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The impact of Euro 4 automobile emission regulations on the development of technological capabilities in ASEAN countries

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Abstract
This research evaluates strategies aimed at lowering automobile emissions in the automobile industries of 4 ASEAN countries- Thailand, Indonesia, Malaysia, and the Philippines, with an emphasis on the Philippines's implementation of Euro 4 gas emission standards. Regulations based on vehicle technology are critical in reducing greenhouse gas emissions. However, restrictions vary based on each country's level of economic development, policy, and technological foundation. Using the example of Euro 4 car emission rules, this research studied the implementation process and strategies of each ASEAN nation. It then examines the responsibilities of the government, foreign automakers, and local suppliers in the Philippines. The findings indicate that the strategies of car manufacturers have had a favorable influence on the technological capabilities of local suppliers.

Keywords: ASEAN; emission regulations; Euro 4 Policy; Philippines

1.Introduction

The purpose of this study is to assess strategies for lowering automobile emissions in ASEAN nations, with a focus on the Philippines. Vehicle technology regulations are crucial in lowering greenhouse gas emissions. However, constraints differ according to each country's economic progress, legislation, and technological foundation. The number of motor vehicles sold in the Association of Southeast Asian Nations (ASEAN) has risen rapidly during the previous three decades and is expected to rise more in the next decades (Rasiah 2001). As a result, automobiles have become a significant source of pollution as well as the fastest-growing source of greenhouse gas (GHG) emissions, which contribute to climate change and global warming. For these reasons, efforts are being made to influence motor vehicle legislation from the perspective of GHG management (Ambrose et al. 2017). Several prior studies have used computable general equilibrium models and input-output tables to forecast the effects of climate change on ASEAN states under various policy interventions (e.g. Rasiah et al. 2016, 2017). The goal of this article is to evaluate ASEAN countries' strategies targeted at reducing car emissions.Vehicle technology-based regulations are critical in reducing GHG emissions.
However, laws vary based on a country's economic growth stage, policy, and economic structure. The first section of this article examines the methods and tactics utilized to apply Euro 4 car emission standards on ASEAN. Following that, the paper provides a full description of automobile emission regulations on ASEAN. Following that, the article delves into its impact on Japanese automakers in the Philippines.

2. Theoretical considerations

Since the COP yearly summit, further efforts have been made to decarbonize the world economy. One such effort is the installation of emission control to lower industrial emissions in the transportation sector.It demonstrates how ASEAN nations are working to find a balance between the issues of economic development, environmental preservation, and energy security in addition to European initiatives.Even though each member state has made a significant contribution to bringing about this change, there are still many obstacles standing in the way of the auto industry becoming more environmentally friendly. These obstacles include the high cost of producing clean vehicles and, more importantly, the requirement to build new infrastructure that will support them. Another difficulty is convincing consumers to change their fuel consumption habits. Figure 1 depicts the paper's analytic framework in light of the preceding concerns. In the face of climate change difficulties, transportation considerations must be assessed from both an energy and a transportation standpoint. Cleaner, more efficient automobiles are a component of ecologically sustainable transportation. Simultaneously, fuel economy is crucial for immediate action to reduce GHG emissions. This research looks at cleaner, more efficient autos as a method of attaining environmentally sustainable transportation. By enacting both short- and long-term strategies that can cut conventional vehicle emissions by bolstering car emission requirements, ASEAN can transition to cleaner vehicle technologies. Therefore, the goal of this research is to analyse the environmental policies of the governments of ASEAN member nations for cleaner and more effective cars. Thailand, Indonesia, Malaysia, and the Philippines were chosen as the countries to evaluate in order to encourage the use of clean and efficient automobiles because they are the key automotive producing nations in ASEAN. Then, using the example of a higher exhaust gas regulation imposed by an upgrade from Euro 2 and Euro 3 to Euro 4, I look at the development of the implementation of higher exhaust gas regulations to achieve cleaner air in ASEAN, paying particular attention to the government, automakers,

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and local suppliers in the Philippines' Euro 4 market.

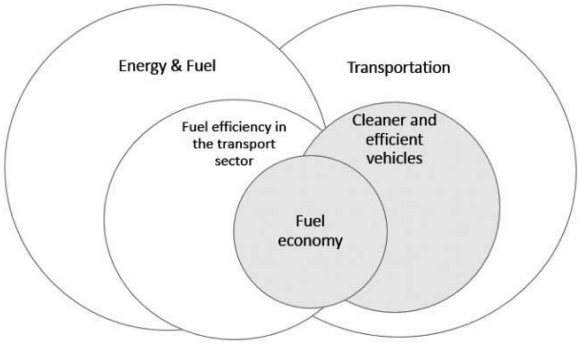

Figure 1. Analytic framework. Source: Author.

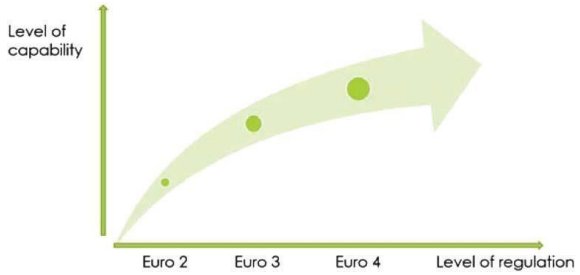

Figure 2. Research question of this paper. Source: Author.

