Penerbit Akademia Baru

Journal of Advanced Research Design

Journal homepage:
https://akademiabaru.com/submit/index.php/ard
ISSN: 2289-7984

A Comprehensive Review on the Adverse Effect of Traffic Noise

Chua Chee Yung[1], Toh Yoke Teng[1*], Muhamad Shahril Mohd Abdullah[2], Viknheswar Chandira Segaran[3]

[1] Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, Batu Pahat 86400, Malaysia
[2] Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia
[3] Teambuild Construction Group, 9 Defu South Street 1, 533844, Singapore

ARTICLE INFO

Article history:
Received 14 February 2025
Received in revised form 28 March 2025
Accepted 15 July 2025
Available online 11 August 2025

Keywords:
Noise; health; permissible limit; policies; environment

ABSTRACT

Traffic noise is an omnipresent issue in urban environments, significantly impacting public health, property values, and wildlife. This review paper examines the multifaceted adverse effects of traffic noise, focusing on health consequences, economic impacts on property values, and disruptions to animal habitats. Chronic exposure to high levels of traffic noise is linked to a range of health problems, including cardiovascular diseases, sleep disturbances, and impaired cognitive function. Property values in noise-polluted areas often depreciate, reflecting the decreased desirability of such locations. Additionally, traffic noise interferes with animal communication, breeding, and survival, leading to ecological imbalances. This paper also explores the permissible limits for traffic noise as established by various national and international regulatory bodies, with a particular focus on Malaysia. Existing noise regulations and policies worldwide are reviewed to provide a comparative analysis. Through this comprehensive review, the paper aims to underscore the need for stringent noise control measures and highlight best practices for mitigating the adverse effects of traffic noise. Recommendations for future research and policy development are discussed to promote healthier, quieter, and more sustainable urban environments.

1. Introduction

Noise pollution is one of the most serious types of pollution globally and can become a persistent component of daily life. Murphy and King [1] stated as cities expand, there is mounting evidence to suggest that regulating noise pollution becomes increasingly difficult for authorities to keep pace with. However, noise pollution's detrimental impacts are often underestimated by many authorities worldwide in comparison to other varieties of pollution like land, air and water pollution [2]. Noise is a by-product of various human activities, with transport-related activities being the most frequent causes of environmental noise. In fact, behind fine particulate matter pollution, traffic noise has been identified as the second most significant environmental factor contributing to adverse health effects in Western Europe [3]. The vehicle's engine on the road produced traffic noise, especially when vehicles idle at the intersection and traffic lights. The noise also can be generated when the surface

* *Corresponding author*
E-mail address: toh@uthm.edu.my

https://doi.org/10.37934/ard.142.1.1725

interaction between tire and road. It also relies on the variety types of factors, including the condition of the road, the speed of the vehicle and the volume of traffic.

Currently, people are exposed to a variety of sound levels in their everyday lives, and experts have determined that the acceptable range for maximum sound intensity falls between 75 and 85 decibels [4]. If exposed to loud sounds repeatedly over a lengthy period, hearing loss is a possibility. It is crucial to note that 85 decibels are the threshold at which exposure to noise is deemed harmful for the general public [5]. Apart from the detrimental health impacts, traffic noise pollution can also adversely affect property values and overall community satisfaction. According to a study conducted, residential properties exposed to noise pollution had a 3.1% lower rental value compared to properties that were unaffected by the traffic noise pollution [6]. Traffic noise has brought some negatively impact to the human life. Besides the study by Sulaiman *et al.,* [7] highlighted that the speed of the vehicle and traffic volume are the main causes that contribute to the increases of noise level. Another research found that a 50% drop in traffic volume led to a 3 dBA reduction in overall noise. Additionally, a decrease of 50% and 75% in traffic speed led to a noise reduction of 3 dBA and 6 dBA, respectively [7].

