of feasibility study and are in the same stage of implementation which they have already approved from the cabinet and are in the open tender process.
4. Critical case: They are in the urgent projects in Thailand 20-year National Strategy 2017-2036 (NESDB, 2016a).

According to the criteria of selection, they are appropriate for this study area and are proper to reflecting propositions in the conceptual framework. The summary of specifications of these two lines is shown in Table 3.1. The routes of the Pink and the Orange lines are demonstrated in Figure 3.4.

Table 3.1 Line description of the Pink and the Orange lines

| Line Description | MRT Pink Line | MRT Orange Line |
|---|---|---|
| Line alignment | Khae Rai - Min Buri | Taling Chan - Cultural Centre - Min Buri |
| Land use | Residence, commerce, and official places | Residence, commerce, and official places |
| System | Straddle Monorail (10,000-44,000 persons/hr/route)  | Heavy rail (30,000-80,000 persons/hr/route)   |
| Purpose | Feeder line for Northwest - East route | Primary line for West - East route |
| Critical case | The urgent projects in Thailand 20-year National Strategy 2017-2036 | The urgent projects in Thailand 20-year National Strategy 2017-2037 |
| Expected operation | 2020 | 2023 |

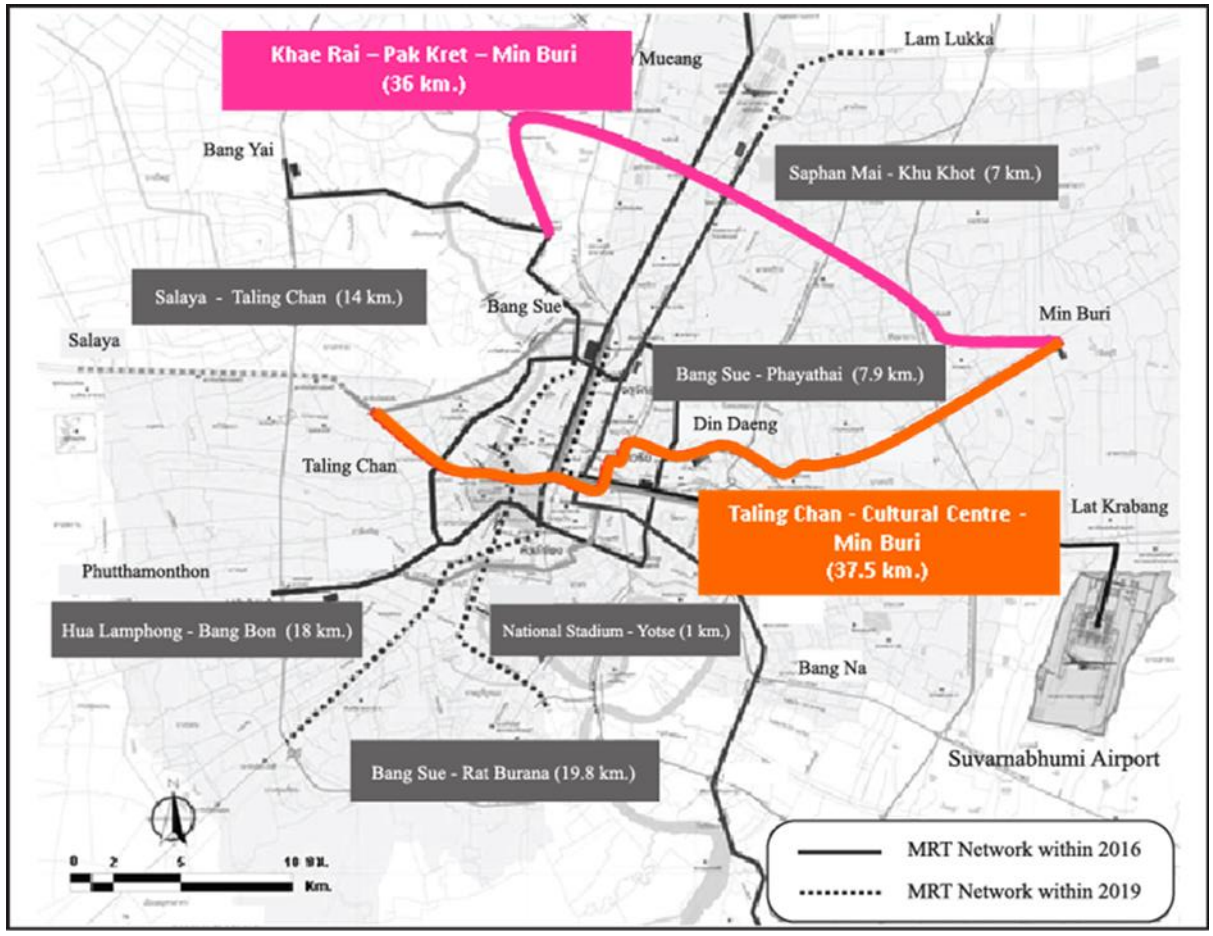



Figure 3.4 The routes of the Pink and the Orange mass transit lines
Source: Modified from OTP (2010b)

## 3.3 Data Collection

Data collection used in this study included desk study and semi-structured stakeholder interviews using questionnaire. These techniques are one of empirical research techniques in qualitative research approach using for gathering in-depth and enrich of data and information.

### 3.3.1 Desk Review

Desk review of literatures and relevant documents was studied in order to understand the current situations according to the existing problems and their consequences as well as to study the current management in dealing with these situations. These studies generate better conceptualization to the research and provide more perspectives which can support in the process of data collection and data analysis. The literature reviews were based on three key concepts consisting of sustainable transport, low carbon city, and low carbon development strategy as were described in the conceptual framework section.

For the desk review on other documents that related to policies and plans which relevant to mass rapid transit system, pollution and air quality, road safety, sustainable transport, and low carbon city. They were identified into three levels included international policies, national policies, and local policies. Moreover, the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-Map) as well as the feasibility study reports, EIA reports, and other relevant documents in which related to the two selected mass transit lines were also reviewed. These are discussed in Chapter 4 Policy Reviews and Chapter 5 Research Results and Discussion. Table 3.2 highlights the documents review in policies and plans related to mass rapid transit system and sustainable transport in Thailand.

Table 3.2 The document reviews related to policies and plans in mass rapid transit system and sustainable transport in Thailand.

| Policy level | Plan / Report |
|---|---|
| National Level | The 20-year National Strategy (2017-2036)<br>The 12th National Economic and Social Development Plan (2017-2021)<br>The 11th National Economic and Social Development Plan (2012-2016)<br>Climate Change Master Plan (2015-2050)<br>Environmental Quality Management Plan (2012 - 2016)<br>Transport and Traffic Development Plan (2011-2020)<br>Transport and Traffic Statistics and Information Report<br>Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts (2013 – 2030)<br>Environmental Impact Assessment (EIA) Report for the Mass Rapid Transit - Pink line<br>Environmental Impact Assessment (EIA) Report for the Mass Rapid Transit - Orange line<br>Thailand State of Pollution Report<br>Annual Summary of Air Quality Data<br>Annual Report on Traffic Accident |
| Local Level | BMA Action Plan on Global Warming Mitigation (2007-2012)<br>The 12-year Bangkok Development Plan (2009-2020)<br>The Bangkok Master Plan on Climate Change (2013-2023) |

### 3.3.2 Semi-structured Questionnaire Development for In-Depth Interview

According to the study of Harrell and Bradley in 2009, they mentioned that an in-depth interview is aimed to gather background information, facts and expert knowledge, also semi-structured interview are usually applied in the policy research. In this study, open-ended and descriptive questions were used in developing for the semi-structured interview. These let the respondents to provide insight information and further suggestions that the researcher might not have considered before. In addition, two rating questions were constructed in the interviews in which ordering or value of the items and themes in the study. Probing was used to ensure that consistent and clarification of information was acquired across different interviews. The interview has 2 sections (as shown in Appendix A) including general information of respondents and in-depth questions composing of 6 sets of questions as follow:

| | |
|---|---|
| Section 1 General information of respondent | 6 questions |
| Section 2 In-depth questions consisting of 6 sets of questions | |
| Set 1 Current situation of transportation in Bangkok Metropolitan | 3 questions |
| Set 2 Environmental dimension | 4 questions |
| Set 3 Social dimension | 8 questions |
| Set 4 Economic and development dimension | 5 questions |
| Set 5 Operational factors of organization to achieve sustainable transport development plan | 2 questions |
| Set 6 Further recommendation for the research | 1 question |

### 3.3.3 Semi-structured Stakeholder Interviews

The study and information that were derived from the literature reviews and desk reviews were used to construct guidelines for the semi-structured stakeholder interviews of the study. Purposive sampling method was applied in order to select the key respondents. This technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources (Patton, 2002). The study considered the possible sources of knowledge or information as well as the different informant categories which appropriate to answer the specific questions of the main research questions.

A total of thirty respondents were interviewed between July and December 2016. 70% of respondents participated in face-to-face interviews and the rest of respondents participated in reply to the interview questions by e-mail. All respondents are from six different stakeholder categories including 40% of the respondents are government agencies, 17% of them are MRT operators, 13% are consulting companies and another 13% are international organizations, 10% are non-profit organizations, and 7% are experts from universities. Figure 3.5 shows respondent categories.

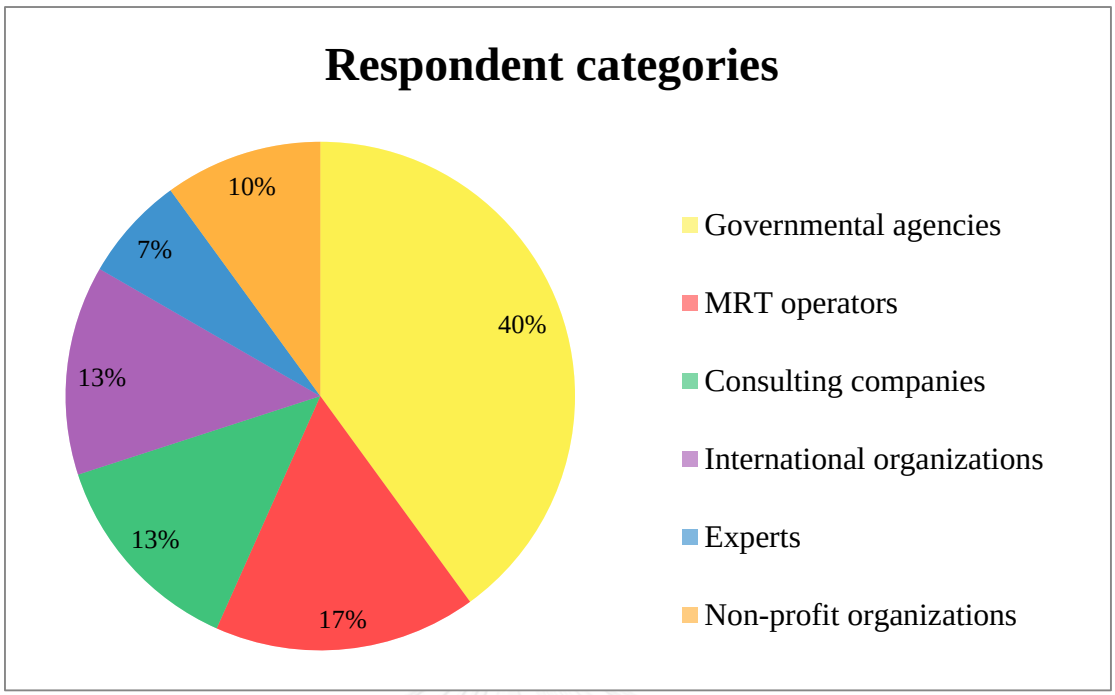



Figure 3.5 Respondent categories

The stakeholder interviews were conducted with respondents from various organizations. They are identified to play key roles in the policy and plans related to sustainable transport and the mass rapid transit project in the study. Some are associated and could provide additional perspectives on these issues. Table 3.3 summarized the respondent groups and their organizations.

Table 3.3 Respondent groups and their organizations

| Types of respondent | Organizations | Number of respondents (N = 30) |
|---|---|---|
| **Governmental agencies** | Office of Transport and Traffic Policy and Planning (OTP)[1]<br>Mass Rapid Transit Authority of Thailand (MRTA)[1]<br>Bangkok Mass Transit Authority (BMTA)[1]<br>Office of Passenger Transport, Department of Land Transport[1]<br>Thailand Greenhouse Gas Management Organization (TGO)[2]<br>Office of Natural Resources and Environmental Policy and Planning (ONEP)[2]<br>Pollution Control Department (PCD)[2]<br>Traffic and Transport Department, BMA[3]<br>City Planning Department, BMA[3]<br>Environmental Department, BMA[3]<br>Health Impact Assessment Division, Department of Health[4]<br>Thailand Railway Technology Development Institute Project, National Science and Technology Development Agency (NSTDA)[5] | **12** |
| **MRT operators** | The Krungthep Thanakom Co., Ltd.<br>Bangkok Mass Transit System Public Company Limited | **5** |
| **Consulting companies** | TEAM Consulting Engineering and Management Co., Ltd.<br>Asian Engineering Consultants Corp., Ltd.<br>MAA Consultants Co., Ltd.<br>Panya Consultants Co., Ltd. | **4** |
| **International organizations** | United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)<br>German International Cooperation (GIZ)<br>Japan International Cooperation Agency (JICA) | **4** |
| **Non-profit organizations** | Thailand Environment Institute Foundation<br>Green World Foundation<br>Foundation for Environmental Education for Sustainable Development (Thailand) | **3** |
| **Experts** | Academia from universities | **2** |

Notes: [1] Ministry of Transport
[2] Ministry of Natural Resources and Environment
[3] Ministry of Interior
[4] Ministry of Public Health
[5] Ministry of Science and Technology

Regarding stakeholder respondents, they are from multi-organizations with different levels of operation as well as various fields of expertise. These provide multiple viewpoints of key stakeholders in this study. The respondents' expertise are classified in seven different fields including transportation engineering, transport policy and planning, environmental impact assessment, urban planning and development, environmental education and management, mechanical engineering, and environmental health. All these fields of expertise are shows in Figure 3.6.

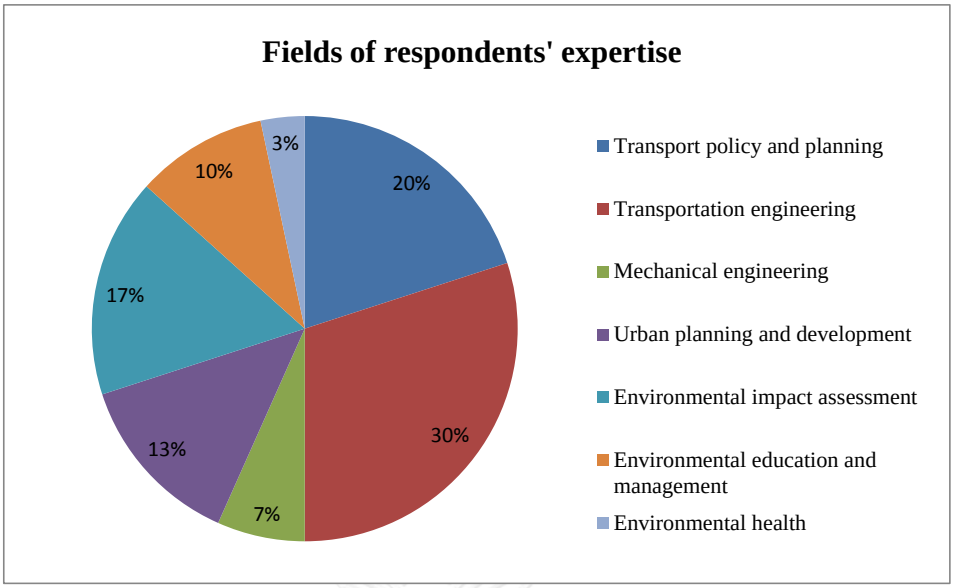



Figure 3.6 Fields of expertise of respondents

## 3.4 Data Analysis

### 3.4.1 Qualitative Data Analysis Approach

Content analysis and coding were used for analyze the data with aligning to the conceptual framework of the study. Both deductive and inductive analyses were applied in data analyzing phase. Deductive analysis was used to gather answers and information to a particular question, also was used to confirm or refute research hypotheses that the researcher presumed (Harrell and Bradley, 2009). Inductive analysis was used to explore the data and validate or extend a conceptual framework or theory (Zhang and Wildemuth, 2009). In this study, transcribed data was refined into the patterns and themes using the systematic coding as recommended by Corbin and Strauss (1990). The systematic coding includes three steps of open, axial, and selective coding. These steps were applied to assign themes and categories for developing the research model. Zhang and Wildemuth (2009) pointed that categories and coding themes can be derived from three sources consisting of the data, previous related studies, and theories. Therefore, coding themes in this study were developed both inductively and deductively which were come from data collection techniques included desk study and semi-structured stakeholder interviews. Regarding the

stakeholder interviews were conducted with respondents from multi-organizations with different levels of operation as well as various fields of expertise, the spider chart is suitable for analyzing and presenting multiple viewpoints of different key stakeholder groups in the study. It is somewhat useful for the inductive analysis processes.

### 3.4.2 Qualitative Validity and Reliability

In terms of qualitative validity and reliability, source triangulation was used to increase the conformability of the result findings. In this study, various sources of data and information were integrated in order to build a coherent for themes and to confirm the validity. Transcripts were rechecked to make sure that they did not contain mistakes made during transcription. Reconciling qualitative and quantitative data are methods triangulation often in a form of comparative analysis in which able to strengthen its reliability (Patton, 1999). The study was defined whether results had the degree of convergence and some were divergence which typically yields a more balanced the overall result. In addition, Patton (1999) suggested that consistency in overall patterns of data from different sources including reasonable explanations for divergence can contribute significantly to the overall credibility of findings. Last but not least, qualitative generalization is an essence for qualitative research. Yin (2003) described qualitative research can be as analytic generalization which is not generalization to some defined population that has been sampled, but instead their results contribute to a general theory of the phenomenon being studied. Normally, qualitative case study results can be generalized to some broader theory and can be occurred when the study add cases and generalize findings to the new cases.

# CHAPTER IV

# POLICY REVIEWS

## 4.1 International Policies

### 4.1.1 Agenda 21

The role of transport in sustainable development was first recognized at the United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit in 1992, its outcome document – the Agenda 21 (UNCED, 1992). It is an action plan to be taken globally, nationally and locally by organizations of the United Nations system, governments, and other multilateral organizations around the world. Agenda 21 is consisted of 40 chapters that have been grouped into 4 sections: social and economic dimensions, conservation and management of resources for development, strengthening the role of major groups, and means of implementation. Regarding to these several chapters, notably Chapter 7 on Human Settlements and Chapter 9 on Atmosphere recognized transport as a key development issue.

According to Chapter 7, it aimed to promote sustainable energy and transport systems in human settlements. It mentioned that developing countries had rapid motorization, insufficient investments in infrastructure, ineffective of urban-transport planning and traffic management. These led to increasing problems many aspects of accidents and injury, health, noise, congestion and loss of productivity. Therefore, promoting efficient and environmentally sound urban transport systems should be a comprehensive approach to urban-transport planning and management.

In Chapter 9, it noticed to the transport sector as a source of atmospheric emissions, and there is need for a review of existing transport systems and for more effective design and management of traffic and transport systems. This program area aimed to develop and promote cost-effective policies to limit, reduce or control, as appropriate, harmful emissions into the atmosphere and other adverse environmental effects of the transport sector as well as the specific local and national circumstances

and safety aspects. It encouraged use of transportation modes that minimize adverse impacts on the atmosphere and develop mechanisms to integrate transport planning strategies and urban and regional settlement planning strategies in order to reducing the environmental impacts of transport. In addition, the program stated to strengthen ability in collecting, analyzing and exchanging relevant information on the relation between environment and transport, with particular emphasis on the systematic observation of emissions and the development of a transport database.

### 4.1.2 The United Nations Commission on Sustainable Development

The United Nations Commission on Sustainable Development (UNCSD) was established by the United Nations General Assembly (UNGA) with the adoption of Resolution A/RES/47/191 in 1992 to ensure effective follow-up of the Earth Summit. The CSD is the high-level forum for sustainable development within the United Nations system that has a responsibility for reviewing progress in the implementation of Agenda 21 and the Rio Declaration on Environment and Development; as well as providing policy guidance to follow up the Johannesburg Plan of Implementation (JPOI). It held the first substantive session in 1993 and has annual meeting since then. There have several sessions of the Commission which realized the importance of the sustainable transport and climate change issues.



The ninth session of the Commission (CSD-9) was held in 2001 and came out with the document E/CN.17/2001/19 had appointed the sustainable transport planning: choices and models for human settlements, designs and vehicle alternatives in to the session (UNCSD, 2001). It pointed that there was need to reduce use of private car and support public transportation. Moreover, sustainable transport solutions should have an integrated into land-use planning and collaboration among all stakeholders.

The fourteenth session of the Commission (CSD-14) brought up air pollution and climate change issues. The report pointed that there were a wide range of sources of air pollution including transport systems and these were required the specificities of

each be taken into account in efforts to mitigate air pollution (UNCSD, 2006). It mentioned in reducing energy consumption and air pollution and greenhouse gas emissions from motor vehicles; one of the implementation was to conduct long-term measures to promote a modal shift from road to rail transport. In addition, the report stated that transport sector was a particularly important for reducing air pollution. The fifteenth session of the Commission (CSD-15) report appointed an action to promote less polluting public and mass transport systems (UNCSD, 2007).

The eighteenth session of the Commission (CSD-18) highlights the importance of the transport sector in terms of climate change mitigation (UNCSD, 2010). Multimodal systems inclusive all modes of transport such as maritime, air transport, road and rail, and non-motorized transport can provide options for passenger transport and freight. Additionally, it mentioned that many developing countries and their metropolitan areas had rapid economic growth and significantly increased demand for urban transport led to worsening traffic congestion and air quality. It suggested that the enhancement of sustainable urban transport requires policy coherence and a holistic approach as well as the integration of transport in urban development policies. Furthermore, enhancing the modernization of transport technology in terms of mobility services and promoting climate-friendly mobility management can restrain the projected growth in greenhouse gas emissions and support sustainable development. The universal design for public transport including women, youth, the elderly and the disabled with safety and security, should be considered.

The nineteenth session of the Commission (CSD-19) pointed that “sustainable transport is a central component of sustainable development and economic growth” (paragraph 1; UNCSD, 2011). It is necessary to take action at different levels of government to enhance access to sustainable transport to promote improved transport linkages between urban, suburban and rural communities. It supported to encouraging non-motorized transport such as bicycling and walking in conjunction with public transport in particular in urban and suburban communities. Moreover, an integration

of transport considerations in urban planning needed to be better understood not only as a technology issue, but also as a policy issue.

### 4.1.3 The Future We Want (The Rio+20 Conference)

The Future We Want is an endorsed outcome document of the United Nations Conference on Sustainable Development held in 2012 or known as Rio+20 (UNCSD, 2012). This document is the declaration on sustainable development and a green economy including broad sustainability objectives within thematic areas and cross-sectoral issues such as poverty eradication, food security and sustainable agriculture, water and sanitation, energy, sustainable tourism, sustainable transport, sustainable cities and human settlements, health and population, and promoting full and productive employment. It called for the negotiation and adoption of internationally agreed Sustainable Development Goals. It called for the UN resolution strengthening and consolidating in terms of finance and institution so that it can better disseminate environmental information and provide capacity building for countries.

According to sustainable transport, the document noted that transportation and mobility are central to sustainable development; sustainable transport can enhance economic growth and improve accessibility and achieve better integration of the economy while respecting the environment. In this regard, it recognized that accessible to environmentally sustainable transport, road safety and affordable transportation are as a means to improve social equity, health, resilience of cities, urban-rural linkages and a part to achieve sustainable development. Additionally, it supported the development of sustainable transport systems, energy-efficient multimodal transport systems, public mass transportation systems, clean fuels and vehicles, as well as recognized the need of promoting an integrated approach to policymaking at the national, regional and local levels for transport services and systems to promote sustainable development.

Regarding to sustainable cities and human settlements section in the document, sustainable transport also was addressed in promoting sustainable

development policies and integrated approach to planning and building sustainable cities and urban settlements. In addition, it recognized the importance of mixed-use planning and locally appropriate transport systems to sustainable urban planning benefits for the multiple stakeholders. Moreover, non-motorized mobility including pedestrian and cycling infrastructures are endorsed to promote and encouraging to implementation.

### 4.1.4 Sustainable Development Goals (SDGs)

The United Nations General Assembly (UNGA) adopted the following outcome document of the United Nations summit for the adoption of the post-2015 development agenda: the Member States of the United Nations embraced a global vision for sustainable development with the 2030 Agenda and its 17 Sustainable Development Goals (SDGs) on outcome document entitled "Transforming our world: the 2030 Agenda for Sustainable Development" (A/RES/70/1) of 25 September 2015. The goals acknowledge that development decisions and actions must consider the social, economic and environmental benefits and negative impacts. The 17 SDGs are as follow:

**Sustainable Development Goals**

Goal 1 End poverty in all its forms everywhere

Goal 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3 Ensure healthy lives and promote well-being for all at all ages

Goal 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5 Achieve gender equality and empower all women and girls

Goal 6 Ensure availability and sustainable management of water and sanitation for all

Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10 Reduce inequality within and among countries

Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12 Ensure sustainable consumption and production patterns

Goal 13 Take urgent action to combat climate change and its impacts

Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

Sustainable transport is one of essential elements to achieving of the proposed SDGs and acts as an enabler to achieve other SDGs and targets, including on climate change, energy, equality, health and safety. The United Nations Secretary-General's High-level Advisory Group on Sustainable Transport presented its first Global Sustainable Transport Outlook Report; entitled "Mobilizing Sustainable Transport for Development" highlights the fundamental role sustainable transport plays in achieving the SDGs (UNSGs, 2014). The report stated that "transport drives development, linking people, connecting local communities to the world, building markets and facilitating trade. In turn, sustainable transport can drive sustainable development" (UNSGs, 2014). Figure 4.1 illustrates sustainable transport can impact on achieving the SDGs in several aspects as follow:

- **Safe, affordable and accessible**: people even disabilities and elderly people can maintain their independence and equity in safe transport systems as well as enables access to all people need. Moreover, it can reduce deaths and illnesses from pollution.
- **Efficient**: it promotes sustainable production and consumption and improvement in energy efficiency and expenditure on fossil fuels.
- **Resilient**: it provides quality, reliable, sustainable and resilient infrastructure to support economic development and human well-being; also promotes sustainable cities includes an expanding public transport to support positive economic, social and environmental links between urban, suburban and rural areas.
- **Minimizing carbon and other emissions and environmental impact**: it takes an action in mitigating greenhouse gas emissions as well as reducing the adverse environmental impact of cities.

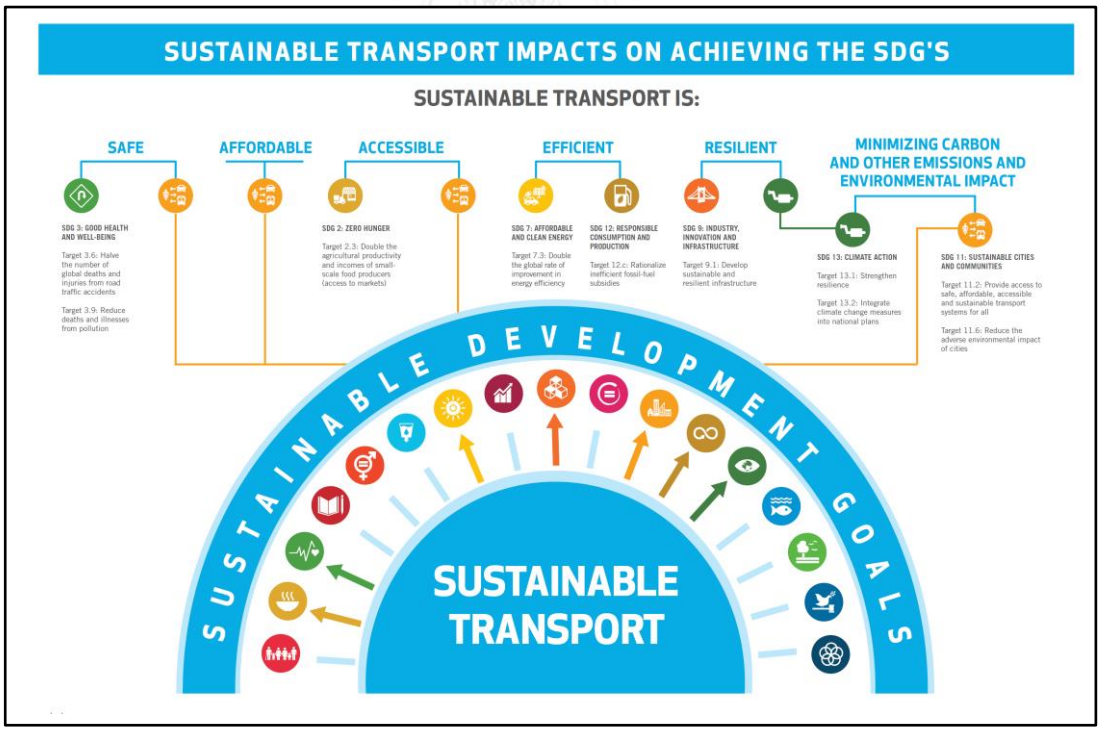



Figure 4.1 Sustainable transport impacts on achieving the SDGs

Source: UNSGs (2014)

According to these connections, some SDGs are directly and indirectly connected to sustainable transport through targets and indicators. Table 4.1 shows the linkages of SDGs, their targets and indicators to sustainable transport concept.

Sustainable transport concepts consist of environmental, social and economic aspects can be interrelated to SDGs and their targets in many ways. Regarding to environmental aspects, sustainable transport plays the key role in achieving SDGs in climate action and sustainable cities by reducing the adverse environmental impact such as air pollutions and greenhouse gas emissions of cities. At national level, sustainable transport promotes the countries an integrated policy and plan across multi-sectors in order to take action to combat climate change and its impacts (SDG 13). At local level, it can reduce the levels of air pollutions in the cities (SDG11). In terms of social aspects, people acquire safe, affordable and accessible transport options through sustainable transport systems for all so that it supports economic development and human well-being for sustainable communities (SDG 3, 9 and 11). Also, sustainable transport can support economic aspect in terms of improvement in energy efficiency and ensure sustainable consumption and production in proportion of total national expenditure on fossil fuels (SDG 7 and 12). Additionally, sustainable transport enhance trans-border infrastructure to support economic development in transfer passenger and freight volumes by mode of transport (SGD 9).

Table 4.1 SDGs and sustainable transport

| Sustainable Development Goals (SDGs) | | Sustainable Transport |
|---|---|---|
| **Goals and targets** | **Indicators** | |
| **SDG 3: Ensure healthy lives and promote well-being for all at all ages** | | Social aspect |
| 3.6: Halve the number of global deaths and injuries from road traffic accidents | 3.6.1 Death rate due to road traffic injuries | |
| 3.9: Reduce deaths and illnesses from pollution | 3.9.1 Mortality rate attributed to household and ambient air pollution | |
| **SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all** | | Economic aspect |
| 7.3: Double the global rate of improvement in energy efficiency | 7.3.1 Energy intensity measured in terms of primary energy and GDP | |
| **SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation** | | Social aspects<br>Economic aspect |
| 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all | 9.1.1 Proportion of the rural population who live within 2 km of an all-season road<br>9.1.2 Passenger and freight volumes, by mode of transport | |
| **SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable** | | Social aspects<br>Environment aspects |
| 11.2: Provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons | 11.2.1 Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities | |
| 11.6: Reduce the adverse environmental impact of cities including by paying special attention to air quality and municipal and other waste management | 11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted) | |
| **SDG 12:Ensure sustainable consumption and production patterns** | | Economic aspect |
| 12.c: Rationalize inefficient fossil-fuel subsidies | 12.c.1 Amount of fossil-fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels | |
| **SDG 13: Take urgent action to combat climate change and its impacts** | | Environment aspects |
| 13.2: Integrate climate change measures into national policies, strategies and planning | 13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production | |

Source: Modified from UNSGs (2014) and UNGA (2015)

## 4.2 National Policies

### 4.2.1 The 20-year National Strategy Plan (2017-2036)

The 20-year national strategic plan was endorsed by the Office of the National Economic and Social Development Board (NESDB) which aims to ensure continuation of Thailand's economic and social development goals and stability in policy formulation and its vision as a developed nation with "Stability, Prosperity, and Sustainability" in accordance with the principles of Sufficiency Economy Philosophy. The strategy is set to be translated into action through the 12th to the 15th National Economic and Social Development Plans. These five-year plans can ensure that its proposed measures are with the changing contexts of development, while keeping in the long-term goals (NESDB, 2016a). This plan is consisted of six primary strategies as follows:

Strategy 1: Security

This strategy aims to bring about national stability for national development toward prosperity and sustainability such as

- Strengthening national security institutions and democracy
- Developing and maintaining the security of national natural resources, the environment and the protection of national interests of the sea, as well as enhancing food, energy and water security
- Setting up a comprehensive and sustainable management also developing legislation to facilitate operations with systematic follow-up

Strategy 2: Competitiveness enhancement

This strategy proposes to strengthen the economy and enhance competitiveness on a sustainable basis such as

- Maintaining economic stability and promoting trade and investment in the public and private sectors
- Developing skills and knowledge of entrepreneurs and enhancing labor productivity to promote the competitiveness of the country

- Developing special economic zones and cities as well as infrastructure development

Strategy 3: Human resource development

This strategy intends to enhance and develop the potential of human capital such as

- Improving quality of education and learning for all and developing quality assurance and accreditation systems including the reform of the learning system
- Creating the potential and role of family institutions with morality, ethics, honesty, and public consciousness
- Promoting lifestyles to support good physical and mental health

Strategy 4: Social equality

This strategy aims to ensure justice and reduce social disparities such as

- Ensuring economic stability and health insurance system in order to reduce socioeconomic disparities
- Developing infrastructure and environment for the elderly and the disadvantaged
- Strengthening social institutions, cultural capital of the community



Strategy 5: Green growth

This strategy targets to promote green growth for sustainable development such as

- Enhancing conservation system restoration and protection of natural resources
- Promoting environmentally friendly in energy consumption and mitigating greenhouse gas emissions
- Developing eco-friendly cities and adapting to climate change

Strategy 6: Rebalancing and developing public sector management

This strategy means to enhance the efficiency of public sector management and promote good governance such as

- Improving structure of government agencies in order to enhance efficiency and productivity in public administration and transparency in public administration
- Developing service center with e-service and web-portal to provide public access to public services
- Improving laws and regulations to facilitate the public administration, business international agreements and international competition

Figure 4.2 shows the 20-year National Strategy Plan (2017-2036) framework.

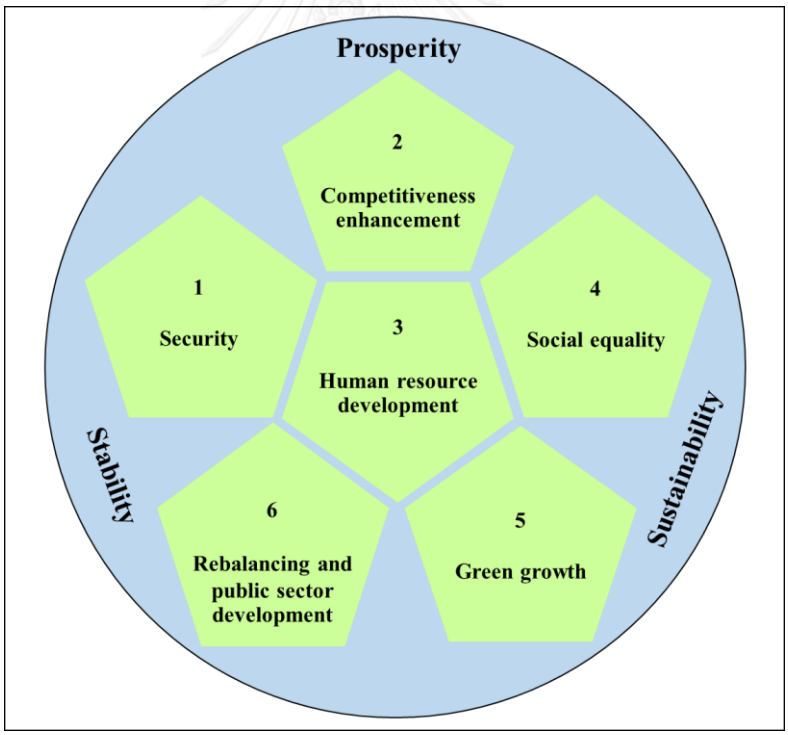



Figure 4.2 The 20-year National Strategy Plan (2017-2036) Framework
Source: Modified from NESDB (2016a)

According to the 20-year national strategic plan**,** the Office of Transport and Traffic Policy and Planning (OTP) in Ministry of Transport has drafted Thailand's

Transport Development Strategy: 20 years plan (2017 – 2036) as of May 2017. It consists of a conceptual idea of three main concepts as (1) green transport, (2) transport efficiency and (3) inclusive transport as shown in Figure 4.3.

(1) Green transport focuses on reducing fossil energy, adapting to clean energy or alternative energy, and promoting technology in environmentally friendly transport for examples;

- Promoting electric vehicles
- Mitigating carbon emission
- Developing public transport systems in regional cities
- Supporting non-motorized travel and transportation e.g. biking and walking

(2) Transport efficiency aims to improve transport and logistics efficiency by reducing logistics costs. Rail and water transport will be promoted to main transport modes. In addition, it focuses on developing infrastructure linkage to transport systems in both domestic and international regions. Also, intelligent transport systems are expected to be tools in increasing effectiveness in transportation system management.

(3) Inclusive transport aims to support universal design for transportation for all such as accessible, affordable and equitability.

This draft composes of five strategies as follows:

Strategy 1: Integrated Transport Systems

This strategy aims to transport infrastructure and services by integrating with all relevant agencies in both infrastructure planning and development. Multimodal transportation is promoted to achieve a comprehensive transport network in order to support mobility and economic gateway. Regarding to environmental aspect, these integrated systems expect to enhance mechanism in reducing energy consumption and greenhouse gas emissions in the transport sector.

Strategy 2: Transport Services

This strategy intends to enhance transport service and management in trade facilitation, supply chain management and logistics on time schedules and cost savings.

Strategy 3: Regulations and Institutional arrangement

Legal and regulations are going to adjust in infrastructure investments and transport services to meet international standards as well as to comply with the national policy. Also this strategy focuses on reorganizing the organization and related transport organizations to play a clear role and governance. In addition, public private partnership (PPP), good governance, transparency, and equity are essential in transportation management and services.

Strategy 4: Human Resource Development

This strategy focuses on human resource as an important basis for planning and implementing policies so that it aims to establish institutions for developing and training of transport personnel in order to provide the transport infrastructure and services with international standards.

Strategy 5: Technology and Innovation

This strategy aims to promote research and development in technology and intelligent systems in order to enhance the development of infrastructure and transportation services to be more efficient.

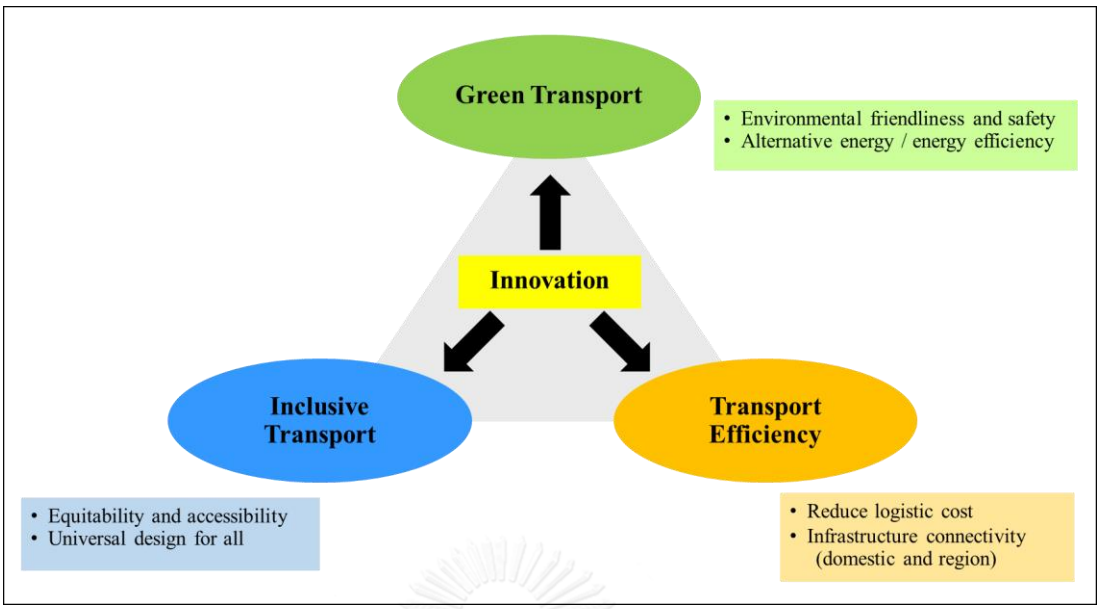



Figure 4.3 Conceptual ideas for Thailand's Transport Development
Source: Modified from OTP (2017)

The Ministry of Transport recognizes the importance of developing transport infrastructure. The strategic plan is divided into three operational periods: critical issue, medium, and long-term periods.

Critical issues period such as

- Traffic congestion in Bangkok and its vicinity areas including major cities in the region
- Road safety and rate of deaths from road accidents
- Traffic and transportation law enforcement
- Restructuring of state-owned enterprises in road, water and air transport

Medium period

This period focuses on the development of transport infrastructure and providing coverage in both major cities in the region and neighboring countries. Legal and relevant regulations are going to adjust with infrastructure investments and transport services to meet international standards.

Long-term period

This period expects to ensure the infrastructure to be comprehensive systems, meet international standards in transport services and safety, and always maintained in perfect conditions.

### 4.2.2 The 12th National Economic and Social Development Plan (2017-2021)

The 12th National Economic and Social Development Plan (2017-2021) was endorsed by the Office of the National Economic and Social Development Board (NESDB). The implementation of the 12th Plan was begun on 1 October 2016 and will continue until 30 September 2021. The NESDB reported that the 12th Plan is in accordance with the 20-year national strategy plan (2017-2036). The 12th Plan will continue to adhere to the Philosophy of Sufficiency Economy. The philosophy aims to change the priority of economic policy from "growth" to "social development." The main objective is to bring about happiness and the people's well-being (NESDB, 2016b). People-centered development and participation are continuing to apply throughout the national development process. It has been followed as a shared value by people, and guiding to transformation a new national management system, based on the goals of stability, prosperity, and sustainability. The 12th Plan is aimed to reduce income disparity and poverty, strengthen the economy and enhance the country’s competitiveness, promote natural capital and environmental quality, and further towards the international community.



