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Does Adaptation of Renewable Energy and Use of Service Industry Growth Diminution CO_2 Emissions: Evidence of ASEAN Economies

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ABSTRACT

According to recent years, ASEAN economies mainly focused on the development of renewable energy, which contributes to leading role of changing the economic structure towards service sector industry. So, most of the studies ignored the effect of heterogeneity and cross-sectional independence. It caused the biased and spurious results. Hence this study used the panel of 9 ASEAN economies of the time from 2000 to 2018, and Arelleno Bond Generalized Method of Moments (GMM) is used to examine the impact of renewable energy and the development of the service sector on Carbon emissions in ASEAN economies. Moreover, GMM overcomes the problem of cross-sectional dependence and heterogeneity so that the results will be unbiased and consistent. Results showed that an increase in the level of renewable energy usage and economic development leads to decrease in the level of CO_2 emissions. Furthermore, development in the service sector industry and urbanization boost the level of emissions of carbon dioxide. So, the policymakers need a revolution in the renewable energy sector, which increased economic growth and total energy production and keep the environment safe, healthy and clean.

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1. Introduction

ASEAN economies consist of ten developing countries in the world, namely Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. In the last few years observed rapid economic development in ASEAN countries and global economic growth, and these countries have made a tremendous impact on economic growth (Ozturk, 2015). According to the report of the world bank WDI (2020), real GDP in 2017 was an average of 18.82 trillion US dollars for ASEAN countries. At the same time, the significant growth in CO2 emissions led to the rapid economic development for ASEAN countries. According to WDI (2020) 13.985 billion tons of CO2 emissions in 2017 from ASEAN states 41.82% of worldwide CO_2 emissions and the expected more carbon emission (Wu, Liu, Liu, Fang, & Xu, 2015). In 2017, Indonesia, Thailand, Malaysia, Vietnam, Philippines, Singapore, and Myanmar ranked the first, second, third, fourth, and five and so on as a contributor to CO_2 emissions in ASEAN countries, respectively, which are shown in Table 1 and figure 1.

Moreover, they are globally high ranked countries, so ASEAN nations are now under pressure to decrease carbon dioxide emissions to attain sustainable development in the world. Typically environmental curve uses to inspect the outcome of economic expansion on carbon productions. Kuznets (1955) confirmed that in the late phase of economic

expansion had worse effects due to environmental destruction. However, by using clean energy, economic development and environmental pollution eventually reduces after a certain period. The exists conflict between the environmental damage and economic development regarding environment Kuznets curve hypothesis and transferring economic structure and energy consumption optimization make this conflict ease.

Table 1
CO_2 emissions and GDP growth in ASEAN economies

Year	Country	GDP	CO_2
2017	Brunei-Darussalam	1.3286	9.47464
2018	Brunei-Darussalam	0.052238	9.570155
2017	Cambodia	7.01503	9.20334
2018	Cambodia	7.49796	9.306741
2017	Indonesia	5.06741	12.86366
2018	Indonesia	5.17127	12.79379
2017	Malaysia	5.74183	12.47516
2018	Malaysia	4.74161	12.49899
2017	Myanmar	6.75863	10.77783
2018	Myanmar	6.20005	10.94584
2017	Philippines	6.67755	11.76156
2018	Philippines	6.24374	11.81859
2017	Singapore	3.69978	10.97615
2018	Singapore	3.13946	10.988
2017	Thailand	4.02409	12.80651
2018	Thailand	4.12923	12.84979
2017	Vietnam	6.81225	12.32808
2018	Vietnam	7.07579	12.4116

