731 Intro to Regional Planning, Fall 2015 Semester

Congestion in Bangkok

And Lessons from London and Singapore

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Abstract

This paper will explore the congestion problems in regional Bangkok Metropolitan Area and the possible solutions from London Metropolitan Area and Singapore as case studies. London and Singapore are selected as case studies for Bangkok because of the similarities in terms of contexts.

London Metro is very similar to Bangkok Metro in terms of area and total number of population. Moreover, London has the approximately the same number of vehicles compared to Bangkok in 2004. But within 10 years, the number of vehicles of Bangkok has doubled as compared to 2004, while the number of vehicles in London kept steady. According to statistics, Greater London Authority (GLA), the London metro region agency, is more successful in controlling number of vehicles and implementing public transit policies. The GLA can propose and enforce their transportation-related plans for London metro area separately from the conventional UK's administrative structure. Thus, the administrative structure and authorities of London regional planning agency are a good role model for Bangkok.

Singapore is half the size of Bangkok and has 36% of population compared to Bangkok Metro. But the location of the country is in Southeast with very similar social, cultural and economic contexts. Furthermore, Singapore has top-down administration approaches The policies on transportation were assigned by Ministry of Transport, same as Thailand's administration structure. Hence, Singapore will be a good case study for planning and implementation through top-down administration which Bangkok Metro can learn from.

The paper will be divided into 4 sections: Bangkok Metropolitan Area, Greater London, Singapore, and summary. The first section is Bangkok Metropolitan Area. It will consist of the administrative structure with the current comprehensive plans, and existing congestion issues which cause traffic congestion problems in the region. The other two sections will be the explorations through Greater London and Singapore's administrative structures and attempts to solve congestions by various policies in the regional level.

In the summary, the possible solutions which can be adapted to Bangkok Metropolitan Area will be discussed.

Bangkok Metropolitan Area

Bangkok Metropolitan Area and administrative structures

Bangkok Metropolitan Area refers to a governmental definition of Bangkok City and urban surrounding areas which are the five adjacent provinces of *Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan,* and *Samut Sakhon*.

Bangkok Metropolitan Area by a political boundary covers an area of 7,761.50 km^2 or 2,996.73 mi^2, with a total number of population by 2010 census of 14,565,520. While Bangkok City itself covers an area of 1,568.737 km^2 or 605.69 mi^2 and a number of population of 8,249,117 persons (*Citypopulation.de, 2015*) or 20% of the metro area and 56.63% of the metro population.

According to the *National Government Organization Act, BE 2534 (1991),* the services of Thai government have been divided into three levels: central, provincial, and local level. Bangkok City is a part of the local governmental organization called Bangkok Metropolitan Administration or BMA. The government is composed of 2 branches, the executive branch or the governor, and the legislative branch or the Bangkok Metropolitan Council. The governor of Bangkok and the metro council are directly elected separately to a renewable term of 4 years. In accordance with *Bangkok Metropolitan Administration Act, BE 2528 (1985*), the governor has a power to formulate and implement policies for the Bangkok Metropolitan Area; appoint and remove deputy governors, advisors, board members, city officials, and public servants; and has the power to draw up legislation and bills for the city, to be considered in the Bangkok Metropolitan Council.

The other five adjacent provinces are parts of provincial government, have administered by provincial governors who was appointed by Minister of Interior with no renewable term.

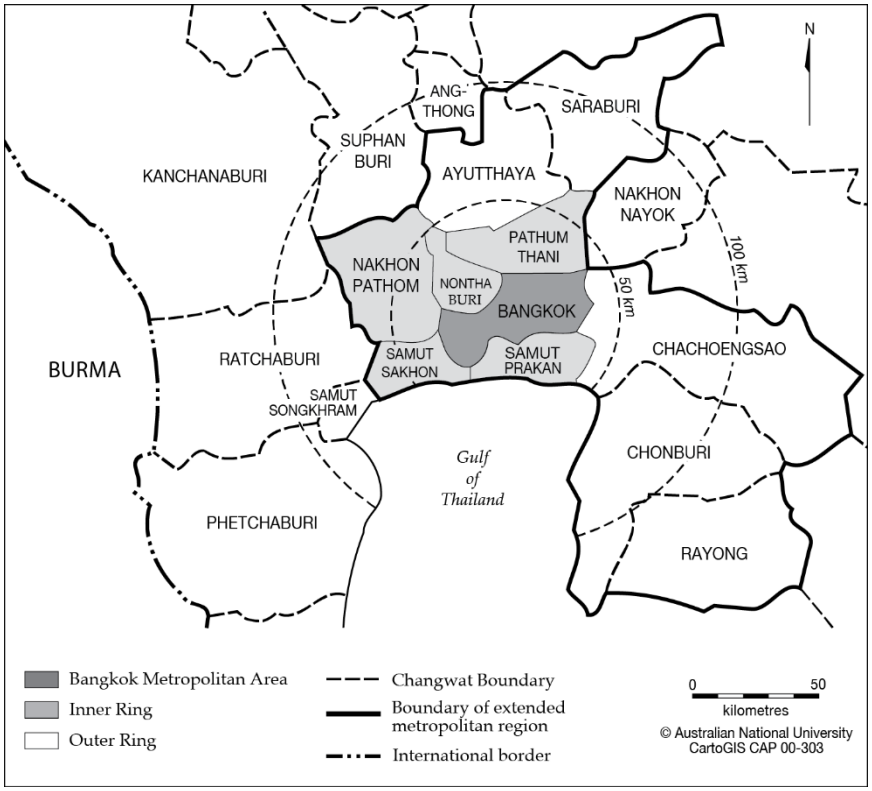


Figure 1 Bangkok Metropolitan Area

Comprehensive planning of the metropolitan area

Comprehensive plan for Bangkok Metropolitan region is studied and documented by National and Regional Planning Bureau, Department of Public Works and Town & Country Planning, Ministry of Interior in 3 levels, 50 year long-term plan, 10-15 year mid-term plan, and 5 year urgent plan. The long-term plan provide projected strategies for BE 2600 (CE 2057) *(National and Regional Planning Bureau, 2011)*.

The traffic-congestion-related policies mentioned in the *BE 2600 Comprehensive Planning for Bangkok Metropolitan Area* are divided into three major topics: road, rail, and water system development policies accordingly. The major goals are overcrowding and congestion reduces; transportation mode connectivity increase; and mass transit service coverages for the whole metropolitan area.

By roads, the metro area should be developed to have higher car capacities by increasing total road area, tunnels and crossing bridges; install VICS (Vehicle Information and Communication System) and ETC (Electronic Toll Collection System) to reduce traffic congestion; increase the number of mode-changing stations for passengers and freights to reduce the number of vehicles and encourage high-capacity transportation; and develop more BRT (Bus Rapid Transit) to encourage mass transportation modes.

By rails, the metro area should be developed to have more rail lines with connectivity to suburban areas; install rail-system amenities such as tunnels and bridges over rail lines to increase rail system capacities; reduce taxes to encourage passengers and freights using rail system; and consolidate service responsible agencies to have better quality and service controls.

By water, the boat bus system should be developed to have more connectivity with the other modes of transportation; have more quality control on pollution production and water quality; better landscape aesthetic and safety to encourage passengers to use boat bus system.