We extend our examination by offering the following research questions: First, will the introduction of stronger environmental restrictions boost domestic technological capabilities? Second, how will the restrictions affect domestic automakers? (Figure 2 illustrates these research challenges diagrammatically.) According to Kuznets (1968), capacity at the government level is defined as the government's demand for qualified personnel to be installed with the express purpose of implementing industrial and economic stabilization measures. Initially, such jobs were done by Japan's Ministry of International Trade and Industry and Korea's Economic Development Board. The Economic and Social Development Board and Central Bank in Thailand, the National Economic Development Agency in the Philippines, the Economic Planning Unit in Malaysia and the Economic Development Board in Singapore are some of the ASEAN institutions that have performed this duty. Government economic technocrats are primarily responsible for formulating effective public policies, implementing them and evaluating them in the light of broader policy objectives. In addition, as shown in Table 1, it is essential that the government understands how the needs of the public and the business community will influence legislation. Between government and business, there are many intermediary organizations. Government will become more responsive to market issues and better equipped to play its role in addressing market failures as information is shared (Suehiro 2008). Furthermore, the policy maker's independence from politics is crucial. As shown in Table 1, an essential indicator for measuring social capacity for industrialization is workplace capacity, which includes local engineers, technicians and skilled workers, as well as enterprise capacity, which includes international corporations and local entrepreneurs.

Table 1. Indicators for social capability for industrialization.

Lev el	Acto rs	Index of capability
Governme nt	Economic technocrats	• Organizational ability to formulate and implement policies • Information sharing systems • Independence from politics
Enterprise	Entrepreneurs	• Display of individual entrepreneurship • Innovative combination of managerial resources • Upgrading of corporate organization
Workplace	Engineers, technicians, skilled workers	• Individual capacity for learning technology

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- Organizational capacity for technology formation
- Social capacity for technology formation

Source: Summarized by author based on Suehiro (2008).

Figure 3. Local supplier development process. Source: Author.

As shown in Figure 3, corporate social competence is generally strongly stimulated and facilitated by government policies, regulations, and incentives. In the case of the automobile industry, the government through industrial policies stimulates multinational companies and car manufacturers, imposes specific regulations and incentives, and increases the social capabilities of companies. Good competence of local suppliers For example, the local content initiative of a multinational car manufacturer demonstrated the growth of local suppliers by providing production assistance and training to qualified personnel (Sadoi 2003). The concept of modern technology absorption states that for local suppliers the social aptitude to absorb modern technology is human resources (Minami 1994). To keep pace with industrialization, it is important to be able to absorb modern technology. A key challenge, especially for latecomers, is how to effectively absorb modern technology from rich countries. Latecomers can benefit from staying behind the schedule. The question is how countries should internalize the advantage of backwardness compared to modern economic growth. Fluctuations in industry "returns" relative to the normal state of technology. The longer the retardation continues, the more prominent the potential becomes (Okawa and Rozovsky 1973). The advantages of being behind the times are internalized by certain industrial organizations (Minami 1994, 113-116). According to Gerschenkron's paradigm, the excellent economic performance of East Asian countries during the 1960s seems to demonstrate the importance of social competence (Gerschenkron 1962). Watanabe (1979) identifies three factors: company management ability, skilled workforce and policy. Technology transfer generally refers to the movement of commercial technology between countries and to a lesser extent within countries (Lall 2001). Technology (and knowledge in general) has been moving between companies and countries since the beginning of trade. The term "technology" is used both to describe the set of physical processes that transform inputs into outputs and to describe the knowledge and skills that organize the necessary activities. To perform these Kim (1997). Technology is the practical application of knowledge and skills to the development, upkeep, expansion, and improvement of the infrastructure required for such transformation as well as the planning and improvement of the outcomes. Multinational firms play an important role in international technology transfer. Technology has diffused across organisations and countries via person-to-person and firm-to- firm exchanges. Many studies have been undertaken from various viewpoints on the operation of multinational organisations. Teece (1977) looked into it by evaluating the resource cost of transferring technological know-how in multinational corporations.

Cantwell (1995) revisited the theories associated with earlier versions of the product cycle model (Vernon 1966), whereas Yap and Rasiah (2017) studied how company strategies differed by industry and host-site. As demonstrated by Rasiah et al. (2015), innovation synergies typically demand host-site organisations supporting the innovative use of current technologies.

