Energy Efficiency Improvement in the Transport Sector through Transport Improvement and Smart Community Development in Urban Areas

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This report was prepared by the working group on the 'Study on Energy Efficiency Improvement in the Transport Sector through Transport Improvement and Smart Community Development in the Urban Area' under the Economic Research Institute for ASEAN and East Asia energy project. Members of the working group, who represent the participating East Asia Summit countries, discussed and agreed to utilise certain data and methodologies to assess the efficiency improvement in the transport sector. These data and methodologies may differ from those normally used in each country. Therefore, the calculated results presented here should not be viewed as official national analyses of the participating countries.

PREFACE

Coping with increasing oil demand is one of the top policy agendas of East Asia Summit (EAS) countries since higher oil demand renders a variety of concerns for each country, such as the deterioration of oil supply security, exacerbation of fiscal balances, and worsening of air quality.

Although a number of studies were conducted to address this issue, few had focused on the interrelation between automobile traffic and energy consumption. This study is unique in its approach in that it will interconnect energy policy and city planning, and quantify the effect of traffic flow improvement on efficiency improvement. In the end, the goal of this study is to provide suggestions to policy planners in the EAS region on how they can improve energy efficiency in the transport sector.

I hope this study can bring new insights to those who are involved in this issue.

Ichiro Kutani
Working Group Head
June 2015

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Ichiro Kutani
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June 2015

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LIST OF ABBREVIATIONS AND ACRONYMS

BRT	bus rapid transit
DaCRISS	The Study on Integrated Development Strategy for Da Nang City and Its Neighbouring Area in Viet Nam
EAS	East Asia Summit
HCMC	Ho Chi Minh City
OD	origin–destination

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EXECUTIVE SUMMARY

Since fiscal year 2012, there has been some success in identifying investment options to reduce traffic congestion, and thus to reduce the demand for oil. However, it has also become clear that the proposed investment and policy measures have limited effects and some fundamental change is therefore required to attain a better future in the case of existing megacities such as Jakarta. From the initial development stage, appropriate measures must be implemented gradually to allow these cities to develop.

Meanwhile, the East Asia Summit region has many mid- to small-sized cities that are about to launch—or have just launched—a rapid urbanisation and motorisation. This paper thus decided to deal with mid- to small-sized cities in their initial development stage, taking Da Nang of Viet Nam as the subject of a case study, and analysing policy and infrastructure measures for preventing future traffic problem in advance, thus avoiding excessive use of energy in the future.

Possible Improvement in Infrastructure

Da Nang City in Viet Nam plans to develop a bus rapid transit (BRT) system in the near future but does not have any blueprint for the necessary feeder line bus system that enables the BRT to perform better and, accordingly, to avoid traffic problems and excessive demand for oil. Therefore, this feeder line bus system issue will be tackled in this study.

Meanwhile, the basic development of the method of specifying the feeder network and its headways' optimal route was completed, and preliminary analysis was carried out. The following findings were obtained:

- The addition of a feeder network increases the public transport's use rate although the rate reaches a plateau after a certain investment level.
- In the results of feeder network optimisation, routes with many origins and destinations are preferentially selected.
- The public transport selection rate near BRT stations is higher than that of those near the stations of feeder networks (in this study, the former has 28.5 percent; the latter, 8.0 percent).

Meanwhile, some points diverted from reality due to insufficient modelling. In particular, the function can be improved to better reflect the actual choice behaviours regarding different transportation modes. As such, tweaking the model to reflect the local situations may be required in the next step.

Policy Recommendations

This study analysed how urban transport can be improved (and consequently improve the sector's energy-use efficiency) by promoting a shift in transport mode when a mass rapid transit system is introduced. The study investigated various precedent actions and relevant policies throughout the world. Findings indicate that many localities experienced significant economic loss and difficulties in addressing the problem due to policies not able to catch up with the rapid development of cities.

Thus, to prevent such deterioration in the traffic system, this study reviews the framework of problem awareness in urban transportation. After all, once appropriate preventive measures are in place and functioning properly, economic losses and recurring traffic problems could be avoided. Meanwhile, due to the lack in precedents, this study has anticipated that some cities may have difficulty in formulating proactive measures. Thus, its policy recommendations pertain to these four steps on how to formulate effective preventive measures:

- Identify and share the concerns around potential traffic problems.
- Present measures on the transport sector as part of urban planning.
- Secure financial resources and formulate a sustainable policy mix.
- Share values and collaboration with citizens and companies.

CHAPTER 1

INTRODUCTION

The demand for energy in East Asia Summit (EAS) countries—led mostly by their power and transport sectors—has been growing substantially. The energy demand in the transport sector is mainly on oil, of which imports have been growing rapidly as the demand surpasses domestic production, causing concerns on energy supply security. Some EAS countries subsidise oil products to ensure affordable price levels for social considerations, but this exacerbates their fiscal balance. In addition, the upsurge in motorised vehicles in their cities has worsened the air quality. As these incidents prove, increases in transport demand—and thus oil demand—have great socio-economic impact, and the improvement in the efficiency in the transport sector's oil demand is an important policy agenda across EAS countries.

The growth in the transport sector's oil demand has been caused by the motorisation in cities where income levels have been rising rapidly. Particularly in urban areas, such rise in passenger vehicle ownership has been causing a number of socio-economic issues, including chronic traffic congestion. In fact, the average travel speed in some urban areas in Asia is low—for example, Jakarta's travel speed is at 15 km per hour, and Bangkok's is at 12 km per hour. This incurs energy waste, lost time in economic activities, and poor air quality.

It is thus necessary for EAS countries to take on a growth pattern different from that of developed countries. For a sustainable socio-economic development, emerging Asian countries are required to meet three objectives: enhance energy security, improve environmental quality and stabilise economic growth, and create 'smart communities'. Unlike conventional economic development paths, these three objectives have to be achieved simultaneously.

Smart communities aim to simultaneously achieve efficiency in the transport sector and lower the environmental burden by optimising transport infrastructure such as roads and railways, introducing next-generation vehicles (hybrid, plug-in hybrid vehicle, and electronic vehicle), and managing the transport. In other words, a smart community for the transport sector can cope with various transport issues in Asian urban areas.

A number of studies had considered the energy saving potential in Asia's transport sector by shifting towards fuel-efficient vehicle units. However, this particular study is unique in that its approach focuses on the interrelationship between energy demand and traffic flow. It utilises a simulation model that will be able to analyse the impact of infrastructure development on traffic flow and the subsequent impact of the transport sector's energy-efficiency improvements. The outcomes from the study are expected to provide new insights that will contribute to the sustainable development in EAS cities with urban transport improvements.

1. Rationale

The rationale for this study is derived from the 17th Energy Cooperation Task Force[1] meeting held in Phnom Penh, Cambodia on 5 July 2012. In this meeting, the Economic Research Institute for ASEAN and East Asia (ERIA) explained and proposed new ideas and initiatives for EAS energy cooperation, such as strategic usage of coal, optimum electric power infrastructure, nuclear power safety management, and smart urban traffic.

Participants of the Energy Cooperation Task Force meeting exchanged views and agreed to commence the proposed studies. As a result, ERIA formulated the working group for the 'Study on Energy Efficiency Improvement in the Transport Sector through Transport Improvement and Smart Community Development in the Urban Area'. Members from Indonesia, Japan, the Philippines and Viet Nam were represented in the working group with the Institute of Energy Economics, Japan acting as the secretariat.

2. Objective

This study aims to draw out policy recommendations for improving energy efficiency in EAS countries' transport sector. Special focus is given to traffic flow

[1] Under the Energy Minister Meeting of EAS countries.

improvements and the subsequent effects. The study consists of two different approaches, policy study and simulation analysis, to bring out more comprehensive and unique results.

3. Work Stream

First Year:

a) *Selection of model cities.* Several aspects were considered, including size of the city, traffic congestion level and data availability, before deciding to focus on Jakarta, Indonesia.

b) *Policy analysis 1*. Various policies and experiences were examined and summarised into four categories under the Avoid-Shift-Improve-Finance framework.

c) *Simulation analysis 1.* The model that can describe car traffic in a specific area was developed. Some options to improve traffic were considered, and costs (e.g. investment cost for roads) as well as benefits (e.g. reduction of congestion, and thus oil consumption) were estimated.

Second Year:

a) *Policy analysis 2*. Policies that could enhance the modal shift from private car to public transportation were implemented.

b) *Simulation analysis 2.* A survey of the general public's preferences was conducted in Jakarta to explore the factors that can drive a modal shift. Some options for improving public transportation utilities, especially bus rapid transit (BRT), were considered and the subsequent effects (e.g. increase in BRT usage and the subsequent reduction in oil consumption) estimated.

c) *Policy implication.* Based on these analyses, policy implications were derived.

Third Year:

Since FY 2012, there have been some successes in identifying investment options for reducing traffic congestion as well as its effects, including the reduction in oil demand. Meanwhile, it also became clear that the proposed investment and policy measures have limited effects and require a fundamental change to obtain a better landscape in the future for existing megacities such as Jakarta.

For instance, the case study on Jakarta for the past two years showed that traffic congestion has deteriorated considerably. Measures for fundamental improvements have been limited and now require massive short-term investment. Meanwhile, the EAS region has many mid- to small-size cities that are about to launch, or have just launched, their phase of rapid urbanisation and motorisation. From the initial development stage, appropriate measures must be implemented gradually to ensure a sound development for these cities.

Given this background, the case study in FY 2014 targets mid- to small-size cities in the initial development stage, and analyses policy and infrastructure measures that aim to improve traffic and energy efficiency. From this analysis, this study derives forward-looking policy recommendations for similar cities in the EAS region.

a) Selection of model city

In selecting the target city for this phase's case study, two of the considerations were the road traffic and transport infrastructure conditions, and the availability of data for analysis. Of the options, the research team chose Da Nang in Viet Nam.

b) Analysis of policy implementations in accordance with the development stage

While various policies can effectively improve traffic (and reduce energy consumption), the appropriate ones apparently differ based on the development stages of the urban and transport system of the city. Therefore, the analysis here will focus on the potential of policies to address the issues in the development stage of the model city.

c) Model development and initial assessment

This study first developed the model to replicate the traffic flow in Da Nang. Once the simulation model was in place, the effects of the implementation of different routes of feeder bus lines were assessed. The assessment results served as feedback for the improvement of both the simulation model and analysis approach.

d) In-depth simulation analysis for traffic improvement and impact

This step involved a quantitative analysis of any increase in energy efficiency through the improvement in traffic flows as gathered from step (c) above.

e) Draw policy recommendations for traffic and energy efficiency improvement in developing cities

Policy recommendations of this study will pay particular attention to urban and traffic systems’ development stages.

CHAPTER 2
CURRENT SITUATION AND DEVELOPMENT PLAN IN DA NANG CITY

1. Current Situation

1.1. Introduction

Da Nang City is the centre of economy and culture in Central Viet Nam. It is located 964 km north of Ho Chi Minh City (HCMC) and 764 km south of Hanoi City. It is the main centre of the North–South integration of socio-economic development in Viet Nam, and its role is expected to grow further. Da Nang City has also been serving as a trading centre for the central region, and its strategic importance is growing rapidly as the gateway of the East–West corridor. Relatedly, it is responsible for the development of the Greater Mekong Subregion Economic Zone. It is close to the world cultural heritages (Complex of Hue Monuments, Hoi An Ancient Town, and My Son Sanctuary) as well as to historical and cultural resources for tourism (Figures 2.1, 2.2).

Da Nang City was a small transit port in the mid-16th century and promoted as the centre of regional trading in the beginning of the 20th century. It was the site of a hard-fought battle during the Viet Nam War (1960–1975). It attained its independence in 1975. Reconstruction of the city mainly started in 1986, and it has since then grown rapidly. In 1996, the city was segmented from Quang Nam Province and established its role as the centre of the Central Focal Economic Zone. In 2011, it received the ASEAN Environmentally Sustainable Cities Award.

Figure 2.1: Location of Da Nang City in the GMS Economic Zone

Figure 2.2: Location of Da Nang City in the Central Region

GMS = Greater Mekong Subregion.
Source: Study Team.

1.2 Socio-economic Conditions

Population

Da Nang City includes seven districts and 56 communes. Its population has increased with urbanisation trends, reaching 928,000 in 2012 (Table 2-1). From 2005 to 2010, its population grew by 3.2 percent per year. Such population growth rate is low in built-up areas in the city centre while relatively high in peri-urban areas, where urbanisation areas have been expanded. Urban areas extend towards the north and south, along main roads with low density in an unplanned manner.

If the urbanisation trend continues, Da Nang City will face urban problems (traffic congestion, urban sprawl, lack of housings for low- and middle-income groups, deterioration of living environment, worsening of urban landscape, expansion of income gap, etc.) similar in 2012. Gross domestic product per capita increased from to that encountered by HCMC and Hanoi City.

Economy

High economic growth has continued, where the GDP growth rate rose from 10.6 percent during 2005–2010 to 12.6 percent US$950 in 2005 to US$2,310 in 2010. Da Nang City's economic sector is driven by the stable expansion of the industrial sector and growth in tourism. In addition, the role of foreign direct investment is significant. About 83 percent of the total foreign investment projects in Da Nang City are real estate projects such as offices, high-rise apartments and resorts.

While Da Nang City is recognised as an attractive investment environment, the amount of foreign direct investment has drastically decreased because of the global economic depression, a turn of events that is more serious than the Asian economic crisis in 1998. Income tax revenue in 2013 is less than half of 2010. Finally, while investment was very active due to resort developments, this source of city revenue had dwindled after the land sales were completed.

Since Da Nang City's future strategy is to promote IT-based industrial development, the High-tech Park has been developed. Many Japanese affiliated firms have promoted businesses in the industrial zones, which helped generate employment in the city and surrounding areas. Nonetheless, these firms also noted that one major downside in Da Nang City is its lack of human resources managers and engineers.

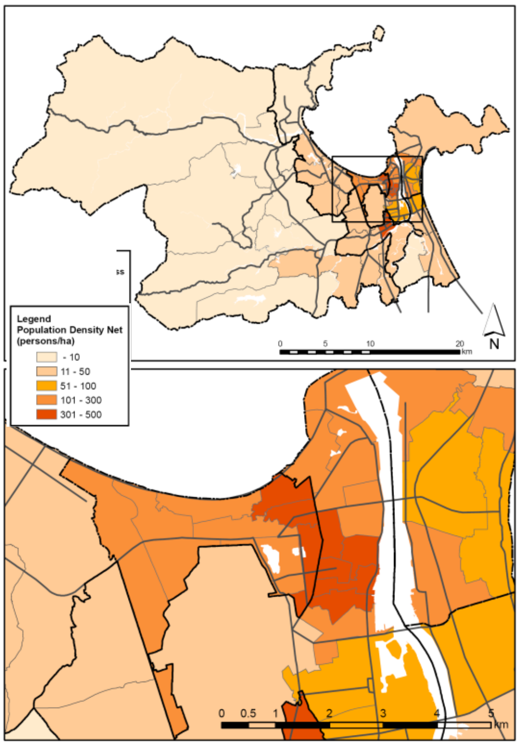
Table 2.1: Major Indicators of Da Nang City

Indicator			Year 2012
Area (sq km)			1,283
Population	1000 persons		928
	Annual growth (%)		2.8 (‘00-’10)
	Proportion of over age 65 (%)		7.1 (‘08)
Economy	Gross regional domestic product (GRDP) (US$ m)		2,236
	Annual growth (%)		9
	GRDP per capita (US$)		2,310
Social	Poverty rate (%)		2.0 (‘08)
	Jobless rate (%)		4.9 (‘06)
	Literacy rate (%)		94% (national)
Infrastructure	Modal share of public transport (%)		0.2 (bus, ‘08)
	No. of vehicles (000)		682 (as of M/C 94.1%)
	Coverage (%)	Water supply	60.9 (‘08)
		Solid waste collection	51.6 (‘08)
Environment	Hazard risk		15% area flood prone
	Green coverage (%)		17.6 (‘08)
Finance	Revenue (US$ m)	Central budget	12.1 (‘08)
		City budget	331.4 (‘08)
	Expenditure (share of investment, %)		80% (‘08)

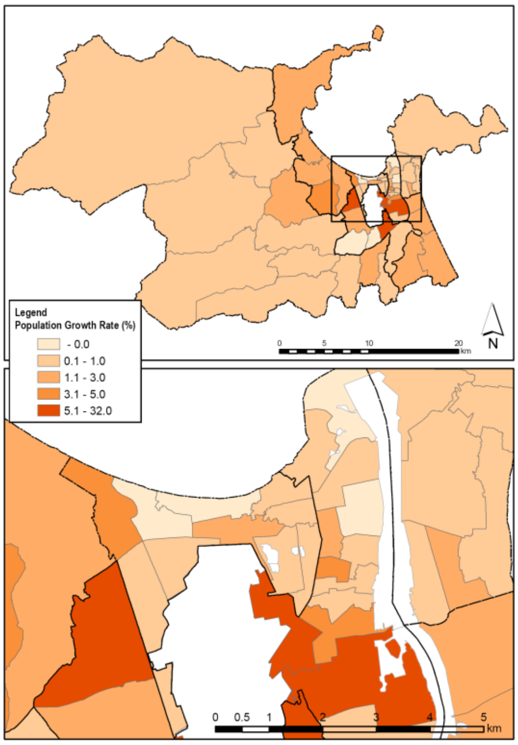
Source: Study Team.

Figure 2.3: Population Density and Growth Directions in Da Nang City

Population Density (2007)



Population Growth (2005–2007)



Source: DaCRISS (2010).

Land Use

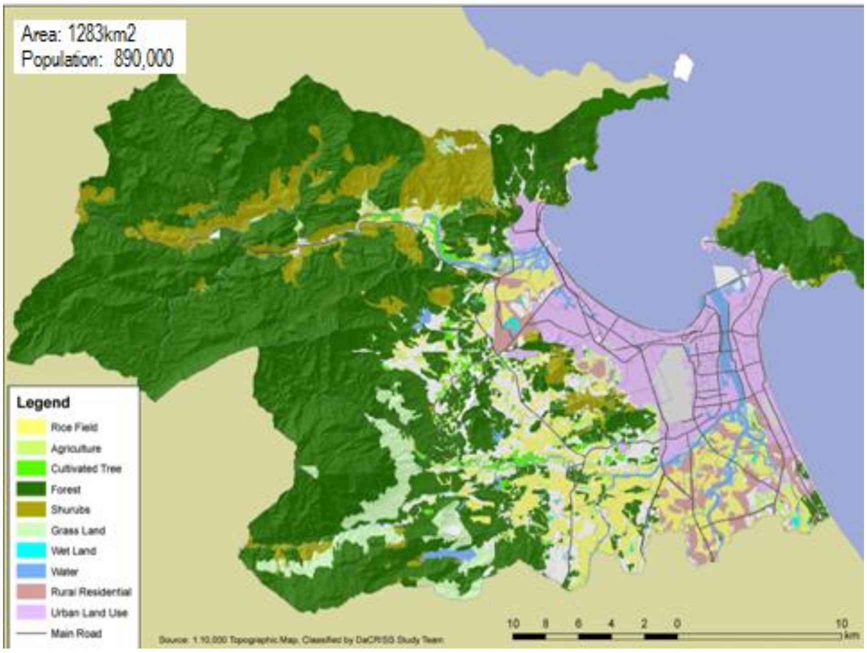
Da Nang City covers 1,256 sq km (950 sq km if excluding islands). Most land in the west of the city is covered by mountainous rural areas, while urbanised areas have been developed on the eastern side along the East China Sea. Potential development area is 341 sq km (excluding rivers, lakes, forests, airports, ports, army land, cemeteries).

Da Nang City's mountainous and forest areas account for about 60 percent of the city limits and lie north-west of the city. The long beautiful sandy beach followed by the South China Sea is vast, making its eastern part an important tourism resource. Lakes and rivers connect the mountains and sea. Open space comprises 28 percent of the total land use.

Land classified for urbanised land use is limited to 10 percent, but the city is composed of compact urban areas with high population density and scattered rural areas. The urbanisation trend has rapidly spread to suburban areas, especially towards the south and southwest.

In the north of the city, industrial zones have been developed, where many Japanese-affiliated firms have located. Along the sea are many exclusive resort development areas under foreign or Vietnamese investment.

Figure 2.4: Existing Land Use of Da Nang City (2006)



Source: DaCRISS (2010).

1.3. Urban Transport System

The overall characteristics of Da Nang City's urban transportation are as follows:

a) In 2008, total urban transportation demand in the city was about 2.3 million trips (including walking trips), or 1.9 million excluding walking trips a day. This means that each resident makes 2.9 trips/day (including walking) or 2.3 trips/day (excluding walking).

b) Motorcycles and bicycles are the dominant modes of transportation. More than 90 percent of Da Nang households own motorcycles, while 58 percent possess more than two motorcycles.

c) City peak hour for travel is from 6:00 a.m. to 7 p.m. with travel time pegged at 14.9 minutes.

d) The total road length in Da Nang is 480 km, of which about 65 percent is paved with asphalt or cement concrete. The remaining roads, mostly in the rural areas, have simple double bituminous surface treatment, gravel or earth surfaces.

e) There are nearly 2,700 road intersections in Da Nang, 18 of which have traffic lights, 27 are operated as roundabouts, 8 are controlled by traffic policemen, and about 2 percent have some sort of traffic control; and

f) Urban bus services are very limited, with an average bus ridership ranging from 540 to 1,750 passengers only per line per day in 2008.