From the exploration through the plan, there is no budget and the responsible agencies mentioned in the plan. Office of Transportation and Traffic Policy and Planning, Ministry of Transport is assumed to be the responsible agency for detailed transportation planning and policy implementations. But there is no official publication of any transportation plan in the data base of the office's website. Thus this problem is included as one of the weaknesses of Bangkok Metro transportation planning in this paper.

Existing issues of traffic congestion in Bangkok Metro Area

The causes of congestion problems in Bangkok Metropolitan Area can be divided into 4 main issues: number of private vehicles, inefficiency of road system planning compared to cities in developed countries, lack of regional transportation policy, and fragmented governance between Bangkok City and five adjacent provinces. Each of them will be discussed one by one.

High rate of private vehicles per capita

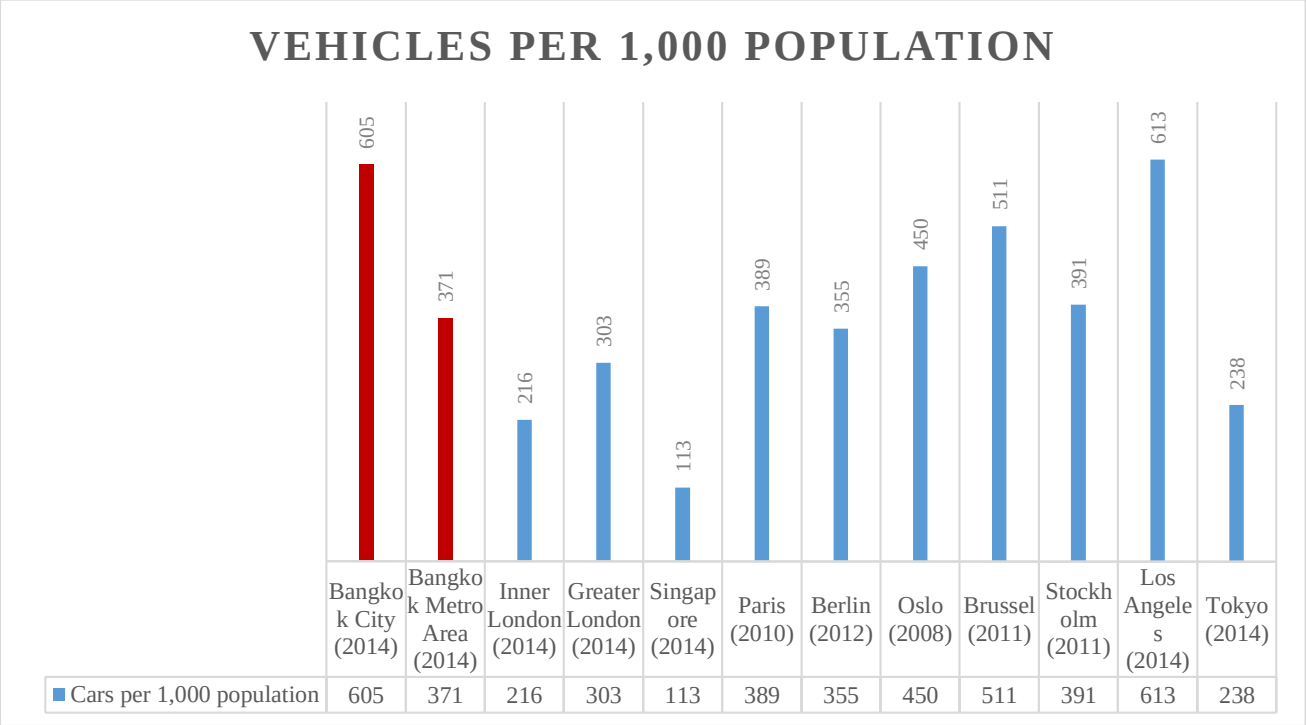


Figure 2 Vehicles per 1,000 population of Bangkok Metro and other sample cities

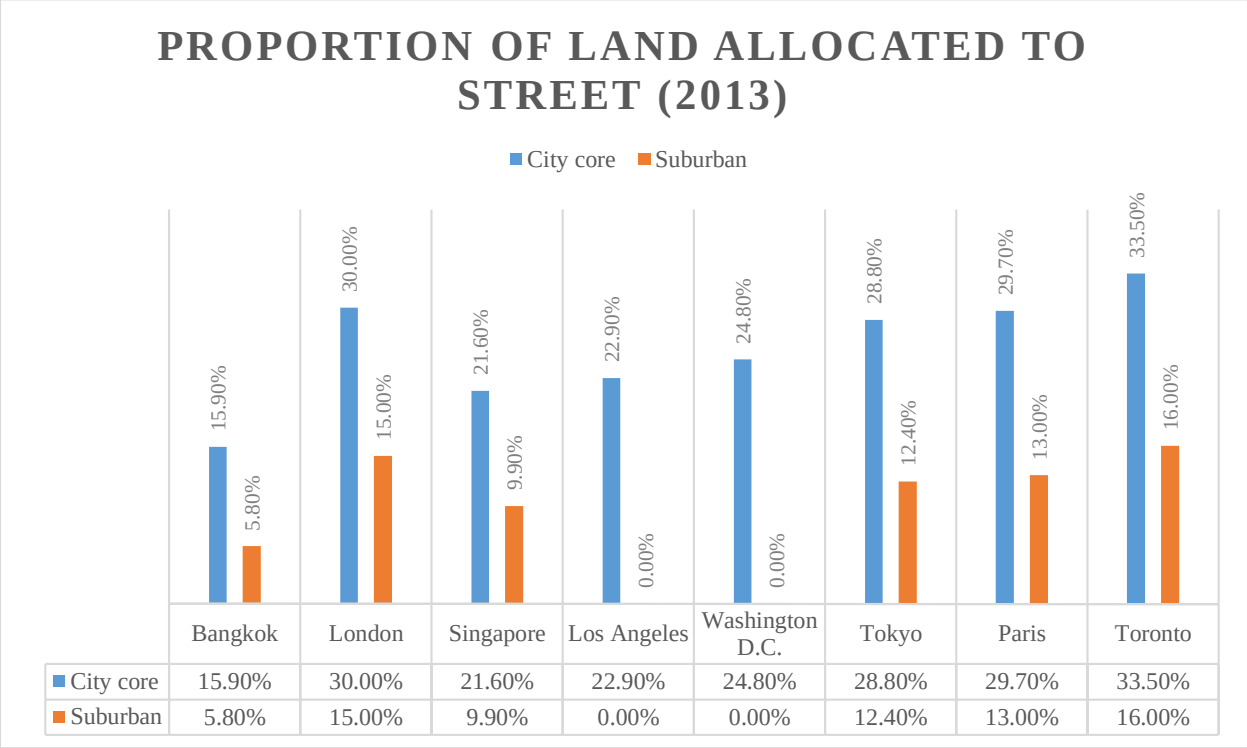
Bangkok city has very high number of private vehicles per 1,000 population, at 605 vehicles. Compared to the samples of cities in developed countries, Bangkok has roughly twice by Paris and Berlin; 2.5 times by Tokyo; three times number of vehicles by Inner London or London urban core areas, and 6 times by Singapore.

In addition, the number of vehicles per 1,000 population of Bangkok Metropolitan Area is 371 vehicles, compared to Greater London Area at 303 vehicles and Singapore at 113 vehicles. The Bangkok Metro has higher number of vehicles by 1.2 times than Greater London and 3 times than Singapore.

