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A Comparative Evaluation of Pedestrian Facilities Outside Schools: Current Conditions Against Design Guidelines

Naimah Osman[1*], Na'asah Nasrudin[2], Yusfida Ayu Abdullah[2]

[1]*Postgraduate Studies, College of Built Environment, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*
[2]*Studies of Town and Regional Planning, School of Town Planning and Landscape Architecture, College of Built Environment, Universiti Teknologi MARA Selangor Branch, Puncak Alam Campus, 42300 Bandar Puncak Alam, Malaysia*

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ABSTRACT

This study assesses the condition of pedestrian facilities outside school areas by comparing the findings from site observations with established design guidelines derived from national and global practices. The research uses qualitative data from site observations conducted in five (5) primary schools in Shah Alam. School selection was based on similar socio-economic characteristics, land use, and geographical proximity. The findings indicate that the existing pedestrian facilities significantly fail to meet the requirements outlined in current design guidelines. Critical deficiencies include inadequate infrastructure, poor maintenance, and the presence of obstacles that hinder safe pedestrian movement. Furthermore, the analysis reveals a lack of proactive oversight and maintenance by the responsible authorities, exacerbating safety risks for schoolchildren and community members who use the facilities. This paper highlights the urgent need for improved design, regular maintenance, and increased investment in pedestrian infrastructure to enhance safety and accessibility around schools. Recommendations are provided to local authorities to foster a safer walking environment for children and promote active transportation within the community.

INTRODUCTION

Walking falls into the category of physical activity, and research done by Uddin et al. (2019)) shows that it is a behaviour that improves health among children and adolescents. Choosing active travel modes, such as walking and biking to school, is conducive to increasing the children's physical activity levels (Sirard et al., 2008). According to World Health Organisation (WHO) recommendations, children and adolescents between the ages of 5 and 7 should engage in at least 60 minutes of moderate-to-vigorous-intensity physical activity (MVPA) daily (Activity, 2020). This consistent physical activity is vital for their growth,

[1*] Corresponding author. *E-mail address*: naimahosman.phd@gmail.com
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development, and overall well-being. Furthermore, according to Hawley et al. (2019), children and adolescents may benefit further from this type of activity in terms of their health, contributing not only to improved physical fitness but also to enhanced mental and emotional well-being, fostering a holistic approach to health in young people.

According to compelling data, children who utilise active transportation are more likely to be physically active than those who rely on passive modes of transportation (Lu, Sun, Gou, Liu, & Zhang, 2019; Uddin et al., 2019). According to (Tewahade, S., Li, K., Goldstein, R. B., Haynie, D., Iannotti, R. J., & Simons-Morton, B., 2019), children's commute to and from school can significantly impact rates of physical activity and health outcomes. However, few nations worldwide have high rates of AST engagement (Tewahade et al., 2019; Uddin et al., 2019). Similarly, schoolchildren in Malaysia are more frequently transported to school by bus or automobile than by foot or bicycle. As a result, children's physical activity raises concerns.

Many developed countries have been actively investigating factors that hinder people from engaging in active travel in the last few years (e.g., distance to home, safety concerns, and parent perceptions). According to the literature, most school travel studies have been conducted in Western developed countries. On the other hand, research in middle-income nations has been infrequent. According to recent empirical and experimental research, active school travel behaviour is complicated, with various factors interacting at different levels and differing determinants across situations (Hawley et al., 2019). Therefore, this study aims to provide an overview of one (1) aspect and outline the potential contributions from the urban planning field toward exploring the built environment, focusing on the existing pedestrian facilities outside the school zones in Shah Alam City, Malaysia.

LITERATURE REVIEW

National Policies on Walkability

The approach to formulating the National Physical Plan 4 focuses on several key areas to achieve a prosperous, resilient, and liveable nation. This document serves as a spatial framework for physical planning at the national, regional, state, and local levels, translating various related policies into strategic directions and actions to achieve national goals. Among these strategies, Action CI3.1B, which advocates for a comprehensive pedestrian and bicycle network to support community amenities, is directly linked to the overarching goal of creating a Liveable Environment and Inclusive Community, as outlined in CI3 of the plan (Department of Town and Country Planning, 2021). This strategic direction is particularly relevant to the development of walkable environments around schools and supports the study's objective, which focuses on evaluating pedestrian facilities near primary schools.