Noise was also known as the noise that the recipient does not want to hear. The noise levels will be recorded and measured using the decibel (dB) unit [8]. As recorded in established guidelines by the Department of Environment (DOE), the maximum allowable sound levels for residential areas in urban, suburban and mixed-use zones are 60 dBA at night (10:00 pm to 7.00 am) and 65 dBA during the day (7:00 am to 10:00 pm) [9]. A study of traffic noise pollution has been determined that noise that produced by road traffic is the primary contributor of noise pollution when compared to other types of noise. This is in line with previous research that has consistently identified road traffic as a major source of noise pollution in urban areas [10]. The movement of vehicles on road networks produces noise that has a big impact on the environment. The expansion of noise pollution is facilitated by the construction of additional roads and the increase in traffic volume, raising noise levels in areas close to major roads [11]. Averaging at 62.3 dBA across a frequency range of 840 Hz to 970 Hz, the sound level has the potential to be the main source of aggravation for the people [12]. The main sources of noise in an actual traffic scenario are the engines and the exhaust systems of cars, buses, lorries and motorbikes. Thus, noise emission brought on by vehicles has a significant impact on environmental pollution. To further illustrate this, Figure 1 depicts the varying levels of human discomfort associated with different types of noise sources. The figure demonstrates that road traffic is consistently associated with higher levels of discomfort than other types of noise.

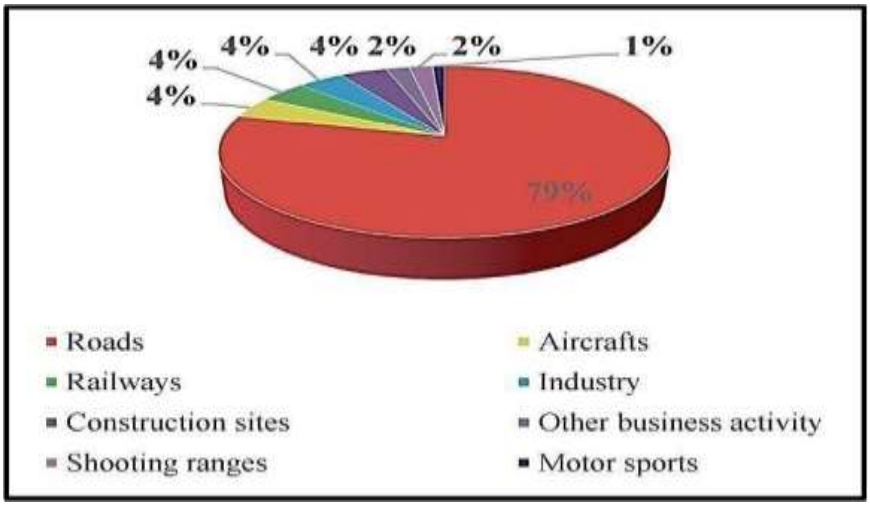

Fig. 1: Human discomfort associated with varying types of the noise sources

This paper provides a comprehensive review of the adverse effects of traffic noise, addressing the problem of poor urban planning which results in limited space and increased exposure to health and safety hazards. The paper highlights the escalation of traffic noise, particularly in residential areas. The objectives include reviewing existing knowledge on traffic noise and identifying its adverse impacts. The scope covers the effects of traffic noise on health, property values, and animals, as well as an examination of existing noise regulations and policies both in Malaysia and globally.

2. Adverse Effect of Traffic Noise

Previous studies have shown that traffic noise significantly affects daily life [13], physical health [14] and mental health [15,16], with prolonged exposure linked to higher mortality rates [17]. This study aims to assess the impact of traffic noise in residential areas, where poor urban planning has led to the construction of homes near busy traffic lanes, posing health risks. The lack of buffer zones and soundproofing exacerbates road traffic noise pollution. By focusing on residential areas, this research addresses a significant gap in current studies. The findings will offer recommendations for noise reduction measures to protect community health and ensure compliance with Department of Environment guidelines [9]. This study aligns with Wang *et al.,* [18], who highlighted the need for assessing noise pollution to support effective prevention and control measures. Therefore, it is crucial to conduct a detailed assessment of traffic noise levels to determine the extent of noise pollution in residential areas. This case study will evaluate whether traffic noise exceeds the permissible levels set by the Department of Environment, Malaysia [9].

Traffic noise is a pervasive environmental pollutant that significantly impacts health, property values, and wildlife. Chronic exposure to high levels of traffic noise is linked to numerous health issues, including cardiovascular diseases, sleep disturbances, and reduced cognitive function, posing serious risks to public well-being. In residential areas, persistent traffic noise can lead to a decline in property values, as the quality of life is diminished, and potential buyers are deterred by constant disturbance. Additionally, traffic noise adversely affects animals, disrupting their communication, breeding, and survival, which can lead to broader ecological imbalances. This review explores these multifaceted adverse effects, emphasizing the urgent need for effective noise management and regulatory measures to mitigate these impacts.