It consists of ten strategies for the national development plan and these are their development approaches are as follow:

Strategy 1: Strengthening and developing human capital potential

- Promoting Thai values to ethics, discipline, public morality
- Developing human potential in terms of knowledge at all ages
- Enhancing quality of education and continuous learning
- Optimizing public health system management
- Developing systems of care and environment for elder people

Strategy 2: Ensuring fairness and reduce social disparities

- Reducing income disparity and tackle poverty
- Disseminating public services such as education, public health and welfare
- Empowering and strengthening economic and finance of communities with philosophy of sufficiency economy

Strategy 3: Sustainable economic growth and competitiveness

- Strengthening stability and sustainability of the economy
- Strengthening and developing the competitiveness of the manufacturing and service sectors such as agriculture, industry, and tourism

Strategy 4: Green growth for sustainable development

- Balancing natural resource conservation, utilization and sustainability
- Optimizing water resources management to ensure sustainability
- Reducing environmental crisis and accelerating air pollution control, waste, waste water, and hazardous waste which are generated from production and consumption
- Encouraging eco-friendly production and consumption
- Supporting in greenhouse gas mitigation and increasing adaptability to climate change
- Driving Strategic Environmental Assessment (SEA) to be legally enforceable and to lead the practice

Strategy 5: Strengthening national security for national development to stability and sustainability

- Maintaining internal security in order to achieve peace in society and to preserve national institutions
- Developing of defense capacity building to prepare and cope with threats in both military and other threats
- Promoting international cooperation on security and integrating with the countries for economic, social and transnational threats

Strategy 6: Management in the public sector to prevent corruption, misconduct and good governance in Thai Society

- Improving organizational structure, roles, mission and transparency
- Enhancing public service delivery to international standards

- Improving management efficiency for local government organizations

Strategy 7: Infrastructure and logistics development

- Developing transport infrastructure such as rail, road, water, and air transports
- Increasing the volume of public transport and non–motorized transport in the city and urban areas as well as promoting transit oriented development
- Encouraging and supporting research and development of technology and innovation as well as human resources development related to transport infrastructure development
- Developing the standard of logistics, supply chain management and logistics service providers
- Promoting energy conservation and increasing energy efficiency
- Increasing management capacity, production and consumption of renewable energy and energy clean
- Promoting digital economy development
- Developing effective water management

Strategy 8: Science, technology, research and innovation development

- Strengthening science and technology of the country
- Enhancing ability in apply science, technology and innovation to improve the competitiveness of the manufacturing and service sectors as well as the quality of life of the people

Strategy 9: Urban and economic zone development

- Promoting spread the prosperity and economic opportunity to the region more thoroughly
- Developing core economic areas to be environmentally friendly and improving quality of life in the community
- Developing new economic areas to enhance their competitiveness and sustainable development

Strategy 10: International cooperation for development

- Expanding trade cooperation and investment with the countries for Thai products and services

- Developing partnerships with countries in the sub-region, region and international
- Promoting regional and international cooperation in security such as energy, food, environment and disaster management

Regarding to the fourth and the seventh strategy are major subjects related to low carbon development and sustainable transport. The fourth strategy involves the green growth for sustainable development which aims to reduce GHG emissions and to increase capacity building and adaptation to climate change. The seventh strategy involves infrastructure and logistics development. Regarding to development of urban public transport, this strategy focuses on development of rail and water mode of transportations which aims to increase ridership of these transport modes. One of achievement indicators is to increase the ratio of mass rapid transit ridership in Bangkok metropolitan region from five percent to fifteen percent by 2021.

In the seventh strategy, the mass rapid transit projects according to the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-Map) are set as an urgent plan in order to cope with city growth and dynamic. In addition, enhancing service quality and modifying public transport routes are taken into account for support people shift to multimodal transport. Furthermore, transit oriented development (TOD) and non–motorized transport include pedestrians and universal design are also the concern issues to develop and to promote in this strategy.

### 4.2.3 The 11th National Economic and Social Development Plan (2012-2016)

The 11th National Economic and Social Development Plan (2012-2016) was endorsed by the NESDB. The 11th Plan had adhered to the Philosophy of Sufficiency Economy and has adopted to apply to all parties at all levels. Development of people, society, economy, environment and politics are integrated holistically to increase Thailand's capacity for resilience and adaptation at the level of the family, community and the nation. The NESDB reported that people-centered development and participation are applied throughout the national development process (NESDB,

2011). The 11th Plan is the first step toward the long term vision of 2027. There are four missions in this plan are:

1) To promote a fair and quality society so as to provide social protection and security, to enjoy access to a fair judicial process and resources, and to participate in the development process under good governance.
2) To develop people with integrity, knowledge and skills appropriate to their ages, and to strengthen social institutions and local communities for positive adaptation to changes.
3) To enhance the efficiency of production and services based on local wisdom, knowledge, innovation and creativity by developing food and energy security, reforming the structure of the economy and consumption to be environmentally friendly, and strengthening relations with neighboring countries in the region for economic and social benefits.
4) To build a secure natural resource and environmental base by supporting community participation and improving resilience to cushion impacts from climate change and disasters.

The 11th Plan mention in their objectives and targets that related to low carbon emission concepts in developing efficient and sustainable economy by upgrading production and services based on technology, innovation and creativity with effective regional linkages, improving food and energy security, upgrading eco-friendly production and consumption toward a low-carbon-society. In addition, it can shift the development paradigm and the country to low carbon and environmentally friendly economy and society. The country's production and consumption behavior will be restructured to prepare for a transition toward a low carbon and environmentally friendly economy. Also, energy efficiency in transportation sector will need to be enhanced in order to reduce greenhouse gas emissions. Development of eco-cities is important, with emphasis on urban planning which integrates cultural, social and ecological aspects.

### 4.2.4 Environmental Quality Management Plan (2017 - 2021)

The Environmental Quality Management (EQM) Plan (2017-2021) was developed by Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment as incorporate the strategies and guidelines in natural resources and environmental management as defined in the 12th NESD Plan reflect the country's 20-year strategic development plan. It supports joint efforts from all sectors on ethical and efficient resource management. In addition, it promotes equitable use of natural resources by providing equitable access to natural resources by different population groups, while introducing measures to protect and create resilience against climate change and natural disasters in preparation for more acute impacts of global warming, resilience to climate change and more intense natural disasters. This EQM Plan consists of six strategies as follows:

Strategy 1: Balancing natural resources management

This strategy focuses on conservation, restoration and utilization of natural resources in order to maintain the stability of the natural and balanced natural resource base.



Strategy 2: Environmental quality management, protection and rehabilitation

This strategy aims at prevention of environmental problems at original source and reduction of the amount of waste at all stages also support the recycling. It promotes a centralized management system for waste management to increase the responsibility of the manufacturers to play a role in managing their own product and providing opportunities for all sectors to participate in the management.

Strategy 3: Increasing efficiency of natural resources uses and sustainability

It encourages all sectors to use natural resources in a cost effective way and minimize the impact on the environment. This strategy promotes eco-friendly behavior change plan and environmentally friendly energy promotion program along with the promotion of sustainable production and services in agriculture, industrial and tourism sectors.

Strategy 4: Building capacity to climate change and natural disasters as well as promoting international cooperation

It creates capacity building of people in vulnerable areas in adapting to climate change and disaster impacts by building knowledge and understanding of people. It also recognizes the importance of strengthening cooperation in the implementation of commitments and agreements with neighboring countries, regions and the global community.

### 4.2.5 Climate Change Master Plan (2015-2050)

Thailand Climate Change Master Plan was proposed by the ONEP, Ministry of Natural Resources and Environment in 2015; it is a framework of integrated policies and action plans relating to climate change agenda. The master plan has objectives to guide actions in mitigating and tackling problems from climate change impacts, to promote the conduct of appropriate and effective action plans in all sectors, and to encourage Thailand to move towards low carbon society in accordance with the concept of sufficient economy (ONEP, 2015).

Vision of Climate Change Master Plan is Thailand has achieved climate resilience and low carbon growth in accordance with sustainable development agenda. There will have four missions are as follow

1. To build climate resilience for Thailand's development by mainstreaming climate change adaptation into development planning of all sectors and levels
2. To reduce GHG emission and establish policy instruments to encourage sustainable and low-carbon development
3. To develop appropriate knowledge base, databases and technologies to support climate change adaptation and low-carbon development
4. To enhance capacity and awareness of development partners at all levels to enable effective engagement in executing climate change policy and plan

This master plan provides a continuous framework for measures and actions in the long-term which has laid out a vision to achieve climate-resilient and low-carbon

growth in line with sustainable development path by 2050. The operational framework is divided into 3 targeted periods: short, medium, and long-term with arranging for follow-up and evaluation of the operation as well as the improvement of the master plan every 10 years in order to improve the overall efficiency of the master plan and operation. The three targeted periods of operational framework of Climate Change Master Plan (2015-2050) are as follow:

**1. Short targeted period:** The target year is 2016 with the goal of developing a mechanism and capacity building on key urgent issues.

- Adaptation to climate change impacts: It aims to develop maps to show the risk areas on climate change impacts and a linkage of database of socio-economic and environmental dimensions. In addition, it proposes to increase proportion of conservation area and biodiversity in the country also, to integrate coastal rehabilitation plans and ecologically sound management practices.
- Mitigation of greenhouse gas emissions: It aims to develop roadmap and targets to reduce greenhouse gas emissions in medium and long term plan. Additionally, it targets to establish a national internal mechanism to supportive in economics and law in order to motivate the development of low carbon emissions.
- Capacity building and operational approach: It proposes to establish research and development on climate change center and contains information to support the implementation of climate change as well as to develop a national strategy and action plan for the implementation. Furthermore, the relevant agencies would have developed their strategies for development climate change operations. A domestic mechanism would be established for international support in finance, technology and capacity building.

**2. Medium targeted period:** The target year is 2020 by targeting the development of mechanisms and build capacity in time period required to operate and their outcomes.

- Adaptation to climate change impacts: It aims to develop weather forecast systems and early warning systems on natural disasters including forecasting systems insect and pest outbreak alert for agriculture. The proportion of

conservation areas will be increased to protect biodiversity. Rehabilitation of coastal areas plan will be developed for all coastal in provinces plan. In addition, a local action plan will be developed to adapt to climate change.

- Mitigation of greenhouse gas emissions: It aims to develop roadmap and targets the country's greenhouse gas emissions decrease by 7-20 percent in the energy sector and transportation compared to business-as-usual (BAU). Renewable energy ratio will be 25 percent of the country's final energy consumption. The municipality has increased a green area of urban community.
- Capacity building and operational approach: Smart grid technology has been introduced nationally. The mechanisms and tools in reduce greenhouse gases will be developed to meet the international standard and can be linked to international mechanisms and instruments.

**3. Long-term targeted period:** The target year is 2050 by targeting the results of long-term operation including continuous targets.

- Adaptation to climate change impacts: There are several targets to be achieved such as the areas of farming benefiting from irrigation areas increased, the proportion of people with access to clean water increased, and the proportion of ecotourism increased.
- Mitigation of greenhouse gas emissions: There are several targets to be achieved such as the proportion of public transport increased, the proportion of greenhouse gas emissions from land transportation decreased, the proportion of industry investments in low-carbon and environmental friendly increased, and the proportion of greenhouse gas emissions to GDP decreases.
- Capacity building and operational approach: The proportion of human development in central, regional and local agencies increased in order to support low carbon development guidelines and adaptation to climate change.

Regarding to mitigation greenhouse gas emissions and promote low-carbon growth section in the Climate Change Master Plan, there are guidelines and measures in 8 sectors such as (1) Electricity, (2) Transportation, (3) Energy use in buildings, (4) Industry, (5) Waste, (6) Agriculture, (7) Forestry, and (8) Urban management. In

terms of sustainable transport and low carbon city are subject to such guidelines and measures in transportation and urban management sectors.

According to transportation sector, it focuses on the optimization of travel and transportation structural development and low carbon emissions including travel demand management and sustainable transport management approaches and measures such as

- To motivate people and business sector in making the transition in more efficient vehicle and transportation e.g. hybrid car, eco-car, and electric car
- To set fuel economy standards for vehicles
- To support for energy pricing that reflects real costs and the use of tax measures to promote energy conservation and use of renewable energy in transportation sector
- To promote Intelligent Transportation System (ITS) to support travel decisions and manage traffic more effectively
- To improve the efficiency of the bus service, channels and interconnected bus system
- To accelerate the development of urban mass transit networks to cover and connect rail systems and bus system
- To develop infrastructure as the connection point and to facilitate the multi-modal travel such as park-and-ride and joint ticket management system
- To improve pedestrian and routing for bicycles to promote non-motorized transportation for short trips
- To promote urban development and facilitate systematic travel and transit-oriented development
- To develop of a network of rail and waterway transportation systems
- To propose congestion pricing and parking fees in Bangkok area to motivate travel by modal shift

In urban management sectors, it focuses on increasing green space as a source of carbon sinks and pollutants including reducing greenhouse gas emissions from various development activities and generating mixed use of land and transit-oriented

development towards sustainable cities. The development of sustainable urban transport is measured to increase efficiency in transport systems and reduction of greenhouse gas emissions and to promote urban development conducive to use the mass transit system.

### 4.2.6 The National Transport and Traffic Master Plan (2011-2020)

The national transport and traffic master plan (2011-2020) was developed by the OTP, Ministry of Transport. The objectives of the master plan are to promote energy savings and environmentally friendly transport and to decrease ratio of and volume of energy consumption by the sector, and to reduce pollution. These would be achieved through encouragement and support to shift mode of transport to rail and water and promotion and development of technology to provide for use of clean and environmentally friendly vehicles (OTP, 2011). In order to response to sustainable transportation development under the Eleventh Plan, this plan focus on the balancing of three development aspects which are economy, society, and environment.

The master plan set a vision as “Towards Sustainable Transport” and composed of six goals of transport development master plan are as follow:

1) Promoting Thailand a hub for connectivity
2) Providing efficient transport system, good service level and accessibility to economic zones and communities
3) Improving safety in passenger travel and freight transport
4) Promoting energy savings and environmentally friendly transport
5) Increasing the accessibility and the use of public transport
6) Increasing mobility in passenger travel and freight transport.

The strategic plan of this master plan is consisted of four sectors of transport which are road transportation, rail transportation, water transportation and air transportation. According to the sustainable transport with mass rapid and achieving the master plan’s goals. This strategic plan focuses on development of public rail transportation in the city area such as Mass Rapid Transit (MRT) in Bangkok which can load lots of passengers also can mitigate traffic problems and environmental

impacts in urban areas. The public sector encourages more a modal shift from road transportation toward rail transportation. The relevant goal and strategy for MRT are as follow:

1. To make rail public transport as accessible basic transport in order to increase volume of passengers using MRT, as well as to increase satisfaction of passengers and level of equity on accessibility
2. To encourage a change to use more rail transport in order to increase volume of rail travel and to decrease emission of pollution from transport sector

### 4.2.7 Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts (2013 – 2030)

The study of Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts (2013 – 2030) was developed by the OTP, Ministry of Transport and it aims to provide the direction for the transportation system development in Thailand along with to mitigate the impacts of climate change. The main objectives of the study are to prepare a Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts for a short-term program (2013-2017) and a long-term plan (2018-2030) and to promote the integration of planning and implementing processes for the environmentally sustainable transport systems and mitigation of climate change impacts. The vision of this plan is “an efficient transport model that is environment-friendly, appropriate for the development of sufficient and sustainable socio-economic infrastructure for Thailand” (OTP, 2013). From the study, the master plan has initiative six strategies with some of their development approaches as follow:

Strategy1: Upgrade capability of agencies and personnel for the development of an environmentally sustainable transport system

- Plan for upgrading capability of transport business operators
- Development and training in "global warming and transport" for the Ministry of Transport's officers and local officers
- Expert-level training courses for energy conservation personnel

- Promotion of officers' participation in meetings and seminars to share ideas about sustainable transport and global warming
- Activities to re-educate policy makers/organization leaders for understanding and acceptance of low-carbon development and to prepare them for change through information and incentives

Strategy2: Establish appropriate plans and mechanisms for interfacing and monitoring of transport and traffic work plans/measures/ projects; and to move them forward to implementation

- Plan for development of public transport in regional cities
- Study and preparation of integrated master plan for traffic management in Bangkok Metropolitan region (BMR)
- Study for project to develop a central transport and traffic data management system
- Establish fund for promotion of sustainable transport development
- Systematic measure of emission factors of domestic vehicles for development as database for accurate analysis of pollution emissions in transport sector
- Promote the development of transport and traffic systems that reduce greenhouse gas emissions in regional cities

Strategy3: Establish comprehensive and inter-connected transport infrastructure

- Construction of highways in support of inter-modal road transport
- Construction of water transport terminals for the sake of energy saving
- Expansion project of Suvarnabhumi Airport (phase two)
- Study and development of high-speed rail network
- Expansion mass rapid transit projects
- Promotion of non-motorized transport (NMT) and improvement of transport connections
- Improvement and development of bus routes and privileges for buses

Strategy4: Efficient transport management for sustainability and greenhouse gas reduction

- Study of market-based measures on reduction of greenhouse gas emissions in Thailand's air transport sector

- Study on tax and fee privileges to encourage the use of energy-saving and environment-friendly vehicles and fuels
- Procurement of new efficient buses with low pollution emissions
- Study of standards for travel demand management
- Study of Peak-hour congestion charge on motorists
- Study of the promotion of arrangement of near-office accommodation or carpooling through tax privileges and subsidies
- Study of standards for parking control/fee collection of parking lots

Strategy5: Promote transport research and development as well as adoption of environment-friendly innovations and technologies

- Support Geographic information system (GIS) project for bus system development
- Support for establishment of eco-friendly centers of excellence in academic and research institutions
- Promotion of the use of eco-friendly vehicles such as hybrid, electric and fuel cell vehicles
- Research project on alternative fuel for sustainable transport

Strategy 6: Promote public awareness of the environment

- Holding public relations activities and provision of knowledge about eco-friendly driving
- Holding public relations activities to promote measures encouraging the use of public transport
- "Car Free Day" campaign to encourage reduction in private car use but MRT and public transport

Table 4.2 shows the potential of GHG emissions reduction in the transport sector derived from the project potential assessment of each year's master plan is listed as follows:

- In Year 2017 GHG emissions of 11-13 million tons $CO_2$e can be reduced
- In Year 2020 GHG emissions of 15-16 million tons $CO_2$e can be reduced,
- In Year 2030 GHG emissions of 27-30 million tons $CO_2$e can be reduced.

As for the target of the master plan of GHG emissions reduction in the transport sector, it is considered that the reduction should be in line with energy saving target of the next 20 years namely:

- In Year 2017 GHG emissions of 10 million tons $CO_2e$ are to be reduced in the transport sector
- In Year 2020 GHG emissions of 12 million tons $CO_2e$ are to be reduced in the transport sector
- In Year 2030 GHG emissions of 23 million tons $CO_2e$ are to be reduced in the transport sector

Based on the master plan, Thailand should be able to reduce GHG emissions by 15-16 million tons of $CO_2$ in 2020 or around 20-22 percent of the 2020 BAU (OTP, 2013).

Table 4.2 Potential and target in greenhouse gas emissions reduction in transport sector

| Year B.E. (A.D.) | GHG Emissions($CO_2$) in Transport Sector BAU (million tons $CO_2e$) | Potential for GHG Emissions Reduction in Transport Sector | | Target in GHG Emissions Reduction in Transport Sector (based on 80% of potential) | |
|---|---|---|---|---|---|
| | | (million tons $CO_2e$) | (%) | (million tons $CO_2e$) | (%) |
| 2548 (2005) | 57.52 | - | - | - | - |
| 2560 (2017) | 67.35 | 11 – 13 | 16 – 19 | 10 | 15 |
| 2563 (2020) | 74.02 | 15 – 16 | 20 – 22 | 12 | 16 |
| 2573 (2030) | 102.82 | 27 - 30 | 26 - 29 | 23 | 22 |

Source: OTP (2013a)

## 4.3 Local Policies

### 4.3.1 BMA Action Plan on Global Warming Mitigation (2007-2012)

The Bangkok Metropolitan Administration (BMA) had initiated actions to address the need for long term global warming mitigation strategies involved with organizations and agencies from both the private and public sectors to set guidelines for collaboration on addressing global warming problems. BMA launched its Action Plans on Global Warming Mitigation (BMA, 2007) with a target of reducing the city's

emission by 15 percent below the projected emission level in 2012. The Action Plan contains the following five initiatives.

Initiative 1: Expand Mass Transit and Improve Traffic Systems

This action plan aimed to expand the mass transit rail system within the Bangkok Metropolitan Area in order to encourage passenger car drivers to utilize public transportation. In addition, it intended to improve the public bus system to encourage passenger car drivers to utilize public transportation. Furthermore, improving traffic system can increase the efficiency of Bangkok's traffic system by improving the road network in order to reduce congestion and emissions.

Initiative 2: Promote the Use of Renewable Energy

This action plan aimed to promote the use of biofuels and gasohol in order to increase the proportion of biofuels and gasohol usage in order to be the one of the main targets in the effort to reduce GHG emissions in the energy sector.

Initiative 3: Improve Electricity Consumption Efficiency

This action plan intended to improve building energy consumption efficiency and energy efficiency of Bangkok Metropolitan by promote and support the implementation of energy conservation schemes in privately owned buildings. It promoted electricity conservation campaign in reducing use of air-conditioning in order to increase awareness among private homes and small enterprise owners to the importance of being more careful in their use of electrical appliances.

Initiative 4: Improve Solid Waste Management and Wastewater Treatment Efficiency

This action plan was based on the 3Rs concept – Reduce, Reuse and Recycle. It also aimed to increase wastewater treatment capacity and reduce household wastewater.

Initiative 5: Expand Park Areas

This action plan aimed to increase the number of trees for $CO_2$ absorption in Bangkok by planting trees in public areas under the jurisdiction of the BMA. In addition, it supported tree planting on private land in Bangkok by encourage other government agencies, schools, temples and private households to plant more trees.

Regarding to the BMA action plan, transportation sector was the most important sector to contribute to reductions in Bangkok's future GHG emissions. This action plan intended to take advantage of the potential of transportation sector for significant emissions' reductions by implementing an expanded and improved mass transit system that drew drivers out of their cars to shift to public transportation, developing a more efficient road network that reduced the length of time vehicles spend on Bangkok's roads. Furthermore, initiating a campaign to support the increased use of bio-fuels and electricity consumption represented another major sector that played a key role in Bangkok's global warming mitigation plan. However, the implementation of this Action Plan on Global Warming Mitigation by the Bangkok Metropolitan Administration required full support from all stakeholders.

### 4.3.2 The 12-year Bangkok Development Plan (2009-2020)

BMA developed this development plan according to the rapid change of Bangkok in terms of economic, social environmental and physical aspects. This plan aimed to serve and support many dimensions such as urbanization and urban management, infrastructure development, energy efficiency, environment degradation, sustainable urban form and self-contained communities. The Vision of Bangkok 2020 incorporated of long-term structure and culture changes in order to harmonize the development in all aspects to be the sustainable city based on the concepts of gateway, green, and good life. This plan consisted of five strategies are as followed:

Strategy 1: Strengthening Infrastructure for Regional Mega-City

This strategy aimed to support the gateway concept in terms of developing infrastructure and communication for enhance Bangkok to become the economic and financial hub as well as human resource and education.

Strategy 2: Developing Strong Economy and Knowledge-based Society

This strategy purposed to support the concept of gateway in terms of social, cultural and economic, particularly in finance, service and tourism. It intended to enhance knowledge-based and local resources capacity.

Strategy 3: Striving for Green Bangkok

This strategy aimed to support the concept of green and good life in terms of environment, basis services, income distribution, and equality. For environmental aspect, there were monitoring air and noise pollution and quality. In addition, they purposed to encourage passenger car drivers to utilize public transportation as well as energy efficiency use in order to reduce GHG emission. Waste and water management were increase their measurement and campaigns.

Strategy 4: Providing Good Quality of Life in Cultural Mega-City

This strategy supported the concept of green and good life in terms of safety as well as promoted local culture and identities for developing their competency in order to improve quality of life in each local.

Strategy 5: Mastering Best Service and Mega-City Management

This strategy aimed to develop the effective administration services for people by increasing variety and electronic for services as well as the authority and structure would be more decentralization.

### 4.3.3 The Bangkok Master Plan on Climate Change (2013-2023)

The Bangkok Master Plan on Climate Change (2013-2023) was developed by BMA with coordinated by Japan International Cooperation Agency (JICA) under a technical cooperation project. It is as the framework for the efforts in greenhouse gas mitigation and strengthening capacity and adaptation to climate change. Based on the

economic growth and rapid urbanization of Bangkok, there is a general trend of increasing GHG emission in all sectors. In this regard, while absolute GHG emission amount will still increase even with mitigation measures, the emission will be greatly reduced against the BAU scenario. The GHG emission prospects in BAU and mitigation targets in the respective sectors are shown in Table 4.3.

As Table 4.3 shows the comparison of GHG emission in future in different scenarios in 2020, GHG emissions in Bangkok will increase significantly if the current socio-economic conditions are maintained per BAU assumptions. It is expected that GHG emission in Bangkok could grow from 43.87 million tons $CO_2$ equivalent by the year 2013, to 53.74 million tons $CO_2$ equivalent by the year 2020. This master plan expects to yield total net GHG emissions in the year 2020 of 46.44 million tons $CO_2$ equivalent with expected reduction and absorption amount against BAU approximately 13.57%.

Table 4.3 Comparison of GHG emission in future in different scenarios in 2020

(Unit million t-$CO_2$e)

| Sector | Year 2013 | Year 2020 | | |
|---|---|---|---|---|
| | GHG emission | Future GHG emission in BAU Scenario | Future GHG emission with Bangkok Master Plan Implementation | Expected reduction/ absorption amount (reduction rate against BAU) |
| Transport | 13.76 | 17.91 | 14.91 | 3.00 (-16.75%) |
| Energy | 25.60 | 30.94 | 26.85 | 4.09 (-13.22%) |
| Waste and wastewater | 4.55 | 4.93 | 4.73 | 0.20 (-4.06%) |
| Green urban planning | -0.045 | -0.045 | -0.049 | -0.004 (+8.89%) |
| Total | 43.87 | 53.74 | 46.44 | 7.29 (13.57%) |

Source: BMA (2015)

The master plan covers five sectors are as follows:

1) Environmental Sustainable Transport

Transport sector shares a large portion of the total emission in Bangkok. Mitigation measures include development of environmentally sustainable

transportation infrastructures and promotion of modal shifts, as well as public awareness-raising. By conducting such mitigation measures, it is also expected to upgrade transportation modes and systems in order to improve mobility and convenience for people in the areas. In the transportation sector, most measures will focus on reducing GHG emission from private vehicles. Measures aim to construct infrastructures and to facilitate convenience modal shift particularly improvement of connectivity of public transportation and services. In addition, non-motorized transport is taken into account of the measures in such a way that can contribute to reduction of GHG by replacing private vehicle use. Mitigation measures in the transport sector are shown in Table 4.4.

Table 4.4 Mitigation measures in the transport sector

| Category | Measure |
|---|---|
| 1. Public transportation (Infrastructure) | 1.1 Development of Monorail and Light rail Transit System |
| | 1.2 Extension of BTS |
| | 1.3 Development of MRT |
| | 1.4 Development of BRT |
| | 1.5 Development/improvement of water transportation |
| 2. Public transportation (Supporting measures) | 2.1 Improvement of connectivity of public transportation |
| | 2.2 Improvement of bus service |
| | 2.3 Development of passenger shelter at bus station |
| | 2.4 Development/expansion of Park & Ride |
| | 2.5 Introduction of common ticket system |
| 3. Measures on motor vehicles | 3.1 Introduction of low emission vehicles (LEV) to BMA vehicles |
| | 3.2 Introduction of natural gas vehicle NGV to BMTA buses |
| | 3.3 Promotion of Eco-driving |
| 4. Non-motorized transport (NMT) | 4.1 Development/expansion of bikeway |
| | 4.2 Expansion of "Bike-for-Rent" |
| | 4.3 Development/expansion of pedestrian |
| 5. Traffic volume and flow control | 5.1 Development/improvement of road, bridge, tunnel |
| | 5.3 On-street parking control |
| | 5.3 On-street parking control |
| 6. Public awareness rising | 6.1 Promotion of public transportation |
| | 6.2 Classes for school to learn about environment/transport |
| | 6.3 Organizing workshops and seminars |

Source: BMA (2015)

2) Energy Efficiency and Alternative Energy

The mitigation measures focuses on introducing energy efficiency and renewable energy. The primary area of actions is mitigation efforts in BMA owned buildings such as offices, schools, and hospitals such measures contribute to reduction of GHG. It also promotes participation from the private sector to advance their efforts to increase energy efficiency in their commercial and office buildings, as well as citizens in their residential buildings. Additionally, it will introduce to apply energy standard such as Leadership in Energy and Environmental Design (LEED) of the United States and Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) of Japan. By applying such energy standards, building can follow rating systems, protocols, and guidelines in order to provide holistic system for their energy management. Mitigation measures in the energy sector such as

- Energy saving requirements for retrofitting works of BMA facilities and setting of high-level of energy efficiency Acquisition of certification for energy saving renovation work (CASBEE or LEED etc.)
- Daytime energy reduction by daylight sensor
- Introduction of waste water recycling system
- Introduction of Solar power generation systems
- Promoting environmental education at school
- Promotion of low-carbon and energy saving detached house



3) Efficient Solid Waste Management and Wastewater Treatment

Waste and wastewater are sources of methane and $CO_2$ emissions as in landfills and waste transportation in order to reduction of GHGs, it requires the reduction of waste and wastewater amount generated. BMA efforts to introduce upgraded technologies and facilities for waste management and wastewater treatment and promotes the reduction of generated amount by separation of waste. In addition, BMA promotes enhancing public awareness and partnership through public relations and campaigns, in order to promote waste separation at source, the private sector, citizens, and NGOs/community organizations are encouraged to join such activities. Mitigation measures in the waste and wastewater such as

- Promoting participation on waste reduction and separation at source

- Constructing waste-to-energy incineration facility
- Promoting reduction of water usage at house
- Feasibility study for construction of separated sewerage collection system
- Promoting water reuse

4) Green Urban Planning

Green urban development provides many co-benefits of mitigation actions in terms of functions as CO2 sink, helping the reduction of energy use as green roof tops, and increasing attractiveness of the city. For this sector, BMA will make efforts in its parks, but it is also important that private land owners should participate in such actions. Mitigation measures in the green urban development sector such as

- Increasing new green areas (Public parks)
- Increasing new green areas (Public area)
- Planting new trees along roadside areas
- Reforestation mangroves
- Well-managing and maintaining of planted trees
- Promotion rooftop greening and wall greening on government and private area
- Promoting the public awareness campaign to children, student, and citizens with tree distribution



5) Adaptation Planning

Bangkok is vulnerable to climate change negative impacts such as flooding, coastal erosion, and draught. Bangkok is located on the floodplains of the Chao Phraya River and subjected to the tides of the sea which results in trapped water from rainfall and subjected to the tides of the sea. In addition, withdrawal of groundwater is another cause of land subsidence problem in the area. It is expected that with climate change the vulnerability of Bangkok will increase in the future so that it may cause large scale of economic and social losses. As one of the priority areas of adaptation measures, BMA will take actions to prevent and minimizing impacts by expanding retention areas, developing flood management information system with link to other sectors such as road constructions.

# CHAPTER V

# RESEARCH RESULTS AND DISCUSSION

## 5.1 The Mass Rapid Transit Master Plan in Bangkok Metropolitan Region

According to the governmental policy in expanding the mass transit network in Bangkok Metropolitan Region (BMR) which aimed to developing the public transport to serve the higher travel demand and to reducing traffic congestion and number of private car used as well as reducing energy consumption, the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-Map) reviewed in the network, route alignments, and the form of project development to optimize the policy goals. The M-Map final report described the feasibility study, the strategies to implement the mass transit projects according to the master plan. The followings are the main sections in the report.

### 5.1.1 Urban Development Direction

The future development direction of BMR is going to be the decentralization of activities in the central business districts (CBDs) and surrounding areas will be high-density land use in the current commercial centers. So, the commercial sub-centers will have activities the same as in the CBDs.regarding the traffic congestion in the areas, the transportation networks have to develop for serving the travel demand within those areas also linkage to CBDs. There are seven commercial sub-centers which are Bang Bamru, Bang Kapi, Makkasan, Phahonyothin, Rat Burana, Saphan Mai, and Taksin. In addition, it included two Bangkok vicinities such as Nonthaburi and Samut Prakan. Most sub-centers are the existing community areas and supporting for urban sprawl. There are seven sub-centers in Bangkok which are Bang Khunthian, Lat Krabang, Min Buri, Nong Chok, Prawet, Suvarnabhumi, and Taling Chan, including one sub-center in Pak Kret in Nonthaburi. Therefore, due to the urban development direction, it leads to the changes in travel behavior. Use of public transport can reduce the use of private car and can improve the traffic congestion.

### 5.1.2 Transport Network Development Concept

M-Map analysis and its concept considered the accordance with urban development plan and the existing transport networks in order to continue the overall of development plan. Socio-economic conditions, land use change, and travel behavior pattern were taken into account in the M-Map plan. All of these can be affected to the framework of mass transit network development plan which are:

(1) Overview of mass transit network

(2) Coverage area and accessibility

(3) Mass transit network pattern

(4) Existing Network

The mass rapid transit network in M-Map consists of 12 mass transit line alignments with a total length of 508 km (as shown in Figure 5.1).

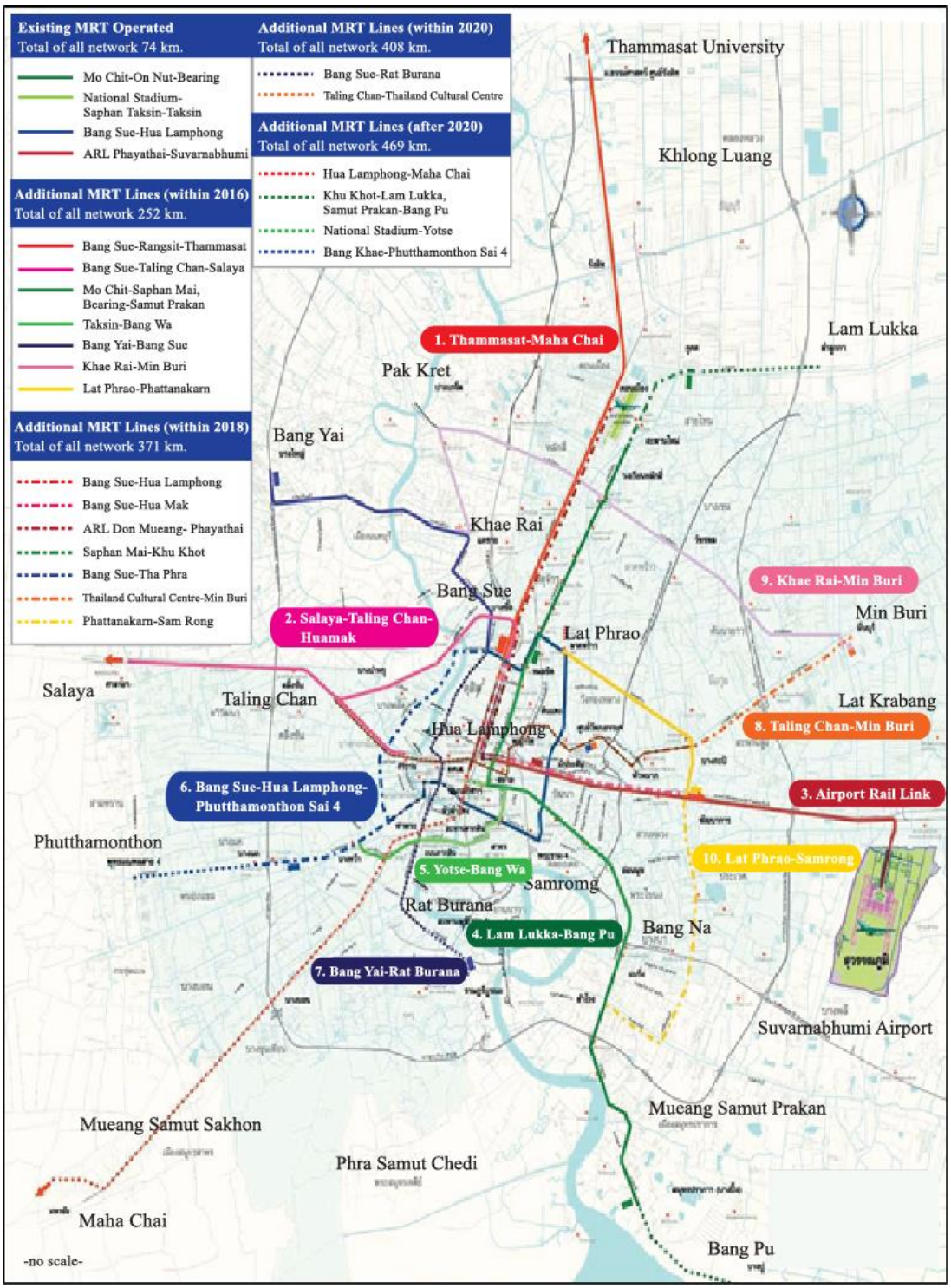
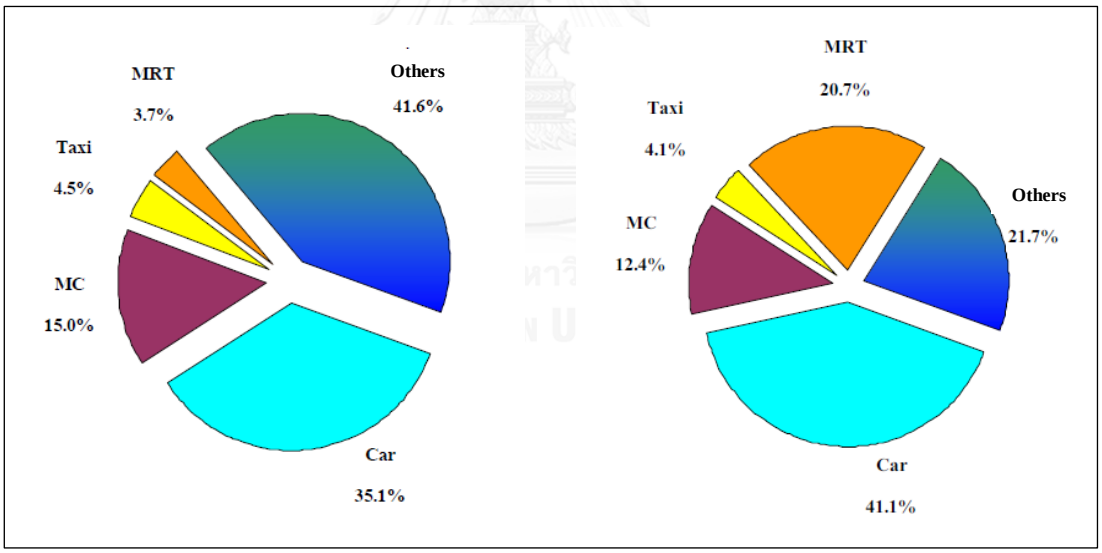



Figure 5.1 The mass rapid transit network in M-Map

Source: Modified from MRTA (2014a)

### 5.1.3 Ridership Forecast

The Office of Transport and Traffic Policy and Planning (OTP) conducted the extended Bangkok Urban Model (eBUM) which developed based on the CUBE Voyager program to forecast the ridership in this project. The traffic volume and the number of passengers were studied. In 2008, the travel demand in Bangkok and its vicinity approximated to 15.3 million trips per day which categorized by main mode of transport (as shown in Figure 5.2a): by personal vehicle (PV) 54.7% (Car 35.1%, Motorcycle (MC) 15%, and Taxi 4.5%) and by public transport (PT) 45.3% (MRT 3.7% and other modes 41.6% (bus, boat, train, and BRT). In 2029, as the master plan implementation, the travel by PV will be 57.6% and by PT will be 42.4%. Ratio of travel by MRT will be higher from 3.7% in 2008 to 20.7% in 2029 (as shown in Figure 5.2b). Table 5.1 shows the ridership forecast in passenger number (person-trip/day) of total 12 lines based on 5-, 10-, 20-year master plan.




(a) (b)

Figure 5.2 (a) Main mode of transport in 2008
(b) Main mode of transport in 2029

Source: OTP (2010b)

Table 5.1 Ridership forecast of mass transit 12 lines from M-Map within 2029

| Line | Passenger volume (person-trip/day) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Yr. 2014 (5th yr.) | | | Yr. 2019 (10th yr.) | | | Yr. 2029 (20th yr.) | | |
| | Boarding | Transfer | Total | Boarding | Transfer | Total | Boarding | Transfer | Total |
| Dark Red | 110,000 | 12,000 | 122,000 | 357,000 | 119,000 | 476,000 | 518,000 | 204,000 | 722,000 |
| Light Red | 38,000 | 12,000 | 50,000 | 145,000 | 83,000 | 228,000 | 253,000 | 218,000 | 471,000 |
| ARL | 119,000 | 9,000 | 128,000 | 144,000 | 33,000 | 177,000 | 161,000 | 59,000 | 220,000 |
| Dark Green | 600,000 | 55,000 | 655,000 | 721,000 | 165,000 | 886,000 | 1,038,000 | 410,000 | 1,448,000 |
| Light Green | 376,000 | 40,000 | 416,000 | 246,000 | 132,000 | 378,000 | 272,000 | 168,000 | 440,000 |
| Blue | 254,000 | 119,000 | 373,000 | 673,000 | 301,000 | 974,000 | 974,000 | 562,000 | 1,536,000 |
| Purple | 69,000 | 27,000 | 96,000 | 372,000 | 132,000 | 504,000 | 490,000 | 225,000 | 715,000 |
| Orange | - | - | - | 377,000 | 165,000 | 542,000 | 521,000 | 291,000 | 812,000 |
| Pink | - | - | - | 156,000 | 53,000 | 209,000 | 233,000 | 121,000 | 354,000 |
| Yellow | - | - | - | - | - | - | 175,000 | 139,000 | 314,000 |
| Grey | - | - | - | - | - | - | 206,000 | 136,000 | 342,000 |
| Light Blue | - | - | - | - | - | - | 162,000 | 144,000 | 306,000 |
| **Total** | **1,566,000** | **274,000** | **1,840,000** | **3,191,000** | **1,183,000** | **4,374,000** | **5,003,000** | **2,677,000** | **7,680,000** |

Source: MRTA (2013)

According to the changing in travel behavior pattern, the project predicted the number of MRT passengers will be higher in 2019 and 2029. The project studied the comparison of the ratio of travel volume by personal vehicle (PV) and the average speed in the road networks between with and without M-Map. Figure 5.3 illustrates the radius from the central business district of Bangkok into three zones are 5 km, 5-10 km and 10-20 km radial distance that was used to analyze in the project.

