Visualization And Forecast For Pollution Death Threats In ASEAN

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Abstract.

Air pollution is a serious problem experienced by all countries because it can cause many health problems and even death. The situation in countries of the Association of Southeast Asian Nations or ASEAN is the high air pollution-related mortality rates, especially in countries like Laos, Myanmar, and Cambodia, which face elevated risks due to poor air quality. Raising public awareness about air pollution requires a concerted effort involving various strategies and channels. The paper provides research findings on air pollution, including data on air pollution-related deaths, regional variations, and forecasting using Tableau software. It underscores the need to address air pollution challenges, particularly in ASEAN, to protect public health. Due to industrialization, ASEAN countries are grouped into high and low mortality clusters and ongoing air pollution challenges in Asia. Continued efforts are needed, especially in Myanmar, Cambodia, the Philippines, and Laos.

Keywords: *Death rate, air pollution, countries, visualization and trends.*

I. INTRODUCTION

Air pollution is a serious problem experienced by all countries today. WHO data shows that as much as 99% of the world's population has breathed polluted air [1]. In other words, almost the entire world's population has been contaminated by dirty air. Air pollution itself is environmental pollution indoors or outdoors by any chemical, physical, or biological substance that changes the quality and characteristics of the air. The general factors of air pollution consist of several types, such as household combustion products, motor vehicle exhaust, industrial facilities, and forest fires. The factors that cause air pollution produce pollutants that harm human health, such as carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide. These pollutants of air pollution materials can have a severe impact on human health if exposed frequently and in large quantities that can cause death. In Indonesia alone, in 2017, the highest number of deaths due to pollution was caused by air pollution [2], as shown in Fig. 1. Air pollution ranks first for the most deaths, with a total of 123,753 deaths, followed by extinction due to water pollution second with 60,040 deaths, lead pollution in third with 32,850 deaths, and finally, pollution in the workplace with 16,331 deaths. Based on the impact of air pollution that causes death in Indonesia, the authors want to analyze the visualization results of the number of deaths in all countries.

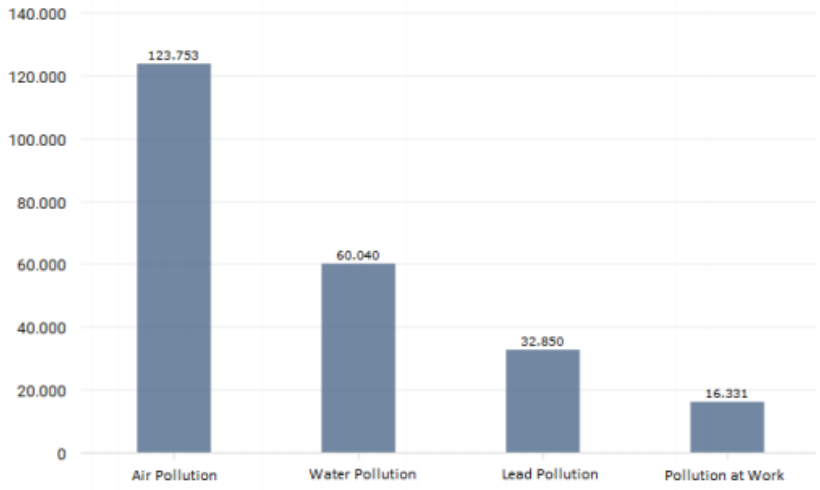

Fig 1. Number of deaths due to pollution in Indonesia in 2017 [2]

Prior studies have addressed air quality visualization, such as one focusing on creating portable pollution monitoring devices using sensors [3] and another on developing an interactive air quality system to reduce air pollution [4]. Some researchers show only the visual global impact of death from outdoor air pollution [5],[6]. Other researchers also focused on Europe [7], [8]. Other researchers try to connect the air pollution with some diseases [9], [10]. However, there is a lack of study that focuses on ASEAN and produces some forecasts rather than just showing the current state.Therefore, this research aims to visualize the number of deaths due to air pollution in ASEAN along with the causal factors by using Tableau so that it can contribute as an additional source in analyzing which countries still have a high index of deaths due to pollution, which means that the country has an index poor air quality. Tableau is an excellent and valuable visual analytics tool for forecasting [11]. State leaders, health organizations, or even ordinary people can use the results of this visualization of the death index as insights and input into handling air pollution in their respective locations.