Inefficiency of Road System Planning

The second issue of traffic congestion in Bangkok Metropolitan Area is inefficiency of road design. The issue can be divided into two subcategories: low road coverage percentage and low street connectivity index compared to cities which have better traffic conditions in developed countries.

Firstly, Bangkok has lower road coverage percentage to total region's area compared to cities in developed countries. From the UNHabitat's Proportion of Land Allocated to Street 2013, Bangkok has percentage of road coverage only 15.90% in the city core area and 5.80% in the suburban compared to the other cities, above 20% in city core and 10% in suburbs (See Figure 3). The number indicates that congestion problems in Bangkok Metropolitan Area are caused by inadequacy of road surfaces.



	Bangkok	London	Singapore	Los Angeles	Washington D.C.	Tokyo	Paris	Toronto
City core	15.90%	30.00%	21.60%	22.90%	24.80%	28.80%	29.70%	33.50%
Suburban	5.80%	15.00%	9.90%	0.00%	0.00%	12.40%	13.00%	16.00%

Figure 3 Proportion of Land Allocated to Street (2013)

Secondly, roads and streets in Bangkok are not effectively connected to each other. Composite Street Connectivity index of Bangkok is 14.90% in the city core area and 5.30% in the suburban areas. Compare to the other cities, above 20% in city cores, and 10% in suburbs (except Singapore). The number indicates that Bangkok Metro has many cul-de-sacs which decrease flow and efficiency of road transportation.

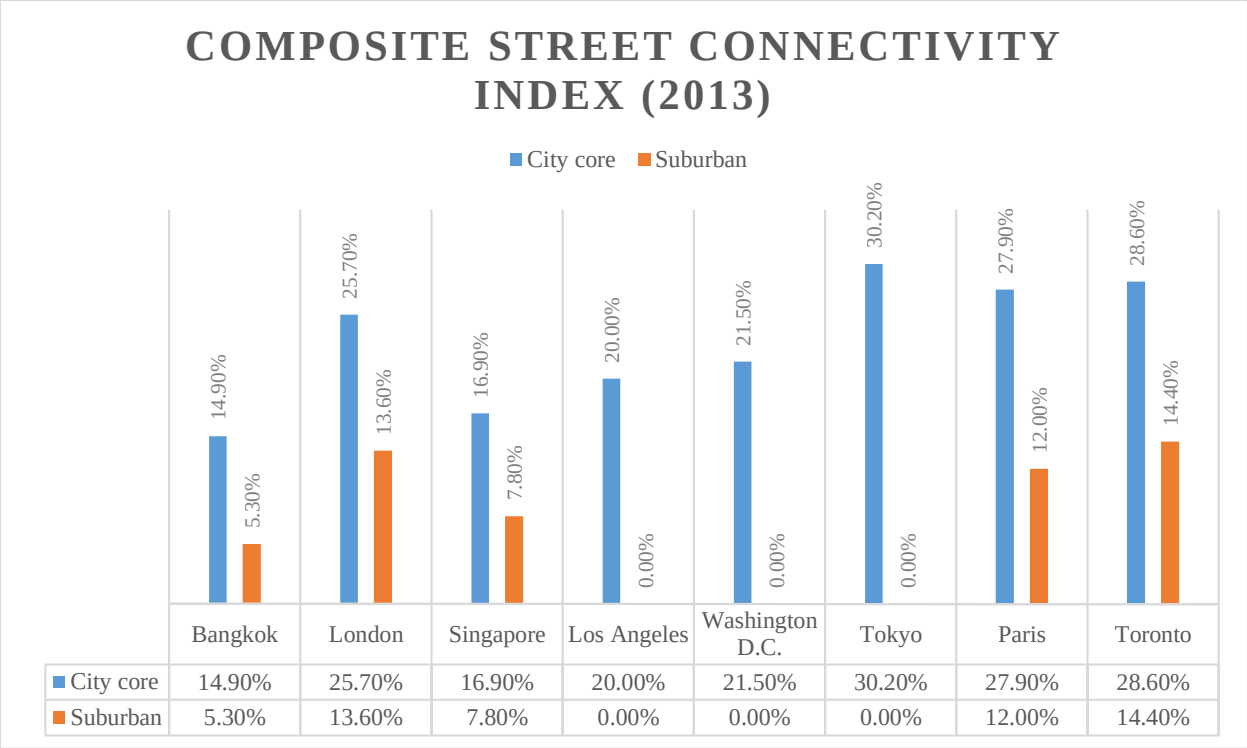


Figure 4 Composite Street Connectivity Index (2013)

Transportation Policies of Bangkok Metropolitan Area

The Bangkok metro region has no effective transportation policy to control increasing number of vehicles. Also, the BMA has no authority for transportation-related plan proposal and implementation process. Only operation and monitoring process are executed by BMA itself. Lack of regional policies can cause the region to be affected by policies from the other levels of the government. Such as the federal policy on Car Subsidy in 2011 which has the direct effects to Bangkok Metro region's growth of vehicle populations and worse transportation conditions.

The Metro Area has been affected by 2011 First Car Subsidy Program, a federal level policy to subsidy THB 100,000 (approximately USD 2850) to every first car buyer. The policy was passed by the cabinet resolution in September, 2011, aimed to promote economic activities and automobile industries after losses from the flood hazards in the early 2011. This program has been accounted from October 1st, 2011 to December 31st, 2012, with funding from Ministry of Finance to pay the THB 100,000 margins

back to the vehicle buyers. The result of the program is more than subsidized 367,000 cars, pick-ups, and double cabs were registered in Bangkok Metropolitan Area or 30% of all First Car Program Registered cars in the country (The Exercise Department, 2013). The subsidy program has made the number of licensed cars in Bangkok metro increased from roughly 4-7% increases annually to 10-11% in 2011-2012.

As Bangkok Metropolitan Area lacks of effective transportation policies to control number of vehicles and traffic authority by itself, the region has direct negative effects from the First Car Subsidy Program and has a potential to be affected by conflicting future federal policies.

