Appendix 2-1

Database Results

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Appendix 2-1: Database Results

Database Results of ERIA Research Project

on

"Project toward the
"Sustainable Automobile Society" in East Asia"

Economic Research Institute for ASIAN and East Asia (ERIA)

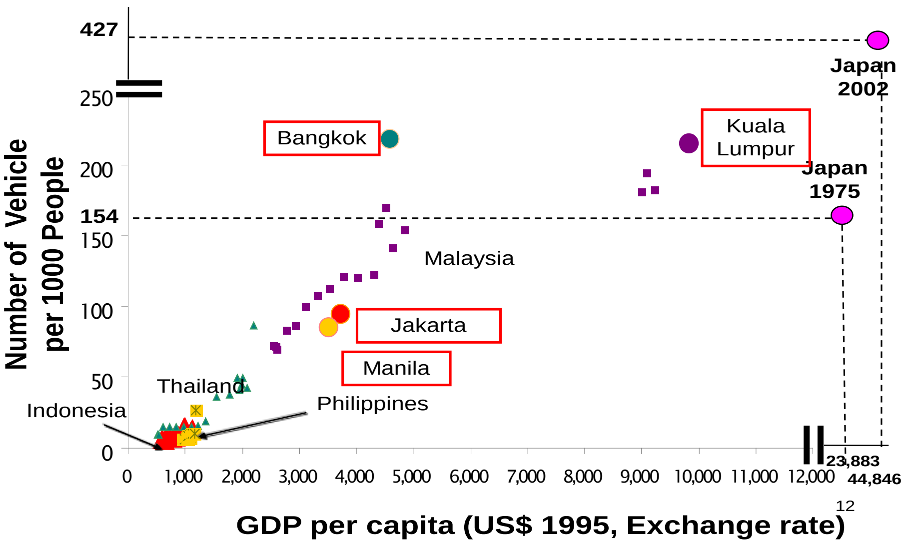
1. Introduction of Database Result

Asian countries are facing major air pollution problems due to rapid economic growth, urbanization and motorization. Mortality and respiratory diseases caused by air pollution are believed to be endemic in cities of these countries. Regulations and standards are the first requirement for reducing emissions from both fixed and mobile sources. In order to reduce vehicle emissions, governments of the four countries are making efforts to introduce vehicle emission regulations for new vehicles. This database results attempt to compare the implemented policies for air pollution reduction and CO_2 reduction. This report emphasizes monitoring problems such as vehicle registration systems, inspection and maintenance (I/M) systems and fuel quality monitoring systems for vehicles in use. Monitoring problems in developing countries share similar characteristics such as a weakness in government initiatives and inadequate operation of government agencies, which results from a lack of human resources and availability of adequate facilities.

Finally, this database results propose a method to assure air quality improvement under the different shares of emission regulations in these Asian countries and introduces an example of an evaluation method based on a policy survey to improve air quality. For the proposal, the database needs to improve data quality and quantity.

2. Background of Air Pollution

Asian countries have been facing a major air pollution problem due to rapid economic growth, motorization and urbanization. Figure A 2.1 shows GDP per capita[43] and number of vehicle per 1000 people over the period 1985-2002 for Bangkok[4],[47], Kuala Lumpur[54], Jakarta[14], Manila[45], and Japan[37]. As the first observation, compared to Japan (1975), Bangkok (2002) and Kuala Lumpur (2002) are already beyond it in terms of vehicle numbers per 1000 people. These Asian cities have a faster process of motorization in terms of GDP per capita. As the second observation, the national average level [32][37] follows the city level in accordance with economic growth. In the future, there is a high probability of achieving at Japanese level (427 units per 1000 people) at the national level in Asian countries.