II. METHODS

The object of this research was all countries from 1990 to 2017 grouped into several continents, such as Africa, America, Asia, Australia, and Europe. These areas will visualize the number of deaths with the total number of deaths and the contributing factors, namely indoor air pollution, outdoor air pollution, and ozone pollution. This research uses several visualization types: maps, line charts, clusters, trend lines, forecasts, heatmaps, bar charts, scatter plots, text tables, and Level-of-detail expressions. As shown in Fig. 2, this research study was conducted within the framework of DCOVA adopted from [12], a structured methodology encompassing key phases: Define, Collect, Organize, Visualize, Analyze, and Insights. This methodological framework provides a systematic and rigorous approach to the research process, facilitating the extraction profound insights and knowledge from the data at hand.

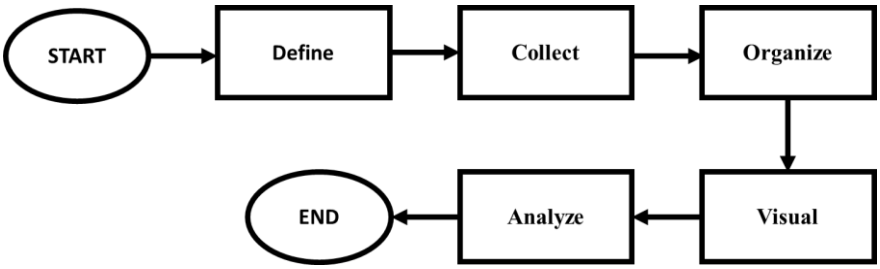

Fig 2. Research Flow

2.1 Define Stage

Visualizing crash data in Australia is essential for improving road safety. Data visualization helps identify accident patterns and informs interventions. Key research questions include: (a) What is the global impact of air pollution death threats, particularly in ASEAN? And (b) What is the global trend of air Pollution death threats, particularly in ASEAN?

2.2 Collect Stage

The Collect Stage gathers worldwide air pollution-related death data from 1990 to 2017, sourced from Kaggle (https://www.kaggle.com/datasets/akshat0giri/death-due-to-air-pollution-19902017). Kaggle is a highly esteemed data science community, providing extensive datasets and cutting-edge tools tailored for artificial intelligence and machine learning. The dataset utilized in this study is comprehensively detailed in Table 1.

Table 1. Data

Columns	Data Type
Entity	String
Code	String
Year	Number
Air pollution (total) (deaths per 100,000)	Number
Indoor air pollution (deaths per 100,000)	Number
Outdoor particulate matter (deaths per 100,000)	Number
Outdoor ozone pollution (deaths per 100,000)	Number

2.3 Organize Stage

Subsequently, a thorough data validation and cleansing process will be executed in Python to identify and rectify any instances of empty or missing values. Once the data is refined and pristine, it seamlessly integrates with the Tableau application. This integration will enable the creation of a structured table that encapsulates the mortality statistics, rendering it accessible for comprehensive visualization and analysis.

2.4 Visual Stage

Tableau software helps present data in a visually accessible and understandable manner, making it easier for researchers and readers to analyze and interpret the information effectively [13]. The Tableau Workbooks are meticulously structured to incorporate diverse worksheets, each as a potent canvas for illuminating the mortality rates linked to air pollution data. These worksheets are meticulously crafted to extract nuanced insights from the data. Following the intricate data visualization process, these individual worksheets artfully converge into two masterfully designed data dashboards. This astute consolidation augments the visual analysis, delivering a seamless and comprehensive perspective on the mortality rates attributed to air pollution during the specified period. Each worksheet, woven with a rich tapestry of visualization techniques, serves as a distinct lens through which unique analyses and insights are unveiled, thus fostering a multifaceted comprehension of this pivotal dataset.

2.5 Analyze Stage

Tableau proves indispensable for four distinct types of analysis. First, it facilitates descriptive analysis by summarizing and illuminating data characteristics through data aggregation, summary statistics, and visual charts. Second, it empowers forecast analysis [14], leveraging historical data to forecast future outcomes via analysis tools. Third, Tableau enables exploratory data analysis through interactive visualizations, drag-and-drop functionality, and dynamic filters, allowing in-depth data exploration from multiple angles, pattern identification, and hypothesis generation. Lastly, its spatial analysis capabilities empower users to dissect data based on geographic locations, fostering insightful geographical data visualization and analysis.