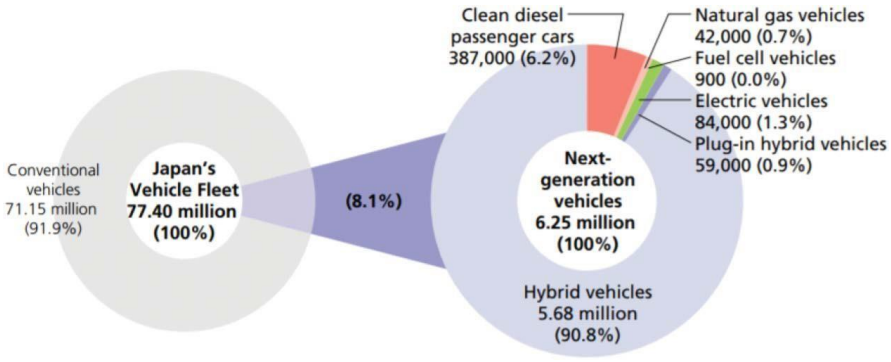

Figure 4. Composition of vehicles with breakdown of next-generation vehicle share, Japan, 2015. Source: Cited from Japan Automobile Manufacture Association (2016, p. 25).

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The transmission of technology in the Japanese industrial sector has been studied in many ways Itagaki (1997) said that in order to manage human resources, it is important to introduce technology into the Japanese industrial system. For a successful technology transfer, the Japanese talent creation system in particular is crucial (Koike and Inoki 1990). Japan was a pioneer in creating a framework for skill development. As Asian countries adopted Japanese technology, businesses started to consider and use the value of human resource development. Tighter rules may enhance the technology of local suppliers through technology transfer from Japanese manufacturers, according to the research subject. The introduction of green energy cars, the reduction of vehicular GHG emissions through the adoption of fuel efficiency regulations, and the control of air pollution are the three main focuses of environmental policies and trends in each ASEAN member state. Green energy vehicles must be adopted in order to comply with future environmental requirements, yet issues (b) and (c) are significant concerns for current auto regulations. Figure 4 shows how the Japanese automobile market is divided, with 91.9% of vehicles using conventional gasoline engines and 8.1% using next- generation green energy sources as of 2015. 90.8% of green energy next-generation cars are hybrid vehicles (HV), with just 2.3 being electric vehicles (EV) or plug-in hybrid vehicles (PIHV). This means that 0.2% of all vehicles on the road are EVs or PIHVs with zero emissions. As a result, this article focuses on the issues (b) and (c) that demand immediate and urgent action in the car industry.

2. ASEAN policies on gas emission regulation

According to an ASEAN statement at the COP22 (2016) meeting, ASEAN Member States have made considerable efforts to address climate change by timely submitting Intended Nationally Determined Contributions following the Paris Agreement signing on April 22, 2016 in New York, USA. The ASEAN Community Roadmap 2009-2015, which includes the ASEAN Action Plan on Joint Response to Climate Change (AAP-JRCC), the ASEAN Forging Ahead Together 2025, and the creation of the ASEAN Post 2015 Strategic Plan on Environment, has already begun (ASPEN). Furthermore, member states have encouraged sustainable forest management to reduce forest degradation and deforestation while also increasing carbon sink capacity via their own abilities. ASEAN (2016) members have also asked developed nations to hasten the availability of measures for tackling mitigation, adaptation, and loss and damage associated with the adverse consequences of climate change in the pre- and post-2020 time frame. Because of the concentration of people and economic activity along the coast, South-East Asia is especially vulnerable to climate change. According to an Asian Development Bank study, the region's mean temperature increased by 0.1-0.3 8 degrees Celsius every decade between 1951 and 2000, while rainfall fell and sea levels rose by 1-3 millimetres each year. Heat waves, droughts, floods, and tropical cyclones have all become increasingly severe and frequent in recent years (ASEAN 2016). The study predicted that by 2100, average annual temperatures will rise by 4.8 degrees Celsius and average sea levels by 70 centimeters in Indonesia, the Philippines, Thailand and Vietnam. As the sea level rises, some major coastal cities in ASEAN, including Jakarta, Bangkok and Manila, will face serious problems (2016). As a result, ASEAN member states announced voluntary reduction targets in 2016, which included a 26 percent reduction in Indonesia's operations. Business-as-usual (BAU) emissions increase by 41% by 2020 possible with increased international aid, Malaysia to reduce energy intensity of GDP by 40% by 2020 compared to 2005, Philippines by 20% Of the BAU percentage reduction, the Philippines was 16%. % below BAU level. by Singapore (ASEAN 2016) by 2020. In terms of motor vehicle legislation, several ASEAN member states have agreed to introduce stricter pollution limits, new fuel requirements and lower emissions from vehicles. In addition to the assessment of roadside pollution, a mandatory vehicle inspection and maintenance program was introduced. Recent efforts to regulate the auto industry in ASEAN member states represent a major move in favor of better pollution control and cleaner vehicle technology. Each ASEAN member country has different environmental policies depending on the level of economic growth, the volume of car production and the development stage of the car market, so the emission regulations of ASEAN are different. As seen in Table 2 and Figure 5, Thailand is the largest automobile producer in the ASEAN region, followed by Indonesia and Malaysia. The Philippines has 23 car owners per 1,000 people, far less than Malaysia (400) or Thailand (227). ASEAN has introduced Euro 1, 2, 3, 4, 5 and 6 emission regulations, the latest of which came into effect in 2013. The level and amount of acceptance in the country is different. Thailand and Malaysia introduced Euro 4 in 2012 and 2013 respectively. The Philippines introduced Euro 4 in 2016 with a two-year extension.

Table 2. ASEAN 5 economic data 2015.