● : City level, ▲ : National Level

Data sources: Alfa Research Co.Ltd.,[4] ,BPS[13][14] ,National Statistics Office[47],Land Transport Office[45],NSCB[46] JARI[37], JETRO[43], Statistical Bureau[54], UITP[44]

Figure A 2.1: GDP per capita and number of vehicle per 1000 people

Table A 2.1 shows air quality monitoring in large Asian cities using the criteria of WHO guidelines[22] [57] as of 1990 and the most recent years of 2002-2005[3][8][9][10][11][58][59][60]. The air pollutants PM_{10} and NO_2 become serious concerns from 1990 to the most recent years. Catalyst based after-exhaust treatment technology, can reduce HC, CO, and NO_x according to vehicle emission regulation levels. However, rapid motorization may negate out the efforts of air pollution reduction policies. Lead concentration in air was reduced in Bangkok from 1990 to 2005[11], in Manila from 1990 to 2002 [8] and in Kuala Lumpur from 1990 to 2004 [3][54] because lead had been phased out from automobile fuel in these cities [24][25] (Table A 2.1). Lead concentration in air increased in Jakarta from 1990 to 2004[2][15][60] because lead was phased out from automobile fuel in 2006 [27] [29](Table A 3.1).

Table A 2.1: Air quality monitoring in four Asian Large Cities

Latest Year（2002-2005）

City		CO	NO_2	PM_{10}	O_3	SO_2	Lead
Jakarta	2004	E	C	E	C	D	D
Kuala Lumpur	2004	C	D	D	C	B	A
Manila	2002	C	E	E	D	C	B
Bangkok	2005	A	D	D	B	C	B

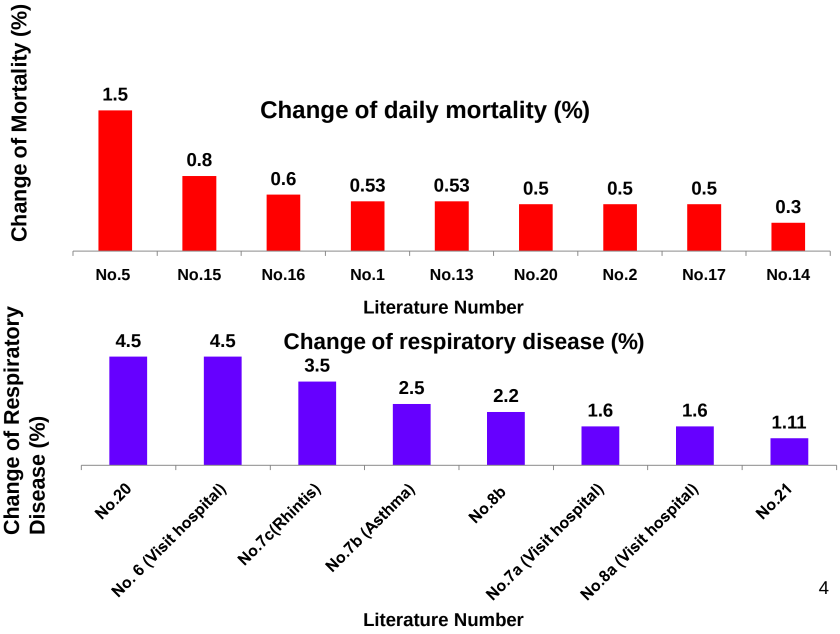
1990

City		CO	NO2	PM10	O3	SOx	Lead
Jakarta	1990	C	B	D	C	C	C
Kuala Lumpur	1990	C	C	B	C	B	C
Manila	1990	D	D	D	D	B	C
Bangkok	1990	B	B	E	B	B	C

A	**50 % below from WHO standard**
B	**Within WHO standard**
C	**Within 200 % from WHO standard**
D	**Within 300 % from WHO standard**
E	**300 % over from WHO standard**

Data sources:ACFA[2], ADB [8] [9][10][11], Alam Sekitar Malaysia Sdn.[3], BPS [15],Hirota[24] [25][27][29], WB,[58][59][60],WHO[57]

According to the World Health Organization (WHO)[57], mortality caused by air pollution in large cities is estimated to be 800,000 people[22]. Two-thirds of the deaths are concentrated in Asian cities. With these concerns of mortality and respiratory disease caused by air pollution in large cities, it is an urgent matter to reduce air pollution in Asian cities. Figure A 2.2 shows the 21 reports/literatures from HEI surveys [22] on changes in mortality and respiratory disease by increase of PM_{10} in Asia during 1990-2006. When PM_{10} increases at 10 ug/m^3, mortality change increases at a rate of 0.3% to 1.5% from natural mortality. When PM_{10} increases at 10 ug/m^3, of respiratory disease change increases at a rate of 1.1% to 4.5% from the normal probability of respiratory disease. Taking into consideration the future health costs [49], policy implementation of emission regulations for new vehicles in early motorization can reduce the cost of air pollution reduction. If the cost of air pollution is reduced at present, the cost of health care is reduced in the future.