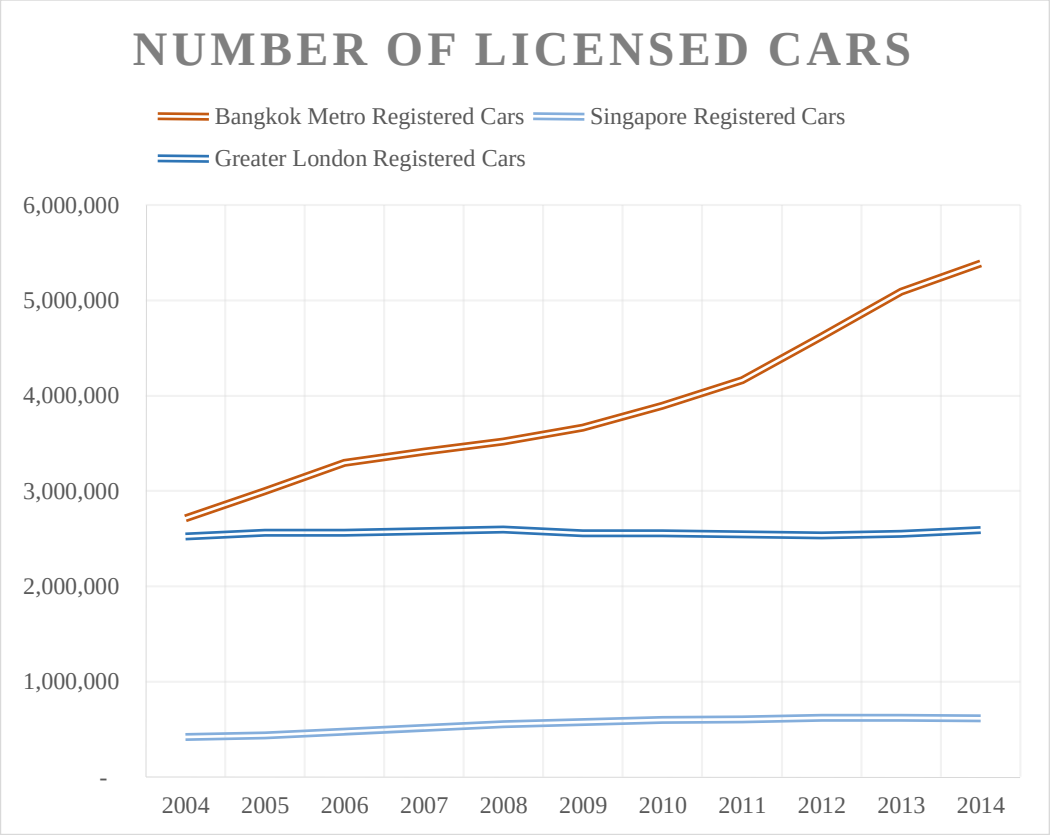


Figure 5 Number of Licensed Cars in BMA, Greater London, and Singapore (2004-2014)

Table 1Number of cars in BMA, Greater London, and Singapore (2004-2014)

	Bangkok Metro Registered Cars	% Changes	Greater London Registered Cars	% Changes	Singapore Registered Cars	% Changes
2004	2,715,787		2,523,129		417,103	
2005	2,996,182	10%	2,561,914	2%	438,194	5%
2006	3,296,735	10%	2,560,103	0%	472,308	8%
2007	3,411,987	3%	2,578,943	1%	514,685	9%
2008	3,521,369	3%	2,594,741	1%	550,455	7%
2009	3,663,004	4%	2,556,729	-1%	576,988	5%
2010	3,893,082	6%	2,557,384	0%	595,185	3%
2011	4,160,913	7%	2,542,734	-1%	603,723	1%
2012	4,618,877	11%	2,535,453	0%	617,570	2%
2013	5,090,310	10%	2,549,275	1%	621,345	1%
2014	5,386,893	6%	2,588,373	2%	616,609	-1%

Fragmented Governances between Bangkok City and Five Adjacent Provinces

Some congestion problems in Bangkok Metropolitan Area are caused by fragmented governance and lack of authority to control the region.

Bangkok Metropolitan Authority has no authority to make comprehensive plans for the Bangkok Metro Area by itself. As mentioned previously, the comprehensive plans for the region are compiled by the National and Regional Planning Bureau, Department of Public Works and Town & Country Planning, Ministry of Interior. The transportation strategies have been accommodated in the plan roughly. While the strategic plans for transportation and transit systems are compiled by Office of Transportation and Traffic Policy and Planning, Ministry of Transport.

Fragmented intergovernmental cooperation with lack of regional authority over the whole metro area of the BMA cause conflicts in the BTS light rail system since 2011. The extensions of existing light rail system from city core of the metro area to the suburbs, from Onnut to Bearing Station, could open for services after the construction was completed in 2009, or for approximately 2 years. The difficulty is caused by the fragmented authority between Bangkok city and the outer metropolitan areas. Bangkok Metropolitan Authority has no authority over the metro areas outside of Bangkok, and the inter-governmental implementation processes are struggled between the BMA and the provincial authorities.

The other issue is the extensions of the BTS system outside the boundaries of Bangkok City, Onnut Station to Bearing Station and Wongwienyai Station to Bangwa Station, is owned by BMA while the existing lines are the concession of the Bangkok Mass Transit System Public Company Limited. Unfortunately, BMA and the BTS Company cannot make an agreement on the fare charges. The result is passengers have been charged for additional THB 10 (approximately USD 0.27) fares for the extension (BTS, 2015).

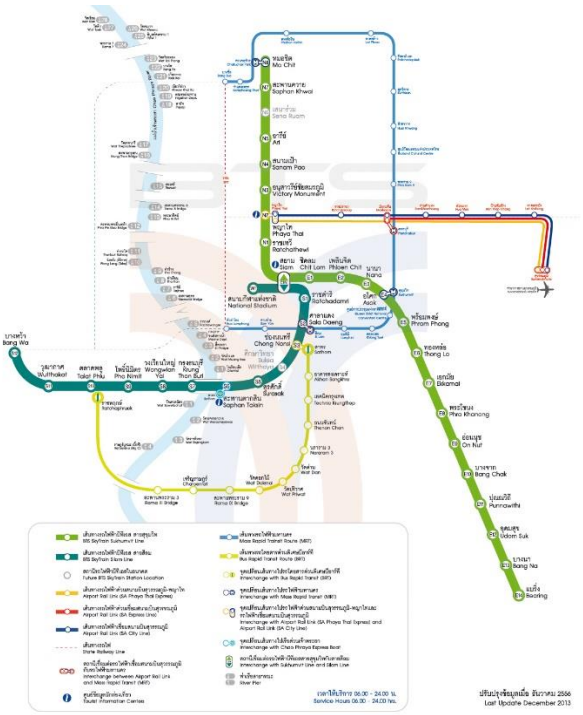


Figure 6 BTS system map

London Metropolitan Area and Greater London

London Metropolitan Area or London Commuter Belt is the metropolitan area which is practical to commute to work in the central London area, the boundary of the metro area are not fixed. The 3236 mi^2 metro area covers 43 districts in 9 counties which are Bedfordshire, Berkshire, Buckinghamshire, East Sussex, Essex, Greater London, Hampshire, Hertfordshire, Kent, Surrey, and West Sussex. From Eurostat's data on Population by sex and age groups, London Metro Region has the highest population among European countries with a population of 13,879,757 in 2013.

Greater London's Administrative Structures

The authority of London Metropolitan Area is Greater London Authority and local authorities. Greater London Authority is administrated over Greater London area which covers only 20% all London metro region. The other areas are administrated under borough administration.

Greater London Authority or GLA which is a strategic regional authority created in 1965 by *London Government Act 1963* due to the rapid expansion of built-up area outside of the city of London. It consisted of Mayor of London, London Assembly, and four functional bodies: Transport for London, the Mayor's Office for Policing and Crime, London Fire and Emergency Planning Authority, and GLA Land and Property. The Mayor of London and London Assembly are elected by vote to a renewable term of 4 year using proportional representation system. The functional bodies have authorities on transportation, land use and zoning policies, fire and emergency planning, and economic development. It covers the area of Greater London which is a region consisted of 33 districts of London and the surrounding areas. In Figure 2, Greater London Area is located within the black bold boundaries inside the commuter belt.

The other 10 districts outside the Greater London area are under local authorities which are divided into two levels: upper-tier county level, and lower tier district level.