2.1 Health

Road traffic noise is a major health hazard that adversely affects individuals. The pervasive nature of noise pollution is evident, and its long-term detrimental effects on health are widely recognized. In urban and semi-urban areas, a substantial proportion of noise pollution is attributed to insufficient space and poor urban planning, with road traffic noise being a significant contributor. Consequently, the general populace is exposed to various health hazards associated with noise pollution [19]. Zare Sakhvidi *et al.,* [20] investigated the relationship between the exposure to noise and diabetes mellitus. The study indicated that the continued growth in the prevalence of diabetes mellitus around the world has been partially influenced by noise exposure. The analysis of data indicated that prolonged exposure to traffic noise increases the risk of diabetes mellitus. The meta-analysis carried out in the study concluded that there is a 6% higher likelihood of having diabetes mellitus with every 5 dB rise in noise exposure. Van Kempen *et al.,* [21] has been carrying out a comprehensive assessment to examine the relation of environmental noise with its impact on cardiovascular health and metabolism. The research highlighted proof evidence that exposure to traffic noise considerably raises the risk of ischemic heart disease (IHD). The risk of IHD was increased by 8% per 10 dBA of

noise exposure, with the risk becoming even greater at exposure levels starting at around 50 dBA. The pooled studies indicated that significant increases in the prevalence and incidence of IHD have been attributed to the rise in road traffic noise.

Based on the research that conducted by Jafari *et al.,* [22], noise can act as a stressor and negatively impact parts of brain that are responsible for regulating stress response, such as the hippocampus and amygdala area. The study resulted that noise could lead to a reduction in cortical thickness and activate stress pathways in the brainstem and hypothalamus, resulting in an increase in the release of neurotransmitters like noradrenaline and dopamine. Furthermore, noise can also cause a disturbance in the prefrontal cortex, which plays a crucial role in executive function- related cognition. Another study that was performed by Lan *et al.,* [23], a random-effects meta- analysis was conducted to carry out the correlation between traffic-related noise and mental health. The study suggested that stress and behavioral processes could explain the correlation between noise and mental health. Repetitive stimulation of the endocrine and autonomic nervous systems by transportation noise has been shown to cause physiological arousal and release of hormones that are associated with stress like cortisol and adrenaline. The study's result revealed a clear association between increased anxiety levels and traffic noise. Traffic noise had a substantial negative effect on mental health; a 10 dBA increase in daytime or nighttime was linked to a 9% higher likelihood of experiencing anxiety. Mixed traffic noise, out of few categories of traffic noise, generated the most anxiety (44%), subsequently followed by road traffic.

In Hesse, Germany's region, Hegewald *et al.,* [24] earlier research revealed that noise produced from vehicles had a considerable negative influence on local's health and quality of life. According to the estimates, a total of 26,501 years of healthy life (DALY) will be lost in 2015 due to depressive disorders, annoyance and cardiovascular disease that are caused by prolonged exposure to road traffic noise. Based on an official EU Environment Noise Directive-exposure data, this translated to an estimated of 1000 individuals will lose a total of 4.3 years of healthy life. The study also revealed that the actual disease burden caused by noise-induced cardiovascular disease and depressive illness was underestimated by 76 %.

2.2 Property Value

Ozdenerol *et al.,* [25] has studied the relationship between traffic noise and property prices in Memphis and Shelby County. The study utilized anticipated noise levels from various sources such as cars, trains, motorways, and railroads, and found that traffic noise had a significant and consistent effect on house prices. The findings of the study displayed a direct relationship between noise levels and the decrease in the values of property, with the reduction on the pricing of houses rising as the noise levels grew. The study also identified that high transportation usage and congestion were contributing factors in the continual depreciation of housing values.

A previous study conducted by Zambrano-Monserrate and Ruano [26] investigates the impact of ambient noise on house rental costs in developing nations. The research study's conclusion revealed a negative association occurs between noise level and housing rental costs, with the price of a home decreasing by an average of 1.97 % for each unitary increment in sector's noise level (dB). Interpolation maps were constructed to identify the noise level during specific times of the day, showing that the noise level can reach up to 78 dB. Road vehicles are the primary source of noise due to excessive horn usage and frustrated drivers at out-of- synch traffic lights.

Guijarro [27] applied the hedonic model to demonstrate that the price of residential properties is significantly impacted by both distance and daily traffic volume. The study collected data on the cost and specifications of 21,634 residential properties and the traffic volume at 3,904 distinct

locations through Madrid, Spain. It was found that traffic-related factors can affect the price of residential real estate. Specifically, the distance between a residential building and the nearest traffic measurement point (TMP) has a positive effect on price, resulting in an average increase of 0.7% at a distance of 1 km, while prices are reduced by 1 % for every 100,000 vehicles passing the TMP.