Most of Da Nang's main problems on road transportation include insufficient road coverage, bumpy main roads, lack of facilities, and an undeveloped public transportation system. In particular, buses have a poor level of services in terms of availability, comfort, punctuality, and frequency.

Figure 2.5: Urban Transport System in Da Nang

Source: Author.

Road Transport

Except for the old town east of the airport, the trunk road network connects to the north, south, east, and west. In addition, there are collector roads with two lanes and sidewalks in the old town. The city's road extension rate is 3.98 km/sq km while the road coverage ratio is 6.41 percent (13.58 sq m/capita), both of which imply relatively favourable conditions.

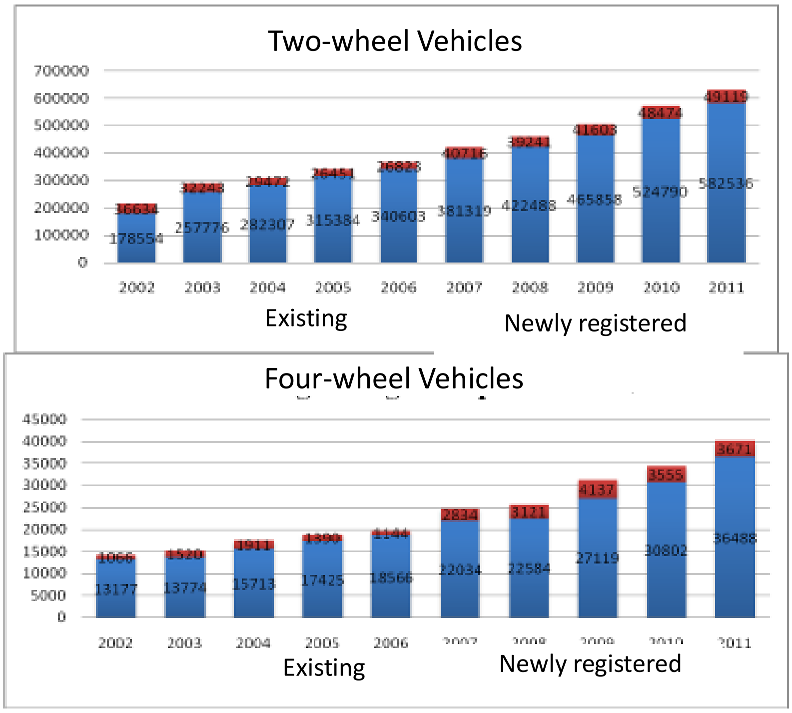
There is a total of five bridges, including two bridges under construction, at an interval of about 5 km from the mouth of the Han River. Meanwhile, Cam Ly River has three bridges, including one under construction. There are also new bridge construction plans; thus, the capacity to cross rivers is considered sufficient.

Roads in the city centre are wide with enough lanes, so accessibility from the city centre is relatively good for connecting industrial zones, logistic centres, and new residential areas along the sea and to the south of the city.

In 2012, more than 90 percent of the road transport was composed of two-wheel vehicles: 78 percent were motorbikes; and 12 percent, bicycles. While there were more than 580,000 registered two-wheel vehicles, there were only about 36,000 (6 percent) registered four-wheel vehicles. On the overall, the number of registered vehicles has double compared to their volume in 2005.

The traffic environment is relatively good at present. Traffic congestion and lack of pedestrian space is seen in the old towns, but do not cause any serious traffic problems. However, the traffic demand will eventually rise as both the population and economy are expected to grow in Da Nang City.

Figure 2.6: Number of Registered Vehicles in Da Nang City



Source: Department of Transport, Da Nang City.

Public Transport

The major public transportation mode is the bus. However, Da Nang City's modal share of buses is only 0.9 percent—very low compared to the 14 percent of Hanoi City. The bus network of the city centre covers 0.222km/sq km, which is lower than the 4km/sq km in Hanoi City. The average interval between bus stops is about 2.5 km, so a dense bus service is not provided.

There are five routes for the city's 90 buses. The inner-city bus service is limited to Route 2, while the other four routes are inter-city services connecting to suburban areas. There are overlapping bus routes; thus, the bus service coverage is limited.

About 15,000 passengers took the bus daily in 2011. Although the public transport service had not been developed, the number of passengers steadily increased along with the rise in the population.

Da Nang City, which owns the buses, offers contracts to private-sector operators for the operation and maintenance. Regardless of distance, there are flat rates for each route. According to the Department of Transport, bus operation is profitable and does not require subsidies from the government.

Figure 2.7: Bus Route Network in Da Nang City and Neighbouring Areas

Source: DOT, Da Nang City.

Inter-city Railway

Da Nang is located in the middle of the Viet Nam South–North Railway connecting Hanoi City and HCMC. Da Nang Station is located in the city centre, 2.8 km from Tam Ky Station. The distance from Tam Ky Station to the next station is about 10 km.

From Da Nang Station, it takes 17 hours to HCMC (935 km), 9.5 hours to Nha Trang (523 km), 2.5 hours to Hue (103 km), and 16 hours to Hanoi City (791 km).

1.4 . Urban Transportation Demand

Travel Demand and Trip Rates

As mentioned earlier, each resident makes 2.9 trips/day (including walking) or 2.3 trips/day (excluding walking) in 2008 (Table 2-2). Compared with other Asian cities, the trip rate of Da Nang City residents is high and comparable to that of other Vietnamese cities including Hanoi City, HCMC, and Haiphong. Such high level of mobility in Vietnamese cities is explained by the high level of ownership of motorcycles and bicycles, as well as the compactness of urban areas with highly mixed land use.

Table 2.2: Trip Rate of Residents of Da Nang City and Other Selected Cities

City		Year	Population (000)	Trip Rate: No. of trips/person/day	
Vietnam	Da Nang	2008	867	2.9	2.3
	Hanoi	2005	3,186	2.7	2.0
	HCMC	2002	7,693	3.0	2.5
	Haiphong	2007	715	2.7	2.0
Manila (Philippines)		1996	13,565	2.2	1.8
Chengdu (China)		2001	3,090	2.6	1.8
Tokyo (Japan)		1998	34,000	2.3	n.a.

Source: DaCRISS HIS (2008).

Vehicle Ownership and Modal Share

In 2008, more than 90 percent of Da Nang households have motorcycles, with 58 percent owning more than two motorcycles (Table 2-3). This extremely high level of motorcycle ownership helps people move around and access necessary services and destinations easily. This brings the share of motorcycles in urban transportation demand to as high as 77 percent, while that of public transportation is very low.

Table 2.3: Vehicle Ownership among Households in Selected Cities of Viet Nam

Type of Vehicle Owned		Da Nang [1] (2008)	Hanoi [2] (2005)	HCMC [3] (2002)	Haiphong [4] (2007)
None		3.5	2.3	1.3	2
Bicycle Only		5.0	11.5	4.4	18
Motorcycle	Single	31.6	39.8	33.8	47
	Over Two	58.1	44.7	58.9	33
Car		1.5	1.8	1.7	0.5
Total		100.0	100.0	100.0	100.0

Source: 1 DaCRISS HIS (2008). 2 HAIDEP HIS (2005), 3 HOUTRANS HIS (2002), 4 ALMEC.

Table 2.4: Modal Share of Trips (Excluding Walking Trips) in Selected Cities of Viet Nam

Mode	Da Nang	Hanoi		HCMC	
	2008 [1]	1995 [2]	2005 [3]	1996 [4]	2002 [5]
Bicycle	21.6	61.1	27.9	32	13.8
Motorcycle	77.0	35.8	59.6	64	79.0
Car	0.5	1.1	2.5	1	1.6
Bus	0.2	0.6	5.6	2	2.1
Others	0.7	1.4	4.5	1	3.8
Total	100.0	100.0	100.0	100	100.0

Source: 1 DaCRISS HIS (2008), 2 SIDA VUTAP (urban districts only), 3 HAIDEP HIS (2005), 4 HCM Transportation Study (1996, DFID), 5 HOUTRANS (2002).

Trip Generation and Attraction

Table 2.5 below presents the travel demand (generated and attracted number of trips in a day) by district. In 2008, there was a large volume of generated[2] and attracted[3] trips in Hai Chau and Thanh Khe districts, especially ‘to work’ and ‘to school’ trips. Hai Chau attracted the most number of ‘to work’ trips (141,000 trips a day, or 1.2 times the generated trips).

Table 2.5: Trip Generation and Attraction (Excluding Walking Trips) in Da Nang (2008)

District	Generation (No. of Trips, 000/day)						Attraction (No. of Trips, 000)					
	To Work	To School	Private	Business	To Home	Total	To Work	To School	Private	Business	To Home	Total
Hai Chau	116	53	112	3	300	585	141	66	150	10	227	593
Thanh Khe	94	49	87	4	155	390	66	38	81	3	202	389
Son Tra	55	31	58	2	103	250	50	24	48	2	128	251
Ngu Hanh Son	29	17	30	1	62	139	23	21	26	2	65	138
Cam Le	32	20	42	1	71	165	33	14	34	1	77	159
Lien Chieu	39	25	43	1	113	222	54	35	41	5	88	223
Hoa Vang	36	29	29	1	70	165	25	26	24	1	89	165
Hoang Sa	0	0	0	0	0	0	0	0	0	0	0	0
Total	402	225	402	14	875	1,917	390	225	404	24	876	1,919

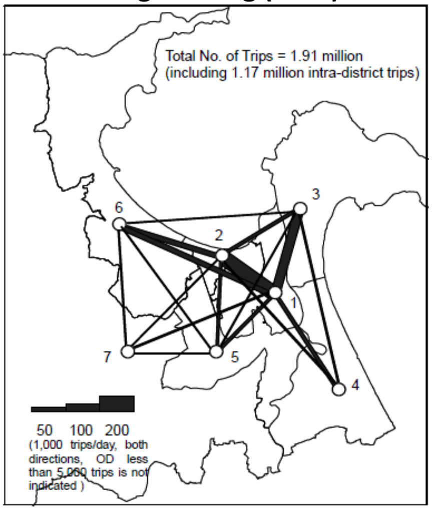
Source: DaCRISS HIS (2008).

[2] Person trips generated from the designated area to other areas.
[3] Person trips attracted to the designated area from other areas.

Trip Distribution

In 2008, about 1.2 million trips a day were generated and attracted in urban centres (i.e. Hai Chau and Thanh Khe districts), which is nearly half the total demand in Da Nang City. The figure below illustrates the distribution of inter-district transportation demand.

Figure 2.8: Distribution of Transport Demand between Districts, Excluding Walking (2008)

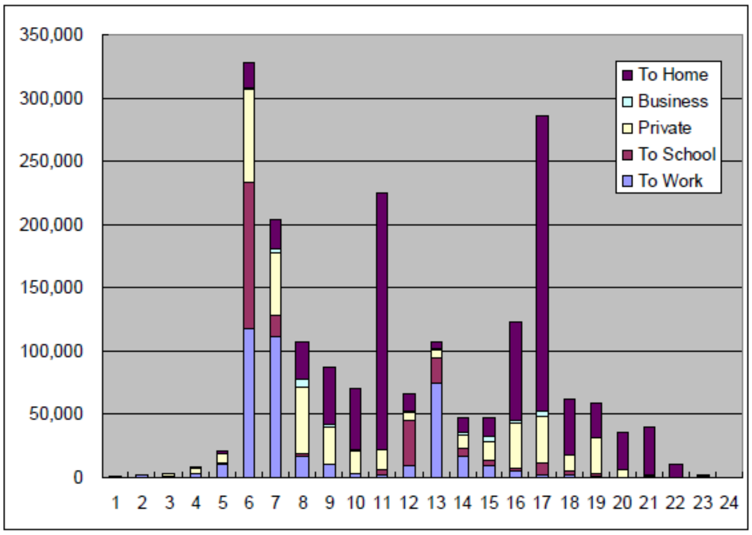


Source: DaCRISS HIS (2008).

Hourly Distribution of Demand

Figure 2.9 shows the hourly distribution of trips. There are three peak periods each day (6 a.m.–7 a.m., 11 a.m.–12 p.m., and 5 p.m.–6 p.m.). The highest peak hour for travel is from 6 a.m. to 7 p.m.; the other two peak hours, both of which are in the afternoon, are due to the ‘to home’ trips from schools.

Figure 2.9: Number of Trips Excluding Walking Trips, by Hour and Purpose (2008)



Source: DaCRISS HIS (2008).

Travel Time and Trip Length

The average travel time and trip length in all modes in Da Nang City are 14.3 minutes and 3.76 km, respectively (Table 2.6). The time and distance for 'to work' trips are slightly longer than the averages at 15.8 minutes and 4.85 km, respectively. Users of *xe ôm* (motorcycle taxis), cars/taxis, and buses make trips that last for more than 20 minutes as well as travel at longer distance—i.e. 8 km by *xe ôm*, and more than 20 km by cars/taxis and buses. On the other hand, users of bicycles and those who travel on foot make shorter trips in terms of time and distance.

Table 2.6: Average Travel Time and Trip Length by Mode and Purpose Da Nang City (2008)

Item	Trip Purpose	Walking	Bicycle	M/C			Car/Taxi	Bus		Others	Total
				Driver	Pas-senger	Xe Om		Public	Private		
Average Travel Time (min.)	To Work	13.1	16.3	15.8	15.7	24.1	19.3	19.6	26.4	19.6	15.8
	To School	11.5	15.5	19.4	11.0	15.0	11.9	23.0	26.8	11.1	14.9
	Business	9.4	15.8	16.4	16.8	-	23.2	-	20.0	18.4	17.0
	Private	11.4	12.0	12.3	13.9	27.9	26.1	16.3	25.0	21.3	12.5
	To Home	11.6	14.8	15.2	13.4	18.5	20.4	25.4	25.9	20.7	14.4
	Total	11.7	14.7	14.9	13.1	22.5	21.9	22.6	25.7	19.7	14.3
Average Trip Length (km)	To Work	1.32	2.41	4.46	4.25	7.42	18.43	5.71	21.36	7.11	4.85
	To School	1.10	2.33	6.86	2.14	2.19	1.99	8.24	9.98	6.40	3.15
	Business	2.94	1.74	12.18	2.95	-	15.30	-	38.97	10.59	19.80
	Private	0.95	1.61	3.09	3.31	9.89	29.06	30.24	23.63	10.57	3.30
	To Home	1.05	2.15	4.21	2.99	7.49	11.49	7.15	7.77	7.66	3.29
	Total	1.05	2.15	4.23	2.96	8.20	19.92	21.65	23.39	8.08	3.76

Source: DaCRISS HIS (2008).

2. Development Plans

2.1 Socio-Economic Development Plan

The Socio-Economic Development Plan (SEDP), formulated every five years by the Da Nang People's Committee and relevant departments such as the Department of Planning and Investment of Da Nang City, was revised in 2011. The SEDP describes the economic conditions of the city, opportunities and challenges, and goals and objectives for the five-year period from 2011. It also defines the contribution of regional major tourism resources and facilities to economic growth, and the importance of opening up the economy and market.

2.2 City Master Plan (General Construction Plan)

The master plan of Da Nang City, called the Construction Plan, is composed of a general and regional plan for urban areas. The Department of Construction is in charge of drafting the plan in consultation with relevant organisations. After the People's Committee approval was sought, the 'General Construction Plan of 2030 with the vision for 2050' was submitted for approval to the Prime Minister.

The basis of the proposed master plan is the City Development Master Plan Study (DaCRISS), a comprehensive urban plan study conducted in 2010 by the Japan International Cooperation Agency (JICA). This study acknowledged that Da Nang City's sustainable development was limited, given that it has a small population and limited hinterlands. Thus, the city needed to develop itself as a leading force in the central economic zone.

During the deliberation on the Construction Plan, the strategies on how to take advantage of the strengths while working on the city's weaknesses were discussed. The key points were:

- Da Nang City adopts a growth strategy different from Hanoi City and HCMC (where there is a large hinterland population and foreign direct investment–led development, mainly in the manufacturing industry). Its strategies are based on a development that puts importance on industrial sites while considering the strengths of the central region such as the three world heritages, natural environment, and a suitable living environment (i.e. appropriate for the development of tourism, IT, education, human resource development, medical services, etc.).

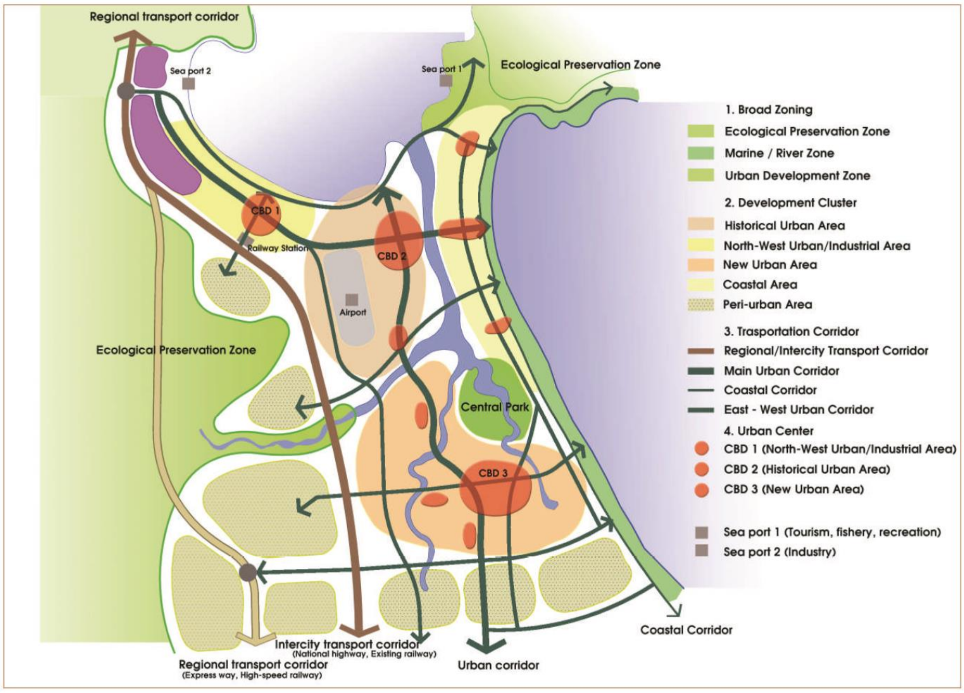
- As an international gateway, Da Nang City connects to the world via air to Asian countries in particular, not via Hanoi and HCMC. Thus, its connection with neighbouring countries through the GMS East–West Corridor is strengthened. Meanwhile, it connects with the major cities in Viet Nam, including Hanoi City and HCMC by attracting tourism, recreation and investment from HCMC and Hanoi City.
- Da Nang City's development strategies aim to maximise the welfare of citizens with a synergistic effect by incorporating the external factors such as strengths of the central region and connectivity with other foreign and domestic areas.
- Da Nang City strengthens its cooperation with Hue and Quang Nam Provinces for regional coordination.
- National projects that have a significant value to Da Nang City include the North–South highway, North–South high-speed railway, North–South railway improvement, port development, and airport development.
- Da Nang City aims for a 2.5 million to 3 million population as part of its aspiration to become a competitive urban centre that boasts of high-quality services.
- Da Nang City has a limited land area that is surrounded by the sea to the east, mountains to the west, and mountains and sea to the north. Compact city development is made possible by the south-to-north mass rapid transit, and development of central business districts, as well as well-managed population rate and urbanisation.

Based on the DaCRISS discussions, basic concepts are included in the proposed Master Plan. For example, central business districts are designated as follows:

- Existing city centres (Hai Chau District, Thanh Khe District, part of Son Tra District) where Provincial People's Committee, Han River and the airport are located.
- Ngu Hang Son District, where district PCs are located and home to cultural heritage sites as well as the Marble Mountains. Here, small-scale businesses cluster.
- Lien Chieu District, as the new north-west central business district, has high development potential, thanks to the National Highway 1A, industrial zones, and Lien Chieu Port. The railway station will be relocated to this area, although it will take a while for the district to develop new urban areas.

- Cam Le District in the south has a population that has not increased although basic infrastructure is already in place.

Figure 2.10: Urban Structure of Da Nang City



Source: DaCRISS (2009).

<u>Amended City Master Plan</u>

After numerous deliberations and amendments on the original proposal, the master plan was finally submitted to and approved by the Prime Minister of Viet Nam in December 2013. The goals, vision, and scope of the goal are summarised as follows:

<u>Development Goals:</u>

- To develop Da Nang city into a modern, urban centre that contributes to the social and economic development of the central and highland region of Viet Nam.
- To implement the spatial urban development of the city in a comprehensive and sustainable manner, ensuring good security and defence capability.

