

# Traffic-Related Air Pollutants and Health Impacts on E-Hailing Services Drivers in Southeast Asia: A Literature Review

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**ABSTRACT** - E-hailing services in Southeast Asia have revolutionised transportation, which raises concerns about air pollution exposure among drivers, who often spend extended hours in high-traffic areas. This paper review evaluates exposure to traffic-related air pollutants and the health impacts on e-hailing drivers in Southeast Asia, providing insights to support urban policymakers and stakeholders in designing safer, healthier transportation models. The result of the review illustrates particulate matter, ozone, sulphur dioxide, carbon dioxide and nitrogen dioxide are the sources of traffic related air pollutants, with associated main risks for respiratory and cardiovascular health. Owing to the lack of research on the e-hailing service, there is little evidence in the existing literature on health impacts dimension of e-hailing services. This indicates a need for further research in this area to further investigate health impacts and evaluate the benefits and challenges associated with e-hailing service as an urban transport solution.

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## 1. INTRODUCTION

Southeast Asia is a market of over 650 million people and its ride hailing sector is expected to be worth about USD20 billion by 2025. In 2023, the market in Southeast Asia amounted to approximately 24 billion U.S. dollars and was forecasted to increase by 2025, in which the online transport and food market was expected to reach 31 billion U.S. dollars across the Southeast Asia region [1]. In Southeast Asia, e-hailing is a key source of on-demand labor [2]. The rapid growth of e-hailing services in Southeast Asia has reshaped urban transport, accommodating the rising demand for convenient travel alternatives [3]. Information and communications technology (ICT) developments have paved the way for new business models for labour platforms. Labour platforms facilitate the market for work, which can be location-based or web-based [2]. E-hailing services, a form of location-based work, in recent years, have seen significant advances in urban areas in Southeast Asia. This is an important area for future improvement as it has received widespread interest and is changing the urban mobility landscape [4]. The proliferation of e-hailing services has raised concerns about their role in cities [5] as e-hailing drivers spend more time in traffic compared than the general population, making them vulnerable to the health effects of poor air quality. Despite e-hailing significance, transportation industry generated 15% of all anthropogenic and 23% of global energy related greenhouse gases (GHGs) emissions in 2019. The industry is responsible for 8.7 Gt of carbon dioxide emissions and is projected to double the volume by 2050 [6]. The growth of e-hailing services also significantly impacted human health from the exposure to traffic-related air pollutants inside vehicles for example ultrafine particles, particulates matter and carbon dioxide that contribute to the respiratory health risks of the drivers.

Air pollution poses an increasing global threat to human health, affecting occupational health. For many workers, the nature of their job and the conditions in which they work significantly impact their exposure to air pollution, beyond general ambient exposure [7]. Nevertheless, air pollution is classified as a high-level risk and occupational exposure to particulate matter, gases, and fumes is considered a more specific occupational hazard. This risk is associated with nine health effects, including cardiovascular disease, respiratory infections and tuberculosis, chronic respiratory diseases, maternal and neonatal conditions, as well as diabetes and kidney infections [8]. Statistic show that air pollution causes 7 million deaths worldwide every year and is the fourth leading risk factor of premature death globally [9]. This threat to human health has sparked interest in the community. Understanding air pollution exposure among e-hailing drivers may prove important for their health and well-being. Compared to the rest of the world, Southeast Asia had the second highest premature mortality due to air pollution in 2010 and is projected to have the highest premature mortality due to air pollution by 2050 [10, 11]. This review examines literature from 2019 to 2024, focusing on air pollution exposure and the health impacts on e-hailing drivers in Southeast Asia, where cities like Kuala Lumpur, Jakarta, and Bangkok face pressing air quality challenges. While e-hailing applications are prevalent in Southeast Asia, particularly for commuting purposes, study on the in-vehicle exposure to traffic-related air pollutants and the health impacts on e-hailing drivers in Southeast Asia is limited.