Providing a robust network for pedestrians and cyclists encourages active transportation modes, which aligns with fostering a liveable environment where residents can walk and cycle safely. In school zones, such infrastructure is crucial for supporting children's independent mobility and reducing traffic congestion during peak school hours. The emphasis on pedestrian facility provision, particularly near key locations such as educational institutions, resonates directly with the present study's aim of comparing existing infrastructure with official design guidelines.

Reducing reliance on private vehicles for local transportation is greatly aided by a well-developed pedestrian network throughout the city, particularly at focal points like city centres, transit hubs, employment districts, neighbourhood centres, tourist spots, and educational institutions. In this context, the condition and availability of pedestrian infrastructure near schools become a vital component of broader

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urban mobility goals. Consequently, this fosters the utilisation of public transit and environmentally sustainable modes of mobility, such as walking and cycling. Thus, continuous, comprehensive, convenient, safe, user-friendly, and easily accessible pedestrian facilities must be provided in every Malaysian town and city, a principle that underscores the need for detailed site observation, as undertaken in this study.

Furthermore, this study aligns with the current policies outlined in the government's 12th Malaysia Plan (2021-2025), specifically under Chapter 8: Accelerating Green Growth for Sustainability and Resilience (Economic Planning Unit, 2021). Within Priority Area A, which focuses on implementing low-carbon, clean, and resilient development, the plan strongly emphasises promoting environmental sustainability, resilience, and continuous socio-economic growth. One (1) of the key areas highlighted is the transition to a low-carbon economy, which includes reducing emissions from the transportation sector by encouraging walking and cycling. By assessing the quality and compliance of pedestrian infrastructure around primary schools, this study contributes to understanding how current built environments align with national-level aspirations for sustainable and active mobility.

The strategic framework "Towards a Low-Carbon Country" also encourages collaboration among federal and local governments, the private sector, and civil society to support this transition. This includes promoting green cities and environmentally friendly transportation, with a particular focus on enhancing walkability and accessibility. Hence, pedestrian infrastructure around schools is not only a matter of student safety and accessibility but also one (1) of environmental stewardship and urban resilience.

The government also introduced a Low-Carbon Mobility Blueprint, which serves as a comprehensive framework for planning, executing, monitoring, and assessing initiatives to promote eco-friendly mobility ("Low Carbon Mobility Blueprint 2021-2030," 2021). This plan encompasses initiatives to improve the accessibility, connectivity, safety, and reliability of public transportation services, as well as the pedestrian environment. Specific attention is given to improving walking and cycling conditions, including traffic calming and design elements that are directly relevant to the current study's site observations of school pedestrian zones.

Therefore, this study focuses on the most crucial elements influencing this decision-making process: the provision and condition of pedestrian facilities and infrastructure. Concentrating on school zones enables a targeted evaluation of how well current infrastructure supports children's walking to school, in alignment with both safety needs and national planning priorities. Through this lens, the study aims to identify gaps between current practice and policy intent, thereby offering evidence to guide future improvements at the local level.

RESEARCH METHODOLOGY

This study uses qualitative research data from site observations conducted in five (5) primary schools in Shah Alam City. School selection was based on similar socio-economic characteristics, land use, and geographical proximity. Choosing schools with similar socio-economic characteristics is essential to ensure that the findings are not skewed by economic disparities, enhancing the reliability of the data obtained. Additionally, selecting schools within a similar land-use context and geographical proximity minimises variability related to urban planning or environmental factors. The school selection likely represents typical settings within Shah Alam City, making the research findings more generalisable to similar contexts. Lastly, the criteria for school selection align closely with the study's aim, ensuring that the selected sites provide relevant data to address the research questions effectively.

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Site observation was conducted to understand the current state of the research area, the behaviour of children walking to school, and the condition of the pedestrian amenities. The researcher also examined how the land was utilised around the school, which became an integral part of the built environment.