Another study conducted by Kuehnel and Moeckel [28] in the Munich, Germany employed the hedonic price regression model to estimate the impact of traffic-induced noise on rental costs. It was found that the levels of noise predicted by the transportation model had a significant effect on the rental cost of the house. The study found a Noise Sensitivity Depreciation Index (NSDI) of 0.4, meaning that a 1 dBA increase in noise levels corresponded to a 0.4 % reduction in rental costs. Additionally, the study also found that locations with particularly high noise levels could experience discounts of up to 9.6 % when noise was used as a categorical variable.

Wen *et al.,* [29] performed a case study that showed the negative impact of urban road traffic on the nearby residential property values owing to the noise and air pollution caused. The study found that road traffic noise has a significant effect on the property value, especially lower levels of high-rise structures. Furthermore, the negative impact of the vehicle's speed is greater than that of its density. The study showed that there was an average decline of 0.221 % and 0.100 % surrounding a property for every 1 % increase in the speed and density of the vehicle, respectively. When both vehicle speed and density are increased by 1 %, the property price will be reduced by 4072 Yuan and 2374 Yuan, respectively.

2.3 Animals

There is consensus among scientists that noise has a significant impact on an animal's physiology and behaviour. Prolonged exposure to noise can damage an animal's reproductive capabilities, long-term survival due to chronic stress and energy balance [30]. Therefore, the rapid and significant increase in ambient noise levels in urban areas needs to be considered in terms of its impact on acoustic communication of animals. As noise levels increase, the range and area within which animals can hear auditory signals decreases. Table 1 illustrates the audible frequency range (in Hz) of typical urban and zoo animals, highlighting the potential impact of urban noise on animal communication.

Table 1
Audible frequency range (Hz) of animals

Species	Approximate range (Hz)
Goldfish (*Carassius auratus*)	20-3,000
Cat (*Felis catus*)	45-64,000
Cow (*Bos taurus*)	23-35,000
Horse (Equus caballus)	55-33,500
Sheep (*Ovisaries*)	100-30,000
Rabbit (*Oryctolagus cuniculus*)	360-42,000
Rat (*Rattus rattus*)	200-76,000
Mouse (*Apodemus sylvaticus*)	1,000-91,000
Bat (*Myotis spp*.)	200-76,000
Dog (*Canis lupus familiaris*)	67-45,000
House sparrow (*passer domesticus*)	675-18,000
Barn Owl (*Tylo alba*)	200-12,000
Chicken (*Gallus domesticus*)	125-2,000
American Crow (*Corvus brachyrhynchos*)	300-8,000
Cockatiel (*Nymphicus hollandicus*)	250-8,000

Balwan [31] conducted research to study the effect of traffic noise pollution on human health and animal. The result found that noise has diverse effects on animal behaviour, such as avian breeding behaviours, psychiatric changes in cows and goats and neurobiological effects on animals. Several studies have also reported that anthropogenic noise unquestionably harms on birds and animals living in the urban areas as well as domestic cattle. Osbrink *et al.,* [32] conducted a research experiment to investigate the impact of traffic noise on the cognitive ability of zebra finches, which have been utilized in various cognitive tasks, such as spatial memory, motor learning and colour association. The experiment revealed that zebra finches exposed to traffic noise recordings exhibited lower performance in cognitive tasks when compared to the control group. Moreover, there was evidence that traffic noise negatively affected social and motor learning, as well as inhibitory control, which could have harmful indirect consequences on animals living close to roads. According to a study done by Giordano *et al.,* [33], the experiment applied speakers emitting noise at approximately 62 dB. The result showed that road noise led to a decrease in small mammals' risk perception of predation, resulted in increasing food consumption and negatively affecting their foraging efficiency and alertness. Such changes in behaviour can have severe consequences on population dynamics if they affect the survival of prey and their predators. The study also found that road noise impairs prey's ability to recognize and react to their predators as intended.

3. Existing Noise Regulation and Policies

According to the guidelines set by the DOE, the acceptable limits for continuous sound pressure level ($LLAAAAAA$) in urban residential zones are 65 dBA during the daytime and 60 dBA at night. To prevent serious annoyance among residents, the World Health Organization also suggest that outdoor noise levels should not exceed 53 dBA during the day and 45 dBA at night [34]. These noise level limits are made to safeguard residents and guarantee their wellbeing.