<u>Vision for 2050:</u>

- To construct and develop Da Nang City into a specialised city that is oriented to become a sustainably developed, world-class urban centre.

<u>Population Forecasts:</u>

- The population of Da Nang City in 2012 was approximately 967,800, of which the urban population consisted of about 822,630.

- The population forecast for 2020 is about 1.6 million, of which the urban population will be about 1.3 million.
- For 2030, the population forecast for Da Nang City is about 2.5 million (including temporary population and tourists in 2030), of which the urban population will be approximately 2.3 million.

Specific Development Orientations Determined:

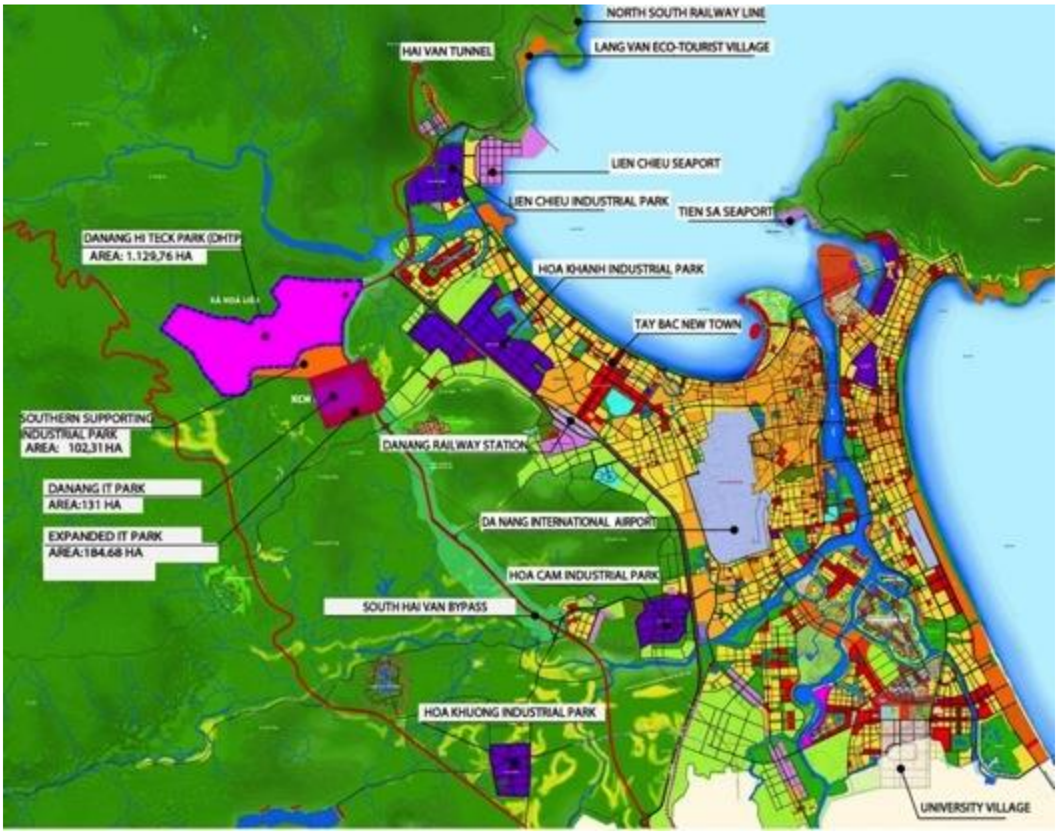
- Urban spatial development orientation
- Urban design orientation
- Development orientation of technical infrastructure system
- Strategic environment assessment
- Prioritised programmes and projects

In the master plan, the importance of a target modal share of public transport is described as thus:

According to the report by the Japan International Cooperation Agency (JICA) on the development master plan of Da Nang for 2030 (DaCRISS), target modal share (*Share*: motorcycles*,* 50 percent*;* cars*,* 15 percent*;* buses*,* 35 percent*. Passenger* occupancy: motorcycle*,* 1.3*;* car*,* 2.0*;* bus*,* 36) was recommended and *to be* used as a basis for master planning of the urban transport network in Da Nang *C*ity.

The amended master plan gave the number of potential public transport corridors as three metro lines, 8 BRT corridors and 15 bus corridors.

Figure 2.11: General Construction Plan of Da Nang City in 2030 with Vision for 2050



Source: General Construction Plan of Da Nang City in 2030 with Vision for 2050.

Threats of Current Development Trend

Coverage of the master plan is limited to Da Nang City only, but the actual development trend is moving toward Quang Nam Province on the south side. While the resort development along the coast has progressed rapidly in particular, there is also a lack of resources for the infrastructure development

Construction of high-rise buildings is in progress along the Han River. Unfortunately, the area has also seen its landscape deteriorate as commercial signages began to proliferate along the river. Because Da Nang airport is located in the city centre, building height is controlled but there are no landscape regulations in place.

As part of the plan to turn Da Nang City into the site for IT-based industrial development, the construction of a high-tech park is under way. At present, there are Japanese companies operating in existing industrial parks, which generate employment for Da Nang City and neighbouring provinces. However, many of these companies are challenged by a lack of available managerial pool and by the poor performance of engineers.

2.3 Urban Transport Master Plan

In 2012, the Department of Transport of Da Nang drafted the 'Urban Transport Master Plan in 2020 with a Vision Towards 2030', with support from the World Bank. This comprehensive transport management plan covered the development of road networks, bridges, parking, public transport networks, signal and traffic management, etc. It was approved in April 2014.

The network plans for road and public transport for 2030 are shown in Figures 2.12 and 2.13.

Figure 2.12: Road Network Plan for 2030

Source: Urban Transport Master Plan in Da Nang in 2020 with a Vision Towards 2030.

Figure 2.13: Public Transport Plan for 2030

Source: Urban Transport Master Plan in Da Nang in 2020 with a Vision Towards 2030.

2.4 Public Bus Transport Plan

In November 2013, the 'Master Plan for Public Passenger Transport by Bus in Da Nang City for the period 2013–2020 and Vision for 2030' was issued. Its objectives are as follows:

Overall Goal: To develop public passenger transport by bus for the period 2013–2020 and reduce traffic congestion and road traffic accidents in Da Nang City.

Specific Objectives:

- Occupancy of public passenger transport sector up to 2020 shall be 20 percent of all travel demand, of which public passenger transport by bus accounts for 9 percent while that by BRT bus shall be 3 percent.
- Control road traffic accidents and improve traffic safety in urban areas and neighbourhoods.
- Reduce energy consumption and emissions from the transport sector in general and from public passenger transport in particular so as to protect the urban environment.
- Promote the economic development of Da Nang City and provinces in Central Viet Nam's Economic Focal Region.

Route Network:

- Period of 2013–2015: Network of public buses consists of 11 routes of ordinary buses.
- 2015–2020: Network of public buses will have 20 routes: two BRT routes, three BRT standard routes, and 15 routes for normal buses.
- 2020–2025: Network of public buses consists of 26 routes: four BRT routes, three BRT standard routes, and 19 routes for normal buses.
- 2025–2030: Network of public buses consists of 28 routes: four BRT routes, three BRT standard routes, and 21 routes for normal buses.

Ongoing BRT Project

After the Priority Infrastructure Investment Project (PIIP) was completed in June 2008, the five-year Sustainable Development Project was commenced in June 2013. The PIIP includes four components:

- Bus Rapid Transit (BRT)
- Da Nang–Quang Ngai Ring Road (7 km in the north, 7.8 km in the southern part)
- Three sewerage treatment plants and pipelines
- Capacity development for above

According to the World Bank, the BRT lines are expected to be operational in 2017.

CHAPTER 3

POLICY COMBINATIONS FOR MODAL SHIFTS

1. Introduction

Traffic congestion is one of the common problems in urban cities of modern nations. The problem manifests itself as a country undergoes economic growth, which is often accompanied by mass motorisation. In developing cities, an increase in traffic volume is not considered a problem; on the contrary, it is viewed as a favourable phenomenon as it symbolises economic growth. There was a time when market mechanisms, i.e. the price of the car, curbed car use. However, as the population and personal income grow, more people become private cars owners.

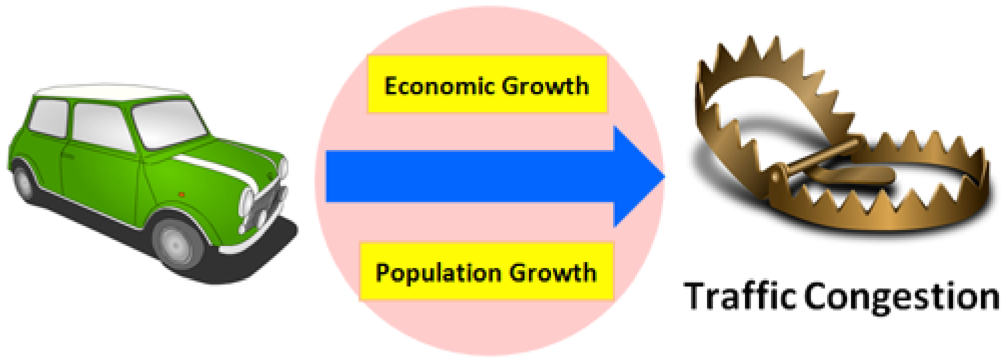
This trend lasts until the disincentive—in the form of the number of hours spent stuck in traffic, the accompanying stress, as well as the environmental implications brought by too many vehicles—exceeds the incentive to buy and use a new private vehicle. Traffic congestion, if left unmitigated, negatively affects a country's economy, ecology, energy security, as well as individuals' mental health. While most public policymakers understand the urgency in averting the inefficiencies brought by traffic congestion, the irony is that quite a number of cities continue to suffer from such.

Why then do such transportation bottlenecks persist? The main reason is the tendency of stakeholders to do nothing until the consequences of the situation escalate. When the situation is not deemed serious enough, ordinary citizens will never raise their voices. Similarly, politicians are unlikely to tackle an issue that is a concern to only a few voters.

Past research studies noted that the problem with congestion is hard to resolve once they arise. For one, it is not easy to reduce the need to travel. People do not simply stop driving just because of traffic congestion. In this regard, this study has taken a look at several solutions to the traffic problems, and has identified two of what seem to be the most suitable frameworks. One is the 'advanced automobile society', which is characterised by optimisation of traffic flow and liquidity. This method aims to enable vehicles to move as smoothly as possible via road reforms and the introduction of new technologies. This framework sees the increase in car use as an inevitable course of events and tries to tackle it from the perspective of road capacity adjustment and traffic efficiency.

The other is 'sustainable compact society with modal shift', which tries to control car use volume and shift it to other forms of transport. In both ways, the solution often results in a conflicting policy that further hinders the present traffic's function. For example, road widening and metro rail construction both hamper the existing traffic flow during the construction period. Besides, owing to the heavy traffic congestion, some transport systems such as buses without exclusive bus lanes do not function normally and will create dissatisfied bus users. This will eventually result in a recurring traffic congestion and an unpopular public transport system. In many situations, traffic congestion *per se* makes the congestion more intractable. Worse, most of the solutions require vast amounts of funds within a short period. Financial limitation can delay any resolution. Thus, some cities are mired in this 'traffic congestion trap' with the pain of serious economic loss.

Figure 3.1: Traffic Congestion Trap



Traffic Congestion Trap

1, We do nothing until the situation gets serious.

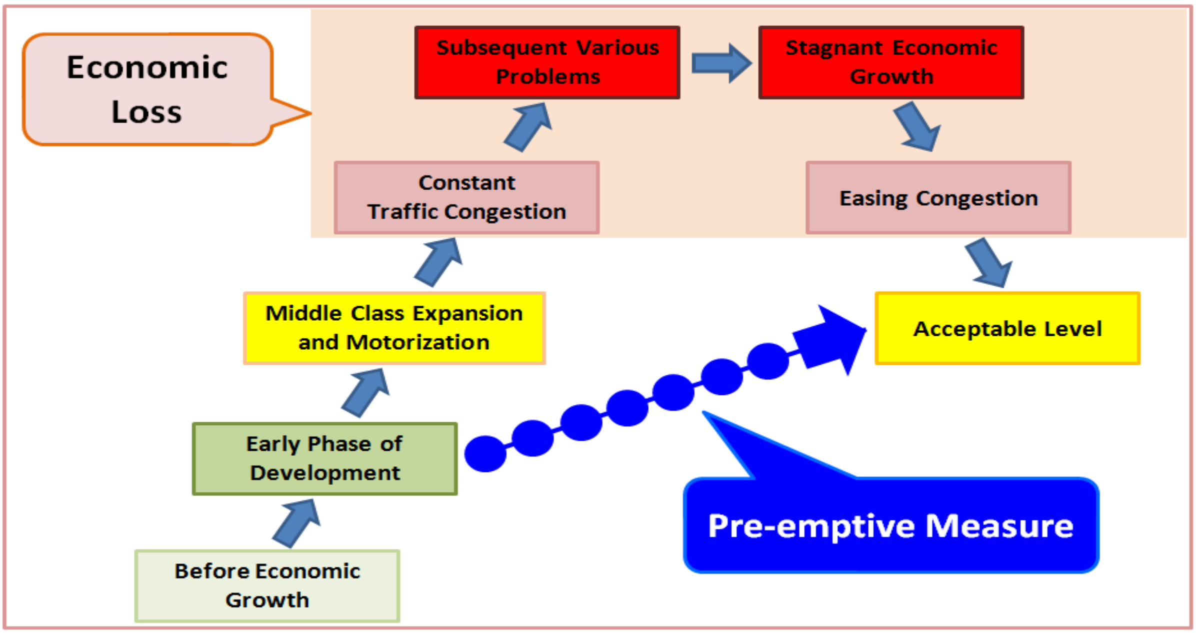
2, The problem is hard to resolve once it arises.

Source : Author.

It has to be remembered that traffic problems are a symbol of economic development and, in a sense, somewhat reasonable and 'structurally natural'. Hence, the remedy to the problem can often be stressful and detestable to car users. Car users may be like a child who is outraged when his parent takes away the candy he bought with money he saved up for a long time, because the candy is deemed detrimental to his health. Worse, some solutions entail actual economic loss in the short term.

In all these, one however needs to defy the normal development process and avoid the mistakes that some leading cities have made. As mentioned earlier, once a city gets into a bad traffic situation, it will be unnecessarily arduous even to take countermeasures. It would make sense instead to set up every pre-emptive measure possible in the early phase of economic development, before full-scale motorisation happens.

Figure 3.2: Concept of Pre-emptive Measures



Source : Author.

Pre-emptive measures are effective because they can make it possible to develop relevant measures unaffected by existing problems. In contrast, it is historically obvious that reactive measures entail a lot of difficulties. However, this does not mean that pre-emptive measures are less difficult than reactive measures. After all, pre-emptive measures are associated with different types of difficulty.

In the case of the reactive measures, citizens in cities are extremely fed up with road congestion and hungry for a magic bullet to solve the traffic situation. This particular state of mind plays a significant role when implementing the countermeasures.

Many will be willing to pay taxes for road widening or the introduction of public transport systems. In the pre-emptive case, such disposition or stance cannot be expected because people in this scenario have nothing to complain about with the current traffic situation. Thus, they might furiously oppose the imposition of taxes. Simply put, it is very difficult for the pre-emptive measures to acquire public sympathy.

Thus, to make people realise the gravity of the future traffic problems (in pre-emptive scenarios), the first step would be to raise awareness of the problem throughout the city. Since the correlation between GDP per capita and the private car ownership ratio is corroborated by numerous data, the future traffic problems are to some extent foreseeable. Based on the projected GDP per capita and population growth, the approximate number of cars and the timing of emergence and scale of the traffic problems in the future city may be calculated. Where possible, the economic loss or environmental impact brought by the traffic congestion should also be computed. These projections will not only contribute to raising awareness on problems but help as well in making a concrete plan for the pre-emptive measures. In any case, pre-emptive measures cannot be specific and persuasive enough without an explicit picture of the future traffic problem. Clear awareness of the problem itself is thus a must.

Only a few cities have succeeded in taking pre-emptive measures. However, most of the cities that have overcome seriously bad traffic situations are generally characterised by some sort of successful 'modal shift'. Thus, this report will dissect the effective ways to realise the modal shift, especially for pre-emptive measures that were put in place through the introduction of a public transportation system. It will mainly focus on the policy aspect rather than operation, technique, or traffic engineering for when it comes to pre-emptive modal shift, a persistent policy stance is indispensable, and undoubtedly will be the key success factor.

2. Compact City and City Design

As mentioned in the previous section, two frameworks seem to offer the most suitable solution to traffic congestion: 'advanced automobile society' and 'sustainable compact society with modal shift'. Table 3.1 shows the typical features of each solution.

Table 3.1: Modal Shift and Automobile Society

	Modal Shift (Public Transport)	Modal Shift (Walking & Cycling)	Automobile Society
Density	High	Super High	Low
City Function	Centralised / Multi-core	Focused	Decentralised
Travel Distance	Medium	Short	All Distances
Required Road Capacity	Small / Medium	Small / Medium (+ Cycling Roads)	Large
Other Infrastructure	Efficient	Efficient	High Cost
Vulnerable Group	Residents out of Public Transportation Service Area	Elderly/ Suburban Residents	Low Income / Elderly/ Children / Disabled
Strong Points	Energy Efficient Eco-friendly Traffic Specialisation	Flexibility Low Stress Eco-friendly	Flexibility Low Stress
Weak Points	Urban Stress Less Privacy	Low Speed Distance Constraints Vulnerable to Weather Conditions	High Accident Risk Affected by Health Eco-unfriendly

Source: Author.

If a society shall depend only on private cars, it would have no choice but to keep the city area decentralised because even the largest capacity roads and leading-edge technology cannot prevent traffic congestion when a large number of citizens converge in the central area. It would be impractical to build parking spaces as this would mean having to accommodate millions of cars in a very limited area. As a result, the city would naturally sprawl out. Some automobile societies in the world (for example, Los Angeles) demonstrate the sprawl phenomenon and large road capacity. However, decentralisation is not always observed. As the population grows, many of these cities become exposed to the imperfections of the traffic system. In addition, the structure of the sprawling city is inconvenient from the aspect of investment cost. In sprawling cities, not only roads but also other infrastructure such as channels or electric cables require huge investment.

Since there exist certain limitations behind transport expansionist policies and economic inefficiency in automobile societies, this report will mainly cover the policies for compact societies with modal shifts. In practice, however, there is no pure and simple automobile society or compact society with modal shifts. The question is going to be where and when, or how much to take of each measure according to the situation of the city.

As each city has a different background and situation, there are a number of ways to implement modal shifts. In fact, various combinations of measures can be considered for each location's case. However, when implementing a modal shift in advance of all the measures, there is one indispensable variable: the existence of substitute goods. The underlying cause of traffic congestion is a relatively advanced travel demand. That is, to avoid or mitigate traffic congestion with a modal shift, the travel needs of people who have abandoned or refrained from purchasing private cars should be addressed by substitute goods.

Substitute goods here generally mean the public transport system. Based on the outlook of the city, a concrete introduction plan—which includes the type of transport system and vehicle, as well as the timing—will be instituted. At this stage, the planner must address and identify the network route of the system, including the access and egress, transfer connections, and so on. Initial efforts to determine the whole route through simulation based on a city map will perhaps be in vain, noticing that a city without a public transport system is founded on the premise that one is essentially not to be contained.

This thus creates an enormous gap between the ideal situation and reality. For convenience, this gap shall be called 'disharmony between the city and transport system'. It can be loosely categorised into two general types: physical and economic. Physical disharmony is very simple. For example, even if the planner plans to have a bus route on a certain street, there are cases when the road is too narrow for buses to pass through (i.e. designed more for pedestrians). In this case, one finds that there is enough latent demand, but the system cannot function physically.

Economic disharmony, meanwhile, is exemplified by the case where the city planner wants to extend the route to a certain area, but the number of expected passengers is too few to be profitable.

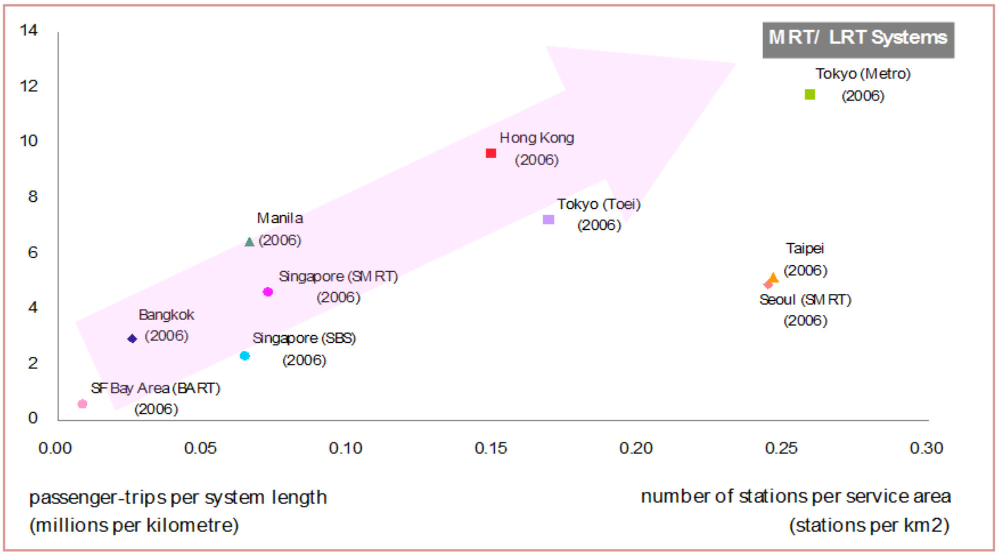
Meanwhile, to evolve into a 'sustainable compact society with modal shift', it is the city—not the bus route—that must make drastic changes. This is because the transport system may be beyond the scope of the city's original plans or might have spontaneously evolved without any intent or plan. Establishing a transport system plan is essentially synonymous with making a city plan.