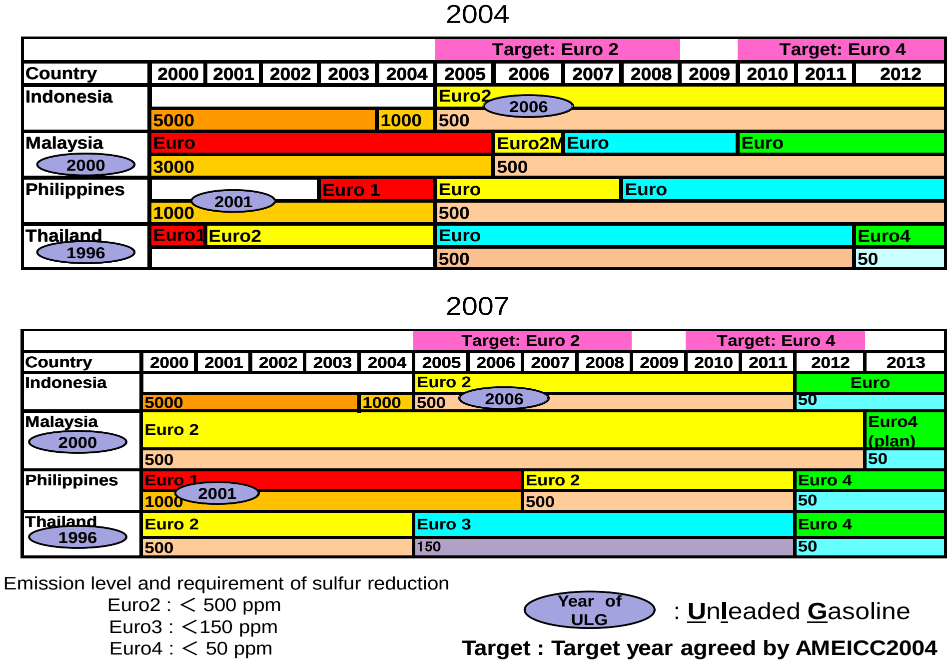


Data sources: HEI[22]

Figure A 2.2: Change of daily mortality and respiratory disease with respect to PM emissions (Total number of literature =21)

3. Introduction of Vehicle Emission Regulations and Fuel Quality

The introduction of emission and fuel regulations are merely the first step toward political implementation of air pollution reduction policies. In recent years, governments in Asian countries have been introducing vehicle emission regulations for new vehicles[7]. Table A 2.2 shows the time schedule of the vehicle emission regulations and sulfur content for new gasoline-driven passenger vehicles in Asian countries. The common target is the introduction of EURO 2 by 2008 and EURO4 by 2012[6]. In fact, the time schedule of 2007 is delayed compared to the time schedule of 2004 [28][38][39]. In order to meet the EURO 2 standard level, it is important to install catalytic converters to meet the emission regulation level (CO, HC, NO_x etc). Since lead in gasoline cause the catalytic converter to malfunction [19], leaded gasoline in ASIAN countries have been phased out already [23][24][25]. As the next step, lowering the sulfur content (below 500 ppm) is the focus for introducing stricter emission regulations [26][27].



Data Source: Governmental documents, AMEICC 2007 [1] AMEICC 2004[6], AAF[7]

Table A 2.3 shows availability of clean vehicles in Asian countries. Most of Asian countries introduced bio fuel, natural gas, hybrid vehicle, electric vehicle and LPG vehicles. DME is introduced only in Japan and Vietnam.