Images and videos of the pedestrian amenities at school zones were taken during the site observation survey to aid the researcher in the analysis stage. Conditions that arose during the peak hour of the day were noted to monitor the surrounding environment and comprehend how pupils walked to school. Along with a few other components, the researchers measured the width of the pedestrian facilities, observed the pavement materials, and examined several vital elements that support the pedestrian facilities and infrastructure in detail. The measures were required since the researcher wished to compare the pedestrian facilities measured on-site with the fundamental recommendations and international norms and design guidelines. Also, the researcher observed the land use surrounding the school location through a series of random observations.

RESULTS AND DISCUSSIONS

Existing Conditions of Pedestrian Facilities

Most students walk to school, not only from the bus stop to the school building, but also from nearby residential areas. The pedestrian path inside the school should be connected to or accessible outside the gate to make it easier for students who ride buses and other forms of transportation. Meanwhile, footpaths should be provided between schools and nearby residential areas to encourage students to walk to school safely. The existing condition of the pedestrian path in every school zone is presented as follows.

During the site observation, the researcher noted that the pathway's width varies significantly, ranging from 1.6 to 3.3 meters. This variability in width may have essential implications for pedestrian flow, accessibility, and overall usability of the pathway. There is data on human body shape studies related to the planning of pedestrian facilities, specifically the width, size, height, and thickness of the adult body when walking in various styles. A person who walks needs enough space to swing their limbs, providing comfort when moving. Generally, pedestrians require 2.5 feet (0.76 meters) of space per person to cross paths safely. For pedestrians walking together, a width of 2.2 feet (0.67 meters) is required for each person to maintain a safe distance from their fellow pedestrians. According to Jabatan Kerja Raya (2015), sidewalks should be wide enough to accommodate the expected volume of pedestrian traffic, including both schoolchildren and their parents. The recommended minimum clear width for sidewalks is 2.0 meters.

Based on the above information, the pathway width at the site nearly fulfils the minimum requirement. At its narrowest point of 1.6 meters, the pathway poses no challenges for two (2) way pedestrian traffic, thereby avoiding congestion and discomfort for users. Similar to the broader sections at 3.3 meters, the path facilitates smoother movement and can accommodate more pedestrians simultaneously, enhancing the overall experience. It is essential to consider these measurements in the context of the surrounding environment, as the pathway's width may influence safety, accessibility for individuals with mobility challenges, and the potential for social interactions among users. Therefore, future design considerations should optimise the pathways' width to balance functionality and user comfort, ensuring that they meet the needs of all pedestrian groups, including schoolchildren.

Street lighting is another element that must be considered while providing pedestrian facilities. The provision of street lighting on the footpath depends on the need and the financial budget. In many urban areas, the street lighting system, in addition to illuminating the main traffic flow, also needs to consider

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lighting for pedestrian paths. Installing street lighting is encouraged, particularly in areas such as crosswalks, intersections, building entrances, outside school zones, and high-traffic conflict zones. However, the lights' location and height must meet the standard design and guidelines. The recommended illumination level for the path's surface is between 5.38 and 21.53 lux (0.5 and 2.0 footcandles).

Fig. 1. (left) This Figure is Blurry, which is Unacceptable; (right) This Figure has a Higher Resolution

Source: Authors (2024)

The placement of streetlamps must be at a distance of 4.5 meters to 6.1 meters apart to ensure that the light illuminating the path remains connected without causing any area to become dark and thus posing a danger. Each lamp post must be arranged in an orderly manner and placed in the designated reserve, which is 0.4 meters from the side of the footpath. Placement in the middle of the pathway is not allowed to avoid

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interfering with the user's journey and creating discomfort for the user. The height of lamp posts' lights is between 2.1 meters and 3 meters. The standard height is outlined to ensure that the level of lighting provided can illuminate pedestrians. Additionally, it also aligns with the human height scale.

