

ASSESSING INDUSTRIALISATION AND URBANISATION IMPACT ON ENVIRONMENT SUSTAINABILITY IN MALAYSIA

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Abstract: The rapid industrialisation and urbanisation in Malaysia have led to significant environmental degradation, which presents a pressing issue for sustainable development. The rapid expansion of industries and a rising demand for urban infrastructure has led to the escalation of resource depletion, intensified waste production, and carbon emissions. Therefore, this study seeks to explore the dynamic impact of industrialisation and urbanisation on environmental degradation in Malaysia. This research paper aims to identify the key drivers of such ecological decline. Time series data from 1970 to 2018 was analysed using the Johansen Co-integration test. Findings indicated the negative effect of industrialisation on emissions. The findings implied that rapid industrialisation did not seem to have aggravated the environmental situation in the nation. This could suggest that possibility of transformation in the industry structure that is more inclined towards adopting sustainable environmentally friendly production. However, urbanisation has a statistically positive impact on pollutants and carbon emissions in Malaysia. This indicated that the urban population consumes more energy, which causes an uptick in carbon emissions. Additionally, findings from this article concluded the presence of a dynamic relationship among industrialisation, urbanisation, and environmental degradation. The implications from such finding could support policymakers with their efforts to design new policies that ensure sustainable urbanisation and industrialisation while promoting economic growth.

Keywords: Industrialisation, urbanisation, economic growth, environment, sustainable.

Introduction

The climate change and energy security crises have been a global issue that has persisted for decades. These issues have forced many countries, including Malaysia, to try and resolve several critical environmental challenges. There is no doubt that these challenges will continue to threaten the sustainable development and impede the country's progress, especially in its attempts to achieve the 17 United Nations Sustainable Development Goals (SDGs). As a result, it has become increasingly critical to answer the question: What are the contributing factors that exacerbate environmental degradation in Malaysia?

Countries were discovered to have taken extraordinary measures to restrict the rise of carbon emissions in response to increasingly severe global warming (Wang *et al.*, 2018). Rapid industrial development and urbanisation over the last two decades has given rise to an increase in the variety and quantity of toxic and hazardous waste materials in Malaysia (Abdullah, 1995). This has certainly supported the need for an assessment to be carried out with regards to the dynamic long-run relationship between urbanisation and industrialisation in the effort to promote sustainable development.

The process of urbanisation and industrialisation is accelerating in tandem with the rapid growth of the national economy. Sun *et al.* (2018) identified urbanisation as the key driving factor for economic growth. The core of urbanisation is found in people's movement towards urban areas. Urbanisation facilitates economies of scale, as it improves efficiency in the labour market, and promotes innovation by fostering concentrated networks of knowledge and expertise. This concentration creates a favourable environment for industries to prosper. It has been argued that the rapid growth of urbanisation may lead to an increase of congestion and eventually higher deterioration of environmental conditions.

The phenomenon of urbanisation, along with the expansion of the populace and the rise in individual household consumption is anticipated to play a critical function in the escalation of indirect emissions (Liu *et al.*, 2011). Hence, Liang and Yang (2018), Sun *et al.* (2018) and Yuan *et al.* (2019), have conducted analysis that depicts how the population density in urban areas contributes to environmental degradation. However, although prior studies had examined the link between urbanisation and carbon emission, a consensus on the matter has proven elusive (Azam & Khan, 2015).

Aside from urbanisation, the process of industrialisation could also have costly implications on the environment. In the effort to boost industrial output and expand the economy, many countries may have neglected to consider environmental conditions when planning their growth strategy. Industrialisation, which involves the growth of manufacturing and infrastructure, enhances productivity, generates employment, and results in higher income levels. Additionally, it aids urbanisation by drawing residents of rural areas to urban centres in search of better job prospects. These processes work together synergistically to expedite economic growth, boost the national Gross Domestic Product (GDP), and enhance living standards.

According to Mahmood *et al.* (2020), the environment and the carbon footprint remained

the most notable elements of an economy that are susceptible to being adversely impacted by industrialisation. Many past studies such as those done by Raheem and Ogebe (2017), Liu and Bae (2018), Wang *et al.* (2019), Li *et al.* (2019), Anwar *et al.* (2020), Kahouli *et al.* (2022), Talib *et al.* (2022), Vo *et al.* (2024), and Thanvisitthpon *et al.* (2024) were conducted to investigate the relationship between environmental quality and industrialisation. However, these findings failed to reach a consensus with each having conflicting results.