Table A 2.3: Availability of clean vehicles[1]

	IDN	CN	SG	TH	PH	IN	JPN	KR	VN	ML
Bio-fuel vehicle	Yes	Yes-E10	Yes	Yes	Yes	Yes	Yes	No (On trial run)	Yes (pilot)	Yes (*)
Natual gas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes (pilot)	Yes
DME	No	No	No	No	No	No	Yes	No	Yes (pilot)	No
Hybrid vehicle	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes (On trial run)	Yes (pilot)	Yes (imported car)
Electric vehicle	No	Yes	Yes	Yes (but not yet available)	Yes	Yes	Yes	No (On private roads)	Yes	No
LPG	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes(For Taxi, Rental Car, Cars for the disabled)	Yes	Yes

(*)Malaysia has National Biofuel policy

Source: ERIA database

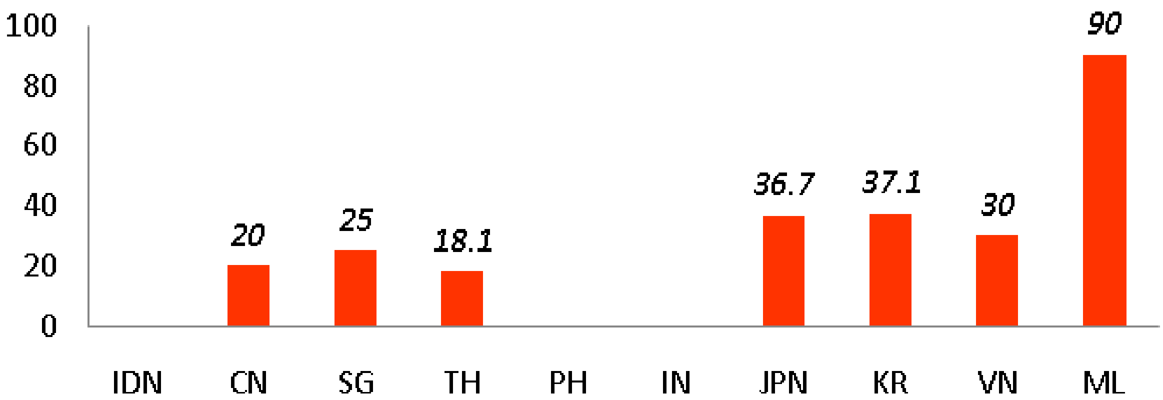
[1] CN: China, IDN: Indonesia, PH: Philippines, SG: Singapore, TH: Thailand IN:India, JPN: Japan, KR:Korea, VN: Vietnam, ML:Malaysia

Not only implementation of emission standards for new vehicles, but also regular inspection and maintenance of vehicles with uncontrolled emissions are effective for emission reductions. For example, the annual passenger vehicle kilometers traveled (VKT) is higher by 2-3 times in other Asian countries than that of Japan (Table A 2.4). Figure A 2.3 show average vehicle speed on road in urban area. The average speed is diverse among various Asian countries.

Table A 2.4: VKT in Asian countries

		IDN	CN	SG	TH	PH	IN	JPN	KR	VN	ML
VKT: Annual travel distance per vehicle (km/year)	Passenger vehicle	No data	26000	20,000	14,853	No data	No comprehensive and recent data could be accessed	10,000	18225km(avg. of all reg veh.) , 64321km(avg.commercial only)	15,000-20,000km/year	NA
	Bus	No data	45000	85000	39,268	No data		55,000	29950km(avg. of all reg. bus) , 86674 km(avg. commercial only)	15,000km/year	NA
	Truck	No data	65000	35000	45,744	No data		70,000	20892km(avg. of all reg veh.) , 53399km(avg. of all commercial)	50,000km/year	NA
	Motorcycle	No data	7500	13000	5,627	No data		3,000	N/A(not collected)	5000-9000km/year	NA
Have you heard how to measure driving distance (km/vehicle) in your country?		No data	Investigation in the parking lot, 3S shop and etc.	The average kilometres travelled per vehicle are estimated based on mileage survey of in-use vehicles conducted at mandatory periodic vehicle inspections.	This figure is from secondar y calculatio n of 2003 data	No existing program for measuring driving distance.	This is often based on the surveys involving data collection from the drivers, vehicle owners, based on the odometer readings and other records. Also there may be some estimates based on the fuel consumption data, road usage data etc.		Collected during vehcle inspection by Inspection Authority, KOTSA(www.kotsa.or.kr)	Estimation from the fact	