The site observation revealed a notable absence of dedicated street lighting for pedestrian facilities. This condition has raised concerns regarding safety and visibility among individuals using the pathways, especially at dark. Currently, the existing streetlamps are positioned along the road shoulder and are primarily installed to serve vehicular traffic, necessitating a shared lighting arrangement. Based on the researcher's experience walking in that area at night, the installed streetlamps do not adequately illuminate the pedestrian areas. This situation may lead to increased risks for pedestrians, as they may be less visible to drivers and face challenges navigating the pathway in low-light conditions.

Referring to the actual case that happened in 2018, a 49-year-old woman was struck and killed by a self-driving Uber vehicle in Tempe, Arizona, while crossing the street outside of a crosswalk. The accident investigation revealed that the pedestrian crossing did not meet the minimum lighting requirements outlined in the Manual on Uniform Traffic Control Devices (MUTCD), which made it difficult for the vehicle to detect the pedestrian (Tanvir, 2024).

Furthermore, the distance between the road lights and the pedestrian facilities further exacerbates the issue, creating areas of shadow that could deter usage and compromise safety. During the site observation, the distance between road lighting measured is between 30 and 49 meters, which is too far apart. Therefore, to enhance pedestrian safety and encourage greater use of these facilities, it is imperative to consider installing dedicated lighting solutions at reasonable distances that prioritise the needs of pedestrians.

Fig. 2. Street Lighting at SK Seksyen 7

Source: Authors (2024)

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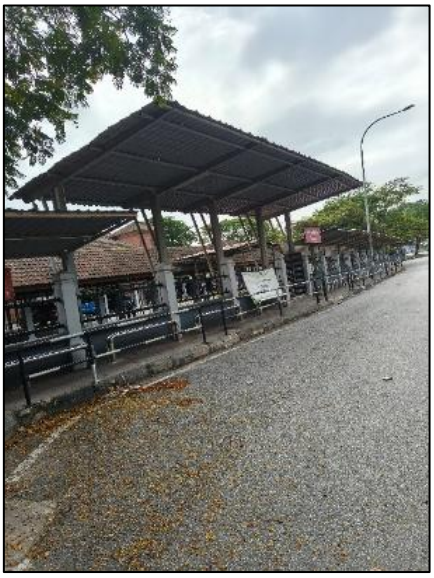

Fig. 3. Covered Walkway at SK Seksyen 7

Source: Authors (2024)

Besides, the requirements of roofs on footpaths must be considered to ensure well-lit pathways that promote a secure and inviting environments for all users. All sidewalks within the designated school district should have roof covers to protect school children from the weather. These sheltered sidewalks are essential for the comfort and safety of children, helping to discourage them from loitering in inappropriate areas. However, the site observation revealed that the pedestrian facilities lack adequate protection from the elements, as no roofs or covered walkways are in place. The open-air design exposes pedestrians to the direct effects of weather conditions, such as rain, sun, and wind, making the walking experience less comfortable and potentially discouraging usage during inclement weather.

Moreover, the absence of a covered walkway also contributes to the poor lighting conditions observed along the pedestrian facilities. Without a roof or overhead structure to reflect and distribute the available light, the pathways remain dimly lit, particularly in areas where streetlamps are sparsely placed or inadequate. As a result, this combination of open-air exposure and insufficient lighting can create an unwelcoming environment for pedestrians, potentially compromising their sense of safety and security, especially at night or in low-light conditions. Thus, to enhance the usability and appeal of these pedestrian facilities, it is crucial to consider the installation of covered walkways or roofs that not only provide shelter from the elements but also help to improve lighting conditions along the pathways, creating a more inviting and accessible environment for all users, including schoolchildren.

The Basic Guidelines on Pedestrian Facilities released by the Roads Branch of the Public Works Department Malaysia (1997) stated that School Children's crossings have been marked in various ways in different areas of Malaysia. However, none of them has any legal or regulatory backing. Consequently, this poses a severe legal problem for road authorities, such as the Public Works Department, in the event of any court action arising from an accident at such sites.