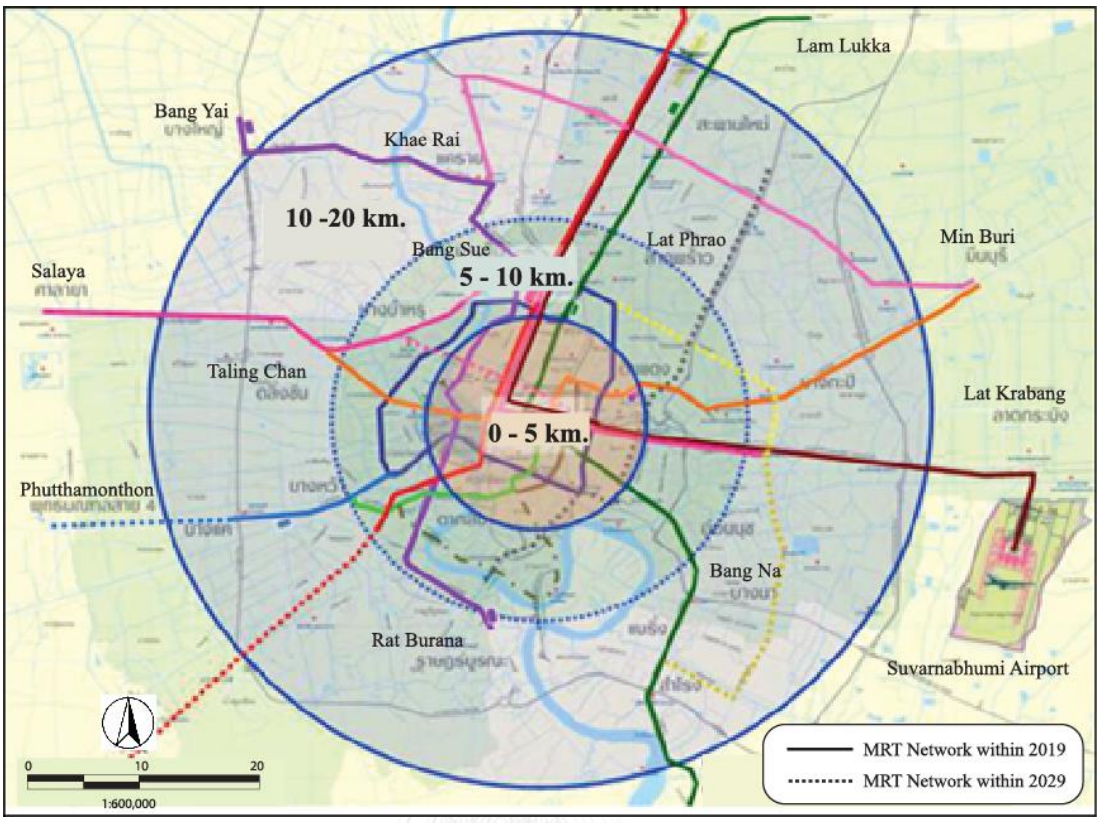



Figure 5.3 The radius from the central business district of Bangkok

Source: Modified from OTP (2010b)

Table 5.2 shows that the ratio of travel volume by personal vehicle (PV) with M-Map will be reduced as following:

- Within 5 km radial distance - the ratio of travel volume by PV will be reduced by 5.88% and 13.85% by 2019 and 2029, respectively
- 5-10 km radial distance - the ratio of travel volume by PV will be reduced by 3.45% and 8.02% by 2019 and 2029, respectively
- 10-20 km radial distance - the ratio of travel volume by PV will be reduced by 1.53% and 4.41% by 2019 and 2029, respectively

Table 5.2 The forecasting in the ratio of travel volume by personal vehicle, 2014-2029

| Year | The ratio of travel volume by personal vehicle (with and without M-MAP) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-5 km. | | | 5-10 km. | | | 10-20 km. | | |
| | Without M-MAP | M-MAP | Ratio | Without M-MAP | M-MAP | Ratio | Without M-MAP | M-MAP | Ratio |
| 2014 | 51.0% | 50.7% | -0.59% | 50.5% | 50.3% | -0.40% | 56.2% | 56.1% | -0.18% |
| 2019 | 52.2% | 49.3% | -5.88% | 54.0% | 52.2% | -3.45% | 59.8% | 58.9% | -1.53% |
| 2029 | 52.6% | 46.2% | -13.85% | 57.9% | 53.6% | -8.02% | 63.9% | 61.2% | -4.41% |

Source: Modified from OTP (2010a)

Furthermore, based on the master plan, the difference in average speed in the road networks between with and without M-Map shown that the M-Map can increase the average speed in the road network, the details are shown in Table 5.3.

Table 5.3 The forecasting in the average speed in the road networks, 2014-2029

| Year | The average speed in the road networks from the CBD (km./hr.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-5 km. | | | 5-10 km. | | | 10-20 km. | | |
| | Without M-MAP | M-MAP | Difference | Without M-MAP | M-MAP | Difference | Without M-MAP | M-MAP | Difference |
| 2014 | 14.89 | 15.01 | 0.12 | 12.50 | 14.08 | 1.58 | 10.99 | 13.52 | 2.53 |
| 2019 | 15.39 | 15.50 | 0.11 | 13.68 | 15.11 | 1.43 | 11.56 | 14.41 | 2.85 |
| 2029 | 23.74 | 23.84 | 0.10 | 20.11 | 21.25 | 1.14 | 17.39 | 20.21 | 2.82 |

Source: Modified from OTP (2010a)

Regarding the project results, it shows that the project with M-Map the overall the ratio of travel volume by PV will be reduced while the average speed in the road networks will be increased. It can lead to less traffic congestion and can provide less air pollution.

### 5.1.4 Environmental Study

Regarding the existing of master plan development process and policy framework in Thailand have been emphasized on economic development, it can affect the policies and plans lacking of the integration of environmental and social dimensions. Although, there is the regulation for the project to conduct the

environmental impact assessment (EIA), it is only by project. The M-Map conducted the initial environmental examination of the overall MRT system, also prepared EIA of each MRT alignment. Therefore, they need to adapt the concept of strategic environmental assessment (SEA) to lead in the process to master plan development. SEA has a broadly rationale which is to ensure the environmental considerations are taken into account for higher levels to make decision (Sadler et al, 2011). In addition, SEA is a systematic and proactive analysis approach in taking potential environmental consequences into decision-making process. SEA is an environmental evaluation process at the level of policy, plan and program which aims to develop the sustainability in economic, social, environment, and technology aspects. The impacts of each dimension are as follows:

- Economic dimension: It consists of economic costs, value of travelling time, and vehicle operating cost, environmental cost, etc.
- Social dimension: It comprises of social benefits and quality of life including health, safety, and livelihood.
- Environmental dimension: It concerns in environmental impact both direct and indirect impact such as air quality, noise and vibration, water quality, historical and cultural places, and aesthetic and visual impact.
- Technological dimension: It concerns in the selection on type of MRT system that should be appropriate to the network and others conditions including its impact to the plan.

The integration of SEA and transport planning can provide a potent analytical tools to identify equity and environmental effects, highlight policy conflicts, trade-offs and alternatives to resolving them (Sadler et al, 2011). Although, SEA is an essential strategy, in Thailand there are challenges and barriers in conducting and implementing in decision-making process including policies, plans and programs.

### 5.1.5 Economic Analysis

The economic analysis section aims to assess the overall project impacts and benefits on the welfare of all stakeholders in society. There are consisted with two parts:

(1) Project cost estimate
- Construction investment cost
- Operating and maintenance cost

(2) Economic analysis
- By section: there were 34 sections and each section was analyzed based on the assumptions which the 5-year construction period. The results are used to prepare the first 10-year plan (by 2019) and the second 10-year plan (by 2029).
- By plan: there were 3 plans which are Urgent plan (by 2016 with a total length of 236 km), the first 10-year plan (by 2019 with a total length of 391 km), and the second 10-year plan (by 2029 with a total length of 508 km).

The project economic analysis process is as shown in Figure 5.4; the direct benefits were evaluated as followed:

- Saving of vehicle operating cost (VOC): This benefit results from faster in transportation less traffic congestion, and less fuel and maintenance costs.
- Saving of road user's travel time (VOT): This benefit can be considered in shorter travel time that can reduce lost in opportunity cost during travel.
- Saving of environmental cost (ENV): This benefit results from lower pollution level, saving pollution control cost.

For financial analysis, the route alignment and the ridership forecast were studied in order to find out the financial returns in terms of Internal Rate of Return (IRR), Net Present Value (NPV), and Benefit/Cost Ratio (B/C Ratio) for each mass transit route.

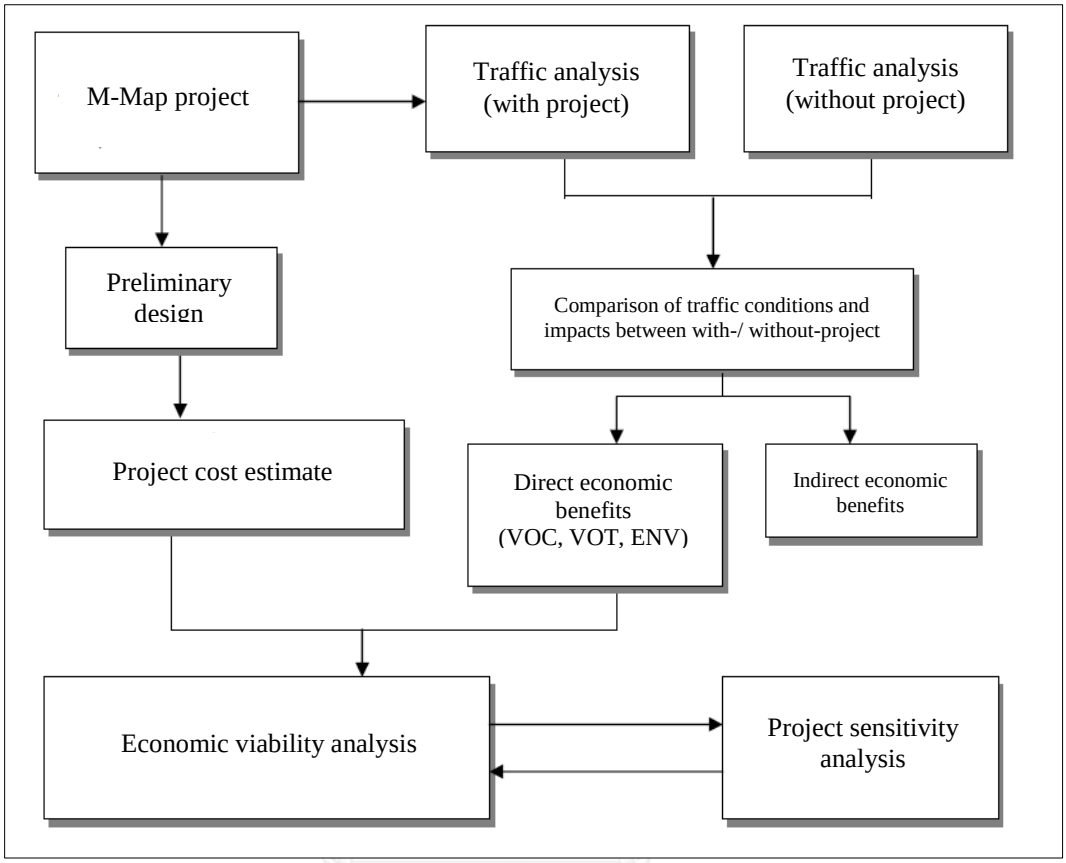



Figure 5.4 M-Map project economic analysis process
Source: OTP (2010b)



### 5.1.6 Implementation Plan

Mass Rapid Transit Commission (MRTC) is established as the independent administrative organization and is responsible for developing and planning rail transit projects, funding, investment scheme, fare policy, regulating standards of construction, and safety and level of services. MRTC consists of two units which are mass transit development and financial support. Mass transit development unit consists of three main agencies are responsible for the M-Map project.

(1) Mass Rapid Transit Authority of Thailand (MRTA) responsible projects are: Blue Line, Purple Line, Dark Green Line (partial), Orange Line, Pink Line, and Yellow Line.
(2) Bangkok Metropolitan Administration (BMA) responsible projects are: Dark Green Line (partial), Light Green Line, Grey Line, and Gold Line.
(3) State Railway of Thailand (SRT) responsible projects are: Dark Red Line, Light Red Line, and Airport Rail Link.

There are operators who are responsible to operate the mass transit lines in Bangkok which are: Bangkok Mass Transit System Public Company Limited (BTSC), Bangkok Expressway and Metro Public Company Limited (BEM), The Krungthep Thanakom Company Limited, and SRT Electrified Train Company Limited. The mass transit projects are implemented under the policies and plans by the OTP. Figure 5.5 shows the organization structure of mass transit projects.

Regarding many governmental agencies and operators are involved in the mass transit schemes, the integration in mass transit project management is needed. There is lacking of interagency cooperation in terms of system linkage both in physical and management aspects. Six major issues on mass transit management problems are as follows:



1. Lack of unity and governance in operation
2. Barrier in fare collection and joint ticket
3. Barrier in connectivity among service providers
4. Operation and private cooperation pattern have no standardization
5. Master plan is inconsistency and cannot be achieved in plan
6. Lack of bargaining power in the procurement caused by no integration in operation

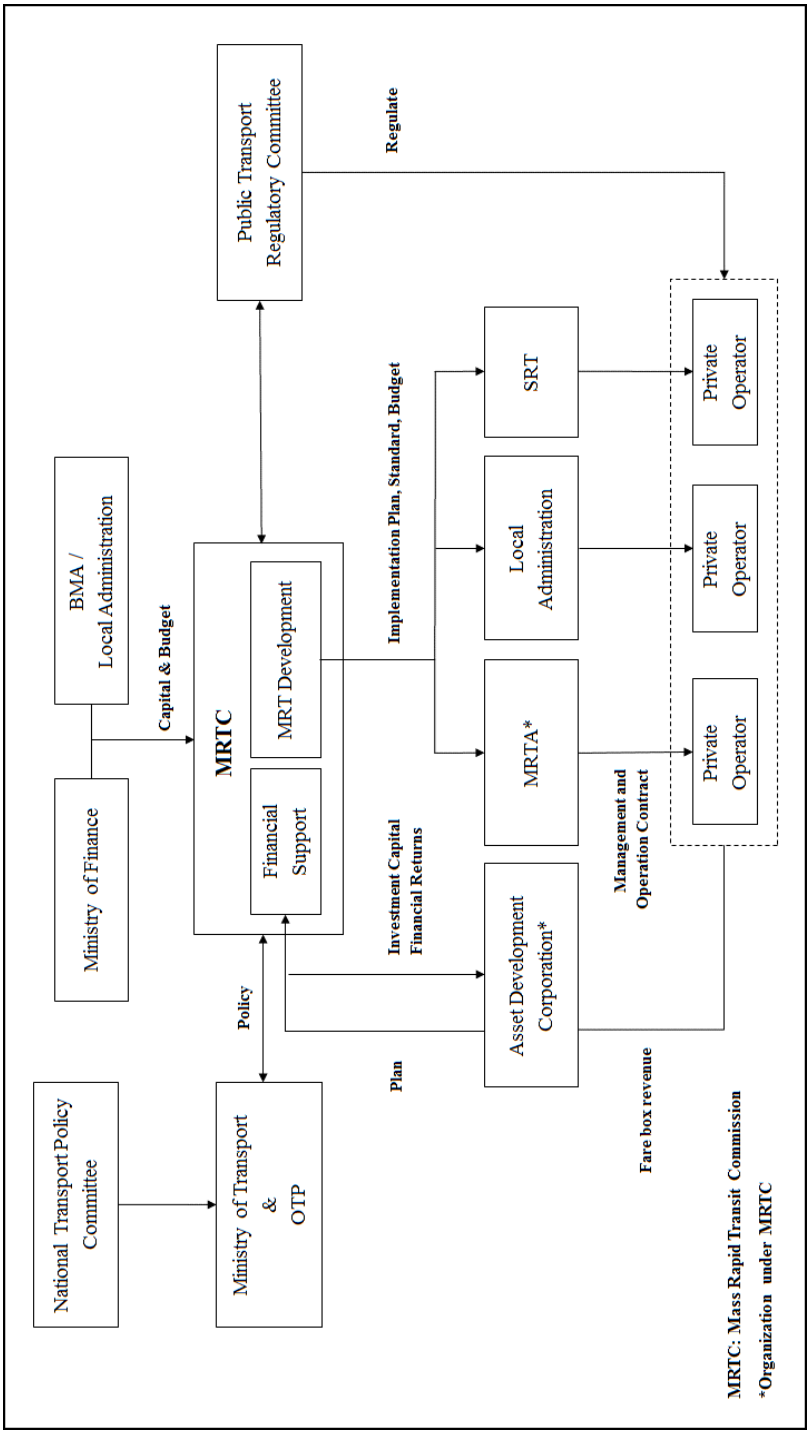



Figure 5.5 Organization structure of M-Map
Source: OTP (2010b)

**5.2 Mass Rapid Transit Project - Orange Line**

According to M-Map, the mass rapid transit – Orange line (Taling Chan-Min Buri) is a primary line which will serve passengers from the West to the East of Bangkok. The original route is for Taling Chan – Thailand Cultural Centre - Min Buri with total length of 39.8 km. The system is heavy rail with transit capacity 30,000 - 80,000 persons/hour/route. The average speed is 35 km/hr and 80 km/hr as a maximum. This line aims as primary line for the West – East route which expect to operate in 2019 with passengers 543,000 persons/route/day.regarding the feasibility study of this line had been adjust some details in line alignment, OTP and MRTA consented to determine the Orange line to start at Taling Chan Station which is also connected to the commuter rail – Red line at Taling Chan Train Station. Then it will go along to Bangkok Noi train track – Siriraj Hospital – pass under Chao Phraya River at Somdet Phra Pinklao Bridge - Ratchadamnoen Road - Larn Luang Road - Yommarat Intersection - Phetchaburi Road - Ratchaprarop Road – Din Daeng - Bangkok City Hall 2 – Thailand Cultural Center – Rama 9 Road - Ramkhamhaeng Road – Lam Sali Intersection - Kanchanaphisek Road at the intersection with Rom Klao Road – and end at intersection to Suwinthawong Road. MRTA is responsible in this project.



The total length will be 39.8 km with 30 stations that it consists of (as shown in Figure 5.6). Underground MRT will be length in 30.6 km with 23 stations and elevated MRT will be length in 9.2 km with 7 stations. The mass rapid transit – Orange line comprises of two line alignments which are the original route that had got EIA approval and the new route that has not done the EIA.

1) The original route

   The original route is the line alignment that had done the feasibility study, detailed design, and EIA report, which got the approval by the National Environment Board. The original route consisted of orange line (Bangkapi - Samsen) with length of 12 km, responsible by MRTA and brown line (Lam Sali – Min Buri) with length of 12.4 km, responsible by the OTP.

2) The new route

The new route is the line alignment from Taling Chan – Din Daeng which was followed plan in M-Map. The total length was around 15.6 km. However, this new route has been conducting in the process of the feasibility study, detailed design, and EIA report.

The mass rapid transit –Orange line project will use heavy rail system which has track structures in both elevated and underground MRT. (as shown in Table 5.4).

Table 5.4 The Orange line track structure and its length

| **MRT Orange line** | **Track structure and length** | | | **Status** |
|---|---|---|---|---|
| | **Elevated** | **Underground** | **Total** | |
| Taling Chan - Thailand Cultural Center | - | 15.4 | 15.4 | Feasibility study and design |
| Thailand Cultural Center - Lam Sali | - | 12.0 | 12.0 | Open tender phase in 2016 |
| Lam Sali - Min Buri | 9.2 | 3.2 | 12.4 | |
| **Total** | **9.2** | **30.6** | **39.8** | |

Regarding the consistency and availability of information, the following data was going to describe only the Orange line (Thailand Cultural Center-Lam Sali-Min Buri) based on the EIA final report on the mass rapid transit Orange line (Thailand Cultural Center-Lam Sali-Min Buri), 2014 which was approved from the cabinet. Figure 5.7 shows the mass rapid transit project – Orange line route and stations (Thailand Cultural Center-Lam Sali-Min Buri).

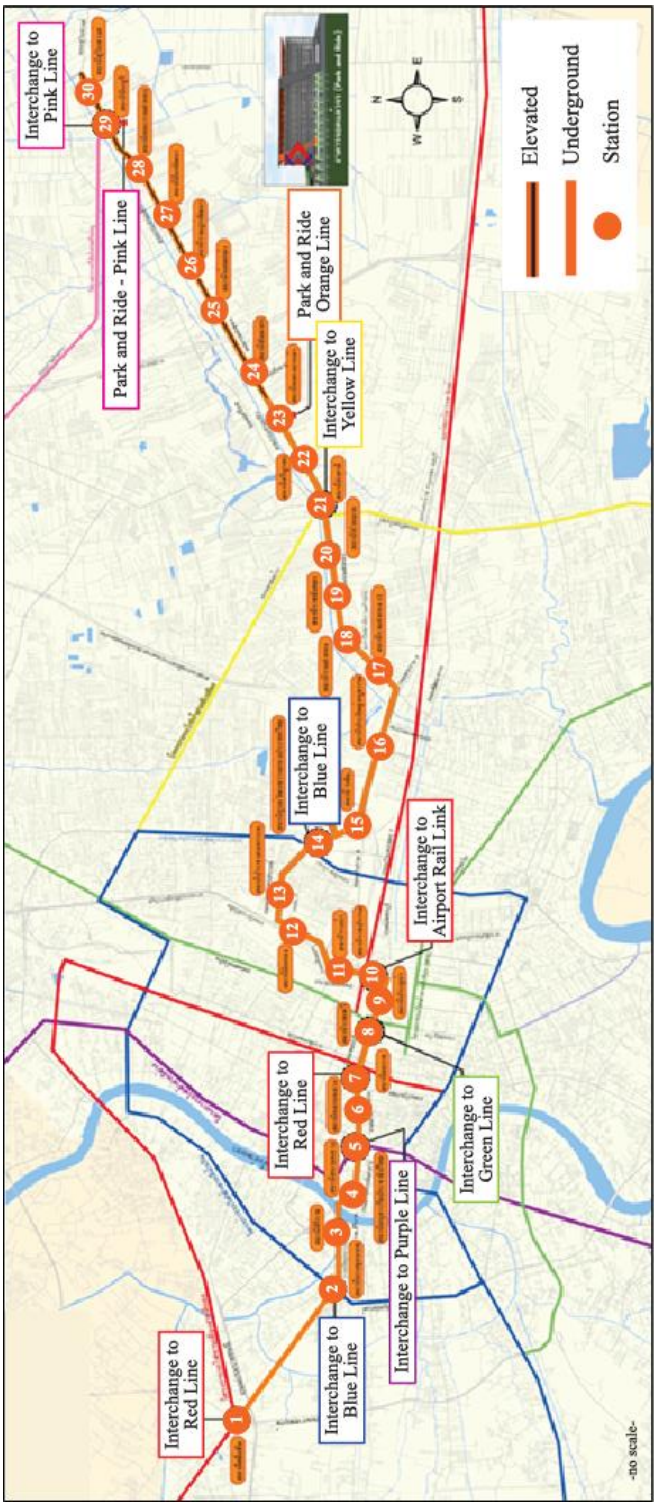



Figure 5.6 The mass rapid transit project – Orange line route and stations

Source: Modified from MRTA (2014a)

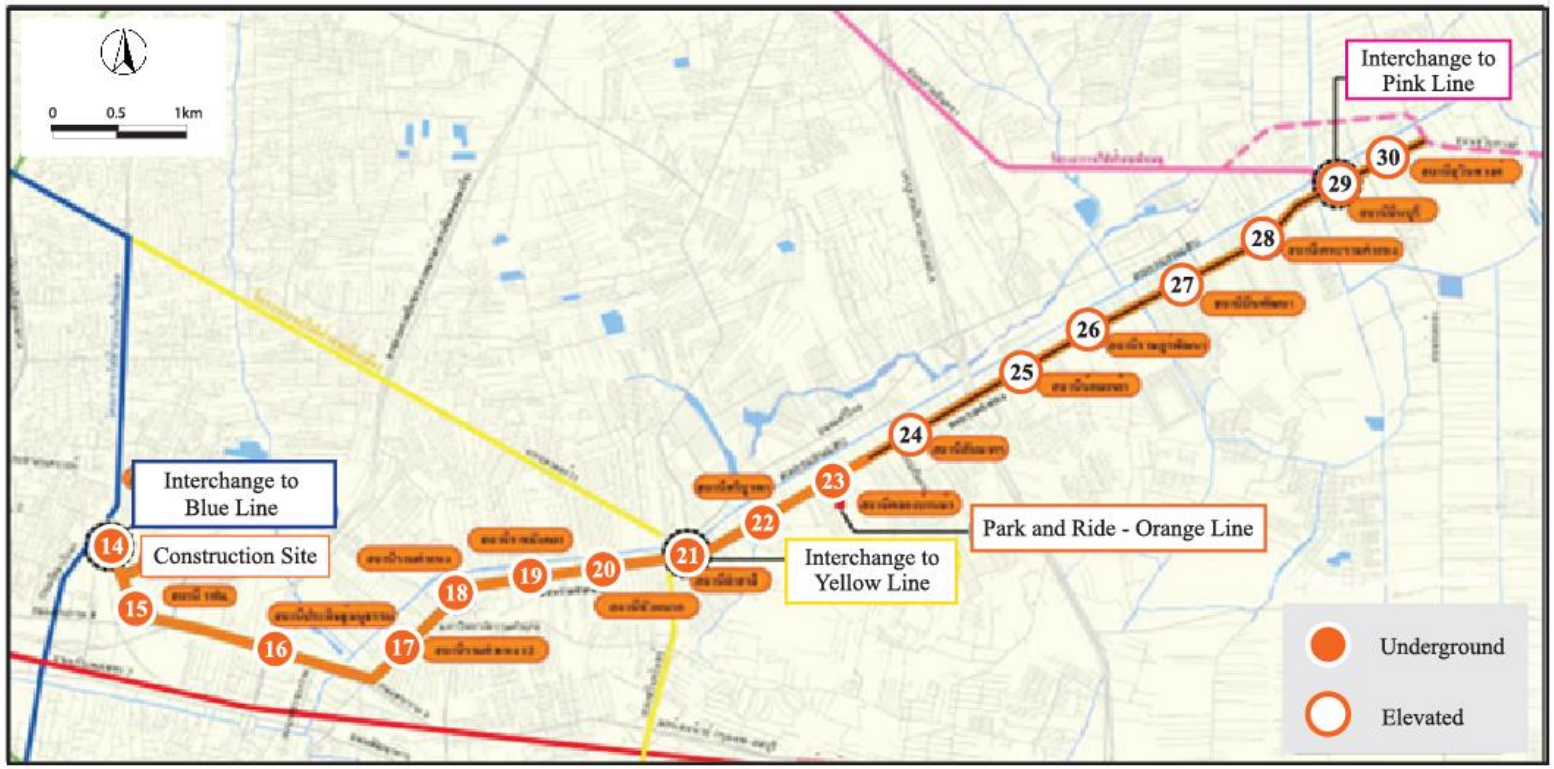



Figure 5.7 The mass rapid transit project – Orange line (Thailand Cultural Center-Lam Sali-Min Buri)

Source: Modified from MRTA (2014a)

### 5.2.1 Line Alignment

The mass rapid transit - Orange line (Thailand Cultural Center-Lam Sali-Min Buri) section consists of 17 stations which are

| Section No. | Station | Road | Interchange |
|---|---|---|---|
| Underground MRT (10 stations) | | | |
| OR-14 | Thailand Cultural Center | Ratchadaphisek | Blue Line |
| OR-15 | MRTA | Rama 9 | |
| OR-16 | Pradit Manutham | Rama 9 | |
| OR-17 | Ramkhamhaeng 12 | Ramkhamhaeng | |
| OR-18 | Ramkhamhaeng | Ramkhamhaeng | |
| OR-19 | Hua Mak Sports Complex | Ramkhamhaeng | |
| OR-20 | Hua Mak | Ramkhamhaeng | |
| OR-21 | Lam Sali | Ramkhamhaeng | Yellow Line |
| OR-22 | Sri Burapha | Ramkhamhaeng | |
| OR-23 | Khlong Ban Ma | Ramkhamhaeng | |
| Elevated MRT (7 stations) | | | |
| OR-24 | Sammakorn | Ramkhamhaeng | |
| OR-25 | Nomklao | Ramkhamhaeng | |
| OR-26 | Rat Pattana | Ramkhamhaeng | |
| OR-27 | Min Pattana | Ramkhamhaeng | |
| OR-28 | Ramkamhaeng Government Housing | Ramkhamhaeng | |
| OR-29 | Min Buri | Ramkhamhaeng | Pink Line |
| OR-30 | Suwinthawong | Ramkhamhaeng | |

Based on the eBUM model, this MRT section ridership forecasts will be 542,000 person-trip/day and 812,000 person-trip/day in 2019 and 2029, respectively.

### 5.2.2 Previous Environmental Situation in the Study Area

In the report conducted environmental examination on air quality, noise and vibration, water quality, land use, land expropriation, as well as historical and cultural places in the surrounding areas of the project. In this research focused only on air quality and its pollution since these are the main factors in analyzing and developing the LCDS model in sustainable transport leading to low carbon city.

1) Monitoring method and station

The project considered in selection on sensitive area where was to be the monitoring station in order to collect based data for the adjusted route from Thailand Cultural Center – Ramkhamhaeng station and Suwinthawong station, which were the areas at KPN Tower (Thailand Cultural Center – Ramkhamhaeng) and the Metropolitan Waterworks Authority Office – Min Buri Branch (Suwinthawong). The monitoring process was for examining concentration of total suspended particulates (TSP), Particulate matter (PM-10), carbon monoxide (CO), and nitrogen oxides ($NO_2$).

2) Monitoring results

Based on the monitoring results of air quality, the concentration of total suspended particulates (TSP), Particulate matter (PM-10), carbon monoxide (CO), and nitrogen oxides ($NO_2$) of both two monitoring stations were in the standard level. Table 5.5 presents the monitoring results of air quality in area around Thailand Cultural Center – Ramkhamhaeng stations which monitored in October 2012 at KPN Tower station. The monitoring result showed that the concentrations of all air quality indexes were within the standard level. Similarly, Table 5.6 also presents the monitoring results of air quality in area around Suwinthawong station that the concentrations of all air quality indexes were within the standard level.

Table 5.5 The monitoring results of air quality in area around Thailand Cultural Center – Ramkhamhaeng stations.

| Station | Date | Concentration | | | |
|---|---|---|---|---|---|
| | | TSP (24 hr) ($mg/m^3$) | PM-10 (24 hr) ($mg/m^3$) | CO (1 hr) (ppm) | $NO_2$ (1 hr) (ppm) |
| KPN Tower | 18-23 October 2012 | 0.045-0.070 | 0.038-0.048 | 0.060-1.970 | 0.008-0.149 |
| Standard level | | 0.33 | 0.12 | 30.00 | 0.17 |

Source: MRTA (2014a)

Table 5.6 The monitoring results of air quality in area around Suwinthawong station.

| Station | Date | Concentration | | | |
|---|---|---|---|---|---|
| | | TSP (24 hr) ($mg/m^3$) | PM-10 (24 hr) ($mg/m^3$) | CO (1 hr) (ppm) | $NO_2$ (1 hr) (ppm) |
| Metropolitan Waterworks Authority - Min Buri | 10-16 October 2012 | 0.079-0.113 | 0.058-0.087 | 0.23-2.97 | 0.001-0.050 |
| Standard level | | 0.33 | 0.12 | 30.00 | 0.17 |

Source: MRTA (2014a)

Although the concentrations of all air quality indexes were within the standard level, according to the EIA report in the environmental impact measure and monitoring in air quality for the Orange line (Thailand Cultural Center-Lam Sali-Min Buri) section had assigned more stations during construction and operation phases (as shown in Table 5.7). This aimed to conduct the regulations and to ensure that the air quality and pollution are in the standard level.

Table 5.7 The environmental impact measure and monitoring in air quality

| Air Quality | Air pollutant index | Monitoring station | Frequency | Agency |
|---|---|---|---|---|
| Construction phase | Total suspended particulates (TSP)<br>Particulate matter (PM-10)<br>Wind speed (WS)<br>Wind direction (WD) | Total 12 stations (as shown in Figure 5.8)<br>1) Chanwit school<br>2) Wat Thep Leela<br>3) Ramkhamhaeng Hospital<br>4) Huamarkwittayanusorn School<br>5) Ramkhamhaeng Advent International School<br>6) Somapanussorn School<br>7) Kasemrad Hospital Sukhaphiban 3<br>8) Suwanchard Pet Hospital<br>9) Triamudomsuksanomklao School<br>10) Kindergarten Jitkasame<br>11) Thepaksorn School<br>12) Minprasatwitaya School | - Before construction: monitoring once for 5 consecutive days<br>- During construction: monitoring one time per month with 5 consecutive days per time | MRTA |
| Operation phase | Total suspended particulates (TSP)<br>Particulate matter (PM-10)<br>Carbon monoxide (CO)<br>Nitrogen oxides ($NO_2$)<br>Wind speed (WS)<br>Wind direction (WD) | Total 6 stations (as shown in Figure 5.9)<br>1) Somapanussorn School<br>2) Kasemrad Hospital Sukhaphiban 3<br>3) Triamudomsuksanomklao School<br>4) Kindergarten Jitkasame<br>5) Thepaksorn School<br>6) Minprasatwitaya School | - Monitoring 4 times a year with 5 consecutive days per time for 5 years, then reduce to conduct 2 times a year with 5 consecutive days per time | MRTA |

Source: Modified from MRTA (2014a)

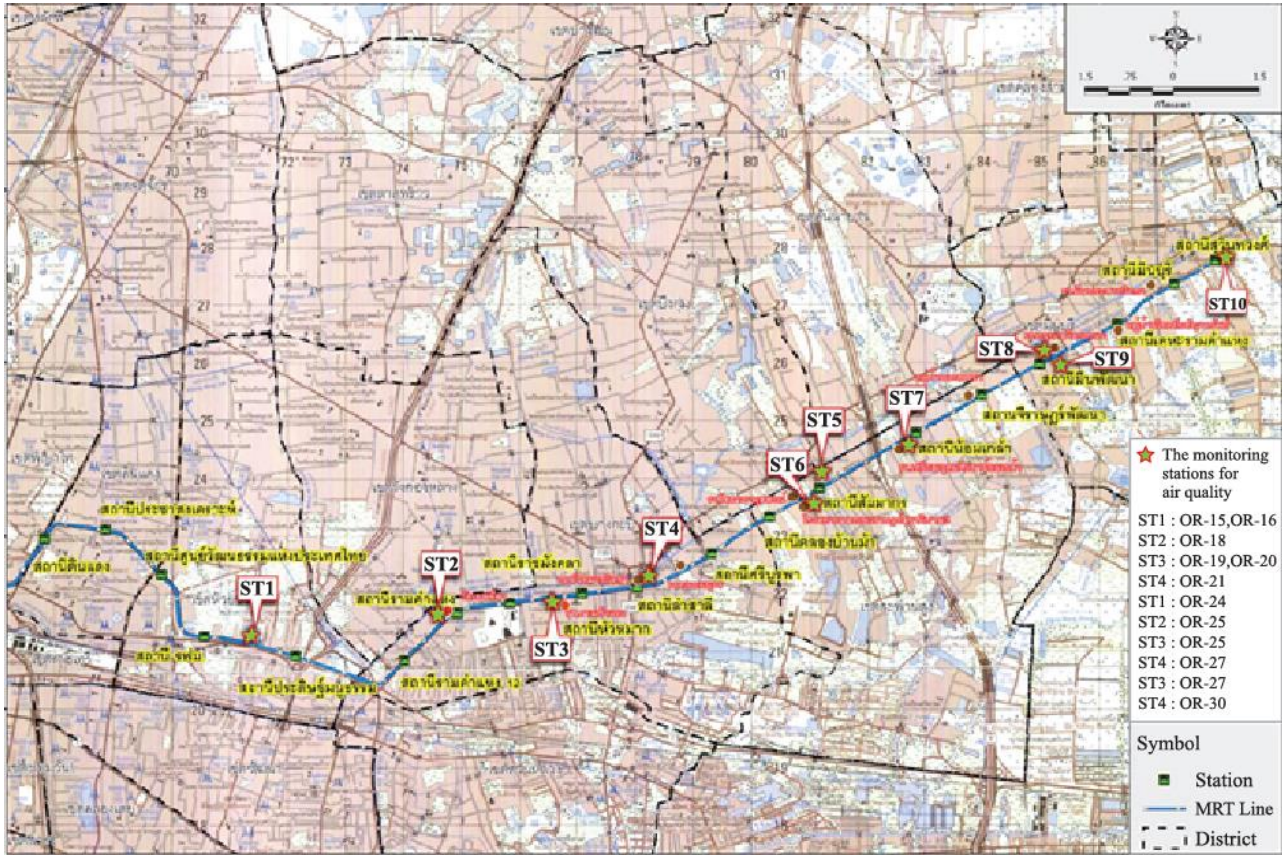



Figure 5.8 The monitoring stations for air quality in construction phase

Source: Modified from MRTA (2014a)

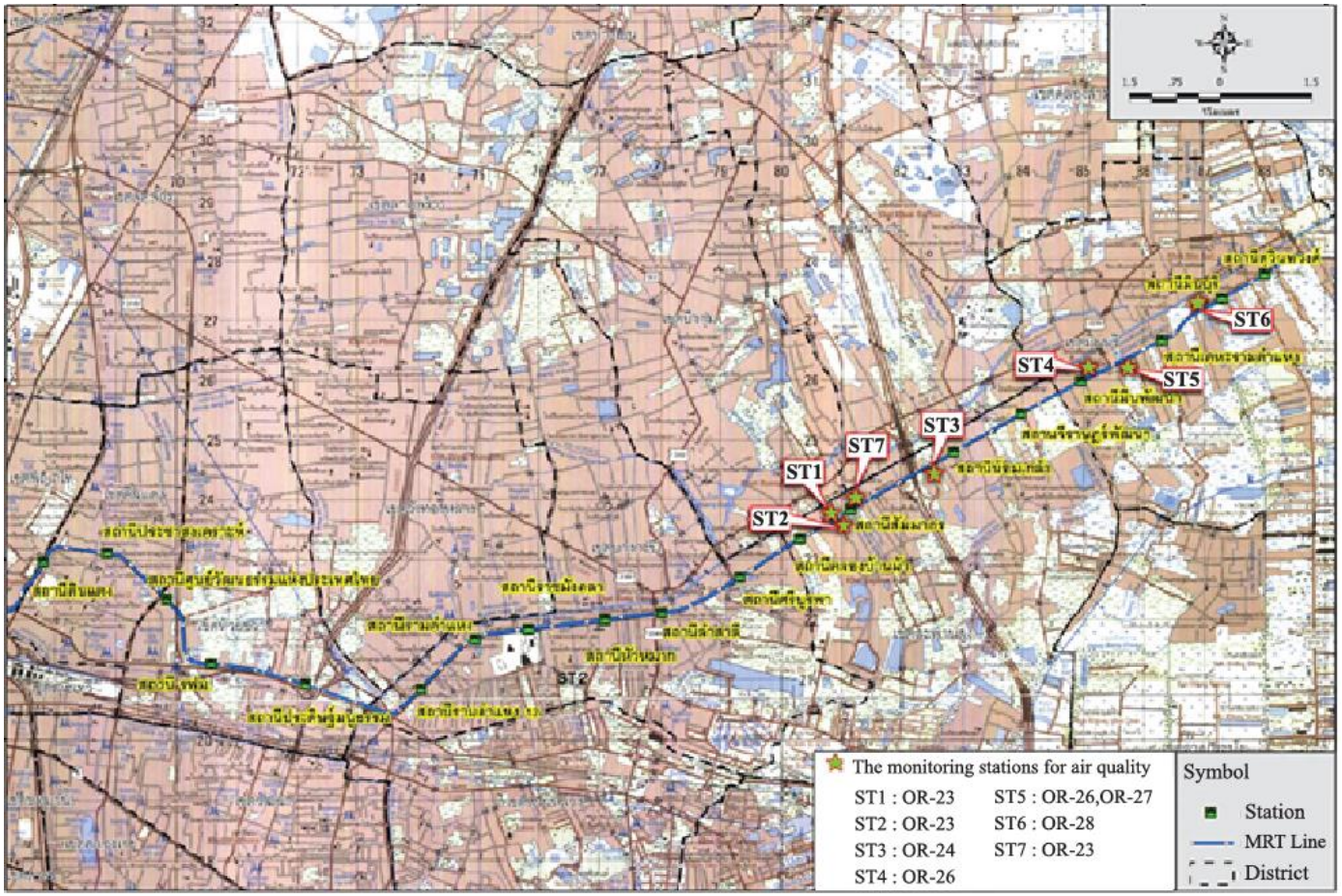



Figure 5.9 The monitoring stations for air quality in operation phase

Source: Modified from MRTA (2014a)

### 5.3 Mass Rapid Transit Project - Pink Line

The mass rapid transit - Pink Line project (Khae Rai-Min Buri) is the feeder line with total length 36 km., 30 stations and two park and ride. Pink line will serve passengers from the Northwestern (Khae Rai and Pak Kret) to the East of Bangkok (Min Buri). The system is monorail with transit capacity 10,000 - 44,000 persons/hour/route. The average speed is 35 km/hr and 80 km/hr as a maximum. This line aims as feeder line for the Northwest – East route which expect to operate in 2019 with passengers 218,000 persons/route/day. Pink line is proposed to be interchange points to Purple line, Red line, Dark green line and Orange line which can be increasing and optimizing an efficiency of the overall MRT network. Mass Rapid Transit Authority of Thailand (MRTA) is responsible in this project. The project will go onto construction phase in 2017. Figure 5.10 shows the mass rapid transit project – Pink line route and stations.