## 2. LITERATURE REVIEW

Growing occupational health concerns and the maturation of e-hailing services requires precise measurement of the potential contribution of e-hailing services to urban sustainability, specifically to health of e-hailing drivers, increasingly necessary. Drivers within the e-hailing industry frequently encounter a range of occupational health hazards stemming from factors such as environmental exposures, extended working hours and traffic congestion. A significant concern is the in-vehicle exposure to traffic-related air pollutants, including particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), and black carbon (BC). These pollutants have been correlated with respiratory inflammation, oxidative stress, and heightened cardiovascular risks [12, 13]. E-hailing drivers are particularly susceptible due to their extensive time spent in traffic-dense environments, often coupled with inadequately efficient in-cabin air filtration systems. Furthermore, irregular working hours and night shifts contribute to sleep deprivation and fatigue. These factors, in turn, escalate the risk of road accidents and long-term health deterioration [14]. Prolonged sedentary behavior and suboptimal ergonomic postures elevate the risk of musculoskeletal disorders, particularly lower back and neck pain [15].

### 2.1 E-Hailing Services

Intermediation business (e-hailing) is a service provided to book public transport services through electronic applications. These services include e-hailing vehicles and taxis. E-hailing vehicle is a private vehicle used to provide public transport services to passengers [16]. E-hailing services have revolutionized urban transportation, providing a modern alternative to traditional taxi services. The service facilitated by mobile applications, allows users to book rides conveniently and efficiently [17, 18]. Nevertheless, e-hailing services are widely adopted across Southeast Asia countries. Similar terminology of e-hailing services are ride-hailing, ride-sourcing, Transportation Network Companies, and other relevant terms, such as mobile taxi booking, online taxi, Uber, and Grab Taxi [20]. In Malaysia and Singapore, car-based e-hailing services are more dominant. Meanwhile, motorbike-based e-hailing services are indeed dominant in Indonesia, Vietnam, and Thailand. This prominence is attributed to the widespread use of motorcycles in these countries, especially in urban areas where traffic congestion makes two-wheeled transport more efficient.

### 2.2 Southeast Asia Countries

Southeast Asia (SEA) comprises 11 countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste, and Vietnam. This region is characterized by rapid urbanization, diverse cultures, and varying levels of economic development. Urban transportation systems in SEA face numerous challenges, including traffic congestion, inadequate public transportation, and environmental degradation. The introduction of e-hailing services in SEA region has been both a boon and a bane, providing new mobility options while contributing to regulatory and infrastructural challenges [3]. Meanwhile, the Association of Southeast Asian Nations (ASEAN) is a regional intergovernmental organization comprising ten Southeast Asian countries that promotes economic growth, cultural development, and regional stability. ASEAN countries have embraced e-hailing services to varying degrees, influenced by their respective regulatory environments, technological infrastructure, and public acceptance. In cities like Jakarta, Kuala Lumpur, and Manila, e-hailing services have become vital components of the urban transportation landscape. These services have enhanced mobility and stimulated discussions on regulatory frameworks and sustainable urban development [3]. Since the emphasis of this literature was on the SEA countries, the search included relevant studies conducted in other smaller SEA countries, such as Brunei Darussalam, Cambodia, Lao PDR, Myanmar and Singapore.

### 2.3 Traffic Related Air Pollutants

Transportation is a significant source of environmental emissions, contributing to air pollution and climate change. Vehicles powered by fossil fuels emit greenhouse gases (GHGs) such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), along with pollutants like nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM). The rapid increase in vehicle numbers in urban areas exacerbates these emissions, posing severe traffic related air pollutants and occupational health risks. E-hailing services, while providing convenient transportation options, also contribute to these emissions, especially in cases where they increase vehicle miles travelled (VMT) and reduce the efficiency of public transit systems [19, 20]. Among many environments, the motor vehicle cabin micro environment has been of particular public concern. Although commuters typically spend only 5.5% of their time in vehicles, emissions from various interior components of motor vehicles and exhaust fumes carried by ventilation supply air are significant sources of harmful air pollutants that could lead to unhealthy human exposure due to their high concentrations inside vehicles' cabins [21]. These pollutants, originating in areas with very high concentrations, are transported throughout the surrounding environment, including into vehicle cabins. Once inside, they can accumulate, increasing passengers' exposure. Numerous toxicological and epidemiological studies have linked high levels of these toxic pollutants including ultrafine particles (UFP) and nitrogen oxides (NO<sub>x</sub>) to exacerbated respiratory inflammation, allergies, asthma, and a range of long-term health issues, including lung cancer and cardiovascular diseases [22, 23]. In these confined vehicle spaces, passengers can encounter over 300 types of carbon-based gases, ranging from volatile organic compounds (VOCs) to combustion-related gases (NO<sub>x</sub>, CO, etc.) and particulate matter [24].