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Fig. 4. Pedestrian Crossings in front of SK Seksyen 7 and SK Seksyen 17

Source: Authors (2024)

Figure 4 is an image of pedestrian crossings located at SK Seksyen 7, which have clear markings compared to the crossings in SK Seksyen 17, which have unclear markings. Based on the above figure, it can be observed that the responsible authorities did not adequately maintain the existing facilities due to unclear road markings. The absence of clear markings may lead to confusion among pedestrians and drivers, potentially resulting in road accidents. It is particularly challenging for those individuals who are visually or mobility-impaired. This group may lack the necessary cues to navigate safely. Therefore, providing pedestrian crossings with high visibility to approaching other motorised users is essential, possibly using warning signs and traffic calming measures. Furthermore, this type of crossing typically does not prioritise pedestrians, requiring them to judge when it is safe to cross. Even though they can facilitate a smoother traffic flow, they pose significant risks, especially in areas with higher traffic volumes or speeds.

According to the U.S. Department of Transportation (2021), in 2021, a 14-year-old student was struck and killed by a vehicle while crossing the street to get to his school bus stop in Baton Rouge, Louisiana. This incident occurred due to the faded road markings of the zebra crossings and inadequate lighting, which failed to meet the visibility requirements outlined in the MUTCD. The residents of that area had previously requested safety improvements at the location, but the responsible authorities took no action.

According to the Public Works Department Malaysia (1997) in the Basic Guideline on Pedestrian Facilities, school children's crossings are most likely to be installed at secondary arterial, collector roads, and local roads, where children must regularly cross the road. Subject to firm arrangements being made for the Children's Crossing Flags to be placed (or the flashing lights to be switched on) during the appropriate periods of the day when children are expected to be crossing the road and for the flags to be removed (or the flashing lights switched off) outside the crossing periods. This arrangement often includes an adequately authorised, 'instructed,' and uniformed 'Crossing Supervisor', who operates the crossing equipment and conducts the children safely across the road.

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There are two (2) types of level pedestrian crossings with traffic lights: single-level crossings and two (2) level crossings. Single-level crossings are level crossings with traffic lights suitable for being built on roads with a few lanes (two (2) lanes - single road without a divider). Pedestrians who want to cross the road only need to press the button on the traffic light pole once before they are allowed to cross the road. The application is straightforward, especially for school children.

A two (2) level crossing is a level crossing equipped with traffic lights, typically located on a wide road (double road with a road divider). It is generally built in urban areas, and its application is almost the same as that of a single-level crossing, where pedestrians must push a button on the traffic light pole provided before crossing (first time) and after crossing the road divider to proceed (refer to Figure 5). In other words, pedestrians will cross the road in stages while reducing waiting time for different users.

Fig. 5. Example of a Two (2) Level Crossing

Source: Authors (2024)

Fig. 6. Sketch of Signalised Pedestrian Crossing at School Zone

Source: Department of Town and Country Planning (2021)

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According to the Road Engineering and Geotechnics Department (2014), a level pedestrian crossing with traffic lights located outside the school area only should be built based on the existing standard design, which is referred to as Signalised Pedestrian Crossing School Zone, Drawing Number KPKR/J/R/STD AM 222-1 dan AM 222-4 (refer Figure 6).

Typically, a signalised pedestrian crossing phase consists of two (2) main phases: the vehicle movement phase and the pedestrian crossing phase, which provide clearance time for pedestrians to cross. Some aspects must be considered when giving pedestrian crossings with traffic lights. For example, pedestrian speed must be considered, as it determines the appropriate transit times based on the road width and the category of pedestrians crossing, such as schoolchildren, people with disabilities, or older people, ensuring they can cross safely. Typical speeds for pedestrians are:

(i) The minimum walking speed of pedestrians = 0.74 m/s, and the maximum walking speed of a pedestrian walking = 2.39 m/s

(ii) The commonly used pedestrian walking rate is 1.0 m/s

Besides, there are several essential characteristics of signalised crossings, such as the number of traffic light poles installed is sufficient (minimum of two (2) poles), installing related notification and warning signs (traffic light crossing), and making it adequate and integrating the construction of pedestrian crossings with the construction of footpaths (existing tactile surfaces and curb ramps for crossings areas) and street lights. Additionally, the minimum distance between pedestrian crossings is 400m, taking into account the need for street lighting installation, particularly when there is pedestrian crossing activity at night. The sketches of pedestrian crossings with traffic lights are shown in Figure 6.1.

