URBAN TRANSPORT POLICIES : ENERGY AND ENVIRONMENTAL IMPLICATIONS
THE ASIAN EXPERIENCE

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The paper views urban transport policy in the perspective of urban transport externality management. The case of southeast Asian cities is used to demonstrate two contrasting effects of different policies adopted.

2. ABSTRACT

Urban transport is an important source of different types of negative external effects which are classified broadly as congestion externality and environmental externalities. Mainstream economics recognizes these externalities as a source of market failure and to correct this failure, government intervention is justified. Policy instruments in standard economics are classified as either belonging to the traditional command-and-control or economic instruments.

Southeast Asian realities are presented as an illustration of success and failure of government intervention in correcting market failure due to externalities. The paper concludes that, as in the case of Singapore, a series of well-designed market instruments directed at different levels, from ownership to the use of private transport, and their reinforcement by the traditional policy of command-and-control could result to an effective urban transport externality control. There are, however, necessary preconditions on the effectiveness of these policies such as the existence of efficient urban infrastructure system, effective management of this infrastructure and the existence of an efficient public transport system as an alternative to private transport.

Albeit policy strategies are sufficient to explain the efficacy of externality control, the paper suggests at the end that institutions and culture have played an important role. Policy instruments are only effective with efficient institutions while the existing traditions of the society could influence the choice and the acceptability of policy instruments.

3. INTRODUCTION

3.1. Transport externalities and standard policy classification

Urban transport is a major source of wide ranging type of negative externalities. Globally, they can be classified into two generic groups : environmental externalities and congestion externality. The former includes air pollution, noise, accidents, visual intrusion, vibrations and community severance, while the latter consists of traffic congestion (Button, 1993). All these negative effects, in standard economics, are reduced to monetary terms and represent costs to the society.

There exists a voluminous reference to the formal definition of negative externalities, but its simple definition is equally satisfying, that is, externalities occur when an individual's utility function includes real variables (non monetary) in which their values are chosen by others (individuals, enterpises, governments) without taking particular attention to the welfare of that individual (Mishan, 1971 ; Baumol and Oates, 1988) and the decision unit responsible for choosing the value of those real variables does not compensate the recipients by an amount equal to the marginal cost of its actions (Baumol and Oates, 1988 ; Tietenberg, 1992 ; Bromley, 1993). The above-mentioned social costs effected by urban transport are among the consequences of urban mobility not being supported by motorists. Households or firms consider only the private costs in their mobility decisions. The possible reasons for this are, either they are not aware (or not made aware) of the full social costs of their mobility, or they refuse to consider these due to the fact that there is no effective method to evaluate these social costs, and economic valuations always remain uncertain.

Mainstream economics recognizes externalities as a source of market failure. While the market is a powerful, relatively inexpensive and responsive mechanism for allocating resources, it fails to achieve the economic criterion of social optimum in the real world where externalities are present. To correct this market failure, governement intervention is justified.

Externality policy instruments are classified in standard economics as either belonging to regulatory (command-and-control) or economic incentives. Traditionally, governments control externalities by imposing bans, mandating processes and adopting other regulatory measures to meet the technical definition of socially acceptable externality levels, without reference or with vague reference to the costs involved. Economists innovate policy instruments that confront externality producers with a price for incremental externality generated. They favor this measure since it is the only way to achieve the criterion of economic efficiency (optimum quantity of externality is produced). In the real world of imperfect markets, however, and with the impossibility of determining the actual social optimum (optimizing), economic rationality accepts a satisficing objective (Simon, 1981). In practice, the choice of economic instruments is evaluated not with economic efficiency criterion but according to their cost-effectiveness and the cost of administration. Cost effectiveness merely requires that policies achieve a reduction of externalities at least cost while consideration is also given to the cost the regulators face when administering the externality abatement strategies.

3.2. Urban Road Transport : Energy - Externality Nexus and Policy Directions

While the externalities enumerated above are of equal importance, the concern of this paper limits to traffic congestion and local air pollution which have direct links to energy use.

Although wasted energy due to congestion is not an externality, energy concern, however, is not a misplaced concern considering the excessive amount of energy wasted during severe congestion (as in the case of Asian megacities). As urban traffic simulation studies would show, average fuel consumption is inversely proportional to a certain range of traffic speeds. Energy efficient speeds are between 40 and 60 kph of a given traffic (Hickman and Waters, 1993). Correlatively, emissions of major pollutants such as CO, HC and NOx varies with traffic speeds. To a certain extent, the above relationship also holds for emissions of these major pollutants : reduction of emissions could be achieved in improving traffic speeds (Degobert, 1992). Thus, for given technologies of traffic fleet and transport fuel, improving the level of congestion results to important energy savings and substantial pollution reduction.

Policy strategies such as TSM (transportation systems management) or TM (traffic management) and LUM (land-use management) which are geared to ameliorate urban traffic conditions, would not only diminish the social cost of congestion but also reduce the private cost of energy use and the social cost of air pollution. This is particularly important in Asian megacities where traffic speeds during severe conditions are reduced to crawl rates of around 1-2 kph.