Source: ERIA database



Source: ERIA database

Figure A 2.3: Average speed of vehicle on road (urban area)

4. Monitoring system (I&M, FQM)

Asian countries have legislation regarding registration and inspection systems. However, operation of the registration, I/M (inspection and maintenance) systems and fuel quality monitoring system used in developing countries are observed to share similar characteristics, such as a weakness of government initiative and inadequate operation by government bodies, which results from shortages of human resources and analysis facilities[27][31].

A better operation of I&M system enables used vehicles to be regularly checked for defects in vehicle parts and improve them by replacing them with better parts and also by tuning the engine etc. A better operation of inspection system can definitely phase out high-emission vehicles. According to a GTZ report [17], vehicles which did not pass an inspection test emitted 1.7-7 times higher CO levels than vehicles which did pass. As a successful example, in 2000 a voluntary I/M bus project called the "Blue Sky project" in Jakarta reduced HC by 49%, CO by 53%, soot by 61%, and increased fuel saving by 5%[55][53].

A better operation of I/M system is based on a better operation of registration system. A better operation of registration confirms the track record of vehicle registration by year, model, and vehicle age, which assure tax revenue from the vehicles. Less-efficient operation of registration system allows these four Asian countries to keep old vehicles on the road for longer. Table A 2.5 shows the type of vehicle inspections, intervals and deregistration processes. Due to less-efficient operation of registration systems, the number of inspected vehicles is very limited, so that the system is unable to reflect the overall emission quality situation in the real world. Less-efficient operation of registration system can hardly protect consumer rights from recalls and stolen vehicles. The lack of deregistration is another problem [18][33][42][52] in registration system. Deregistration process can clarify the track record of discarded vehicles by number and year.

One of the problems is related to vehicle tax system (Table A 2.6). If vehicle related tax is differentiated by vehicle performance related to emission or energy saving, air pollution including CO_2 can be reduced by the system. Many Asian countries have introduced vehicle related taxes. Some countries have also introduce environmental taxes. Another problem is regional differences in technology levels between auto dealers and local factories. In order to support I/M system, it is necessary to identify the technology level by a nationwide certification system for engineers, inspectors and mechanics. Asian countries do not have a nationwide certification for mechanics, while some local private maintenance shops do not have adequate skills for tuning EURO 2 vehicles. If technical skill is identical, vehicle users can send vehicles to any dealers or maintenance workshop. While car dealers have the knowledge and technology to tune EURO 2 level or higher vehicles, local factories do not sometimes have either knowledge or the technology to tune EURO 2 vehicles. A nationwide certification system can smoothly guarantee and monitor more stringent emission standards in the future. With the nationwide certification system, more stringent emission regulation than EURO 2 can also be introduced with better effectiveness. This certification system can create a new business opportunity of maintenance shop, thereby creating job opportunities.

For policy recommendation, operations of registration and deregistration should be improved similar to that of developed countries. In the future, the better operation of registration system will be essential for monitoring the vehicle recycle process. It enables us to collect tax revenue properly. It can also differentiate vehicle tax levels by technical performance.

Table A 2.5: Inspection and maintenance guidelines for different categories of vehicles Asian countries