Aside from resolving the disharmony between the transport system and city, city plans are requisites for another reason. A compact city model is immensely effective to prompt modal shifts in transport. In this context, a city plan is needed to convert a city to the more appropriate form that can accommodate modal shifts. Moreover, some traffic problems can be solved through city reforms. For example, putting homes and workplaces in close proximity to each other will readjust commuters' travel demand drastically. The redevelopment of slum areas and inhibiting city sprawl will also improve economic and energy efficiency.

A bold and clear vision of the city plan defines the strategy and design for its public transport system. As mentioned earlier, reactive measures are difficult not just because coping with a traffic problem becomes more challenging after it gets too serious, but partly because of the absence of a reliable city plan that covers the fundamentals of the transport plan. In a slightly extreme case, it might be reasonable for a policymaker to purposely adopt a do-nothing policy for areas that a city plan had designated as urbanisation control areas, and instead focus on developing an urbanisation promotion area so that more city dwellers will relocate their residence according to the strategy of the city plan. However, *posteriori* supportive measures often result in inconsistent stopgap actions. Without a city plan, while each tactical countermeasure might work independently, it will never be an essential or consistent measure. A reactive measure does not control the traffic; quite the reverse, it is controlled by traffic problems.

A compact city is the key success factor because first of all, its presence facilitates modal shifts. Generally, most people head for the central area of a city in the morning for work or study, and in the other direction in the evening. High population density in compact cities—because of the sheer volume of passengers—leads to higher frequency and better accessibility of the public transport system. Furthermore, a fulfilling transport network enhances the convenience of an area and attracts more and more people there. The relation between more passengers and an excellent transport system creates a kind of virtuous cycle of modal shifts and changes the transport structure of a city.

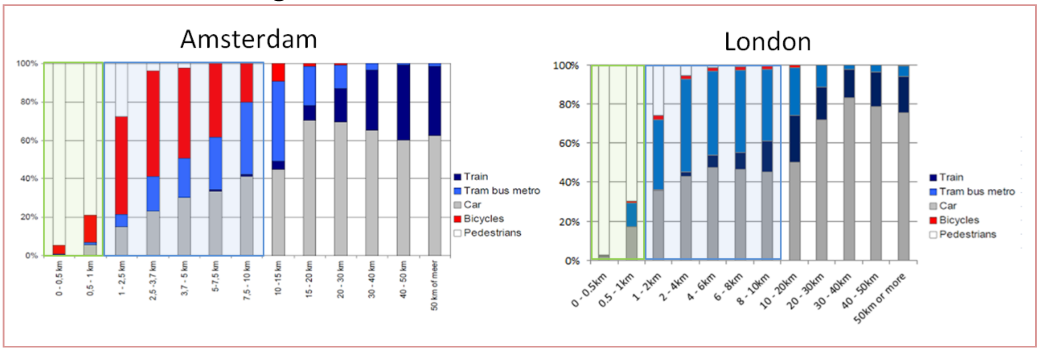
Figure 3.3: Accessibility and Modal Shift



Source: APERC, Urban Transport Energy Use in the APEC Region.

Another reason a compact city is a success factor in modal shifts is that it shortens the distance commuters have to travel. 'Compactifying' the city directly means the geological compression of each function of the city—that is to say, from house to school or from one office to another. This will help save energy in the transport sector. It also enables other types of modal shifts, particularly walking and cycling. Data show that if the conditions are right, people are likely to choose 'walking' and 'bicycling' when the travel distance is under 1 km and 10 km, respectively. The graph below shows the modal split for Amsterdam and London. The walking ratio is clearly high when the travel distance is within 1 km. In Amsterdam, the cycling ratio is also high within 10 km, while the public transport system is popular in London for within the 10-km distance. There are, of course, relevant conditions that explain the difference in results for the two cities: climatic variance such as the amount of rainfall in Amsterdam versus in London that makes one more conducive for biking or walking, preferences of residents for one mode of transport, amount of cycle roads or parking spaces, quality of walkways, etc.

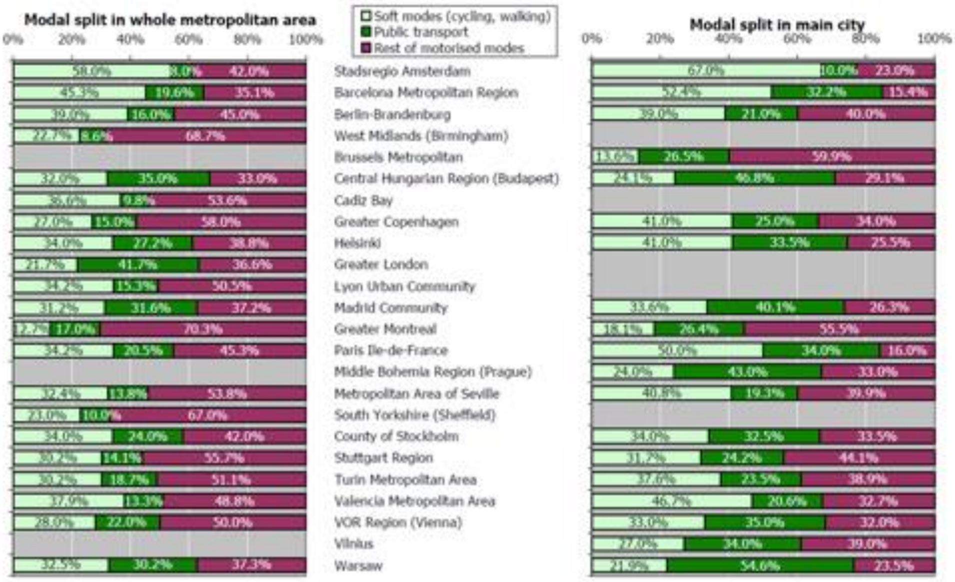
Figure 3.4: Modal Share of Amsterdam and London



Source: René Meijer, Traffic planning in Amsterdam, 2012.

The next graph approaches the subject from a different angle, showing that, without any known exception, modal shifts are more successful in the main or central city areas than in local or suburban zones of the city. This contributes to the profitability of investment and efficiency of public transport systems and other infrastructure such as walkways or cycling roads.

Figure 3.5: Modal Split in Metropolitan Areas and Main Cities



Source: EMTA, Barometer of public transport in European metropolitan areas.

In addition, a compact city is preferred from the perspective of other economic efficiency considerations. Cost of infrastructure development is determined by its scale—i.e. the area of paved roads or the length of water pipes or electric cables. This is not a one-off cost but a long-lasting imposition as it requires maintenance fees, which usually increase with age and wear. The same is true for rail tracks. A compact city will decrease these costs by narrowing down the area of development (Table 3.2). This will surely contribute to the productivity and competitiveness of businesses as well as help households in an area, thus resulting in a sustainable transport system reform.

Table 3.2: City Design and Public Service Cost

Public Services Capital Costs, Billions

	Dispersed	Compact	Difference
Roadways	$17.6	$11.2	$6.4 (-36%)
Transit	$6.8	6.2	0.6 (-9%)
Water and Wastewater	$5.5	$2.5	$3.0 (-54)
Fire Stations	$0.5	$0.3	$0.2 (-46%)
Recreation Centres	$1.1	$0.9	$0.2 (-19%)
Schools	$3.0	$2.2	$0.8 (-27%)
Totals	$34.5	$23.3	$11.2 (-33%)

Source: VTPI, Smart Growth Savings (2014).

One has to keep in mind that travel demand is generally not an essential demand—in the same way that shopping is not an essential demand. In the process of economic development, social division of labour has proceeded deeply. Unlike in olden times, today's people are unable to supply even essential commodities of life by themselves; everyone has become professionals who needs to travel to the offices to work as well as to move around to benefit from other professionals—benefits whose utility is much higher than the cost of travelling. Some people might like driving or shopping per se, but most just want to reach a destination or obtain something such that if it were possible to skip having to drive or get to a grocery store, many people would gladly do so. The purpose of a transport reform is to improve the efficiency of, or minimise, this extra process. A compact city aims to shorten the travel distance, which has to actualise the incorporation of professional people.

Nonetheless, however compact a community can be, it is impossible to rid city dwellers of all the travel demands because there are just too many professions in modern societies. For example, according to the Ministry of Labor of Japan, there are around 30,000 professions. In spite of the progress in information technology, the transfer of people or goods is indispensable in connecting these different parts and substantialise organically tied and highly divisional society. Ultimately, the question turns to: 'How can we travel more efficiently?' In this sense, modal shifts are a sophistication of society. Productivity is improved by mechanisation and upsizing. Like industrialisation, societies entrust their travel to professional drivers under the principle of division of labour. In this sense, driving a car is like city dwellers engaging in farming for fun. Both might be reasonable as a hobby. They are an interesting and healthy activity; however, few people would think of them as socially efficient endeavours.

To make traffic reforms more effective, policymakers should think about the city per se before turning to the transport policy. City reforms are one of the strong points of pre-emptive measures. Pre-emptive measures can tailor-fit the structure of a city with the transport system—something that is very difficult, if not impossible, to execute under reactive measures as such will cause a huge burden on the city's existing structure and economy. This may be one reason a metro rail is often preferred as a countermeasure—i.e. it can be built with little harmful effects on the existing social system.

3. Policy Analysis and Strategic Combination

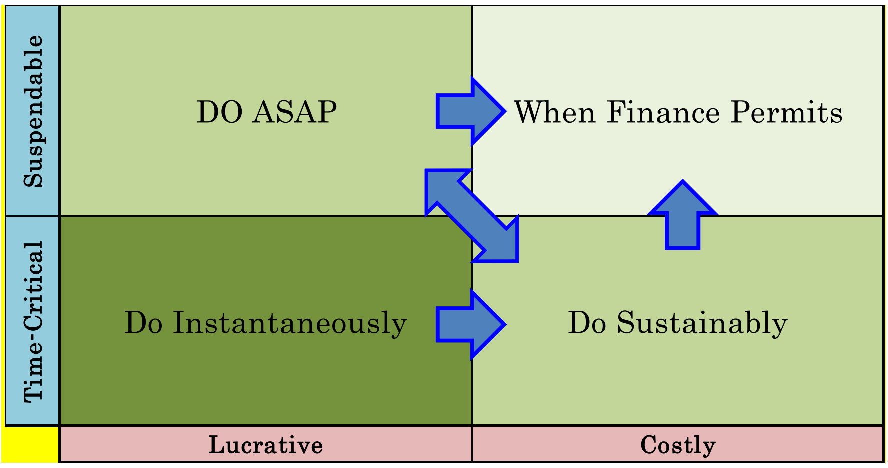
Whether building a public transport system or making a city plan, it is a common fact that both require huge amounts of money. Securing financial resources for a project is one of two objectives of relevant policies. The other objective is to provide a strong incentive: In this case, the traffic congestion itself is naturally expected to cause modal shifts. After all, in today's post-motorisation societies, people are strongly motivated to grapple with traffic problems. It is this motivation that facilitates the modal shift immensely.

Typical options for the first objective—i.e. securing funds—are taxation and licensing systems, which usually also drive modal shifts because they increase the costs of car users.

Addressing transport problems requires a combination of policies. Measures do not have to be effected all at the same time, though. With sustainability in mind, these measures should be implemented gradually and at the right time (Figure 3.6). Although many factors determine the right timing of implementation (e.g. public opinion or economic conditions), two indicators—cost and urgency—are critically associated with the sustainability of a plan. When financial support is not enough, implementing a costly project will be risky. In fact, financial sustainability is required not only for reforms in the transport sector. Securing financing for *any* project is always an absolute requirement from policymakers.

Meanwhile, acquiring a sense of urgency is one lesson that can be learned from past transport reform cases. What tends to be ignored in the reform process is the timing. Most cities caught in the congestion trap had not taken effective measures in advance. Urgency thus is key in discerning what measures should be taken pre-emptively.

Figure 3.6: Transport Measure Matrix



Source: Author.

Transport policies can be categorised according to their features (Table 3-3). Some policies directly affect travel demand whereas some deal with the problem by improving traffic liquidity. As there are multiple ways to resolve traffic issues, the most sensible goal is to target an efficient traffic system rather than aim for an extreme objective such as a total ban of car utilisation. Assuming that the goals are set at a reasonable level, a combination of policies is the best way to address existing transport issues.

Table 3.3: Categories of Transport Policy

Travel Demand		Traffic Liquidity	
Rid	Home Office Telephone Meetings	Road Capacity	Road Widening Increase Lanes
Reduce	Compact City Fuel Tax	Road Structure	Grade Separation Linearization
Substitute	Public Transport Walkway Arrangements Rental Cycles	Others	Drainage / ETC Parking Enforcement Strict Licensing Safety Rules
Time	Flextime System Equalize Vacations		

Source: Author.

In this section, some of these policies are identified and analysed from different angles such as cost, urgency, impact, and advantages/disadvantages. Again, the challenge here is how to combine varied measures to have the best mix of traffic solutions for the city.

3.1 Fuel Tax

Imposing an effective tax on gasoline and diesel is the most recommended measure. Rather than adopt one-off methods, a continual and specific duty is effective in driving modal shifts. Figure 3.7 shows the gas price and tax in several countries. Although tax rates differ from country to country, the average revenue from environment tax—90 percent of which comes from gasoline tax—represents about 2 percent to 2.5 percent of GDP.

Figure 3.7: Price and Tax of Gasoline

Source: International Energy Agency (IEA), Energy Prices and Taxes, 2nd Quarter 2014.

Fuel tax is tremendously effective in controlling the demand for fuel, too. According to an earlier study, the short-term price elasticity of gasoline is -0.13 to -0.26 percent. However, in the long term, it rises to -0.37 to -0.46. On the other hand, note that the short-term elasticity is not significantly high because cars are a type of quality good that only a few people will discard before the end of their life cycle because of high oil prices. In this light, gasoline tax ought to be introduced in advance. It goes without saying that the level of price elasticity is affected by related social circumstances, including the situation of substitute goods or traffic conditions.

Typical concerns around fuel tax are ‘international competitiveness of the energy-intensive industry’, ‘management cost’, and ‘regressivity of taxation’. A decline in international competitiveness of certain industries is often regarded as a downside of fuel tax imposition; however, data do not show that competitiveness deteriorates in majority of countries. Most environmental taxes are imposed mainly on the household and transport sectors; the industrial sector is usually exempted from these. In other words, even if the competitiveness of a specific industry deteriorates, such does not directly mean a loss for the whole country. Management costs of tax reforms, meanwhile, are acceptably low. For instance, in Germany, the total management cost of tax system reform is said to be only 0.13 percent of its revenue. When introduced at the state level, total operating cost (including tax collection and project assessment) is about 0.9 percent of revenue.

Regressivity of taxes is also a point of dispute. Some data seem to show that fuel tax is regressive; some do not. To mitigate this regressivity, some researchers note that reducing other tax rates is effective. However, this particular study is adopting a different stance on the issue: It categorises private cars as luxury goods because their users are usually in the relatively wealthy strata of society. Therefore, this study states that (1) when a city has reasonable substitute goods for cars, the policymaker need not align the regressivity of the fuel tax, and (2) car users have the right to enjoy driving their cars freely at a cost commensurate with its luxury. Using the tax revenue as a financial source for modal shifts can contribute to fair income redistribution as it will benefit sectors of society who struggle financially.

3.2. Vehicle Tax

Vehicle tax is another main automobile-related tax that has been introduced in many countries. There are two key points on vehicle taxes: (i) the timing of imposition, i.e. whether at the time of acquisition only or a periodic imposition; and (ii) rate setting.

With regard to timing, a 'periodic and step-up' imposition is recommended because a one-time imposition will not incentivise car users to shift to other modes of transport. A one-time imposition sometimes encourages car owners to use their vehicle as long as possible as they feel that the car is all the more worth keeping for the cost they have paid. Step-up imposition, meanwhile, will discourage people to own the same car for a long time. This may not be favourable to owners considering the long life of durable items, but such scheme will facilitate modal shifts and encourage new technology that will contribute to energy efficiency. For example, Japan imposes a vehicle acquisition tax whereas the United States, United Kingdom, and Germany do not in principle, with some exceptions. What should be noted is that all these countries have in place a car ownership tax that is imposed periodically.

The table below shows the vehicle tax of private cars in the United Kingdom. There are 13 car emission bands, and the tax rate differs according to emission levels (Table 3.4). Other vehicles such as heavy goods vehicles or motorcycles also have several emission bands with their concomitant tax rates.

Table 3.4: Vehicle Tax in the United Kingdom

Car emission band		Standard Cost (£)	Cost for first year (£)
Band A	(up to 101 g/km)	0	0
Band B	(101-111 g/km)	20	0
Band C	(111-121 g/km)	30	0
Band D	(121-131 g/km)	105	0
Band E	(131-141 g/km)	125	125
Band F	(141- 151 g/km)	140	140
Band G	(151 to 166 g/km)	175	175
Band H	(166 to 176 g/km)	200	285
Band I	(176 to 186 g/km)	220	335
Band J	(186 to 201 g/km)	260	475
Band K	(201 to 226 g/km)	280	620
Band L	(226 to 256 g/km)	475	840
Band M	(Over 256 g/km)	490	1065

Source: Gov.UK, https://www.gov.uk/vehicle-tax-rate-tables

3.3 Congestion Charge

A toll charge is a type of duty that attempts to resolve traffic congestion by charging cars directly for use of public roads. The common aim of a toll charge is the optimisation of traffic volume. This is an effective way to control the traffic volume in some limited areas although its management method and cost are not as simple. When a road has several access points, all these points have to be managed or else car drivers would have a way to avoid paying the fee. This, thus, either increases the operating costs as it will mean having to install more toll gates or instituting efficient surveillance systems, or debases the accessibility of the area by blockading connecting passages.

In London's case, the congestion charge zone (Figure 3-8) was introduced in 2003. According to Transport for London, the imposition of the congestion charge drove 10 percent to 18 percent of the area's car drivers to switch to public transport in the first six months and resulted in a 10 percent reduction in the city's traffic volume between 2000 and 2012. It imposed a standard charge of £11.50 for each day, and total revenue went up to more than £200 million. More than half of the revenue was spent on running the toll system. While the operating cost is high, the operation also contributed to job security in the area.

One upside in this case is that drivers often welcome the charges. They generally detest the congestion, so some do support the charge system and are even willing to pay the toll in exchange for a comfortable road drive. In sum, this is a question of balancing toll rate and the severity of congestion. Theoretically, the rate should be increased until the target traffic liquidity improvement is obtained.

If modal shifts are to be driven by this duty, attention should be given to the side effects of the policy, including motorists' propensity to shift to exempted vehicles or disorderly street parking outside of the congestion zone. A situation where one countermeasure causes more or equally complicated problems should be avoided. In this case, policymakers should have an appropriate sense of purpose and be able to discern the pros and cons of each taxation.

Figure 3.8: Congestion Charge Zone in London

Source: Author.

3.4 Driving Licence

Most countries adopt a driving licence system. This requisite is rarely used as a measure for modal shifts. Thus, this is where the licence system in Japan differs from other countries. Its period of validity is relatively short (usually three years) compared to the 5 to 10 years or unlimited in many countries. While the short validity is often not welcomed by drivers, the frequent renewal requirements might be effective in three ways. First, the process of licence renewal itself can be an incentive for modal shifts. It prompts drivers to reconsider other transport alternatives other than their personal vehicles.

Second, it can be a source of revenue. Although the amount involved is not substantial, the collection can fund traffic reforms. For example, in Tokyo more than 8 billion yen (US$70 million) is collected from licence commission fees and related services. The amount is equivalent to about a fifth of the diesel tax revenue.

Lastly, the driving licence can be used as a means to improve the driving manners of car users. Refresher trainings can be used as a pre-requisite to the renewal process so as to evoke drivers' safety awareness. This would also be the perfect opportunity to remind drivers to avoid parking on the streets, or to give the right-of-way to public vehicles if bus rapid transit (BRT) or light rail transit runs in the city.

In sum, Tokyo's process exemplifies how its licensing system can be used for modal shifts. As maintaining the system involves a huge operating cost, it does make sense to maximise its latent capabilities.