In view of the mixed findings of the available literature, this article has attempted to fill in the gap by exploring the joint effects of industrialisation, urbanisation, and economic growth on pollution levels. As Malaysia is transitioning into a high-income economy underpinned by industrialisation and urbanisation, this shift away from the agricultural sector has led to escalating concerns on the environmental impact. With the limitations imposed by a more localised context, the Malaysia specific focused analysis provides a useful insight that explains the dynamic interactions between industrialisation, urbanisation, and sustainability. Unlike past studies, this study will also examine the dynamic impact of industrialisation and urbanisation on environmental degradation by formulating a new model through integration of multiple theories.

Therefore, the contributions of this finding will be threefold. Firstly, this study conducted a comprehensive examination of industrialisation and urbanisation, which are closely related. Secondly, given the accelerated economic growth undertaken by the country, this study will also examine joint relationship between industrialisation, urbanisation, and economic growth on environmental degradation. And last but not least, multiple theories that were derived from the study of the available literature was adapted and used to create a more relevant model that will be applicable for a country-specific study, focused on Malaysia.

These research findings will contribute significantly by uncovering the effects of rapid urbanisation and industrial expansion on the environment, urging policymakers to prioritise eco-friendly industrial policies for long term sustainability. Additionally, these findings could provide valuable insights for environmental challenge mitigation and promoting a more sustainable future in Malaysia.

Literature Review

According to the Environmental Kuznets Curve (EKC) theory, economic advancement has the potential to ameliorate environmental degradation after an economy attains a sufficient threshold of economic development. In the initial phases of economic expansion, characterised by a predominance of primary production, there exists a surplus of natural resource stocks and a minimal generation of waste due to the restricted scale of economic activities. Throughout the trajectory of development and as a consequence of industrialisation, there is a notable depletion of natural resources accompanied by the accumulation of waste products (Kaika & Zervas, 2013). With continued economic progression, the advancements in technology, the dissemination of information serves to constrain the material underpinnings of an economy, thereby facilitating a decline in environmental degradation (Panayotou, 2013).

In relation to the effects of urbanisation on environmental pollution when examining the urbanisation-pollution nexus, there were three existing theories that could be examined (Poumanyong & Kaneko, 2010). Firstly, the compact city hypothesis claims that as the population of a city grows, economies of scale for public facilities and energy production grow, reducing the environmental impact. Secondly, according to the ecological modernisation hypothesis, urbanisation is a social restructuring process that encourages a structural shift from an industrial to service economy, hence, reducing negative environmental impact indirectly. Thirdly, the urban environmental transition theory indicated the rising pace of

urbanisation will lead to increasing demand for energy consumption, which in turn raises the environmental degradation.

Voluminous empirical research looked at the economic growth-pollution hypothesis using various econometric methodologies, samples, and time spans. Previous research findings have shown a positive correlation between the GDP of a nation and its carbon footprint, suggesting that as the GDP of a country increases, so does its carbon emissions. The growth-pollution nexus is frequently discussed using the well-known Environmental Kuznets Curve (EKC) theory (Kuznet, 1955). The EKC theory states that environmental deterioration results from earlier stages of development. At certain level of income, pollution levels fall. It is also depicted as inverted U-shaped relationship. To date, there have been many studies which support this theory. Furthermore, the Environmental Kuznets Curve has been applied as approval means of explaining environmental conditions in countries like North Africa (El Menyari, 2021), Pakistan (Hassan *et al.*, 2015), and Indonesia (Sugiawan & Managi, 2016).

However, evidence from single country empirical studies on the EKC theory produced mixed results. In one of the findings, Halliru *et al.* (2020) for West African nations confirmed the U-shaped relationship between CO₂ emissions and economic growth in low, intermediate, and high emission countries opposing the inverted U-shaped EKC hypothesis. Meanwhile, Ahmada *et al.* (2016) concluded a strong positive linkage found between CO₂ emissions and the GDP in Malaysia. Dogan and Turkekul (2016) refutes the EKC theory's applicability to the United States during the period between 1960 and 2010. Their study claimed that the promotion of GDP will raise environmental degradation. Similarly, economic growth significantly raises CO₂ emissions as indicated in a study conducted at China (Kongkuah *et al.*, 2021).