	Inspection interval			
	Passenger	Bus	Truck	Motorcycle
CN	Vehicle age (VA)≦6 0.5-0.5-0.5- 6<VA≦15 1-1-1- VA>15 2-2-2-	VA≦5 1-1-1- VA>5 2-2-2-	VA≦8 1-1-1- VA>8 2-2-2-	VA≦4 0.5-0.5-0.5- VA>4 1-1-1-
IDN	No	0.5-0.5-0.5-	0.5-0.5-0.5-	No
TH	VA ≤ 7 not required VA > 7 1-1-1- Taxi:0.3-0.3-0.3-	≤ 20 seats: 3-3-3- Others: 0.5-0.5-0.5-	Unloaded vehicle ≤ 3.5 t: 3-3-3- Others: 0.5-0.5-0.5-	VA ≤ 5 not required VA > 5 1-1-1-
SG	VA ≤ 3 not required 3 ≤ VA ≤ 10 2-2-2- VA > 10 1-1-1-	0.5-0.5-0.5-	VA ≤ 10 1-1-1- VA > 10 0.5-0.5-0.5-	VA ≤ 3 not required VA > 3 1-1-1-
PH	1-1-1-	1-1-1-	1-1-1-	1-1-1-
IN	Fittness: Commertial vehicle: 2-1-1- Private vehicle VA > 15 years: 2-1-1- PUC:0.5-0.5-0.5- (Commercial vehicle only)	Fittness: Commertial vehicle: 2-1-1- Private vehicle VA > 15 years: 2-1-1- PUC:0.5-0.5-0.5- (Commercial vehicle only)	Fittness: Commertial vehicle: 2-1-1- Private vehicle VA > 15 years: 2-1-1- PUC: 0.5-0.5-0.5- (Commercial vehicle only)	Fittness: Commertial vehicle: 2-1-1- Private vehicle VA > 15 years: 2-1-1- PUC: 0.5-0.5-0.5- (Commercial vehicle only)
JPN	3-2-2-	1-1-1-	1-1-1-	2-2-2-
KR	Private : 4-2-2- Commercial : 2-1-1-	VA ≤ 5 1-1-1- VA > 5 0.5-0.5-0.5-	Middle scale : 1-1-1- commercial large scale : VA ≤ 2 1-1-1- VA>2 0.5-0.5-0.5	NA
VN	VA ≤ 7 1-1-1- 7< VA ≤20 0.5-0.5-0.5- No usage after 20years			NA
ML	VA> 10 years old 5-5-5-	1-1-1-	1-1-1-	No inspection

* Valid period until next inspection. Number shows "First inspection year-Second inspection year-Third inspection year".
Ex) 1-1-1- : Annual inspection

Data sources: ERIA database
Data reference: JARI-UN conference [42]
AIT[12], Ministry of Industry, Indonesia[18] Aminuddin[33],JASIC[40][41]Ovasith[52]

Table A 2.6: Vehicle related tax system in Asian countries

Stage		IDN	CN	SG	TH	PH	IN	JPN	KR	VN	ML
Aquisition	Acquisition (registration fee)	Yes	Encourage smaller engine capacity	COE, Additional Registration Fee (ARF)				Green tax	City compact car (under 1000cc) : 50% tax cut , Registration fee: cut Bus: $1000 tax cut, subsidy for NGV Hybrid car (by 2009 July) : acquisition tax cut up to $1000	Registration tax: 12% Registration fee: 2-3mil VND/case	
	Excise tax,V	Yes	Yes	Exercise Duty, Goods & Services Tax (GST = 7%)	HEV (<3,000cc), EV, FCV = 10% Eco-Car =17% E20 & E85 ≤ 2,000 cc. = 25%, E20 & E85 2,001-2,500 cc.= 30% NGV =20% Otherwise, <2,000cc = 30% 2,001-2,500cc = 35%	Yes	Yes	Yes	Yes	VAT: 5% (before 10%)	
	Import tax	Yes	Yes		Yes	Income Tax Holiday Tax & duty-free	Yes		No		
Ownership	Local tax	Yes	Yes- Local tax paid annually		Yes		Yes		Hybrid car : (by 2009 July) registration tax cut up to $1000		
	Ownership (Annual tax)			Road Tax, Road Tax Surcharge (for vehicles over 10 years), Special tax for diesel-driven vehicles		Yes		Green tax			
Motoring	Fuel	Subsidy for fuel	Heavier tax for leaded G	Tax on Petrol (Gasoline)	Cheaper bio fuel tax			Yes	Compact car: fuel tax refund up to $80 per year taxi : fuel tax refund Fuel subsidy for compact car, truck, taxi	Road and Bridge fee (separated and sometime included in Fuel price)	
	Incentive		Eraly scrappage	Partial Additional Registration Fee (PARF) Rebate, Green Vehicle Rebate (GVR)	Clean energy vehicle			Low emission better fuel Economy	Compact car: Parking fee 50% cut		Yes, incentives for public transport companies