	Populati on (million)	GDP per capita (US$)	Car people	per 1000	GDP growth rate (%)	Consumer price index (%)	Car production (10,000units)	Car sales (10,000units)
Indones ia	255	3362	82		4.8	6.4	109.9	101.3

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Thailand	69	5742	227	2.8	0.9	191.3	80
Malaysia	31	9557	400	5	2.1	61.5	66.7
Philippines	102	2858	23	5.8	1.4	9.9	28.9
Vietnam	92	2088	4	6.7	0.6	17.2	20.9

Source: Data from IMF, ASEAN automobile federation, Japan Automobile Federation, listed by author.

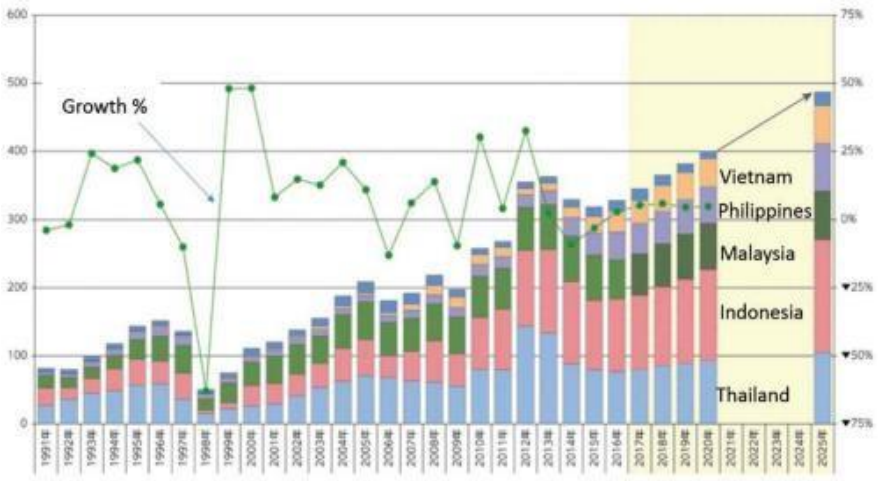

Figure 5. Automobile production volume, ASEAN, 1991–2025. Source: Adapted from Fourin (2017). Note: Unit 10,000 vehicles.

What do Indonesia and Vietnam think about Euro 2 to Euro 4 now (Table 3). Table 4 shows the emission limits for each element from Euro 2 to Euro 5. This section covers emissions, environmental taxes and regulations related to vehicles in Thailand, Malaysia, Indonesia and the Philippines, after explaining the status of car production, emissions and Euro environmental initiatives .

Thailand

Tables 5 and 6 show Thailand's emission regulations. The Ministry of Technology and Environment coordinates the current emission policy (MTE). Since 2012, MTE has also led the Euro 4 level regulations. (Table 5) Thailand is the first country in Southeast Asia to implement the eco-car program, a system that strongly incentivizes car manufacturers to invest and develop environmentally friendly vehicles. Phase 1 of the Eco Car Initiative was launched in 2007, as shown in Table 7. The following year, five car manufacturers were awarded the eco-car classification. In 2013, the second phase of the eco-car program began. This includes eight years of corporate income tax, lower excise duties, exemptions from machinery imports and a two-year reduction of 90 percent in raw material imports. In Phase 2, incentives are slightly better.

Table 3. Introduction of Euro exhaust gas regulations, ASEAN, 1995–2022.

Country	95	96	97	98	99	0	1	2	3	4	5	6	7	8	9	10	11	12
		13	1															
EU	1	Euro 2					Euro 3						Euro 4				Euro 5	
	Euro 1		Euro 2				Euro 3										Euro 4 Malay	
	Euro 1						Euro 2						Euro 4					
Indonesia	Euro 2																	
Philippines	Euro 1																	
									Euro									
									Euro 4	Vietnam								

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Table 4. Gas emission regulations (g/km).

		Euro 2	Euro 3	Euro 4	Euro 5
Gasoline	CO	2.2	2.3	1	1
	HC	0.5	0.2	0.1	0.068
	NO_x	n/a	0.15	0.08	0.06
Diesel	CO	1	0.67	0.5	0.5
	HC	0.9	0.56	0.3	0.23
	NO_x	n/a	0.5	0.5	0.05
	PM	0.1	0.05	0.025	0.0025

Source: Author's hearing from auto makers.

Table 5. Thailand emission regulation (g/km).

	CO		HC		$HC + NO_x$		NO_x		PM
Category	Gas.	Dsl.	Gas.	Dsl.	Gas.	Dsl.	Gas.	Dsl.	Dsl.
M	1.00	0.50	0.10	–	–	0.30	0.08	0.25	0.025
N1I	1.00	0.50	0.10	–	–	0.30	0.08	0.25	0.025
N1II	1.81	0.63	0.13	–	–	0.39	0.10	0.33	0.040
N1III	2.27	0.74	0.16	–	–	0.46	0.11	0.39	0.060

Note: Gas. = gasoline; Dsl.= diesel.
Source: Mitsubishi UFJ Research & Consulting (2016).

Table 6. Vehicle tax, Thailand, 2016.