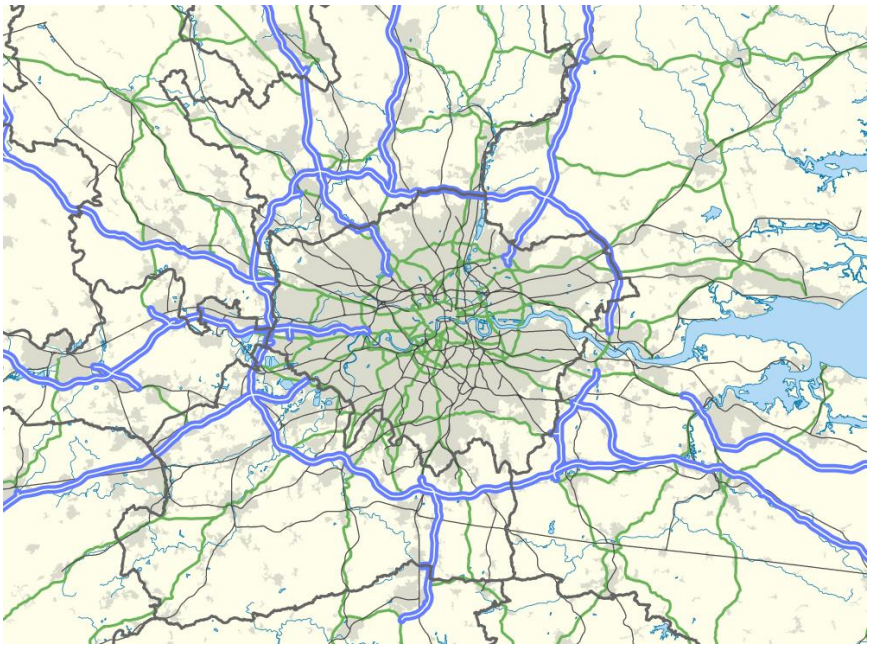


Figure 7 London Metropolitan Area and Greater London Area

Transportation Strategies

Transport for London (TfL), a part of the Greater London Authority, has been assigned to prepare transportation plans for the metro area, such as deciding on new transportation infrastructure investment, transportation-related goal proposes, plan implementation, and results monitoring. Their plan is called Mayor Transportation's Strategy (MTS). The MTS plan is developed along with London Plan and Economic Development Strategy (EDS) as a strategic framework for 20-year transportation vision. The current plan's preparation was finished in 2010, projected future development plan through 2031. The key goals include (Transport for London, 2015) underground transit system expansion, light rail capacity increases, new rail lines and rail system capacity increases, biking and walking facility promotion, congestion charging zone, and low emission zone (LEZ).

TfL is funded from five main sources: fares income, property income, grant funding from Greater London Authority (GLA) and Department for Transport (DfT), cross rail funding, and cash movements. Fares income is accommodated for 40% of all funding, with 23% received from DfT and GLA. Since

major of their funding is from their own income, the TfL are less dependent on federal policies and has more dynamic vision.

In this paper, cycling promotion and congestion charging zone, policies aimed to reduce number of vehicles and congestion problems, will be discussed.

Cycling Promotion

Theoretical Background

Cycling infrastructure investment idea is conceived after the cycling promotion success in London's 2012 Summer Olympic. Greater London Authorities proposed to promote cycling to be one of the highest priorities of TfL as it promotes easier commuting mode, recreation, cleaner air, and less traffic. The new separated bike lanes are believed to alleviate congestion problems especially in rush hours and reduce delay time.

The major processes to implement the plan for Greater London Area is cooperation between TfL and 33 boroughs under the regional boundaries. Because only 5% of roads in the metro area are owned by Tfl, while the other 95% are owned by local administrations. The GLA decided to sign a partnership agreement with locals to encourage them to follow the improvement plans and promote cycling to their residents.

Mayor's Vision for Cycling in London

TfL's biking promote strategies are provided in the Mayor's Vision for Cycling in London report. The Mayor of London has signed the bike improvement projects to spend GBP 400,000,000 by 3 years or GBP 145,000,000 annually, 2.5 times higher than budget proposed in the previous plan, to invest in new infrastructure for bikes.

The budget will be spent on constructing various types of bike infrastructure. Mainly, there are Barclay Cycle Superhighway system, New Bike Quietways, and other bike-related infrastructure such as bike and pedestrian bridges, Cycle Superhubs at local railway stations, and 80,000 more bike parking

spaces. Firstly, Barclay Cycle Superhighway system will be bike lanes fully separated from the vehicle roads and junctions. The bike superhighways are 15 mile stretched from the outer east through the city core of London to the outer west side. The bike superhighway system has been proposed for hurry cyclists who need fast routes for rush hours. Fully separated bike lanes will improve bike safety for cyclists to commute on the same roads with other motor vehicles. Secondly, New Bike Quietways are proposed for new or more cautious cyclists who need to ride slower or for recreation-related. The bike lanes will be built on low traffic back-streets and off-road greenway routes through parks and along waterways in Greater London Area. The quiet way construction will operated along with the bike education programs for schools and disadvantaged people to promote better equity in cycling. Lastly, the other bike infrastructure such as bike & pedestrian bridges, Cycle Superhubs at local railway stations, and 80,000 more bike parking spaces are proposed to improve bike safety and connectivity to other mode of transportation such as rail, and underground transit systems.

Figure 8 East-West Cycle Superhighway

Evaluation

The prospected results for the investment is more than 1,000 cyclists per hour will use the bike superhighway system, the number is equivalent to four entire trainloads. TfL believes that thousands of vehicle users will be encouraged to use bikes in the outer London area.