III. RESULT AND DISCUSSION

3.1. What is the impact of air pollution death threats globally, particularly in ASEAN

As seen in Fig. 3, among all continents worldwide, the death toll due to air pollution is notably high in Africa and Asia, as indicated by red. Meanwhile, other continents can still be considered relatively safe, marked in green. Africa has the highest number of deaths, totaling 208,108, with Asia in second place with 130,367 deaths. The stark contrast between Africa and Asia compared to other continents suggests significant regional variations in air pollution and its consequences. It's essential to delve deeper into the causes and sources of pollution in these regions to develop targeted interventions.

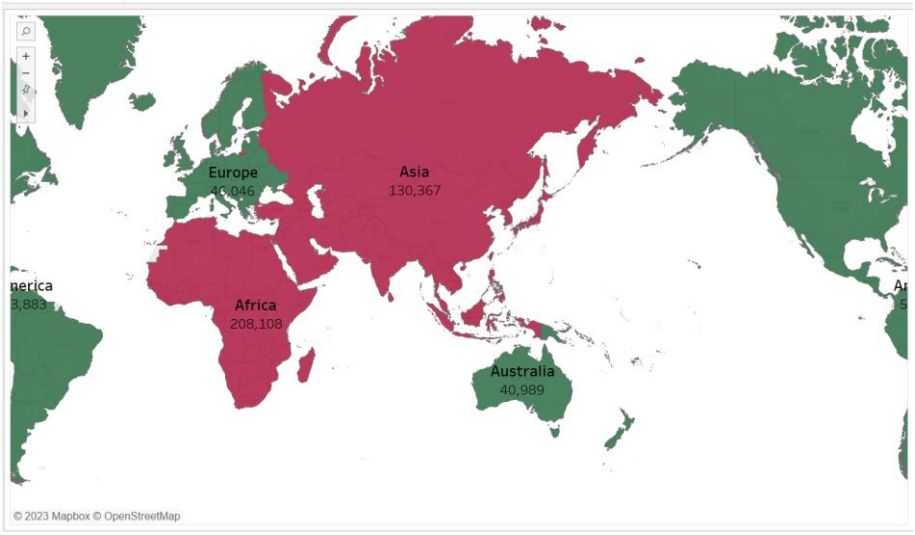

Fig 3. Total Air Pollution Deaths on all Continents from 1990 to 2017

While the information provided earlier did not specify the predominant source of these deaths, further insights can be gleaned from Fig. 4, which elucidates the breakdown of air pollution-related deaths across different continents. Notably, in Africa and Australia, most air pollution-related deaths occur indoors. Conversely, outdoor air pollution plays a more significant role in contributing to the mortality rate in the continents of America, Asia, and Europe.In Africa, indoor pollution is a significant contributor, resulting in a substantial difference from other continents, accounting for 158,171 deaths. In Asia, the indoor and outdoor sources of pollution are relatively close in terms of impact, resembling the situation in Africa. Specifically, outdoor air pollution leads to 67,543 deaths, while indoor pollution causes 57,808 deaths.Additionally, it is noteworthy that deaths attributed to ozone are relatively low across all continents. The relatively low impact of ozone-related deaths on all continents indicates that ozone pollution may not be a primary concern compared to other pollutants. Nonetheless, ongoing monitoring and efforts to reduce ozone pollution are still crucial for overall air quality.

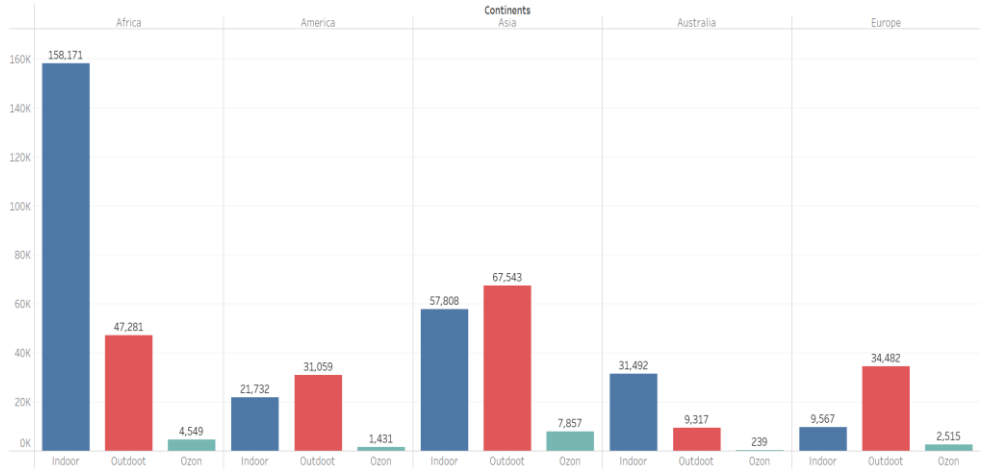

Fig 4. Breakdowns of air pollution-related deaths in different continents from 1990 to 2017 per 100,000 jiwa.