### 2.4 Air Pollutants' Health Impacts

Long-term exposure to air pollution can lead to severe adverse health effects, including premature death from respiratory and cardiovascular diseases [23]. Every year, more than 4 million people worldwide die due to long-term

exposure to outdoor (ambient) air pollution alone [25]. A significant number of these occur in Asia, where air quality has deteriorated alongside rapid fossil-fueled expansion and population growth. Ambient air pollution mostly arising from anthropogenic activities, such as using cars, causes of 4.2 million deaths to acute and chronic effects on human health [26]. An emission inventory study in Kuala Lumpur also reported that road traffic accounted for the largest contribution of PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>2</sub> and NO<sub>x</sub> emissions in the city [27]. Exposure to ambient air pollution is one of the most important causes of morbidity and mortality all over the world [28].

## 2.5 Traffic Related Air Pollutants Health Impacts

Traffic is a major source of air pollution to urban populations, and thus traffic-related air pollution (TRAP) is the most studied exposure in air pollution epidemiology [29]. TRAP contributes substantially to the increase of the global burden of disease in the past quarter of century in parallel to of population ageing and changes in non-communicable disease rates [30]. Human exposure studies concerning TRAPs were of primary importance because vehicular traffic represented one of the main contributors to outdoor levels of air pollution [31]. In-vehicle traffic related air pollutants exposure poses significant health risks, with high concentrations of pollutants such as particulate matter (PM), carbon monoxide (CO), and ultrafine particles (UFPs) [32]. Studies across European cities reveal that pedestrians generally have the lowest exposure levels, while car users tend to experience the highest [33]. Factors influencing exposure include transport mode, built environments, and time of day [34]. In addition, other health impacts of concerns due to driving as per Medical Examination Guidelines for Vocational Drivers are medical condition related to visual, hearing, obstructive sleep apnea, neuromuscular, diabetes, fatigue and stress [35].

## 3. METHODOLOGY

The initial step in developing a review of the literature on e-hailing services in Southeast Asia (SEA) is to enhance the understanding of in-vehicle exposure to traffic-related air pollutants and the health impacts on e-hailing drivers in Southeast Asia and to inform related planning and regulatory efforts in the context of developing countries. As part of the review process, relevant articles were retrieved from electronic databases including ScienceDirect, Taylor & Francis, and SAGE Publications, with a publication date range from 2019 to October 2024. A single research paper or review article has been considered as the unit of analysis. A set of keywords including 'air pollution from e-hailing services in Southeast Asia', 'in-vehicle exposure to traffic-related air pollutants in e-hailing services' and 'e-hailing services and drivers' health impacts in Southeast Asia' were used in this process. These keywords have been applied with different combinations of AND/OR operators to assure the collection of a sufficient number of studies. The collected literature has been analyzed under abstract studies to enhance the understanding of in-vehicle exposure to traffic-related air pollutants in e-hailing services and the drivers' health impacts in Southeast Asia. These efforts resulted in identification of 771 articles; however, only twenty-five remained after the second stage of the screening process. This initial search revealed the following results: Science Direct-N = 98 results, Taylor & Francis-N = 477 results and Sage Publications-N = 196. These articles abstracts were reviewed. After 177 duplicates were removed, titles and abstracts of the articles were screened based on the inclusion and exclusion criteria in Table 1.