Air pollution generation from urban transport which takes account the vehicle technology, transport fuels and vehicular use (but discounting the complexity of traffic congestion) could be roughly represented by the following relation :

$$\text{emissions} = (\text{emissions/liter fuel})\{1\} \times (\text{liters/kilometer})\{2\} \times (\text{kilometers driven/trip}) \times (\text{number of trips})\{3\}.$$

The first term on the right hand side of the above relation implies that emissions of major pollutants such as lead, SOx, CO, HC and NOx could be reduced through improvement of fuel quality and a shift to cleaner transport fuels, through improvement of vehicle combustion technologies and a shift to cleaner vehicle technologies, and through treatment of exhaust gases by adopting tailpipe technologies. Policy strategies placing environmental constraints to consumer products in order for industries to develop and for consumers to prefer clean transport technologies and transport fuels would have the above impact. These strategies also include inspection and maintenance (I & M) programs and vehicle retirement programs to control the level of emissions of in-use vehicles.

Improving vehicle energy efficiency has also an important effect in the global emissions of pollutants as represented by the second term of the above relation. Policies such as the CAFE (corporate automotive fuel economy) of the United States fall into this category.

Equally important is the level of use of private transport as function of mileage and number of trips as expressed in the last term of the above relation. Technological improvement could be eroded by the increase in actual vehicle use (increase in vehicle-kilometers and number of trips), as in the case of the United States2. This poses a challenge on the effectiveness of policy strategies of the TDM (transportation demand management) which has gained ground in

the field of transport policy in recent years. To differentiate TDM from TSM, the latter seeks to optimize the use of the transportation systems infrastructure while the former shapes the demand for urban transport (Federal Highway Administration, 1990). The suggested goal for TDM is economic efficiency and environmental protection (AUSTROADS, 1992).

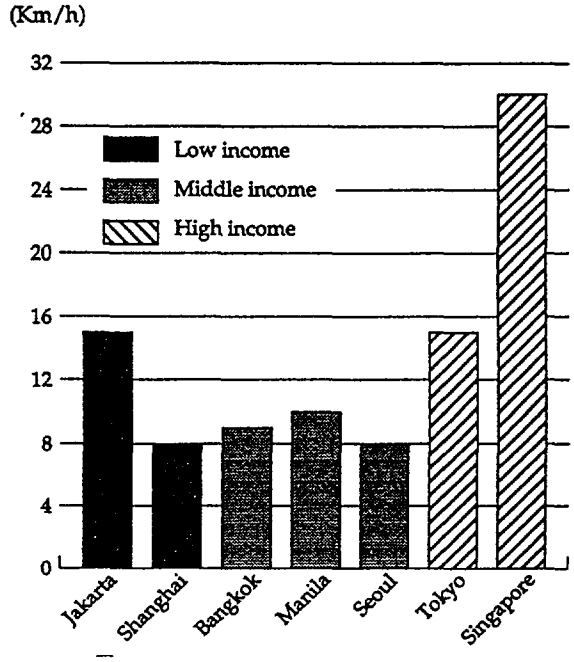
4. ASIAN REALITIES : TALE OF TWO SYSTEMS OF CITIES

The image of the capital cities of southeast Asian countries could on one extreme, be characterized by chaos and pollution (as in Bangkok, Jakarta and Manila) while an orderly and clean environment (Singapore) characterizes the other extreme.

As shown in Figure 1, the inner-city average travel speeds in most Asian megacities are around 10 kilometers per hour. During worst conditions, as in the case of Bangkok and Manila, travel speeds are reduced to crawl rates of 1-2 kilometres per hour. A governement study estimated that in Bangkok an average individual spends around 44 days per year on the road due to traffic congestion. Translated to its productivity opportunity, this represents around 10 % of country's GNP (Bangkok Post, 1990).

In contrast, traffic speeds of the above-mentioned cities are far below that of Singapore at 30 kilometres per hour. Interestingly, this average speed in Singapore has been stable since the 1980s (Midgley, 1994).

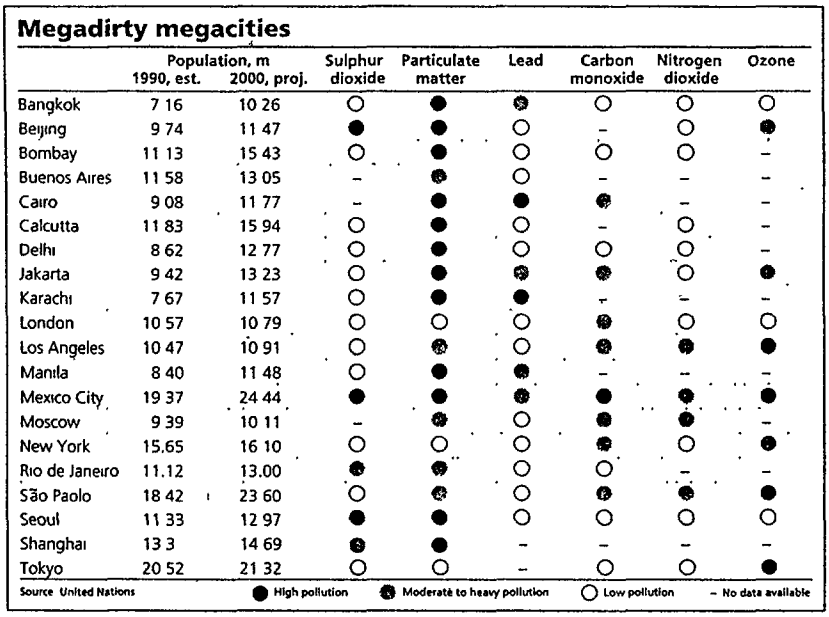
Figure 1. Inner-city Average Travel Speeds in Selected Cities in Asia



Source : MIDGLEY, Peter. 1994. Urban Transport in Asia : An Operational Agenda for the 1990s, World Bank.