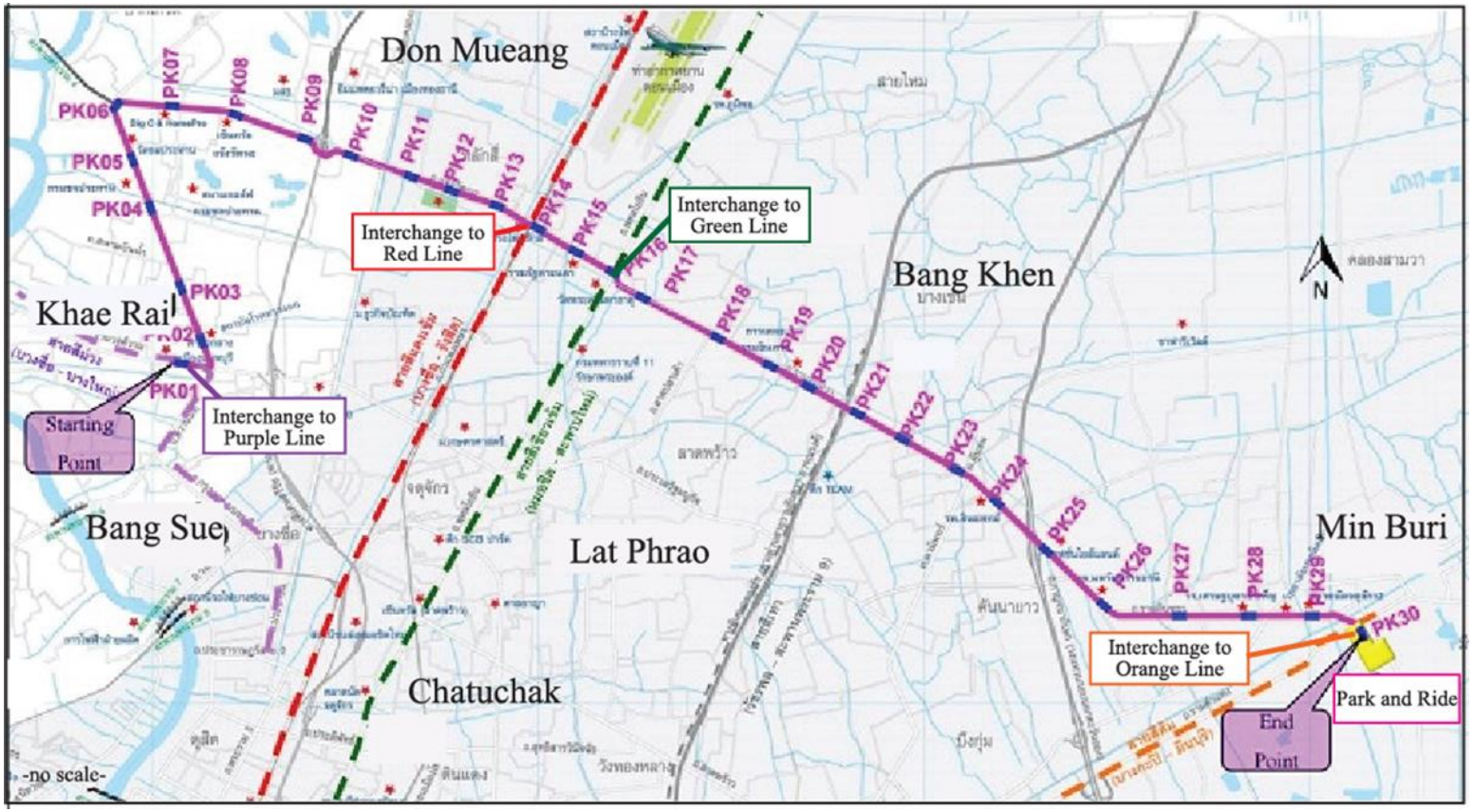



Figure 5.10 The mass rapid transit project – Pink line route and stations

Source: Modified from MRTA (2014b)

### 5.3.1 Line Alignment

The mass rapid transit – Pink line (Khae Rai-Min Buri) has total of 30 stations which all use monorail - straddle type, two park and ride will be at Sanam Bin Nam and Rom Klao (near Min Buri station). The total of 30 stations of MRT Pink line is as follow:

| Section No. | Station | Road | Interchange |
|---|---|---|---|
| PK-1 | Nonthaburi Civic Center | Rattanathibet | Purple Line |
| PK-2 | Khae Rai | Tiwanon | |
| PK-3 | Sanam Bin Nam | Tiwanon | |
| PK-4 | Samakkhi | Tiwanon | |
| PK-5 | Chonlaprathan | Tiwanon | |
| PK-6 | Pak Kret | Chaeng Watthana | |
| PK-7 | Liang Mueang Pak Kret | Chaeng Watthana | |
| PK-8 | Chaeng Wattana-Pak Kret 28 | Chaeng Watthana | |
| PK-9 | Mueang Thong Thani | Chaeng Watthana | |
| PK-10 | Si Rat | Chaeng Watthana | |
| PK-11 | Mongkut Watthana | Chaeng Watthana | |
| PK-12 | Bangkok Government Complex | Chaeng Watthana | |
| PK-13 | TOT & MICT | Chaeng Watthana | |
| PK-14 | Lak Si | Chaeng Watthana | Red Line |
| PK-15 | Phranakhon Rajabhat | Chaeng Watthana | |
| PK-16 | Wongwian Lak Si | Rarm Intra | |
| PK-17 | Ram Inthra 3 | Rarm Intra | |
| PK-18 | Lat Pla Khao | Rarm Intra | |
| PK-19 | Ram Inthra 31 | Rarm Intra | |
| PK-20 | Raminthra Government Housing | Rarm Intra | |
| PK-21 | Watcharaphon | Rarm Intra | Grey Line |
| PK-22 | Ram Inthra 40 | Rarm Intra | |
| PK-23 | Nawamin | Rarm Intra | |
| PK-24 | Ram Inthra 83 | Rarm Intra | |
| PK-25 | Khan Na Yao | Rarm Intra | |
| PK-26 | Siam Park City | Rarm Intra | |
| PK-27 | Bang Chan | Rarm Intra | |
| PK-28 | Setthabut Bamphen | Rarm Intra | |
| PK-29 | Sihaburanukit | Sihaburanukit | |
| PK-30 | Min Buri | Ramkhamhaeng | Orange Line |

### 5.3.2 Previous Environmental Situation in the Study Area

1) Survey and sample collection for air quality
   - The sample collecting points were on public transport network
   - There were seven monitoring stations where were sensitive receptor such as school, hospital, community, etc. (as shown in Figure 5.11)

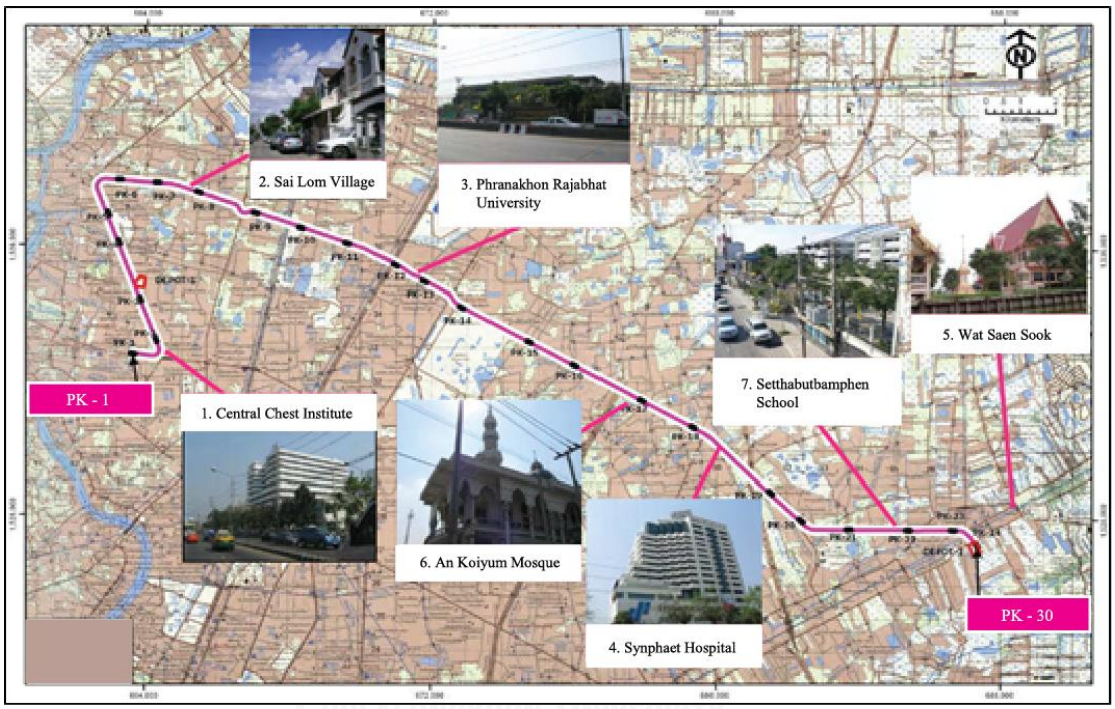



Figure 5.11 The monitoring station for air quality – Pink line

Source: Modified from MRTA (2011)

2) Collecting periods were five consecutive days per time, the collection was conducted for three times which were during 5-17 March 2008, 14-26 May 2008 and 22-27 April 2009
3) Collection and analysis methods were followed the standard in US-Environmental Agency or Methods of Air Sampling and Analysis: 3rd Edition, AWMA, ACS, AICHE, APWA ASME, AOAC, HPS, ISA (MRTA, 2011).

4) The air quality results shown that air pollutants such as TSP, CO, and $NO_2$ had a concentration in standard level. Only PM-10 in some monitoring station had a concentration beyond standard level (as shown in Table 5.8).

Table 5.8 The air quality results from survey and sample collection.

| Station | Duration | Concentration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TSP (24 hr) | PM-10 (24 hr) | CO (ppm) | | | $NO_2$ (ppm) | | |
| | | ($mg/m^3$) | ($mg/m^3$) | (1 hr. max) | (1 hr. min) | (1 hr. avg) | (1 hr. max) | (1 hr. min) | (1 hr. avg) |
| 1. Central Chest Institute of Thailand | 5-10 March 2008 | 0.145 | 0.110 | 1.83 | 0.53 | 1.04 | 0.038 | 0.009 | 0.019 |
| | 21-26 May 2008 | 0.106 | 0.054 | 3.44 | 1.57 | 2.30 | 0.023 | 0.001 | 0.007 |
| 2. Sai Lom Village | 12-17 March 2008 | 0.124 | 0.084 | 3.31 | 0.12 | 2.01 | 0.074 | 0.008 | 0.030 |
| | 21-26 May 2008 | 0.126 | 0.106 | 6.32 | 2.41 | 4.11 | 0.115 | 0.044 | 0.068 |
| 3. Phranakhon Rajabhat University | 5-10 March 2008 | 0.158 | 0.101 | 2.12 | 1.79 | 1.90 | 0.030 | 0.009 | 0.019 |
| | 21-26 May 2008 | 0.066 | 0.037 | 1.08 | 0.43 | 0.70 | 0.027 | 0.007 | 0.007 |
| 4. Synphaet Hospital | 7-12 March 2008 | 0.097 | 0.071 | 1.47 | 0.08 | 0.50 | 0.034 | 0.004 | 0.015 |
| | 14-19 May 2008 | 0.079 | 0.057 | 2.45 | 0.91 | 1.27 | 0.025 | 0.005 | 0.014 |
| 5. Wat Saen Sook | 12-17 March 2008 | 0.087 | 0.047 | 0.54 | 0.02 | 0.16 | 0.017 | 0.003 | 0.008 |
| | 14-19 May 2008 | 0.111 | 0.052 | 2.40 | 1.18 | 1.67 | 0.023 | 0.003 | 0.011 |
| 6. An Koiyum Mosque | 22-27 April 2009 | 0.176 | 0.064 | 2.26 | 1.14 | 1.67 | 0.028 | 0.003 | 0.010 |
| 7. Setthabutbamphen School | 22-27 April 2009 | 0.155 | 0.058 | 2.44 | 0.86 | 1.29 | 0.048 | 0.005 | 0.014 |
| Standard level | | 0.330 | 0.120 | 30.00 | | - | 0.170 | | - |

Source: MRTA (2011)



### 5.3.3 Environmental Impact Assessment – air quality

Although monorail system of the Pink line does not have air pollution ventilation, during operating period, it depends on the ventilation of vehicles in main roads along the Pink line. In case of elevated structure, the forecasting on concentration of air pollutants would not higher than standard level. Table 5.9 shows the forecasting in ventilation of vehicles in main roads (6 lanes) in high traffic congestion. In addition, the study in air quality impact around the MRT station platforms forecasted that the concentration of air pollution is depended on traffic congestion condition. Table 5.10 shows the result of study in volume of CO ventilation from vehicles in high traffic congestion (speed in 0-1 km/hr and 8 km/hr) during 1993, 2006, and 2019. It showed that air pollution concentration trend to decrease during the periods. Most of the forecasting of CO volume in each station was

below standard, however there were some stations still had high CO level due to the stations are in commercial area and high density community. Therefore, it needed to figure out the measures in preventing and reducing the air quality impact.

Table 5.9 The forecasting in ventilation of vehicles in main roads (6 lanes) in high traffic congestion during 1993, 2006, and 2019

| Speed (km/hr) | Concentration of CO | | | | | |
|---|---|---|---|---|---|---|
| | 1993 | | 2006 | | 2019 | |
| | g/100 m/hr | g/sec/$m^2$ | g/100 m/hr | g/sec/$m^2$ | g/100 m/hr | g/sec/$m^2$ |
| 0-1 km/hr | 50,506 | 7.01 | 33,915 | 4.71 | 26,672 | 3.70 |
| 8 km/hr | 16,800 | 2.33 | 11,300 | 1.57 | 8,900 | 1.24 |

Source: MRTA (2011)

Table 5.10 The forecasting in volume of CO ventilation from vehicles in high traffic congestion during 2008-09, 2019, and 2043

| Speed (km/hr) | Concentration of CO - 1 hr (ppm) | | | Concentration of CO - 1 hr with maximum level (ppm) | | |
|---|---|---|---|---|---|---|
| | 2008-09 | 2019 | 2043 | 2008-09 | 2019 | 2043 |
| 0-1 km/hr | 2.26 | 1.76 | 1.39 | 8.67 | 8.17 | 7.80 |
| 8 km/hr | 0.87 | 0.59 | 0.46 | 7.28 | 7.00 | 6.87 |
| Standard level 30.00 ppm | | | | | | |

Source: MRTA (2011)

### 5.3.4 Economic Analysis

Economic analysis in the MRT project considers in five types of economic benefits which are as follow (as shown in Table 5.11):

1) Vehicle operating cost savings (VOC)

To saving expenses caused by the use of vehicles to travel, this study applied data categories to be converted these expenses into monetary costs for evaluation such as average speed of vehicles, road physical, fuel price, and

other parameters. According to the MRT project can support travel faster and reduce traffic congestion, this results in increasing vehicle operating cost savings in terms of saving fuel and maintenance costs.

2) Value of time on road saving (VOT Road)

   The value is equivalent to money which people can save cost in travel on road; such a cost is as a loss of opportunity cost to spend in other activities. To calculate this value, it consisted of socio-economic data such as population, household size, number of employment, travel proportion in the area, and the ratio of cars and the number of passengers per car.

3) Value of time on rail saving (VOT Rail)

   The value is the same as VOT Road but it represents in term which people can save cost in travel on rail.

4) Value of reducing expenditure on greenhouse gas emission (GHG)

   To saving cost of reducing on greenhouse gas emissions including emission control costs, tracking and quality measurements

5) Value of reducing expenditure on air pollution

   The value on saving cost of disposal of pollutants from use such as dust removal cost, carbon monoxide, nitrogen dioxide and other toxic substances management.

Table 5.11 Economic benefits of base case throughout the project lifetime

| Year | Economic benefits | | | | | |
|---|---|---|---|---|---|---|
| | VOC | VOTROAD | VOTRAIL | Value of reducing expenditure on air pollution | | Total |
| | | | | GHG | Noxious gas | |
| 2013 | 1,861.5 | 2,535.2 | 217.4 | 57.8 | 740.9 | 5,412.8 |
| 2017 | 4,170.3 | 5,861.9 | 627.2 | 126.6 | 1,622.7 | 12,408.7 |
| 2022 | 4,754.3 | 6,883.3 | 919.5 | 141.3 | 1,811.3 | 14,509.7 |
| 2027 | 5,231.7 | 7,545.7 | 1,084.5 | 155.9 | 1,998.6 | 16,016.4 |
| 2032 | 5,508.9 | 8,173.7 | 1,464.0 | 160.2 | 2,054.4 | 17,361.2 |
| 2037 | 6,250.2 | 9,479.9 | 1,968.9 | 179.0 | 2,294.5 | 20,172.5 |
| 2042 | 7,091.4 | 10,994.9 | 2,639.3 | 199.9 | 2,562.7 | 23,488.2 |
| 2043 | 7,458.7 | 11,666.6 | 3,527.8 | 208.9 | 2,862.3 | 25,724.3 |
| **Project lifetime** | **163,948.6** | **241,878.6** | **42,104.1** | **4,800.9** | **61,740.7** | **514,472.9** |

Source: MRTA (2011)

According to the EIA report (MRTA, 2011), the Pink line project will be generate many economic benefits. Vehicle operating cost savings will increase along the lifetime project as well as value of time on road saving and rail saving will be gradually increased. In terms of value of reducing expenditure on greenhouse gas emission and air pollution, the Pink line project also expected in gradually reduce the expenditures for the project lifetime.

### 5.3.5 Environmental Economics Analysis

According to the study in MRT Pink line concluded that the operation of Pink line is one of main factors to reduce the using of vehicles. In addition, it results in declining in volume of fuel consumption, air pollution, and GHG emission.regarding the detailed adjustment report in EIA report of the mass rapid transit project - Pink Line (MRTA, 2014b), the report applied the environmental economics analysis to find out fuel consumption ratio without and with project in order to compare the reduction on GHG emission with project case in different price level. The assessment result showed that the value of environmental economics on fuel combustion from vehicles when it compared between fare charge by distance to 20 baht all routes, 20 baht all routes case can provide higher amount of the value of reducing expenditure on greenhouse gas emission (GHG) and the value of reducing expenditure on air

pollution. Vehicle-kilometers travelled or VKT is one of the main variables used as a measure of a road network. Estimates of VKT are used extensively in transportation planning for allocating resources, estimating vehicle emissions, computing energy consumption and assessing traffic impact. A decrease in VKT is represented as saving in terms of cost and energy consumption. Vehicle Hours of Travel or VHT is the total time spent by vehicles travelling on the study area. Reduction in VHT is regarded as more efficient in the road network. According to Table 5.12 shows the analysis of average speed and GHG emission in case of 20 baht all routes for MRT –Pink line, it presents that the Pink line project can saving in terms of cost and energy consumption as well as reducing GHG emission.

Table 5.12 The analysis of average speed and GHG emission in case of 20 baht all routes for MRT –Pink line

| Details | 2018 | | 2027 | | 2037 | |
|---|---|---|---|---|---|---|
| | VKT (pcu-km/hr) | VHT (pcu-hr/hr) | VKT (pcu-km/hr) | VHT (pcu-hr/hr) | VKT (pcu-km/hr) | VHT (pcu-hr/hr) |
| Without project | 14,595,403 | 662,902 | 17,969,023 | 826,945 | 21,198,850 | 1,073,923 |
| With project | 14,554,592 | 657,059 | 17,906,211 | 815,978 | 21,108,188 | 1,055,895 |
| Without project | | | | | | |
| Average speed (km/hr) | | 22.0174 | | 21.7294 | | 19.7396 |
| Fuel consumption (km/liter) | | 5.8915 | | 5.8420 | | 5.4252 |
| GHG (g/pcu-km) | | 400.5771 | | 404.5113 | | 435.007 |
| With project | | | | | | |
| Average speed (km/hr) | | 22.1511 | | 21.9445 | | 19.9908 |
| Fuel consumption (km/liter) | | 5.9181 | | 5.8769 | | 5.4877 |
| GHG (g/pcu-km) | | 398.7766 | | 401.5723 | | 430.0527 |

Source: MRTA (2014b)

Furthermore, Table 5.13 presents the study of reduction in GHG emission in case of 20 baht all routes for MRT –Pink line. It showed that the project is more efficiently increase in GHG reduction than without project. The differences of GHG reduction between with and without project were expected from 43 $tCO_2e$/hr in 2018 to 144 $tCO_2e$/hr in 2037.

Table 5.13 The study of reduction in GHG emission in case of 20 baht all routes for MRT –Pink line

| Year | Without project | | | With project | | | GHG reduction ($tCO_2e$/hr) |
|---|---|---|---|---|---|---|---|
| | GHG (g/pcu-km) | VKT (pcu-km/hr) | GHG emission ($tCO_2e$/hr) | GHG (g/pcu-km) | VKT (pcu-km/hr) | GHG emission ($tCO_2e$/hr) | |
| 2018 | 400.5771 | 14,595,403 | 5,847 | 398.7766 | 14,554,592 | 5,804 | 43 |
| 2027 | 404.5113 | 17,969,023 | 7,269 | 401.5723 | 17,906,211 | 7,191 | 78 |
| 2037 | 435.0070 | 21,198,850 | 9,222 | 430.0527 | 21,108,188 | 9,078 | 144 |

Source: MRTA (2014b)

## 5.4 Current Situations of Transportation in Bangkok Metropolitan

Bangkok was divided into two zones: inner and outer. The inner zone is defined as an area within 10 km radius from the Victory Monument, the division between the inner and outer zone are shown in Figure 5.12. Other parts of Bangkok outside the 10 km radius were considered as outer area. Bangkok has 21 inner districts and 29 outer districts (Burapatana and Ross, 2011). It can be said that Bangkok has become to suburbanized city because in general a suburbanized city is low population density in inner areas but high population density in the suburbs. The population density trend in Bangkok during 1998-2008 as shown in Figure 5.13 shows that population had moved out of Bangkok inner area whereas population density of Bangkok outer area had been increased.

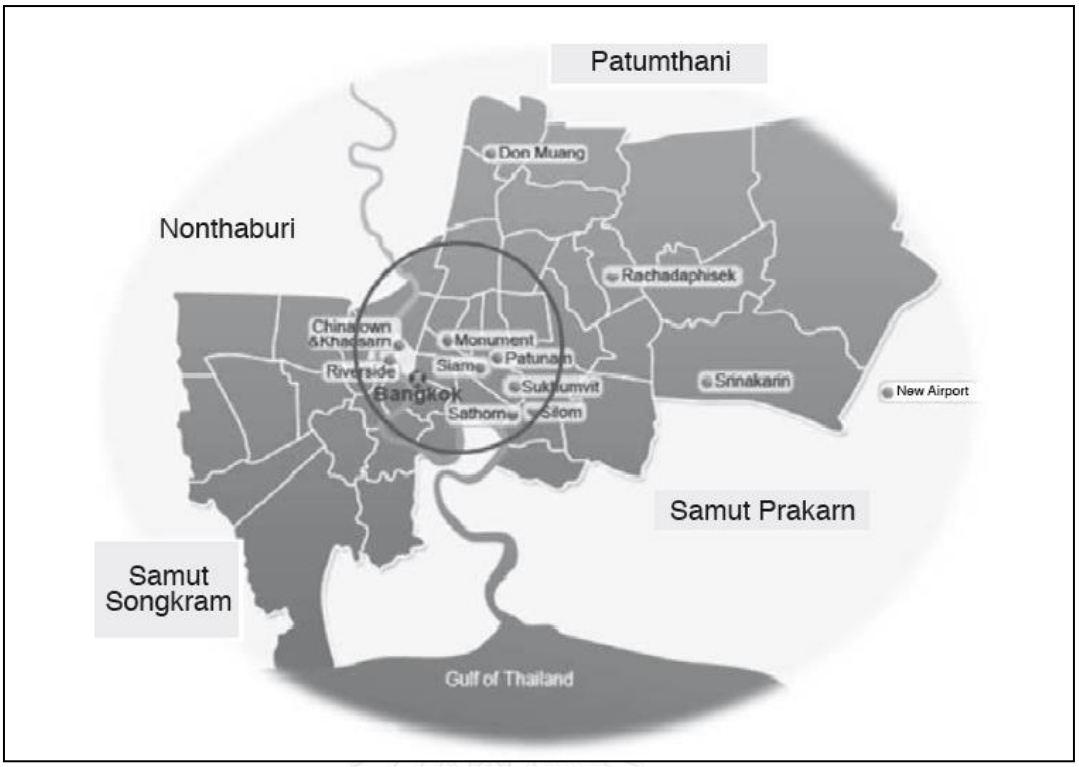



Figure 5.12 The inner and outer zones of Bangkok and vicinities location

Source: Burapatana and Ross (2011)

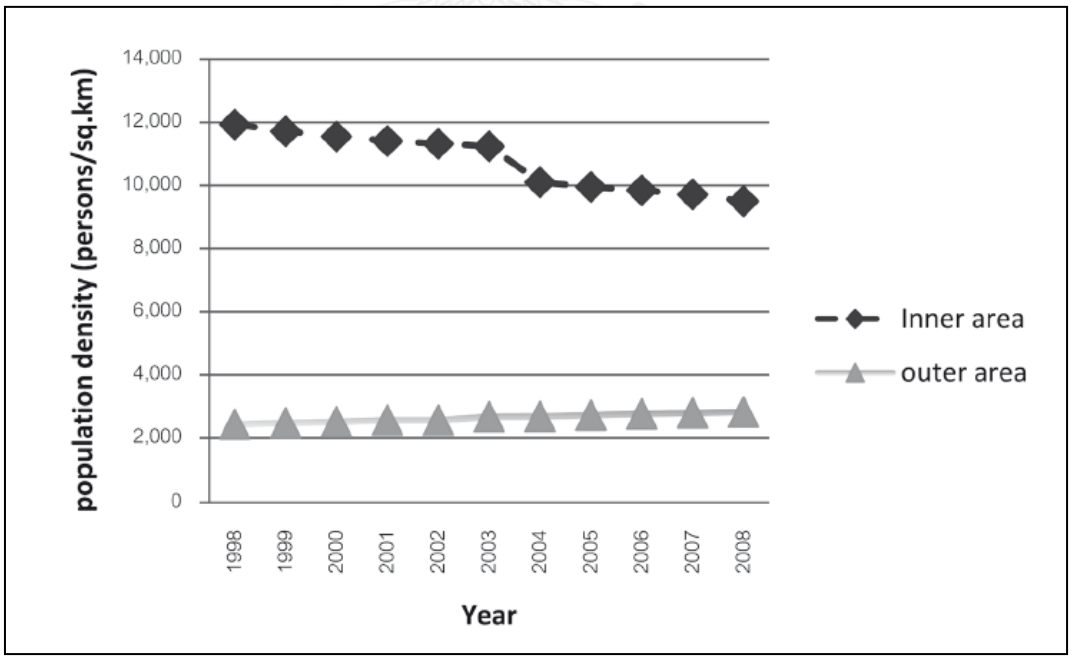



Figure 5.13 Population density trend in Bangkok during 1998-2008

Source: Burapatana and Ross (2011)

Bangkok has its vicinities including Samut Prakan, Nonthaburi, Pathum Thani, Nakhon Pathom and Samut Sakhon or called as the Bangkok Metropolitan Region (BMR) which covering 7,761.50 square kilometers with total population of 14,565,547 people (NSO, 2011). All these five vicinities also had high average population growth rate around 1.99 in 2010 (BMA, 2011). Figure 5.14 shows the top ten provinces which had the highest population density in 2010 (NSO, 2011). It showed that all the vicinities were in the top ranking. The reasons why the vicinities had tended to high population growth rate, one was urban sprawl that there had been increasing number of people who moved from the inner city to settle down in suburban and vicinities. Another reason was that the official places moved to those areas, for example the Government Complex in Laksi district. In addition, there were many real estate projects had expanded to the areas such as condominiums, housing and community malls.

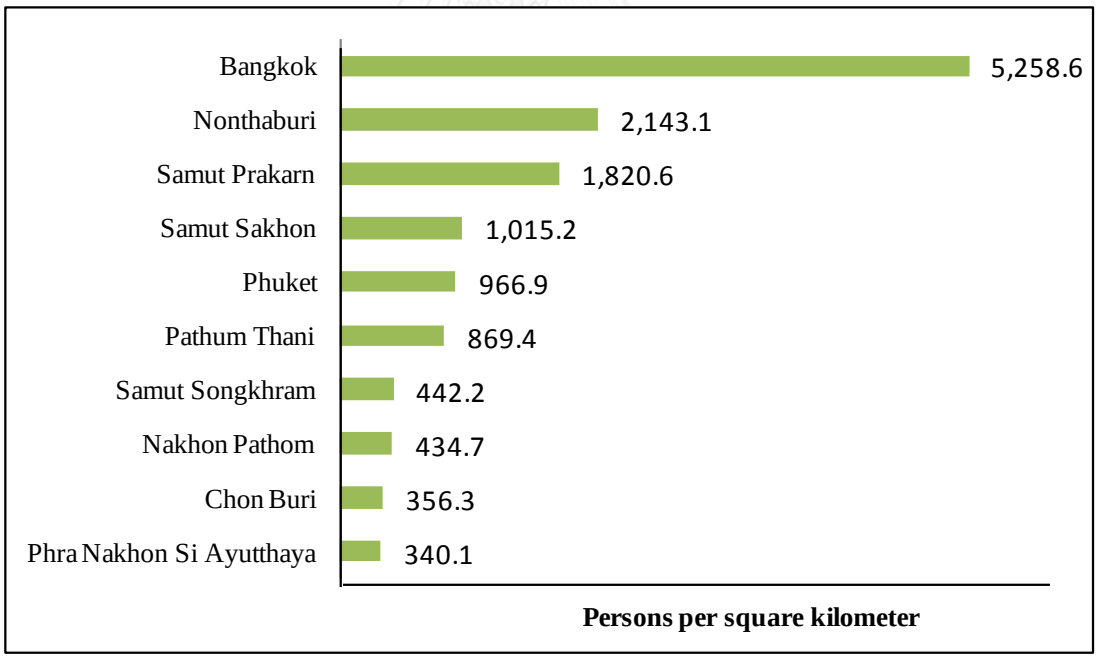



Figure 5.14 Ten provinces with highest population density in 2010
Source: National Statistical Office (2011)

In terms of transportation, Asian Development Bank (ADB) report in 2011 stated that traffic congestion in Bangkok had significantly reduced the efficiency of the urban transport network, and had created more travel time consuming, excessive

fuel consumption, and polluting emissions. Regarding the estimation from the Office of Transport and Traffic Policy and Planning's (OTP) Bangkok Transport Model, public transport represented about 40% of all daily person trips in Bangkok, which consisted of 36% by bus but only 4% of trips by mass rapid transit including BTS, MRT and Airport rail link. Only a small number of trips were made by water transport or called river taxi. For private transport, four- and two-wheel vehicles represented 46% of trips and 14% on foot (ADB, 2011). Figure 5.15 shows the ratio of transportation modes using for daily person trips in Bangkok.

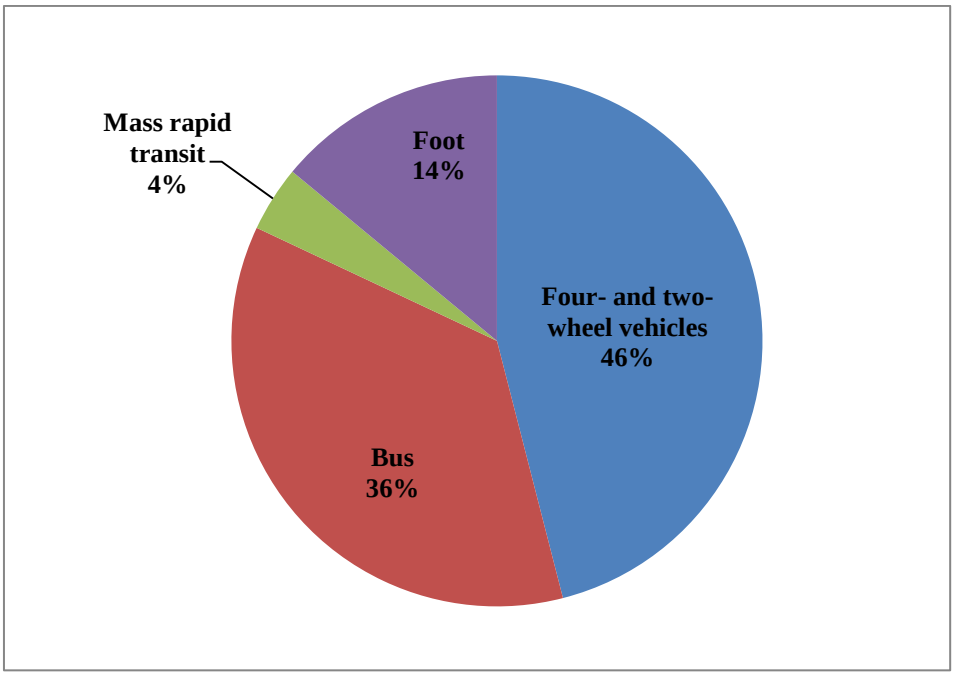



Figure 5.15 The ratio of transportation modes using for daily person trips in Bangkok
Source: Modified from ADB (2011)

Furthermore, ADB (2011) reported that although the development plan of an expanded MRT system would be almost four times of the current operating length, the expected MRT mode share was forecasted to rise to only about 15% of all daily person trips, with the share of bus trips would be falling from 36% to 31%. In contrast, the number of four- and two-wheel vehicles trended to increase every year. In 2013, total number of vehicles registered in Thailand was 34,624,406 vehicles while Bangkok was 8,216,859 vehicles. Total vehicles registered in Bangkok

represented 23.73% of the total vehicles registered in Thailand. In addition, the 10-year of number of vehicles registered (2004-2013) shows that Bangkok had growth rate in the number of vehicles registered 47.81% which was higher than the growth rate in Thailand which was 40.43% as shown in Figure 5.16.

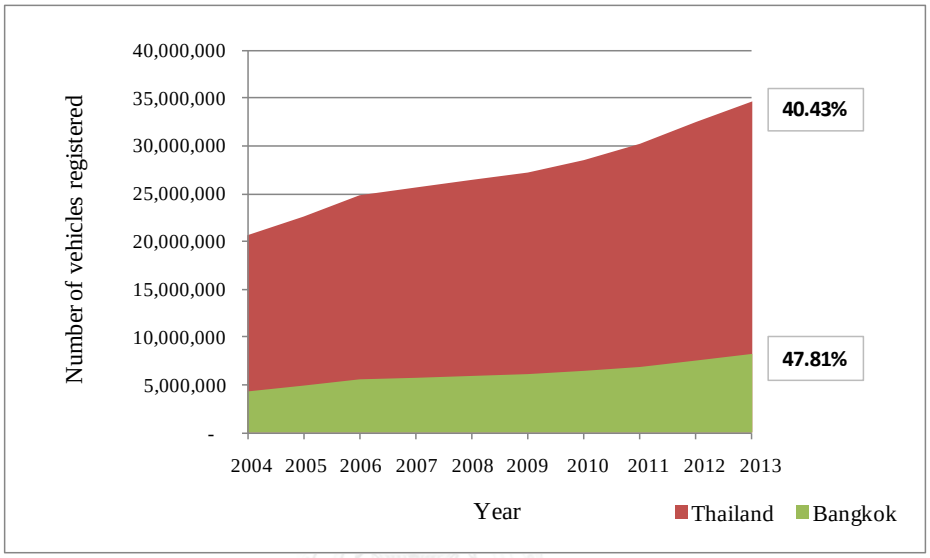
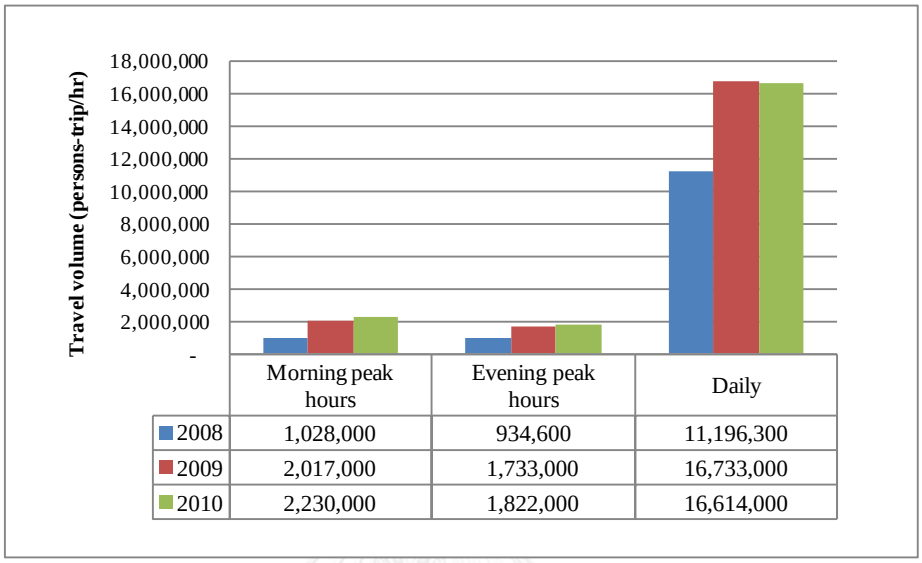



Figure 5.16 Number of vehicles registered in Thailand and Bangkok (2004-2013)
Source: Department of Land Transport (DLT), Ministry of Transport (2014)

The increasing number of population of BMR and insufficient in transport integration can lead to the increasing in number of private vehicles every year (Ranjith, 2006). Furthermore, Ranjith's study noted that another factor which motivated car dependency was the growing in numbers of the new central businesses and commercial activities in the outer bound of Bangkok. Also, the outer ring road circling of Bangkok resulted in urban sprawl to the Bangkok vicinities.

Regarding the Office of Transport and Traffic Policy and Planning (OTP), Ministry of Transport has applied the Extended Bangkok Urban Model (eBUM) in order to predict and to assess travel volume and traffic congestion on BMR road network. Figure 5.17 shows that travel volume during morning and evening peak hours during 2008-2010 has a significant increasing in average growth rate in the morning peak hours 53.38% and 45.28% in the evening peak hours. In 2010, travel

volume on BMR road network was 2,230,000 person-trip/hr in the morning peak hours and 1,822,000 persons-trip/hr in the evening peak hours.




| | Morning peak hours | Evening peak hours | Daily |
|---|---|---|---|
| 2008 | 1,028,000 | 934,600 | 11,196,300 |
| 2009 | 2,017,000 | 1,733,000 | 16,733,000 |
| 2010 | 2,230,000 | 1,822,000 | 16,614,000 |

Figure 5.17 Travel volume on BMR road network (2008-2010)
Source: National Information Center (NIC) (2014)

Figure 5.18 shows vehicle kilometer of traveled (VKT) on BMR road network during 2008-2010 which trended to increase in average growth rate in the morning peak hours 14.04% and 11.37% in the evening peak hours. In 2010, VKT on BMR road network was 13,600,900 vehicles-kilometers (veh-km) in the morning peak hours and 12,924,300 veh-km in the evening peak hours.

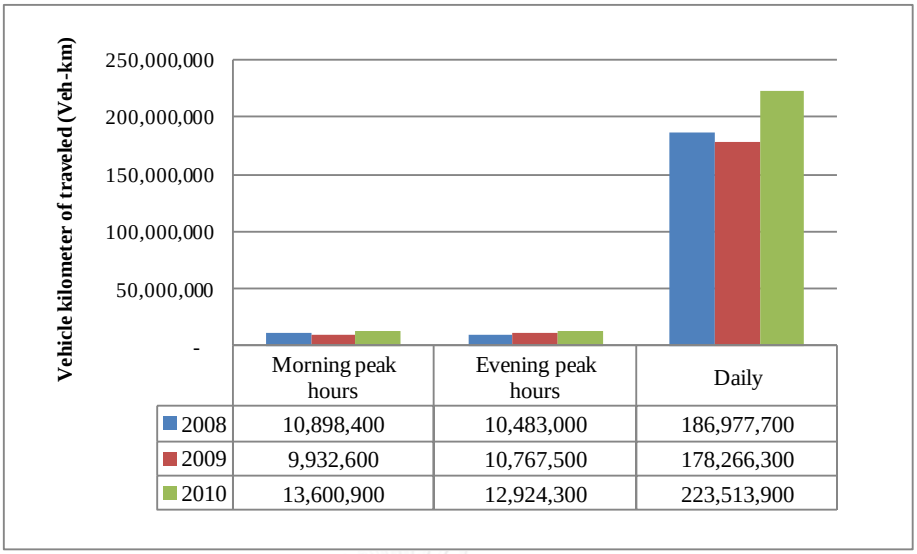



Figure 5.18 Vehicle kilometer of traveled on BMR road network (2008-2010)
Source: NIC (2014)

Figure 5.19 shows vehicle hours of traveled (VHT) on BMR road network during 2008-2010 which trended to increase in average growth rate in the morning peak hours 31.31% and 20.34% in the evening peak hours. In 2010, VHT on BMR road network was 816,600 vehicles-hrs (veh-hrs) in the morning peak hours and 637,500 veh-hrs in the evening peak hours.