Car model	Old tax system			New tax		
	Displacement	Fuel type	Tax %	Displacement	Fuel type	Tax %
Passenger car	<2000 cc	E10	30	<100 g/km	E10	30
		E20	25		E20	30
		E85	22		E85/ng	25
	2001–2500 cc	E10	35	<101–200 g/km	E10	35
		E20	30		E20	35
		E85	27		E85/ng	30
	2501–3000 cc	E10	40	200 g/km<	E10	40
		E20	35		E20	35

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	E85	32		E85/ng	35
Eco car	Diesel	17	<100 g/km	Diesel	14
			101 g/km<	Diesel	17
	E85	17	<100 g/km	E85/ng	12
			101 g/km<	E85/ng	17
Hybrid vehicle	<3000 cc	10	<100 g/km		10
			101–150 g/km		20
			151–200 g/km		25
			201 g/km<		20
EV/fuel cell vehicle	<3000 cc	10			10
	3001 cc<	50			50
	<3250 cc	3	<200 g/km		3
			201 g/km<		5
Pick-up truck(sin	<3250 cc	3	<200 g/km		5
			201 g/km<		7
Pick-up truck(dou	<3250 cc	12	<200 g/km		12
			201 g/km<		14
PPV	<3250 cc	20	<200 g/km		25
			201 g/km<		30
Pick-up truck	3,251 cc<	50	3251 cc<		50

Source: Mitsubishi UFJ Research & Consulting (2016).

Table 7. Eco car policy, Thailand. Year 2007
Applied by 2014 Producedby 2019

Fuel efficiency	<120 g/km (20 km/L<)	<100 g/km (23.3 km/L<)
Exhaust gas regulation	Euro 4	Euro 5
Displacement	1300 cc<	<1300 cc gasoline
<1500 cc diesel		
Others	100,000 units/year volume after the fifth year	100,000 units/year volume after the fourth year

Source: Compiled from Kasikorn Bank (2015).

Malaysia

Malaysian vehicle environmental law covers two areas: gas emission regulation and fuel efficiency for CO2 reduction. For commercial and passenger diesel cars, the first Euro 1 gas emission regulation law was Approved in 1996. In 2000, the Euro 2 standard was introduced for gasoline-powered commercial and passenger cars. Euro 2 was applied to commercial and passenger cars with diesel engines, while Euro 3 was implemented in 2012 for cars with gasoline engines. Euro 4 launch announcements were made in 2016. To reduce GHG emissions and CO2 emissions, Malaysia introduced energy-efficient vehicles (EEV) with target fuel economy (L/km) set by the National Automotive Policy 2014. EEV is shown. In Table 8 per category. The Malaysian government offered tax incentives to encourage the use of EEVs. Initially, both imported and indigenous goods were eligible for knock-down (KD) HV and EV tax incentives. But in 2013, tax breaks for imported cars were abolished, making only domestically built KDs or EEVs eligible (Figure 6). This strategy was used to convince Malaysian automakers to develop HVs, EVs and other EEVs there.

Indonesia

In Indonesia, there are different standards for trucks, motorcycles and passenger automobiles when it comes to gas emissions. Euro 2 standards were launched in 2005, to accommodate newly released models of passenger automobiles, light lorries and heavy trucks.

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Table 8. Fuel efficiency regulations, Malaysia.

Catego ry		Vehicle weight (kg)	Fuel efficiency (L/100 km)
A	Micro car	Under 800	4.5
	City car	891–1000	5.0
B	Super mini car	1001–1250	6.0
C	Mall family car	1251–1400	6.5
D	Large family car	1401–1550	7.0
	Compact Executive car		
E	Executive car	1551–1800	9.5
F	Luxury car	1801–2050	11.0
G	Large 4 £ 4	2051–2350	11.5
	Others	2351–2500	12.0

Source: Malaysia (2014).

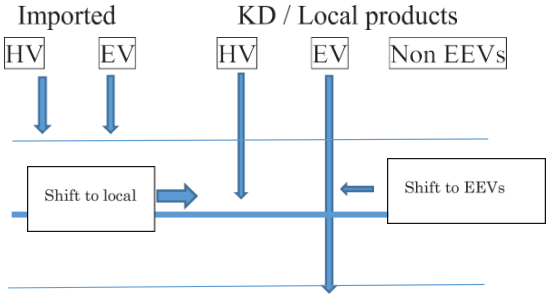

Figure 6. Tax incentives, EEVs, Malaysia. Source: Malaysia (2014).

Table 9. Gas emission regulations, Indonesia, based on Euro 2 (g/kg).

Reference weight		CO		HC + NO_x	PM
	Gasoline	Diesel	Gas	Diesel	Diesel
1	Under 1250 kg	2.20	1.00	0.50	0.70 0.08
2	1250–1700 kg	4.00	1.25	0.60	1.00 0.12
3	Over 1700 kg	5.00	1.50	0.70	1.20 0.17

Source: The Council of the European Communities, 'Official Journal of the European Communities, No.L 295/1'.

Table 10. Gas emission regulations for passenger cars in Jakarta.