Meanwhile, in Africa, economic expansion had a negative impact on the CO₂ emissions, albeit the effect varied by region and income level (Namahoro *et al.*, 2021). According

to Nikensari *et al.* (2024), the economies of the Association of Southeast Asian Nations (ASEAN) nations experience declining intensity profit economically from the rising carbon emissions.

Furthermore, according to Marsiglio *et al.* (2016), Yassin and Aralas (2020), the positive relationship in the first stage of EKC hypothesis may be due to the process of industrialisation and urbanisation. According to the findings of both research papers, the industrialisation process and the growth of urbanisation cause the environment to deteriorate in the early stages of development. On the contrary, Saboori *et al.* (2016) and Yun (2021) suggested that over time, a decline in carbon emissions is expected to result from Malaysia's increased economic growth. This is in line with the Environmental Kuznets Curve (EKC) hypothesis and supports the significant positive effects of economic growth on environmental health and well-being in the long run.

Yang *et al.* (2021) discovered significant rise in CO₂ emissions occur as the manufacturing sector grows. Meanwhile, Ali *et al.* (2021) examined the linkage between fossil fuel usage, industrial advancement, and CO₂ emissions in Vietnam. Their finding shows the causality that runs between industrial growth and CO₂ emission in both short run and long run. Howbeit, Sung *et al.* (2018) evidently indicated that industrial GDP and clean production can significantly improve the environment as demonstrated by census data gathered from the Chinese manufacturing sector. In another study by Li and Lin (2015), the industry sector showed varying impact of environmental degradation based on the income levels of these nations. This revealed that industrialisation increases CO₂ emissions in the low-income groups, but insignificant results were found for both the middle- and high-income groups.

Empirically, urbanisation has been demonstrated to be one of the most significant drivers to worldwide environmental degradation. Ali *et al.* (2019) analysed the impact of urbanisation on carbon emissions in Pakistan

using the Autoregressive Distributed Lag (ARDL) method. According to their research, Pakistan's urbanisation increased emissions over both the short and long run. Liu and Bae (2018) examined the effects of urbanisation, industrialisation, economic growth, and energy consumption on CO₂ emissions in China. Their study used both ARDL and a Vector Error Correction Model (VECM) to determine the short run and long run effects, as well as its causal direction from 1970 to 2015. The outcome demonstrated that China's carbon emissions were boosted by both urbanisation and industrialisation.

Interestingly, in panel settings, few studies such as that by Huo *et al.* (2020) who used the Stochastic T Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model for China's 30 provinces demonstrated the negative effect of urban populations on carbon emissions. This finding was consistent with Wang *et al.* (2021), which indicated that developed countries are known to exhibit similar adverse effects of urbanisation on carbon emissions. With these inconsistent results, several empirical studies also explored the urbanisation and carbon dioxide emissions in inverted-U shape relationship framework. A recent study by Zhang *et al.* (2021) revealed an inverse U-shaped association between carbon emissions and urbanisation in China from 2008 to 2017. Similarly, Bekhet and Othman (2017) pointed out inverted U-shaped association between urbanisation and CO₂ emissions in Malaysia.

Issue of rising pollution levels in Malaysia have piqued the curiosity of scholars who want to learn more. The lack of a comprehensive analysis that considers the intricate interactions among the factors has motivated this research. While studies have distinctly examined the individual effects of industrial, urban, and economic growth on the environment (Ehigiamusoe, 2023; Bi *et al.*, 2024), there is a lack of research that integrates these variables to understand their combined effect on environmental quality. Existing studies have shown that economic

growth and urbanisation can have negative implications on the environment, leading to increased emissions (Ridzuan *et al.*, 2023; Ramli *et al.*, 2023).

However, there is a need for a more holistic approach that considers the interplay between industrialisation, urbanisation, and economic growth to develop effective policies that promote sustainable development while mitigating environmental degradation (Awan *et al.*, 2022).

To the best of our knowledge, studies focused on Malaysia's industrial sector and the urbanisation effect on the environment are still limited. Through the integration of multiple relevant theories extracted from the literature, a new framework was created specifically for analysis in Malaysia. Therefore, the present paper seeks to address the research gaps of the past literature by developing a new framework that integrates multiple theories to evaluate the environmental impact of urbanisation and industrialisation in Malaysia. In addition, the findings of this article will provide new insights that fit the local context and to explicitly link these findings to practical policy recommendations.