3.5 Remove Obstacles on the Road

The Road Traffic Act lists what constitutes traffic violations. It is useless to enact a law in name only, so enforcement is important from a practical aspect. There are many violations, some affecting traffic liquidity, but those that most aggravate the traffic situation are ‘traffic accidents’ and ‘street parking’.

Traffic accidents mostly occur because of drivers’ mental and physical conditions—e.g. alcohol involvement, distraction or impatience—rather than technical or climatic factors. The number of road fatalities per number of motor vehicles is said to be lesser in frigid snowy areas despite the bad conditions such as frozen roads. According to the Saskatchewan Government Insurance data, 48 percent of collisions in urban areas are due to ‘human causes’. The top three driver-caused actions are ‘failing to yield’, ‘following too closely’, and ‘driving too fast’.

Meanwhile, ‘driver’s inattention’, which is classified as a human condition, is the biggest factor in accidents. While driving too fast may be curbed by enforcing speed limits or imposing massive fines, it is not easy to handle the three human causes earlier mentioned. The second biggest cause is road conditions, including structure.

Although street parking is, as mentioned earlier, one of the significant causes of road congestion, this is easier to mitigate directly, unlike traffic accidents. Effective measures are already in place to curb street parking.

Parking facility management covers the two objectives of transport policies: securing financial sustainability and promoting modal shift. To effect modal shift, market mechanisms may not be as effective. Market mechanisms function beautifully when the aim is to achieve the optimal balance of demand and supply. However, it is not necessarily ideal when the objective is to effect transport reforms.

Table 3.5 shows the differences between conventional policies and the more-recent smart growth parking policies. Conventional parking policies are problematic as they tend to promote more car utilisation because free and abundant parking supply is nothing less than an incentive for car use. Smart growth policies, on the other hand, are much better in many ways. Although the nuance of ‘optimal supply’ is unclear, this study takes the term to means the optimal supply in terms of the principle of market competition. If so, another concept is recommended by this study: the optimal supply for traffic liquidity. All in all, both the parking supply and pricing scheme can control the inflow and internal traffic volume to some extent, but these must be supported by two other policies: street parking crackdown and an advanced reservation system.

Table 3.5: Conventional and Smart Growth Parking Policies

Conventional Parking Policies	Smart Growth Parking Policies
Managed only for motorist convenience	Managed for transport system efficiency
Maximum parking supply	Optimal parking supply (not too little, not too much)
Prefers free parking	Prefers priced parking (user pays directly)
Dedicated parking facilities	Shared parking facilities
Favors lower-density, dispersed development	Favors compact development.

Source: Victoria Transport Policy Institute, https:www.vtpi.org/park_man.pdf#search='parking+report+problem+pdf'

Theoretically, the inflow and internal traffic volume (except passing and outgoing cars) can be managed by controlling the parking supply. After all, of what use is the car when there is no space to park around the destination? Under limited parking supply, some car drivers may need to use public transport or ask their acquaintance to give them a lift.

However, the principle behind the scheme cannot function without two supportive policies. When there are no parking lots, drivers resort to parking on the streets. Thus, there is a need to crack down on such parking violators to remove obstacles on the road and, more importantly, to control the oversupply of parked vehicles. In other words, parking supply plans and street parking management are inextricably interconnected. The oversupply of parking lots adds to traffic congestion, one of the typical external diseconomies. If it is difficult to control the number of parking lots due to a strong public backlash, then imposing a parking tax on parking space owners as an environmental tax may be an option. For example, employers in Nottingham (United Kingdom) that offer workplace parking spaces are required to apply for a Workplace Parking Levy licence and pay a fee. When the number of cars increases, it is structurally natural for the number of parking lots to increase to meet the demand; otherwise, drivers should find space to park on the streets. The purpose of a parking regulation here is not to minimise the traffic volume but to control it; to be exact, this is to ascertain that the traffic volume is proportionate to road capacity, lest the traffic flow slows down, causing harm to the economy.

Table 3.6: Parking and Traffic Volume and Parking Policies

Total Traffic Volume	Destination	Parking Demand
Passing Vehicle	Outside	No
Outflow Vehicle	Outside	No
Inflow Vehicle	Inside	Yes
Internal Vehicle	Inside	Yes

CONTROL

Parking Form	Price	Supply
Parking Lot	Regulation + Market Mechanisms	Control + Market Mechanisms
Street Parking	Free	Crackdown

Source: Author.

An advanced reservation system for the parking system is another option. As mentioned earlier, traffic reforms are determined by a combination of various measures. When other factors do not work enough to control traffic volume, then regulating the number of parking lots may be the other recourse.

However, one may ask: Is this really the case? Even if drivers are unsure of finding a vacant parking lot, they will not be deterred from driving around in search of one. They will keep driving all over town looking for a parking space in vain while emitting carbon dioxide, or make a queue for a parking space, thus contributing to the area's traffic congestion (Figure 3.9).

Figure 3.9: Long Lines for Parking

Source: Author.

When people travel to other cities, they feel secure when they have reserved a hotel room in advance. This early arrangement allows them to adjust their travel plans in cases where, for example, they cannot find a room to book. Such efficient booking option would not be possible had there been no advanced reservation system in place. In the same vein, control over the supply of parking spaces, including their pricing schemes, would work only when those on the demand side are aware of these. For example, perhaps a few car users will choose not to pay the parking fee and will rather drive back home if they find the fee to be more expensive than expected (or conversely, demand can increase if the parking fees are discounted). Disclosure and sharing of information, thus, are important in filling the gap between demand and supply.

The financial aspect is a very important consideration in policy or enforcement regulations. Although many governments try to cut operating costs by outsourcing some enforcement activities to private companies, the related expenditure still exceeds the income. Such is the case of a municipal government in the United Kingdom, as seen in its annual report in the table below. Data show that the total profit comes mainly from the income from parking fees. Note too that the enforcement cost is relatively high, mainly because of the cost of maintaining a pool of parking lot keepers and traffic wardens assigned to search for street-parking violators. Despite the cost, there is no reason to refrain from enforcing parking rules. The question though is how to make a sustainable policy mix whose expenditure is tolerable from a long-term perspective. In this sense, relying only on enforcement seems to be financially risky.

Table 3.7: Parking and Transport Income and Expenditure in Durham

	Income (£)	Expenditure (£)
Administration	0	468,475
Enforcement	644,468	842,810
On and Off Street Parking	2,061,578	438,152
Road User Charge and Access Management	2,650	52,717
Park and Ride	866,215	1,332,268
Total	£3,574,911	£3,134,422

Source: Durham Gov.UK, Parking & Transport Infrastructure Annual Report 2013/2014.

The issue regarding parking systems clearly demonstrates an important point. It seems that limiting the number of parking lots will never work out on its own. The regulation appears to have a latent ability to inhibit traffic volume, but this will simply increase street parking when no crackdown campaign against street parking violators is undertaken. This illustrates the importance of a combination of right policies and the downside of evaluating the effects of a policy on its own.

Getting the right mix of policies, though, can have its synergistic effects. For example, policymakers can facilitate the wide use of parking reservation systems by dictating that such process be taught in driving schools. In addition, the same directive can also instruct the school to suggest the use of public transportation systems in cases where the car user cannot make a space reservation. The point here is that policymakers should consider all the opportunities available to be able to arrive at the 'right mix' of policy actions.

3.6 Compact City

The second part of this paper has explained why creating a compact city is important. Yet, people have reasons for preferring to live in suburban areas: low stress, tranquil environment, and affordable land prices, to name three. This brings to fore two questions: Are there policies that support the development of a compact city? Conversely, are there economic incentives that promote the sprawling society instead?

Data in the previous section of this paper (Figures 3-2 and 3-10) indicate that a low population density in suburban areas will increase the cost of infrastructure. To promote a compact city and a shift in modes of transport, the government may consider introducing a different pricing scheme that imposes more charges on users in low-density areas. For example, the pricing schemes of water and sewage systems or electricity may reflect the extra cost following the beneficiaries pay principle. After all, the leisurely life in suburban areas, just like owning a private car, carries hidden costs because it entails extra infrastructure investment. Similarly, the government may also consider introducing suburban road taxes or reduce the fixed assets taxes in central areas.

There too is the concept of residential liquidity—i.e. promoting rented accommodations and supplying rental houses will be an important policy. Whether to impose a heavy tax on home purchases or not is a question with no ready answer yet. That is, while a tax on home purchase can be a disincentive for future home buyers, it can likewise incentivise existing homeowners to keep their homes longer simply because of the costs paid.

Figure 3.10: Suburban Roads and Cost of Getting to School

Source: Per Square Mile, http://persquaremile.com/category/sprawl

3.7 Other Policies

Although several policies here have been discussed, these are just the tip of the iceberg, so to speak. There remain many more transport policies that can be considered. Some of the important ones will be summarised below.

Table 3-8 lists the ‘Rid’ policies—policies that eradicate the extra need to travel directly and whose impact is high. For instance, private companies and staff may be encouraged to shift their work or lifestyles so they become the risk takers. Meanwhile, while consumers’ growing preference for online shopping can increase the travel demand of transport operators, the latter’s transport efficiency is generally higher than that of individual commuters. In the end, an increase in online shopping will eventually help reduce the traffic volume.

Table 3.8: 'Rid' Policies

Policy	Note
SOHO	Promote private companies Remote communication
Telephone Meetings	Same as above
Online Shopping	Travel demand of transport operators increases

Source: Author.

There are more measures under the 'Reduce' policies than what is listed in Table 3-9. Caution should be taken when implementing these policies because when users are reluctant, their reaction can aggravate the traffic situation. These policies may work better in tandem with other policies.

Table 3.9: 'Reduce' Policies

Policy	Note
Car-free District	Substitute transport is requisite
High Occupancy Vehicles Priority	Fake carpooling partner business
Freight Transport Management	Overloading, overwork

Source: Author.

In Table 3-10, public transport systems are part of the 'substitutes'. Conventional public transport vehicles have two advantages: accessibility and connectivity. They exist to allow commuters a swift transit and convenience on their way to their destination—advantages that can surpass the conveniences offered by a private vehicle.

Table 3.10: 'Substitute' Policies

Policy	Note
Public Transport	Finance, profitability, accessibility
Walkways	Same as above
Rental Cycles Park and Ride	Same as above
	Same as above

Source: Author.

'Time' policies (Table 3-11) approach traffic from a different angle. They focus on the temporal shift of traffic demand and increase road capacity by utilising time scales. This generally costs little as drivers only have to depart earlier or later. The issue, though, is whether such changes will affect their business.

Table 3.11: 'Time' Policies

Policy	Note
Flextime	Customer relations, internal communications
Work Schedule	Same as above

Source: Author.

On 'Road Improvement' policies (Table 3.12), any increase in road capacity and road structural enhancement will improve traffic liquidity. Most of these policies require enormous costs not only for investment but for maintenance as well. As tentative measures, they might be effective. However, these will not solve the fundamental problem with traffic volume. After all, road improvements do mean comfortable driving conditions for car users.

Table 3.12: 'Road Improvement' Policies

Policy	Note
Road Widening	Finance, Disincentive for Modal Shifts
Increase Lanes	Same as above
Bypass	Same as above
Grade Separation	Same as above
Road Linearisation	Same as above

Source: Author.

Table 3.13 is an excerpt from the report of a Canadian transport institute[4]. This list illustrates the scope of available strategies on mobility management. In the future, IT-related measures will become more and more important. Just like the benefits of an advanced reservation system, information on volume of vehicles on the road and the chance to avoid congestion spontaneously are valuable to car users. At the same time, it is also important to keep traffic options flexible so that people can choose to stop driving and shift to another transport mode easily such as that offered by the 'park and ride' scheme.

[4] https:www.vtpi.org/park_man.pdf#search='parking+report+problem+pdf'

Table 3.13: Mobility Management Strategies by VTPI

Improved Transport Options	Incentives to Shift Mode	Land Use Management	Policies and Programs
Alternative Work Schedules Bicycle Improvements Bike/Transit Integration Carsharing Guaranteed Ride Home Security Improvements Park & Ride Pedestrian Improvements Ridesharing Shuttle Services Improved Taxi Service Telework Traffic Calming Transit Improvements	Bicycle and Pedestrian Encouragement Congestion Pricing Distance-Based Pricing Commuter Financial Incentives Fuel Tax Increases High Occupant Vehicle (HOV) Priority Pay-As-You-Drive Insurance Parking Pricing Road Pricing Vehicle Use Restrictions	Car-Free Districts Compact Land Use Location Efficient Development New Urbanism Smart Growth Transit Oriented Development (TOD) Street Reclaiming	Access Management Campus Transport Management Data Collection and Surveys Commute Trip Reduction Freight Transport Management Marketing Programs School Trip Management Special Event Management Tourist Transport Management Transport Market Reforms

Source: Victoria Transport Policy Institute (VTPI) Parking Management.

3.8 Indeterminacy of Policies

The importance of implementation capability cannot be highlighted enough. Policies can take time before the expected outcome is achieved. However, the waiting becomes challenging when the policies are faced with financial problems, public backlash, or political barriers. Most of all, it can be disappointing when a policy seems to be meaningless and a waste of time and money.

As for the impact of each policy, the fact is that no one policy behaves like a chemistry experiment—i.e. where the same process repeated several times will have the same result. For example, a strenuous drivers' licence examination may be an incentive in a country whose people are extremely curious, but the same exam can be viewed as a disincentive by examinees in other countries.

The indeterminacy of policies' outcome may be due to the mix of policies, skill of executors, timing, and recipients. When one policy is sound and based on economic theories but has not attained its goal, a reconsideration of other policies affecting the target group should first be made before one can conclude on this one policy's effectiveness. This is where the mix of policies must be reviewed.

Meanwhile, how executors of policies define or implement a policy also affects the result. For example, when introducing a gasoline tax, one politician might say, 'We will introduce this tax to decongest the traffic situation', whereas another might state, 'We will introduce this tax to secure financial resources for the public transport system because the negative effect of private vehicles on the environment is now at a serious level.' The same policy, two different definitions. The former statement sounds more encouraging to drivers. As a result, people will react differently.

Timing is also important. Gasoline tax is often introduced or raised when the oil price is relatively low to mitigate public criticisms. Conversely, imposing such a tax when the oil price is high is expected to elicit a bigger public outcry.

While incentives are used to drive the public to move in a certain direction, one cannot guarantee with accuracy that the response will be exactly as hoped for. After all, every individual responds to incentives differently. Thus, policymaking is not a constraint imposed by the top but a collaborative process with reciprocal influences between the top and down. Based on this, every policy mix should have some level of flexibility to make room for some adjustment or change in the combination, depending on its effect on its targets.

4. In Anticipation of 2030: Scenarios for Da Nang City

Ordinary folks who were born in a city used to end up living happily and dying in the same town. Today, more and more people move from one city to another. What attracts people to relocate in one city in lieu of another is the key. Attractive cities grow and progress, whereas the rest suffer from shrinking populations. Thus, the first step in drafting a city plan is for its planners to identify how they envision the city to be in the future. The options and potential of a city are aplenty, but it is better to focus on select aspirations because the resources are limited in many ways.

Da Nang City is the starting point of the almost-1,500 km long East–West Economic Corridor that leads through Lao PDR and Thailand to Myanmar. It is located in the central area of Viet Nam and has the potential to be the strategic traffic point of the area. Bullet train routes to megacities such as Ho Chi Minh City (HCMC), Hanoi, Bangkok, Vientiane, Phnom Penh, or Siem Reap will provide tourists with the chance to call at Da Nang en route.

However, inadvertent intercity connection can have disastrous effects. Some researchers ascribe to the concept of demographic gravitation, which states that large numbers of people in a city, for example, act as a magnet for other people to migrate there. Although there is substantial doubt over this scientific theory, it has its advocates. For instance, Reilly's law of retail gravitation is also based on the same concept.

It might thus be wiser to build express traffic infrastructure for the core cities that are relatively small and within short range of each other such as Hue, Hoi An, or Quang Ngai. It would also be an interesting attempt to make a connection to Pakse and National Biodiversity Conservation areas of Lao PDR, which will take less than one hour to reach by bullet train. By shortening the travel time, neighbouring cities behave like one united area, and Da Nang can further enhance its attraction. The power of demographic gravitation will change through this process. Table 3.14, which is a travel ranking from 2013 of Chinese cities located at the Pearl River Delta, illustrates that the geographic proximity of attractive cities does not necessarily lead to cannibalisation but often generates synergistic effects.

Table 3.14: Ranking of Top 100 City Destinations

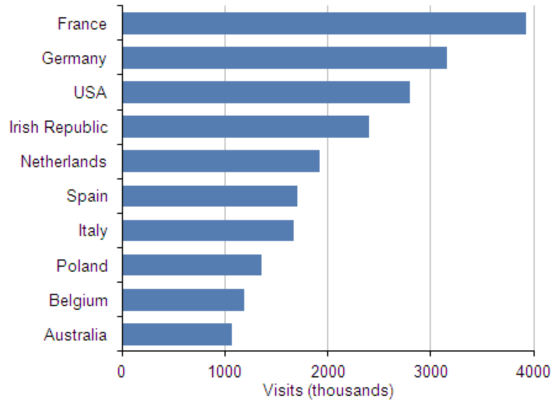
City	Ranking	Arrivals 2013 ('000)
Hong Kong	1	25,587.3
Macau	6	14,268.5
Shenzhen	8	11,702.5
Guangzhou	16	7,630.1
Zhuhai	58	2,886.5
Total		62,074.9

Source: Euromonitor International, 2015, http://blog.euromonitor.com/2015/01/top-100-city-destinations-ranking.html'

In discussing inner-city issues, focus will be on the city's attractiveness in terms of the relationship between its sightseeing sector and the traffic system. Any exposition on the commercial sectors will be out of scope in this section, as some of the key points have already been discussed in the earlier part of this paper within the context of compact cities and economic efficiency.

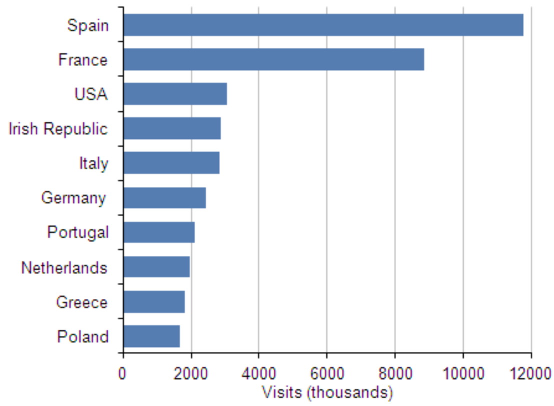
Figure 3.11 shows the top 10 countries where visitors to the United Kingdom originated. Most travellers clearly came from countries proximate to the United Kingdom. By the same token, residents from the United Kingdom also tended to visit their neighbouring countries in 2013 (Figure 3.12). Of course, accessibility may not be the only reason for such proclivity. One can assume that the travellers also took into consideration such factors as airline fares, cultural closeness, safety, security and so on.

Figure 3.11: Top 10 Countries Providing Visitors to the United Kingdom (2013)



Source: Office for National Statistics, Travel Trends 2013.

Figure 3.12: Top 10 Countries Visited by UK Residents for at Least One Night (2013)



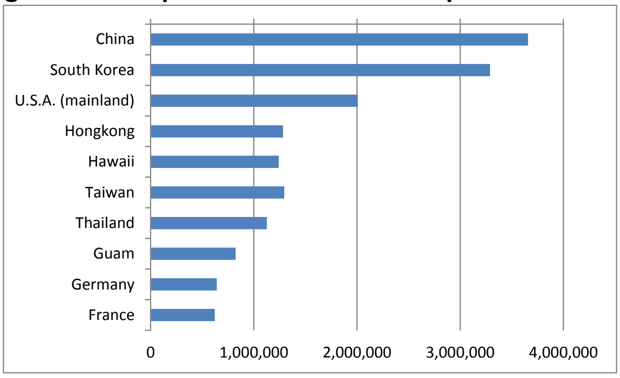
Source: Office for National Statistics, Travel Trends 2013.

However, Chinese and Japanese tourists also follow a similar tendency (Figures 3-13, 3-14). Furthermore, Japanese travellers to Da Nang, Viet Nam skyrocketed last year, after Viet Nam Airlines started direct flights from Tokyo to Da Nang. Data from the Japan Association of Travel Agents show that except for a few cases, the ratio of travellers from adjacent areas is high. All things being equal, travellers—whether domestic or international—are more likely to visit places that are nearer and easily accessible.

Figure 3.13: Top 10 Destinations for Chinese Tourists

Source: Wall Street Journal. Japan Is Most Preferred Destination for Chinese Tourists in 2015, http://blogs.wsj.com/chinarealtime/2015/01/07/japan-is-most-preferred-destination-for-chinese-tourists-in-2015/

Figure 3.14: Top 10 Destinations for Japanese Tourists



Source: Japan Association of Travel Agents, https://www.jata-net.or.jp/data/stats/2013/05.html

In terms of the sightseeing sector, one key issue is the balance between pursuit of economic development and tourism. There are instances where this commitment to economic development can have irreparable effects on tourism. For example, Dresden Elbe Valley used to be a world heritage site, but the status was revoked due to the construction of a bridge that was meant to remedy inner-city traffic congestion. The bridge was completed in 2013 and is said to have contributed to traffic improvement, although the total impact remains to be seen.