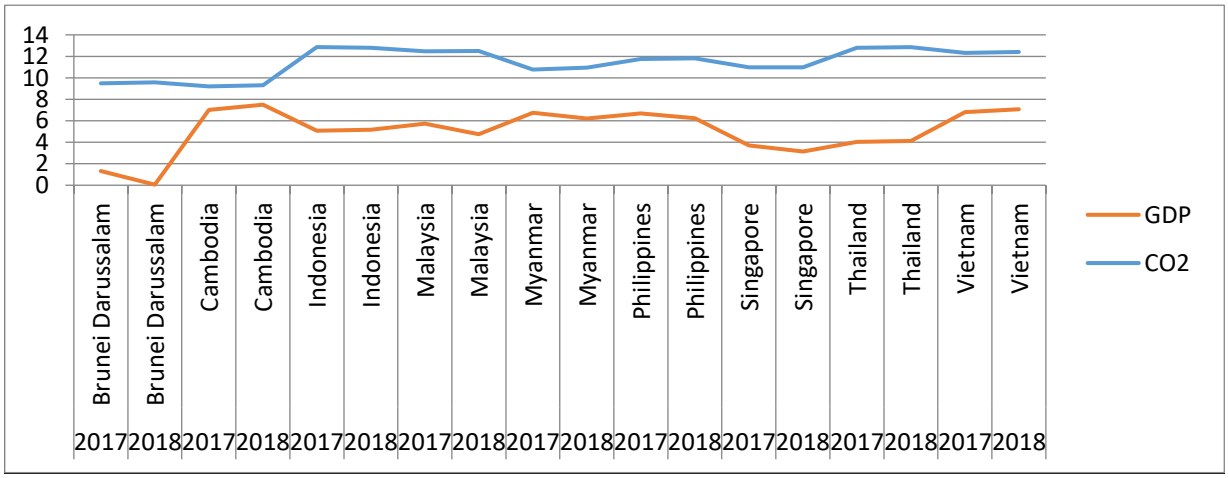

Figure 1: Time trend of CO_2 Emissions and GDP growth in ASEAN economies

In recent years, ASEAN countries plays significant role in shifting the service sector industry of economic structure and development of renewable energy to attain the economic development from carbon emissions (Dudin, Frolova, Artemieva, Bezbah, & Kirsanov, 2016). Recently, the ASEAN countries made strategic planning and polices, such as monetary and financial policies and government regulation to the upgrade industries to maximized power construction and attain low and green carbon growth. Renewable energy (i.e., solar, hydro, geothermal energy, biomass energy, and wind energy) usage creates the environment green and healthy (Dong et al., 2018).

In recent years, ASEAN countries promoting the development of renewable energy activities to attain outstanding achievements. For example, the Vietnam government issued a revolution strategy in the consumption revolution and Energy production. It is proposed that total energy consumption from fossil energy in 2016 attained 15% and 20% in 2020 and 2030 (Mi et al., 2017). Dudley (2018) reported that in ASEAN countries, renewable energy usage was 163 million tons, due to that, ASEAN states received fast growth with renewable energy consumption. In the meantime, the government of ASEAN countries not promoting the development of service industries. For example, the Indonesian government published the work plan for controlling greenhouse gases by improving Indonesia's service sector industry.

Furthermore, the service sector played a vital role in economic development. So, the service sector played a vital role in the development of the economy. As reported by (WDI, 2020), the ASEAN economies' service industry attained a rapid increase from 1996 to 2017. Each country experienced that the service sector contributes more than 50% in 2017 occupying the prominent position, for easing the fight around carbon emissions, economic development service sector and renewable energy usage playing a vital role. Hence it is essential to explain the impact of the service sector industry and renewable energy use on reducing carbon emissions in ASEAN states.

However, recent studies are insufficient for explaining the influence of development in the service sector and energy sector (i.e., attainment of renewable energy) towards the emission level of CO2 in ASEAN economies. In particular, the effect on carbon emission in the presence of service industry development in ASEAN states has not greater attentiveness acknowledged. Moreover, according to researches/past studies, heterogeneity and cross-sectional correlation not sufficient in the model. Suppose the industrial structure and energy resource endowments neglect, the ASEAN countries' economic exchange cause biased results (Cowan, Chang, Inglesi-Lotz, & Gupta, 2014; Muhammad A Nawaz & Hassan, 2016). The fixed and random effect is not better applicable than the Generalized Method of Movements (GMM) method for the panel data method in the presence of fixed effect and heterogeneity problem.

According to the above discussions, the present study gives a more robust exploration of both the short and long-run effects of developing the service sector industry and energy sector on the emission level of CO2 for ASEAN countries. Within heterogeneity and cross-sectional assumptions and energy, development means using nonrenewable energy rather than fossil fuel and others. The current study is an addition to the existing literature and also for policymaking in the following ways. For example, it is innovative work that explores the impact of the service sector industry and renewable energy usage in ASEAN states, to offer economic growth in dissociating from carbon emissions in ASEAN economies. This study's objective is to consider a reduction in carbon emission in the current severe situation of ASEAN countries. To carry out robust exploration, this study considers the heterogeneity issues and cross-sectional dependence in its methodology.

The remaining part of this study as follows: section 2, based on existing literature, section 3 discusses data and methodology, section 4 results and discussion of the study, and lastly, conclusion and policy suggestions are given.