	CO	HC
Using gasoline vaporizer	Under 3%	Under 700 ppm
Using gasoline fuel injection	Under 2.5%	Under 500 ppm

Source: Energy and Environment Research, 'Exploring Variation of Maintenance Action and its Impacts on Emission and Cost in Jakarta City', December 2011.

The Indonesian Ministry of Environment set a target of moving from Euro 2 to Euro 4 by 2012. However, as of 2017, no such alteration had occurred. The Tables 9 and 10 show the Euro 2 gas emission criteria for various weight groups of automobiles. In Indonesia, consumer gasoline fuel prices are composed of the base price + VAT (value-added tax) + motor fuel tax (PBBKB) + corporate profit.The gasoline tax is a state tax, and the rates vary by state. For example, the car gasoline tax in Java and Madura Islands is 5%, however it is 10% on Bali Island. The Indonesian government created a tax incentive system for low-cost green cars that match the following standards in 2013.

- Displacement:Gasoline – 1200 cc or less; Diesel – 1500 cc or less

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- Fuel consumption rate:20 km/L or more
- Mobility: less than 4.6 m minimum turning radius
- Local content rate: 80% or more

Philippines

The Philippines adopted the Republic Act 8749 (Clean Air Act) in 1999 (See Table 11), which had the highest emission requirements in ASEAN, to mandate exhaust pollution controls for enterprises and automobiles. It was replaced in 2003, 2005, and 2008, respectively, with the implementation of the Euro 1 and Euro 2 gas emission limits. The projected year of Euro 4's adoption is 2018.

Table 11. Exhaust emissions regulations, Philippines.

	CO	(g/km)	HC + NO_X (g/k)		
Light vehicles	2.72	0.97			
			0.14 (g/km)	PM	
Light commercia		Weight (kg)	CO (g/km)	HC + NO_X (g/km)	PM (g/km)
	Categor y 1	<1250	2.72	0.97	0.14
	Categor y 2	1250–1700	5.17	1.4	0.19
	Categor y 3	1700< HC	6.9	1.7	0.25
Heavy duty vehicles	CO (g/kWh) 4.5	(g/kWh) 1.1	NO_X (g/k Wh) 8		PM (g/kWh) 0.36

Source: Diaz (2017).

Table 12. Bio-ethanol and bio-diesel r egulation timeframes, Philippines.

	2013–2015	2016	2020	2025	2030
Bioethanol	E10	E10	E10	E20	E20/E85
Biodiesel	B5	B5	B10	B20	B20

Note: B20: 20% bio-diesel, E20: 20% bio- ethanol.

Source: Foreign Agricultural Service, a 'Philippines Biofuels Annual: Philippines Biofuels,Situation and Outlook', October 2013.

Even though the fuel efficiency regulations have not yet taken effect, the Philippine government introduced the National Energy and Efficiency and Conservation Program through a national campaign seminar and workshops to meet 60% of energy self-sufficiency, to promote CO2 reduction,and through the Government Energy Management Program to reduce 10% of fuel use by public automobiles. As part of the Bio-Fuel legislation, the National Biofuels Plan (NBP) 2013–2030 required that by 2009, diesel fuel include 2% biodiesel (Republic Act 9367). The government also mandated an increase in biodiesel and ethanol usage to 10% and 20%, respectively, by 2025. (Table 12). The major ASEAN auto-producing countries have put in place stringent laws to promote the adoption of environmentally friendly technologies. Greater and stricter emission regulations are in effect in Thailand, Malaysia, and the Philippines than in other ASEAN nations that manufacture cars. In Thailand and Malaysia, incentives are being offered more often to promote the development of environmentally friendly vehicles. Most Japanese manufacturers take use of the incentives to develop new models for international markets, especially in Thailand. We examine the instance of the Philippines in the section that follows.

2. Focused study on the Philippines: shifting from Euro 2 to Euro 4

According to the Philippine government, Euro 4 went into effect in January 2018. "How might more regulation improve local capabilities?" is the research question stated in this study. This empirical study, which utilises the Philippines as a case study, examines how the changeover from Euro 2 to Euro 4 may be affecting regional automakers in the Philippines. The following section examines the various methods and plans that Philippine automakers and component suppliers employ. Which technological advancements are initially required to make the switch from Euro 2 to Euro 4 exhaust gas regulations? The least dangerous substances in Euros 2 to 4 are shown in Table 2. All hazardous chemicals in exhaust gas have to be reduced by half or less to meet Euro 4 criteria. How are the toxic substances taken out of the exhaust gas? The

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exhaust system is the main component of vehicles powered by gasoline. Figure 7 depicts the location of the exhaust system from the engine to the muffler. The catalytic converter, which is situated between the engine and the muffler and eliminates water (H2O), carbon dioxide (CO2), and nitrogen oxide from exhaust emissions, must be used to remove hazardous substances (see Figure 8). Diesel engines require catalytic converters, NO occlusion catalysts, diesel, and particle filters to eliminate toxic chemicals (see Figure 9). These devices will clearly be useless if internal combustion engines are outlawed in Europe and Japan in 2040. (Rasiah et al. 2017).

