Geojournal of Tourism and Geosites
ISSN 2065-0817, E-ISSN 2065-1198

Year XVII, vol. 53, no. 2, 2024, p.522-527
DOI 10.30892/gtg.53215-1227

THE EFFECTS OF AIR POLLUTION ON TOURISM IN THAILAND

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Citation: Nonthapot, S., Sihabutr, C., & Lean, H.H. (2024). THE EFFECTS OF AIR POLLUTION ON TOURISM IN THAILAND. *Geojournal of Tourism and Geosites*, 53(2), 522–527. https://doi.org/10.30892/gtg.53215-1227

Abstract: Air pollution not only affects people's health but also tourism especially in Thailand because it is the most important industry in Thailand. Therefore, this research aims to examine the effects of air pollution on the number of tourists using particulate matter (PM10) data as the proxy for air pollution and the number of tourists staying at accommodation establishments in the province as the agent of the number of tourists (Tourist). Furthermore, the effect of the price of tourism factor represented by the consumer price index (CPI); and the weather factor with indicators such as rainfall (RAIN) and highest temperature (TMAX), on the number of tourists were also considered. The research data were panel form, and the cross-section data were collected from seven significant tourist provinces representing each region with the time series during March 2018 to December 2021. These data were tested for cross-section dependence and the panel unit root test. After that, the long- and short-term relationships were detected by using the panel autoregressive distribution lag (Panel ARDL) model with the pool mean group (PMG). The findings revealed that the increase of PM10, CPI, TMAX and RAIN reduced the number of tourists.

Keywords: Air pollution, tourism, panel autoregressive distribution lag, Thailand, JEL: Z3; Q5

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INTRODUCTION

Thailand is a popular destinations visited by international tourists from all over the world. Before the Coronavirus disease (COVID-19) pandemic in 2019, up to 40 million tourists visited the country. However, many regions in Thailand have also suffered from air pollution, particularly from particulate matter (PM) caused by many factors, including the burning of agricultural waste, transportation, and the industrial sector (Kanjanasiranont et al., 2022). Furthermore, the pollution that moves from its origin to other regions due to air currents has become harmful to health (Mebrahtu et al., 2023) and is likely to have a negative effect on Thailand's tourism in the long term.

In 2019, almost 40 million international tourists visited Thailand because of various natural, historical, artistic, and cultural sites, as well as aspects of modernity that fulfill tourist demand. Chiang Mai (Northern region), Nakhon Ratchasima (Northeastern region), Chon Buri (Eastern region), Surat Thani (Southern region), Kanchanaburi (Western region), Phra Nakhon Sri Ayutthaya (Central Region), and Bangkok (capital city) were the main destinations in each region that tourists visited. there was around 17 million international tourism who visit in these provinces or 43 percent of total international tourism in 2019 (Ministry of Tourism and Sports, 2023). However, the quality of life of Thai people and international tourists staying in Thailand has been affected by air pollution in many areas. This has been an ongoing issue that is worsening due to the burning of agricultural waste after harvest as it offers a quick and convenient preparation of farming plots. There is also much pollution caused by the industrial and transportation sectors (Teerasuphaset, 2024). In particular, PM2.5-10 (PM10) microns, which are visible in large amounts, and PM particles of less than 2.5 microns (PM2.5) which are macroscopic, are extremely dangerous and harmful to living things (Wang, 2021). To make matters worse, the problem has spread to broader areas via air currents resulting in negative impacts (Manisalidis et al., 2020).

Regarding the health effects, there is a study reveals the negative effect of PM on the cardiovascular mechanism in humans, such as causing acute myocardial infarction, coagulation, and platelet problems (Anderson et al., 2012). Increasing PM in the short term has increased the number of patients with ischemic heart disease and heart failure. In addition, long-term impacts were noted as evidenced by the positive relationship between exposure to PM and death from lung cancer and cardiopulmonary disease (Anderson et al., 2012). In addition to pollution, the number of international tourists was impacted by other related factors, especially economic factors, such as the real exchange rate, transportation costs, relative price, gross domestic product (GDP) in the country (Praditthong et al., 2022), and capital investment (Nonthapot, 2017). Some factors reflect the demand side and include the real exchange rate, transportation costs, and relative price, which affects the cost of vacations. At the same time, the falling GDP of the country reflects the influence of falling tourist income.