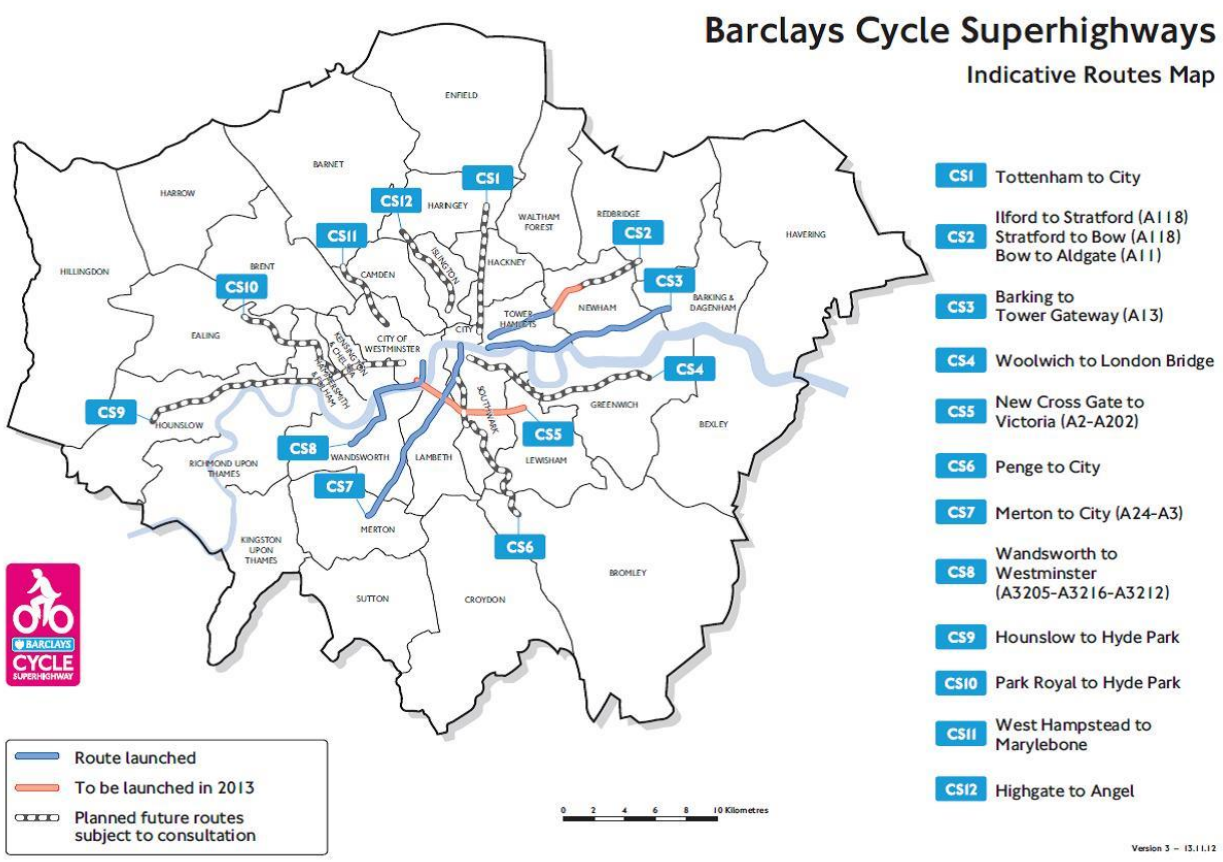


Figure 9 Barclay Cycle Superhighway Indicate Map

From the report (ENS, 2015), TfL found that until February 2015, the Barclay Cycle Superhighway system reduce the whole-route traffic delay in the morning rush hour, the worst affected time, by 60 percent compared to previous proposals. The delay is now reduced from 16 minutes to just over six minutes in the busiest morning hour.

Congestion Charging Zone's

Theoretical Background

Congestion charge was first conceived by transport planners in the 1960s (Smeed, 1964; Walters, 1961). Smeed (1949) proposed what later dubbed the Smeed's Law explaining a direct relationship between traffic fatalities and traffic congestion. The law implies that without an incentive scheme, congestion will remain at the equilibrium where the marginal cost of driving (congestion) equals to the

marginal benefit of driving (driving safely). For instance, he predicted that the traffic in Greater London will always move at nine miles per hour. This equilibrium, however, is not the optimal level of congestion for the system.

A simple demand-supply model demonstrates that each additional vehicle creates a negative externality for every other vehicle by increasing traffic congestion (Prud'homme and Bocarejo, 2005). Therefore, by charging a fee for this negative externality incurred by drivers, planners can provide an incentive for them to scale back or more efficiently schedule their driving. Theoretically, this will lead to an optimal level of congestion. In recent years, the range of negative externalities expand to also include environmental issues such as noise pollution and carbon emission.

Congestion Charging Scheme

Began in February 17, 2003, London's congestion charging is a zoning scheme in the Greater London region (Central Zone) aimed to moderate the traffic within the area as well as to raise funds for transport infrastructure (Banister, 2003).

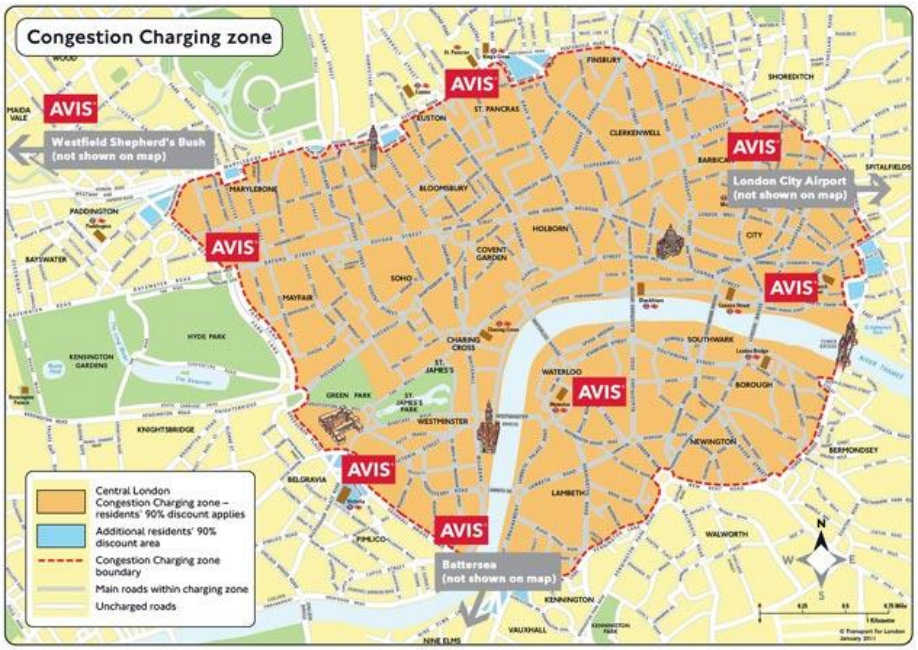


Figure 10 London Congestion Charging Zone

The zone, spanning eight square miles, is London's commercial and financial region comprising about 370,000 inhabitants and 1.2 million jobs (Prud'homme and Bocarejo, 2005) much like Manhattan's 8.5-square-mile Central Business District (Komanoff, 2013). At present, a driver must pay a £11.50 daily charge in order to drive within the Congestion Charge Zone (CCZ) between 7 am to 6 pm from Monday to Friday. Drivers may pay the charge through postage, credit or debit cards, and cash at retail outlets. Due to London's lack of an electronic toll gate system, more than 1,360 security cameras are installed within and around the perimeter. Each camera scans for a license plate a matches it to the database of paid congestion charges. If it detects an unpaid vehicle, a fine of £40-120 according to how swiftly the driver pays it will be applied to the driver ("Congestion Charge", 2003). In light of environmental concerns, public transportation, electronic vehicles, and vehicles with low carbon emission are exempted from congestion charge.

Evaluation

According to *Travel in London Report 5* (2012), the congestion charging scheme has achieved its goal in mitigating traffic congestion. The scheme resulted in a 15-20% boost in car and bus speeds. Congestion delays are reduced by 30%. The London Underground runs 5% more train-miles with travellers' delays down by a third. Bus usage also reached a 50-year high in 2011, with 30% more service and 20 percent less waiting compared to 2000-01. Bike commutes increased 79% from 2001 to 2011. And traffic fatalities and injuries are also at an all-time low in 2011. These results prove as a concrete evidence for the effectiveness of congestion charging.

Summary of Greater London's congestion strategies and reflections on Bangkok

Congestion management policies are successful in both results and operations because TfL has authorities to propose and implement congestion management policies over London metropolitan region. Moreover, operating under GLA, TfL can set their goals beyond reducing congestion problems. They can cooperate among the other subdivision departments in GLA to reduce fragmented and conflicting plans.

Thus, the side-advantages of congestion alleviation policies are assigned and success such as traffic injuries decreases, and urban environmental quality improvements.