Correlatively, the southeast Asian megacities (Bangkok, Jakarta and Manila) rank among the worst in the world in terms of environnemental air quality (Figure 2). In Bangkok, excessive exposure to lead causes 200,000 - 500,000 cases of hypertension, resulting to 400 deaths a year. Rough estimates suggest that lead poisoning in children causes an average loss of 4 or more IQ points by the age of seven, with long term implications for their productivity as adults (World Bank, 1992). In Jakarta, health costs associated with selected air pollutants (lead, suspended particulate matter, and nitrogen dioxide) are estimated to be US $ 220 million a year. This includes the costs of avoidable deaths, restricted activity days, outpatient visits, hospital admissions, respiratory illness, hypertension cases, asthma attacks, and loss of intelligence in children (World Bank, 1993). In metropolitan Manila, the potential productivity impact of air pollution is approaching an estimated US $ 20 million a year (World Bank, 1993). As shown in Table 1, urban transport is the major culprit in the degradation of urban air quality in these cities (Faiz, 1992).

Figure 2. *State of Urban Air Quality in World's Megacities*



Source : The Economist, September 17th - 23rd, 1994.

Table 1. *Contribution of Motor Vehicles to Conventional Pollutant Emission*

	year	pop.	Anthropogenic emissions	Percent Attributable to Motor Vehicles					
		million	('000 t/y)	CO	HC	NOx	SOx	PM	Total
city									
Beijing	1989	9.7	n.a.	39 %	75 %	46 %	n.a.	n.a.	n.a.
Bombay	1981	8.1	546	86 %	20 %	44 %	n.a.	3 %	31 %
Calcutta	1978	7.9	537	87 %	15 %	25 %	n.a.	n.a.	n.a.
Delhi	1987	7.0	428	90 %	85 %	59 %	13 %	37 %	57 %
HongKong	1984	5.2	550	93 %	n.a.	47 %	2 %	18 %	n.a.
K. Lumpur	1987	1.3	435	97 %	95 %	46 %	1 %	46 %	79 %
Manila	1987	7.1	496	93 %	82 %	73 %	12 %	60 %	71 %
Seoul	1983	10.1	n.a.	15 %	40 %	60 %	7 %	35 %	35 %
country									
S. Korea	1988			25 %	57 %	85 %	8 %	8 %	
Taiwan	1988			46 %	53 %	50 %	14 %	1 %	
Thailand	1982			60 %	46 %	23 %	15 %	3 %	
Malaysia	1988			50 %	95 %	36 %	1 %	8 %	

Source : FAIZ Asif, Motor Vehicle Emissions in Developing Countries : Relative Implications for Urban Air Quality, 1992.

Associated with the above worst traffic conditions is a substantial amount of energy being wasted in the above-mentioned megacities. In Bangkok for example, it is estimated that around US $ 1.4 million of fuel is wasted daily by vehicles idling in traffic. This loss amounts to about US $ 500 million annually (Bangkok Post, 1990).

In juxtaposition with the above trend, Singapore has achieved the image of clean and green city. A study ranks the country as one of the most liveable among the 100 largest cities in the world based on a wide range of economic, social and environmental criteria. Its air quality, crime rates, rush-hour traffic speeds and secondary completion rates also rank one of the best among the world's 100 largest cities (Kingsley et al, 1994).

An assessment of transport management strategies in Singapore reveals that management measures to curb traffic congestion, though difficult to quantify, have substantial positive impact on energy consumption (Ang, 1990). Judging from the past trends, energy intensity of the road-based passenger transportation system could have increased from 1.14 to 1.60 Megajoules per passenger-km or fuel consumption (gasoline and diesel) could have increased by US $ 167 million (excluding government taxes) in 1990 had the existing transport measures not been adopted (Ang, 1993).

5. URBAN TRANSPORT POLICIES

5.1. The ASEAN megacities : a case of piecemeal and unclear policies

5.1.1. Transport infrastructure planning, development and management

Transport planning in ASEAN megacities has progressed in accordance with the planning stages that occurred in developing countries since 1960s : first was the stage of grand infrastructure plans before the first oil shock in 1970s, followed by the incremental improvement stage triggered by the economic crisis following the oil shock in which TSM strategies were promoted by the World Bank as alternative to infrastructure construction. Then came the balanced approach stage in recognition of the need to sustain the continued growth of cities in developing countries not only by the efficient management of existing transport infrastructures, but also to plan for future transport infrastructure, at least in medium-term (Thomson, 1983). The most recent is the total urban management approach in response to the failure of the previous strategies in solving problems of urban transport while recognizing sectoral interdependencies and city priorities (ADB, 1989). Available information shows that transport planning in Bangkok and Manila seemed to follow, though not strictly, the above stages (Esguerra, 1993).

Albeit the existence of grandiose plans, actual implementations are limited. This is due to the fact that the major elements of the above plans are actually infrastructure investment plans which are subject to the availability of funds. Recently, however, the region discovered that with right policies, private funds could be tapped to finance transport infrastructures as in the case of Bangkok, Jakarta and Manila (in the planning stage).