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Thailand's tourism sector grew from 2000 until the start of COVID-19. The lockdown to control the pandemic significantly reduced the number of tourists. Nevertheless, after the country was reopened in 2022, Thailand's tourism sector started recovering. However, the PM issue still affects the number of tourists. Additionally, the study of such issues in Thailand is not inclusive, so this research was extended to other regions in the country to support policymakers in regard to the control of PM10 sources to reduce PM10 emissions and to promote tourism. This research aims to study the effects of PM10 on tourism in Thailand by considering the Tourism price based on the Customer Price Index (CPI) and the weather factor by including the highest temperature and rainfall by using panel data from March 2018 to December 2021 in the following popular tourist destinations: Chiang Mai (North), Nakhon Ratchasima (Northeast), Chon Buri (East), Surat Thani (South), Kanchanaburi (West), Phra Nakhon Sri Ayutthaya (Central), and Bangkok (Capital).

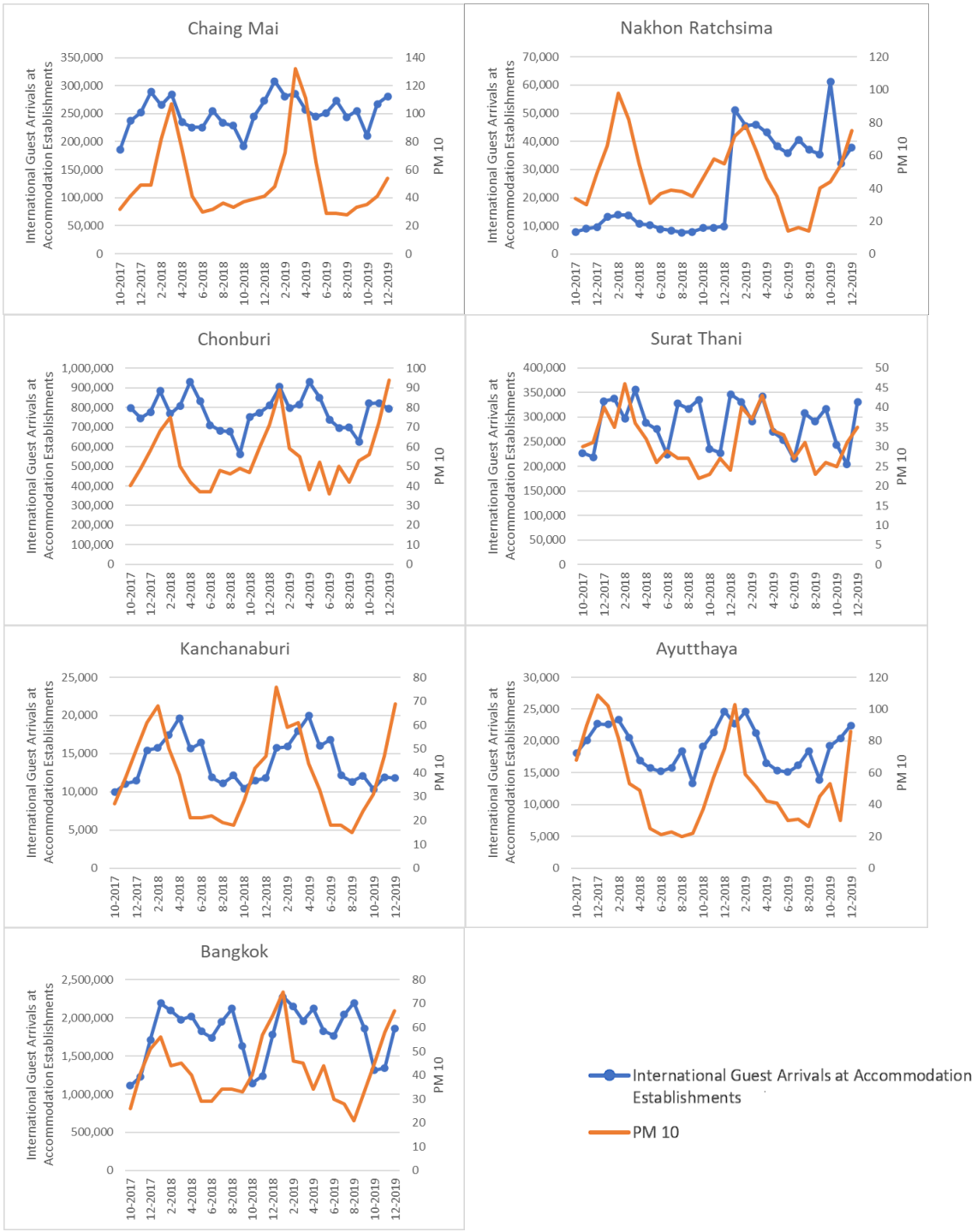

Figure 1. Relationship between the amount of PM10 in the significant provinces in each region and the number of international tourists residing at the accommodation establishments in each province (Source: The figures are created by the authors; Data Source: Ministry of Tourism and Sports (2023) and Pollution Control Department

LITERATURE REVIEW

Nowadays, tourism industry is one of the most important sectors of Thailand. However, many provinces in Thailand as

the tourism destination face the environmental problem that will affect on the attraction components especially air pollution which not only harmful the health but also may obscure the tourism destination scenery. Eusébio et al. (2021) concluded the impact of air quality on tourism demand that it was reflected by two aspects. The first aspect is related to tourism behavior, tourism intention, decisions on selecting a tourist destination, quality of life, tourist satisfaction, and the image of the tourist destination. The second aspect is related to global tourism demand, which is negatively affected by air pollution.