2. Literature Review

It was examined that the influence of economic and energy development on CO2 emission had been an empathetic problem for researchers. Most of the existing studies commonly use short-run and long-run panel analysis. In the present research, we focus on the two aspects of relevant literature; (a) the effect of the service sector industry with the presence of energy development (use of renewable energy) on the level of carbon emission, (b) development in the methodology which helps the analysis for panel data to unbiased estimates.

They explored the impact of development in the service industry and the energy sector from nonrenewable energy to renewable energy to carbon emissions. Firstly, as explored by Shahbaz, Khan, Ali, and Bhattacharya (2017) and Zhou and Li (2019), the effect of economic development and renewable energy on CO2 emission is extensive heterogeneity in different economies. Moreover, some studies examined the impact of renewable-energy usage on CO_2 dioxide production in the BRICS region but mostly failed to find out the effect of heterogeneity and cross-sectional relationship on estimation outcomes. Liu, Zhang, and Bae (2017) use Ordinary Least-square (OLS), (DOLS) Dynamic Ordinary Least-square, fully modified Ordinary Least-square (FMOLS) and (VECM) Vector Error-Correction model to investigate the outcome of consumption of nonrenewable-energy &and renewable-energy on CO_2 in BRICS states cover the period from 1992–2013. These studies proved that there is an increasing and significant effect of nonrenewable energy on carbon productions. In contrast, carbon emission decreases due to renewable energy consumption.

Nassani, Aldakhil, Abro, and Zaman (2017) examined the impact of renewable energy on carbon productions in BRICS states for the time period of 1990 to 2015. Results confirmed the inverse relationship among the level of CO_2 with the help of traditionally fixed and random effect models and the Granger Causality test also verified by that (Muhammad Atif Nawaz, Azam, & Bhatti, 2019). Gielen et al. (2019) discovered the economic and technical features of faster power usage to 2050 and explained that globally total demand is fulfilling through renewable energy, reducing carbon emissions. Additionally, scarce studies considered the difficulties of heterogeneity and cross-sectional. Dong, Sun, and Hochman (2017) discussed the role of usage of renewable energy & natural gas in the case of BRICS economies from 1985 to 2016 by using the MG method that deals with heterogeneity cross-sectional-dependence. The research findings revealed that renewable energy and the consumption of natural gas had significant effects and reduced CO_2 production. Ummalla and Samal (2019) inspected the casual association among economic growth, use of renewable energy and CO2 in India & China, and discovered that variable concern have long term equilibrium affiliation also supports by (Bakhtyar, Kacemi, & Nawaz, 2017).

Nguyen and Kakinaka (2019) discovered how the association between CO_2 and renewable energy usage is linked with economic expansion by using a panel of 107 countries for panel cointegration analysis from 1990 to 2013. The result found that there is a clear difference among classes with lower and higher-incomes. In the lower level of economies confirmed that the use of renewable energy reduced the output level and boosted the CO_2 emission. In contrast, it is the opposite in the high-income group, which boosts the output level by reducing the CO_2 emission level. Dong et al. (2018) explained the linking amongst economic development, CO_2 releases, renewable energy, and population development and used unbalanced panel data of 128 economies from the time period from 1990–2014 across regions. The findings revealed that the population's economic development and size significantly and positively impact CO_2 emissions in both the regional and worldwide levels. At the same time, a rise in renewable energy reduces CO_2 emanations at the worldwide level. Though, there is a lack of robust checks because conclusions are achieved from one method. Generally, most studies found robust results. For BRICS countries, renewable energy consumption influencing carbon reduction. Therefore, it is essential to make more investigations related to the outcome of renewable energy on CO2 emissions by using efficient methods that use heterogeneity and cross-sectional in BRICS states.

Ozcan (2013) had verified the EKC hypothesis in just three states of 12 Middle East states. It institutes no funding, no causality relationship was established. Arouri, Youssef, M'henni, and Rault (2012), displayed that energy has a meaningful and positive impression on the real GDP and CO_2 emissions establish a quadratic association with emissions of CO_2 in a study of 12 MENA economies. Narayan and Popp (2012) originated that EKC's hypothesis was not reinforced for 43 economies' panel with Middle Eastern nations. Furthermore, detected that the elasticity of GDP in the long term is lesser than the short-term estimation for the Middle Eastern region's panel and also suggested that a rise in income bases a weakening in CO_2 emissions. Jaunky (2011) verified the EKC framework for three MENA economies, including 36 high-income countries, and found that a rise in income, in the long run, lead to higher CO_2 emissions. Soytas and Sari (2009) examined the associations amongst employment, use of energy, income & carbon emanations in five designated OPEC nations, with Saudi Arabia, and establish a co-integrating association amid the variables.