One weakness common to these three megacities is the failure to have an effective integrated transport plans and land-use plans. In fact, even the existing land-use plans have failed. This is attributed to the fact that the given plans act only as guidelines for city development and have no legal powers. Inner city redevelopment as in the case of Metro Manila, is led by the private sector, and there is no control in the site and total floor areas developed for residential uses. The corresponding demand for transport infrastructure, hence, could not be planned for. In Jakarta and Bangkok, there is no control in the actual use of urban land. Equally, transport plans have failed. In general, the failure in transport planning could be attributed to the apparent lack of clear transport policies (Miyamoto, 1992). The lack of integrated planning in land-use and transport developments which leads to uncoordinated and inefficient urban functioning and growth, hence to serious traffic conditions, is attributed to the fact that there is no effective methodology or mechanism to integrate/coordinate the land-use and transport planning process (Miyamoto, 1992).

One of the main problems in urban road infrastructure in these megacities is the lack of road space. Road network density per thousand inhabitants is within the range of 400 meters (Bangkok and Jakarta) and 600 meters (Manila). Moreover, road networks in Bangkok occupy around 8 % of the total urban area which is relatively low compared to the range of 20 - 25 % in developed countries' megacities (London, Paris and New York) and 25 - 30 % in most American cities. The existing road systems have become inadequate to meet the demands of the fast expanding metropolis and these have been developed for many years with minimal planning and control resulting to the lack of structural coherence and unclear road hierarchy. In Metro Manila, the road network is characterized by the partially developed arterial road system, inadequate distributor and collector roads, uncoordinated development and inaccessible private roads, and ill-maintained pavement and drainage structures (Esguerra, 1993). In Bangkok, the major road networks are not well connected, creating unnecessary and excessive commuting. Distributor or collector roads are very scarce adding to more traffic concentration on major roads (Tanaboriboon, 1992).

There exists common strategies in the management of existing transport infrastructure in these megacities. The one-way street schemes are found to have positive impacts in Metro Manila though minimal in Bangkok due to the relatively high traffic volumes. Demonstration projects on bus only lanes have positive effects in the overall traffic speeds both in Manila and Bangkok, though problems are encountered in their city-wide applications due to non-respect of traffic laws by motorists and lack of traffic law enforcement on the part of the authorities. Truck bans during peak periods are also found to alleviate traffic congestion in the three cities though it is reported in Manila that congestion is shifted to peripheral areas due to a long queue of trucks waiting for the end of the peak-hour period. The three cities are reportedly successful in enforcing parking restrictions on arterial roads but not on distributor and collector roads. Equally, the installation of Area Traffic Controls (ATCs) were found to contribute to the increase of traffic speeds in these megacities. The major part of their traffic control network, however, are manually operated and hence, the gains of ATCs are offset by the inefficiency of manual operation. Staggered working hours are on the experimental stage for government offices in Bangkok, though only 40 % of government employees have actually chosen to spread their working hours.

5.1.2. Private transport management

Vehicle pricing policies of the three cities are influenced by their national industrialization policies. Although the structure and organization of the automobile industries in these countries are different, they share a common policy : the protection of the national automobile industry. This is translated to the following measures : discouragement of the importation of CBU's (completely built-up units) either by taxation (Philippines and Thailand) or by direct prohibition (Indonesia) ; and the promotion of domestic local components in the assembly of imported CKD's (completely knocked down) (Guy and Mayo, 1991). The effects of this policy are the rise in prices of the locally assembled vehicles due to cost penalty in imported components, higher taxation and inefficiency in the local assembly, and the deterioration of output quality due to low technological as well as managerial capabilities of the local assemblying operations and the low quality of domestically supplied parts and components (Odaka, 1983).

What is interesting in the vehicle taxation policy is that there already exists a bias against private cars especially in Thailand and Indonesia. Private cars are subject to additional taxation (Indonesia) or higher rate of taxation (Thailand). This partially explains why there is a rapid rise in the sales of light commercial vehicles (pick-ups) in these two countries which triggers the dieselization of the automobile fleet. The recent wave of liberalization in the region, however, has reached the automobile industry. In 1991, low product quality was the main reason in the liberalization of automobile industry in Thailand, which resulted to the reduction of vehicle prices. The reduction of average price of motor cars by 10 % contributed to the rise in sales of private cars during this period (IIEC, 1992). At present there also exists a liberalization plan in automobile industry in the Philippines. The direct effect of liberalization in the automobile industry is the decrease in vehicle prices and the promotion of motorization in the region.

There are several measures in place that could have potential effect in the use of private transport in these three cities. These are urban tollway, parking management and fuel pricing. Urban tollway in Jakarta and Bangkok serves as an alternative to congested roads. The toll pricing system in these cities, however, does not take into account the opportunity cost of the road but rather to recover the costs of investments and as source of additional revenue to the government. In static terms, the tollway could help alleviate the congested roads by diverting some of its users. In the case of these cities, however, it also attracts motorists who used to be deterred by the level of congestion and had foregone the use of private transport. The tollway, therefore, also encourages the use of private transport. Proper parking management which allows the reflection of the opportunity cost of parking space in central areas could help discourage the use of private transport. Aside from the lack of traffic rules in these three cities, however, parking fees are relatively low and considered only as a source of government revenue. Road fuel pricing, as practised in some developed countries, could be used to internalize social costs of transport. Thailand and the Philippines are net importers of petroleum fuels while Indonesia is an OPEC member country. Despite the difference, the three countries have followed the same policy of energy pricing, that is, to impose more tax on the fuels used by the affluent members of the society while subsidizing the type of fuels used by the poor. There already exists social considerations in the fuel pricing system in these countries. Gasoline is thus taxed more than diesel fuel, which in effect, reinforces the existing dieselization trend of the automobile fleet. These social considerations, however, do not take into account the social costs of road transport but are being used as means of redistributing wealth.