In the linkage of air pollution and tourism behaviour, Wang et al. (2023) found the positive effect of Air Pollution Index disclosure on real tourism income per capita and tourist reception per capita which imply the important of air pollution information on the tourist demand. Conform with the Nguyen (2019) study which revealed the negative impacts of air pollution on the total number of tourist arrivals, especially the impact of nitrous oxide emissions from using fossil fuels for transportation and the Su and Lee (2022) study who found the influence of air quality on the number of tourist arrivals exhibits heterogeneity by the evidence that middle-income countries, low-income countries, high concentrations of PM2.5, and countries with less numbers of tourists have negative effects on tourist arrivals in neighboring countries but the contrary groups have positive effects on tourist arrivals. Moreover, the study also found the countries with higher research and development intensity have better air quality and thus attract more tourists. In Thailand, the study in Chiang Mai province of Praditthong et al. (2022) revealed that PM 2.5 was related to the number of tourists arriving in Chiang Mai in the form of a nonlinear effect. The increasing of PM2.5 decreased the number of tourists in Chiang Mai if the volume of PM 2.5 was over 36.835 micrometers or the quarterly average of Chiang Mai. Nonetheless, the number of tourists and the amount of PM 2.5 were found to be positively related if the volume of PM 2.5 was under 36.835 micrometers. According to these results, this may imply the negative effect of Air pollution on the tourism demand.

More than the air pollution, there are many environment factors such as the Rainfall and Temperature which may be effect on tourism demand. In the case of Rainfall, the number of visitors to Jeju Island was positive effected by the rainfall in Korean tourist (Bae and Nam, 2020). In contrast, there was negative effect of the rainfall on the number of tourist arrivals in the Small Island Developing States (Fauzel, 2019). These studies imply that there is the difference impact of the rainfall on tourism demand in each country. For a while, in the case of temperature, there was a several type of the effect of temperature on the tourism demand. Bae and Nam (2020) study found that the average temperature had a positive impact on tourism demand among Southeast Asian tourists to Jeju Island. In Kazakhstan, Ibragimov et al (2022) found the optimal temperature of international tourists visiting Kazakhstan is obtained at 7°C, moreover, international tourists prefer to travel to Kazakhstan at a moderate temperature, that is neither too hot nor too cold. For a while, there was negative effect of temperature on the number of international tourisms in Indonesia (Susanto et al., 2020).