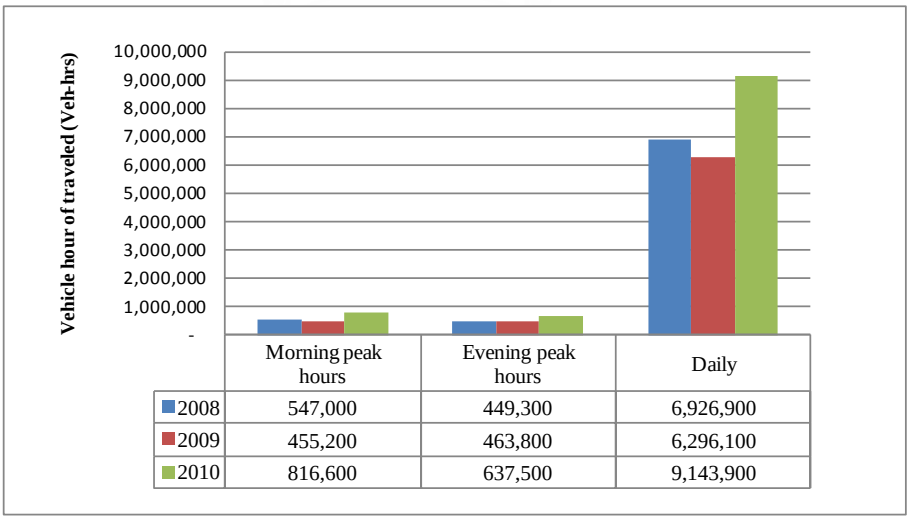
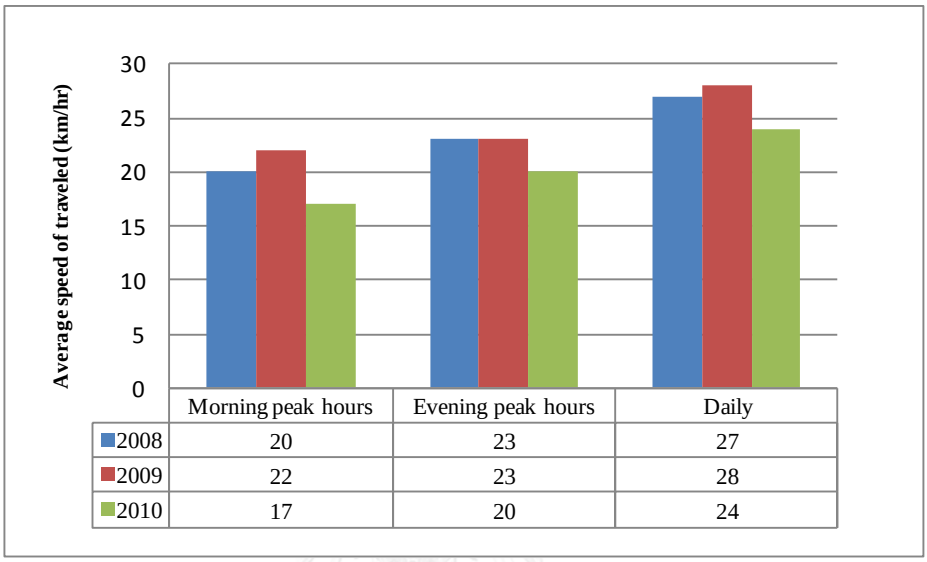



Figure 5.19 Vehicle hours of traveled on BMR road network (2008-2010)
Source: NIC (2014)

According to the number of cars travelling had been increased every year but limited in road space as a result, average speed of traveled on BMR road network during 2008-2010 had decreased from 20 to 17 km/hr in the morning peak hours and from 23 to 20 km/hr in the evening peak hours as shown in Figure 5.20.




| | Morning peak hours | Evening peak hours | Daily |
|---|---|---|---|
| 2008 | 20 | 23 | 27 |
| 2009 | 22 | 23 | 28 |
| 2010 | 17 | 20 | 24 |

Figure 5.20 Average speed of traveled on BMR road network (2008-2010)
Source: NIC (2014)

As the growing number of population in Bangkok particularly in suburban areas and the vicinities also rising in number of private vehicles every year, it resulted in severe traffic congestion which could effect to environment and socio-economic dimensions in Bangkok. The following sections were going to discuss about the current situations and the impacts of transportation system in Bangkok in terms of environment, quality of life, economic, governance and policy.

### 5.4.1 Environmental situation

The impacts of air pollution on environment and human health were gaining increasing attention by urban residents and local governments. Globally, it had been estimated that a record 3.2 million people died from air pollution in 2010, compared with 800,000 in 2000 (Lim et al, 2012 cited in UN-Habitat, 2013). The main groups of local air pollutants were nitrogen oxides ($NO_2$), sulfur dioxides ($SO_2$), carbon

monoxide (CO), volatile organic compounds (VOCs), Ozone ($O_3$) and particulate matter.

Air quality in Thailand during the last decade has been improved. The ambient levels of key air pollutants of CO, $NO_2$ and $SO_2$ in Bangkok have fallen dramatically and are now complied with Thailand National Ambient Air Quality Standards. As the phasing out of leaded gasoline, use of CNG for private car and taxis, NGV public buses and banning of two-stroke motorcycle engines have significantly drive the improvement of air quality in Bangkok (Ranjith, 2006). However, the level of particulate matter sized smaller than 10 micrograms per cubic meter ($PM_{10}$), VOCs and $O_3$ are still higher than the standard. Figure 5.21 shows trend of concentration of CO average 8 hours in Bangkok by roadside monitoring stations during 2004-2013. There was a remarkably declined in level of CO since 2007 and now it is far below the standard that the level of CO in 2013 was around 4.8-0.0 ppm. while the standard is not to excess 9.0 ppm.

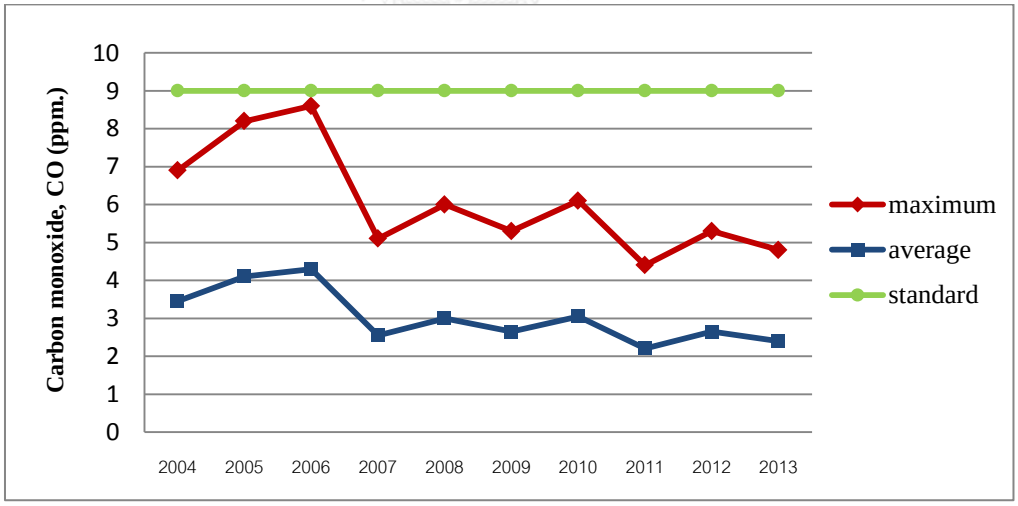



Figure 5.21 Concentration of Carbon monoxide (CO) average 8 hrs. in Bangkok
Source: Pollution Control Department (PCD) (2014)

Figure 5.22 shows trend of concentration of $NO_2$ average 1 hour in Bangkok by roadside monitoring stations during 2004-2013. The average level of $NO_2$ during the last ten year had been quite stable though there had been fluctuation in the

maximum level of $NO_2$. However, the overall of $NO_2$ level was in the standard range that the level of $NO_2$ in 2013 was around 168-0 ppb.

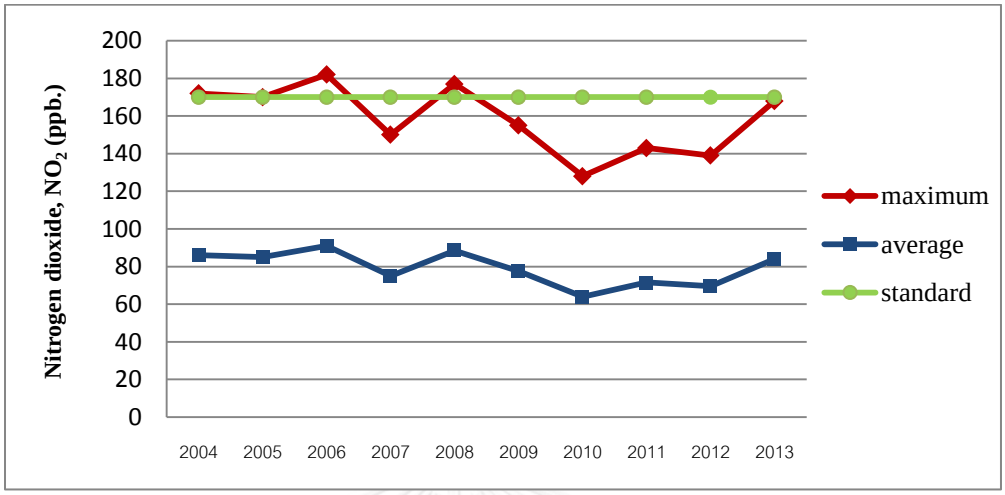



Figure 5.22 Concentration of Nitrogen dioxide ($NO_2$) average 1 hr. in Bangkok
Source: PCD (2014)

Figure 5.23 shows trend of concentration of $SO_2$ average 1 hour in Bangkok by roadside monitoring stations during 2004-2013. The average level of $SO_2$ during the last ten year had been gradually declined and now it is far below the standard that the level of $SO_2$ in 2013 was around 26-0 ppb.

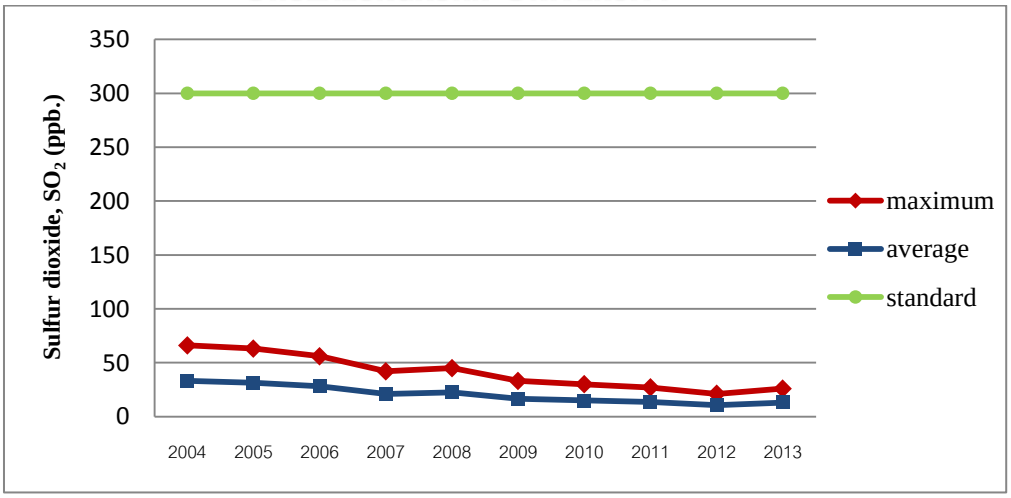



Figure 5.23 Concentration of Sulfur dioxide ($SO_2$) average 1 hr. in Bangkok
Source: PCD (2014)

In contrast, the level of $PM_{10}$ average 24 hours in Bangkok by roadside monitoring stations during 2004-2013 as shown in Figure 5.24 shows that the average level of $PM_{10}$ during the last ten year had been in the standard range but it trends to have a growth rate in the past two years. In addition the maximum level of $PM_{10}$ was higher than the standard and had a significantly increased since 2012. In 2013, the level of $PM_{10}$ was around 303-7 $\mu g/m^3$.

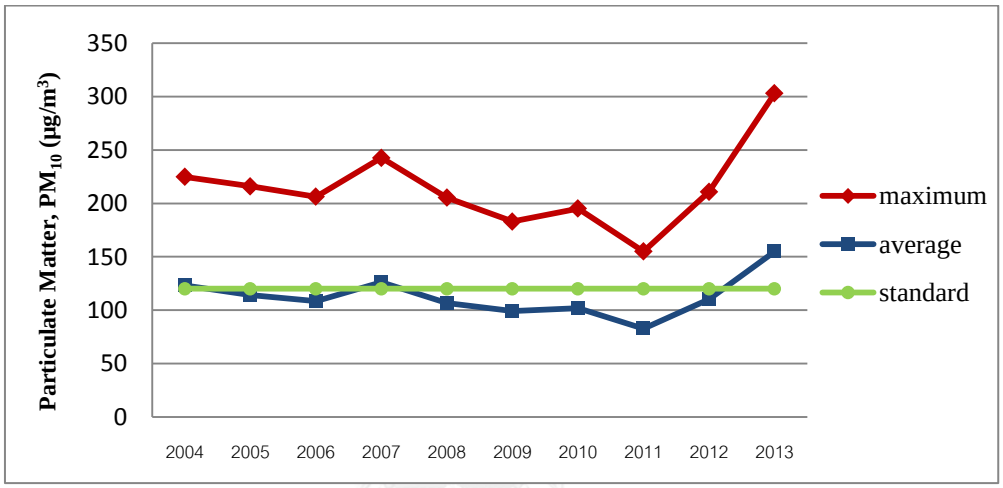



Figure 5.24 Concentration of Particulate Matter ($PM_{10}$) average 24 hrs. in Bangkok
Source: PCD (2014)

Benzene is one of the concentration trends of 4 types of VOCs which exceeded the standards over the 5-year period (2008 – 2012) - Benzene, 1,2-Dichloroethane, Chloroform and 1,3-Butadiene. Figure 5.25 shows that the Benzene levels were higher than the standard in all areas. However, in 2012 the levels declined from the previous year due to improved new vehicle and fuel standards. Ministry of Energy had regulated the use of Benzene and gasohol that meet EURO 4 standards. The composition values of Benzene and 1,3-Butadiene would be lower than the EURO 3 standards and would result in less concentrations of those chemicals released from vehicles that used EURO 4 standard fuel (PCD, 2013).

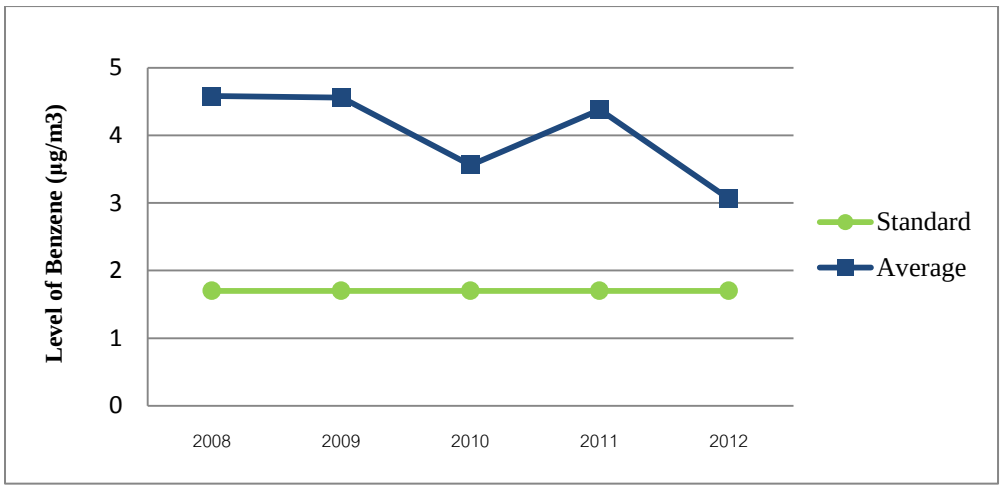



Figure 5.25 Concentration of Benzene annual average in Bangkok

Source: PCD (2014)

During the last ten year (2004-2013), the level of $O_3$ in maximum rate was higher than the standard and trended to increase while the average was in the standard range as shown in Figure 5.26. The level of $O_3$ in 2013 was around 104-0 ppb. while the standard value not exceeding 100 ppb. Ozone is a highly reactive gas formed by the reaction of Volatile Organic Compounds (VOCs) and $NO_2$ in the presence of heat and sunlight. High ozone concentrations are normally observed in the suburban areas downwind from center of Bangkok (Ranjith, 2006). However, in Ranjith's study indicated that $O_3$ problem in Bangkok is controlled by VOCs not by $NO_2$. In order to reducing the level of $O_3$, it would have to limit VOCs emissions.

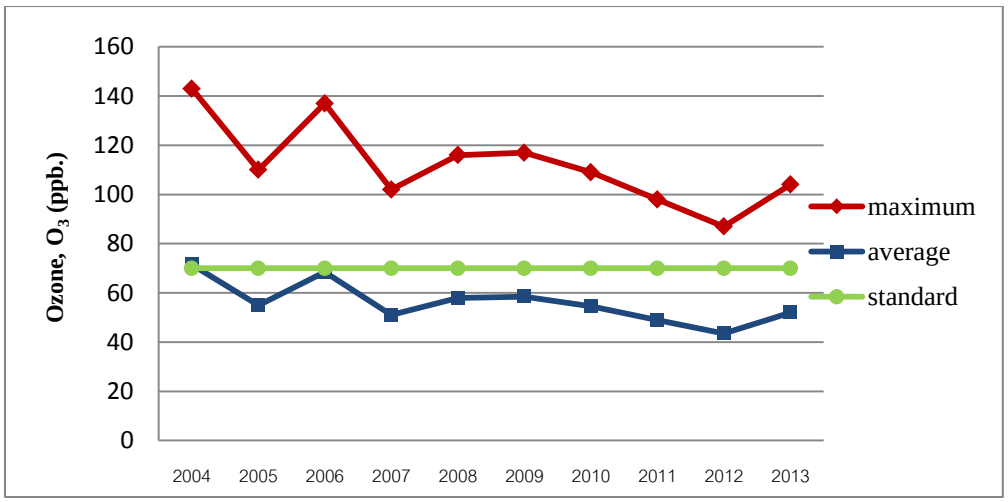



Figure 5.26 Concentration of Ozone ($O_3$) average 1 hr. in Bangkok
Source: PCD (2014)

In terms of GHG emission in Bangkok Metropolitan, transportation in Bangkok was dominated by the use of $CO_2$ producing vehicles. The Department of Energy Business, Ministry of Energy, estimates that Bangkok's transportation sector consumed approximately 28 million liters of gasoline per day, which was equivalent to approximately 21.18 million tons of $CO_2$ emissions annually (BMA, 2007). With combining energy and transportation sector were responsible for 84% of Bangkok's GHG emissions as shown in Table 5.14 and Figure 5.27.

Table 5.14 GHG emission in Bangkok by sectors

| Sector | CO2 Emission (million ton p.a.) | % |
|---|---|---|
| Electricity | 14.86 | 34 |
| Transportation | 21.18 | 50 |
| Waste/Wastewater | 1.13 | 3 |
| Other Sources | 5.58 | 13 |
| Total | 42.75 | 100 |

Source: BMA (2007)

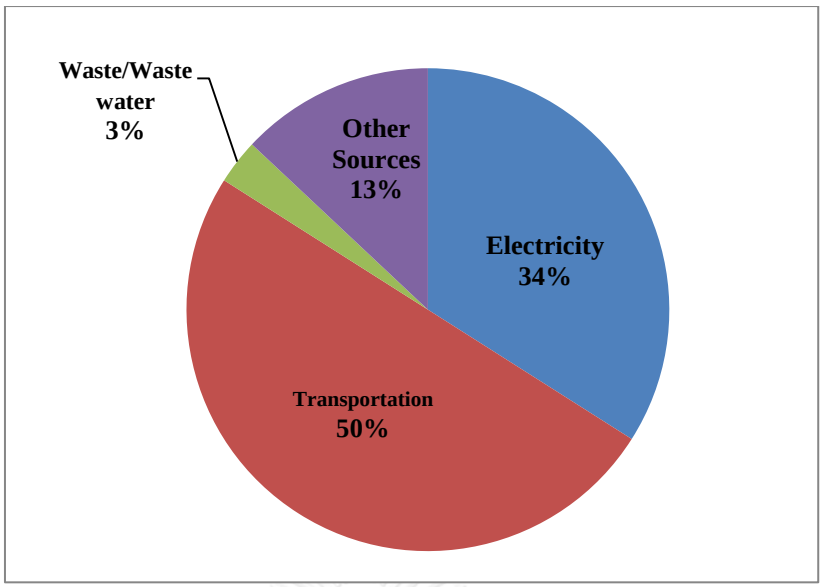



Figure 5.27 The ratio of GHG emission in Bangkok by sectors
Source: BMA (2007)

GHG emissions in Bangkok will increase significantly if the current socioeconomic conditions are maintained per business as usual (BAU) assumptions. The Bangkok Metropolitan Administration's target was to reduce future GHG emission by at least 15% through the implementation of activities under the Action Plan on Global Warming Mitigation 2007 - 2012. This plan aimed to yield total net GHG emissions in the year 2012 of 38.94 million tons $CO_2$ equivalent, approximately 20% below BAU projections and better than Bangkok Metropolitan Administration's targets prior to the development of this Action Plan as shown in Figure 5.28.

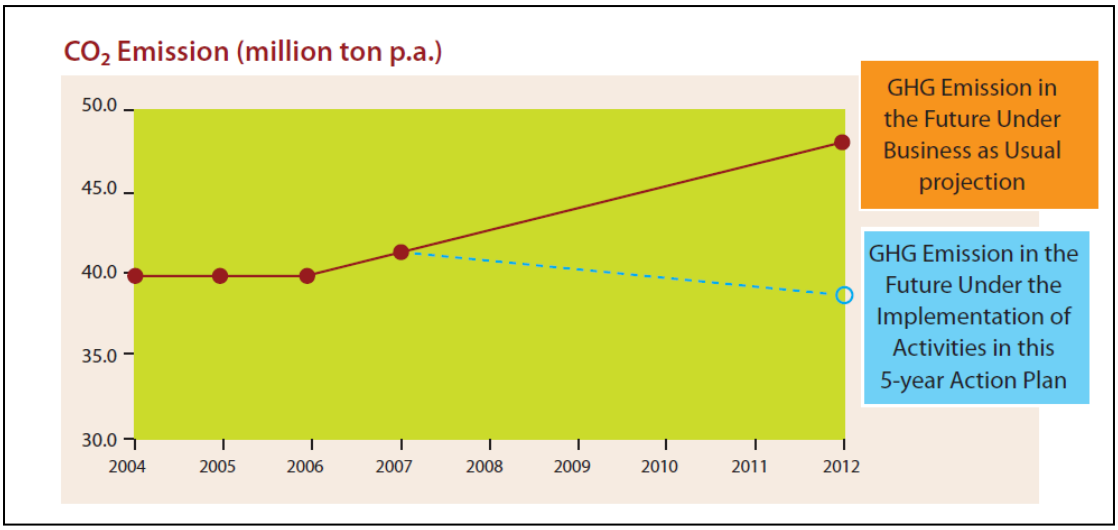



Figure 5.28 Bangkok's future $CO_2$ emission under the 5-year action plan
Source: BMA (2007)

### 5.4.2 Quality of life situation

Beside the environmental problems, health and social problems often arise from suburbanization such as reducing in quality of life by increasing road accidents and health problems. Globally, road injuries killed high at 1.24 million people per year, as well as around 20–50 million were nonfatal road injuries in 2010 (World Health Organization (WHO), 2013). Road traffic injuries were also the eighth leading cause of premature mortality, accounting for 2.5% of all global deaths (WHO, 2013). Furthermore, there has been an increasing of number of death and patients caused by polluted air. In 2010, the estimation of exposure to pollution from vehicles, in terms of particulate matter pollution (PM2.5) derived from vehicular emissions, resulted in 184,000 deaths globally. This includes 91,000 deaths from ischemic heart disease, 59,000 deaths from stroke, and an additional 34,000 deaths due to lower respiratory infections, chronic obstructive pulmonary disease, and lung cancer combined (The World Bank, 2014).

The United Nations General Assembly in March 2010 was officially announced "the Decade of Action for Road Safety 2011–2020", a global plan to guide efforts at national and local levels in order to achieve its goal to stabilize and then

reduce the forecasted level of road traffic fatalities around the world. If this ambitious target is achieved, a cumulative total of 5 million lives, 50 million serious injuries and US$ 5 trillion could be saved over the Decade as shown in Figure 5.29.

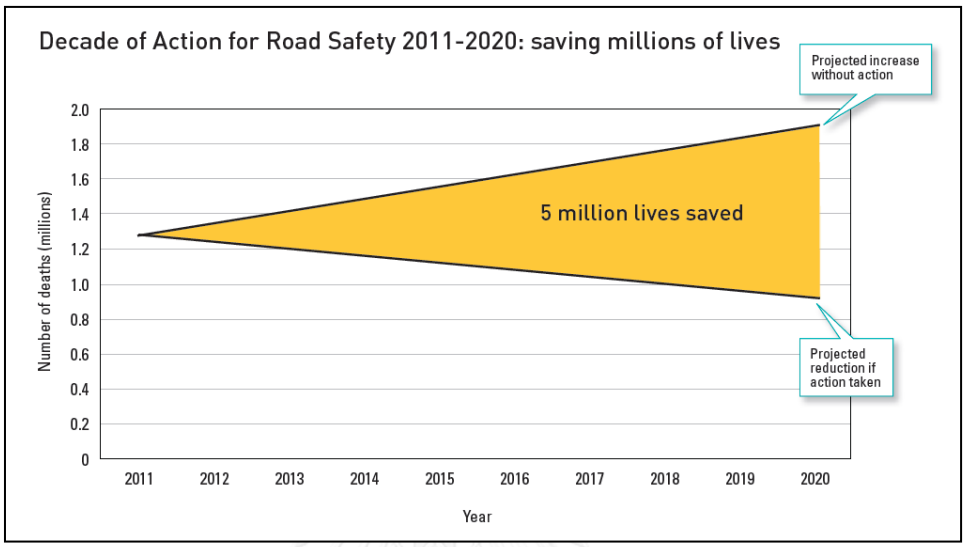



Figure 5.29 Decade of Action for Road Safety 2011-2020
Source: WHO (2011)

According to the global status report on road safety 2013, there were great differences in road traffic death rates between regions as shown in Figure 5.30 (WHO, 2013). The road traffic death rate was highest in the African Region (24.1 per 100,000 population), and lowest in the European Region (10.3 per 100,000 population). There were similar to rates in South East Asia and Western Pacific Regions (18.5 per 100,000 population).

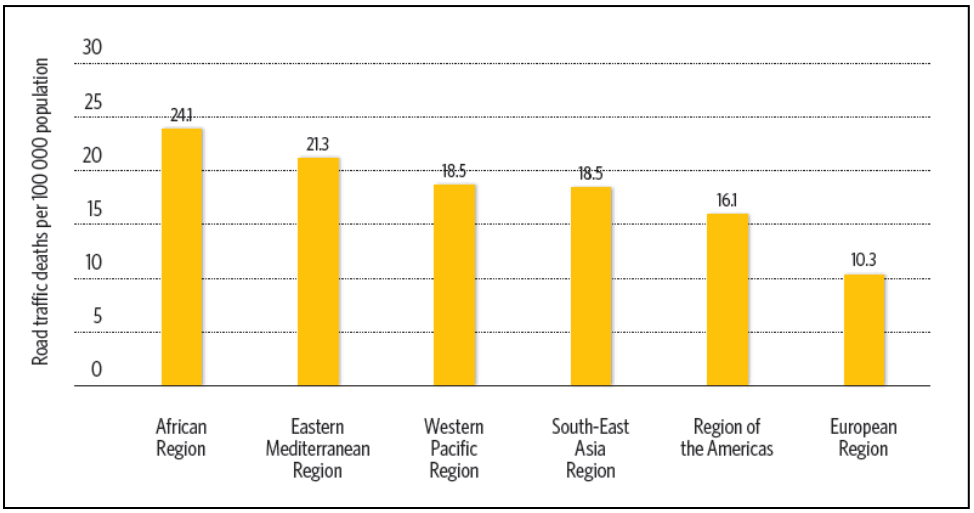



Figure 5.30 Road traffic deaths per 100,000 population, by WHO region
Source: WHO (2013)

In ASEAN, Thailand got the highest in the road traffic death rate (38.1 per 100,000 population) as shown in Figure 5.31 which was remarkably higher than the rate in South East Asia by WHO region. Figure 5.32 shows Thailand's deaths by road user category in 2010 that the first majority was riders motorized 2- or 3-wheelers (74%), the second were drivers and passengers 4-wheeledcars and light vehicles (13%) and pedestrians, cyclists and the others (13%). In addition, the Transport for Health: The Global Burden of Disease from Motorized Road Transport by The World Bank and Institute for Health Metrics and Evaluation reported that in year 2010 Thailand had 13,365 official road injury deaths, estimated 542,010 nonfatal injuries and 1,521 deaths caused by motor vehicle air pollution (The World Bank, 2014).

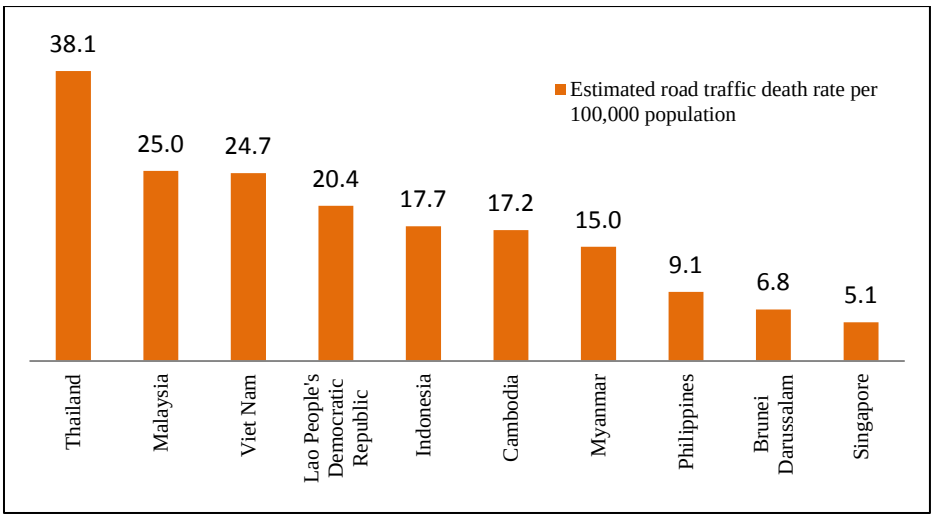



Figure 5.31 Estimated road traffic death rates per 100,000 population

Source: WHO (2013)

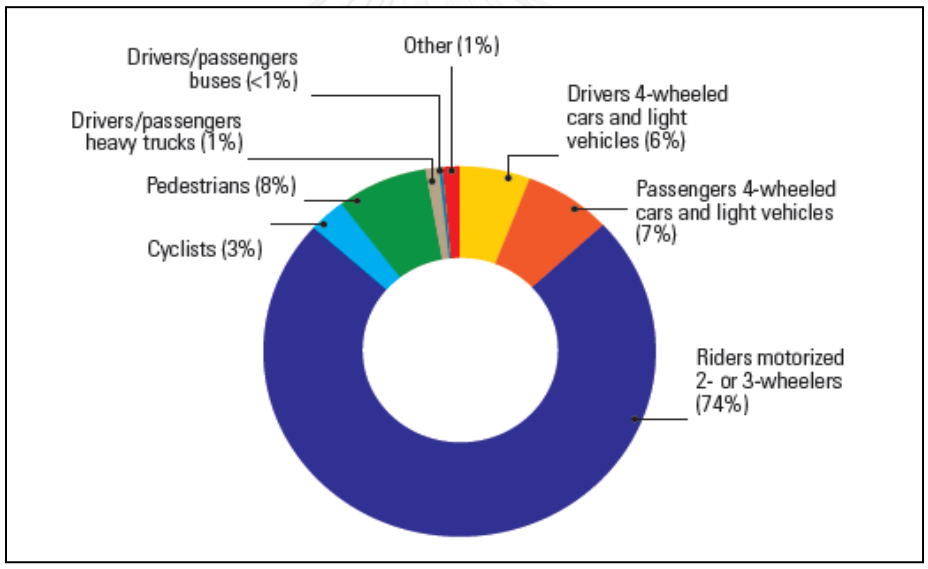



Figure 5.32 Thailand's deaths by road user category in 2010

Source: WHO (2013)

In Bangkok Metropolitan, the annual reports from Bureau of Highway Safety, Ministry of Transport reported that the traffic accident in Bangkok during 2008-2013 had been declined. The road traffic death rate had been reduced from 17.81 per 100,000 population (2008) to 5.01 per 100,000 population (2013). Similarly, the road traffic injury rate had been decreased from 362.15 per 100,000 population (2008) to 113.03 per 100,000 population (2013), details as shown in Table 5.15.

Table 5.15 Bangkok's traffic accident on Royal Thai Police (2008-2013)

| Year | Accident in 2011 | | | Rate per 100,000 population | | |
|---|---|---|---|---|---|---|
| | Accident | Death | Injury | Accident | Death | Injury |
| **2008** | 41,764 | 1,017 | 20,682 | 731.31 | 17.81 | 362.15 |
| **2009** | 42,137 | 785 | 18,389 | 738.91 | 13.77 | 322.47 |
| **2010** | 45,012 | 258 | 6,811 | 789.49 | 4.53 | 119.46 |
| **2011** | 35,947 | 360 | 7,923 | 633.44 | 6.34 | 139.62 |
| **2012** | 32,675 | 306 | 7,225 | 575.92 | 5.39 | 127.35 |
| **2013** | 29,285 | 285 | 6,427 | 515.01 | 5.01 | 113.03 |

Source: Bureau of Highway Safety, Ministry of Transport (2013)

### 5.4.3 Economic situation

Regarding the economic dimension, the increasing in motorization and severity of traffic congestion can impact to loss of sources and budgets such as human and property losses from road accident and air pollution as well as travelling cost. These could lead to reducing in quality of life and competitive performance in transport system capacity and reliability in urban freight transport due to lower driving speeds and frequent disruptions.

According to the Study of Traffic Accident Cost in Thailand by the Department of Highways, Ministry of Transport, the project aimed to identify actual traffic accident costs and the burden placed on society for use in raising the awareness of policy makers and the public, started in September 2005 and completed in August 2007. This applied human capital approach on accidental costing which consists of many items of cost all of which fall into main three categories: human costs; property damage costs and general costs of a crash. The cost items in each of these categories must be evaluated in monetary terms. The items are listed below.

Human Costs Category such as

- Loss of productivity - costs related to instructing, training, and repositioning employees in order to resume production as well as hiring costs which necessary to hire a replacement
- Loss of quality of life – costs related to loss from physical and/or mental impairments and limitations caused by a personal injury that affect ability to participate in activities that gave the person pleasure before the personal injury occurred including quality time with family, recreational activities, hobbies, enjoyable paid work, volunteer work, and other avocations
- Medical care – costs related to medical bills, medicine, and other medical-related expenses
- Emergency medical service – costs of emergency service dedicated to providing out-of-hospital acute medical care, and transport to definitive care
- Long-term care – costs associate with services which both medical and non-medical needs of people who cannot care for themselves for long periods

Property Damage Costs Category such as

- Vehicle damage - cost of vehicle repairs
- Non-vehicle damage - cost of towage and cost of time lost due to unavailability of vehicle

General Costs of Crash such as

- Insurance administration
- Police administration
- Judicial system
- Emergency rescue service
- Travel delay

The Office of the National Economic and Social Development Board (NESDB) released the official report on Thailand's social development in the fourth quarter and the year 2013, the report showed that death and number of cases had been decreasing by year. However, it should be observed in damage costs by accident which had a slightly increased from 396 million baht in 2010 to 519 million baht in 2013 as shown in Figure 5.34.

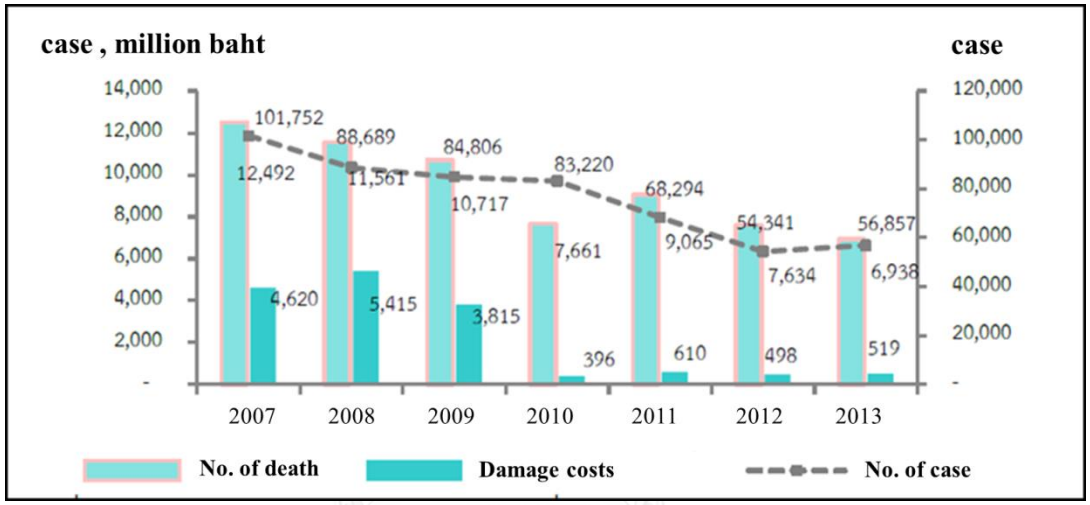



Figure 5.33 Thailand's statistics of traffic accident between 2007 and 2013
Source: NESDB (2014)



Regarding traffic accidental statistics in Bangkok, the Royal Thai Police reported that the number of accidental cases had been decreasing by year during 2007-2015. While the damage costs by accidents had increased from 19 million baht in 2007 and moved to around 112 million baht in 2012. However, the costs had decreased to 39 million baht in 2015. These statistics of traffic accident and property damage costs in Bangkok during 2007-2015 are shown in Table 5.16 and Figure 5.34.

Table 5.16 Bangkok's statistics of traffic accident between 2007 and 2015

| Year | No. of case (case) | Damage costs (Baht) |
|---|---|---|
| 2007 | 49,321 | 19,424,162 |
| 2008 | 41,764 | 30,255,404 |
| 2009 | 42,137 | 29,226,598 |
| 2010 | 45,012 | 60,018,562 |
| 2011 | 35,947 | 71,672,210 |
| 2012 | 32,675 | 112,329,425 |
| 2013 | 29,285 | 79,026,555 |
| 2014 | 26,671 | 70,370,377 |
| 2015 | 25,779 | 39,665,038 |

Source: Modified from the Royal Thai Police (2016)

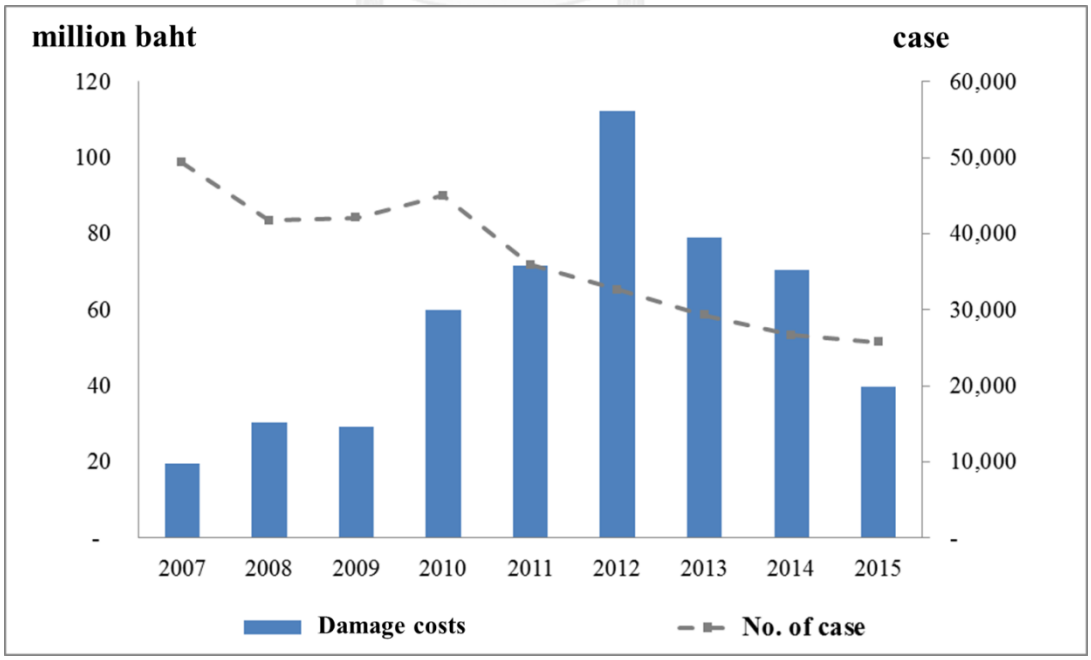



Figure 5.34 Bangkok's statistics of traffic accident between 2007 and 2015

Source: Modified from the Royal Thai Police (2016)

According to health care costs relating to air pollution, as The World Bank estimated that in 2010 Thailand would has 1,521 deaths caused by motor vehicle air pollution and Disability-Adjusted Life Years (DALYs) for total burden of air pollution and road injuries was in Rank 5 (The World Bank, 2014). WHO also presented Thailand health expenditure per capita in 2012 that there was an increasing rate for total expenditure on health ($197) and government expenditure on health ($153); whereas households out of pocket spending on health ($25) tended to be decreased as shown in Figure 5.35.

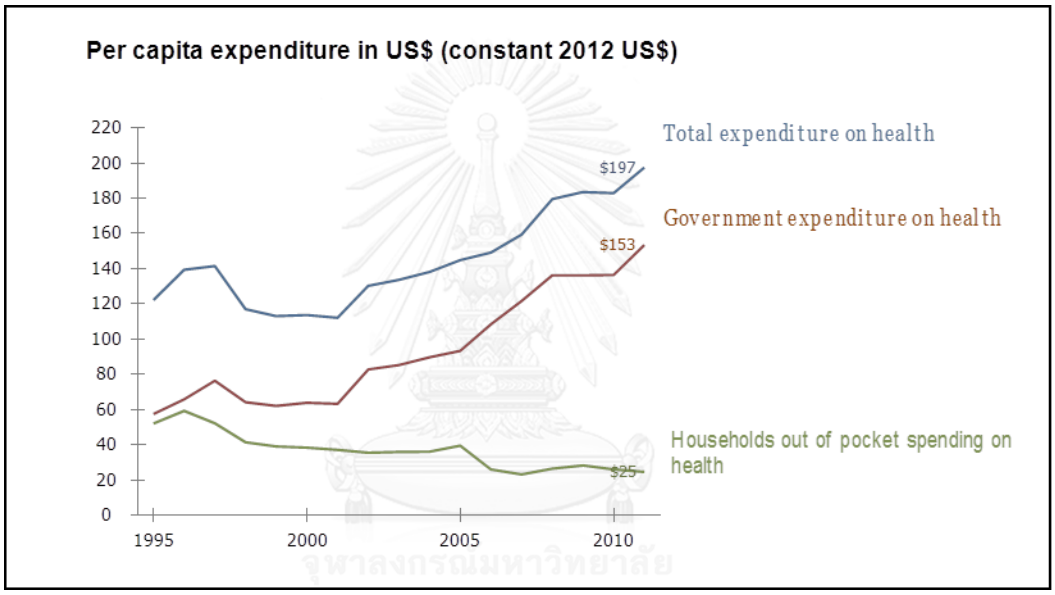



Figure 5.35 Health expenditure per capita: Thailand, 2012
Source: WHO (2014)

For travelling cost, the Statistical Thailand 2013 was provided by Ministry of Public Health reported that transport and communication expenditure was the second topmost expenditure which took around one-fifth of total average monthly expenditure per household, also it has been increasing every year as shown in Table 5.17.