Fig. 7. Traffic Light in SK Seksyen 7 and SK Seksyen 17

Source: Authors (2024)

Figure 7 shows the existing condition of pedestrian crossings in front of SK Seksyen 7 and SK Seksyen 17. Based on the observations, the traffic lights were not functioning in most school zones the researcher observed. There is no signage to notify of the presence of traffic lights provided, and the provision of traffic

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lights does not meet the design standard set by the Road Engineering and Geotechnics Department. In the areas where traffic lights are not functioning, pedestrians are left to navigate the roads without any automated assistance. This situation can be particularly hazardous, as vehicle users may not expect pedestrians to cross without the guidance of traffic signals. School children who walk may feel uncertain about when to cross, leading to hesitation or risky behaviour.

In the absence of traffic lights, both pedestrians and motorised vehicle users need to take extra caution and vigilance. Walking schoolchildren should carefully observe traffic patterns and make eye contact with drivers before crossing the street. On the other hand, vehicle users should be prepared to yield to pedestrians and maintain a slower speed in the affected area.

Based on the current scenarios, local authorities must promptly address the issue. Temporary signage or manual traffic control may be proposed to guide pedestrians and other road users until the traffic lights are necessary. The researcher was informed that a guard assistant is appointed to control the traffic in front of the school, but this is not enough to ensure the safety of walking schoolchildren.

Surrounding Land Use of the School Area

Based on the observation, it was discovered that the surrounding land use in the areas adjacent to schools predominantly consists of residential neighbourhoods and commercial establishments. This mixed-use environment plays a vital role in influencing children's decisions to walk to school. It is due to the proximity of residential areas that provide families or individuals with convenient access to educational facilities, which encourages walking as a viable mode of transportation.

However, the presence of shop lots still exposes both opportunities and drawbacks. On the one (1) hand, a commercial area near the school can enhance the walkability of the environment by providing essential services and amenities (Zhou et al., 2023). For example, grocery stores and cafes may motivate parents and schoolchildren to choose walking over motorised vehicles. On the other hand, these activities may raise safety concerns, especially if pedestrian facilities are inadequate or poorly maintained. The interaction between residential areas and commercial areas thus significantly influences the schoolchildren's walking habits, emphasising the need for safe, well-designed pathways that can accommodate residents and the lively activity from the nearby businesses. Ultimately, promoting active transportation among children and enhancing their overall well-being is crucial for creating a safe and improved environment for walking.

CONCLUSION

The findings of this comparative study reveal significant deficiencies in the existing pedestrian facilities in school zones. The data collected through site observations clearly shows that the pedestrian infrastructure in the site area does not meet the requirements and standards set forth when compared to design guidelines.

The key issues identified include the lack of proper sidewalks and crosswalks, insufficient lighting and signage for pedestrian safety, uneven surfaces, the absence of roof or covered walkways, unclear road markings, and malfunctioning traffic lights. Furthermore, the responsible authorities are not adequately maintaining and repairing the pedestrian facilities to keep them in good condition and fully functional for the user. Defects, damage, and deterioration were commonly observed anywhere.

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The deficiencies and inadequate conditions of pedestrian facilities outside school areas can be attributed to several factors that hinder compliance with design standards. These factors include a lack of comprehensive planning, poor maintenance and upkeep, inadequate awareness and enforcement, and the failure to implement design standards fully, as well as the absence of specific design standards for pedestrian facilities and infrastructure outside the school area.

The following actions are recommended to address the deficiencies mentioned above. Responsible authorities may comprehensively assess all pedestrian facilities within a certain radius of every school to identify specific needs and prioritise the improvements. Additionally, they can develop and implement a regular maintenance program to inspect, clean, and repair pedestrian infrastructure, with a focus on high-priority areas around schools. Additionally, it is recommended that sufficient funding be allocated to local area budgets to upgrade existing pedestrian facilities following current design guidelines, with a focus on providing continuous sidewalks, marked crosswalks, curb ramps, and pedestrian-scale lighting. By taking these steps, local authorities can work to bring pedestrian infrastructure up to current standards, providing a safer and more accessible environment for walking for schoolchildren and the broader community.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Naimah Osman conducted the research, prepared, and wrote the original draft. Na'asah Nasrudin supervised the research activities, Yusfida Ayu led the review, revisions and approved the final manuscript.