Besides the environment factors, the tourism demand may be considered by macro factors, such as CPI which usually use as the relative price in the tourism which usually be negative effect on the tourism demand. As the study of Nguyen (2022) in Vietnam which adapted the CPI as the relative price and found the negative effect of the factor on the tourism demand into Vietnam. Conform with the study result of Praditthong et al. (2022) who found the negative effect of the relative price which be adapted by CPI on the tourism demand in Chain Mai. According to the above, although the studies on such issues was beginning to gain widespread attention in the impact of environmental factors on tourism especially in Chiang Mai, the impact has not yet been extended to other major tourist provinces in Thailand.

METHODOLOGY

This research examines the effects of air pollution on the number of tourists in Thailand by considering the PM10 in each province and the number of international tourists staying in the accommodation establishments in each province by using panel data which comprised cross-section data from the most popular destinations for tourism in each region such as Chiang Mai (North), Nakhon Ratchasima (Northeast), Chon Buri (East), Surat Thani (South), Kanchanaburi (West), Phra Nakhon Sri Ayutthaya (Central), and Bangkok (Capital), and time series data from March 2018 to December 2021. All factors relating to the data are shown in Table 1.

Table 1. Source of the data

Factor	Data	Abbreviate	Source
Number of Tourists	International guest arrivals at accommodation establishments in each province.	Tourist	Ministry of Tourism and Sports (2023)
Particulate Matter (PM10)	Average volume of particulate matter less than 10 microns (PM 10) in one month for each province.	PM10	Pollution Control Department (2023)
Rainfall	The average monthly rainfall	RAIN	Data Innovation and Governance Institute (2023)
The highest Temperature	The highest temperature in the month. (°C)	TMAX	Hydro – Informatics Institute (2023)
Consumer Price Index	Customer Price Index (base year = 2019) for each province	CPI	Bureau of Trade and Economic Indices (2023)
Covid-19	Dummy variable which indicates the effect of the Covid-19 pandemic (Co is one during 2020M1 to 2021M9 and is zero at other times)	Co	Assigned by author

The cross-sectional dependence of these data was examined by employing Pesaran (2021)'s method to determine the interrelationships within the cross-section term. The cross-sectional dependence test (CD test) in this study was considered with the following equation:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{i,j}\right) \quad \text{Eq. (1)}$$

If the data show cross-sectional dependence, the 1st generation of panel unit root may be unsuitable to detect the unit root in these data. Thus, they were tested by the 2nd generation of panel unit root with the cross-sectionally augmented panel unit root test (CIPS test) of Pesaran (2007), which is more suitable. The CIPS test was considered as follows:

$$CIPS(N,T) = N^{-1}\Sigma_{i=1}^{N}(N,T) \quad \text{Eq. (2)}$$

After the cross-sectional dependence and unit root properties were detected, the long and short run effect of these independent variables on Tourist was analyzed with the Pool Mean Group - autoregressive distributed lag (PMG – ARDL). This research utilized the model consisting of the intercept as follows: PMG - ARDL model

$$Tourist_{it} = \alpha_i + \xi_i Co_i + \Sigma_{j=1}^{p}\alpha_{1,i,j}Tourist_{i,t-j} + \Sigma_{j=0}^{q_1}\alpha_{2,i,j}PM10_{i,t-j} + \Sigma_{j=0}^{q_2}\alpha_{3,i,j}CPI_{i,t-j} + \Sigma_{j=0}^{q_3}\alpha_{3,i,j}TMAX_{i,t-j} + \Sigma_{j=0}^{q_3}\alpha_{3,i,j}RAIN_{i,t-j} + \varepsilon_{i,t} \quad \text{Eq. (3)}$$

where α_i, and $\varepsilon_{i,t}$ are the intercept, and error term, respectively. The model can re-parameter to the VECM form as the following:

$$\Delta Tourist_{it} = \alpha_i + \xi_i Co_i + \psi_i ECM_{i,t-1} + \Sigma_{j=1}^{p}\alpha_{1,i,j}\Delta Tourist_{i,t-j} + \Sigma_{j=0}^{q_1}\alpha_{2,i,j}\Delta PM10_{i,t-j} + \Sigma_{j=0}^{q_2}\alpha_{3,i,j}\Delta CPI_{i,t-j} + \Sigma_{j=0}^{q_3}\alpha_{3,i,j}\Delta TMAX_{i,t-j} + \Sigma_{j=0}^{q_3}\alpha_{3,i,j}\Delta RAIN_{i,t-j} + \varepsilon_{i,t} \quad \text{Eq. (4)}$$

where ψ_i is the speed of a long-term equilibrium adjustment, and the value should be negative with a statistical significance to confirm the long-term relationship from the independent variable to the tourist.

In sum, the methodology of this study can be summarized in Figure 2.

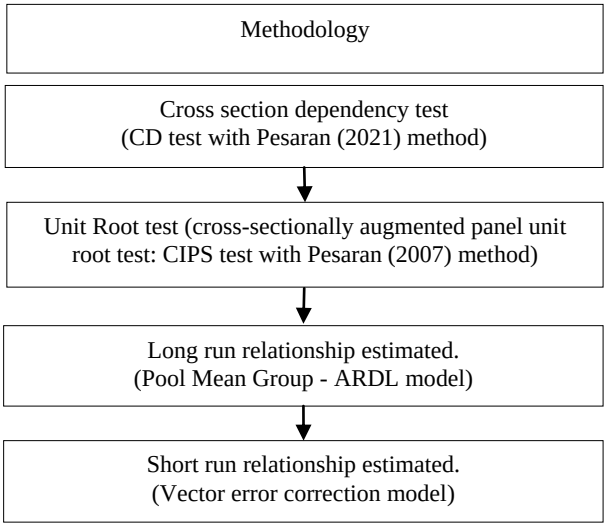

Figure 2. Step of data analysis

RESULTS AND DISCUSSION

As shown in Table 2, all variables showed cross-section dependence. Because the 1st generation of the unit root test in the panel, data is not sufficient. Hence, the panel unit root of the 2nd generation must be detected to show the cross-section dependence in the data on the cross section test. The results confirmed that the residuals of all variables are cross-section dependent. Next, we employed the CIPS test for the panel unit root test. The results shown in Table 3 reveal the stationary properties of all variables that are stationary at the level.

Table 2. Cross section dependence test (Source: Author's own calculation)

CD Test	Statistic
Tourist	29.76***
PM10	20.78***
CPI	26.46***
TMAX	21.10***
RAIN	18.18***

Table 3. CIPS test (Pesaran, 2007) (Source: Author's own calculation)

Variable	Level		
	None	Intercept	Intercept and Trend
Tourist	-4.78***	-4.88***	-4.83***
PM10	-3.87***	-3.95***	-4.43***
CPI	-2.46***	-2.44**	-2.69
TMAX	-4.29***	-5.62***	-5.67***
RAIN	-5.53***	-5.34***	-5.37***

The results of the estimation with the panel ARDL indicated a negative relationship between PM10 and the number of international tourists staying in the tourist provinces (Table 4), which was consistent with the results of Praditthong et al.

(2022). It could be said that the increase in PM10 may impact the health of the tourists (Anderson et al., 2012). In addition, a negative effect in long run relationship was also found for CPI, TMAX and RAIN on the Tourist.

The effect of CPI on the Tourism may indicate the influence of price on the number of tourists in each region. This relationship from CPI to TR conformed with the findings of Nguyen (2022) and Praditthong et al. (2022) who detect this direction of the relationship in Vietnam and Chiang Mai. According to the property of CPI which represents the price in the overall, the increasing of CPI may rise the cost to traveling of the tourism which reduce the purchase power of tourism.