Since private transport is the major contributor to the generation of externalities, placing externality constraints directly (such as environmental constraints) could have an effect in the use of private transport. Among the three countries Thailand has advanced more in this respect. The three cities have adopted the USEPA ambient air quality standards with modifications to suit the local conditions. With the ambient air quality of these cities not satisfying the standards, their first moves were to improved the transport fuel quality. Target plans in reducing lead in gasoline and sulfur in diesel oil for Asian countries is shown in Table 2. Furthermore, the Thai government has mandated the production and the sale of reformulated transport fuels recently. To manage a rapid transition in the use of cleaner fuels, as in the case of Thailand, the government adopted the strategy of reducing the taxes of gasoline according to their lead content levels (differential taxation). To promote the sale of unleaded gasoline, it offered a subsidy of 1 baht per liter to refiners and importers. Moreover, after six months, it removed the tax contribution of unleaded gasoline to the oil stabilization fund, thus increasing the price difference between unleaded gasoline and premium gasoline. In the same manner, diesel oil with less sulfur content is also taxed less. To promote the sale of clean diesel fuel, the government offered a subsidy of 0.14 baht per liter to refiners and importers. In effect, the government did not actually pass the environmental burden to the consumers in the transition process, but has absorbed the possible cause of rupture in fuel prices.

Table 2. *Present and Expected Fuel Quality Standards in Asian Countries*

Country/area	Gasoline's lead content (g/l)						Diesel's sulfur content (wt%)		
	Premium			Regular					
	1991	1995	2000	1991	1995	2000	1991	1995	2000
Japan	0	.....	.....→	0	.....	.....→	0.4	0.2	0.05
ROK	0.25	0	... .→	0.05	0	.....→	0.4	0.2	0 1
Taiwan	0.12	0.026	.....→	0	.....	.....→	0.5	0.3	0 05
China	0 13	.....	.....→	0 26	.....	... .→	0 5	0.2	.....→
Singapore	0.15	0	.....→	0 15	0	.....→	0.5	0 3	.....→
Indonesia	0 4	.....	.....→	0 4	.....	.....→	0.6	.....	.....→
Malaysia	0.15	.....→	0 013	0.15	.....→	0.013	0 5	.....	0.1
Thailand	0.4	0.013	.....→	0.4	0.013	.....→	1.0	0.5	0.25
Philippines	0.84	0.4	... .→	0.6	0.2	.....→	0.9	0.4	.....→
N.A. West Coast	0	.....	.....→	0	... .	.....→	0.25	0.05	.....→
Australia	0.013	.....	.....→	0 013	.....	.....→	0 5	0.15	0.05

Source : KOYAMA, K. "Outlook for Oil Supply and Demand in the Pacific Rim and Its Implications for Japan", Energy in Japan, no. 120, March 1993.

Aside from transport fuels, the Thai government has also acted on vehicle technology. In 1980, the Office of National Environment Board (ONEB) has adopted a relatively lenient vehicle emission standard. Initial monitoring has shown that most of the vehicles have not passed the set limits. Problems, however, arose in the implementation due to lack of institutional coordination. At present, there is no actual practice in vehicle inspection relating to emissions, but recently, the government has required that all new cars sold way back the end of 1993 must be installed with catalytic converters. The potential effect of this policy would be a relative increase of car prices.

5.1.3. Public transport

Among the three megacities, only Metro Manila has a rapid mass transit system, a 15-km LRT (light rail transit), although heavy rail forms a part of the public transport system in Bangkok and Jakarta. In Bangkok, however, a network of mass rapid transit is underconstruction. Common to the three megacities is the urban public transport system which is dependent on road transportation. Buses are the backbone in road public transport system in Bangkok and Jakarta while a paratransit service (jeepneys) is dominant in Metro Manila.

In Bangkok, bus services are provided mainly by the Bangkok Mass Transit Authority (BMTA) while the rail services by the State Railway of Thailand (SRT). Bus services operate over 2800 km in about 120 routes. The fleet averages 70000 km per year, and in 1992, the total number of buses (including air-conditioned buses) was 4100, which carried 1.4 billion passengers in the same year. The SRT operates a heavy rail in three routes for a total of 197 route km with about 84 stations. It carried urban passengers of around 18 million in 1992. In Jakarta, bus services are operated by Perum Damri (PPD) and rail services by the Indonesian State Railways. There were around 2300 buses operating in 164 routes with a total length of 2208 km in 1992. The system carries an average of 650 million passengers per year. The heavy rail system operates a 55-km route with around 100 trains per day and carries around 15 million passengers per annum. In Metro Manila, bus services are operated by both government and private sector. The government bus company, the Metro Manila Transit (MMTC) operates on 19 routes covering about 500 km with a fleet of about 500, which carried 22 million passengers in 1992. Private bus operations consist of 2500 buses in 150 routes over 3000 km carrying 750 million passengers per year. In addition there were some 30000 privately operated jeepneys in 500 routes covering around 4000 km in 1992. It carried around 44 % of the total urban transport demand of 17.65 million passengers per day in 1990. The light rail system operates on a single route 14 km long, with 18 stations. An articulated twin-unit coach travels an average of 45000 km per annum and carried a total passengers of 129 million in 1990.