Table 1. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Types of literature / studies	All relevant quantitative and qualitative studies/literature on the phenomenon	Editorial, short communication and letters
Time period	1 <sup>st</sup> January 2008 until 30 <sup>th</sup> October 2024	Before 1st January 2008 and after 30 <sup>th</sup> October 2024
Location of study	Southeast Asia countries	Non-Southeast Asia countries
Types of drivers	E-hailing services driver	All other professional drivers
Phenomenon of interest	Health impacts on e-hailing services drivers due to in-vehicle exposure to traffic-related air pollutants Health impacts on e-hailing services drivers due to traffic-related air pollutants	All other impacts of e-hailing services on drivers

A total of twenty-five articles were identified as the references in identifying the traffic related air pollutants health impacts towards e-hailing services drivers, while eight relevant articles selected in forming the basis for the present article (Table 2). The articles identified allowed suggestion on health impacts of the air pollution specifically traffic related air pollutant toward e-hailing services drivers. To delve into the recent academic contributions about the impacts of e-hailing services, this study applies focus on the health as the sustainability dimensions. Regarding the location, the majority of studies were conducted in the Indonesia, Thailand and Vietnam. Through reviewing the literature, this study aims to identify the health impacts of these services towards the drivers and to inform related planning and regulatory efforts in the context of developing countries in resolving issues related to urban transportation.

Table 2. Articles selected in forming the basis

Southeast Asia Country	Title of article	Finding suggested
Indonesia	Peningkatan Pengetahuan mengenai Bahaya dan Risiko Gangguan Pernapasan pada Pengemudi Ojek Online [36]	<ul style="list-style-type: none"> <li>The study found a 25.5% increase in knowledge about the risks and respiratory tract disorders among online motorcycle taxi drivers after counselling activities.</li> <li>The percentage of correct answers increased from 4.8% to 40.5% in pre-test and post-test evaluations.</li> </ul>
	Hubungan kualitas udara, aktivitas kerja, dan kesehatan paru pada driver ojek online di kota Denpasar [37]	<ul style="list-style-type: none"> <li>The study involved 30 online motorcycle taxi drivers in Denpasar with an average age of 35.3 years.</li> <li>Most drivers worked for more than four years and more than eight hours a day, with high use of PPE.</li> <li>There was no significant relationship between work activity and lung health.</li> </ul>
	Environmental health risk assessment of air pollutants in online motorcycle taxi drivers in the special capital region of Jakarta [38]	<ul style="list-style-type: none"> <li>The study reported that online motorcycle taxi drivers in Jakarta are exposed to levels of particulate matter (PM10) and ozone (O<sub>3</sub>) that exceed recommended safety thresholds, with associated risks for respiratory and cardiovascular health.</li> <li>The values for SO<sub>2</sub>, CO, and NO<sub>2</sub> were &lt;1, indicating safe exposure levels.</li> </ul>
	Hubungan lama paparan polusi udara dan perilaku merokok terhadap fungsi paru pada driver ojek online [39]	<ul style="list-style-type: none"> <li>There is a significant relationship between smoking behavior and lung function among online motorcycle taxi drivers.</li> <li>There is no significant relationship between the duration of exposure to air pollution and lung function.</li> <li>The study suggests that using masks and quitting smoking could be beneficial for reducing health impacts.</li> </ul>
Indonesia	Hubungan lamanya paparan asap kendaraan bermotor terhadap faal paru pengemudi ojek online di Kota Malang [40]	<ul style="list-style-type: none"> <li>There was a correlation between the duration of traffic air pollution exposure and FVC, with a Pearson correlation score of -0.694, indicating that longer exposure decreases FVC.</li> <li>There was no correlation between the duration of working in a day and lung function parameters such as FVC and FEV<sub>1</sub>/FVC.</li> <li>The study concluded that there is a correlation between the duration of traffic air pollution exposure and FVC in taxi motorcycle riders in Malang City.</li> </ul>
	Respiratory symptoms and lung function among online motorcycle taxi drivers [41]	<ul style="list-style-type: none"> <li>10.1% of online motorcycle taxi drivers had restrictive lung function impairment, and 5.1% had obstructive lung function impairment.</li> <li>Age was significantly associated with restrictive lung disorders and lung function parameters like FVC and FEV<sub>1</sub>.</li> <li>Respiratory symptoms such as cough (17.2%) and shortness of breath (6.1%) were prevalent, but their relationship to lung function impairment was not significant.</li> </ul>
	Thailand	Considering the effects of ambient particulate matter on the lung function of motorcycle taxi drivers in Bangkok, Thailand [42]
Vietnam	The current status of job quality for technology drivers in Vietnam [43]	<ul style="list-style-type: none"> <li>Drivers are exposed to pollution and traffic hazards.</li> <li>Common health issues include respiratory problems.</li> </ul>