Ozturk and Acaravci (2010) deliberated the association among employment, CO2 emissions, GDP, and consumption of energy in Turkey's. They established that neither consumption of energy nor CO_2 emissions Granger cause per capita real GDP growth. The literature reviewing the affiliation among economic development, consumption of energy consumption, and CO_2 emanations connecting only the GCC nations are comparatively rare. However, there have been numerous researches on the Association of Petroleum Exporting Countries (APEC), the Middle East and North African (MENA) nations, and all GCC high-income states. The study of Omri (2013) found a uni-directional causality affiliation in the middle of economic development and consumption of energy consumption on 14 MENA economies.

Secondly, several types of research discussed the impression that the service industry increased on CO_2 releases. According to the methodology, mostly heterogeneity and cross-sectional dependence problems are neglected. Some studies for the BRICS countries inspected the influence of the service industry on carbon emissions by using the Granger

causality, and fixed panel effect model, Nassani et al. (2017) discussed that the tourism industry and railway transport generated significant growth in carbon emissions from the time period from 1990 to 2015 in BRICS economies. Meanwhile, researchers usually grasp that the service industry is a cognition-intensifier industry, so the transfer of economic construction to the service industry donates to a decrease in carbon emissions (Kaika & Zervas, 2013).

At the same time, researchers question growing in passage time and maintain that the impact of service industry growth on carbon emission reduction is not clarified. Taking the relations between states, W. Zhang, Peng, and Sun (2015) explained that the indirect effect of carbon emissions on the consumption of the service industry are far-away than its straight impact on carbon emissions in maximum in regions and countries, and in developed economies, the demand for facilities sharping the demand for services. Liu et al. (2017) examined the same situation in the case of China.

Additionally, as the industrial sector is different across countries, so the service sector effect varies on carbon emissions. Boutabba (2014) examined the causal association and the long-run effect of economic expansion, open trade, carbon discharges, and energy consumption on economic growth for India. Granger causality results confirmed that there exists uni-directional causality from financial growth, energy use, and carbon emissions. Hence, after taking into account the dissimilarities in industrial advantages and economic interactions over states; whether or not the significant rise in the service sector business gives a reduction in CO_2 had not the last result.

3. Data and Methodology

According to the study's data availability and objective, we used the panel of ASEAN[1] countries from 2000 to 2018. The variable is described in lists in Table 2.

Table 2
Data Description

Variable	Description	Unit	Source of Data
CO2	CO2 emissions	Kiloton (kt)	World Bank (2020)
GDPPCG	GDP per capita growth	Annual %	World Bank (2020)
RE	Renewable energy consumption	% of total final energy consumption	World Bank (2020)
SVA	Services, value-added	% of GDP	World Bank (2020)
POPD	Population density	people per sq. km of land area	World Bank (2020)

3.1. Theoretical Model and Construction of Variables

Based on the objective of the studies, the theoretical model has been designed as:

$$CO_2 = f\ (GDPPCG, RE, SVA, POPD) \quad (1)$$

The focus of the research is to check the effect of industrial growth and renewable energy consumption on environmental degradation because industrial growth, for example, railway industry or transportation industry, improved the growth level of the country that ultimately maximize the level of carbon emission which harm the environment (Nassani et al., 2017).

3.2. Econometrics Model

According to equation 1, the general model becomes:

$$\mathrm{CO2}_{it} = \alpha_o + \alpha_1 \mathrm{GDPPCG}_{it} + \alpha_2 \mathrm{RE}_{it} + \alpha_3 \mathrm{SVA}_{it} + \alpha_4 \mathrm{POPD}_{it} + \mu_{it} \quad (2)$$

[1] Brunei-Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam

3.2.1. Econometrics Estimation

In this research, we use the panel of ASEAN countries. There is a chance of endogeneity in the model to over endogeneity by Generalized Dynamic Methods of Movement (GMM) in the panel data. GMM also handle the problem of endogeneity in the model as well as the problem of autocorrelation and heteroscedasticity.