Methodology

The model for the analysis was developed through the integration of a few underpinning theories consisting of Environmental Kuznets Curve (EKC) theory, Ecological Modernisation theory, Ecological Urbanisation theory, and Urban Environmental Transition theory. The new model will be employed to empirically explore the dynamic link between urbanisation, industrialisation, and environment degradation in the long run. The relevant data on Malaysia's urbanisation, industrialisation, and environment was retrieved from the World Bank database for the period between 1970 and 2018.

Urban Environmental Transition theory postulated that cities tend to face many environmental problems with urbanisation. Meanwhile, the Ecological Urbanisation theory advocated the relationship between emissions

and urbanisation, assuming that urbanisation may effectively increase environmental problems. According to Bekhet and Othman (2017), urbanisation has transformed the society to prioritise raising their level of income rather than working on environmental sustainability. The increase of income levels among the society will lead to an increase in demand for energy consumption, which likely will cause more pollution.

On the other hand, the Ecological Modernisation theory pointed out the non-linear link between industrialisation and the environment. It was expected that the initial industrialisation would lead to increase of environmental problems. However, these problems tend to decline in the long run with green technologies being introduced and an increase in public awareness of environmental sustainability (Majeed & Mazhar, 2019). This relationship supports the environment conservation hypothesis regarding the impact of industrialisation, which aligns with the argument in favour of the Environmental Kuznets Curve (EKC) theory.

Environmental Kuznets Curve (EKC) theory hypothesised an inverted U-shaped relationship between environment degradation and economic growth. Growth in economy causes more greenhouse gas emissions, worsening the environment (Ahmed *et al.*, 2021). At the early economic growth stage, the increase of economic activities with the increasing demand has led to a negative impact on the environment. At the subsequent growth stages, the economic structure will experience a transformation and the society will become more inclined towards environmentally friendly activities.

These theories formed the theoretical underpinnings behind the relationship between urbanisation, industrialisation, economic growth, and the environment. As such, the variables of industrialisation (IND), urbanisation (URB), and real Gross Domestic Product (GDP), which correspond to the underlying theories were selected for analysis. As in most environmental studies, this study will also use emissions

as the means of measuring and indicating environmental degradation. Table 1 shows the variables description. The development of the empirical model can be designed as follows:

$$CO_{2t} = f(IND_t, URB_t, GDP_t) \tag{1}$$

where CO_2 : carbon emissions, IND : industrialisation, URB : urbanisation, GDP : real Gross Domestic Product.

All the series will be transformed into logarithmic form before regression estimation was done. Bano *et al.* (2018) claimed that compared to simple linear approaches, log-linear can yield better efficient results. Thus, the empirical model was rewritten into the following:

$$\ln CO_{2t} = \beta_0 + \beta_1 \ln IND_t + \beta_2 \ln URB_t + \beta_3 \ln GDP_t + \varepsilon_t \tag{2}$$

where t : time period, ε : error term.

The unit root test of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were first conducted to assess the stationary of the data. With the support from these unit root tests, the Johansen Co-integration test can be employed to determine the long run relationship. The integration test is necessary to avoid spurious regression. The data must be stationary so that the Johansen Co-integration test can be carried out (Yun & Yusoff, 2018). Johansen test has several advantages such as its ability to deal automatically with problem of choosing a normalisation and guards against inconsistent

estimation of the cointegrating relationships by incorporating knowledge that there is more than one cointegrating vector (Kennedy, 2008). Various diagnostic tests were performed to validate the model’s results, confirming that the proposed model is structurally stable, having no normality and serial correlation issues or heteroscedasticity disturbance.

Results and Discussion

Table 2 and Table 3 portrayed the unit root tests for both ADF and PP, respectively. Results from both tests clearly indicated that all the series were found stationary at the first difference. These results provide support for Johansen Co-integration test to be employed.

Since all series are stationary at the first order I (1), Johansen Co-integration test can proceed to confirm the co-integrating relationships. The lag order selection test is displayed in Table 4. Meanwhile, Table 5 and Table 6 depicted Johansen Co-integration test (Trace) and Johansen Co-integration test (Max Eigenvalue) results, respectively.