Source: ERIA database

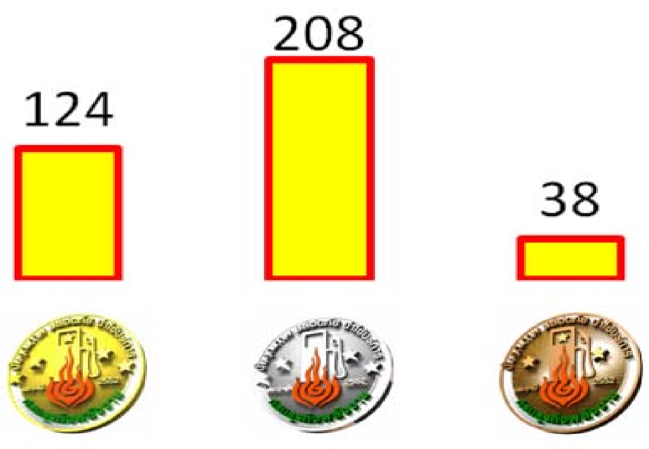
The delay in introduction of more stringent emission regulations is caused by a short supply of appropriate fuel quality [28][38]. The more stringent is the fuel quality (EURO2, 3 and 4), usually more limited is the supply. In Asian countries, FQM law and monitoring system do exist (Table A 2.7), however, the pace of implementation needs to be matching with the proposed implementation of progressive emission norms. The following three examples show the results of fuel quality monitoring. First, the fuel monitoring results for lead content, obtained by the Ministry of Environment in Indonesia and an Indonesian environmental NGO called KPBB[27], have been observed to increase off-specification fuel after the introduction of EURO 2 in 2005. In 2003 and 2004, prior to its introduction, all samples (number of samples = 31 per year) were observed to meet the lead standard at national level. In 2005, after the introduction of EURO 2, 12 out of 31 samples were noted to have exceeded the lead content as compared to the designated standards.

In Thailand, Ministry of Energy Business takes an initiative of a campaign for fuel quality and safety service at petro station. Ministry of Energy Business evaluates fuel quality and safety from 1 to 5 points. If a petro station is rated at full point, it received a gold sticker. If it is rated at 4 point, it receives a silver medal. If it is rated at 3 points, it receives a bronze deal. One thousand two petro stations participated out of 18902 petro station in 2008. One hundred twenty four petro stations received a gold medal sticker. Two hundred eight petro stations received silver medal sticker. Thirty eight petro stations received bronze medal. In total, 370 out of 1002 gas stations, which is 40% of participated petro stations, were certificated. This campaign promotes awareness of fuel quality and safety issue at petro station. By showing these sticker at petro stations, it promotes awareness for consumers.

Table A 2.7: FQM in Asian countries

	IDN	CN	SG	TH	PH	IN	JPN	KR	VN	ML
FQM	Yes	Yes	Yes/No	Yes	Yes	Yes	Yes	Yes/No	Yes	Yes
Which governmental institute is in charge of FQM?	Directorate General Oil and Gas	State Quality Supervision Bureau : FQM	National Environment Agency (NEA)	Department of Energy Business, Ministry of Energy	Department of Energy (DOE)	Ministry of Petroleum and Natural Gas	MITE	Ministry of Environment Ministry of Knowledge and Economy	Vietnam Directorate for Standards and Quality (STAMEQ) - MOST - Technical Center for Standards and Quality No 3.	the Malaysian Center for Energy in the Ministry of Transportation, Communication and Energy
Is there regulation or law of FQM?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: ERIA database



Source: http://www.doeb.go.th/bfbs/index.html

Figure A 2.4 Fuel quality and safety gas station campaign in Thailand

5. Policy instrument of air quality improvement

How to assure air quality improvement under the different share of vehicle types in Asian countries? After an air pollution act, vehicle emission and fuel quality regulations are introduced, and policies of monitoring such as better operation of monitoring systems like registration, inspection, fuel quality monitoring and air quality monitoring should be introduced[28][29][31]. Based on a simulation of emission volume from these policies [5], it is necessary to evaluate if the total emission volume can be ultimately below the prescribed standards.