A positive development in the bus transport system in these megacities is the increasing number of air-conditioned bus fleet. In fact, there is already a plan to convert all the bus fleets in Bangkok to air-conditioned fleets. The comfort these buses can offer would be an alternative to the comfort of private transport, thus encouraging public transport use. To minimize the public transport contribution to emissions of air pollutants, the BMTA has recently introduced an experimental program of 82 new buses designed to operate on Compressed Natural Gas (CNG). The program will be evaluated to monitor the performance of these CNG-powered buses, and if it proves successful their use will be increased.

Despite all these, however, public transport services in the megacites are inadequate. The present state of the predominantly road-based public transport system as in the case of Metro Manila, is characterized by the low level of service in terms of travel speeds, long passenger waiting times at stops, and the operation of dilapidated, pollution-emitting vehicles (Esguerra, 1993). Equally, bus transport services in Bangkok are characterized by overcrowding, excessive waiting time, unrealible services and irregular arrival interval of buses (Tanaboriboon, 1992).

5.2. The Singaporean experience : a case of total urban transport management

5.2.1. Transport infrastructure planning, development and management

It seems that the initial stages of transport planning which occurred to the rest of the developing world was also experienced in Singapore as demonstrated by the existence of the comprehensive transport studies such as land-use and transportations studies in late 1960s and early 1970s and the MRT study in 1970s. It also appears that there existed a divergence in the planning practice between Singapore and the rest of the developing countries in the later stages. The difference lay on the effectiveness in the implementation of their transport plans.

To meet the projected increase of transport demand, Singapore has engaged in massive urban road transport infrastructure development. Between 1974 and 1990 the total length of roads in Singapore has increased by 6 % per year. It was recognized that the increased length of roads has helped improve route planning of public transportation by bus.

More interesting is Singapore's success of developing a multi-nucleated spatial urban pattern in which 87 % of the country's population are housed in high rise apartments in satellite towns with integrated labour intensive industries, schools and recreational facilities. It is reported that this system has minimized the need to travel and have helped alleviate traffic congestion in central areas. As the geographers would contend, a polycentric city or multi-nucleated spatial pattern can relieve traffic congestion without sacrificing the benefits of metropolitan-wide agglomeration economies. Other benefits are the reduction in energy, transportation and land requirements, lowered commuting resulting to cost-savings, preservation of natural resources and the environment, and minimized infrastructure costs (Robinson, 1992).

Other than road construction, Singapore is also successful in implementing traffic management schemes. Strategies on road infrastructure management implemented at present are the following : one-way street schemes (70 % of the roads in central business district, CBD), bus-only stations and lanes (approximately 68 kilometers in 31 principal routes), truck bans during peak hours, counter and tidal flow schemes, installation of ATC systems, and parking prohibition along major routes. It is estimated that the bus-only lanes have contributed to an increase in traffic speeds of buses by 15 %. The first stage of installing the ATC system in 1982 has contributed to an increase in traffic speeds by 16 % (from 25.7 to 31.7 kph), while the installation of the GLIDE system resulted to an increase in motorists' commuting times by 7 %.

5.2.2. Private transport management

Aware of the negative effects associated with increased level of motorization and the constraints of urban space, the government has implemented demand management on private transport. The strategies adopted could be classified as follows : motorization control, implementation of restraints in the use of private transport, and implementation of regulations for the environment.

Since the late 1960s, the Singaporean government has used fiscal measures to control the growth of private transport (refer to Table 3). It must be noted that the automobile industry in Singapore does not involve assembly operations. While the fiscal measures enumerated in the table such as import duty, registration fees and road taxes could be justified according to their intended objectives and uses, the additional registration fee (ARF) which causes the constraint in motorisation could not be justified other than a uniform pigouvian tax. With the continued economic growth and increased private income in recent years, however, the above measures were no longer effective in

controlling growth of private transport. With limited road space, the government has acted recently on the direct control of the quantity of vehicles. Since 1990, the government has been determining the quantity of vehicles to be sold in the market and prospective buyers must obtain a certificate of entitlement (COE) with a validity of ten years through a bidding process. The number of certificates sold is equal to the allowed number of vehicles to be sold. This programme known as the motor vehicle quota system is a variation of Dale's marketable permits. The government estimates directly an acceptable proportion of vehicles to road space (which could be linked to an acceptable level of externality), and allocates them through a market mechanism (bidding process). Since its application, the additional registration fee has been progressively reduced.

Table 3. *Vehicle Taxation in Singapore*

	1968 10/72	10/72 12/73	1/74 3/75	3/75 12/75	12/75 2/80	2/80 10/83	10/83 10/84	10/84 11/88	11/88 11/90
Import duty (% open market value)	30	45	45	45	45	45	45	45	45
Registration Fee (S $)	15	15	15	15	15	1000	1000	1000	1000
Additional Registration Fee (ARF) (% open market value)	15	25	55	55	100	150	175	175	175
Annual Road Tax (cents per cc)									
- 1000 cc	10	10	14	20	35	40	52	60	70
1000 cc - 1600 cc	10	12	15	25	40	50	65	75	90
1601 cc - 2000 cc	10	15	22	30	45	60	78	90	105
2001 cc - 3000 cc	10	20	25	40	50	70	91	105	125
plus 3000 cc	10	30	60	65	80	100	130	150	175

Note : Since 1975, company cars are obliged to pay double of the above rates.