Table 3. Relevant Articles supporting the basis

Relevant article	Summary
Ride-hailing applications in Southeast Asia: A literature review [3]	<ul style="list-style-type: none"> <li>This paper reviews the literature on ride-hailing applications in Southeast Asia. It identified research gaps on how ride hailing app influences traveler behavior, its effects on incumbent transport operators, and its environmental impacts.</li> </ul>
Air pollution and the world of work in Southeast Asia: findings from regional case studies [7]	<ul style="list-style-type: none"> <li>The paper examines air pollution exposures among workers in Southeast Asia. Workers generally lack awareness of occupational exposures to air pollutants, associated health impacts, regulations, and protective measures.</li> </ul>
Air pollution inside vehicles: making a bad situation worse [44]	<ul style="list-style-type: none"> <li>The paper measures high levels of particulate matter air pollution inside vehicles in Thailand. All ventilation and air conditioning conditions tested resulted in PM<sub>2.5</sub> levels above the WHO 24-hour standard, with some conditions also exceeding Thailand's interim 24-hour standard of 37.5 µg/m<sup>3</sup>.</li> </ul>
Air pollution and the world of work: policies, initiatives and the current situation – a scoping and evidence review for Southeast and East Asia [7]	<ul style="list-style-type: none"> <li>This paper provides a scoping review of air pollution impacts on workers in East and Southeast Asia. Air pollution is a growing global threat to human health and occupational health, with the impacts being strongly mediated by social factors like class, gender, and age.</li> </ul>
The prevalence of fatigue and associated health and safety risk factors among taxi drivers in Singapore [45]	<ul style="list-style-type: none"> <li>A high proportion of taxi drivers in Singapore are obese and have chronic health conditions such as hypertension, diabetes, and high cholesterol. Driver fatigue is associated with poor sleep quality, having an additional part-time job, consuming three or more caffeinated drinks daily, and driving for more than 10 hours a day. The prevalence of sleepiness and fatigue among taxi drivers is approximately 32.9%.</li> </ul>
The impact working environment on health problem among e-hailing drivers in Johor Bahru, Malaysia from ergonomic perspective during pandemic Covid-19 [46]	<ul style="list-style-type: none"> <li>This paper examines the working environment and health problems of e-hailing drivers in Malaysia during the COVID-19 pandemic, specifically ergonomic issues. E-hailing drivers often work long hours, with 77.5% working more than 8 hours per day and 77.9% working more than 56 hours per week.</li> </ul>

## 4. RESULT AND DISCUSSION

### 4.1 Sources of Air Pollution in Southeast Asia

The link between health impacts from occupational exposure to particulate matter (PM), gases, and fumes is closely tied to employees' work. In countries with a substantial workforce in manufacturing or agriculture, such as Cambodia, Myanmar, and Vietnam, there is a higher occupational exposure to PM, gases, and fumes. Conversely, countries with a large share of the workforce in the service sector, like Singapore, Brunei Darussalam, and Malaysia, experience a lower health burden from occupational exposure, as well as from ambient and household air pollution overall [47].