The lag selection suggested lag order 1 as the selected optimal lag length. The finding based on Johansen Co-integration test validates the cointegrating relationship within the model. Based on the normalised cointegrating coefficients as shown in Table 7, a significant negative long run relationship was found between industrialisation and environment

Table 1: Sources of data

Variable	Description	Unit	Source
Carbon Dioxide Emissions (CO ₂)	The emissions of carbon dioxide are caused by burning fossil fuels.	Kiloton	WDI
Industrialisation	The net output or value added in the mining, manufacturing, building, gas, water, and electrical industries.	Ringgit Malaysia	WDI
Urbanisation	Urban population are the number of people residing in urban areas.	Annual Percentage (%)	WDI
Real Gross Domestic Product (GDP)	Total gross value added by all the economy’s resident producers.	Ringgit Malaysia (Constant 2010)	WDI

WDI: World Development Indicators.

Table 2: Augmented Dickey-Fuller (ADF) test result

Variables	Level Intercept	First Difference Intercept
LN	-1.739981	-9.016931*
LNIND	-1.437161	-8.415718*
LNURB	0.519987	-4.909662*
LNGDP	-2.357533	-5.731176*

*Significant at 1% significance level.

Table 3: Philip-Perron (PP) test result

Variable	Level Intercept	First Difference Intercept
LN	-1.824293	-8.968631*
LNIND	-1.536609	-15.50470*
LNURB	0.974472	-4.894126*
LNGDP	-2.319046	-5.692549*

*Significant at 1% significance level.

Table 4: VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	170.2148	NA	7.28e-09	-7.387326	-7.226733	-7.327458
1	417.2189	439.1183*	2.54e-13*	-17.65417*	-16.85121*	-17.35484*
2	426.1933	14.35901	3.53e-13	-17.34192	-15.89659	-16.80312
3	437.3497	15.86696	4.59e-13	-17.12665	-15.03895	-16.34838
4	450.1839	15.97142	5.78e-13	-16.98595	-14.25588	-15.96821

*indicates lag order selected by the criterion (each test at 5% level).

Table 5: Johansen Co-integration test (Trace)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.488471	49.87920	47.85613	0.0319
At most 1	0.213555	18.37266	29.79707	0.5387
At most 2	0.108047	7.081753	15.49471	0.5681
At most 3	0.035682	1.707687	3.841465	0.1913

Trace test indicates 1 co-integrating eqn(s) at the 0.05 level.

*denotes rejection of the hypothesis at the 0.05 level.

Table 6: Johansen Co-integration test (Max Eigenvalue)

Hypothesised No. of CE(s)	Eigenvalue	Max Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.488471	31.50654	27.58434	0.0148
At most 1	0.213555	11.29091	21.13162	0.6183
At most 2	0.108047	5.374067	14.26460	0.6941
At most 3	0.035682	1.707687	3.841465	0.1913

Max-eigenvalue test indicates 1 co-integrating eqn(s) at the 0.05 level.

*denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon-Haug-Michelis (1999) *p*-values.

Table 7: Normalised cointegrating coefficients

Dependent Variable	Independent Variables		
LN	LNIND	LNURB	LNGDP
Coefficient	-1.170577	0.577238	0.117013
Standard Error	0.16225	0.14691	0.16908
t-statistic value	-7.21465*	3.929195*	0.6921

*Significant at 5% significance level.

pollution. Hence, implying that the increase of industrialisation could lead to the decline of emissions in the long run. This finding was consistent with Zhou *et al.* (2013) that suggested adjusting the industrial structure can successfully lower emissions. Zhou *et al.* (2013) also emphasised how crucial it is to advance technology and maximise advancement in order to trigger structural changes in industry and create a green economy. The empirical finding from this study was similar to Raheem and Ogebe (2017), which provided robust support to the favourable environmental impact of industrialisation.

Moreover, the findings of this study also indicated a significant positive relationship between urbanisation and emissions in the long run. The determined relationship reflected significant positive effect between rapid urbanisation and the environment degradation. The growing urban population leads to increasing demand for energy consumption, which leads to more pollutants being released. This finding corroborates those of Pata (2018), Sushinsky *et al.* (2013), Shahbaz *et al.* (2014), Farhani and Ozturk (2015), and Wang *et al.*

(2020). The consumption was likely to be higher for urban populations, which indirectly causes relatively higher carbon emissions. According to Tan *et al.* (2020), the estimations from the International Energy Agency (IEA) highlighted urbanisation as a major contributor to energy-related global carbon emissions.