Source : PHANG Sock-Yong, "Singapore's Motor Vehicle Policy : Review of Recent Changes and a Suggested Alternative", in : Transportation Research - A, vol. 27A, no. 4, 1993.

The above strategies could be classified as a uniform externality control (price and quantity). Tietenberg's objection to a uniform externality control, as in the case of urban transport is that, externality generation is not uniform. It is space and time-dependent. Congestion occurs mostly in central business areas and only during peak hours. The use of private transport during daytime contributes to the deterioration of ambient air quality while night-time use or use in peripheral areas may not. On the other hand, air pollution is a complex process involving meteorological conditions. A uniform externality control may thus lead to excessive production in certain places and to excessive abatement in some areas (Tietenberg, 1974). The recent technological innovation in electronic road pricing, ERP, (which had been successfully demonstrated in Hongkong and currently on its experimental stage in Singapore) allows to calculate variations in congestion externality. Before the ERP has been tested, Singapore's response to Tietenberg's objection was to introduce, in 1975, an innovative strategy, the area licensing scheme (ALS). To reduce congestion, vehicles entering designated restricted zones in central areas during morning peak hours had to pay an entrance fee on daily or monthly basis. Buses, motorcycles, commercial vehicles and private cars with 4 passengers (car pools) were exempted from this fee, but was later revoked in 1989 while the system is extended to include afternoon peak hours. Fees were adjusted several times between 1975 and 1989. Short term and long term impact have shown that the system is an effective means of controlling congestion externality and have positive impacts on pollution externality (Behbehani et al., 1984). Furthermore, in response to the notion that other than peak hours private transport in urban areas, to a large extent, is externality neutral, Singapore has introduced a program known as the weekend car scheme. A private car can be registered under this program subject to limited use : weekends, holidays, daily non peak hours and 5 free-day licenses in a year. It can be used outside the permitted hours by purchasing a daily license. In exchange, tax rebates (import duty, registration fee, road tax and COE premium) are effected. In 1991, the maximum rebate was around US $ 8670 (S $ 15000).

Other strategies affecting the use of private transport is the parking pricing policy. Parking pricing increases the monetary pressure in the use of private transport. Singapore has adopted differential pricing of parking spaces that allows the reflection of its opportunity cost. During off-peak periods, the first thirty-minute cost of parking in central

areas is US $ 0.15 and this doubles during peak hours. Road fuel pricing could also have a potential effect in private transport use. At present, gasoline prices in Singapore is the most expensive among the ASEAN countries. Gasoline tax structure in Singapore in 1990 was either US $ 0,33 (S $ 0.60) per liter or 50 % of the pump price, whichever is the highest (Ang, 1993). Due to insignificant elasticity of gasoline demand to price, however, gasoline taxation is ineffective in reducing transport demand (Ang, 1989). The big difference between gasoline prices between Singapore and its neighbouring country Malaysia also poses a problem. It became a practice by motorists living near the border to cross the frontier to purchase cheaper gasoline. In 1985 and 1986, it was reported that this practice was the principal reason for the substantial loss in gasoline sales (Ang, 1989). In 1989, the government imposed a policy of half-tank rule requiring Singaporean motorists crossing the border to have at least half a tank of petrol. This was later superseded by the three quarter rule when an additional tax was imposed in 1991.

As mentioned earlier, environmental constraints could influence behavioral change in the use of private transport. As also presented earlier, Singapore has programs to improve the quality of its transport fuels. It is interesting to note that when the government introduced unleaded gasoline (ULG) in the market, it imposed a S$ 0.15 per liter tax to super gasoline to make the ULG competitive. Since its goal is environmental, we can then interpret this tax as a pigouvian tax. Other than transport fuels, Singapore has placed environmental constraints on vehicle technology. The existing vehicle pricing system tend to cause owners to keep their vehicles for long, which in effect, contributes to the ageing of the national automobile fleet and the deterioration of urban ambient air quality. To interfere with this trend, the government offers a large rebate to owners who prefer to retire their vehicles of less than ten years old. This incentive is known as the preferential additional registration fee (PARF) which is calculated in function of the engine capacity and as percentage of the additional registration fee (ARF). When the motor vehicle quota system was first introduced in 1990, it become obligatory to retire vehicles with age of more than 10 years, or else owners must pay an additional fee equivalent to the year's average quota premium (COE premium). A grace period of 2 years was given to vehicle owners and in 1992 around 10,000 cars were scrapped. In 1986, it was adopted that all vehicles sold in the market must pass the European test ECE 15-04, in terms of emissions. In 1992, it required that all vehicles sold in the country should be installed with catalytic converters. This entailed an additional increase in vehicle prices.

5.2.3. Public transport

In combination with constraints and restraints on private transport, the government has provided an efficient and reliable public transport system. The bus transport is serviced by two private companies, Singapore Bus Service (SBS) and Trans-Island Bus Service (TIBS) which provided 18 hours per day service with a total of 240 routes and 3600 bus fleets servicing 2,9 millions of passengers per day. There also exists supplementary public transport services such as city shuttle services and school buses, and a supplementary public transport system which operates under txwo schemes : scheme A permits lorries, goods vehicles, private hire and school buses are permitted to transport workers between their homes and designated points and places of work ; under scheme B, the same type of vehicles are permitted to supplement the peak hour demand of buses. Equally, there exists an efficient taxi system. In 1990, the mass rapid transit (MRT) become fully operational. It operates two lines crossing north-south and east-west directions with a total length of 67 kilometers and 42 stations. Around 40 % of the central business areas and industrial districts, and more than one-half of the total population are located proximate to the MRT's stations. In the same year, the MRT catered to an avergae of 300 thousand passengers per day.