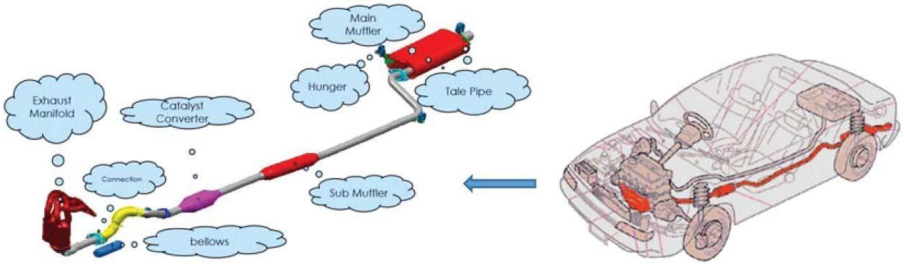

Figure 7. Exhaust system.

Figure 8. Function of catalysis converter.

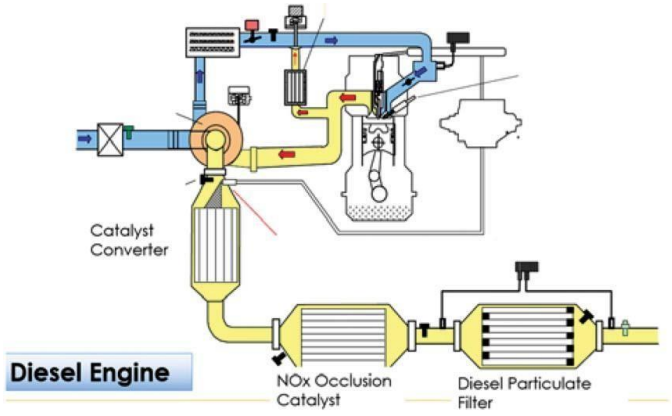

Figure 9. Diesel engine exhaust system.

The Department of Environment and Natural Resources (DENR) in the Philippines set the initial new automobile registration deadline for non-Euro 4 compliant vehicles in the nation as 31 December 2017.Although the Philippines switched to the Euro 4 emissions standard on January 1, 2016, the DENR granted an extension to the auto industry. The DENR handed automakers two years to phase out the current Euro 2 vehicles, citing "long-term production planning of OEMs" and the need for a "major vehicle technological upgrade during the model life."

However, that extension should have expired at the end of 2017 (DENR 2017), implying that effective January 1, 2018, the DENR would no longer recognise Euro 2 Certificates of Conformity as the basis for first registration with the Land Transportation Office, or LTO. Beginning in 2018, new automobiles that have not yet been registered and do not meet Euro 4 emissions regulations will be unable to be registered. This decision has no influence on vehicles that have already been purchased and registered with the LTO. For vehicles purchased before to January 1, 2018, the Euro 2 emissions standard will be used for registration renewal. As a result of change to Euro 4 requirements, automakers have increased their efforts to reach such a level. As a result, based on research conducted on Mitsubishi Motors Philip- pines Corporation (MMPC) in 2017, we investigate the tactics of automakers, as well as its MNC and local suppliers in the Philippines. MMPC was

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founded in the Philippines in 1963 as Chrysler Phils. Corp. and began manufacturing in 1964. In 1985, Mitsubishi Motors Corporation (MMC) Japan (17.5%) and Nissho Iwai Corporation (NIC) (17.5%) joined forces to form this corporation. In 1996, Japanese capital acquired complete ownership of Philippine Automotive Manufacturing Corp, becoming MMPC, with MMC owning 51% and NIC owning 49%. In 2014, MMPC increased its annual car production capacity to 30,000. Typically, 1.5 years must be spent preparing for the switch to the Euro 4 model. Figure 10 depicts the main procedures and the distribution of labour. For instance, as Roberts AIPMC supplies them to MMPC, the capabilities of the local exhaust pipe suppliers in the Philippines needed to be upgraded. For its new Euro 4 model, MMC and MMPC started research and development (R&D). MMC and MMPC chose system suppliers Futaba Japan and Roberts Philippines based on the design requirements. Then, Roberts produces prototypes with technical support from Futaba. Before being shipped from the Philippines to Japan Futaba for additional testing, prototypes are put through a number of tests by Futaba in Japan. The MMC and MMPC are informed of the test findings. Mass production lines are already ready thanks to MMPC. Production of the Euro 4 model will begin at suppliers and MMPC after the testing are successful and are conducted by MMPC (Table 13). MMC and MMPC are notified of test findings.

Mass manufacturing lines have already been established by MMPC. Once the MMPC testing are completed, production of the Euro 4 model will begin at suppliers and MMPC (Table 13).