Compare to the Bangkok metro region, TfL's policies are more concrete, accurate in goals and approaches compared to Bangkok Metropolitan Area's comprehensive plans. Also structurally, the GLA is a powerful regional agency which has authorities to create and implement comprehensive plans for the whole region. They can own transport properties such as roads and earn revenues from them which make GLA less dependent to federal funding. On the other hand, Bangkok's transportation comprehensive plans are inaccurate. They lack short-term and long-term goal in precise steps, amount of budget for each programs, and evaluation methods. The other reflection is Bangkok Metropolitan Authority has no authority over the outer provinces which lead to inefficiency of implementation process.

Singapore

Singapore Administrative Structure

Regions in Singapore are demarcated by Urban Redevelopment Authority (URA) which has frameworks in land use planning, and development control. These regions are not administrative subdivisions. For administrative purposes, Singapore is divided into five administrative districts governed by mayors and Community Development Councils (CDCs) to promote community bonding and cohesion. However, both government agencies have no authority on transportation policies. The transportation policies and management are governed in the federal level by Ministry of Transport (MOT). Ministry of Transport has four statutory boards of government: Civil Aviation Authority of Singapore (CAAS), Maritime and Port Authority of Singapore (MPA), Public Transportation Council (PTC), and Land Transportation Authority (LTA). The responsible board for transport planning and congestion problem alleviation is the LTA.

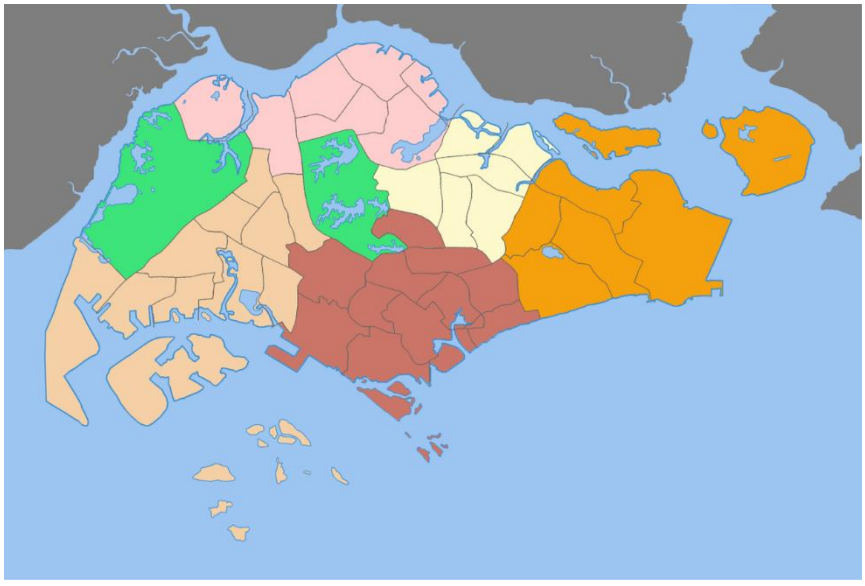


Figure 11 Singapore Planning Region defined by URA

Transportation Strategies

Land Transportation Authority (LTA) is a statutory board to plan and operate rail, bus and road projects in three major concerns i.e. public transport, roads and monitoring, and green transport. In this paper, Electronic Road Pricing (ERP) system, Vehicle Quota System (VQS), Park and Ride (P&R) Scheme, and Parking Guidance System (PGS) will be discussed.

One of strengths of Singapore's transportation management is institutionalized evaluating agency. LTA has established Land Transport Authority Academy (LTAA) in 2006 in order to monitor, evaluate and conduct researches in the field of LTA transportation policies effectiveness. LTAA will study over active transportation policies in Singapore, evaluate the effectiveness, and recommend possible improvements.

Singapore's Road-Pricing: From Licenses to Real-time Pricing

Although the concept of congestion charging was conceived in Britain, Singapore was the first case of its implementation for obvious reasons: the island state houses 4.2 million residents with a meager 250-square-mile area, only 12% of which is road surface.

Singapore started its first congestion charging scheme in 1975 with the Area license System (ALS). The system being a precursor to London's congestion charging has similar purposes and implementation. The Central Business District (CBD) surrounding Orchards Road, spanning 2.3 and later 2.8 square miles, has been designated as the Restriction Zone (RZ). Initially, drivers entering the zone between 7:30 am to 9:30 am from Monday to Saturday must pay S$3 for unlimited entrance; however, due to spikes of peak traffic immediately after 9:30, it was extended to 10:15 am and later 6 pm in order to combat evening congestion in 1994 (Yap and Gwee, 2005). The area licenses could be purchased at area licence sales booths, post offices, petrol stations, and convenience stores. For monitoring, 34 gantries staffed with police officers overlooked the Restriction Zone. Registration numbers of vehicles entering the zone without a license are recorded by the police and a fine of S$70 applied.

ALS achieved immediate success. Traffic volume was reduced by 45%. Vehicle crashes declined by 25%. Average traffic speed increased from 11 mph to 21 mph ("Singapore: The World's First Digital Congestion Charging System", 2014). And use of public transport to the Restricted Area increased from 33% to 70% (Yap and Gwee, 2005). The scheme was highly effective in controlling congestion for twenty years; nonetheless, it had two major limitations: manually inspecting vehicles at gantries created waiting lines, and a flat fee was unable to take into account the spikes of peak traffic ("Singapore: The World's First Digital Congestion Charging System", 2014).

In order to further optimize the level of congestion, Electronic Road Pricing (ERP) was created in 1994. The system dynamically prices the congestion charge according to the amount of traffic within the Restriction Zone at any given time. This allows for more granular smoothing of traffic; that is, whereas ALS deterred traffic equally throughout the designated time, ERP does so for each specific moment in time. For instance, when traffic is heavy during the commuting time, the fee rises, and vice versa when traffic is light. The gantries were also renovated with sensors that detects On-board Units (OBU) installed in each vehicle. When a vehicle passes through, the sensor deducts a cash balance from the On-Board Unit, eliminating the waiting time for each entry into the zone.

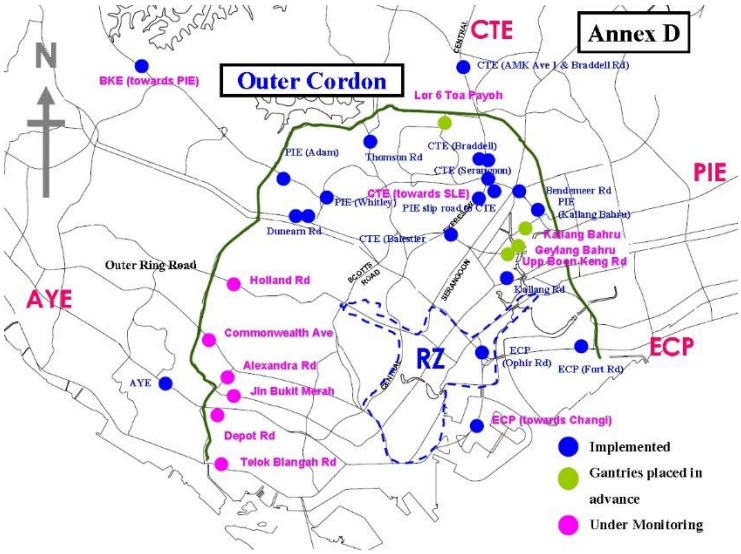


Figure 12 Road Pricing Map in 2007

Figure 13 ERP gantry at North Bridge Road

Evaluation

The implementation of ERP led to a 15% decrease in traffic level ("Singapore: The World's First Digital Congestion Charging System", 2014). Most notably, the traffic during the morning peaks dropped by 7-8% whereas that of the evening peaks rose by 28% (Yap and Gwee, 2005). This clearly demonstrates the smoothing effect.