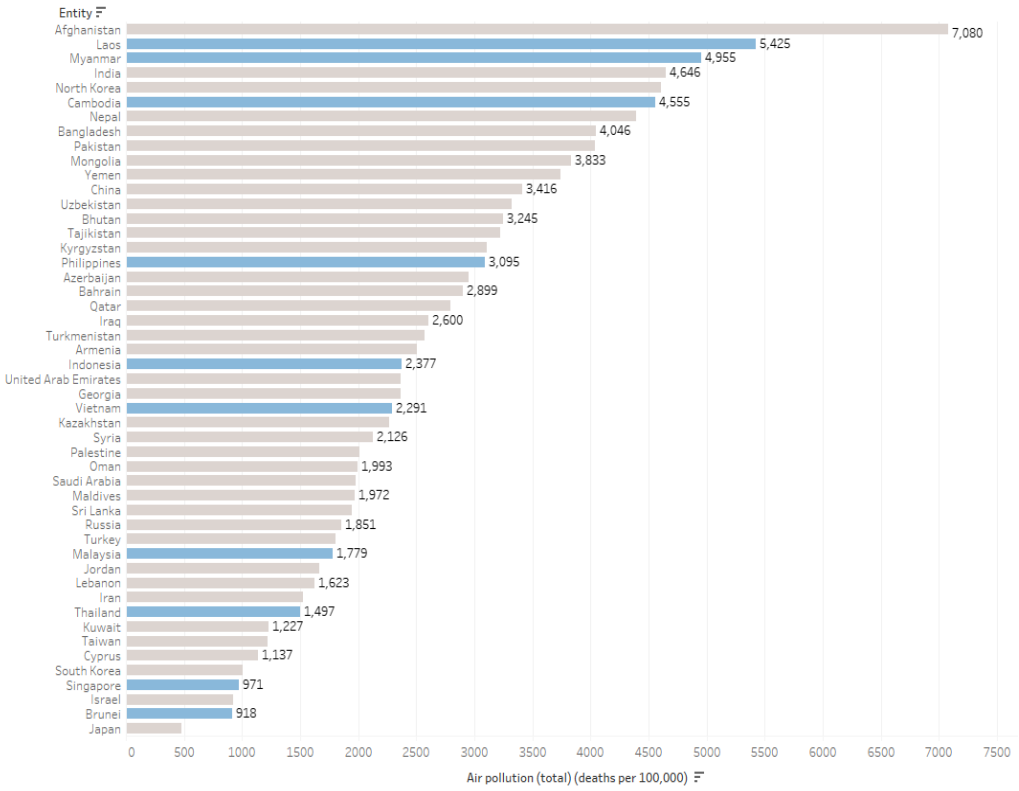

Fig 5. Total Air Pollution Death in ASEAN and Across Countries in Asia from 1990 to 2017

Fig. 5 illustrates the Total Air Pollution-Related Deaths in ASEAN and various Asian countries from 1990 to 2017. Afghanistan records the highest total air pollution-related deaths, with 7,080 per 100,000 population. Neighboring ASEAN countries, including Indonesia, are not exempt from this issue. The distribution of air pollution-related deaths within ASEAN is relatively uniform compared to countries across the Asian continent. Laos, Myanmar, and Cambodia stand out with high mortality rates, with Laos having the highest rate in ASEAN at 5,425 deaths per 100,000 population. The Philippines, Indonesia, and Vietnam are following closely, experiencing moderate mortality levels. In contrast, Malaysia, Thailand, Singapore, and Brunei exhibit relatively low mortality rates associated with air pollution.