Because transport policies can conflict with tourism policies, the question, 'What do you want to be in the future?' needs to be asked again. After defining the aspiration, cities will then have to make consistent and sound policies for the future city. For instance, metro rails are more ideal for old city areas for their landscape to be maintained as tourism sites.

Figure 3.15: Dresden Elbe Valley and Waldschlösschen Bridge

Source: https://de.wikipedia.org/wiki/Datei:050628-elbtal-vom-luisenhof.jpg
https://de.wikipedia.org/wiki/Datei:Waldschl18-small.jpg

A city plan is required not only to develop a compact city but also to preserve national heritage and tourism resources. This plan will prevent, for instance, any haphazard redevelopment of old urban areas. In France, many historic buildings are protected under the *Loi Malraux* (Malraux Law), which aims to preserve, renovate, and commercialise traditional buildings designated by the government. However, Tour Montparnasse, an office skyscraper, was built in an area long known as a centre of artist communes (Figure 3-16). The tower has been criticised for being out of place in the harmonised city. Today, Paris has banned buildings over seven storeys high from the city centre.

Likewise, in China, although many hutongs (old lanes) have been demolished during the country's economic development, some are still designated as protected areas and preserved as part of China's cultural history. This structure is exactly the same as transport problems because city plans and transport policies are closely relevant to each other. Moreover, as earlier mentioned, the 'disharmony between the city and the transport system' encumbers the function of public transport systems. This is where pre-emptive measures should be included in the city plan to make transport policies successful.

Figure 3.16: View of Tour Montparnasse, from the Tower

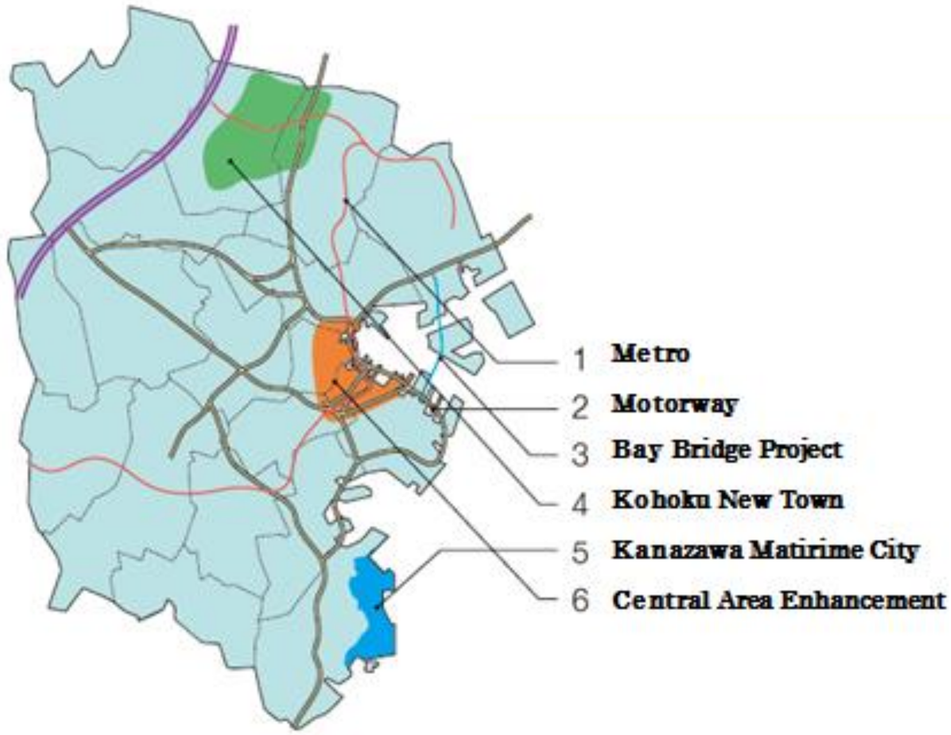
Source: Available at:
https://commons.wikimedia.org/wiki/File:Champ_de_Mars_from_the_Eiffel_Tower_-_July_2006_edit.jpg
and https://fr.wikipedia.org/wiki/Tour_Montparnasse

Finally, this section concludes with a review of the city design of Yokohama, Japan's second largest city after Tokyo. Yokohama has 3.7 million people, slightly larger than the expected population of Da Nang in 2030. It is located along the coastline of the Pacific Ocean and is the most successful harbour city in Japan.

The city reform project started in the latter half of the 1960s to deal with the various urban problems that had emerged at the height of Japan's economic boom. Yokohama's population tripled from 0.6 million in 1945 to 1.8 million by 1965. The city once suffered from the destruction of farmlands and mountain forests, as well as lacked necessary infrastructure such as schools or parks and had to deal with the consequences of haphazard sprawling development. It eventually gathered momentum to develop the central area of the city, create jobs, and enhance its attractiveness. The following goals were set for the project:

- Protect pedestrians; secure safe walking spaces
- Respect natural characteristics such as local land features and flora
- Cherish the local historical and cultural heritage
- Allow open spaces and greenery
- Value water spaces such as seas and rivers
- Increase community space for human interaction
- Seek morphological and optical beauty.

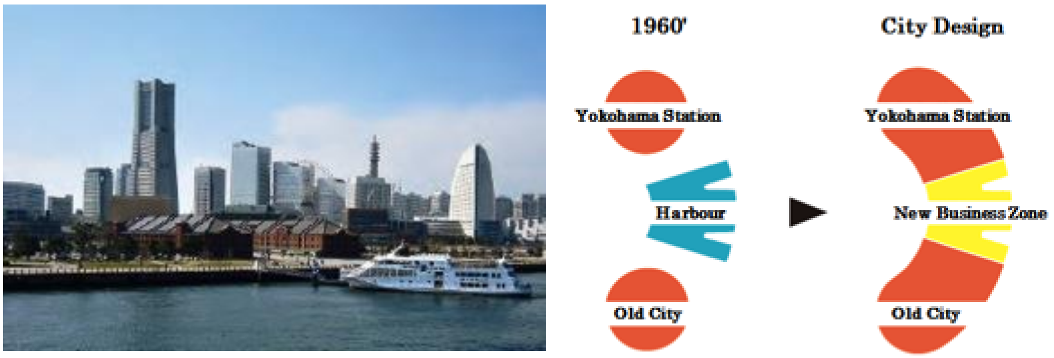
Figure 3.17: Six Major Projects of Yokohama City



Source: City of Yokohama, available at:
http://www.city.yokohama.lg.jp/toshi/design/pdf/udleaflet.pdf#search='urban+design+yokohama'

The new central business district connecting Yokohama's two existing city centres was named Minato Mirai 21, which means 'Harbour Future 21'. The district is divided into two main areas. One is the business centre with the Landmark Tower and Nissan Motor Co., Ltd headquarters; the other is the area characterised by different types of low-rise buildings typified by the Red Brick Warehouse. The latter area is designed with a brown-base colour, which contrasts with the predominantly grey-coloured business zone. Thus, each zone is known for different types of appeal and, as a result, contributes to the vitality of the whole city.

Figure 3.18: New Business Zone and Concept



Source: City of Yokohama, available at: http://www.city.yokohama.lg.jp/toshi/design/pdf/udleaflet.pdf#search='urban+design+yokohama'

What is noteworthy about the urban design of Yokohama is that it stipulates an implementation policy that is based on civic participation and collaboration. It tries to involve all the constitutional units of the city such as the citizens, schools, universities, companies, and community, so that it ultimately solicits more familiar and specific community plans. This is an autonomous revitalisation of communities.

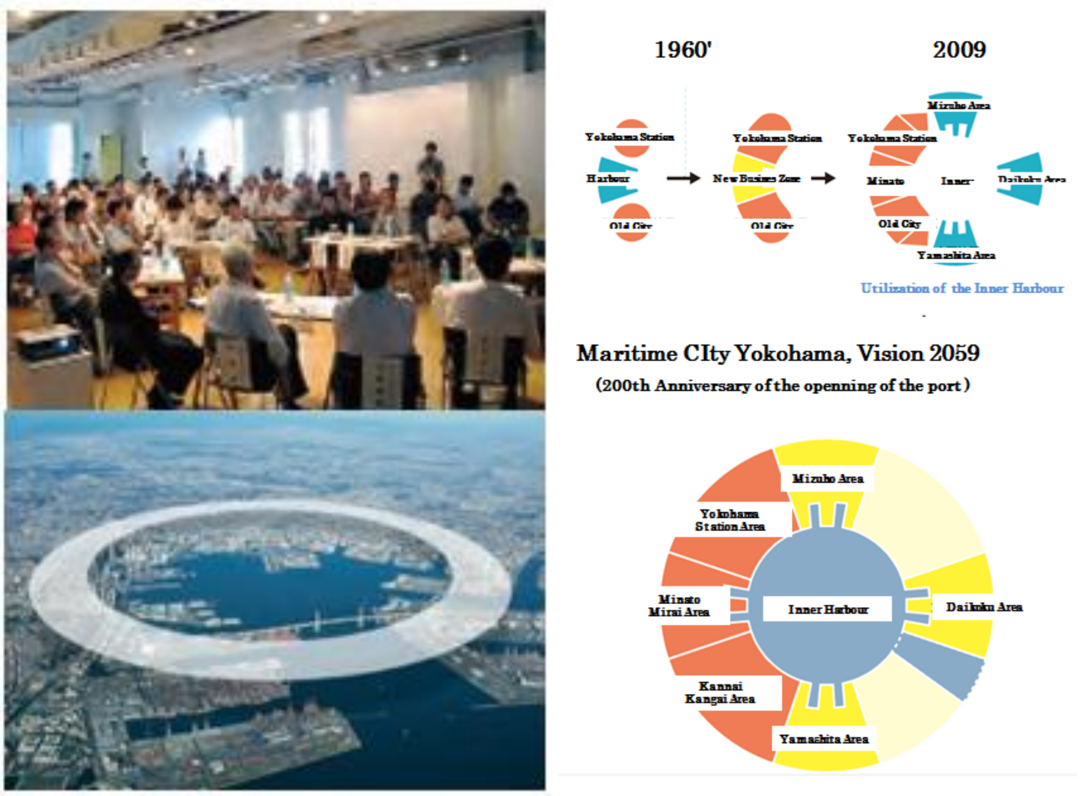
Promoting civic involvement does not mean the end of the city plan. Now that Yokohama has almost completed all its six major projects, it has attained some level of success. It is, however, very concerned for the future, tackling contemporary issues such as energy problems, local autonomy, ageing society with fewer children, and global competition. For the 200th anniversary of the opening of its port, Yokohama is now expanding the scope of the city plan and aiming to unify the circumferential areas of the harbour (Figure 3.19).

5. Future Issues

This report calls for a deeper research on each policy or city design that will support traffic reforms. Specifically, the strategic combination of policies, relationships between city design and the transport system, relationships between the attractiveness of cities and transport systems, and the methodology that involves citizen participation in the plan should be covered in more detail.

Recall that even Yokohama, which takes a far-sighted city plan, could not avoid the development trap in the 1960s. It must have been a laborious and hard task to solve those social problems. After all, it took almost 50 years for the city to complete its six projects. Today, Yokohama is implementing pre-emptive measures by detecting latent social problems that might afflict its society in the future. Its vision for 2059 does not sound like some run-of-the-mill ambition. Rather, its vision of a future maritime city with an inner harbour is nothing but exciting, inspiring, and challenging. This paradigm shift—from mere resolution of negative problems (i.e. reactive measures) to proactive creation of positive projects (pre-emptive measures)—seems to be the key to solving urban traffic. This topic also needs further research.

Figure 3.19: Vision 2059 of Yokohama Maritime City



Source: City of Yokohama, available at: http://www.city.yokohama.lg.jp/toshi/design/pdf/udleaflet.pdf#search='urban+design+yokohama'

CHAPTER 4

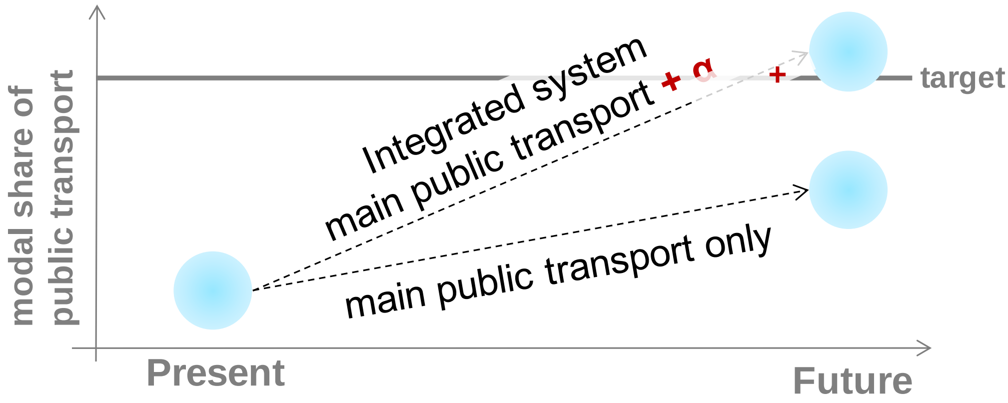
PRELIMINARY DESIGN AND ANALYSIS OF FEEDER LINE BUS

1. Background

1.1 Raising the Attractiveness of Public Transport

How to drive commuters to use public transport is a common goal of Asian countries. Their cities' transport master plans may include detailed goals such as the ideal modal share of public transport, and stipulate measures to achieve the goals. How the public transport system is planned starts with, in most cases, making sure that the main public transport is the centre of the plan. Then, as the master plan requires other components, considerations are then made to additional measures (e.g. feeder networks, traffic demand management) in accordance with the main public transport used. Here, plans for the main public transport are integrated with additional measures that can enhance the former's attractiveness (Figure 4.1).

Figure 4.1: Importance of Additional Measures that Enhance the Attractiveness of Main Public Transport



Source: Author.

For instance, in the case of Da Nang City, one may need to ask, ‘How much can the main public transport alone satisfy the requirements of the goal?’ The city targets a modal share for public transport of 35 percent by 2030. The number of trips coverable by the main public transport alone was calculated based on the traffic data assumed for the year 2030 (Table 4.1). By defining the trips coverable by the main public transport as trips whose origin and destination are within walking distance (i.e. within 400 m) from bus rapid transit (BRT) stations, it calculated the number of such trips as only about 14 percent of all trips. This result indicates that BRT alone is not capable of achieving the target number. Additionally, the simulation assumes the maximum possibility of BRT being selected by the people; in actual situations, the public’s selection will split into public transport and private transport (e.g. cars, bikes). Considering the extremely high rate of bikes currently selected by the people of Da Nang, it can be said that achieving the goal by BRT alone is extremely difficult. In other words, *it is essential to take additional measures to achieve the goal.*

Table 4.1: Trips Covered by Bus Rapid Transit (2030)

a.	**Number of all trips**	7,799,362 trips/day
b.	**Trips within 400 m from BRT stations**	1,099,740 trips/day
c.	**BRT coverage (b/a)**	14%

Source: Calculated by applying the population growth rate in 2025 and 2030 to the Origin–Destination table based on the 2025 Scenario 3 of DaCRISS[5].

1.2 Measures that Enhance the Attractiveness of Main Public Transport

Now, what can be the potentially effective additional measures? Two types of measures are worth considering (Table 4.2).

[5] Scenario 3 is one of the urban development visions stipulated by the city of Da Nang, which is adopted by the city as the scenario with the highest population growth rate. Specifically, it assumes the population of approximately 2.5 million to 3 million people in 2030 as the future urban development target

Table 4.2: Examples of Additional Measures that Enhance the Attractiveness of Main Public Transport

Measures that increase the number of trips covered by public transport	• Enhancement of feeder network • Park & Ride • Transit-Oriented Development
Measures that improve the relative attractiveness and selection rate of public transport	• Appropriate public transport fares • Appropriate gasoline tax • Appropriate parking fees • Priority lanes and traffic lights for public transport

Source: Author.

One type of measure is that which increases the number of potential users for the main public transport. For instance, in the case of Da Nang City, the number of trips covered by the bus rapid transit (BRT) was approximately 14 percent of all trips. To increase this number, the strategy will include:

- measures to enhance the accessibility to the stations of main public transport such as enhancement of peripheral public transport (e.g. feeder network) and park & ride facilities; and
- transit-oriented development[6] measures (e.g., allocation of commercial facilities and residential areas near the target stations)

Another type of measures includes methods that enhance the relative attractiveness of public transport compared to private transport. For instance, in the case of Da Nang where 14 percent of all current trips are covered by BRT, this type of measure is intended to increase the rate of the people selecting public transport over bikes or cars. Such can be achieved by lowering the monetary cost and temporal cost of public transport compared to private transport, including

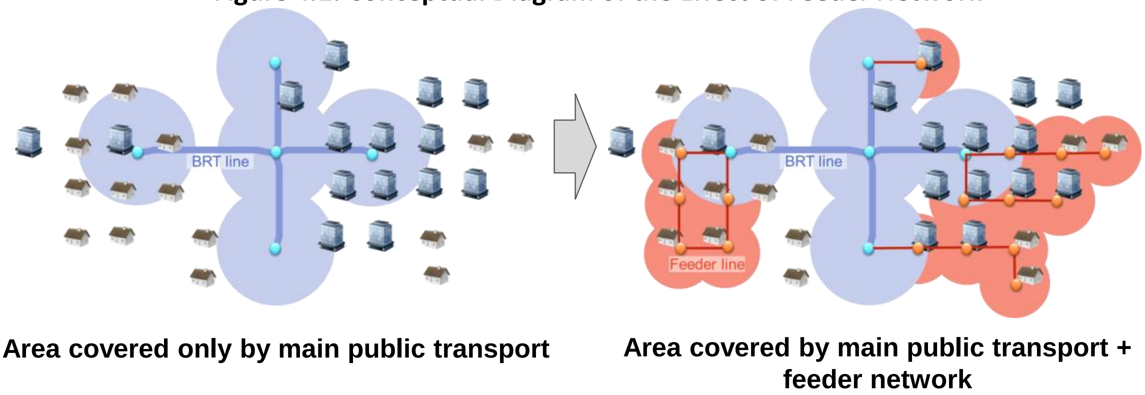
[6] Urban development that aims at achieving a society whose main transportation mode is public transport without relying on cars. Use of public transport is promoted, for instance, by selectively allocating commercial facilities near the public transport stations at city centres and by systematically building residential areas near the public transport stations in suburban areas at the same time.

- raising the cost effectiveness of public transport over other transportation modes (e.g. reducing public transport fare, adding to gasoline cost, charging parking fees, road pricing); and
- shortening the transit time of public transport (e.g. establishing priority lanes and priority traffic lights).

1.3. Scope of Considerations

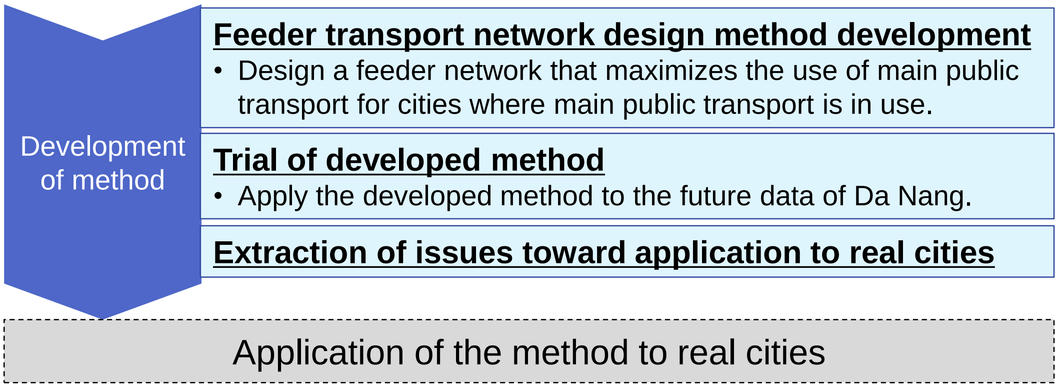
In increasing the number of trips covered by public transport, considerations are given specifically on the feeder network (Figure 4.2). In the case of Da Nang, the considerations were given to fixed route buses, but not to the feeder buses. It is thus worth it to look at the feeder-bus option as an integral part of the main public transport system. Also, in general, past considerations given to the feeder network in the stage of traffic planning by a foreign aid often lingered at the conceptual level, whereas there are actual demands from cities for specific and concrete plans. For this reason, this study found it necessary to develop a generic tool that enables considerations and evaluation of feeder networks for other Asian cities as well. This chapter therefore focuses on the development method for a feeder network design. A trial application of the developed method will cover Da Nang's data up to the year 2016 (details are described in below), where the goal is to extract the potential issues and tasks. The tool's 'live' rollout to other cities is still to be scheduled (Figure 4.3).

Figure 4.2: Conceptual Diagram of the Effect of Feeder Network



Source: Author.

Figure 4.3: Objective of this Chapter



Source: Author.