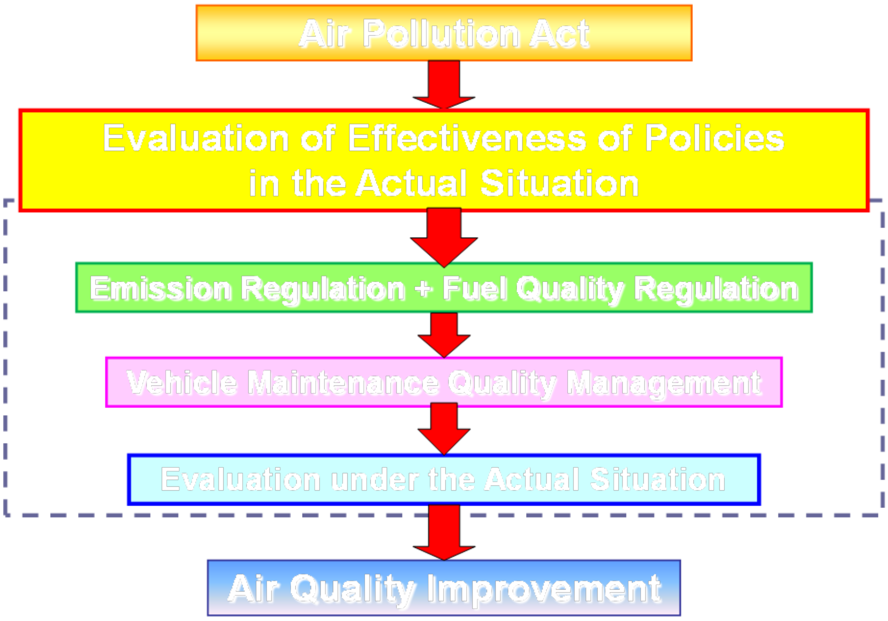


Figure A 2.5: How to assure air quality improvement?

Figure A 2.5 shows an example of an evaluation method based on a survey of policies to improve air quality. First, real vehicle usage such as car stock by vehicle age, vehicle speed and emission factors on-road should be measured as quantitative data. By use of modeling, driving cycle and proper methodology, with quantitative data, the total emission volume is estimated by simulations. This is usually referred as preparation of emission inventory, which often also involved estimates using fuel consumption, VKT travelled and even through actual monitoring of VKT. These data can be validated by air monitoring studies, followed by source apportionment, which can reliable conclude about the contribution from different sources including that mobile sources. After the problem estimation, a list of countermeasures can be worked out as potential options and their techno-economic feasibility can be worked out. From the list of control options, the potential policies/options need to be revised at the activities level and prioritized from the point of cost performance, health impact and other criteria. Finally, the best solution with regard to the actual situation will be proposed to support the political recommendation. Proper implementation of control options and policies remains the last important issue, which will ultimately determine the benefits of emission control efforts.

6. Conclusion toward political recommendations

In order to reduce automobile emissions, governments of Asian countries have been making efforts to introduce stringent vehicle emission regulations. It is also necessary to match the fuel quality to which is necessary for the application of suitable technology for emission control. Vehicle emissions have detrimental effects on air quality, and consumers/users should cover the costs related to emission control. The present results show that early implementation of emission regulations for new vehicles are important. Besides emission regulation implementation, fuel quality monitoring systems, registration systems and I/M systems should support vehicle emission regulations and fuel quality standards.

Finally this database report proposes an example of an evaluation method based on a survey for policy to effectively improve air quality in Asian countries, as these countries to some extent have different challenges of vehicular emission problems with different shares of vehicle type, different emission regulation levels, fuel quality, enforcement issues, environmental awareness, economic considerations etc.

Fortunately, Japan has long experience dealing with air pollution especially related to automobile usage. Japan also has state-of-art technologies related to automobiles as well as emission control. This experience, knowledge and technology should be exploited into Asian countries to ensure improved air quality, leading to a "Sustainable Automobile Society".

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