3.2.2. Generalized Method of Moment (GMM)

Generalized Method of Moment GMM is the estimation technique regularly used in panel data models. Panel data consists of time series and cross-sections, so there might be a chance of endogeneity in the data. Instrument variables minimize endogeneity. According to equation 2, our proposed model is as follow:

$$CO2_{it} = \alpha_o + \alpha_1 GDPPCG_{it} + \alpha_2 RE_{it} + \alpha_3 SVA_{it} + \alpha_4 POPD_{it} + \mu_{it} \quad (3)$$

While as reported by the GMM model, there might be a chance of autocorrelation, which might affect the results biasedness, so to over that problem, we used dynamic panel GMM in which used the lag of the dependent variable as the independent variable to handle the problem of autocorrelation and results become unbiased, so our model becomes:

$$CO2_{it} = \alpha_o + \alpha_1 CO2_{it,j} + \alpha_2 GDPPCG_{it} + \alpha_3 RE_{it} + \alpha_4 SVA_{it} + \alpha_5 POPD_{it} + \mu_{it} \quad (4)$$

As stated by the models, CO_2 Emission is the endogenous variable, and independent variables are lag of Co2 Emission, per capita growth, consumption of renewable energy, service value-added, and population density. Where i denotes the cross-section, and t represents the time period.

3.3. Data Sources

Annual panel data of 9 ASEAN states from 2000 to 2018 has been taken from the World Development Indicators (World Bank, 2018a).

4. Results and Discussion

Descriptive statistics are shown in Table 2, renewable energy resource and service sector growth foster in the environmental degradation level, CO_2 mean value is 10.918, and its lower value is 7.58. The upper value is 13.365, which means a higher value indicates the lousy environment, and a lower value indicates that a pleasant environment. The mean value of CO_2 indicates that ASEAN countries are precisely between the good and bad environment level, which means that the average environment of ASEAN countries is neutral. Same within the case of economic growth and service value addition.

Table 3
Descriptive-Statistics

Variable	Obs.	Mean	SD	Min	Max
CO2	171	10.918	1.576	7.589	13.365
GDPPCG	171	4.150	3.363	-3.702	12.788
RE	171	31.555	27.175	0.000	85.630
SVA	171	45.850	10.753	25.251	70.760
POPD	171	905.490	2169.803	63.219	7952.999

The general model is estimated by dynamic panel GMM econometrics methodology to overcome endogeneity and fix effect and further applied the model diagnostics like the Sargan test for instrument validity and bound test to check the autocorrelation in the model.

According to Table 4, per capita, income, and renewable energy resources diminished the carbon dioxide emission in ASEAN countries. At the same time, population density and service value-added boost the carbon dioxide emission level.

Table 4
GMM Results for ASEAN economies

Dependent variable: CO2				
Variable	**Coef.**	**Std.**	**Z**	**Prob.**
L.CO2	0.695***	0.052	13.250	0.000
C	3.535***	0.597	5.920	0.000
GDPPCG	-0.009**	0.004	-2.170	0.030
RE	-0.018***	0.003	-5.960	0.000
SVA	0.006*	0.004	1.660	0.097
POPD	0.000**	0.000	3.380	0.001
Model Diagnostics				
Prob > chi2				0.000
AR1				0.769
AR2				0.374
Sargan				1.000

Per capita income hurts the level of carbon dioxide emanations. It also means that as per capita income increases, it reduces CO_2 production from ASEAN countries. Consumption of renewable energy creates obstacles in the level of carbon discharge, according to Dong et al. (2017), who also verified that renew-able energy declines the level of carbon emission. This is because the increase in renewable energy consumption rates depends on reducing carbon emissions through energy restructuring. Reducing the burning of fogey power can immediately reduce carbon emissions (Pao & Tsai, 2010). GDP has a positive impact on carbon emissions.

In contrast, the square of GDP hurts carbon emissions. Hence it is confirmed that the members with high per capita income reduced the production of carbon dioxide. On the other hand, we say that the environmental EKC hypothesis is also confirmed in the case of ASEAN countries because we confirmed from the results the effect of income to carbon dioxide is negative. So, it concludes that ASEAN GDP helps in the enhancement in environment level. There are some studies where the EKC hypothesis is also valid (Bölük & Mert, 2014; Farhani & Shahbaz, 2014).