2. Method for Feeder Network Design

2.1 Aim of Feeder Network Design

Since the area covered by the main public transport is limited, the role of a feeder network is to expand the covered area and thereby increase the number of potential users of the public transport system. Introducing a short-headway feeder network to as large an area as possible is ideal. However, in reality, the budget is limited, and it is not practical to run buses to all the areas with an adequate headway. For that reason, route selection and headway setting that achieve the maximum effect within the given budget are the requisites for the feeder network design. Feeder network routes are to be selected from potential routes identified in advance.

Once the design is established, it will then be possible to investigate the costs and benefits of the design, including the use rate of public transport vis-a-vis the allocated budget, which will then be utilised as information for making a decision on the budget.

2.2. Outline of Design Method

The design method of the feeder network consists of the following procedures:

a) Create input data

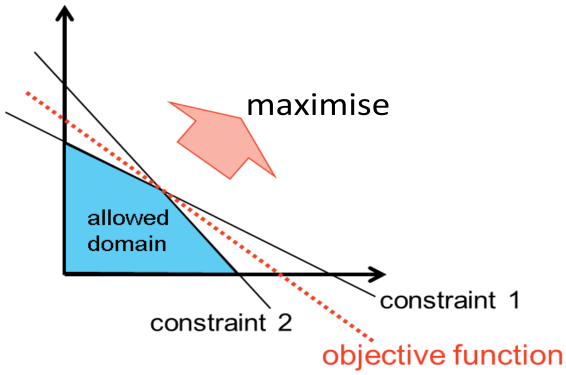
- At this stage, candidate routes of the feeder network are also created. Candidate routes are assumed to be manually (not automatically with computers) using existing or planned bus network as reference.

b) Calculate the 'optimal' route and headway under budgetary restrictions

- The 'optimal' route among the candidate routes created by Procedure 1 and its headway are determined.
-

For Procedure 2 above, mathematical programming is employed. This method is used to find a solution that minimises (or maximises) the objective function under the given constraints (Figure 4.4). A mathematical model for the feeder network design is also created.

Figure 4.4: Conceptual Diagram of Mathematical Programming



Source: Author.

2.3. Modelling

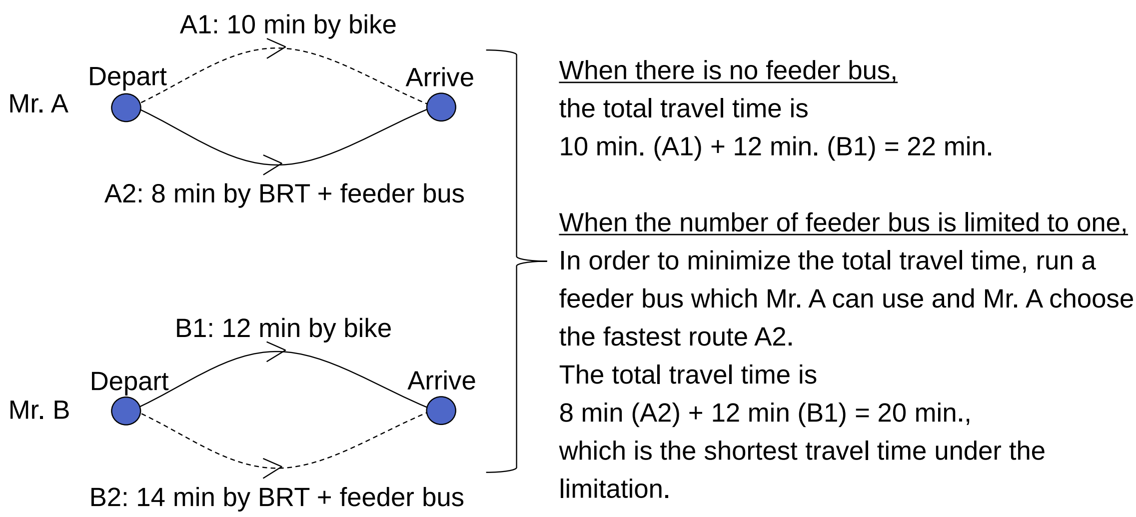
Before determining the objective function and constraints in the model, the mathematical representation of the transportation network needs to be defined. In a transportation system on a time-space network, the variables are the feeder network routes and their timetables (headway).

To determine the route and headway for the feeder network, it is necessary to select from the spatial direction (route) and from the time direction (headway). A feeder network is designed in relation to time (i.e. a timetable is obtained); thus, the traffic demands also need to be factored in, in relation to time. However, traffic demands (OD table) generally lack information on the time direction. For this reason, a specific timeframe (e.g. one hour of traffic congestion) is assumed here, and demands are randomly generated for the given timeframe. The calculation will produce a timetable for each feeder route. However, in principle only the total amount has a meaning as the demand, and a meaning will also be given only to the headway for the feeder network.

Other variables shall be sought in advance. For instance, traffic information such as congestion shall be calculated in advance using a traffic flow simulator, etc. So with the speed of BRT and feeder network.

Users are assumed to travel by either private transport (car or bike) or public transport (BRT or feeder bus), or their combination. Thus, the sum of the travel time of all trips (hereinafter referred to as 'total travel time') is specified as the objective function, and the feeder network design shall aim to lessen the total travel time (Figure 4.5). To minimise total travel time, a feeder network should be designed in such a way that the transit time becomes shorter than that of private transport.

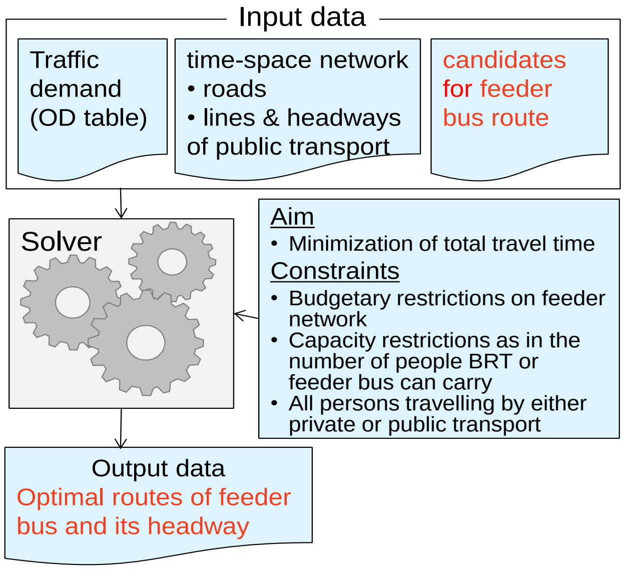
Figure 4.5: Model of Feeder Network Route Selection and Transportation Modal Choice



Source: Author.

Constraints in the feeder network design are summarised as follows (Figure 4.6):

Figure 4.6: Flow of Feeder Network Designing



Source: Author.

- Aim: To minimise the total travel time
- Constraints:
  - ➢ All commuters select either public transport or private transport
  - ➢ There is an upper limit in the budget that can be used for running the feeder network.
    - ✧ In this study, assuming that the cost of feeder network is proportional to the total operational route length, an upper limit is specified for the total operational route length for simplicity.
  - ➢ There is a capacity limit in the number of people a bus or BRT can accommodate.

Meanwhile, the design uses the following assumptions:

- The total travel time specified as the objective function
  - In general, the BRT fare, gasoline cost, etc., in addition to the travel time, are taken into account when selecting a movement mode. Therefore, the model may become more practical when the generalised cost is used as the objective function, instead of the total travel time.
- Upper budgetary limit for the feeder network
  - Since there is no information yet on the actual budget in running the feeder network, the model assigns restrictions to the total operational route length as the index of cost. However, in reality, other factors need to be taken into account, such as the purchasing cost of buses that run on the feeder network and personnel costs.

Future tasks may include investigating the actual situation and modifying the model. However, the basic framework described above is applicable as it is to the modified model.

3. Result of Preliminary Analysis

3.1 Data Used

The preliminary analysis used data on Da Nang City calculated for the year 2016. It was considered easy to examine the appropriateness of the obtained solution and issues by using data that are close to the present (year 2015). Details are as follows:

- Traffic demand data (or Origin–Destination [OD] data)
  - DaCRISS created the OD data for the year 2025, and the 2016 data were created by referencing it. Using Scenario 3[7] of DaCRISS, the ratio of Da Nang City's population in 2016 to that in 2025 was calculated, and the 2016 data was created by applying this ratio to the 2025 data.
  - The obtainable OD data was for one day and too broad to calculate the bus headways. Assuming peak hours, the OD data was used after reducing to 1/10.
  - For the OD data, one representative point was placed to each zone, and the representative points were treated as an origin point or destination point. For that reason, route calculation could not be made for travel within a zone; thus, intra-zone transit data were not counted among the users of public transport.
- Road traffic network
  - The currently existing road network (year 2015) was used.
  - Traffic speed (degree of congestion) of each road section was calculated by traffic flow simulation.
- Public transport network (Figure 4.7)
  - BRT routes
    - The analysis assumed the case where only BRT Line 1 exists, as planned in the Feasibility Study for the Da Nang Sustainable City Development Project by Sinclair Knight Merz Pty. Ltd.
    - BRT Line 1 is to be opened in 2016 as the first route in the plan.
    - Since the location of BRT Line 1 stations is unknown, stations were placed near every intersection and zone representative point.
    - The travelling speed of BRT was specified to be 25 km/h. This speed

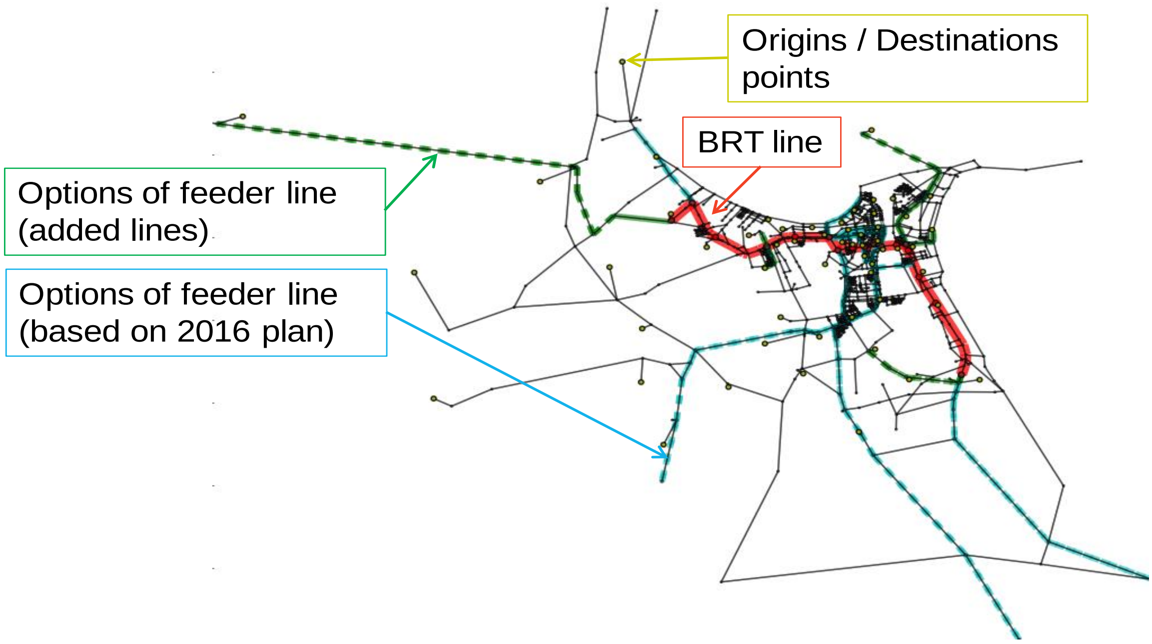
[7] One of the urban development visions adopted by the city of Da Nang as the scenario with the highest population growth rate. Specifically, it assumes the population of about 2.5 million to 3.0 million people in 2030 as the urban development target.

is faster than that of private transport affected by traffic congestion, and assumes that priority roads are used.

- Feeder network route candidates (11 lines)
    - Candidate routes were created through partial amendment of and addition to the fixed route bus lines that exist in 2015. There were 11 candidate lines.
    - Majority of fixed route bus lines shares routes with BRT, and sections of shared routes were omitted. For that, lines split into multiple sections were regarded as different lines. As a result, seven lines remain as candidates.
    - For areas (e.g. suburban areas) where no fixed route bus is currently running and development of transportation network is considered insufficient, four route candidates were added.

The travelling speed of feeder buses was assumed to be the same as that of private transport. No special lanes were developed for feeder buses, and the buses were assumed to travel along with private vehicles.

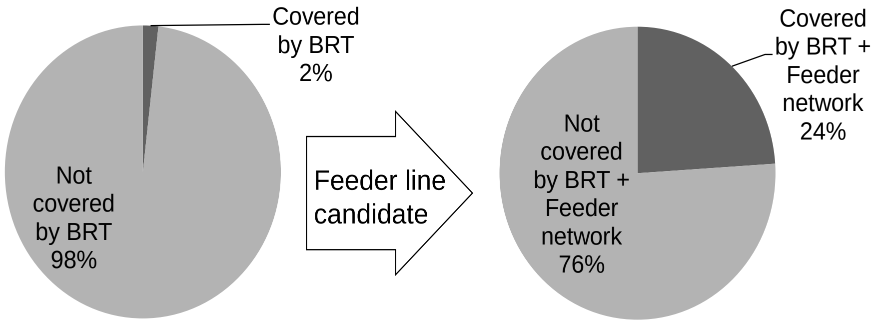
Figure 4.7: Traffic Network Assumed to Exist in 2016



Source: Author.

For these input data, fundamental considerations were made first. Since the role of a feeder network is to expand the coverage of the main public transport (which is BRT Line 1 in this case), the coverage by BRT alone and the coverage for when the feeder network route candidates were added (in reality, some of which may not be selected) were investigated (Figure 4.8). Results show that the coverage of trips where a public transport existing within walking distance (400 m) of both O and D by BRT alone was 2 percent. However, the coverage of trips when feeder network candidates were added rose to 24 percent—a significant increase in coverage. For trips where the travel time becomes shorter by using public transport than by using private vehicles, the use of public transport will be selected.

Figure 4.8: Coverage by BRT and Feeder Line Candidates (potential trips by public transport)



BRT = bus rapid transit.
Source: Author.

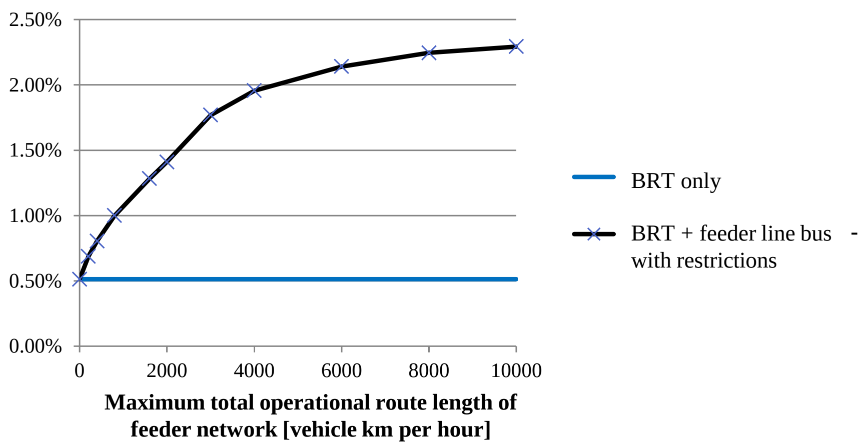
3.2 Calculation Results

The modal share of public transport[8] in relation to the upper limit of total operational route length per hour (i.e. the upper cost limit for operating the feeder network) is shown in Figure 4.9. The modal share of public transport increases as the total operational route length (cost) of the feeder network increases. However, the increase rate of the modal share of public transport starts to significantly decrease at around a constraint

[8] Modal share of public transport was calculated as the percentage of trips where public transport (BRT or feeder network) is used among all the trip types, including intra-zone traffics, inter-zone traffic, walking, and bicycles.

of 4,000 km per hour, reaching a plateau of around 2.3 percent eventually. This result indicates that further investment will not return much benefit. Since the modal share of public transport by BRT alone is around 0.5 percent, it can be said that *investment into the development of feeder networks increases the modal share of public transport by a maximum of 4.6 fold (= 2.3% / 0.5%).*

Figure 4.9: Modal Share of Public Transport



Source: Author.

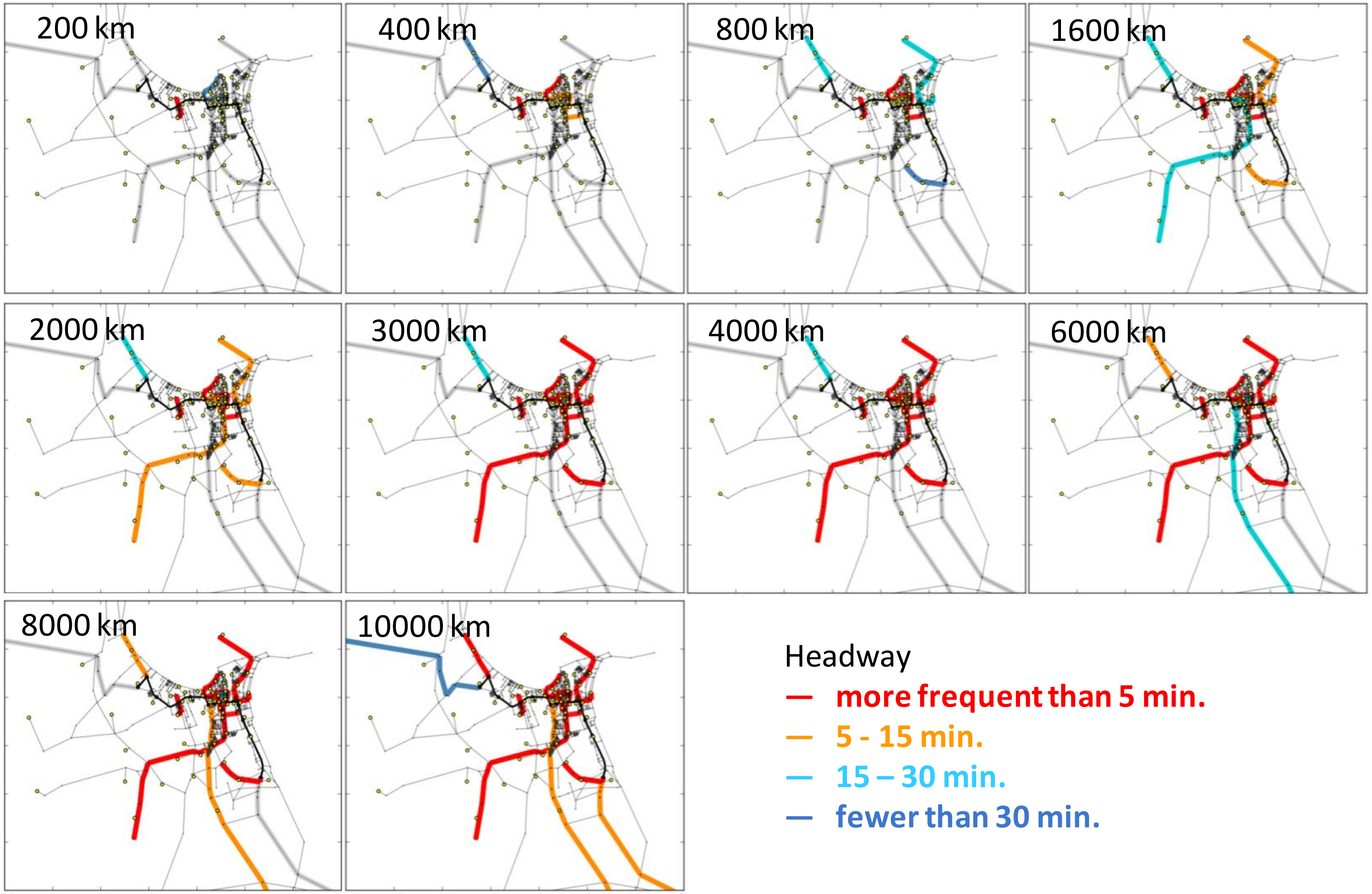
An examination of the feeder network routes in Figure 4.10 identifies the routes at the central section of Da Nang city as preferentially selected, especially when the cost for the feeder network is small (for instance, for cases where the constraint of total operational route length per hour is 200 km, 400 km, or 800 km). As shown in Figure 4.9, the modal share of public transport significantly rises when the total operational route length is increased slightly. Meanwhile, when the cost for the feeder network is large (for instance, in cases where the constraint of total operational route length per hour is 6,000 km, 8,000 km, or 10,000 km), the increase in the modal share of public transport is small. Taking into account these results and the fact that origin points and destination points of many trips concentrate in the central part of Da Nang, one can conclude that investments in lines near the city centre are more effective in increasing the number of people that use public transport. From such findings, the following were derived:

- Preferential coverage for the areas with large traffic demands—specifically, concentrating the operational area of BRT and feeder network into the city centre and its vicinity—increases cost effectiveness.