Table 5.17 Thailand's average monthly expenditure per household (2009-2011)

| Type of expenditure | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|
| | Baht | % | Baht | % | Baht | % |
| Food and beverages (excludes alcoholic) | 5,202 | **32.10** | 5,465 | **32.49** | 5,660 | **32.52** |
| Alcoholic beverages | 225 | **1.39** | 240 | **1.43** | 95 | **0.55** |
| Tobacco products housing, household operation | 111 | **0.68** | 117 | **0.70** | 85 | **0.49** |
| Furniture and equipment | 3,261 | **20.12** | 3,270 | **19.44** | 3,553 | **20.42** |
| Apparel and footwear | 411 | **2.54** | 415 | **2.47** | 494 | **2.84** |
| Personal care | 469 | **2.89** | 503 | **2.99** | 572 | **3.29** |
| Medical and health care | 314 | **1.94** | 287 | **1.71** | 267 | **1.53** |
| Transport and communication | 3,373 | **20.81** | 3,704 | **22.02** | 3,836 | **22.04** |
| Education | 335 | **2.07** | 312 | **1.85** | 272 | **1.56** |
| Recreation reading and religious activity | 323 | **1.99** | 329 | **1.96** | 293 | **1.68** |
| Special ceremony expenses | 220 | **1.36** | 214 | **1.27** | 201 | **1.15** |
| Non-consumption expenditures | 1,961 | **12.10** | 1,964 | **11.68** | 2,075 | **11.92** |
| **Total monthly expenditures** | **16,205** | **100.00** | **16,820** | **100.00** | **17,403** | **100.00** |

Source: Bureau of Policy and Strategy, Ministry of Public Health (2013)



United Nations Human Settlements Programme (UN-Habitat) mentioned that economic challenges for urban transport are capacity of urban freight transport systems (congestion), lower driving speeds and frequent disruptions (reliability), distribution sprawl (space consumption) and e-commerce (home deliveries) (UN-Habitat, 2013). Furthermore, the report described that the tendency of large urban areas to have high congestion levels determine a challenge towards the reliability of freight distribution. It is particularly in the case for the disruptions and lower driving speeds due to urban congestion. This could lead urban freight distribution to inefficiency.

## 5.5 Research Results

As mentioned in the semi-structured questionnaire development for in-depth interview in Chapter 3, respondents were interviewed using questionnaire as attached in Appendix A. It is consists of two main sections which are general information of respondents and in-depth questions relevant to sustainable transportation and low carbon issues.

### 5.5.1 General Information of Respondents

Total numbers of thirty respondents were interviewed between July and December 2016. The respondents comprised of six groups as shown in Table 3.3 and named respondent groups and their organizations. Those groups are as follows:

1) Governmental agencies
2) Mass rapid transit operators
3) Consulting companies
4) International organizations
5) Non-profit organizations
6) Experts

Table 5.18 presents general information of respondents including gender, educational background, career level, and years of work experience. Almost respondents are male (70%), and the rest are female (30%). For educational background, all of them earned degree from undergraduate and graduate schools that 10% are at executive level, 33% at managerial level and 57% at operational level. In terms of their work experience, 37% have at least 15 years of work experience, 10% have experience 11-15 years, 30% have experience 6-10 years, and 23% have experience less than 5 years.

Table 5.18 General information of respondents

| Elements | Stakeholder categories | | | | | | Respondents (N=30) | |
|---|---|---|---|---|---|---|---|---|
| | Government agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Frequency | Percentage |
| **Gender** | | | | | | | | |
| Male | 6 | 5 | 4 | 3 | 2 | 1 | 21 | 70% |
| Female | 6 | - | - | 1 | - | 2 | 9 | 30% |
| **Educational background** | | | | | | | | |
| Bachelor | 1 | - | - | - | - | - | 1 | 3% |
| Master | 10 | 5 | 4 | 2 | - | 2 | 23 | 77% |
| Doctoral | 1 | - | - | 2 | 2 | 1 | 6 | 20% |
| **Career level** | | | | | | | | |
| Operational | 5 | 3 | 2 | 4 | 2 | 1 | 17 | 57% |
| Managerial | 7 | 1 | 1 | - | - | 1 | 10 | 33% |
| Executive | - | 1 | 1 | - | - | 1 | 3 | 10% |
| **Years of work experience** | | | | | | | | |
| 1-5 years | 2 | 1 | 2 | 1 | - | 1 | 7 | 23% |
| 6-10 years | 3 | 2 | 1 | 2 | - | 1 | 9 | 30% |
| 11-15 years | - | - | 1 | 1 | 1 | - | 3 | 10% |
| more than 15 years | 7 | 2 | - | - | 1 | 1 | 11 | 37% |

Roberts (2011) reported that the policy-making process is made up of a complex of different actors or stakeholders who can affect or is affected by an organization, strategy or project in which they can be internal or external influencers as shown in Figure 5.36. Those actors or stakeholders can be at senior or junior levels. These research results are in line with Roberts' study. Additionally, the study found that executive level also plays an important role. Roberts classified key actors or stakeholders into three influent tiers composed of as follows:

1) Policy Center such as minister, officials, legislature, and special advisers
2) Primary Influencers such as other departments, other ministers, and advisory committees
3) Secondary Influencers such as consultants, academia, international bodies, business organizations, and NGOs

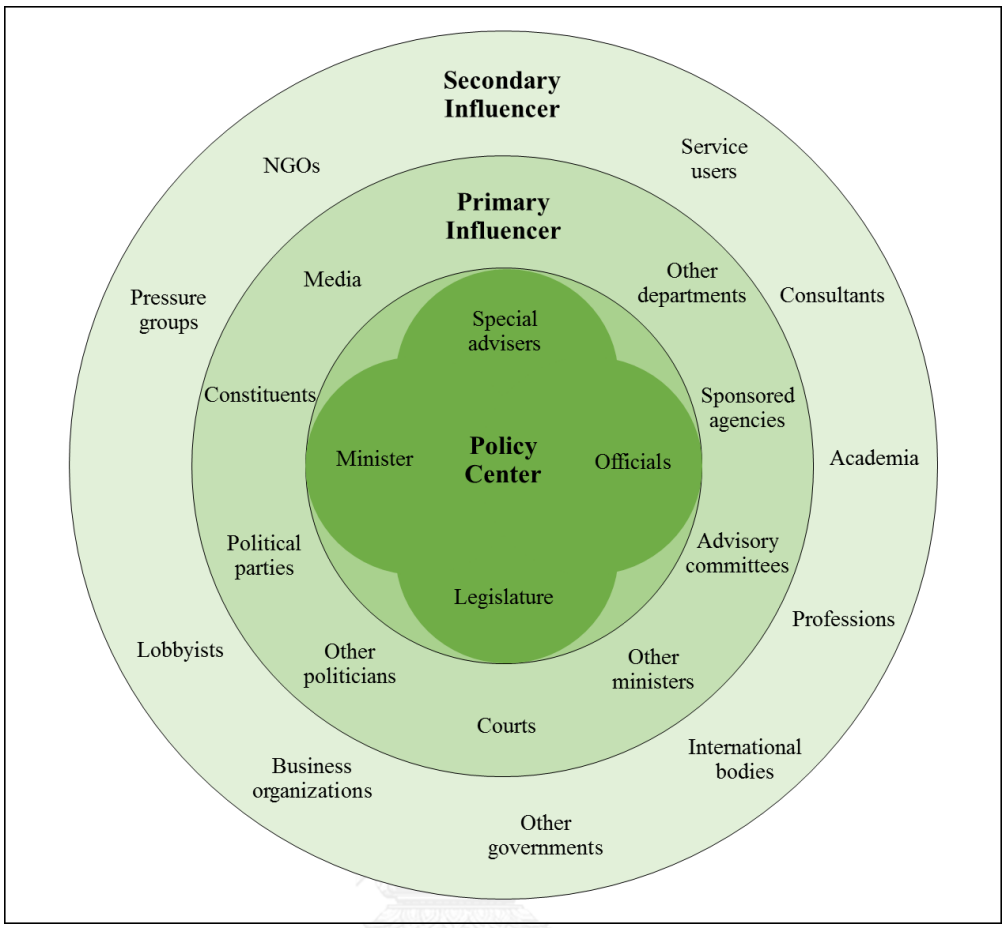



Figure 5.36 Policy-making tiers of influence

Source: Roberts (2011)



Based on Roberts (2011), six stakeholder groups of the study can be identified as follows:

1) Policy Center compose of governmental agencies namely,

- Office of Natural Resources and Environmental Policy and Planning (ONEP)
- Office of Transport and Traffic Policy and Planning (OTP)
- Mass Rapid Transit Authority of Thailand (MRTA)
- Thailand Greenhouse Gas Management Organization (TGO)
- Traffic and Transport Department of, Bangkok Metropolitan Administration
- Environmental Department, Bangkok Metropolitan Administration
- Pollution Control Department (PCD)

2) Primary Influencers compose of governmental agencies and MRT operator namely,

- Office of Passenger Transport, Department of Land Transport
- Bangkok Mass Transit Authority (BMTA)
- City Planning Department, Bangkok Metropolitan Administration
- Health Impact Assessment Division, Department of Health
- Thailand Railway Technology Development Institute Project of National Science and Technology Development Agency (NSTDA)
- The Krungthep Thanakom Co., Ltd. (State enterprise)

3) Secondary Influencers compose of MRT operator, consulting companies, international organizations, non-profit organizations, and experts namely,

- Bangkok Mass Transit System Public Company Limited (BTSC)
- TEAM Consulting Engineering and Management Co., Ltd.
- Asian Engineering Consultants Corp., Ltd.
- MAA Consultants Co., Ltd.
- Panya Consultants Co., Ltd.
- United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
- German International Cooperation (GIZ)
- Japan International Cooperation Agency (JICA)
- Thailand Environment Institute Foundation
- Green World Foundation
- Foundation for Environmental Education for Sustainable Development (Thailand)
- Chulalongkorn University
- King Mongkut's University of Technology Thonburi

### 5.5.2 Causes and Consequences of Current Situation of Transportation

In terms of the current situation of transportation in the study area, the study found that all respondents from six stakeholder groups agreed that the current traffic congestion is in crisis indicating as the following issues:

1) Number of vehicles increasing

2) Longer time use in travelling

3) Congestion being worse during peak hours in the morning and the evening.

This is consistent with the OTP's reports (OTP, 2014) as mentioned in section 5.4.

Regarding causes of high traffic congestion, the study found that 100% of four respondent groups, namely governmental agencies, MRT operators, experts, and non-profit organizations agreed that government supported policies on the first-car tax scheme and subsidized fuel price are one of major causes of high traffic congestion in Bangkok, while 75% of consulting companies and 50% of international organizations do agree with that both of policies are the main causes of the traffic congestion in the study area. Respondents further indicated that these policies encourage people to buy and use more private cars resulting in increasing more number of vehicles usage.

The second major cause of high traffic congestion is inefficient current public transportation system. 79% of respondents stated that the inefficiency means incompletion of the MRT network and the feeder systems. They also mentioned low quality of bus transport system such as insufficient number of buses, routes, and resource management. This makes people unable to shift to use public transport and finally leads to increasing number of private car.

In addition, ineffective and uncontrollable city planning is mentioned as the third major cause of traffic congestion by almost 61% of respondents. An ineffective enforcement of existing laws and regulations in land-use planning still be exist. They further noted that city plan and road networks are not relevant. Based on the studies of Baeumler et al. (2012) and Wang et al. (2012), low carbon cities need compact urban form and smart spatial development to be linked to public transportation networks in

order to good management for rapid expansion of cities. Therefore, the study area needs such actions in policy setting and integrating in city planning and urban transportation network development.

Furthermore, 59% of respondents indicated that the government policies previously focused on development in road transportation networks more than public transportation systems. They viewed that ineffective and discontinuity in public transportation development is main causes of traffic congestion. Based on Thailand national and local policies as mentioned in Chapter 4, these policies aim to promote public transport system towards sustainable transport and low carbon city, while the research results show that public transport system development still has lack of continuity in implementation. Therefore, the study area needs more effective and continuity in the policy implementation.

Additionally, 54% of respondents viewed that inadequate non-motorized transport (NMT) is another traffic congestion cause in the study area. They suggested that NMT needs to be set up in terms of walking and cycling to be more attractive travel choices in order to shift people's travel patterns and reduce car dependency.

The study further found that almost half of respondents mentioned personal attitude in using their own car due to travel convenience as one of traffic congestion causes. Inefficient traffic management and control is up to 47% of their opinions on causes of traffic congestion. Finally, 26% of them viewed that lack of discipline and traffic information is one of these causes as well.

The above results are shown in Table 5.19 and Figure 5.37.

Table 5.19 Causes of high traffic congestion in Bangkok

| Causes of high traffic congestion in Bangkok | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Government supported policies | 100% | 100% | 75% | 50% | 100% | 100% | 88% |
| Inefficiency in public transport system | 67% | 60% | 75% | 75% | 100% | 100% | 79% |
| Ineffective and uncontrollable city planning | 67% | 60% | 25% | 50% | 100% | 67% | 61% |
| Ineffective and discontinuity in public transport system development | 25% | 60% | 25% | 75% | 100% | 67% | 59% |
| Inadequate non-motorized transport | 17% | 40% | 50% | 50% | 100% | 67% | 54% |
| Personal attitude in using their own car | 25% | 60% | 25% | 75% | 50% | 67% | 50% |
| Inefficiency traffic management and control | 25% | 40% | 25% | 25% | 100% | 67% | 47% |
| Lack of displine and traffic information | 58% | n/a | n/a | 50% | 50% | n/a | 26% |

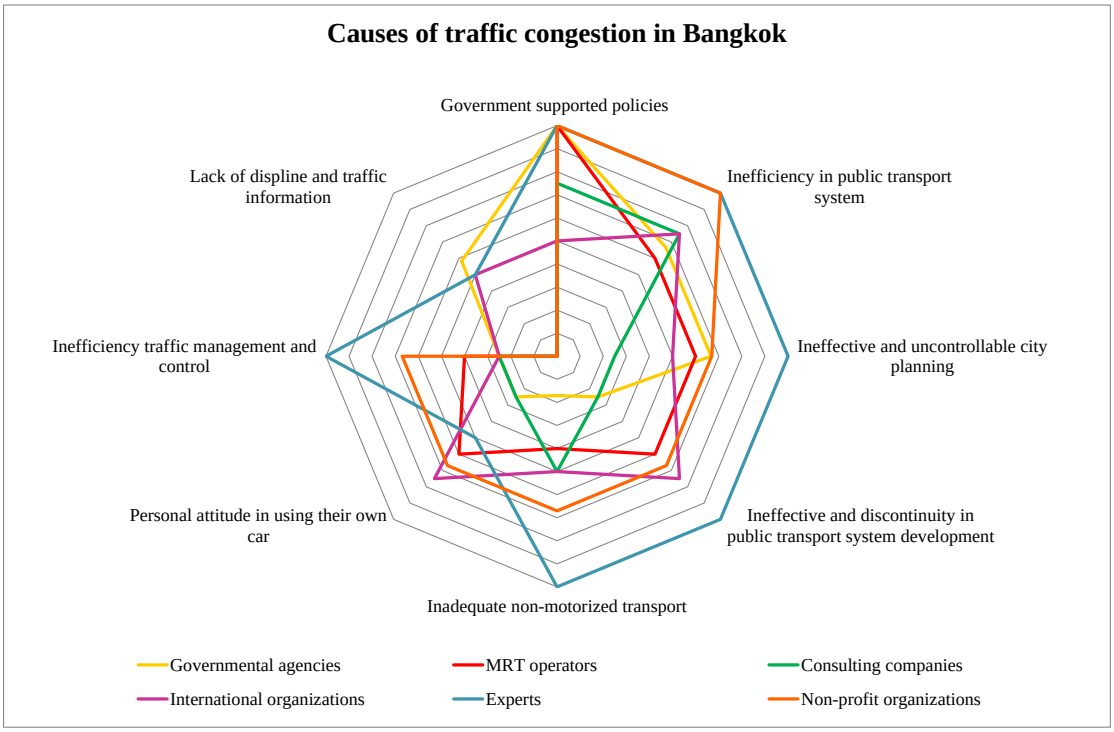



Figure 5.37 Causes of high traffic congestion in Bangkok

Figure 5.37 shows that the government policies are the most important causes of traffic congestion. This is highly agreed by five respondent groups namely governmental agencies, MRT operators, consulting companies, experts, and non-profit organization. In addition, the experts strongly mentioned that the additional main causes of traffic congestion are as follows:

1) Inefficient current public transportation system

2) Ineffective and uncontrollable city planning

3) Ineffective and discontinuity in public transportation development

4) Inadequate non-motorized transport

5) Inefficient traffic management and control

In terms of consequences of high traffic congestion in the study area, they can be classified into personal impact and public impact. For personal impact, travel time consuming and inconvenience in travelling are the most consequent impacts which 96% of respondents mentioned. They revealed that people spend longer time in travel, especially during peak hours that would make them less doing their personal or business activities. Furthermore, they stated that people who travel by public transportation systems need to take or shift to more than one transportation mode in order to go to their destination, particularly during peak hours, resulting in inconvenience in their travelling.

In addition, 86% of respondents stated that travelling expenses and health problems are the second consequences of personal impact from traffic congestion. Those expenses include fuel cost and transportation fares. In terms of health problems, they mentioned that people would have more physical health problems such as respiratory problems and allergy due to air pollution. 85% of respondents viewed that the congestion could lead them getting more stress i.e. impatience, nervousness, resentment, and tension.

Additionally, 89% of respondents mentioned that high traffic congestion leads to increasing of air pollution and GHG emissions. They recognized that lots of private car uses emit GHG and reduced ambient air quality in Bangkok. The BMA Action Plan on Global Warming Mitigation 2007-2012 (BMA, 2007) reported that 50% of Bangkok's GHG emissions resulting from transportation sector. The statistical data of air pollution in Bangkok monitored by the Pollution Control Department (PCD) presented the concentration of particulate matter ($PM_{10}$) was found to be exceeding the standard, especially at roadside areas, at average 24 hours measured between 7 and 303 $\mu g/m^3$ in the year 2013 (PCD, 2014).

Up to 47% of respondents noted that economic loss such as oil imports and transportation cost is one of the consequent effects. While 35% of them mentioned on other environmental impacts such as noise pollution and over fuel consumption.

Table 5.20 and Figure 5.38 show consequent effects of high traffic congestion in Bangkok.

Table 5.20 Consequent effects of high traffic congestion in Bangkok

| **Consequent effects of high traffic congestion in Bangkok** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| **Personal impact** | | | | | | | |
| Time consuming | 75% | 100% | 100% | 100% | 100% | 100% | 96% |
| Inconvenience in travelling | 75% | 100% | 100% | 100% | 100% | 100% | 96% |
| Travelling expenses | 67% | 100% | 50% | 100% | 100% | 100% | 86% |
| Physical health problem | 67% | 100% | 50% | 100% | 100% | 100% | 86% |
| Mental health problem e.g. stress | 58% | 100% | 50% | 100% | 100% | 100% | 85% |
| **Public impact** | | | | | | | |
| Air pollution and GHG emissions | 83% | 100% | 100% | 100% | 50% | 100% | 89% |
| Economic loss | 17% | 60% | 50% | 75% | 50% | 33% | 47% |
| Other environmental impact | 25% | 100% | 50% | n/a | n/a | 33% | 35% |

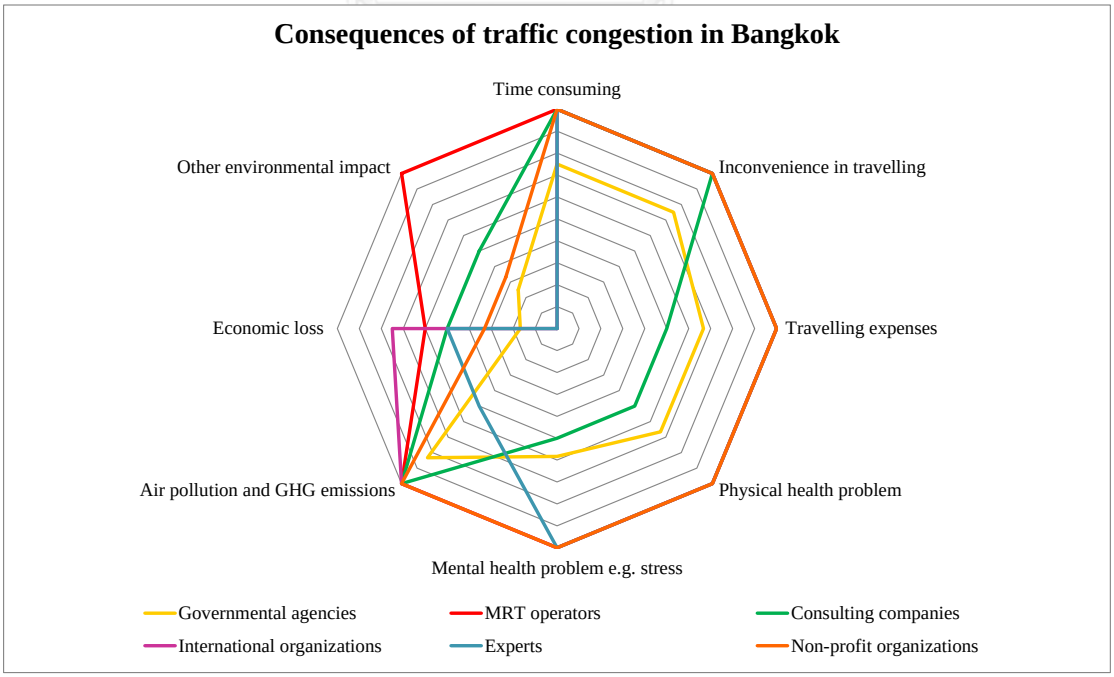



Figure 5.38 Consequent effects of high traffic congestion in Bangkok

In Figure 5.38, the results obviously shown that time consuming and inconvenience in travelling are two major consequent effects. This is highly agreed by five respondent groups namely MRT operators, consulting companies, international organizations, experts, and non-profit organization. While the governmental agencies did not give a significant opinion on time consuming and inconvenience in travelling as the main consequent effects of traffic congestion. In addition, air pollution and GHG emissions was highly mentioned as another major consequent effects by all of four respondent groups excluding governmental agencies and experts. Moreover, travelling expenses, physical health and mental health problems were also notably indicated by most of respondent groups. The other two consequences are economic loss and other environmental impacts getting less mentioned.

### 5.5.3 Transport Policy Implementation and Driving Factors in MRT System Development

In terms of current policies and plans implementations by governmental agencies management on traffic congestion in the study area, the study found that 99% of respondents highly agreed that lack of concrete implementation plan is one of major barriers in implementing the transportation policy. They stated that although transportation policy and plan have been implemented, the traffic congestion remains in crisis such as slower traffic flows and longer travel times.

In addition, 81% of respondents viewed that inconsistent plan of urban transportation system and city development is also one of the barriers. This reflects that the governmental agencies need to pay seriously attention to implementing plan effectively as well as to setting a compatible plan in urban transportation and city development.

Furthermore, 70% of respondents mentioned that shifting political priorities has influence on policy processes. They noted that unpredictably changing in politics could result in different policy priority setting and discontinuity in transport policy implementation. Tilburg et al. (2011) reported that political processes could lead some

plan or program abandoned as a result of shifting political priorities. They suggested that capacity building within government should be institutionalized in order to make less vulnerable to political or personnel changes. The current transportation plans in the study area need such action to be conducted.

Regarding transportation plan, almost 62% of respondents stated that lack of inclusive of transportation modes is another major barrier in implementing the transportation policy. They viewed that each of current implementing plans is isolated. They further suggested that the policy makers need to integrate all transportation system networks into the urban transportation master plan implemented. Finally, up to 48% of their opinion mentioned that insufficient budget allocation for transportation plans is one of the major barriers.

Table 5.21 and Figure 5.39 show barriers to implementation of the current transportation plans in Bangkok.

Table 5.21 Barriers to implementation of the current transportation plans in Bangkok

| **Barriers to implementation of the current transportation plans** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Lack of concrete implementation plan | 92% | 100% | 100% | 100% | 100% | 100% | 99% |
| Inconsistent plan of urban transportation and city development | 92% | 60% | 100% | 100% | 100% | 33% | 81% |
| Inconsistency in political process | 58% | 60% | 50% | 50% | 100% | 100% | 70% |
| Lack of inclusive of transportation modes | 25% | 80% | 50% | 100% | 50% | 67% | 62% |
| Insufficiency in budget allocation | 58% | 60% | 50% | 50% | n/a | 67% | 48% |

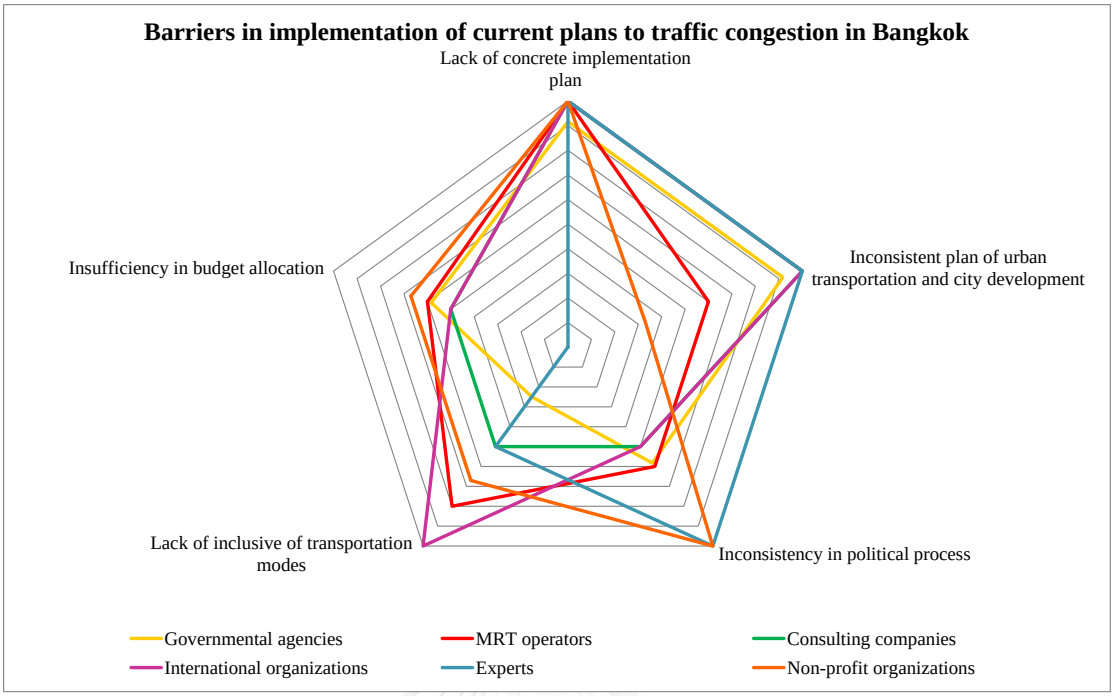



Figure 5.39 Barriers to implementation of the current transportation plans in Bangkok

Figure 5.39 presents that all respondent groups highly agreed on the major barrier is the lack of concrete implementation plan. The inconsistent plan of urban transportation system and city development is highly mentioned by four respondent groups including governmental agencies, consulting companies, international organizations, and experts. In addition, experts and non-profit organizations viewed that inconsistency in political process is another major barrier while international organizations mentioned the lack of inclusive of transportation modes also a barrier.

For driving factors of the MRT system development, 98% of respondents highly mentioned that traffic congestion is one of the major factors to driving MRT system development in Bangkok. They indicated that one of MRT initiatives system is to reduce traffic congestion as setting in the national and local policies and transportation plans. The respondents expected that the MRT system could alleviate the current traffic congestion in the study area.

83% of respondents stated that financial support and project budgets are one of the major driving factors. In the document report “Thailand Transport Development Strategy - 20 years plan” proposed by the OTP (2017) that mentioned the role of public–private partnership (PPP) in financial supports. This issue is in line with the study of Tilburg et al. (2011) that budget allocation process and the sources of finance are required in long term plan and development pathway. Therefore, this factor is essential requirement to ensure institutional capacity in such long-term projects.

81% of respondents viewed that readiness of experts, human resources and technology is a requirement factor for the MRT system development because such development is still limited of capital supported i.e. human skill development and technical knowledge. Based on Thailand Transport Development Strategy - 20 years plan (OTP, 2017), the plan proposed a human resource development plan and an establishment of institution in rail transport. These could sustainably support the MRT system development. Therefore, readiness is a prerequisite of institutional and technical capacity in the MRT system development plan.

79% of respondents mentioned that the MRT system could improve air quality in the study area. They viewed that the increasing of number private cars and high traffic congestion lead to increasing in air pollution as well as GHG emissions. They stated that the MRT system could reduce number of vehicle uses and traffic congestion finally.

76% of respondents indicated that the MRT system could make a transit-oriented development (TOD) relevant to land use, real estate development, and economic development along the MRT lines. They stated that TOD could increase mixed-use community centers around the MRT stations.

Based on the MRT system improving air quality, 71% of respondents linked this issue in improve health problem. They viewed that people would get better physical health as well as get less stress when air pollution is reduced and traffic

congestion is moderated. Finally, up to 60% of respondents mentioned that the MRT system can improve in road safety.

The above results are shown in Table 5.22 and Figure 5.40.

Table 5.22 Driving factors of the MRT system development in Bangkok

| **Driving factors of the MRT system development in Bangkok** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Traffic congestion | 98% | 100% | 100% | 100% | 90% | 100% | 98% |
| Finance support and Budgeting | 82% | 68% | 80% | 100% | 80% | 87% | 83% |
| Experts, human resource and technology | 80% | 60% | 80% | 100% | 80% | 87% | 81% |
| Air pollution | 83% | 72% | 80% | 70% | 80% | 87% | 79% |
| Transit-oriented development | 82% | 80% | 80% | 85% | 70% | 60% | 76% |
| Health problem | 68% | 72% | 75% | 70% | 80% | 60% | 71% |
| Road safety | 67% | 52% | 65% | 55% | 50% | 73% | 60% |

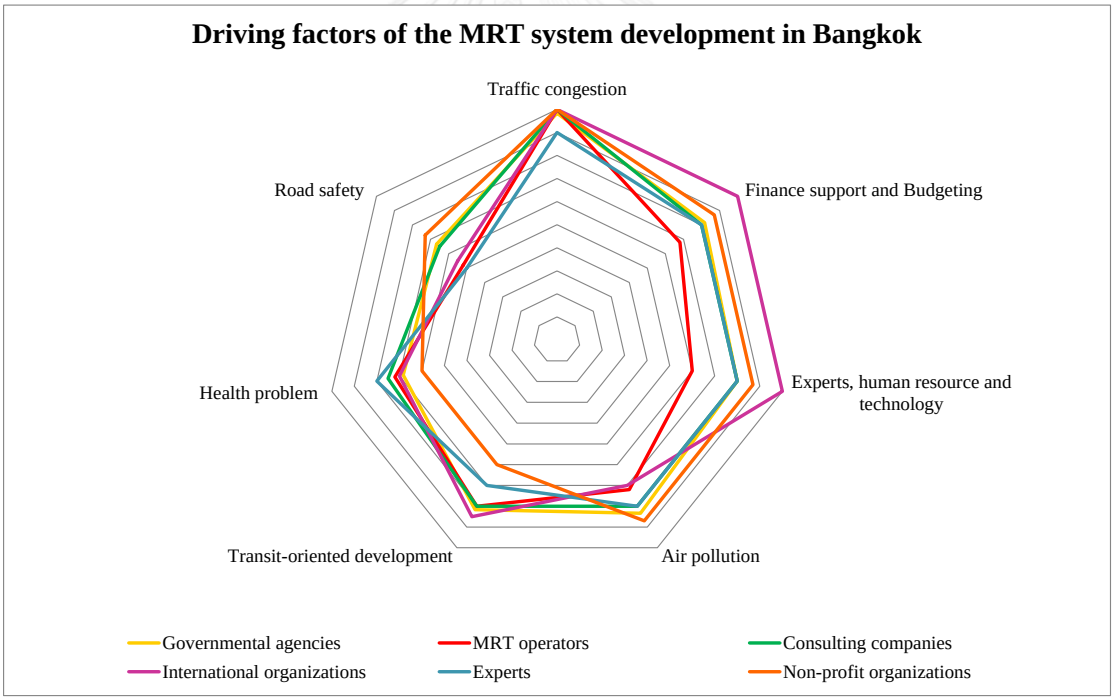



Figure 5.40 Driving factors of the MRT system development in Bangkok

Figure 5.40 shows that traffic congestion is the major driving factor for the MRT system development. This is highly agreed by all respondent groups. While international organizations viewed that financial support and budgets and readiness of

experts, human resources and technology are also the major driving factors for the MRT system development.

### 5.5.4 Sustainable Transport and the MRT System in Environmental Dimension

Regarding environmental impacts of the MRT system, all respondent groups agreed that the MRT system is a sustainable transport approach in mitigating GHG emissions and reducing air pollution from traffic congestion. They viewed that the MRT system is one of effective public transport systems in reducing the number of private car uses and the fuel consumption. These lead to $CO_2$ mitigation and air quality improvement. Based on the studies of Kennedy et al. (2005), Zhao (2010), and Nakamura and Hayashi (2012), they reported that the MRT system plays the key role in $CO_2$ mitigation through sustainable transport toward sustainable city. Baeumler et al. (2012) reported that low carbon vehicles and public transport-oriented system can reduce congestion, air pollution, and GHG emission in the cities.

In terms of people awareness on health and air pollution, only 35% of respondents noted that people has less concern in these issues. They viewed that health problems such as respiratory diseases and lung cancer are hardly identify as a direct consequent impact from air pollution.

Table 5.23 presents the environmental impacts of MRT system in Bangkok as mentioned above.

Table 5.23 The environmental impacts of MRT system

| **The environmental impacts of MRT system** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Mitigating GHG emissions and air pollution from traffic congestion | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| People awareness on health and air pollution issues | 25% | n/a | n/a | 50% | 100% | 33% | 35% |

Based on the Bangkok development plan (BMA, 2007), transportation sector emits high GHG. To developing Bangkok towards low carbon city, promoting public transport is one of the main strategic plans. The study found that all respondents considered the MRT system as the key public transport system in Bangkok to mitigate GHG emissions and to be a low carbon city.

However, 65% of respondents mentioned in achieving low carbon city development, the transportation plan could not rely on the MRT system only. It requires an inclusive transportation plan. They suggested that the MRT system could mainly support such plan and promote multi-modal transport in Bangkok. These above opinions are shown in Table 5.24.

Table 5.24 Roles of the MRT system in Bangkok towards a low carbon city

| **Roles of the MRT system in Bangkok towards a low carbon city** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Major transportation system in GHG mitigation and low carbon city development | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Support inclusive transportation plan and multi-modal transport | 50% | 40% | 25% | 75% | 100% | 100% | 65% |

### 5.5.5 Sustainable Transport and the MRT System in Social Dimension

For social impacts of the MRT system, 99% of respondents stated that the positive impact of the MRT system is reducing travelling time and improving time management effectiveness. 79% of them viewed that the MRT system could increase transportation networks in urban areas making more travelling convenience.

Additionally, 79% of respondents mentioned mental health reduction as the positive impact of the MRT system. 66% of them noted that physical health improvement is the positive impact of the MRT system as well. Baeumler et al. (2012) reported that public transport-oriented system could improve health conditions.

Up to 56% of respondents indicated that another impacts of the MRT system is changing urban land use relating to residential and business areas. In such effect, they mentioned that the MRT system would positively effect on increasing more

condominiums, office buildings as well as shopping centers along the MRT lines. This positive impact is not only a social impact but also economic development impact of the MRT system. Additionally, it results in change of mobility pattern that people might move to live in urban areas where nearby their working places and leisure activities. Based on the research study of the Partnership for Sustainable Urban Transport in Asia (PSUTA) in 2007, changes of urban land use and people mobility without the consistency with urban transport systems could lead to unsustainable transport and unsustainable mobility pattern.

Road safety increasing is positive impact of the MRT system which mentioned by 48% of respondents. They stated that the MRT system could reduce road traffic accident rate and road traffic death rate in the study area. However, they viewed that the MRT system is only an indirect impact to increase road safety. They indicated that other causes have more direct affect on this issue i.e. vehicle speed, drink and drive, traffic discipline, and regulation enforcement. Finally, only 21% of respondents noted that the MRT system would increase accessibility to public services. Such social impacts of the MRT system mentioned above are shown in Table 5.25 and Figure 5.41.

Table 5.25 The social impacts of the MRT system

| **The social impacts of the MRT system** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Reducing travelling time and improving time management effectiveness | 92% | 100% | 100% | 100% | 100% | 100% | 99% |
| Increasing transportation networks and travelling convenience | 67% | 60% | 75% | 75% | 100% | 100% | 79% |
| Mental health reduction | 67% | 60% | 50% | 100% | 100% | 100% | 79% |
| Physical health improvement | 58% | 60% | 25% | 100% | 50% | 100% | 66% |
| Changes of urban land use and mobility patterns | 75% | 100% | 25% | 50% | 50% | 33% | 56% |
| Increasing road safety | 67% | 60% | 25% | 50% | 50% | 33% | 48% |
| Increasing accessibility to public services | 25% | n/a | n/a | n/a | n/a | 100% | 21% |

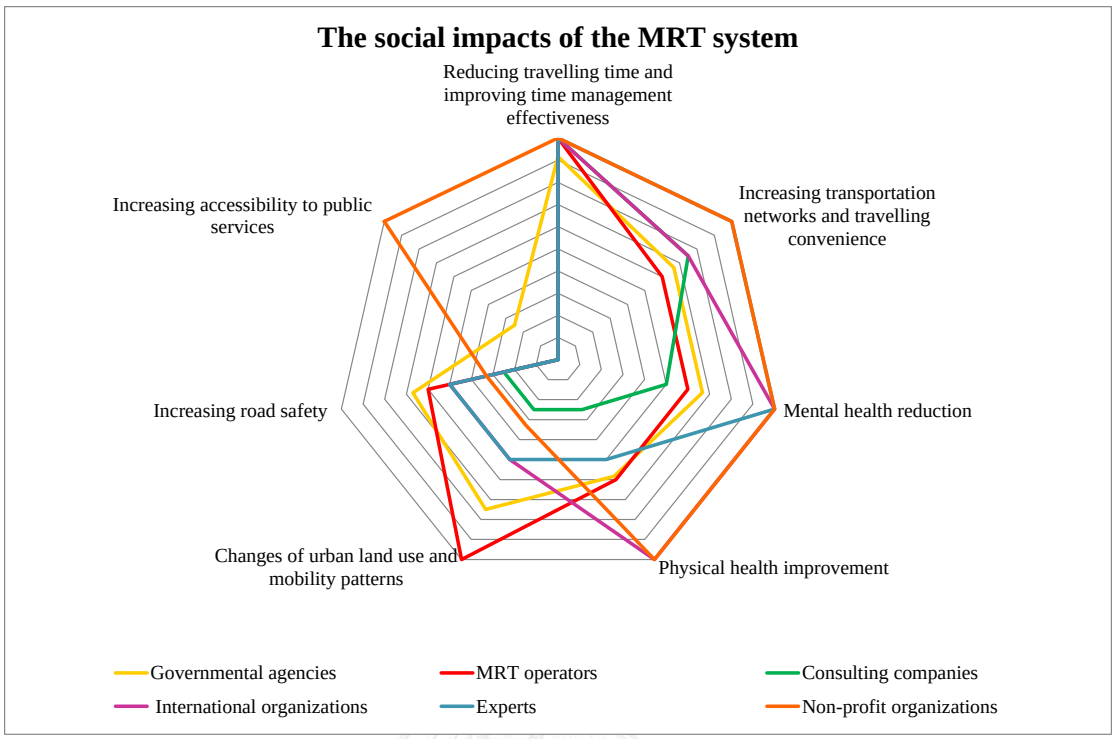



Figure 5.41 The social impacts of the MRT system

Figure 5.41 presents that all respondent groups agreed on reduced travelling time and improved time management effectiveness as the major positive social impacts of the MRT system. Experts and non-profit organizations strongly mentioned that increases of transportation networks and travelling convenience are the main positive impacts. In addition, mental health reduction is another positive impact noted by three respondent groups consisting of international organizations, experts, and non-profit organizations. While groups of international organizations and non-profit organizations viewed that physical health improvement is also the positive impact of the MRT system. The other three positive impacts of the MRT system compose of changes of urban land use and mobility pattern, road safety increasing, and increase of public services accessibility. These three positive impacts are unremarkable mentioned.

In terms of the motivating factors in this study, they are classified into pull and push factors accordingly to push and pull theory that were widely used in previous studies such as migration, tourism, and management case studies (Crompton, 1979;

Mohamed and Othman, 2012; and Guan, 2014). Based on these studies, the pull factor means a benefit that attracts a person to a certain behavior. In the other hand, push factor means a difficulty that drives a person away from a certain behavior.

Regarding the pull factors of people to shifting to the MRT system, all respondents agreed that accessibility is a strong pull factor in attracting people to use the MRT system. They stated that accessibility includes convenience in walking or cycling to the MRT stations, transit-oriented development (TOD), and park-and-ride. The linkages of the MRT stations and other transportation networks are also leading people easy to access the MRT system.

93% of respondents indicated that the MRT line alignment is the strong pull factor. They noted that the line alignment should have consistency with city development and actual travel demand. Additionally, it should have interconnection of the MRT system networks and other transportation networks.

Another pull factor is affordability, 89% of respondents mentioned that the MRT fare price should be considered in supporting people be able to use the MRT system. They recognized that the current MRT fare prices are still not competitive to other transportation modes. In addition, the respondents viewed that travelling by the MRT system is more expensive than other transportation options i.e. motorcycle taxi, vans, and buses.

71% of respondents stated that the MRT's reliable system and its service quality are strong pull factor of mobility behavior change to the MRT system. They indicated that the MRT system could provide frequency and time schedules to supporting in time management effectiveness.