Renewable & nonrenewable energies have a positive influence on CO_2 productions in ASEAN countries. It also explains that renewable energies donate to improving the environment level. As the study agrees that renewable energies reduce carbon emission levels, states utilize a maximum of renewable energy, and the result is compatible with the (Al-Mulali, Ozturk, & Lean, 2015; López-Menéndez, Pérez, & Moreno, 2014; Shafiei & Salim, 2014). On the other hand, it contrasts with that of (Bölük & Mert, 2014). The coefficient of CO_2 emission is -0.018%, it shows that if there is an increase of 1% in NERC, which decreases the carbon emission by 0.018% annually. Furthermore, it concludes that increasing the consumption of the NERC level increase the growth of ASEAN countries within the presence of low-level carbon emission.

The service sector has a substantial and positive impact on carbon discharges, which means that the environment worsens as the value-added service sector increases. This result also indicates a slight increase in carbon emissions because of the expansion of the service sector. This coefficient is small but still worth the attention of policymakers. Al Mamun, Sohag, Mia, Uddin, and Ozturk (2014) explained that transportation and tourism increase carbon emissions. For example, railway boosts the carbon emission level and results in environmental degradation (Nassani et al., 2017). Researchers generally claim that the service industry has minimum material and intensive knowledge and less resource utilization (Perraton, 2006). Besides, the service industry is separated into less carbon production and high carbon production service sectors, and I thought that there was a big difference between the service industry development and development stages in other countries. Thus, the service industry has a straight and compound effect on reducing carbon emissions (Pappas, Chalvatzis, Guan, & Ioannidis, 2018).

According to Table 4, population growth has a significant and positive relationship with the environment's quality. Results indicate that population development has a vital and positive impact on the deterioration of the ASEAN states' environment. The results are similar to the estimates of (Ives & Messerli, 2003; Mink, 1993; D. Southgate & Pearce, 1988; D. D.

Southgate, 1988; Y.-J. Zhang, Jin, & Shen, 2018) also point out that dense areas produce more harmful gases to the environment which results worsen the environment. According to model diagnostics, the Sargan test designates that the tools used in the model are valid.

5. Conclusion

In the existence of cross-section independence and heterogeneity. This study used the dynamic panel Generalized Method of Movements (GMM) econometrics technique to overcome heterogeneity and fix effect by making the dynamic system. This study used 9ASEAN countries to estimate the influence of service and renew-able energy development on CO2 emission for the period of 2000 to 2018. Two important conclusions are drawn from the above results which are based on the conclusions/results mentioned above, the study also attempts to present some model/policy proposals to the national government.

First, much attention given to the continued use of renewable energy and more growth of renewable energy methods and facilities for the maximization and supplementation of renew-able energy technologies (Ruggiero & Lehkonen, 2017). At the same time, they are supposed to make some targets of renewable energy, powerful finance, and financial support; they fully cooperate with internationals on renewable energy in the fields of advancement, methods, and investment. Growth in the renewable energy sector is caused by the domestic consumption of renewable energy (Gu, Renwick, & Xue, 2018; Simonova, Zakrahov, & Mamiy, 2019). It is also necessary to gradually remove fossil fuels while balancing renewable energy with existing foggy fuels (Sasana & Ghozali, 2017).

Secondly, ASEAN countries need to modify their industrial sectors to the service sector according to domestic situations and the current situation of economic expansion. In the presence of high pollution, tremendous energy and most critical resource-intensive industries promoted their industrial level to the service sector for the betterment of economic and environmental conditions and performed for the supply side. It creates a right balance among the service and industrial sectors, where the industrial sector creates a high level of carbon emission, which creates environmental degradation from developing countries. At different stages, it also justified the association among economic development and environmental degradation.

Finally, ASEAN states are supposed to establish models/policies on industrial advice and monetary aid. It is necessary to strengthen support for the growth of the technology-intensive service industry and technological innovation to make improvements in the level of methods and ways within the entire industrial chain. Also, it is vital to concentrate on managing decarburization in the industrial chain to minimize the influence of nonrenewable energies like fossil fuel and instrument preservation management throughout the process to curb carbon emissions in the chain of service industry supply. Besides, policymakers in the ASEAN countries can take more severe measures to tighten environmental regulations in modern industries and oversee and punish polluting industries in service industries. Also, service sub-sectors with low carbon emissions (e.g., wholesale and commission transactions, real estate events, and financial intermediaries) can be encouraged to regulate total carbon productions. However, some service subdivisions produced a higher amount of carbon (i.e., transportation, hotels, restaurants, and tourism) must pay extra consideration whereas designing a policy pointed at reducing emissions.

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