The Environmental Quality Act, 1974 is widely considered as Malaysia's most extensive and comprehensive legal framework for preventing pollution and safeguarding the environment. It serves as a fundamental tool for attaining environmental policy objectives. Based on the Section 23 of the Act, it is prohibited to produce noise at a level louder than permitted, without a license, authorization or permit. To curtail sound emission and its diffusion into the surroundings, six schedules have been formulated as guidelines for Environmental Noise Limits and Control, which correspond to different categories of land use and allowable sound levels (Department of Environment Malaysia, 2019).

The Noise Control Act, 1972 was established a policy to build up a noise-free environment that does not pose a risk to the health and wellbeing of all U.S citizens. The act, specifically, sanctioned the enactment of nationwide noise emission standards for goods disseminated in the marketplace and created an efficient approach for the coordination of federal research and initiatives on noise control. The legislation was significant in educating the people about the characteristics of these items that reduce noise pollution [35,36].

Western Australian Planning Commission: Department of Planning Lands and Heritage [37] has replaced the Implementation Guidelines for State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use with the Road and Rail Noise Guidelines in 2019. The guideline serves as supplementary information to support the implementation of SPP 5.4, outlining the policy requirements at every stage of the planning process and determining the best land-use planning in areas that affected by transportation noise. These instructions provided may aid in assessment methodology, site verification and management plan.

The NSW Government has replaced the Environmental Criteria for Road Traffic Noise with its updated NSW Road Noise Policy (RNP) in 2011. The new policy sets out a range of measures that

must be implemented to reduce road traffic noise and its effects. The RNP aims to assess and mitigate the effects of traffic noise from both ongoing and completed road construction and traffic-generating developments in areas such as homes and other sensitive areas. It works conjunction with other NSW Government policies and plans to ensure that the noise impacts of road traffic are adequately evaluated and addressed in all affected areas [37]. Efforts have been made to reduce noise exposure in neighbourhoods impacted by road traffic noise, including the installation of noise barriers and housing insulation. Guidance on acoustic standard for the resident who lives near the roads was provided by referring to the standard as listed in [36-38].

Vision for 2050: A Healthy Planet for All" has been introduced by European Commission in [39], which highlights crucial targets for 2030 to expedite the decrease of pollution and achieve the 2050 goal. One of the elements is to decrease 30 % the percentage of individuals who suffered from chronic discomfort due to traffic noise by 2030, in accordance with EU regulations. The commission will enhance the regulatory framework on noise related to road vehicles, tyres, railways, aircrafts and globally, as well as researching how to address noise at the source. The Directive also demands that plans for sustainable urban mobility incorporate noise control measures and benefit from the increased utilization of active transportation and environmentally friendly public transport [39]. Table 2 indicates the policy and actions that recommended by World Health Organisation towards traffic noise.

Table 2
Road traffic noise, policies and action (WHO, 2022)

Guidance	Sector involved	Instrument
Improve the choice of appropriate tyres and road surface	Transport Land use planning	Regulation: infrastructure, technology and built environment
Reduce traffic flow and restrict truck traffic (A)(2)	Transport Land use planning	Regulation: taxes and subsidies: infrastructure, technology and built environment
Insulate dwellings, construct barriers (B)(2)	Housing Land use planning	Regulation: taxes and subsidies: infrastructure, technology and built environment
Construct road tunnels (C)(2)	Transport Land use planning	Infrastructure, technology and built environment
Design a "quite side" in the dwelling, create nearby green space (D)(2)	Housing Land use planning	Infrastructure, technology and built environment

4. Conclusions

In conclusion, this comprehensive review underscores the profound adverse effects of traffic noise on public health, property values, and wildlife. The findings highlight that poor urban planning exacerbates the exposure to harmful noise levels, particularly in residential areas, leading to serious health hazards such as cardiovascular diseases and sleep disturbances. Property values in these noisy areas decline, reflecting the diminished quality of life and desirability. Additionally, traffic noise disrupts animal behaviors, causing ecological imbalances. The examination of existing noise regulations and policies in Malaysia and globally reveals a pressing need for more stringent and effective noise control measures. By implementing better urban planning practices and enforcing stricter noise regulations, it is possible to mitigate these adverse effects, promoting healthier, quieter, and more sustainable urban environments. Future research and policy development should continue to focus on innovative solutions to address this pervasive issue.

Acknowledgement

This research was funded by a grant from Research Management Centre (RMC) Universiti Tun Hussein Onn Malaysia (UTHM) (TIER 1 Grant vot Q127).

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