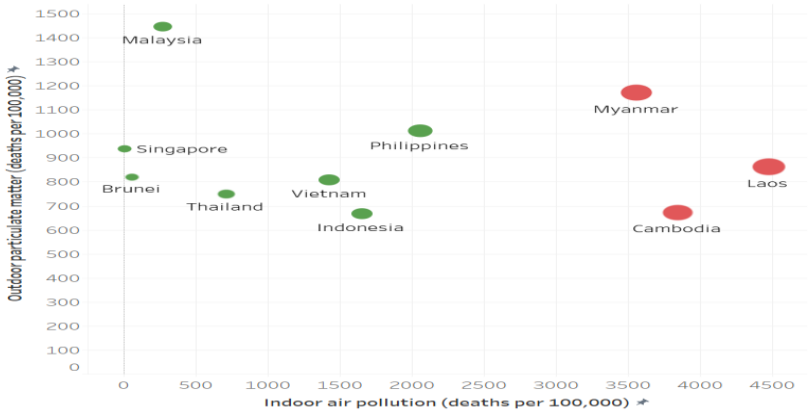

Fig 6. Air Pollution Death Clustering in ASEAN Countries from 1990 to 2017

Based on the indoor and outdoor mortality rates in ASEAN countries, we can categorize them into two clusters: high mortality rates marked in red and low mortality rates in green, as evident in Fig. 6. The clustering was performed using the k-means method in Tableau, resulting in two clusters. The analysis involved 10 data points, with a between-group sum of squares of 0.99858, a within-group sum of squares of 1.0974, and a total sum of squares of 2.096. Myanmar, Laos, and Cambodia are grouped in the high mortality cluster, signifying their elevated risk due to air pollution. Meanwhile, other ASEAN countries currently fall within the low mortality cluster, indicating a relatively safer air quality situation. However, without preventive actions, it is plausible that they may transition into the high mortality cluster in the future.

3.2. What is the global trend of air Pollution death threats, particularly in ASEAN?

The forecasting was conducted using Tableau's Forecast Feature with a confidence interval of 95%. Data from 1990 to 2017 was employed to project trends and predict outcomes from 2018 to 2026. Fig. 7 presents a projection of Air Pollution Deaths extending until 2026, utilizing the forecasting function within Tableau. This projection discerns that considerable challenges persist for the continents of Africa and Asia, marked by the anticipation of substantial mortality figures. Conversely, the Americas, Europe, and Australia regions are expected to make significant strides in reducing casualties to levels approaching 1,000 deaths per 100,000 people. Specifically, Africa, which documented 5,922 deaths in 2016, is projected to decrease to 4,848 by 2026.Similarly, the Asian continent, with 3,411 deaths in 2016, is anticipated to reduce to 2,484 by 2026. This projection underscores the imperative need for ongoing, concerted efforts to address the profound impact of air pollution, particularly in Africa and Asia. It also acknowledges the commendable progress made by the Americas, Europe, and Australia in mitigating air pollution-related mortality.

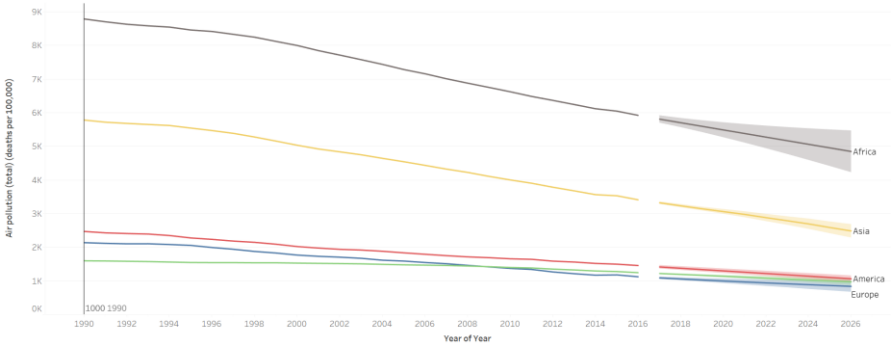

Fig 7. Air Pollution Death Forecast among Continents from 2018 to 2026

Africa and Asia are home to the world's most densely populated countries and cities. Rapid industrialization and urbanization have led to increased emissions of pollutants, contributing to poor air quality. Industrialization and economic growth, while fostering prosperity in many regions of Africa and Asia, have also engendered heightened pollution levels. This phenomenon arises from increased industrial activities, characterized by emissions from manufacturing processes and energy production, primarily reliant on fossil fuels. Urbanization accompanying economic expansion amplifies vehicle traffic and construction emissions, contributing to air pollution. Improper disposal of industrial waste compounds the issue.