For a while, the negative directional effect of TMAX and RAIN on tourism consisted with the study of Susanto et al. (2020) and Fauzel (2019). The direction may be explained by the nature of Thailand which always in the high temperature except the winter and spring which may be lower in some period. The high temperature and Rainfall is the trouble in many tourism activities, for a while, the decreasing of the temperature may be suitable for these activities conform with the Rainfall effect. Table 5 presents the estimation of the short-term relationship from the VECM model that was developed from the panel ARDL. The long-term relationship between the variables was confirmed with the result of ECT (-1), which was a negative value with statistical significance.

Table 4. Panel ARDL model: Long-term relationship

Variable	Panel ARDL (Long Term) PMG
PM10	-281.16
	(-3.64)***
CPI	-4109.68
	(-5.55)***
TMAX	-4172.12
	(-3.40)***
RAIN	-207.60
	(-10.01)***

Table 5. Panel ARDL model: Short-term relationship

Variable	Lag					
	(0)	(-1)	(-2)	(-3)	(-4)	(-5)
ETC(-1)	-0.16					
	(-3.57)***					
CO	-6364.85					
	(-1.65)					
C	15279.02					
	(3.48)***					
D(Tourist)		0.04	0.25	0.06	-0.03	-0.19
		(0.141)	(1.26)	(0.25)	(-0.15)	(-1.16)
D(PM10)	-887.94	2036.38	2421.73	340.70	110.14	-622.38
	(-1.52)	(1.69)*	(1.26)	(0.23)	(0.66)	(-0.97)
D(CPI)	1496.45	-1928.42	-2648.68	2712.56	-9001.2	1109.61
	(0.856)	(-1.29)	(-1.72)*	(0.25)	(-0.72)	(2.02)**
D(TMAX)	-7682.64	-1128.32	1593.58	7479.58	-4120.92	-7538.35
	(-1.01)	(-0.87)	(0.22)	(0.63)	(-0.56)	(-0.95)
D(RAIN)	94.42	79.91	-16.62	129.22	90.58	-361.43
	(2.26)**	(1.37)	(-0.32)	(1.61)	(0.68)	(-1.44)

Note: ( ) is t statistics - the asterisks ***, **, * denote significance at the 1%, 5% and 10% levels of significance, respectively

CONCLUSION AND RECOMMENDATIONS

The research examined the effects of air pollution on the number of tourists in Thailand. The findings affirmed that the increase in PM10 and the price factor, by considering the CPI, reduced the number of international tourists. In addition, the increases in the highest temperature and rainfall decreased the number of tourists. The research is consistent with fundamental economic concepts regarding the factors determining demand and international trade. In addition, the relationship between PM10 and the number of tourists could be explained by the environmental issues and the increase of PM10, which reduced the attraction of the sites. From the the results of the study, the government must prioritize the management of the exchange rate, while state officers, entrepreneurs, the public, and concerned people in each province should focus on product price control because the CPI influences the number of tourists.

Furthermore, all sectors, particularly the agricultural sector and others responsible for causing pollution, must be aware and target reductions in air pollution by minimizing the burning of garbage, industrial production processes, and the burning of agricultural waste for farming preparation since these actions affect the number of tourist arrivals. As a result, the income of the local people may decrease. Therefore, measures and guidelines from the government are necessary to bring about a reduction in crop burning and to determine risky areas for tourists.

Author Contributions: Conceptualization, S.N. and C.S.; methodology, S.N. and C.S.; software, S.N. and C.S.; validation, S.N. and HH.L.; formal analysis, S.N. and C.S.; investigation, S.N. and C.S..; data curation, S.N.; writing - original draft preparation, S.N. and C.S.; writing - review and editing, S.N. and HH.L.; visualization, S.N. and HH.L.; supervision, HH.L.; project administration, S.N. All authors have read and agreed to the published version of the manuscript.

Funding: Not applicable.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study may be obtained on request from the corresponding author.

Acknowledgments: This research project was "supported by Research and Graduate Studies" Khon Kaen University and Office of the Ministry of Higher Education, Science, Research, and Innovation under the Reinventing University System / Visiting Professor Program.

Conflicts of Interest: The authors declare no conflict of interest.

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Article history: Received: 27.01.2024 Revised: 05.04.2024 Accepted: 26.04.2024 Available online: 23.05.2024