6. POLICY ANALYSIS AND CONCLUSION

The key to Singapore's success and to the three ASEAN megacities' failure is obvious : transport policies. The former has a clear direction on urban transport management and has intervened successfully while the latter lacked policy direction and have failed to intervene fully or have intervened incoherently. What is worth noting is that the government of Singapore is aware of the externality problem and has integrated this concern since the development of urban transport infrastructure.

The working strategy of Singapore is simple and could be summarized in three aspects as the following : it has developed an infrastructure network in coordination with land-use and has managed them efficiently ; it has placed control on the growth of private transport, has been effective in placing restraint on their use and has integrated environmental protection in its management ; and, it has provided an efficient public transport system as an alternative to private transport. It must be emphasized that while the key externality policy is the private transport management, its effective implementation is achieved only in parallel with the provision of efficient infrastructure network and public transport system.

Infrastructure development has positive external effects to the economy as manifested by their higher production elasticity coefficients (Aschauer, 1989 ; Munnel, 1990 ; Easterly and Rebelo, 1993) and its successful development

coordination with land-use maximises this positive effects while minimizing the negative external effects (congestion and pollution). It is interesting to note that in these megacities, there is an emerging trend of active private sector participation in transport infrastructure investment. Infrastructure management (traffic management) ensures that congestion externality could not be developed through inefficient use of the infrastructure. Motorization control is a strategy peculiar to Singapore. Singapore is a small island city - a state with no frontier to expand with. Equally, it has no automobile industry to protect with. Unlike the other ASEAN countries where the automobile industry is one of the important industries in their drive to industrialization, welfare gains in Singapore due to externality control could be high compared to the loss of welfare due to the increases in the cost of private transport. Placing restraint and integrating environmental constraint in the use of private transport is the key to reduce external costs due to congestion and pollution in which the ASEAN megacities have not or have only partially implemented. Providing efficient public transport is an imperative complement to the above restraints and constraints. While the private transport is a major source of negative externalities, it must be remembered that the basic economic need is the mobility of the people, and not the mobility of private cars.

Concerning policy instruments, albeit Singapore utilizing both the command-and-control and economic instruments, it relied most on the latter. As we have seen, Singapore uses the market mechanism more in employing restraint and environmental constraints in the use of private transport. In general, it uses the price as the main instrument though its recent strategy of vehicle quota system is a shift to quantity control using the market mechanism (bidding process) to allocate them. With respect to the control on private transport use, the Singaporean case also lends support to Wijkander's (1985) and Sandmo's (1976) line of argument. Wijkander has shown that taxation of complements and the subsidy of substitutes are efficient under fairly general assumptions. Since externality generation of private transport could not be properly taxed, taxation of goods complementary to private transport use such as fuel, parking and road use, and the subsidy of public transport would be efficient. Sandmo presents another situation wherein a related good should be taxed if it is a complement to the polluting activity (externality generating activity) and a substitute for the "innocent" activity, and it should be subsidized if it is a complement to the "innocent" activity while a substitute for the polluting activity (externality generating activity). The differential pricing of central parking, differential fuel taxation and the weekend car scheme fit into this situation.

While neoclassical concepts could explain satisfactorily effective transport strategies in controlling negative external effects, it is far from complete in the Asian context. The success of Singapore and the failure of these megacities are results of different interacting aspects of the society. Neoclassical policy instruments could only be effective with efficient institutions and their acceptability to the existing culture of the society. To understand why a certain type of policy instruments are favored than others needs understanding on how these economies developed.

The success and failure of existing policy are indications of strong and weak (or lack of) institutions. Singapore is successful because it has strong and influential institutions governing the transport sector, while the three ASEAN megacities have failed because they have weak institutions. Institutions are humanly devised constraints that structure human interaction. They are made up of formal constraints (e.g., rules, laws, constituions), informal constraints (e.g., norms of behavior, conventions, codes of cunduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies (North, 1994).

I would like to add, though beyond the scope of this paper, that the strong institutions in Singapore and the Singaporean's acceptability to existing rules are influenced by the strong Confucian tradition of the society. Among its values are the following : it emphasizes group values over individual values, giving rise to cohesive forms of political and business organizations ; it develops meritocratic institutions, creating strong incentives for learning and education ; it creates mutual obligations between government and the governed, yielding (relatively) publicly motivated policy making ; and, it legitimizes authoritarian rule, leading to long-lived regimes and stable, consistent policies (Petri, 1993). With these societal traditions, it appears that neoclassical externality measures are easy to implement.

7. ENDNOTES

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2. The average fuel efficiency of passenger vehicles in the U.S. rose by about 22 % between 1980 and 1988, which by itself should have contributed to reduce emissions. However, aided by falling gasoline prices, greater fuel

efficiency meant that in real terms the fuel cost per mile fell by over 60 % during this period, and contributed in part to the 16 % increase in passenger miles driven per capita. As a result, air quality in many American cities has not been improved significantly in recent years (Levinson and Shetty, 1992).

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