The forecasting was conducted using Tableau's Forecast Feature, with a 95% confidence interval. Data from 1990 to 2017 was utilized to project trends and forecast outcomes from 2018 to 2026 in ASEAN, as shown in Fig.8. Generally, the overall trend indicates a decrease in air pollution-related deaths. However, in Myanmar, Cambodia, the Philippines, and Laos, the number of deaths remains alarmingly high. Myanmar is projected to potentially surpass Laos as the country with the highest death rate from air pollution threats, reaching 93.1 deaths per 100,000 individuals in 2026. Indonesia, Vietnam, and Malaysia will fall in the middle range in 2026. Meanwhile, Thailand, Brunei, and Singapore are forecasted to have lower rates. Singapore is expected to have the lowest air pollution-related mortality rate in ASEAN in 2026, with 7.2 deaths per 100,000 individuals.

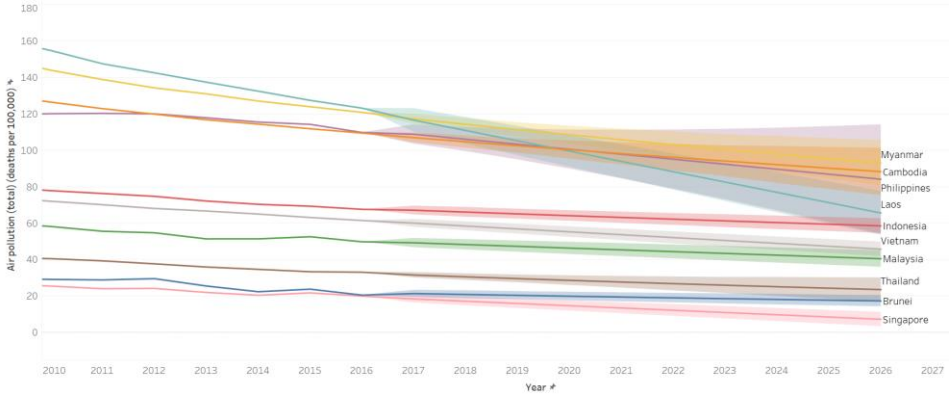

Fig 8. Air Pollution Death Forecast in ASEAN countries from 2018 to 2026

Africa and Asia bear the highest burden of air pollution-related deaths, but the distribution of these deaths varies regarding indoor and outdoor pollution sources. Africa primarily faces indoor pollution-related deaths, while Asia sees a significant impact from outdoor pollution. America and Europe also experience air pollution-related deaths, but their numbers are comparatively lower than those in Africa and Asia. Australia has a moderate number of deaths, with a focus on outdoor pollution. Particularly in ASEAN, to mitigate the potential adverse outcomes, countries with high or medium mortality rates should consider implementing and enforcing stricter air quality regulations, promoting cleaner energy sources, enhancing public transportation, and raising awareness about the health impacts of air pollution [15]. Regional cooperation can also be crucial in addressing transboundary air pollution challenges [16].Furthermore, ordinary people can reduce indoor air pollution by improving ventilation [17] using air purifiers [18]. For outdoor air pollution, they can choose eco-friendly transportation [19] and raise awareness [20]. To combat outdoor ozone pollution, individuals can opt for cleaner transportation, conserve energy, support regulations, and promote clean energy, thus contributing to healthier air quality in their communities.

IV. CONCLUSION

High air pollution-related deaths are evident in Asia, with 130,367 deaths. Outdoor pollution plays a more prominent role in the Asia. Ozone-related deaths are relatively low across continents, emphasizing the need to address regional air pollution variations.Afghanistan has the highest air pollution-related deaths, followed by ASEAN countries like Laos, Myanmar, and Cambodia, with high mortality rates. The Philippines, Indonesia, and Vietnam report moderate rates, while Malaysia, Thailand, Singapore, and Brunei have lower rates. ASEAN nations can be grouped into two clusters: high (red) and low (green) mortality, with Myanmar, Laos, and Cambodia in the high mortality cluster and other ASEAN countries in the low

mortality cluster. Preventive actions are necessary to avoid transitioning into the high mortality cluster in the future.Using Tableau's Forecast Feature with a 95% confidence interval and data from 1990 to 2017, the projection indicates ongoing air pollution-related challenges in densely populated Asia due to rapid industrialization. In contrast, the Americas, Europe, and Australia are making substantial progress in reducing air pollution-related deaths, approaching levels of around 1,000 deaths per 100,000 people. Continued efforts are crucial, especially in Asia, where industrialization and urbanization contribute to heightened pollution. Additionally, the overall trend shows declining air pollution-related deaths, but concerning rates persist in Myanmar, Cambodia, the Philippines, and Laos, with the possibility of Myanmar surpassing Laos as the highest-risk country by 2026.

V. ACKNOWLEDGMENTS

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