Vehicle Quota System

To moderate the growth of vehicle population in Singapore, LTA has passed Vehicle Quota System (VQS) in May, 1990 (Vehicle Quota System Review Committee, 1999). Before VQS was introduced, the number of vehicles kept risen despite increasing taxes, indicated that this method is not effective in controlling the vehicle population growth. VQS is the new vehicle tax structure, allowing prospected motorists to bid for limited quota of license plates or Certificate of Entitlement (COE). COE is classified into 5 subcategories on each type of vehicles such as cars below 1600 cc, cars above 1600 cc, and motorcycles. The quota of COE each year is calculated from the actual number of existing vehicles taken off the roads, replacement of expired COE, and allowable growth from LTA plans. The bidding session is opened twice a month. COE is valid for 10 years. The holders can revalidate for another 5 or 10 years and have to pay 50% or 100% of the previous bidding prices accordingly. After revalidation session expires, vehicles will be exported or destroyed by the government. (LTA, 2015)

Evaluation

After the VQS enforcement, the annual growth of vehicle population rate has been capped from 6.8% in 1993 (Tan, 1999) to 3% in 2009, 1% in 2012, and 0.5% in 2013-2015 (LTA, 2015). The numbers indicate success of Vehicle Quota System to control the number of vehicles in the system. In the future, LTA has a plan to set the rate to be 0.25% for the next 3 years.

Vehicle Quota System Review Committee (1995), proposed suggestions to improve VQS, 2 of them will be discussed in this section. In order to compliment Electronic Road Pricing (ERP) program, firstly, he suggested that LTA should provide more quota on small cars, as they use less fuel and road spaces. On the other hand, bigger car buyers should pay more to bid COE because they require more road spaces. With less road spaces taken, more vehicles can be allowed into Electronic Road Pricing (ERP) system. Secondly, he suggested that the validity length of COE should be changed from 10 year to be based on mileage and usages of vehicles.

Park and Ride Scheme

LTA has introduced parking spaces connected to mass transit system in 1990. The purposes are to alleviate traffic congestion problems and to reduce pollutions from motor vehicles. 39 Park & Ride spaces are provided to encourage riders to use public transport in the downtown area. Passengers can use P&R e-booking ticket or EZ Link, a consolidated ticket for all public transport mode, for services.

Figure 14 Singapore's Park and Ride Map

Parking Guidance System

Parking Guide System (PGS) program, launched by LTA in 2008, is an informative database system for motorists with real-time parking availability in Singapore. The main objective is to reduce traffic circulation and illegal parking caused from searching available parking spaces especially in the city core.

The availability-check equipment is installed on each parking lot, the data is collected by car park management system of each building and send it through wired networks to Central Computer System (CCS) at LTA's Intelligent Transport System (ITS). The collected data will be disseminated to electronic panels and other applications by GPRS data network (Seah Haw Kuan, 2008)

The PGS's information are provided by 3 approaches: electronic signboard panels on Marina Centre, Orchard and Harbour Front shopping belts; websites such as One.Motoring.com.sg; and mobile applications such as MyTransport.SG (On.Motoring, 2015).

Figure 15 System Architecture of PGS

Figure 16 Parking Guidance System Signboard at MarinaCentre

Evaluation

Kuan (2008), an executive engineer of Intelligent Transport System development of LTA, proposed methods to evaluate the effectiveness of PGS by car park occupancy rate, volume of vehicles using parking buildings, and traffic speed. First, car park occupancy rate in parking buildings should be increased after PGS enforcement. The higher occupancy rates indicate success of the program. Second, volume of vehicles using parking buildings should be measure by vehicle queuing outside parking buildings. Shorter queues outside parking buildings indicate effectiveness of informing real-time situations to motorists. Queuing vehicles are used for measurement instead of traffic amount as it is difficult to measure amount of vehicle circulations searching for parking lots. Lastly, traffic speeds along the roads leading to the downtown area are expected to be increased.

Summary of Singapore's congestion strategies and reflections on Bangkok

Due to the fact that Singapore is very small in area, regional planning for transportation is operated at national level. Thus, Ministry of Transport and LTA act as a regional transportation planning agency in Singapore's contexts. The transportation policies are successful in results and operations because of the powerful enforcement, technology-related policy invention, and strong evaluation system. Establishing LTA Academy let LTA be able to evaluate the effectiveness of their policies more precise. Moreover, LTA Academy is also responsible to conduct researches on new possible transportation policies and improvements of existing programs. These factors let LTA can act better in reducing traffic congestion and encouraging citizens to use public transit systems.

In reflections to Bangkok, transportation comprehensive plans assigned from Office of Transportation and Traffic Policy and Planning, Ministry of Transport, may not be effective as Singapore because the size of the region is very different, Singapore is roughly a half in size compared to Bangkok metro region. Hence, Thailand's government should consider promoting more administrative power to BMA to be less dependent on the central government. Moreover, BMA should institutionalize agency to monitor and evaluate transportation-related policies for the whole Bangkok metro region with concrete

research methods. The dynamic of traffic management should be increased from more accurate and precise evaluation system.

Conclusion and Recommendations

From London Metropolitan Area and Singapore's lessons, concrete comprehensive plans, the existence of authoritative regional planning agency and effective evaluation methods can alleviate congestion problems in metropolitan areas. Firstly, Transportation comprehensive plans with both short-term and long-term, measurable goals, accurate budget, and major sources of funding mentioned are more likely to succeed in implementation and enforcement. Transportation goals in accurate numbers with detailed approaching methods are more likely to assign suitable policies for the regional level.

Next, Regional planning agency is the key factor of successful congestion management policies. The authoritative agency that is less federal-funding dependent can be more dynamic and flexible in managing traffic problems on the metro regional level. Furthermore, a transportation planning subdivision under a regional planning agency can set their goals beyond traffic congestion problems because they can cooperate with the other subdivisions with less conflicting policies caused by fragmented governance system.

Lastly, effective evaluation methods are necessary for transportation planning to measure their policies' effectiveness before acting further. If a policy is shown by evidences that it cannot help reduce traffic congestions, the regional planning agency can decide between revising, using other methods to help, or eliminating it. Vice versa, if the policy is shown to be successful, the other regions can consider adopting it.

In conclusion, Bangkok Metropolitan Authority should be assigned from the federal government to have more authorities over the other five adjacent provinces. It must be able to plan and implement transportation-related policies by itself. With less dependency on the federal government, the BMA can propose its own transportation goals with more detailed approaches in the comprehensive plans. The

region will less likely be affected by conflicting policies from the other levels of administration as they can enforce their own policies. Also, the monitoring process will be easier to measure through the whole region before deciding for further strategies.

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Picture references

Figure 1 Bangkok Metropolitan Area

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Figure 6 BTS system map

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Figure 7 London Metropolitan Area

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Figure 8 East-West Cycle Superhighway

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Figure 9 Barclay Cycle Superhighway Indicate Map

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Figure 10 London Congestion Charging Zone

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