REFERENCES

Activity, M. P. (2020, November 25). WHO guidelines on physical activity and sedentary behaviour. https://www.who.int/publications/i/item/9789240015128

Department of Town and Country Planning. (2021). National physical plan 4: The planning agenda for a prosperous, resilient, and liveable Malaysia. Ministry of Local Government Development. https://myplan.planmalaysia.gov.my/portal-main/publication-details?id=23

Economic Planning Unit. (2021). Twelfth Malaysia Plan 2021-2025: A prosperous, inclusive, sustainable Malaysia. Prime Minister's Department. https://rmke12.ekonomi.gov.my/en

Hawley, G., Witten, K., Hosking, J., Mackie, H., & Smith, M. (2019). The journey to learn: Perspectives on active school travel from exemplar schools in New Zealand. Journal of Transport & Health, 14, 100600. https://doi.org/10.1016/j.jth.2019.100600

Jabatan Kerja Raya Malaysia. (2015). Design guidelines on safety facilities for schools: 1. School Drop-Off & Pick-Up areas and 2. school zones. Cawangan Jalan, Jabatan Kerja Raya. Retrieved June 29, 2025, from http://epsmg.jkr.gov.my/images/0/0c/NTJ_30-2015_Design_Guidelines_on_Safety_Facilities_for_Schools.pdf

Low Carbon Mobility Blueprint 2021-2030. (2021). In Malaysian Green Technology and Climate Change. Ministry of Environment and Water (KASA). Retrieved June 28, 2025, from https://www.mgtc.gov.my/storage/2021/11/Low-Carbon-Mobility-Blueprint-2021-2030.pdf

Lu, Y., Sun, G., Gou, Z., Liu, Y., & Zhang, X. (2019). A dose–response effect between built environment characteristics and transport walking for youths. Journal of Transport & Health, 14, 100616. https://doi.org/10.1016/j.jth.2019.100616

Public Works Department Malaysia. (1997). Nota Teknik Jalan 18/97: Basic Guidelines on Pedestrian Facilities. Roads Branch, Public Works Department Malaysia. https://www.scribd.com/document/319057937/18-97-Basic-Guidelines-On-Pedestrian-Facilities-pdf

Sirard, J. R., Alhassan, S., Spencer, T. R., & Robinson, T. N. (2008). Changes in Physical Activity from Walking to School. Journal of Nutrition Education and Behavior, 40(5), 324–326. https://doi.org/10.1016/j.jneb.2007.12.002

Tanvir, S. (2024, September 3). Chapter 4: Design of pedestrian facilities. Sustainable Mobility. https://uta.pressbooks.pub/sustainablemobility/chapter/chapter-4-design-of-pedestrian-facilities/

Tewahade, S., Li, K., Goldstein, R. B., Haynie, D., Iannotti, R. J., & Simons-Morton, B. (2019). Association between the built environment and active transportation among U.S. adolescents. Journal of Transport & Health, 15, 100629. https://doi.org/10.1016/j.jth.2019.100629

Uddin, R., Mandic, S., & Khan, A. (2019). Active commuting to and from school among 106,605 adolescents in 27 Asia-Pacific countries. Journal of Transport & Health, 15, 100637. https://doi.org/10.1016/j.jth.2019.100637

U.S. Department of Transportation (2021). Guide for the planning, design, and operation of pedestrian facilities (3.3). Federal Highway Administration. https://highways.dot.gov/safety/pedestrian-bicyclist/safety-tools/33-guide-planning-design-and-operation-pedestrian

Zhou, L., Wang, C., & Zhen, F. (2023). Exploring and evaluating the spatial association between commercial and residential spaces using Baidu trajectory data. Cities, 141, 104514. https://doi.org/10.1016/j.cities.2023.104514