Table 4. Annual average PM<sub>2.5</sub> concentrations in 2019 and 2020

Southeast Asia country (capital city)	2019 annual average PM <sub>2.5</sub> (ug/m <sup>3</sup> )	2020 annual average PM <sub>2.5</sub> (ug/m <sup>3</sup> )
Cambodia (Pnom Penh)	21.1	21.1
Indonesia (Jakarta)	51.7 (49.4)	40.8 (39.6)
Lao PDR (Vientiane)	22.4	23.151.7 (49.4)
Malaysia (Kuala Lumpur)	19.4 (21.6)	15.6 (16.5)
Myanmar (Yangon)	31	29.4
Philippines (Manila)	17.6 (18.2)	12.8 (13.1)
Singapore	19	11.8
Thailand (Bangkok)	24.3 (22.8)	21.4 (20.6)
Vietnam (Ha Noi)	34.1 (46.9)	28.0 (37.9)

As noted in Table 2 above, particulate matter, ozone, sulphur dioxide, carbon dioxide and nitrogen dioxide are the sources of traffic related air pollutants, with associated main risks for respiratory and cardiovascular health. PM<sub>2.5</sub> is the primary air pollutant, as evidence indicates it imposes the highest disease burden and is associated with a broad range of health

impacts. Additionally, gaseous pollutants such as nitrogen oxides (NO<sub>x</sub>) and ozone (O<sub>3</sub>) are linked to various health effects, including respiratory diseases [48]. In Southeast Asia, three of the 15 most polluted cities are in Indonesia, 10 are in Thailand, and the remaining two are in Vietnam. In contrast, 13 of the least-polluted cities in 2020 were located in Malaysia, which also had one of the lowest annual average PM<sub>2.5</sub> concentrations in Southeast Asia that year (Table 4). The total number of global deaths attributed to PM<sub>2.5</sub> pollution includes 221,600 deaths in Indonesia, 99,700 in Vietnam, and 98,209 in the Philippines [49]. Table 2.1 below provides the annual average PM<sub>2.5</sub> concentrations from the State of Global Air report for 2019 and 2020 by country or administrative area and capital city, where applicable.

#### **4.2 Exposure to Traffic-Related Air Pollutants and the Health Impacts Towards E-Hailing Services Drivers in Southeast Asia**

The emergence of e-hailing services, such as Grab and Gojek, has significantly transformed the transportation landscape in Southeast Asia. These on-demand ride-sharing platforms have provided convenient and accessible transportation options to commuters, while also creating new employment opportunities for drivers. However, the increased number of vehicles on the road, coupled with the unique driving patterns of e-hailing drivers, raises concerns about their exposure to traffic-related air pollutants. TRAP contributes substantially to the increase of the global disease burden in the past quarter of a century in parallel to population ageing and changes in non-communicable disease rates [30]. Concentrations of toxic gaseous and particulate pollutants are very high in urban areas, particularly near major roads and freeways. On-road vehicles are, in fact, the primary source of direct emissions [24]. This review of the existing literature on air pollution exposure and health impacts of e-hailing services drivers in Southeast Asia has revealed several important insights and implications. The key findings from the literature review on traffic related air pollutants' exposure and health impacts associated with e-hailing services drivers in Southeast Asia have revealed that respiratory and cardiovascular health are impacted by the burden of air pollution [43, 50].

The findings are supported with recent studies by a number of researchers that have reported that most frequent health disease found in drivers are respiratory related diseases [51-56]. The second major finding of health impact among drivers due to traffic related air pollutant is cardiovascular disease. Global deaths from cardiovascular disease are increasing as especially in occupation as a driver that have sedentary nature [57-58]. PM can penetrate the pulmonary alveolus, causing breathing difficulties. It can also produce oxidative stress, which has been linked to cardiovascular and neurological issues [59-62].