3

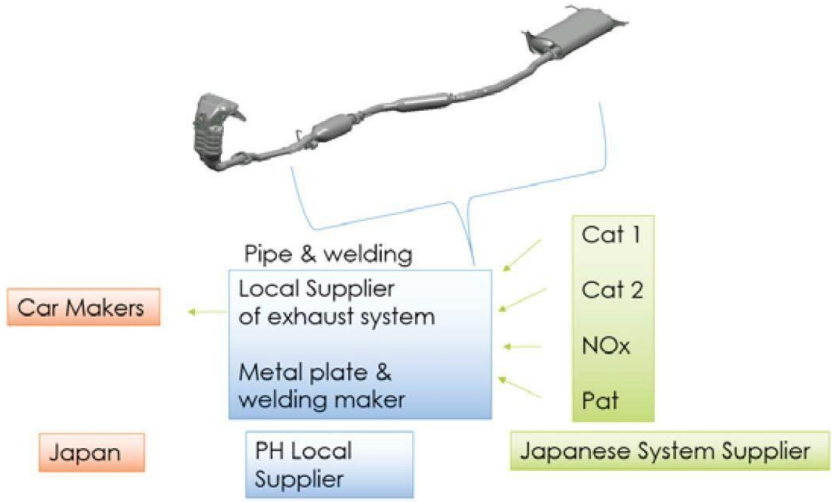

Figure 10. Exhaust system manufactured for Philippines. Source: Figure is cited from Japan Automobile Manufacture Association (2016, p. 25).

Table 13. Division of labour, Euro 4 Model, Philippines.

	Car makers	System suppliers (J)	Local sı ppli
R&D	✓		
Supplier selection	✓		
Prototype making		✓ (TA)	yes
Second tier supplier selection		✓	
Prototype test	✓	✓	
Production preparation	✓		
Production tests and certificate	✓		

Source: Compiled by Author.

The whole exhaust system is built by local business Roberts, Philippines, with the aid of Japanese system supplier Futaba, who was selected by MMC and MMPC. A Japanese systems provider has been the main supplier of the Euro 4 exhaust system to MMC in Japan. The system supplier from Japan, Futaba, has extensive experience and knowledge for the full functions to upgrade the exhaust system to Euro 4. This includes selecting and purchasing catalysis and other necessary components and procedures from other Japanese vendors in Japan and the Philippines. Before collaborating on prototype development, testing, mass production, and quality control with Roberts TA and local Philippine suppliers, Futaba gathers

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the necessary functional components. The finished exhaust systems are then delivered after that to MMPC. Roberts AIPMC was founded in 1968 by the RGC Group, a manufacturer of uratex foam. In South-East Asia, it is a well-known manufacturer of polyurethane foam. The RGC Group developed into the RGC Group of Companies and broadened its product line to include plastics, textiles, automotive, and industrial parts in addition to foam goods. Futaba is optimistic that Philip-Pines suppliers' ability to carry out testing there may be enhanced since it would result in considerable cost savings. As of 2018, the major rivals are Japanese automakers and system companies. Local suppliers continue to be at a disadvantage because of their poor technological capabilities. Local suppliers, however, have to increase their capabilities in order to get new TAs with higher value-added components. The R&D capabilities of local vendors must be increased for this. Under Apple's supervision, Foxconn also had success advancing high-value processes up the value chain (Sturgeon 2002). Local suppliers use a number of strategies to eventually seize control (see Yap and Rasiah 2017). However, the survey found that local suppliers were working on exhaust system prototypes, welding, and final assembly, as well as those with a lot of room for development. During conversations, several problems faced by regional suppliers were highlighted. First, because of their high production costs, local suppliers are unable to successfully compete with Japanese suppliers. Functional parts are more difficult to create since they need more work to generate than the simpler components they now produce. Second, local service providers are unable to swiftly adjust to modifications in the law or in customer demand. MMPC decided to cease producing a number of models and boost the manufacture of Euro 2 models till the end of 2017 due to the Philippines' constrained supply capacity. For instance, MMPC increased the production of one model from 1800 vehicles per month to 3000 till the end of 2017.

3. Conclusions

This research examined the implications of environmental regulations on the automobile industry in a variety of ASEAN countries, with an emphasis on the Philippines' implementation of Euro 4 gas emission standards. The environmental policies of the governments of Thailand, Indonesia, Malaysia, and the Philippines—four of the top producing countries for cars—concerning stricter laws on exhaust gas emissions and financial incentives for the production of environmentally friendly cars— were studied. Despite having identical objectives, each government has adopted a unique strategy and set of regulations to reduce gas emissions. Thailand has led the other ASEAN nations with a strong eco car push, offering incentives to automakers to strengthen pollution control laws. There are no vehicle manufacturers in Singapore. To continue as an export-focused hub for ASEAN's vehicle industry, Thailand must uphold stringent rules from the outset. Malaysia was the next ASEAN nation with the highest automobile density per 1000 people. It has begun the EEV initiative to switch local manufacturing over to HV and EV. The Philippines and Indonesia will focus on upgrading from Euro 2 to Euro 4 emissions next. A initial study carried out in the Philippines indicates that the capacity of local suppliers is expanding to meet plans to switch from Euro 2 to Euro 4 models starting in 2018. Government measures discourage the production of Euro 2 automobiles while promoting the new Euro 4 cars. The data show that there has been no change in the labor-sharing arrangements that currently exist between system manufacturers, local suppliers, and automakers. The exhaust systems utilised by MMPC are mostly designed and tested by the Japanese-owned Futaba before being built by local vendors. Local suppliers will be able to strengthen their technological know-how, their participation in the MMPC value chain, and their competitiveness by focusing on R&D projects.

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