However, empirical results pointed out an insignificant negative relationship between economic growth and pollutants emissions in the long run. This could suggest that Malaysia's economic growth will likely cause a fall in the level of emissions in the long run. However, the result was insignificant to provide robust support to the Environmental Kuznets Curve (EKC). According to Grossman and Krueger (1991), economic growth affects the environment quality via three different growth stages. At the initial and early growth stages, the increase in economic activities is likely to worsen the environmental degradation. In the second stage, the economy's structure would start to transform and this stage becomes the turning point for the inverted U-shaped hypothesis based on the EKC theory. At the third stage, there will be increasing adoption of green and eco-friendly technologies

in the production processes, which would lower CO₂ emissions.

Table 8 reported the diagnostic tests results that were carried out to ensure that the model was structurally stable, has no heteroscedasticity, and serial correlation problem. The Breusch-Godfrey serial correlation LM test indicated that there was no serial correlation problem. Meanwhile, both Breusch-Pagan-Godfrey heteroscedasticity test and ARCH heteroscedasticity indicated that the model is also free from heteroscedasticity. Meanwhile, the Jarque-Bera test indicated that the errors are normally distributed. Both CUSUM (Figure 1) and CUSUM square (Figure 2) were found to be within the 5% critical bands, clearly illustrating that the model was structurally stable.

Discussion

Findings from this study has highlighted the significant impact of industrialisation and urbanisation on the environmental degradation in Malaysia. As indicated by the Johansen Co-integration test result, industrialisation appeared to negatively impact the environmental degradation. This signified that the rapid industrialisation efficiently lowered carbon emissions rather than intensified it in the long run. Such a finding was consistent with the Environmental Kuznets Curve (EKC) theory, which postulated that the expansion of industries in the early stages tends to worsen the environmental degradation. However, the introduction of innovation at the later stage will arrest or improve environmental degradation

Table 8: Diagnostic tests results

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	1.301537	Prob. F(1,40)	0.2607
Breusch-Pagan-Godfrey Heteroskedasticity Test			
F-statistic	1.286379	Prob. F(8,38)	0.2796
ARCH Heteroskedasticity Test			
F-statistic	0.026696	Prob. F(1,44)	0.8710
Jarque-Bera Test			
Jarque-Bera	0.642472	Prob.	0.725252

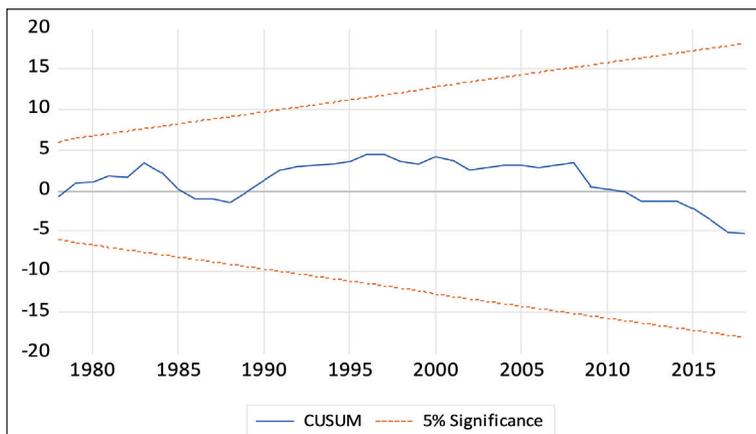


Figure 1: CUSUM plot
Source: Generated from EViews

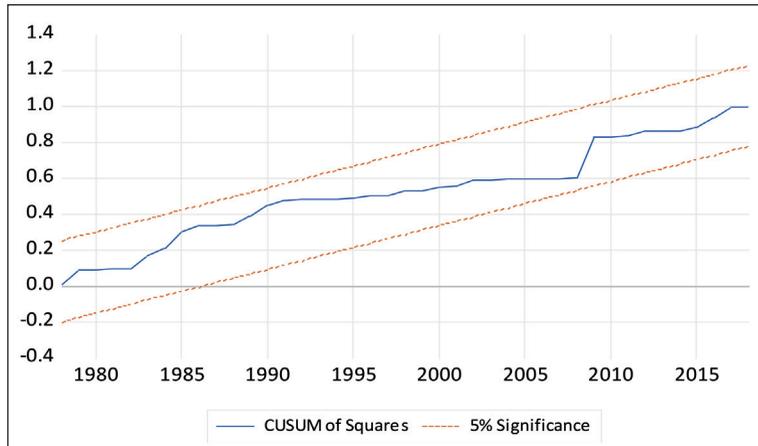


Figure 2: CUSUM of squares plot
Source: Generated from EViews

instead. This finding was consistent with Zhou *et al.* (2013) and Raheem and Ogebe (2017) that posited a favourable correlation between environmental impact and industrialisation in the long term.