In terms of the push factors for mobility behavior change to the MRT system, 76% of respondents viewed that traffic regulations particular in driving restriction zone and parking fee could reduce the numbers of driving car in the inner city. Additionally, 73% of them noted that polluter pay principle could make costly expenses to private car owners in paying taxes relevant to size of engine cubic

centimeters (CC), vehicle kilometers travelled (VKT), and GHG emissions level. Moreover, 62% of respondents mentioned that taxes on new and renewal car registrations could increase expenses on using private vehicle. The study found that all of these strong factors aim to increase private vehicle using expenses leading to reduction of the number car uses.

These are consistent with the context of Thailand national policy, "Climate Change Master Plan (2015-2050)" published by the ONEP (2015) that regarding mitigation greenhouse gas emissions and promote low-carbon growth in transport sector by proposing sustainable transport management approaches in promoting the shifting multi-modal transport including the MRT system and other public transport systems such as

- To accelerate the development of urban mass transit networks to cover and connect rail systems and bus system
- To develop infrastructure as the connection point and to facilitate the multi-modal travel such as park-and-ride and joint ticket management system
- To improve pedestrian and routing for bicycles to promote non-motorized transportation for short trips
- To promote urban development and facilitate systematic travel and transit-oriented development
- Proposing congestion pricing and parking fees in Bangkok area to motivate shifting travel mode

However, all respondents noted that to motivating people in shifting to the MRT system, it needs a parallel implementation on both motivating factors. These motivating factors are shown in Table 5.26 and Figure 5.42.

Table 5.26 The motivating factors in shifting to the MRT system

| The motivating factors in shifting to the MRT system | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| **Pull Factors** | | | | | | | |
| Accessibility | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Line alignment | 83% | 100% | 100% | 75% | 100% | 100% | 93% |
| Affordability | 92% | 40% | 100% | 100% | 100% | 100% | 89% |
| Reliable system and service quality | 58% | 100% | 50% | 50% | 100% | 67% | 71% |
| **Push Factors** | | | | | | | |
| Traffic regulations | 75% | 100% | 50% | 100% | 100% | 33% | 76% |
| Polluter pay principle | 83% | 40% | 50% | 100% | 100% | 67% | 73% |
| Taxes on new car registration and renewal | 83% | 40% | 50% | 100% | 100% | n/a | 62% |

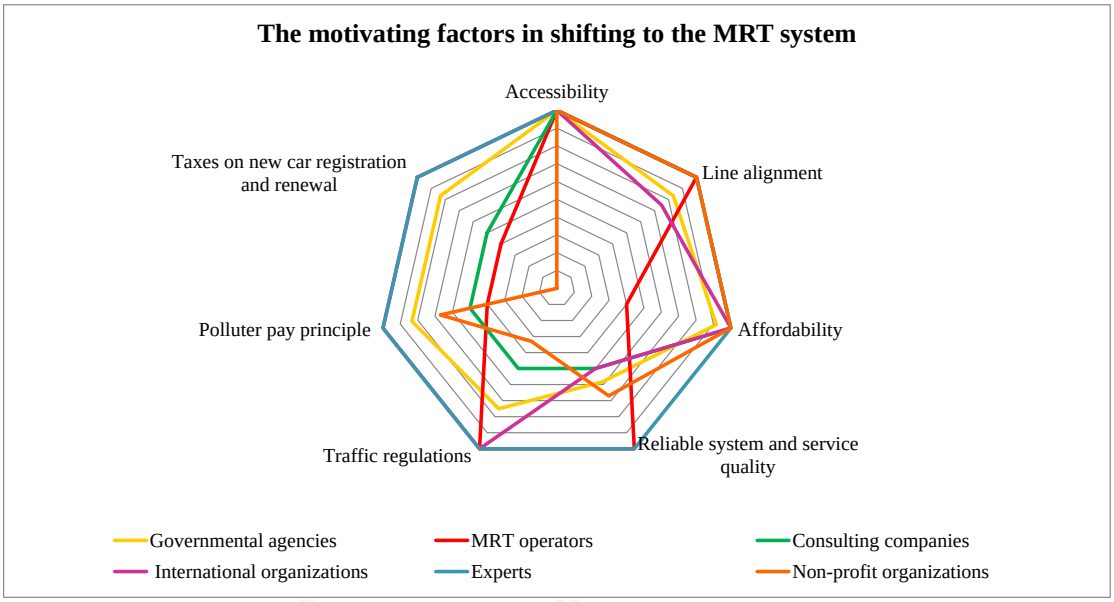



Figure 5.42 The motivating factors in shifting to the MRT system

Figure 5.42 shows that accessibility is the most powerful motivating factor in shifting to the MRT system which agreed by all of respondent groups. In addition, the MRT line alignment is the strong motivating factor which also mentioned by all of respondent groups. Affordability is the motivating factor with noted by five respondent groups except MRT operators that did not give a strong opinion on this factor. Regarding the experts' opinion, they highly concerned in all motivating factors.

### 5.5.6 Sustainable Transport and the MRT System in Urban and Economic Development

Based on economic development impacts of the MRT system, 94% of respondents mentioned that the MRT system leads increasing new business areas by attracting businesses and real estate industry be setting along the MRT lines. 89% of them viewed that the MRT system could support business management and operation i.e. communication, time management, and logistics. Moreover, the respondents noted that the MRT system leads increase of employment generation. Up to 50% of respondents stated that the MRT system could increase transportation system development and connectivity between urban and rural areas. All these positive impacts of the MRT system are in line with the document report of "Thailand National Transport and Traffic Master (2011-2020)" proposed by the (2011) that mentioned to promote public transportation system in providing efficient transport system and accessibility as well as connectivity to economic zones and communities towards sustainable transport and sustainable cities.

Furthermore, 34% of respondents mentioned that reducing fuel cost and oil imports is another positive impact of the MRT system. They viewed that the MRT system is one of alternatives projects in reducing national fuel consumption by promoting people shift from private car to the MRT system. It supports the optimization of travel with energy efficiency and low carbon emissions.

28% of them noted that the MRT system could increase saving of environmental costs. This makes economic benefit in saving cost of air pollution management and control. Finally, only 14% of them viewed that the MRT system also reduces accidental losses.

All positive economic development impacts of the MRT system mentioned above are shown in Table 5.27 and Figure 5.43.

Table 5.27 The economic development impacts of the MRT system

| The economic development impacts of the MRT system | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Increasing new business areas | 67% | 100% | 100% | 100% | 100% | 100% | 94% |
| Supporting business management and operation | 67% | 100% | 100% | 100% | 100% | 67% | 89% |
| Increasing transportation system development and connectivity | 58% | 60% | n/a | 50% | 100% | 33% | 50% |
| Reducing fuel cost and imports | 33% | 40% | 75% | 25% | n/a | 33% | 34% |
| Reducing environmental costs | 33% | n/a | 75% | 25% | n/a | 33% | 28% |
| Reducing accidental loss | 25% | n/a | 25% | n/a | n/a | 33% | 14% |

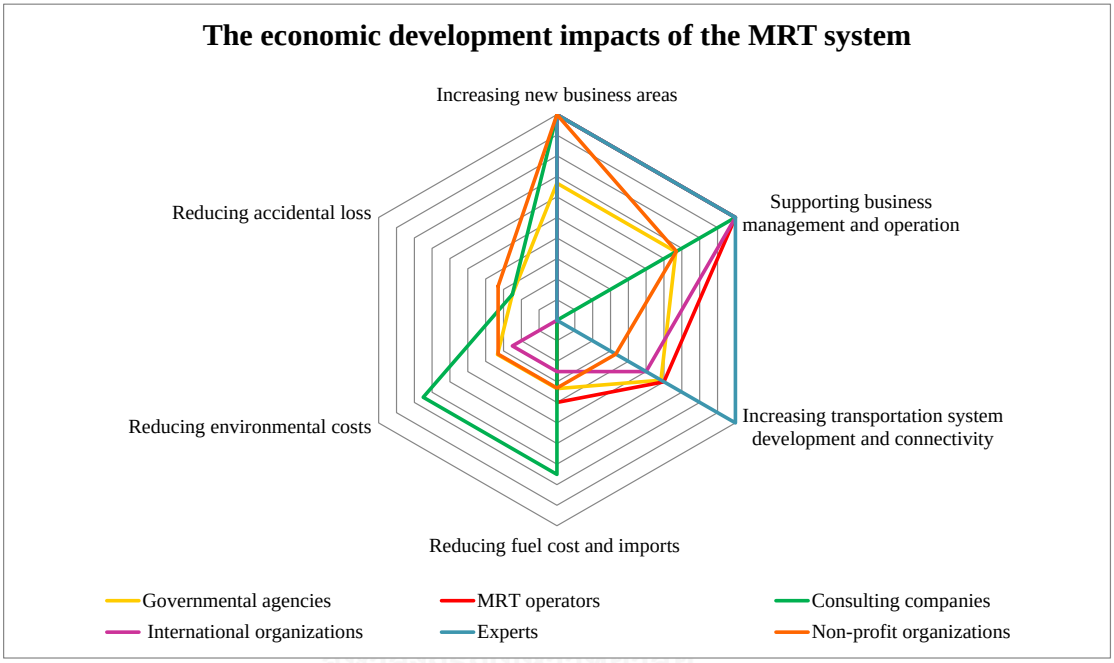



Figure 5.43 The economic development impacts of the MRT system

Figure 5.43 presents that increasing new business areas is the most positive of the MRT system. This is mentioned by five respondent groups namely MRT operators, consulting companies, international organizations, experts, and non-profit organizations. Supporting business management and operation and increasing employment generation are the positive impacts of the MRT system as noted by four respondent groups composing of MRT operators, consulting companies, international organizations, and experts. It can be noted that the governmental agencies did not give a significant opinion on these three main positive impacts. The other four positive impacts of the MRT system include increasing transportation system development and connectivity, reducing fuel cost and oil imports, increasing saving of environmental

costs, and decreasing accidental losses. These four positive impacts are less mentioned.

In terms of urban development impacts of the MRT system, 92% of respondents agreed that the MRT system leads urban land use changes. They viewed that many real estate and business i.e. office buildings, condominiums, shopping centers and residential areas has been growing along the MRT lines. Such areas become more attractive for the business, education, leisure, and cultural activities to operate. Baeumler et al. (2012) reported that the MRT system could increase urban livability.

Up to 71% of respondents indicated that the inconsistency and uncontrollable in urban development direction leads city planning becomes unmanageable. They viewed that ineffective enforcement of existing laws and regulations in urban planning of the study area still exist.

Almost 70% of respondents stated that the study area is less interconnecting points between the MRT system and other transportation networks. Lastly, only 31% of them mentioned on lacking of transit-oriented development (TOD) that they viewed TOD as a linkage between the MRT system and the surrounding areas.



Table 5.28 and Figure 5.44 show all impacts of the MRT system on urban development as mentioned above.

Table 5.28 The impacts of the MRT system on urban development

| **The impacts of the MRT system on urban development** | Governmental agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Urban land use changes | 75% | 100% | 75% | 100% | 100% | 100% | 92% |
| Inconsistency and uncontrollable in urban development direction | 50% | 60% | 50% | 100% | 100% | 67% | 71% |
| Lack of interconnecting between MRT systems and other transportation networks | 58% | 60% | 50% | 50% | 100% | 100% | 70% |
| Lack of transit-oriented development (TOD) | 25% | 60% | n/a | 50% | 50% | n/a | 31% |

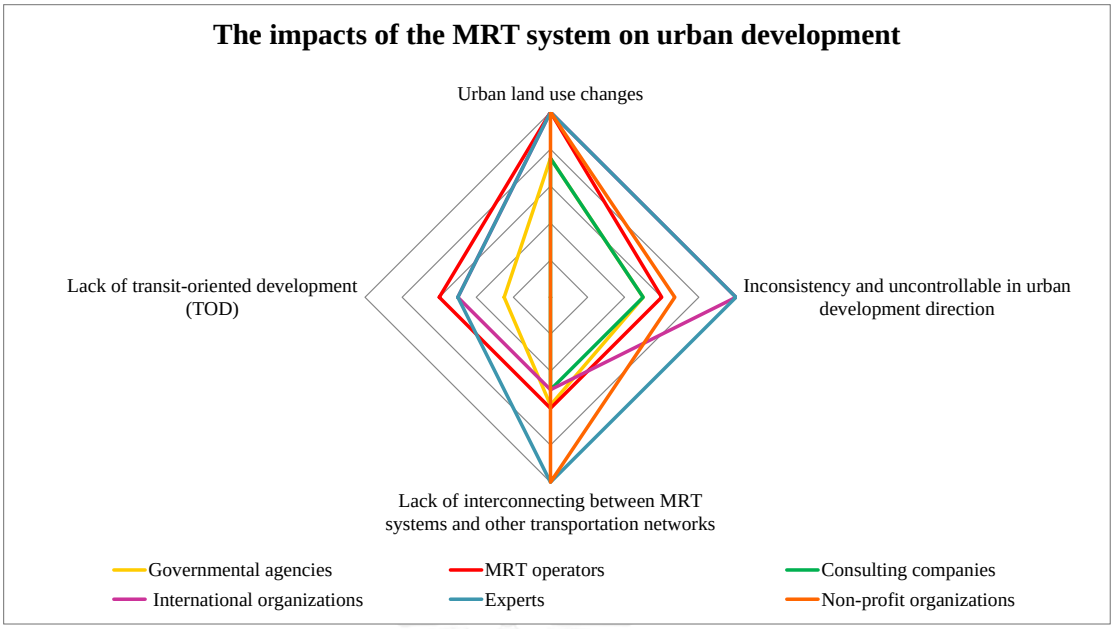



Figure 5.44 The impacts of the MRT system on urban development

Figure 5.44 shows that the positive impact of the MRT system on urban land use changes is the most significance. This is strongly agreed by four respondent groups namely MRT operators, international organizations, experts, and non-profit organizations while governmental agencies and consulting companies did not give a highly mention on this impact. However, the remarkable negative impact is the inconsistency and uncontrollable in urban development direction that is mentioned by international organizations and experts. In addition, less interconnecting points between the MRT system and other transportation networks is another negative impact as noted by experts and non-profit organizations while lack of transit-oriented development (TOD) is slightly mentioned.

Regarding value of the MRT system investment, the study found that the investment on the MRT system could make benefits in terms of financial and economic benefits as shown in Table 5.29. All respondents stated that the MRT project is a transport infrastructure investment requiring long-term financing returns. They noted that the project needs highly invest in finance and project duration. However, the respondents indicated that most of the MRT system generally are loss and requires the government subsidies.

For economic benefits of the MRT system investment, the study found that time saving and quality of life improvement are strongly mentioned by all respondents. 92% of them viewed that the MRT system could increase saving of environmental costs and up to 88% of them noted that it could also increase energy saving. Thailand EIA reports on the MRT projects reported by the MRTA (2011) mentioned that the MRT projects could generate many economic benefits including,

- Vehicle operating cost savings
- Value of time on road saving and rail saving, and
- Value of reducing expenditure on greenhouse gas emission and air pollution

Table 5.29 The values on investment of the MRT system

| The value on investment of the MRT project | Government agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| **Financial benefits** | | | | | | | |
| Long-term returns | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Most of the MRT projects are loss | 83% | n/a | n/a | 100% | 100% | n/a | 47% |
| **Economic benefits** | | | | | | | |
| Time saving | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Improve quality of life | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Environmental costs saving | 75% | 100% | 100% | 75% | 100% | 100% | 92% |
| Energy saving | 83% | 100% | 100% | 75% | 100% | 67% | 88% |



### 5.5.7 Operational Factors of Organization to Achieve Sustainable Transport Development Plan

The study found that 86% of respondents considered in inter-ministerial participation and stakeholders' coordination and communication as the significant operational factor of organization in achieving sustainable transport development plan. They indicated that such participation and coordination are very important to supporting in implementing plans of cross-government sectors. It should be setting up with key sectors such as ministries of transport, energy, and finance. Tilburg et al. (2011) reported that in achieving low carbon development strategy, it needs an inter-ministerial committee which set up with effectively coordinate key sector ministries. The cross-sectoral collaboration is challenging and the support of key ministries is crucial. Based on this significant operational factor, 88% of respondents from

governmental agencies revealed that such of coordination and communication still are inadequate due to the institutional structure of ministries and the tendency in working silos. These could result in overlapping and no corresponding in operational guidelines among agencies. They further noted that the MRT system in Bangkok has many operators so that they really need more coordination and communication among them in order to make operating efficiency for the overall MRT system network. Therefore, inter-ministerial participation and stakeholders' coordination and communication are seriously considered as a prerequisite for cross-sectoral strategic development and sustainable transport development plan.

Another key operational factor is the integration and consistency of policies and plans. 83% of respondents strongly mentioned that there is a lack of this factor in governmental agencies and relevant stakeholders. This results from unclear direction of ministerial sector policies. Furthermore, 90% of respondents from governmental agencies viewed that insufficiency in integration and consistency of policies and plans lead them in operating difficulty and implementing discontinuity in their cross-sectoral strategies. Therefore, the policy processes need to work towards consensus on policies direction among cross-sectoral stakeholders in order to promote more policy integration and consistency.



79% of respondents mentioned that budget and financial support is the operational factors in achieving sustainable transport development plan. They clearly highlighted that this plan requires highly financial support from both domestic and international sources.

In terms of clarification of role, responsibility and awareness of stakeholders, 75% of respondents stated that these are also operational factors in achieving sustainable transport development plan. They indicated that their roles in the organization are apparent due to clear in their job description. However, in operating in the cross-sectoral strategies which involving to many stakeholders, they have unclear roles and responsibilities. This could result in lacking of their awareness, engagement, and ownership to these strategies. Moreover, these could lead to less

stakeholders' coordination and communication. Tilburg's (2011) reported that awareness and engagement among decision makers and all relevant stakeholders is essential to create buy-in for the strategy and its implementation. Additionally, it can be properly integrated across all policy areas and implemented of concrete results.

73% of respondents mentioned in readiness of stakeholders' knowledge, skills, and technology as an important factor in achieving plan. They viewed that such readiness is still limited caused by budgeting supports and the government support policies.

Up to 69% of respondents noted that readiness of data availability, reliability, and analysis is operational factor in achieving sustainable transport development plan. They stated that there are inadequate in data sharing, data organized as well as increasing in data gaps and overlapping due to less coordination and communication among inter-ministerial and relevant stakeholders. Tilburg et al. (2011) reported that readiness in terms of fact base, analytical and institutional capacity to interpret the fact base can meet need in developing and to filling capacity, knowledge and information gaps of the countries in developing the low carbon strategic plan.

All these operational factors for sustainable transport development plan are shown in Table 5.30 and Figure 5.45.

Table 5.30 The operational factors for sustainable transport development plan

| **The key success factors in sustainable transport development plan** | Government agencies | MRT operators | Consulting companies | International organizations | Experts | Non-profit organizations | Average |
|---|---|---|---|---|---|---|---|
| Interministerial participation and stakeholders coordination and communication | 88% | 76% | 80% | 80% | 100% | 93% | 86% |
| Integration and consistency of policies and plans in government agencies and stakeholders | 90% | 76% | 80% | 80% | 90% | 80% | 83% |
| Budget and financial support | 92% | 88% | 95% | 65% | 70% | 67% | 79% |
| Clarification of role, responsibility and awareness of stakeholders | 83% | 32% | 70% | 70% | 100% | 93% | 75% |
| Knowledge, skills, and technology of stakeholders | 75% | 56% | 65% | 70% | 90% | 80% | 73% |
| Availability, reliability, and analytical data | 77% | 32% | 70% | 70% | 80% | 87% | 69% |

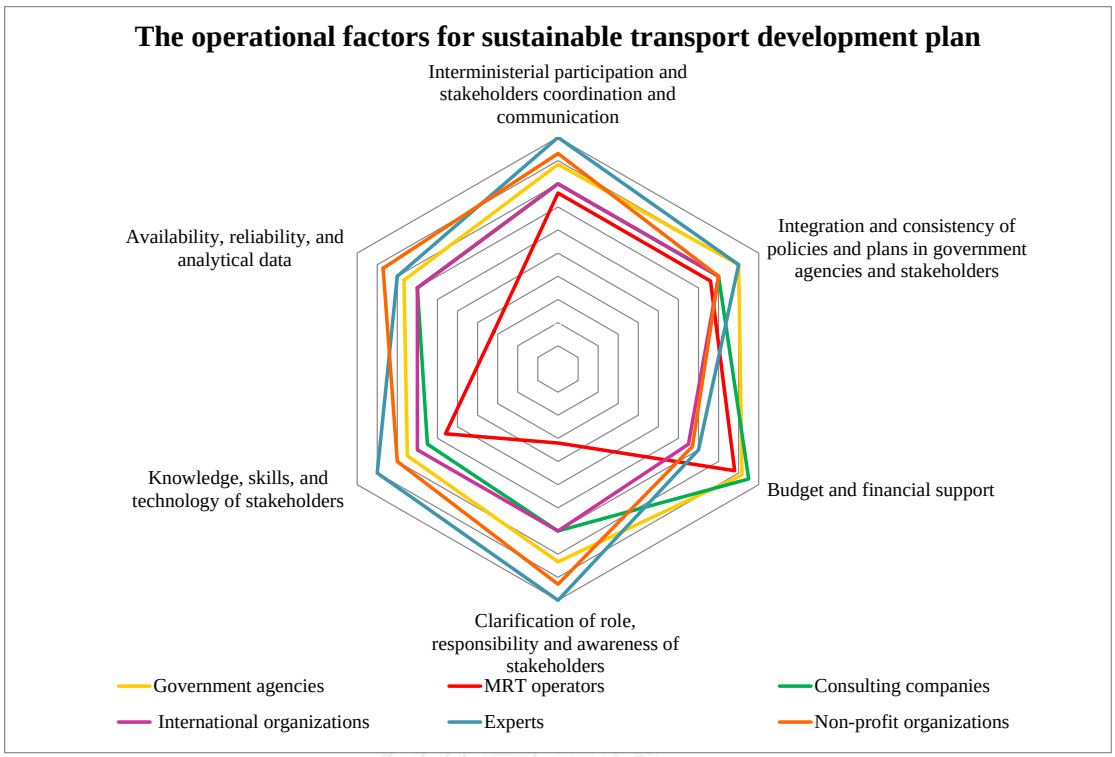



Figure 5.45 The operational factors for sustainable transport development plan

Figure 5.45 presents that two key operational factors are strongly agreed by all respondent groups are as follows:

1) Inter-ministerial participation and stakeholders' coordination and communication
2) Integration and consistency of policies and plans

In terms of budget and financial support, this is highly mentioned by three respondents groups composed by governmental agencies, MRT operators, and consulting companies. However, it is obviously noticed that MRT operators did not emphasized on the factors including

1) Clarification of role, responsibility and awareness of stakeholders
2) Readiness of knowledge, skills, and technology of stakeholders
3) Readiness of data availability, reliability, and analytical data

## 5.6 Low Carbon Development Strategic Setting

The conceptual framework of the study in low carbon development strategic model for sustainable transport towards low carbon city comprised of three concepts namely sustainable transport, low carbon city, and low carbon development strategy that based on the research studies are as follows:

1) Sustainable transport concepts by Partnership for Sustainable Urban Transport in Asia (PSUTA, 2007),
2) Low carbon city in context of sustainable urban development (Baeumler et al., 2012), and
3) Low Carbon Development Strategy (Tilburg et al., 2011)

This section describes a low carbon development strategic setting for sustainable transport towards low carbon city based on the study framework and the main research findings in the context of the MRT system in Bangkok.

### 5.6.1 Elements of Sustainable Transport towards Low Carbon Development Strategy

The PSUTA (2007) summarized the elements of sustainable transport into main four aspects composing of environment, social, economic, and governance. They developed a conceptual approach of city-based sustainable transport planning relevant for Asia. The approach supported by their sustainable transport elements and indicators. However, the study found additional elements of such sustainable transport aspects to enabling low carbon development strategy are as follows:

1) Environmental aspect

The study findings show that mitigating GHG emissions and improving air quality are generally mentioned in environmental dimension of sustainable transport. Additionally, there are two elements which also highly regarded in environmental aspects are as follows:

- Increasing energy efficiency: public transportation system could reduce fuel consumption in private car uses.

- Supporting low carbon city development: sustainable transport plays a major role in mitigating GHG emissions in transport sector for city.

2) Social aspect

The PSUTA (2007) reported the elements of social aspect in sustainable transport consisting of road safety, poverty alleviation and gender, transport demand management, and public participation. Based on the study findings, these elements were less or were not mentioned as the major elements for sustainable transport. However, the study found six different elements to promote social benefits of sustainable transport are as follows:

- Reducing travel time: time consuming reduction by alleviated traffic congestion
- Improving time management: timetabling improvement by reduced unpredictable time in travelling and provided reliable transportation system
- Increasing travel convenience: providing inclusive and interconnecting transportation systems and services
- Mental health reduction: supporting people to get less stress on their travels by alleviated traffic congestion
- Physical health improvement: reducing air pollution in transportation
- Shifting mobility patterns: the study found that there are two-sided effects on this element. Positive effect is to support people to multi-modal transport; however, it requires a consistency of urban transport systems and urban planning to avoid negative effect on unsustainable mobility pattern.

3) Economic aspect

In terms of economic dimension, the PSUTA (2007) identified into three elements including,

- Urban transport financing: the study findings show a significant of requiring financial and budgeting support in transport infrastructure investment.

- Regulation, costs, and subsidies: effective regulation enforcement and the government subsidies are required for sustainably support in institutional and technical capacity of sustainable transport development.
- Urban transport institutions: the study found that the establishment of institution particular in mass rapid transit transport is needed.

In addition, the study found six supplemental elements to support economic benefits of sustainable transport are as follows:

- Increasing new business areas: the study found that the MRT system could attract businesses and real estate development setting around the MRT networks. However, it also leads urban land use change.
- Increasing economic and community connectivity: providing efficient transport system and accessibility in connectivity to economic zones and communities
- Supporting business management and operation: supporting communication, time management, and logistics
- Increasing employment generation: increasing new business areas leading to increasing employment
- Enhancing transportation system development: providing efficient transport system
- Energy and environmental saving: reducing fuel cost and environmental management and control costs

4) Governance and policy aspect

From the study findings, the elements are consistent with the study of the PSUTA (2007) which are summarized as follows:

- Sustainable transport policy: although the study of sustainable transport master plan had already taken, there is still lack of such plan applied in the transport policies.
- Inclusive of transportation plans and multi-modal transport: the findings show sustainable transport policies need inclusive of all transportation modes

including MRT system and other public transport systems as well as non-motorized transport.

Also, the study found additional elements to support sustainable transport governance and policy are as follows:

- Integration of policies and plans in urban transportation system and city development: the study found that such integration is needed in optimizing sustainable transport plan implementation.
- Government support policies: the policies should be setting up to support the optimization of sustainable transport and low carbon development goals.
- Traffic and transportation laws and regulations: supporting and improving in laws and regulations as well as effective in their enforcement are needed.
- Consistency in political process: this could lead policy priority setting stability and continuity in transport policy implementations.
- Technical and institutional capacity: the study found that sustainable transport require budget and financial support, readiness of knowledge, skills, and technology of stakeholders, and readiness of data availability, reliability, and analysis.



Table 5.31 shows the element research findings of sustainable transport towards low carbon development strategy based on sustainable transport concepts by PSUTA (2007).

Table 5.31 Element research findings of sustainable transport towards low carbon development strategy

| Aspects | PSUTA (2007) | Element research findings |
|---|---|---|
| Environment | • Mitigating GHG emissions<br>• Improving air quality | • **Increasing energy efficiency**<br>• **Supporting low carbon city development** |
| Social | • Road safety<br>• Poverty alleviation and gender<br>• Transport demand management<br>• Public participation | • **Reducing travel time**<br>• **Improving time management**<br>• **Increasing travel convenience**<br>• **Mental health reduction**<br>• **Physical health improvement**<br>• **Shifting mobility patterns** |
| Economic | • Urban transport financing<br>• Regulation, costs, and subsidies<br>• Urban transport institutions | • **Increasing new business areas**<br>• **Increasing economic and community connectivity**<br>• **Supporting businesses management and operation**<br>• **Increasing employment generation**<br>• **Enhancing transportation system development**<br>• **Energy and environmental saving** |
| Governance and policy | • Sustainable transport policy<br>• Inclusive of transportation plans and multi-modal transport | • **Integration of policies and plans on urban transportation system and city development**<br>• **Government support policies**<br>• **Traffic and transportation laws and regulations**<br>• **Consistency in political process**<br>• **Technical and institutional capacity** |



### 5.6.2 Elements of Low Carbon City towards Low Carbon Development Strategy for Sustainable Transport

Baeumler et al. (2012) proposed an alignment of low carbon and sustainable development strategies for cities. The alignment related to urban development and benefits of mitigating global climate change which classified into four aspects composed by urban form, energy-efficiency, public transport and low carbon vehicles, and water and waste management.

Regarding the conceptual framework, the study focuses only on public transport and low carbon vehicles aspect as the main factor of low carbon city towards low carbon development strategy. However, the study found supplemental elements of the public transport dimension and other additional aspects which relevant to the study of Baeumler et al. (2012) as shown in Table 5.32. These aspects and their

elements for low carbon city towards low carbon development strategy on sustainable transport are as follows:

1) Public transport-oriented system

The study found that public transport-oriented system plays the key roles in supporting low carbon city development as reported by Baeumler et al. (2012) including,

- Reducing traffic congestion
- Mitigating GHG emissions
- Improving air quality
- Increasing road safety
- Increasing urban livability

Though, the study findings indicate five supplemental elements to enabling low carbon city development relevant to sustainable transport are as follows:

- Shifting mobility patterns: promoting people to multi-modal transport
- Efficiency in public transport system: enhancing transportation system development and provided reliable transportation systems and services
- Inclusive transportation plan: comprehension plan for all transportation modes such as MRT system and other public transport systems as well as non-motorized transport
- Accessibility to public transportation system: easy to access public transport systems such as walking or cycling, transit-oriented development (TOD), and park-and-ride.
- Affordability in public transportation: promoting public transport system for all

2) Urban and economic development

Regarding Baeumler et al. (2012) mentioned on urban form and spatial development as one of aspects in the alignment of low carbon and sustainable urban development, the study found that this dimension is also the major impact factor on

such development. However, the research findings show different elements in this factor relating to urban and economic development are as follows:

- Effective and controllable city planning and urban land use development: the study found the effects on urban land use change and development could make positive effects on economic development and negative effect on unsustainable mobility.
- Integration of urban transportation system and city development plans
- Increasing transit-oriented development: promoting residential and commercial areas in providing easy access to transit station around public transports
- Supporting businesses management and operation
- Increasing employment generation
- Increasing economic and community connectivity

3) Energy efficiency

The study found that energy efficiency aspect of Baeumler et al. (2012) study is one of the major aspects in low carbon city towards low carbon development strategy on sustainable transport. The elements in this aspect are as follows:

- Reducing air pollution
- Mitigating GHG emissions
- Increasing energy saving
- Improving energy security

Table 5.32 Factor and element research findings of low carbon city towards low carbon development strategy for sustainable transport

| Factors | Baeumler et al. (2012) | Element research findings |
|---|---|---|
| Public transport-oriented system | • Reducing traffic congestion<br>• Mitigating GHG emissions<br>• Improving air quality<br>• Increasing road safety<br>• Increasing urban livability | • **Shifting mobility patterns**<br>• **Efficiency in public transport system**<br>• **Inclusive transportation plan**<br>• **Accessibility to public transportation system**<br>• **Affordability in public transportation** |
| **Factor research findings** | **Element research findings** | |
| **Urban and economic development** | • **Effective and controllable city planning and urban land use development**<br>• **Integration of urban transportation system and city development plans**<br>• **Increasing transit-oriented development**<br>• **Supporting businesses management and operation**<br>• **Increasing employment generation**<br>• **Increasing economic and community connectivity** | |
| **Energy efficiency** | • **Reducing air pollution**<br>• **Mitigating GHG emissions**<br>• **Increasing energy costs saving**<br>• **Improving energy security** | |

### 5.6.3 Elements of Low Carbon Development Strategy (LCDS)

Tilburg et al. (2011) proposed the six factors for low carbon development strategic process consisting of readiness, building blocks, continuous process, technical and political alignment, purpose, and outcomes. The study findings indicate that there are common and different details in the factors and elements as follows:

1) Readiness: Tilburg et al. (2011) mentioned on different condition and circumstance of readiness in each case of the study. The study found the elements of this factor are as follows:
   - Data availability, quality, and reliability: the study found that there are inadequate in data sharing, data organized as well as data gaps and overlapping.
   - Experts, human resources, and technology: stakeholders' knowledge, skills, and technology in sustainable transport and low carbon development are inadequate.

- Process and policy: shifting political priorities has influence on policy processes. Unpredictably changing in politics could result in different policy priority setting and discontinuity in transport policy implementation.
- Awareness of stakeholders: lack of stakeholders' awareness, engagement, and ownership to the development plan is still exists leading to less their buy-in for the strategy and its implementation. High-level participation is also required in an important role.

2) Building blocks:

- Assessing the current situation
  - Data collection: inadequate of data availability, quality, and reliability
  - Capacity assessment: the capacity to analyze the data is needed due to insufficiency of stakeholders' knowledge, skills, and technology. Such capacity is still limited caused by budgeting supports and the government support policies.
  - Stakeholder mapping: the study found that unclear roles and responsibilities of stakeholders present in the cross-sectoral strategies implementation. In addition, this could result in lacking of their awareness, engagement, and ownership to the development plan. Moreover, these could lead to less stakeholders' coordination and communication.
  - Institutional setup: although there is inter-ministerial committee which set up with key sector ministries, departments and agencies for the sustainable transport, high-level and inter-ministerial participation are inadequate.
- Identification of policy aims, actions, and interventions
  - Long term vision, targets and actions of the policy: the study found that Thailand policies have long term vision; however, concrete targets and actions are lacked to achieving the long term goals.
  - Finance: the study found needs of financial sources and private sector investment supports in developing the sustainable transport.

- Government intervention: the research findings indicate that government supporting policies and budgeting allocation as well as effective relevant regulations enforcement are the supplemental elements for institutional and technical capacity of sustainable transport development.
- Plan for implementation: effective regulation enforcement and administration supports could support in implementing plan. However, stakeholders' coordination and communication are still inadequate. Also, effective and continuity in implementation are needed.

3) Technical and political process: LCDS should ensure to align with technical and policy process for confirming that the strategy could be implemented properly.
   - Technical assessments: the study findings indicated lack of data availability, reliability, and analysis due to less data sharing, data disorganized as well as data gaps and overlapping. Additionally, the numbers of experts, human resources and technology are inadequate.
   - National political process and decision-makers: the study found that shifting political priorities has influence on policy processes.

4) Continuous process: The research findings from secondary data assessment show that the plans and strategies have policy development process include planning, analysis and design, implementation, and evaluation. However, the study found that continuous and effective implementation plans of stakeholder groups are inefficient.

5) Purpose: Tilburg et al. (2011) indicated that LCDS has different purposes depending on the stakeholders and apply the strategy to their different purposes. However, the study found that in Thailand context the transport policies and plans have common purposes in reducing traffic congestion and improving transportation mobility. For instance, Thailand's Transport Development Strategy: 20 years plan (2017 – 2036) proposed by the OTP in 2017, the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (M-Map) presented by MRTA in 2014, and BMA Action Plan on Global Warming Mitigation (2007-2012) developed by the

BMA in 2007. Although there are different policies and plans which proposed by different stakeholders, they have common purposes.

6) Outcomes: Tilburg et al. (2011) mentioned that LCDS could be changed or adjusted along the process in order to ensure that it would generate the optimal outcomes. Based on the secondary data assessments, the study found that Thailand policies and plans have been adjusted regarding changes of condition and circumstance. For example, Thailand's Transport Development Strategy: 20 years plan (OTP, 2017) has developed the strategic plans in order to achieving the 20-year National Strategic Plan goals by recognizing the importance of the current transport infrastructure development. This strategic plan has three operational periods: critical issue, medium, and long-term periods to ensure the optimization of implementations and outcomes.

Table 5.33 shows factor and element research findings of low carbon development strategy based on low carbon development strategic process by Tilburg et al. (2011).

Table 5.33 Factor and element research findings of low carbon development strategy

| Tilburg et al. (2011) | Factor research findings | Element research findings |
|---|---|---|
| Readiness<br>• Available in data of the current situation<br>• Experts<br>• Process and policy | **Institution and technical capacity** | • **Readiness of data availability, quality, reliability**<br>• **Readiness of experts, human resources, technology**<br>• **Sources of Finance**<br>• **Awareness and engagement of stakeholders** |
| Building blocks<br>• Assessing the current situation<br>• Identification of policy aims, actions, and interventions | | |
| Building blocks<br>• Assessing the current situation<br>• Identification of policy aims, actions, and interventions | **Institutional framework** | • **High-level participation**<br>• **Inter-ministerial committee**<br>• **Political and policy processes**<br>• **Regulations and government intervention**<br>• **Budget allocation and financial support**<br>• **Clear roles and responsibilities**<br>• **Stakeholders mapping** |
| Technical and political process<br>• Technical assessments<br>• National political process and decision-makers | | |
| Continuous process<br>• planning, analysis and design, implementation, and evaluation | | |
| Continuous process,<br>• planning, analysis and design, implementation, and evaluation | **Policy setting and process** | • **Policy and strategic orientation**<br>• **Policy integration and inclusive plan**<br>• **Long-term concrete plan and strategy**<br>• **Stakeholders involvement and buy-in** |
| Purpose<br>• Different purposes depending on the stakeholders | | |
| Outcomes<br>• Strategy could be changed or adjusted along the process in order to ensure that it would generate the optimal outcomes | | |
| Continuous process,<br>• planning, analysis and design, implementation, and evaluation | **Plan of implementation** | • **Concrete action plan and implementation**<br>• **Effective regulations enforcement and administration supports**<br>• **Iterative process and continuity in implementation**<br>• **Stakeholders collaboration and communication** |
| Purpose<br>• Different purposes depending on the stakeholders | | |
| Outcomes<br>• Strategy could be changed or adjusted along the process in order to ensure that it would generate the optimal outcomes | | |



## 5.7 Proposed Model for Low Carbon Development Strategy for Sustainable Transport towards Low Carbon City

Regarding low carbon development strategic setting, the aspects and their elements findings in the strategic setting are applied to develop the proposed model for LCDS for sustainable transport and low carbon city in the context of the MRT system in Bangkok. The proposed model is shown in Figure 5.46. This proposed model consists of three main parts namely low carbon development strategy (LCDS), sustainable transport, and low carbon city.

The LCDS for sustainable transport and low carbon city composes of four factors as follows:

1) Institution and technical capacity

Readiness of data availability, quality, and reliability is required to provide input data of the current situation and related information to the policy maker and decision as well as relevant stakeholders to analyzing and assessing for setting their policies and actions. Readiness of experts, human resources, and technology is needed to increasing capacity in generating knowledge, skills, and technology for develop and implement filling information gaps of the countries in developing the low carbon strategic plan. In addition, sources of finance are essential for high investment in transport infrastructure and budget allocation to key ministries sectors, departments, and agencies. Finally, awareness and engagement of stakeholders are influential factor to make their involvement and buy-in to the process. Therefore, institution and technical capacity is a prerequisite in LCDS process.

2) Institutional framework

Institutional framework is the second factor of LCDS process which calls for high-level attention and participation to develop a stronger awareness and buy-in among decision-makers and a participatory process of high-level political support from the start could provide strong high-level leadership within the government. The framework needs inter-ministerial committee setting up effectively coordinates with key sector ministries, departments and agencies. Shifting political priorities has influence on policy processes resulting in different policy priority setting and discontinuity in transport policy implementation. Therefore, consistency of political and policy are important for institutional framework. In addition, regulations and government intervention could support government agencies in good management and control on the traffic and transportation as well as the city planning. Not only sources of finance is mentioned as a requirement to ensure the institutional and technical capacity, but also budget allocation and financial support are required in institutional framework for LCDS. In terms of stakeholder mapping, clear roles and responsibilities of them are necessary in setting the institutional framework for the

cross-sectoral development strategic plans. Such unclear roles and responsibilities could result in lacking of their awareness, engagement, and ownership to the development plans.

3) Policy setting and process

Based on institutional framework part, this could lead to support policy setting and process for LCDS. With high-level and inter-ministerial participation, these could lead long- term concrete plan and strategy as well as policy integration and inclusive plan. Consistency of political and policy leads to policy and strategic orientation. Additionally, stakeholder mapping and clear roles and responsibilities are essential factors to create stakeholders involvement and buy-in in the policy setting and process.

4) Plan of implementation

In implementing plan, effective regulations enforcement and administration supports are needed to promote efficiency and concrete action and implementation. Iterative process and continuity in implementing plan also support on these actions. In addition, stakeholder collaboration and communication are demanded for the implementation.



These four factors of LCDS which shown in Table 5.34, have interaction to the other two main parts of the proposed model which are sustainable transport and low carbon city.

Table 5.34 Low carbon development strategy factors and elements

| Factors | Elements |
|---|---|
| Institution and technical capacity | • Readiness of data availability, quality, reliability<br>• Readiness of experts, human resources, technology<br>• Sources of Finance<br>• Awareness and engagement of stakeholders |
| Institutional framework | • High-level participation<br>• Inter-ministerial committee<br>• Political and policy processes<br>• Regulations and government intervention<br>• Budget allocation and financial support<br>• Clear roles and responsibilities<br>• Stakeholders mapping |
| Policy setting and process | • Policy and strategic orientation<br>• Policy integration and inclusive plan<br>• Long-term concrete plan and strategy<br>• Stakeholders involvement and buy-in |
| Plan of implementation | • Concrete action plan and implementation<br>• Effective regulations enforcement and administration supports<br>• Iterative process and continuity in implementation<br>• Stakeholders collaboration and communication |

Sustainable transport composes of four aspects namely environment, social, economic, and governance and policy. Each aspect has its elements that present the outcomes and requirements for sustainable transport for the low carbon development strategy as shown in Table 5.35.