An interesting point to note here is the existing research suggests that e-hailing drivers in Southeast Asia face significant challenges in balancing supply and demand, often leading to extended cruising and idling periods to find the next passenger [63]. This behavior generates additional vehicle miles travelled, contributing to increased air pollution exposure. For example, when drivers are exposed to pollution and traffic hazards including long hours of sitting [43]. E-hailing drivers, a rapidly expanding workforce in the region, face significant health risks due to prolonged exposure to in-vehicle air pollution [46]. The road transport system in Southeast Asian countries is a major contributor to energy consumption and CO<sub>2</sub> emissions, exacerbating air quality issues in densely populated cities [64]. To strengthen the point further, study shown online motorcycle taxi drivers in Southeast Asia, particularly in Jakarta, face significant health risks due to prolonged exposure to traffic related air pollutants. Studies have shown that these drivers are at risk of respiratory problems, including decreased lung function and chronic obstructive pulmonary disease (COPD) [39-40]. Lung related diseases are significant in most cities in Indonesia as report on environmental health risk analysis revealed that PM<sub>10</sub> and O<sub>3</sub> ambient exposures are unsafe for drivers in Jakarta [38, 40]. In addition, recent relevant studies suggest health impacts implications due to traffic related are varies, depending on duration of exposure. Acute exposure implications are cough, headache, irritation of the eyes, nose, and throat, allergic reactions, asthma symptom aggravation, wheezing, and complications of symptoms in elderly subjects with chronic respiratory and cardiovascular disease, possibly leading to hospitalization or even death [29].

#### **4.3 The Technological Innovation to Mitigate Exposure to Traffic-Related Air Pollutants and the Health Impacts Towards E-Hailing Services Drivers in Southeast Asia**

The technological innovation to mitigate exposure to traffic-related air pollutants and the health impacts towards e-hailing services drivers in Southeast Asia is highly relevant, especially with the rising gig economy and urban air quality concerns in the region. In a condition of a small car cabin, enclosed space subject to pollutant infiltration or self-emissions. Pollutants can accumulate, depending on traffic and ventilation conditions, exposing passengers and drivers to serious adverse health effects. These pollutants are of different types (gaseous or ultrafine particles) and can reach very high concentrations in comparison with outdoor air [24]. Sensors that monitor for traffic related air pollutants in real time and alerts drivers when pollutants levels are high should be installed in vehicles. An integration with mobile app to display the air quality scores would be beneficial. Smoking behavior among drivers further exacerbates health risks [39]. To mitigate these risks, efforts have been made to increase awareness among drivers about the dangers of air pollution and the importance of preventive measures, such as wearing masks while working [36]. It is expected that the introduction of smart mask technology will improve driver's health, by enhances driver's protection during working. The mask with built-in filters and sensor to detect pollution level and breathing quality.

Studies show drivers experience higher exposure levels while working, especially in congested urban areas [65]. Key factors influencing in-vehicle exposure include route, traffic conditions, time-related variables, and ventilation settings

[66]. An application of route optimization technology with global positioning system (GPS) and artificial intelligence (AI) based apps to avoid high pollution hotspots during peak hours is great technology approach to reduce congested areas thus reduce the health impacts. According to the study conducted in-car particulate matter exposure across ten global cities, coarse particles (PM<sub>2.5-10</sub>) dominated when windows were open. In contrast, fine particles (PM<sub>2.5</sub>) dominated when the fan was on or the air was recirculated, indicating that car filters effectively remove coarse particles but not fine particles [67]. Therefore, strategies such as driving with closed windows [65] and developing responsive ventilation systems [66] have been suggested to cater ventilation aspects.

## 5. CONCLUSION

This paper reports the first attempt to review the relationship between exposure to traffic-related air pollutants and the health impacts on e-hailing drivers in Southeast Asia. While e-hailing applications are prevalent in Southeast Asia, particularly for commuting purposes, studies on the exposure to traffic-related air pollutants and the health impacts on e-hailing drivers in Southeast Asia are limited. Generally, the emergence of e-hailing services has revolutionized the transportation landscape in Southeast Asia, providing a convenient and efficient mode of travel for residents, however, the health implications for e-hailing drivers, who spend extended periods behind the wheel, have yet to be thoroughly explored. Studies have shown that the e-hailing applications can provide various conveniences. However, the effects of e-hailing services on various traffic or travel outcomes have been mixed. While some studies suggest that e-hailing services could shift trips from private cars to transit through better first and last mile connections, thereby reducing congestion. Limited research on the health impacts of exposure to traffic-related air pollutants for e-hailing drivers in Southeast Asia highlights the need for further investigation to analyze health impacts, and evaluate the benefits and challenges associated with e-hailing service as an urban transport solution.

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## DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article.

## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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