A contradictory finding was seen in regard to urbanisation overall. The empirical finding of the Johansen Co-integration revealed that urbanisation has a positive significant impact on the environmental degradation. This implied that rapid urbanisation would raise the carbon emissions eventually. Such findings can be well explained by the growing population density in urban city centres which drive up demand for resources. This results in the rapid depletion of resources and a corresponding increase in waste generation that contributes to the environmental degradation. This explanation is in line with the Urban Environmental Transition Theory that explains how environmental challenges evolve as cities develop economically and socially. The result of this finding is therefore consistent with the Urban Environmental Transition Theory that highlights how urbanisation has transformed the scale and escalated the environmental problems in the long run.

In short, the findings that highlight a positive significant relationship between urbanisation and environmental degradation it also seems to suggest that urban growth in

Malaysia is exerting significant pressure on its natural resources and contributing to multiple environmental issues. This could imply that the existing current policies may have to struggle to keep pace with the expansion of the urban population.

Some policy recommendations that this study would like to propose includes the introduction of policies that advocate for the use of green energy consumption and green innovation development that promotes the urban growth sustainably. From the industrial perspective, a circular economy practice should be promoted and a close collaboration should be fostered between the government, industries, and urban planners in supporting a sustainable and balanced development.

Conclusions

The central aim of this study was to empirically explore the dynamic relationship between industrialisation, urbanisation, and environment degradation in Malaysia. Inconclusive findings in the available literature has motivated this study to continue uncovering the relationship. Furthermore, increasing concerns regarding the issue of environmental degradation due to climate change calls for an immediate need to analyse the joint effects of industrialisation,

urbanisation, and economic growth on the environment. The Johansen cointegration results indicated the existence of Co-integrating relationship among the variables. Rapid industrialisation in the long run is leading to the decline of emissions as reflected by the positive finding.

A statistically insignificant negative relationship between economic growth and carbon emissions was empirically proven. Thus, implying that economic advancements with continuous development simultaneously improve environmental quality in the country over the long run. However, the insignificant finding was not able to support the EKC hypothesis in the long term. Meanwhile, the environmental impact of urbanisation was found to be significant and positive. Rapid urbanisation would lead to an increase in the consumption of resources by the growing urban population, which would lead to a decline in environmental quality. These results are in line with the urban environmental theory which suggests various environmental issues, whether domestic or global, emerged following the rise of urbanisation. However, this conflicts with the ecological modernisation theory, which argued that urbanisation could improve the environment when there is an increase adoption of eco-friendly lifestyle by the urban population in the long term.

This study contributes to filling the gap in the available literature by providing a new insight of the distinct impact between industrialisation and urbanisation to environment degradation in the long term. The results of this study supports the hypothesis that urbanisation exacerbates environmental pollution. However, the same cannot be said for industrialisation. The plausible findings will provide useful insight for the development of sustainable urban development policy and environmental policy that promotes the use of green energy in near future. In addition, a prudent urban planning policy is necessary to help in reducing carbon emissions as more of the population moves from the rural to urban areas. Meanwhile, the negative impact of industrialisation and consequential

environment degradation suggests that there is a need for an effective transformation from high emissions industries to green industries in the long run.

The findings of this study would suggest that the government could rethink the sustainability of the current existing policies in the promotion of circular economy development. For instance, the government can consider promoting green industrial practices among the industries by introducing policies that support the development of green technologies. Green technologies play an important role as they strengthen the circular economy's role in addressing global environmental concerns by increasing its ability to decouple economic activity from the use of finite resources (Yun *et al.*, 2023). Hence, the expansion of the green technologies adoption by both industries and the urban populations are imperative to shift towards a sustainable development with reduction of the overall environmental impact.

Additionally, the knowledge advanced by this article will provide support for future studies to be conducted given that the finding of this article was limited to country specific study and constrained to a limited time frame from between 1970 and 2018. Future studies can build upon the framework developed by this study and extend it to analyse the impact of industrialisation by sectors and the impact of urbanisation by cities. This will provide deeper insights for policymakers to develop strategies that will be context specific according to the respective sectors and cities.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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