Table 5.35 Sustainable transport aspects and elements

| Aspects | Elements |
|---|---|
| Environment | • Mitigating GHG emissions<br>• Improving air quality<br>• Increasing energy efficiency<br>• Supporting low carbon city development |
| Social | • Reducing travel time<br>• Improving time management<br>• Increasing travel convenience<br>• Mental health reduction<br>• Physical health improvement<br>• Shifting mobility patterns |
| Economic | • Urban transport financing<br>• Regulation, costs, and subsidies<br>• Urban transport institutions<br>• Increasing new business areas<br>• Increasing economic and community connectivity<br>• Supporting businesses management and operation<br>• Increasing employment generation<br>• Enhancing transportation system development<br>• Energy and environmental saving |
| Governance and policy | • Integration of policies and plans on urban transportation system and city development<br>• Inclusive of transportation plans and multi-modal transport<br>• Government support policies<br>• Traffic and transportation laws and regulations<br>• Consistency in political process<br>• Technical and institutional capacity |

Regarding low carbon city, there are three main factors include public transport-oriented system, urban and economic development, and energy efficiency. In such factors generate their elements that indicate consequences from conducting low carbon city in the low carbon development strategy as was seen in Table 5.36.

Table 5.36 Low carbon city factors and elements

| Factors | Elements |
|---|---|
| Public transport-oriented system | • Reducing traffic congestion<br>• Mitigating GHG emissions<br>• Improving air quality<br>• Increasing road safety<br>• Increasing urban livability<br>• Shifting mobility patterns<br>• Efficiency in public transport system<br>• Inclusive transportation plan<br>• Accessibility to public transportation system<br>• Affordability in public transportation |
| Urban and economic development | • Effective and controllable city planning and urban land use development<br>• Integration of urban transportation system and city development plans<br>• Increasing transit-oriented development<br>• Supporting businesses management and operation<br>• Increasing employment generation<br>• Increasing economic and community connectivity |
| Energy efficiency | • Reducing air pollution<br>• Mitigating GHG emissions<br>• Increasing energy costs saving<br>• Improving energy security |

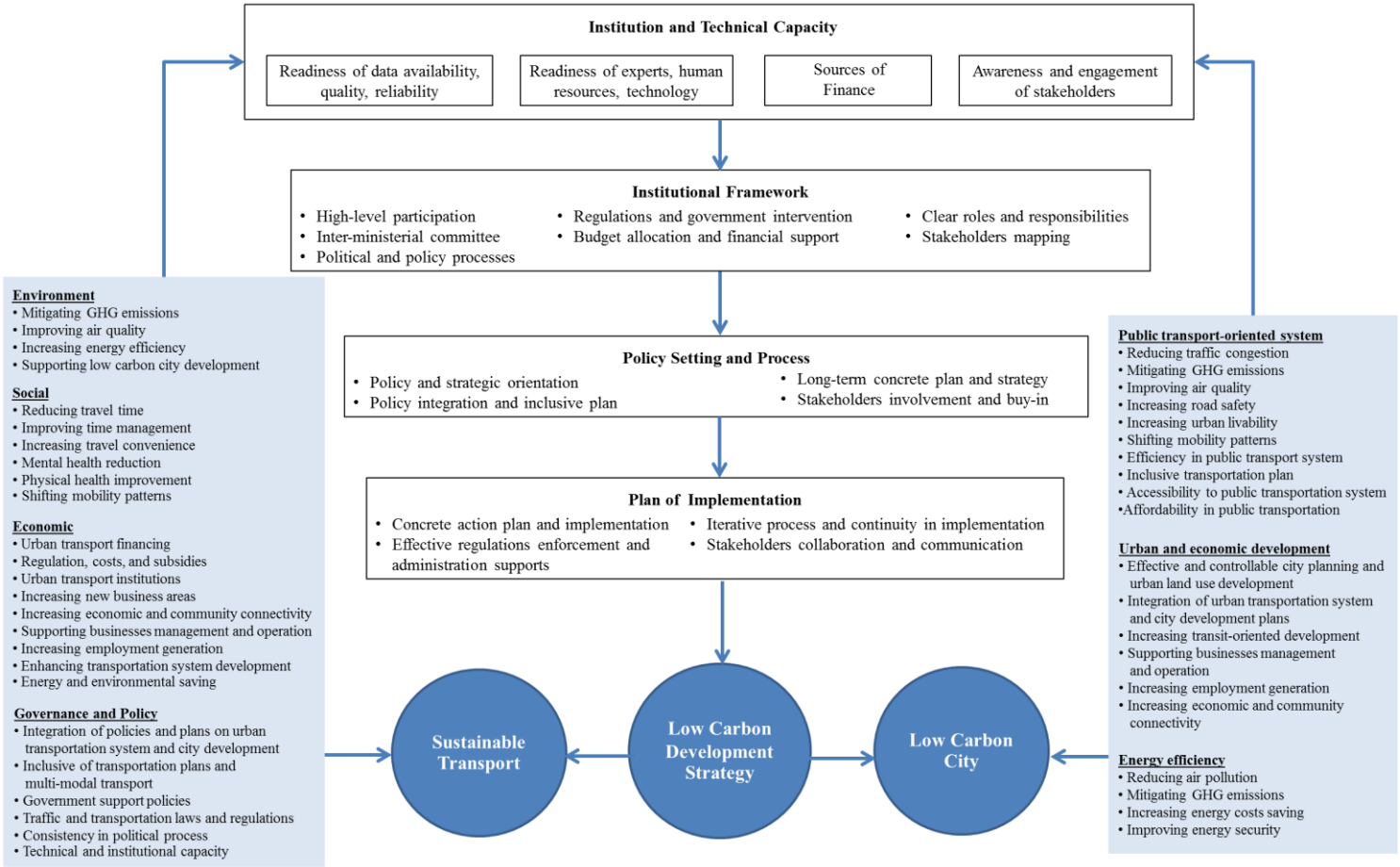



Figure 5.46 Proposed Model for Low Carbon Development Strategy for Sustainable Transport towards Low Carbon City

## 5.8 Discussion on Proposed Model for Low Carbon Development Strategy for Sustainable Transport towards Low Carbon City

The proposed model as shown in Figure 5.46 consists of three components namely low carbon development strategy (LCDS), sustainable transport, and low carbon city.

Regarding the LCDS, Tilburg et al. (2011) proposed the six factors for the LCDS process composing of readiness, building blocks, continuous process, technical and political alignment, purpose, and outcomes as shown in Figure 2.9. The research findings indicate both common and different factors as mentioned by Tilburg et al. (2011). However, the study further found other factors for the LCDS including institution and technical capacity, institutional framework, policy setting and process, and plan of implementation. Each factor comprises of elements as shown in Table 5.34. For example, institution and technical capacity has four elements including readiness of data availability, quality, and reliability; readiness of experts, human resources, and technology; sources of finance; and awareness and engagement of stakeholders. Institutional framework has seven elements such as high-level participation, inter-ministerial committee, and political and policy process. In policy setting and process, there are four elements including policy and strategic orientation, policy integration and inclusive plan, long-term concrete plan and strategy, and stakeholder involvement. For plan of implementation, it consists of four elements including concrete action plan and implementation, effective regulation enforcement, iterative process, and stakeholder collaboration. These four factor research findings would influential in developing low carbon strategy and would towards the LCDS.

In terms of sustainable transport, the study found additional elements to all aspects composing of environment, social, economic, and governance and policy which differ from the sustainable transport elements proposed by the PSUTA (2007) as shown in Table 5.31. For example, not only GHG mitigation and air quality improvement are the environmental elements of sustainable transport but the research found that increasing energy efficiency and supporting low carbon city development are also significant to sustainable transport towards the LCDS. For social aspect, the

study found different elements to promote social benefits such as improving time management, increasing travel convenience, mental health reduction, and physical health improvement. In economic aspect, beyond the urban transport financing and costs, the research findings indicate additional elements such as increasing new business areas, increasing economic and community connectivity, supporting business management and operation, and energy and environmental saving. Besides of sustainable policy and multi-modal transport, the study found that governmental support policies, laws and regulations as well as consistency in political process are needed to take into account. All these elements of four sustainable transport aspects would make sustainable transport planning more inclusive and more effective for the LCDS.

Apart from sustainable transport, low carbon city would be effective results for the LCDS. Low carbon city factor as mentioned by Baeumler et al. (2012) is public transport-oriented system consisting of several elements such as GHG mitigation, air quality improvement, and road safety increasing. However, the study found additional elements for this factor, for instance, shifting mobility patterns, efficiency in public transport system, and inclusive transportation plan. These elements would enable more effective public transport system and would support more efficient in low carbon city development. In addition, the research findings present the other factors leading to low carbon city as shown in Table 5.32 which are beyond the elements of low carbon city reported by Baeumler et al. (2012) composing of urban and economic development and energy efficiency. These factors would make more comprehensive planning and implementing in low carbon city towards the LCDS for sustainable transport.

Therefore, those three sub-modules are integrated into the proposed model for low carbon development strategy for sustainable transport towards low carbon city. This proposed model would support the governmental agencies for the further MRT line projects to be more effective in sustainable transport towards low carbon city development processes.

# CHAPTER VI

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusion of the Study

This research aimed to study the current states of transportation and its impacts in Bangkok Metropolitan in order to propose model of low carbon development strategy for sustainable transport and low carbon city. Bangkok Metropolitan was the study area due to urbanization and motorization leading more traffic congestion crisis and negative consequence effects on environment, social, and economic. Regarding good management in these problems and its impact, the mass transit plans have been developed, but there still lack of sustainable transportation concept applied in such plans. The Mass Rapid Transit Master Plan in Bangkok Metropolitan Region or M-Map developed by the Office of Transport and Traffic Policy and Planning (OTP) is the current master plan to develop an urban rail transit network system serving in Bangkok Metropolitan. Its implementation aims to develop the transportation system towards sustainable transport and low carbon city. The research study focuses on the current state of transportation system and its impacts toward sustainable transportation leading to low carbon city in Bangkok Metropolitan. The transportation system study selected is the Bangkok Mass Rapid Transit (MRT) system including two MRT lines, the Pink and the Orange lines. The conceptual framework of the study was developed based on the three key parts composing of low carbon development strategy (LCDS) (Tilburg et al., 2011), sustainable transport (PSUTA, 2007), and low carbon city (Baeumler et al., 2012).

Data collection used in this study included desk study and semi-structured stakeholder interviews using questionnaire. Desk reviews of relevant documents were studied to understand the current situations according to the existing problems and their consequences as well as the current management of these situations. In addition, another secondary data assessment was policy document reviews relevant to sustainable development, sustainable transport, low carbon city, mass rapid transit

system, and air pollution. The reviews were identified into three levels consisted of international policies, national policies, and local policies. The in-depth interview applied semi-structured interview and the interview protocol was open-ended and descriptive questions. The in-depth interview questions were related to current situation of transportation in Bangkok Metropolitan, sustainable transport on environmental, social and economic development dimensions, and operational factors of organization to achieve sustainable transport development plan as shown in Appendix A. Purposive sampling method were used in order to select the key respondents include who play the key roles and responsibilities in the policies and plans and who are relevant stakeholders to sustainable transport and the mass rapid transit project in the study area. The respondents are from various organizations with different levels of operation as well as multi-fields of expertise. These provided multiple viewpoints of key stakeholders in this study. They are classified into six stakeholder groups namely governmental agencies, mass rapid transit operators, consulting companies, international organizations, non-profit organizations, and experts. Regarding the stakeholder interviews were conducted with respondents from multi-organizations with different levels of operation as well as various fields of expertise, the spider chart is suitable for analyzing and presenting multiple viewpoints of different key stakeholder groups in the study. It is somewhat useful for the inductive analysis processes.



The research results provided the additional elements and indicated different factors from the three major parts of the conceptual framework. The study proposes the model of low carbon development strategy for sustainable transport towards low carbon city composing of three sub-modules namely

1) Low carbon development strategy
2) Sustainable transport
3) Low carbon city

Regarding the LCDS, the research findings indicate both common and different factors as mentioned by Tilburg et al. (2011). However, the study further found other factors for the LCDS including institution and technical capacity,

institutional framework, policy setting and process, and plan of implementation. Each factor comprises of elements as shown in Table 5.34. These LCDS factors and elements are as follows: 1) institution and technical capacity indicates the significance of readiness of data, human resources, technology, finance as well as awareness and engagement of stakeholders to increasing the capacity in analyzing and assessing for setting their policies and implementing in the low carbon strategic plan. 2) institutional framework calls for a high-level attention and participation comprising with inter-ministerial committee setting up in order to develop a stronger awareness and buy-in among decision-makers and strong high-level leadership within the government. This could increase consistency of political and policy. Stakeholder mapping and clarification of roles and responsibilities are necessary for the cross-sectoral development strategic plans and to increasing their awareness, engagement, and ownership to the development plans. 3) policy setting and process needs long-term concrete plan and strategy as well as policy integration and inclusive plan. Additionally, stakeholder involvement and buy-in are also essential in the policy setting and process. 4) plan of implementation requires effective regulations enforcement and administration supports to support efficiency and concrete action. Iterative process and continuity could ensure effective in implementing plan. In addition, stakeholder collaboration and communication are demanded for the implementation. Thus, these four factor research findings would influential in developing low carbon strategy and would towards the LCDS.

In terms of sustainable transport, the study found additional elements to all aspects composing of environment, social, economic, and governance and policy which differ from the sustainable transport elements proposed by the PSUTA (2007) as shown in Table 5.31. In environment aspect, not only GHG mitigation and air quality improvement are the environmental elements of sustainable transport but the research found that increasing energy efficiency and supporting low carbon city development are also significant to sustainable transport towards the LCDS. For social aspect, the study found different elements to promote social benefits such as improving time management, increasing travel convenience, mental health reduction, and physical health improvement. In economic aspect, beyond the urban transport

financing and costs, the research findings indicate additional elements such as increasing new business areas, increasing economic and community connectivity, supporting business management and operation, and energy and environmental saving. Besides of sustainable policy and multi-modal transport, the study found that governmental support policies, laws and regulations as well as consistency in political process are needed to take into account. All these elements of four sustainable transport aspects would make sustainable transport planning more inclusive and more effective for the LCDS.

Additionally, low carbon city would be effective results for the LCDS. Low carbon city factor as mentioned by Baeumler et al. (2012) is public transport-oriented system consisting of several elements such as GHG mitigation, air quality improvement, and road safety increasing. However, the study found additional elements, for instance, shifting mobility patterns, efficiency in public transport system, and inclusive transportation plan that would enable more effective public transport system and would support more efficient in low carbon city development. In addition, the study also found the other factors beyond the elements of low carbon city reported by Baeumler et al. (2012) as shown in Table 5.32 composing of urban and economic development and energy efficiency. These factors would make more comprehensive planning and implementing in low carbon city towards the LCDS for sustainable transport.

This proposed model would support the governmental agencies for the further development plans to be more effective in sustainable transport towards low carbon city development processes.

## 6.2 Recommendations

Based on the proposed model, recommendation on major factors to support effective strategic process for low carbon development strategy on sustainable transport towards low carbon city are as follows:

1. The governmental agencies such as the Office of Transport and Traffic Policy and Planning (OTP), the Mass Rapid Transit Authority of Thailand (MRTA), and Bangkok Metropolitan Administration (BMA) would take a consideration in significant objectives, impacts and options as well as relevant stakeholders' involvement to ensure a comprehensive development plans.
2. Such agencies would have inclusive transport systems and interconnecting systems of all transportation modes as well as the transit oriented development should be included.
3. The intra-connecting network of the MRT system should be effectively operated by the MRT operational department for supporting multi-modal transport.
4. The governmental agencies mentioned should have policies support compact and mixed land use development which connected to multi-modal in order to improve land use accessibility and transport options.
5. The governmental agencies and relevant stakeholders such as the MRT operators should have readiness of institution and technical capacities as a prerequisite component of achieving low carbon development strategy process.
6. The governmental agencies mentioned should have stakeholder mapping and clarification of their roles and responsibilities to enable the strategy to be successfully implemented plan.
7. A high-level decision-makers would have participation and consistency of political and policy process to ensure concrete long-term vision and supportive intervention.
8. Those decision-makers would have a clear direction of the governmental policies that would be strongly support in achieving the sustainable transport towards low carbon city development plans.

## REFERENCES


ANG, G. & MARCHAL, V. 2013. Mobilising Private Investment in Sustainable Transport: The Case of Land-Based Passenger Transport Infrastructure. *OECD Environment Working Papers,* 56.

ASIAN DEVELOPMENT BANK (ADB). 2011. Thailand: Transport sector assessment, strategy, and road map. Asian Development Bank, Philippines.

BAEUMLER, A., IJJASZ-VASQUEZ, E. and MEHNDIRATTA S. 2012. An Overview: Sustainable Low-Carbon Cities in China: Why it Matters and What Can be Done. *Sustainable Low-Carbon City Development in China*, World Bank.

BANGKOK METROPOLITAN ADMINISTRATION (BMA) 2007. The 5-Year Action Plan on Global Warming Mitigation 2007-2012. *In:* DEPARTMENT OF ENVIRONMENT, B. M. A. (ed.). Bangkok, Thailand.

BANGKOK METROPOLITAN ADMINISTRATION (BMA) 2009. The 12-Year Bangkok Development Plan 2009-2020. Department of Environment, Bangkok Metropolitan Administration.

BANGKOK METROPOLITAN ADMINISTRATION (BMA) 2011. Study Report on Population in Bangkok Metropolitan Region. City Planning Department, Bangkok Metropolitan Administration.

BANGKOK METROPOLITAN ADMINISTRATION (BMA) 2012. Bangkok Metropolitan Map - categorized by land uses. City Planning Department, Bangkok Metropolitan Administration. Retrieved from http://www.bangkokplan.org/website/images/stories/bkkplan_02.pdf

BANGKOK METROPOLITAN ADMINISTRATION (BMA) 2015. Executive Summary: The Bangkok Master Plan on Climate Change 2013-2023. Department of Environment, Bangkok Metropolitan Administration.

BANISTER, D. 2011. Cities, Mobility and Climate Change. *Journal of Transport Geography,* 19**,** 1538-1546.

BURAPATANA, T. and Ross, W. 2011. Improving the Quality of Life in Bangkok via Change in City Planning, *Journal of Population and Social Studies.* Vol. 20, No. 1, pp.25-42.

CORBIN, J. and STRAUSS, A. 1990. Grounded Theory Research: Procedures, Canons, and Evaluative Criteria. *Qualitative Sociology*, (13:1), pp. 3-21.

CROMPTON, J. L. 1979. Motivations for Pleasure Vacation. *Annals of Tourism Research*, 6(4), 408-424.

GUAN, L. 2014. Push and Pull Factors in Determining the Consumers' Motivations for Choosing Wedding Banquet Venues: A case study in Chongqing, *China. Graduate Theses and Dissertations.* Paper 13851.

HARWELL, M.R. 2011. Research design: Qualitative, quantitative, and mixed methods. In C. Conrad & R.C. Serlin (Eds.), The Sage handbook for research in education: Pursuing ideas as the keystone of exemplary inquiry *(2nd edition). Thousand Oaks, CA: Sage.*

HARRELL, M.C. and BRADLEY, M.A. 2009. Data Collection Methods: Semi-Structured Interview and Focus Groups. RAND National Defense Research Institute, Santa Monica.

HOORNWEG, D. 2010. Cities and Climate Change: An Urgent Agenda. Urban Development Series, The World Bank, Washington, D.C.

HOORNWEG, D., FREIRE, M., LEE, M.J., BHADA-TATA, P. and YUEN B. 2011. Cities and Climate Change: Responding to an Urgent Agenda. *Urban Development Series,* The World Bank, Washington, D.C.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) 2007. Climate Change, Impact, Adaptation and Vulnerability. Cambridge, U.K: Cambridge University Press.

INTERNATIONAL ENERGY AGENCY (IEA) 2012. CO2 Emissions from Fuel Combustion Highlights. *IEA Statistics.* Paris: International Energy Agency.

INSTITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES (IGES). 2011. Synthesis Report of Transition towards Low Carbon Societies in Thailand and Asia –Dialogue between Policy-makers and Researchers and Cross-sectoral Approach.Institute for Global Environmental Strategies (IGES), Japan.

INSTITUTE OF SOUTHEAST ASIAN STUDIES (ISEAS), THE ASEAN STUDIES CENTRE. 2009.Urbanization in Southeast Asian Countries. Singapore.

INTERNATIONAL TRANSPORT FORUM (ITF). 2012. Transport Outlook 2012: Seamless Transport for Green Growth, OECD/*International Transport Forum*, Paris.

KAINUMA, M., SHUKLA, P. R. & JIANG, K. 2012. Framing and Modeling of a Low Carbon Society: An Overview. *Energy Economics,* 34**,** S 316-S 324.

KEMENTERIAN TENAGA TEKNOLOGI HIJAU DAN AIR (KETTHA) 2011. Low Carbon Cities Framework and Assessment System. Malaysia.

KENNEDY, C., MILLER, E., SHALABY, A., MACLEAN, H. and COLEMAN, JESSE. 2005. The Four Pillars of Sustainable Urban Transportation. *Transport Reviews,* Vol.25, No.4, pp.393-414.

KENNEDY, C., J. STEINBERGER, B. GASSON, T. HILLMAN, M. HAVRANEK, Y. HANSEN, D. PATAKI, A. PHDUNGSILP, A. RAMASWAMI, G. VILLALBA MENDEZ. 2009. Greenhouse Gas Emissions from Global Cities. *Environmental Science and Technology,* Vol.43, No.19, pp.7297–7302. (cited in World Bank, 2011)

KHANNA, P., JAIN, S., SHARMA, P., and MISHRA, S. 2011. Impact of increasing mass transit share on energy use and emissions from transport sector for National Capital Territory of Delhi. *Transportation Research Part D,* Vol.16, pp.65–72.

LIM, S.S., T. VOS, A.D. FLAXMAN, G. DANAEI, K. SHIBUYA, ET AL 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010, *The Lancet 380*: pp. 2224–2260.

MACKETT, R.L. and EDWARDS M. 1998. The Impact of New Urban Public Transport System: Will the expectations be met? *Transportation Research Part A,* Vol.32, No.4 pp.231-245.

MASS RAPID TRANSIT AUTHORUTY OF THAILAND (MRTA). 2011. Environmental Impact Assessment (EIA) Report for the Mass Rapid Transit - Pink line (Khae Rai-Min Buri), MRTA.

MASS RAPID TRANSIT AUTHORUTY OF THAILAND (MRTA). 2013. Mass Rapid Transit Authority of Thailand – Annual Report 2013, MRTA.

MASS RAPID TRANSIT AUTHORUTY OF THAILAND (MRTA). 2014a. The Detailed Adjustment Report in EIA Report of the Mass Rapid Transit Project - Orange Line (Thailand Cultural Center-Lam Sali-Min Buri section), MRTA (December 2014).

MASS RAPID TRANSIT AUTHORUTY OF THAILAND (MRTA). 2014b. The Detailed Adjustment Report in EIA Report of the Mass Rapid Transit Project - Pink Line (Khae Rai-Min Buri), MRTA (May 2014).

MILES, M. B. and HUBERMAN, A.M. 1994. *An Expanded Sourcebook: Qualitative Data Analysis*. Thousand Oaks, CA: Sage.

MINISTRY OF PUBLIC HEALTH. 2013. Statistical Thailand 2013. Bureau of Policy and Strategy. Retrieved from http://bps.ops.moph.go.th/ Healthinformation/

MINISTRY OF TRANSPORT (MOT). 2007. The Study of Traffic Accident Cost in Thailand. Department of Highways. Retrieved fromhttp://siteresources. worldbank.org/INTTHAILAND/Resources/333200-1177475763598/ Sept07-traffic_accident-full-report.pdf

MINISTRY OF TRANSPORT (MOT). 2013. Traffic Accident on National Highways: Annual Report 2013. Bureau of Highway Safety. Retrieved from http://bhs.doh.go.th/files/accident/56/ report_accident56.pdf

MINISTRY OF TRANSPORT (MOT). 2014. Number of vehicles registered in Thailand and Bangkok. Department of Land Transport (DLT). Retrieved from http://apps.dlt.go.th/statistics_web/statistics.html

MOHAMED, N., and OTHMAN, N. 2012. Push and Pull Factor: Determining the Visitors Satisfactions at Urban Recreational Area. *Procedia-Social and Behavioral Sciences*, 49, 175-182.

NAKAMURA, K. and HAYASHI, Y. 2012. Strategies and Instruments for Low-carbon Urban Transport: An International Review on Trends and Effects. *Transport Policy*.Vol.29, pp. 264-274.

NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD (NESDB) 2011. The Eleventh Economic and Social Development Plan (2012-2016). Office of National Economic and Social Development Board. Bangkok: Office of the Prime Minister.

NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD (NESDB) 2016a. The 20-year National Strategic Plan (2017-2036). Office of National Economic and Social Development Board. Bangkok: Office of the Prime Minister.

NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD (NESDB) 2016b. The Twelfth Economic and Social Development Plan (2017-2021). Office of National Economic and Social Development Board. Bangkok: Office of the Prime Minister.

NATIONAL INFORMATION CENTER (NIC) 2013. Registered Vehicles in Bangkok. *In:* Ministry of Information and Communication Technology (ed.). Thailand.

NATIONAL INFORMATION CENTER (NIC) 2014. Traffic Statistics in Bangkok Metropolitan Region on Road Network. Ministry of Information and Communication Technology, Retrieved from http://www.nic.go.th/gsic/ wsdata/ws_mot/mot_06.htm

NATIONAL STATISTICAL OFFICE (NSO). 2011. Population Statistics Group, Thailand. Ministry of Information and Communication Technology, Retrieved from http://service.nso.go.th/nso/nsopublish/TopTen/Top_pophouse.html

NICHOLLS, R.J., HANSON, S., HERWEIJER, C., PATMORE, N., HALLEGATTE, S., CORFEE-MORLOT, J., CHATEAU, J., MUIR-WOOD, R. 2008. Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes. OECD, *Environment Working Paper 1, ENV/WKP* . (cited in Banister, 2011)

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD). 1997. Glossary of Environment Statistics. *Studies in Methods, Series F*, No. 67, United Nations, New York.

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD). 2009. Environmental Cooperation in the Context of Green Growth: Quovadis, Eastern Europe, Caucasus, and Central Asia. *Annual Meeting of the*

*Task Force for the Implementation of the Environmental Action Programme, October 15–16. OECD,* Paris. Retrieved from http://www.oecd.org/dataoecd/52/34/43845140.pdf

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD). 2010. Globalisation, Transport and the Environment, OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264072916-en.

OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING (ONEP). 2011. Environmental Quality Management Plan (2012-2016). Office of Natural Resources and Environmental Policy and Planning. Bangkok: Ministry of Natural Resources and Environment.

OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING (ONEP). 2015. Climate Change Master Plan (2015-2050). Office of Natural Resources and Envionmental Policy and Planning. Bangkok: Ministry of Natural Resources and Environment.

OFFICE OF NATURAL RESOURCES AND ENVIRONMENTAL POLICY AND PLANNING (ONEP). 2017. Environmental Quality Management Plan (2017-2021). Office of Natural Resources and Environmental Policy and Planning. Bangkok: Ministry of Natural Resources and Environment.

OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP). 2010a. Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (2010-2029) - Initial Environmental Examination. Ministry of Transport.

OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP). 2010b. Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (2010-2029) - Executive Summary. Ministry of Transport.

OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP). 2011. The National Transport and Traffic Master Plan (2011-2020). Ministry of Transport.

OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP). 2013a. The study in a Master Plan for Sustainable Transport System and Mitigation of Climate Change Impacts. Ministry of Transport, Retrieved from http://greentransport.otp.go.th/GreenTransport/Front/News/NewsDetail.aspx?rid=35&CatId=12&muid=1&prid=18

OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP). 2013b. The Traffic Performance Indicator in the BMR during 2008-2011 in AM and PM peak. Ministry of Transport, Retrieved from http://www.otp.go.th/th/pdf/Statistic/information/demand/indextraffic_time.pd

OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP). 2017. Thailand's Transport Development Strategy: 20 years plan (2017-2036). Ministry of Transport. Draft as of May 2017.

PATTON, M. Q. 1999. Enhancing the quality and credibility of qualitative analysis. Health Service Research. ;34:1189–208.

PATTON, M. Q. 2002. *Qualitative Research and Evaluation Methods* (3rd edition). Thousand Oaks, CA: Sage.

PARTNERSHIP FOR SUSTAINABLE URBAN TRANSPORT IN ASIA (PSUTA). 2007. Sustainable Urban Transport in Asia: Making the Vision a Reality, Asian Development Bank (ADB) Publishing.

POLLUTION CONTROL DEPARTMENT (PCD). 2013. Thailand State of Pollution Report 2012. Ministry of Natural Resources and Environment (MNRE). Retrieved from http://www.pcd.go.th/public/Publications/en_print_report.cfm?task=en_report2555

POLLUTION CONTROL DEPARTMENT (PCD). 2014. Annual Summary of Air Quality Data 2004-2013. Retrieved from http://aqnis.pcd.go.th/Ministry of Public Health. Bureau of Policy and Strategy. (2013). Statistical Thailand 2013. Retrieved from http://bps.ops.moph.go.th/Healthinformation/

RANJITH, P. 2006. Promoting Travel Demand Reduction in Transport Sector in Cities of Asian Developing Countries: Case of Bangkok, *IGES Discussion Paper, Working Paper, 2006/12*. IGES, Hayama, Japan.

ROBERTS, L. 2011. Engaging with Policy-makers: Influencing Sustainability Policy through Academic Research. in Franklin, A. and Blyton, P. Researching Sustainability: A Guide to Social Science Methods, *Practice, and engagement.* Earthscan, New York. pp. 242-259.

ROYAL THAI POLICE. 2016. Traffic Statistics. Central Information Technology Center, Office of Information and Communication Technology, Royal Thai Police. Retrieved from http://pitc.police.go.th/dirlist/dirlist.php?dir=/traffic

SADLER, B., ASCHEMANN, R., DUSIK, J., FISHER, T. B., PARTIDARIO, M. R. and VERHEEM, R. 2011. *Handbook of Strategic Environmental Assessment*, Earthscan, UK.

STEBBINS, R. A. 2001. *Exploratory Research in the Social Sciences.* Thousand Oaks, CA: Sage, 2001.

TILBURG, X. V., , CONINCK, H. D. & ., B. S. 2011. Paving the Way for Low-Carbon Development Strategies. *In:* (ECN), E. R. C. O. T. N. (ed.). the Netherlands.

UNITED NATIONS (UN). 2002. *Plan of implementation of the World Summit on Sustainable Development A/CONF.199/20*. Johannesburg: United Nations.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED). 1992. *Agenda 21*. United Nations Division for Sustainable Development. Retrieved from http://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED). 1992b. The Rio Declaration on Environment and Development. New York, USA: United Nations.

UNITED NATIONS CENTRE FOR REGIONAL DEVELOPMENT (UNCRD). 2013. The linkages between MDGs and environmentally sustainable transport (EST). Retrieved from http://www.uncrd.or.jp/env/est/docs/EST_and_MDG_Linkages.pdf

UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT (UNCSD). 2001. The Report of the Ninth Session of the Commission on Sustainable Development (CSD-9), E/CN.17/2001/19. New York: United Nations.

UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT (UNCSD). 2006. The Report of the Fourteenth Session of the Commission on Sustainable Development (CSD-14), E/CN.17/2006/15. New York: United Nations.

UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT (UNCSD). 2007. The Report of the Fifteenth Session of the Commission on

Sustainable Development (CSD-15), E/CN.17/2007/15. New York: United Nations.

UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT (UNCSD). 2010. The Report of the Eighteenth Session of the Commission on Sustainable Development (CSD-18), E/CN.17/2010/15. New York: United Nations.

UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT (UNCSD). 2011. The Report of the Nineteenth Session of the Commission on Sustainable Development (CSD-19), E/CN.17/2011/20. New York: United Nations.

UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS (UN DESA). 2012. World Urbanization Prospects: The 2011 Revision. UN DESA, Population Division, New York.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). 2010. World Urbanization Prospects: The 2009 Revision Population Database. United Nations, New York. Retrieved from www.eas.un.org/unup/ index.asp

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). 2012. Asia-Pacific Human Development Report: One Planet to Share Sustaining Human Progress in a Changing Climate. UNDP Asia-Pacific Regional Centre, Bangkok, Thailand.

UNITED NATIONS ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC (UN ESCAP). 2006. Green Growth at a Glance: The Way Forward for Asia and the Pacific. United Nations Economic and Social Commission for Asia and the Pacific, Bangkok. Cited in World Bank. (2011). Thailand: Clean Energy for Green Low-Carbon Growth. The World Bank Group and Office of the National Economic and Social Development Board (NESDB), Thailand.

UNITED NATIONS GENERAL ASSEMBLY (UNGA). 2012. The Future We Want. *In:* (RIO+20), U. N. C. O. S. D. (ed.). Rio de Janeiro, Brazil.

UNITED NATIONS GENERAL ASSEMBLY (UNGA). 2015. Transforming our world: the 2030 Agenda for Sustainable Development. (A/RES/70/1) of 25 September 2015. United Nations.

UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME (UN HABITAT). 2010. Part 5: The Urban Environment and Climate Change. *The State of Asian Cities 2010/11*, pp.162-205.

UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME (UN HABITAT). 2013. Planning and design for sustainable urban mobility: global report on human settlements 2013. United Nations Human Settlements Programme.

UNITED NATIONS SECRETARY-GENERAL'S HIGH-LEVEL ADVISORY GROUP ON SUSTAINABLE TRANSPORT (UNSGs). 2014. Global Sustainable Transport Outlook Report: Mobilizing Sustainable Transport for Development.United Nations.

WANG, X., BERRAH, N., PENG, X., SUGAR, L. AND Du H. 2012. Chapter 3: Low-Carbon Cities in China: Characteristics, Roadmap, and Indicators. Sustainable Low-Carbon City Development in China, World Bank.

WORLD BANK. 2011. Thailand: Clean Energy for Green Low-Carbon Growth. Thailand: The World Bank Group and Office of the National Economic and Social Development Board (NESDB).

WORLD BANK. 2014. Transport for Health: The Global Burden of Disease from Motorized Road Transport. Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation.

WORLD HEALTH ORGANIZATION (WHO). 2004. World Report on Road Traffic Injury Prevention, World Health Organization.

WORLD HEALTH ORGANIZATION (WHO). 2011. Decade of Action for Road Safety 2011-2020: Saving millions of lives. WHO, Switzerland.

WORLD HEALTH ORGANIZATION (WHO). 2013. Global status report on road safety 2013: supporting a decade of action, WHO, Switzerland.

WORLD HEALTH ORGANIZATION (WHO). 2014. Health System Financing Country Profile: Thailand, 2012, Health System Financing Profile by country, WHO. Retrieved from http://apps.who.int/nha/database/Country_Profile/ Index/en

YIN, R. K. 1994. Case study research: *Design and methods (2nd edition)*. Newbury Park, CA: Sage Publications.

YIN. R. K. 2003. *Case study research, (3rd edition)*. Thousand Oaks, CA: Sage.

YIN, R. K. 2009. *Case study research: Design and methods (4th edition).* Thousand Oaks, CA: Sage.

ZHANG, Y. AND WILDEMUTH, B. M. 2009. Qualitative analysis of content. In B.M. Wildemuth (Ed.), Applications of Social Research Methods to Questions in Information and Library Science (pp.308-319). Westport, CT: Libraries Unlimited.

ZHAO, P. 2010. Sustainable Urban Expansion and Transportation in a Growing Megacity: Consequences of Urban Sprawl for Mobility on the Urban Fringe of Beijing. *Habitat International,* Vol.34, pp.236-243.

# APPENDICES

# APPENDIX A
# IN-DEPTH INTERVIEW QUESTIONS

No. .....

Questionnaire

Subject: Low carbon development strategic model for sustainable transport: a case study of mass transit system in Bangkok Metropolitan

Explanation:

1. This questionnaire is subjected to a dissertation research of Ms. Kwanyawee Thaveewatanaseth, a doctoral candidate in the Environment, Development and Sustainability Program, Graduate School, Chulalongkorn University.
2. The purpose of this questionnaire is to collect data related to the research topic on low carbon development strategic model for sustainable transport: a case study of mass transit system in Bangkok Metropolitan.
3. The targets of this research study focus on key stakeholders, who involve in sustainable transport, mass transit system and low carbon development, including experts from universities, executive managerial level in governmental departments, experts and researchers in international organizations, managerial and operational level in state enterprise and public companies, NGOs and medias.
4. The questionnaire consists of 2 sections including
   Section 1 General information of respondent and
   Section 2 In-depth questions consisting of 6 sets of questions

To facilitate the research process, I will take notes and record during the in-depth interview. All data will be confidentially handled for research purpose only.

Your cooperation in this research is greatly appreciated.

Yours sincerely,
Ms. Kwanyawee Thaveewatanaseth

**Explanation:**

This questionnaire is divided into 2 sections including

Section 1 General information of respondent

Section 2 In-depth questions consisting of 6 sets of questions

Question set 1 Current situation of transportation in Bangkok Metropolitan

Question set 2 Environmental dimension

Question set 3 Social dimension

Question set 4 Economic and development dimension

Question set 5 Operational factors of organization to achieve sustainable transport development plan

Question set 6 Further recommendation for the research

**Section 1 General information of respondent**

1. Gender

   ( ) Male ( ) Female

2. Age

   ( )Less than 35 years ( )35 – 40 years ( )41 – 45 years

   ( )46 – 50 years ( ) 51 – 55 years ( )more than 55 years

3. Education

   ( ) Bachelor Degree ( ) Master Degree ( ) Doctoral Degree

   ( ) Others .....

4. Career position

   ( )Executive level ( ) Management level ( ) Operational level

   ( ) Others .....

   Department of .....

   .....

5. Fields of expertise

   .....

   .....

6. How long have you worked in this organization?

   ( ) 1 – 5 years ( )6 – 10 years ( )11 – 15 years

   ( ) more than 15 years

**Section 2 In-depth questions**

**Question set 1 Current situation of transportation in Bangkok Metropolitan**

1.1 What is the current situation of traffic in Bangkok? What are its causes and its consequences?

1.2 What are current action plans taken by the government agencies to traffic congestion in Bangkok?

1.3 What is the level of important of the following factors in driving the development of the mass rapid transit projects in Bangkok?

| Factors | Level of important | | | | |
|---|---|---|---|---|---|
| | Most (5) | Very (4) | Moderately (3) | Slightly (2) | Least (1) |
| Traffic congestion | | | | | |
| Transit-Oriented Development | | | | | |
| Readiness of stakeholders (e.g. expert, knowledge, data, and finance) | | | | | |
| Health problem | | | | | |
| Air pollution and other environmental problems | | | | | |
| Road safety | | | | | |

Please explain the reason of such factors selected,

1) Traffic congestion

2) Transit-Oriented Development

3) Readiness of stakeholders

4) Health problem

5) Air pollution and other environmental problems

6) Road safety

**Question set 2** **Environmental dimension**

2.1 How can sustainable transport reduce GHG emission and air pollution from traffic congestion in Bangkok?

2.2 How can the Mass Rapid Transit Project reduce GHG emission and air pollution from traffic congestion in Bangkok?

2.3 What is/are the key role(s) of the Mass Rapid Transit Project in developing Bangkok towards a low carbon city?

2.4 Have your organization involved in the Mass Rapid Transit Project? How is about your organization/department relevant to reduce GHG emission from traffic congestion in Bangkok? Please specify.

**Question set 3** **Social dimension**

3.1 How can sustainable transport enhance quality of life and social development in Bangkok?

3.2 What is/are the key role(s) of the Mass Rapid Transit Project to improving traffic congestion in Bangkok in a social aspect?

3.3 How can the Mass Rapid Transit Project reduce road traffic accident and road traffic death rate in Bangkok?

3.4 How will people change their mobility behavior to use Bangkok mass rapid transit system if it is available for them?

3.5 What are accessibility and affordability in the current mass rapid transit in Bangkok?

3.6 What is/are barrier(s) to change the mobility behavior of people to use the mass rapid transit system?

3.7 What is/are factor(s) that encourage and motivate people to change their mobility behavior to the mass rapid transit system?

3.8 Have your organization involved in the Mass Rapid Transit Project to support quality of life and social development in Bangkok? Please specify.

**Question set 4 Economic development dimension**

4.1 What is/are the role(s) of sustainable transport in urban development?

4.2 What is the interrelation between the Mass Rapid Transit Project and Bangkok urban development plan?

4.3 What is/are the key role(s) of the Mass Rapid Transit Project in Thailand national energy saving policy?

4.4 Do the Mass Rapid Transit Project in Bangkok have value on investment and economy both in public and private sectors? Please specify.

4.5 Have your organization involved in the Mass Rapid Transit Project to support urban development in Bangkok? Please specify.

**<u>Question set 5</u> Operational factors of organization to achieve sustainable transport development plan**

5.1 What is the level of important of the following factors that would be barriers in sustainable transport development plan?

| Factors | Level of important | | | | |
|---|---|---|---|---|---|
| | Most (5) | Very (4) | Moderately (3) | Slightly (2) | Least (1) |
| Availability, reliability, and analytical data | | | | | |
| Knowledge, skills, and technology of stakeholders | | | | | |
| Integration and consistency of policies and plans in government agencies and stakeholders | | | | | |
| Budget and financial support | | | | | |
| Inter-ministerial participation and stakeholders coordination | | | | | |
| Clarification of role, responsibility and awareness of stakeholders | | | | | |

Please explain the reason of such factors selected,

1) Availability, reliability, and analytical data

2) Knowledge, skills, and technology of stakeholders

3) Integration and consistency of policies and plans in government agencies and stakeholders

4) Budget and financial support

5) Inter-ministerial participation and stakeholders coordination

6) Clarification of role, responsibility and awareness of stakeholders

5.2 Besides the factors in question 5.1, are there any other barriers or challenges that you have experiences?

**<u>Question set 6</u> Further recommendation for the research**

6.1 Do you have further recommendation for this research?

# VITA

Miss Kwanyawee Thaveewatanaseth was born in Bangkok, Thailand, on 18 October 1978. In 2000, she graduated two Bachelor degrees in Life Assurance and Actuarial Science from Assumption University in Bangkok, Thailand with a special certificate of honors from the President of the University. In 2008, she completed her Master of Business Administration from Assumption University. In her career life, Miss Kwanyawee worked as a team manager in the top five life assurance company in Thailand. In addition, she was a part-time lecturer at University of the Thai Chamber of Commerce in Bangkok, Thailand.

Since 2012, Miss Kwanyawee has been studying her doctoral degree in the Environment, Development and Sustainability (EDS) Program at Chulalongkorn University in Bangkok, Thailand. Her research interests focus on sustainable transport, low carbon development strategy, and low carbon city. During her studies, she received a research grant from the Graduate School of Chulalongkorn University and a tuition scholarship from the Environment, Development and Sustainability Program.