- On the contrary, building of points that readily become origin points or destination points (e.g. residential areas, commercial facilities) near the stations of BRTs or feeder network would create demand for public transport. To that end, it may be required to re-consider the land use plan after the traffic plan has been reviewed by the land use planning organisation.

Figure 4.10: Feeder Network Route Selected

(the distance shown in each map indicates the total operational route length of feeder bus per hour)



Source: Author.

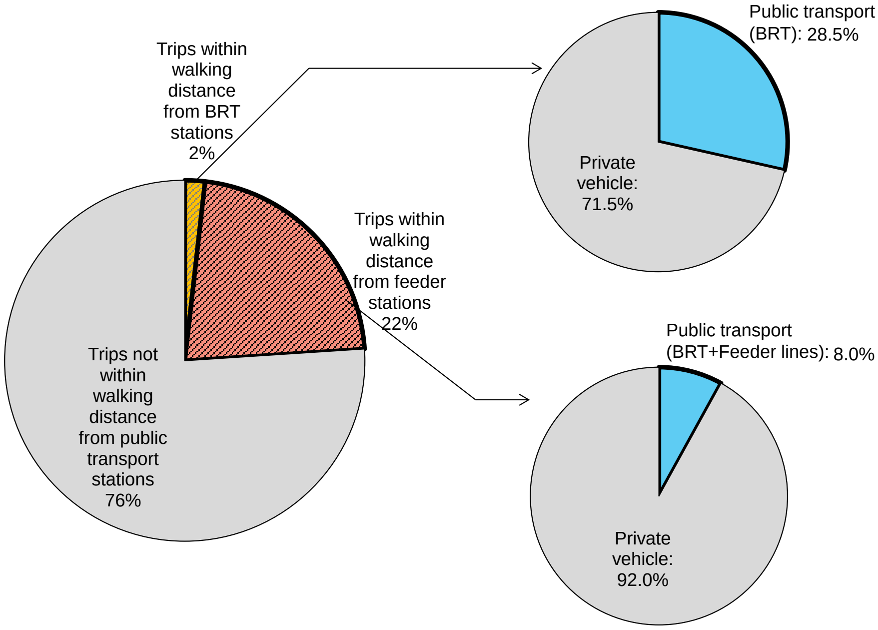
Although most of the discussion here focused on the selection method on feeder networks with high economic effectiveness, it is also necessary to consider the method to raise the plateau value of the modal share of public transport (2.3 percent) shown in Figure 4.9. Thus, details of the transport modal choice were reviewed as well.

Details of the transport modal choice for the scenario where the total operational route length of feeder network is set at 10,000 km per hour (practically limitless) are shown in Figure 4.11. The pie chart on the left indicates that the number of trips within walking distance from BRT stations is only 2 percent of all trips. Although the rate of public transport selection is relatively large at 28.5 percent for these trips (pie chart on the right, top), the population is only 2 percent of all trips—i.e. the number of people using public transport is small. Meanwhile, the number of trips within walking distance from feeder network stations is 22 percent of all the trips (pie chart on the left), indicating a relatively large area being covered. However, the rate of public transport selection is 8 percent (pie chart on the right, bottom), which is significantly smaller than the selection rate for trips within walking distance from BRT stations.

The reasons behind the low public transport selection rate could be: (1) there are no temporal benefits for the feeder network itself compared to private transport since the travelling speed of the feeder network is the same as that of private transport; and (2) buses often have a longer travelling distance compared to private transport. From these, the following are the conclusions:

- When the BRT Line Network expands in the future, the volume of trips coverable by BRT alone increases. Since the public transport selection rate is relatively high for such trips, the expansion may significantly add to the overall public transport selection rate. The city may consider establishing a feeder network that synchronises with the BRT extension plan.
- The public transport selection rate is low for trips covered by the feeder network. It may be required to consider the possibility of increasing the speed (temporal) advantage by using priority lanes and priority traffic lights.
- When public transport cannot maintain its superiority over private transport in terms of speed alone, it must consider other measures such as reduction of public transport fares, application of gasoline tax, and parking regulations.

Figure 4.11: Public Transport Selection Rate When the Total Operational Route Length of Feeder Network is Set Practically Limitless (10,000 km per hour)



Source: Author.

3.3. Summary of Results

Along with the development of the design method, some insights on the optimal route for the feeder network and its headways can be gleaned from the exercise. Among the findings are:

- An additional feeder network increases the public transport use rate. While higher investment into a feeder network increases the public transport use rate, the rate reaches a plateau after a certain investment level (Figure 4.9).
- Based on the study on feeder network optimisation, one can conclude that routes with many O/Ds are preferentially selected (Figure 4.10).
- The public transport selection rate of trips near the BRT stations is higher than that near the stations of feeder networks. (In this study, the former was 28.5 percent; the latter, 8.0 percent) (Figure 4.11).

Meanwhile, some findings were off-course from reality due to insufficient modelling:

- Whereas this study identified the total travel time as the objective function (taking into account the fact that cost is one of the factors in the selection of preferred transportation mode), the generalised cost as the objective function would have been closer to reality.

- While the initial methodology used the total operational route length (km) per unit time as the cost of the feeder network, all other costs, including the number of buses and personnel costs, need to be considered in actual cases. The constraints may have to be adjusted in accordance with the actual cost situation.
- After completing the initial development of the method, the next step is to modify or tweak the model to match the local situations as the researcher sees fit.

4. Identifying Issues from Da Nang's Case

Based on the results of the preliminary analysis, the transport sector issues that needed to be addressed if one were to achieve energy efficiency are summarised below:

a) Some tweaking of the model, including the following two points, is required to match the local situation:

- ➢ Use generalised cost as the objective function
- ➢ Match the cost of feeder networks to reality

b) Since the feeder network design method itself is unable to calculate the fuel consumption, fuel consumption needs to be evaluated using traffic flow simulation.

c) The feeder network design method does not incorporate models that reflect the social structure. To make sure results reflect reality as much as possible, it is necessary to carry out traffic flow simulation using the transport modal choice model for each traffic scenario built by DaCRISS, etc. and verify the appropriateness.

d) Since it is difficult for feeder networks to have temporal advantage over private transport, it can compensate in terms of preferential measures in cost (e.g. lower public transport fare, application of gasoline tax) and imposition of private-vehicle regulations on driving in the city centre.

e) At Da Nang City, a BRT will be introduced in the future. In designing the feeder network, it is necessary to ascertain that its plan considers the expansion plan for the BRT lines as well.

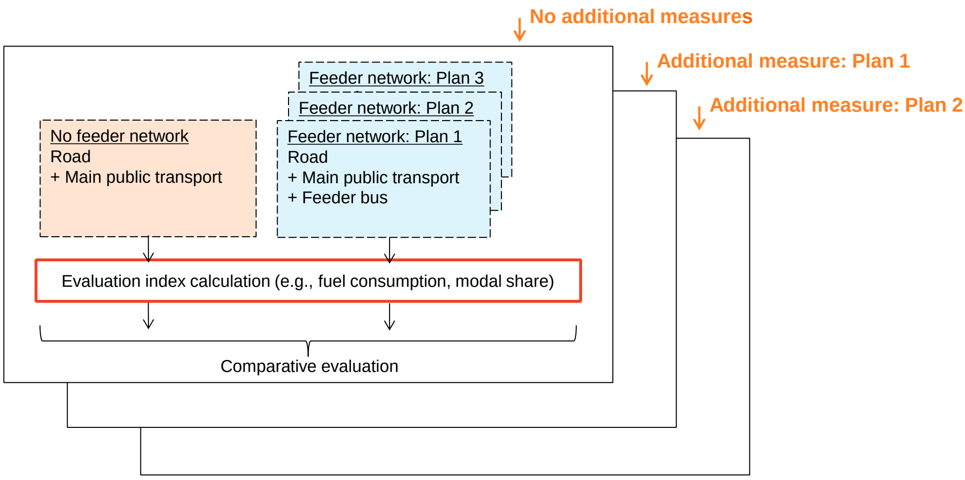
f) To promote the use of public transport, the findings need to be fed back to land use planning so that the planned transport network can be utilised effectively.

Regarding Item 1 above, a modification in the method may be needed after investigating the actual situation of the city to which the method is to be applied.

Items 2, 3, and 4 can be addressed by combining the method developed in this study with the traffic flow simulation. To evaluate fuel-saving effects, fuel consumption should be used as an evaluation index, in addition to the modal share of public transport. Evaluation indices, comparative assessment of scenarios under varying feeder network cost restrictions, and analyses of the effects of other measures that aim to enhance the attractiveness of the main public transport (e.g. preferential measures involving costs) can make the investigation more comprehensive.

For Item 5, devising simulation scenarios may enable proper analysis; this requires further investigation. Finally, whereas Item 6 is an important point, it may exceed the scope of the method developed in this study.

Figure 4.12: Simulation Evaluation Scenario



Source: Author.

CHAPTER 5

MAJOR FINDINGS AND POLICY RECOMMENDATIONS

1. Policy Recommendations

As part of the study on energy-use efficiency in the transport sector, the analysis here has looked at how shifts in modes of transport can improve the urban transport system. The review of past research done on various cities indicated that the failure of policies to address urban transport issues can bring about economic loss as well as allow traffic problems to persist.

This study extolls the ability of pre-emptive measures, when chosen well, to prevent the deterioration of the traffic system. However, as there is no precedent literature, this study has anticipated that some cities may have difficulty in formulating proactive countermeasures. Thus, its policy recommendations pertain to these four steps on how to formulate effective preventive measures:

- Identifying future traffic problems and making the issues transparent to the public
- Setting of countermeasures for the transport sector as part of urban planning
- Securing financial resources and formulating sustainable policy mix
- Sharing of values and collaborating with citizens and companies.

1.1. Identifying and Sharing of Data

As described in Chapter 3, countermeasures for traffic problems tend to fail due to the traffic congestion trap. Such failure may be because (1) there is no potent incentive to solve traffic congestion until it becomes serious; (2) while the main causes of traffic problems are population and economic growth, traffic congestion involves various factors, and discovering the direct causes is no simple task when indirect factors also come into play; and (3) new countermeasures often cause conflict or friction with the existing systems and in many cases are ill-received by the people, resulting in failure to obtain such citizens' consensus.

History proves that implementing countermeasures only after the traffic congestion has emerged poses major difficulties. However, it does not mean that proactive measures are easier to implement than reactive means. When traffic congestion brings mental stress to commuters, this in itself is incentive enough for policymakers to come up with reactive measures. Meanwhile, proactive measures are generally implemented even in the absence of some exigent incentive, and therefore require stronger political will to put forth. When there is no obvious/immediate incentive or where no problem is sensed, it is difficult to make the public understand the rationale behind proactive measures against traffic congestion. Add to that, most policies incur huge costs, making it more difficult to get the public's consensus.

What is required therefore as a first step is to clarify the probability of traffic congestion—and its concomitant inconveniences—occurring in the future. Since data clearly show the link between per-capita GDP and vehicle ownership ratio, it is possible to predict the future vehicle ownership ratio by applying the population forecast. Combining this with other data such as road capacity can indicate the 'time' and 'scale' of traffic problems that may occur.

This study urges the formulation of preventive measures to proactively avoid problems. The irony here, though, is that this is like fighting with an invisible opponent and that the anticipated problem may not surface if things go well. Sceptics can even claim there was no problem from the beginning. Since one is not dealing with a problem that needs immediate resolution, how to discern potential and relevant problems way in advance is crucial. When problem identification is unclear, the possibility of countermeasures becoming irrelevant to the actual problem may be high. To maintain the consistency and appropriateness of countermeasures, it is also necessary to clarify with and state the problem clearly to relevant stakeholders (including the public), and to maintain this communication link with them until the end of a project.

Proposed countermeasures against traffic problems also benefit from quantitative analyses. For instance, in Chapter 4, quantitative values illustrate the effect of feeder networks on the modal shift in the transport sector and the limitations in the effect. In reinforcing the rationale behind any concept, numbers can effectively tell a story. It is thus possible to come up with robust countermeasures when numbers support the concept and, conversely, when concepts validate the accuracy of the calculations. In formulating preventive measures, the quantitative approach makes it possible to discover bottlenecks and avoid excessive investment.

1.2. Setting Countermeasures as Part of Urban Planning

Once future problems are identified and shared, it then becomes necessary to formulate countermeasures. While numerous measures against traffic congestion are highly flexible, it can be said that there are two measures that belong to opposing ends of the spectrum. One axis is the automobile society type, which aims to decentralise cities to avoid traffic congestions while pushing for the use of cars as well as pursuing improvement in road conditions in terms of capacity and speed. The other axis is the high-density compact city, which prompts modal shifts in transport by controlling the use of cars.

The automobile society type offers the possibility of avoiding traffic congestion; but addressing the traffic needs of private cars only is disadvantageous in terms of energy efficiency as well as cost incurred in infrastructure development. This method is theoretically applicable to medium-scale cities.

The high-density compact city type offers an infinite number of policy combinations; yet since it is based on the premise of modal shift, it requires government's determination to replace the use of private cars with other modes of transport. Whereas the development of public transport system is a common method to resolve the issue, planners can formulate policies centring on bicycles and walking, too. In reality, it is impossible for all traffic demands to be addressed by one mode only; modal shifts occur by resorting to multiple modes. In any case, modal shifts can happen only if alternative modes are already in place before the plan is implemented. Otherwise, residents will have no choice but to ride their cars even if various policies discourage car use.

In reality, the solution to traffic problems is highly unlikely to be so extreme such that no cars will be allowed to ply the streets; measures from both axes may be used in combination. However, these policy types have many conflicting areas, and attention needs to be paid to the fact that it is not easy to use them simultaneously. Effective development of policies may require some contrivances, such as addressing the matter by sectioning the area.

Detailed planning of the public transport system means figuring out the best routes and networks, taking into consideration the future traffic scenario. A city prior to the introduction of a new public transport system has its unique structure and, early on, would not have foreseen nor anticipated the emergence of such a transport system. Its structural inter-era disparity may lead to incompatibility between the city plan and the planned transport system. This incompatibility has a physical aspect and an economic aspect, and cannot be resolved without changing the structure of the city. There is no need to plan a new replacement transport method to match the current pre-modern structure of the city; it is more sensible to reform the city so that it can accommodate the new/replacement transport system instead.

Whereas a compact city is extremely effective in reducing the traffic demands and promoting the efficient use of public transport, creating one essentially requires urban planning. Likewise, addressing traffic problems requires urban planning. Some of the future traffic problems may be avoided through urban planning and social change such as the modification of lifestyle, in addition to placing homes and workplaces close to each other and suppressing urban sprawl.

In general, large cities have a major commercial district at their centres, and areas with relatively high population density are automatically developed around it. Except for some US-type cities with excessively advanced urban sprawl, the central area often becomes a highly dense location with a large absolute population. Such areas are prone to severe traffic congestion, and are therefore good candidates to transition to a modal shift type society. On the other hand, medium and small cities have a lower population, tend to use land sparsely, and possibly fall into a situation where there is no central area if they have no clear development plan. Medium cities with no strong core may be required to deliberately carry out highly dense compact city-type urban planning.

Addressing traffic problems directly translates into urban reform. Only when the city has a clear vision can the design and strategic development of the public transport system be part of its function. Since post-incident, remedial measures against traffic congestion often do not have the luxury of time to be implemented along with urban reforms, this is where preventive measures for the transport sector have an advantage.

Traffic management should be connected with urban planning. The proper functioning of a new transport system requires a ‘new city style’, which refers not only to the townscape and sectioning but to the mentality and lifestyle of the residents as well. As mentioned above, proactive measures for traffic issues are different from post-incident, remedial measures for traffic congestion. In practice, planning of proactive measures is urban reform itself as well as the process of creating a new city instead of coming up with mere solutions for problems.

1.3. Securing Financing and Formulation a Sustainable Policy Mix

When urban planning and planning for the replacement transport system have been completed, the next step is to formulate policies that support the plans. It must be noted that urban planning and construction/maintenance of public transport system all involve costs. Regulatory policies incur massive costs in operations and, in some cases, can affect the economy's optimal efficiency; there should be extra attention therefore when implementing policies.

Traffic policies can be divided roughly into two viewpoints. One viewpoint is that traffic congestion can be controlled by manipulating traffic demand. Such can be effected by eliminating, reducing, replacing, or shifting demand. Modal shifts mainly work for demand replacement although, in reality, it may be more appropriate to describe it as a combination of demand replacement and demand reduction. *Demand reduction* mainly asks for ideas outside of traffic policies (e.g. placing homes and workplaces close to each other through urban planning and promotion of SOHO). *Demand replacement* hopes to alleviate congestion by improving traffic mobility. For instance, building of multi-level crossings, road width expansion, and regulations on on-street parking are policies formulated from this viewpoint.

There are three points to note on the operation of traffic policies. The first point is to pay attention to the side effects of traffic policies. This includes economic loss caused by reduced transport mode options arising from taxation and regulations. The second point is to consider policies as a package and not as stand-alone policies. An individual policy is powerless or unreasonable by itself and worthless. The third point is to secure political flexibility. Solutions to traffic problems should not have rigorous goals such as the complete elimination of automobiles. Policies shall always include a system that allows some adjustments to given situations. Additionally, because of the nature of automobiles as an asset, policymakers should be aware of a possible time lag that may occur before the outcome of policies is felt.

Table 5.1: Countermeasures for Traffic Congestion

	Traffic demand		Traffic mobility
Rid	Work at home Phone conference	**Road capacity**	Road width expansion Lane addition
Reduce	Placement of homes and workplaces in close proximity Gasoline tax	**Road structure**	Multi-level crossing Road linearisation
Replace	Public transport system Development of sidewalks	**Other**	Drainage measure / Electronic Toll Collection Illegal parking regulations Advanced technical requirements for driver's licences Driving manner activities
Shift	Flexitime Dispersion of days off		

Thus, when developing a tax system and other systems for policies related to countermeasures for transportation, it is important to establish first a legal and sustainable fund collection system from automobile users. It is required to obtain a clear view of the transport structure and create contrasts in the operation of regulatory measures, while ensuring to limit the application of regulations to areas with serious traffic congestion or external diseconomy, for instance.

1.4 Sharing Values and Collaborating with Citizens and Companies

The end goal of traffic policies is not formulation but effective implementation. Therefore, sharing values with citizens and local companies that accept the policies becomes important. This involves enhancing citizens' understanding of the urban planning and traffic policies. Getting these stakeholders' engagement and cooperation makes it easier to be of the same mindset and minimises resistance.

The directions for the city, the future development plans, and the vision are examples of values that shall be shared with citizens. All must understand that traffic congestion, although undesirable, occurs as population grows and income levels increase. Herein lies the connection between urban planning of growing cities and traffic policies. When implementing preventive traffic policies from this perspective, it is important to allow a paradigm shift on how to look at problems, changing one's view of solutions from 'proactive measures or reactive measures for traffic problems', to one that involves a more positive, creative perspective (e.g. 'create an ideal city of the future'). Also, in urban planning, each policy may sound staid and lack the persuasiveness needed if the framework of the problem remains at the level of traffic measures.

Solving traffic problems generally pertains to alleviating diseconomy and dissatisfaction—i.e. where a certain negative situation is the reference point in principle. Traffic congestion as a side effect of social development is nothing but a waste of the society, and people do not get easily motivated to clean their waste, albeit necessary to do so. Therefore, by taking advantage of the above-mentioned paradigm shift, one can regard mere waste cleaning as a project to enhance the added values. For example, public transport itself is a value. More comfortable and faster travel is another value.

2. Future Issues

Thus, the above discussion can be summarised as: First, predict the 'scale' and 'time' of the problem and clarify the problem before implementing proactive measures. Next, acknowledge that urban planning forms the basis for the continuous development of the city and formulate a public transport plan with the help of quantitative analysis. Then, secure financial resources and build a system that will sustainably implement the traffic policies. Lastly, rebuild the policy framework from one that merely aims to prevent traffic problems into one that aspires to realise the long-term direction and goal of the city, and execute the policies by promoting shared values with citizens and local companies.

As indicated in Chapter 3, to proactively avoid traffic problems that are 'structurally automatic' in a sense, it is important to always refer to the mid- to long-term development goal for the city and bank on these three points: ability to anticipate and identify problems, persuasive goal setting, and execution capability.

Future studies on this subject may focus on the actual implementation of traffic policies rather than discuss the traffic issues at the conceptual level only. Examples of these studies are:

- Study on individual policies – Tax system, licensing system, automobile regulations, urban planning
- Management of the public transport system – Public–private relationship, management strategy, financial strategy, investment strategy
- Operation of the public transport system – Fare setting, headways, public relations strategy, services
- Study on road traffic – Road structure, traffic light functions, sidewalks, drainage, smart functions

Since traffic issues are addressed by a combination of policies, one ineffective policy does not automatically mean the entire exercise is a waste. A detailed look at each policy may identify better combinations and improve the latter's effectiveness. Conversely, future studies may also analyse how packages of traffic policies have been implemented by extracting the common and persistent issues and analysing the methods used to deal with bottlenecks.