

GIS-Based Assessment on the Need and Accessibility of Bus Stops at UTHM Pagoh Campus

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Abstract

The absence of bus stop shelters in Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh Campus is being an issue that all students faced especially for bus users. This study addresses the critical issue of inadequate bus stop shelters which significantly impacts accessibility, comfort, and safety for students and other users. The absence of proper shelters exposes commuters to weather conditions like heavy rain and heat, negatively affecting their transportation experience. This problem becomes particularly acute during peak hours when passenger volumes surge dramatically. The research was conducted with three primary objectives: first, to evaluate current bus stop conditions; second, to analyze shelter demand based on weather challenges and user needs; and third, to map bus stop coordinates using Geographic Information System (GIS) technology for improvement proposals. The study employed a mixed-methods approach combining quantitative surveys with 511 student respondents, detailed field observations, and spatial analysis using GIS software. Findings revealed that 99% of respondents confirmed the lack of shelters at all bus stops, with Stops 1, 2, and 5 identified as most critical due to their high utilization rates. An overwhelming 98% of participants expressed an urgent need for shelter installation, additional seating, and clearer signage. GIS mapping successfully identified locations for shelter installations through spatial data analysis and user needs assessment. The study proposes medium-sized bus stop designs emphasizing accessibility, comfort, and weather resistance. These recommended improvements aim to enhance campus community welfare, support sustainable transportation systems, and serve as a model for other educational institutions. Implementation of these proposals aligns with UTHM's commitment to inclusive infrastructure development and sustainable campus practices.

1. Introduction

Bus transport plays a vital role in campus mobility and helps foster an integrated campus community. As campuses like Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh continue to grow and evolve, establishing and optimizing bus stop shelters becomes essential to improve accessibility and enhance students' quality of life. The UTHM Pagoh campus, located just 20 minutes from the royal town of Muar, Johor, within the Educational Hub Malaysia Pagoh and near the Pagoh Interchange on the North-South Motorway, has an active bus transportation system scheduled during weekdays to facilitate student commutes between academic buildings and other campus facilities. Currently, there are six bus transit checkpoints—one near the college cafeteria and

five others scattered across the campus. However, none of these stops are equipped with proper shelters, resulting in a poor commuting experience, especially when students must wait in unfavorable weather conditions. Weather significantly impacts public transportation by causing delays and reducing rider comfort; for example, waiting for a bus in the rain without adequate shelter can discourage usage [1,2]. Research has shown that weather conditions significantly influence public transportation systems by causing delays and reducing passenger comfort, which in turn can lead to decreased ridership [3]. This study focuses on addressing the urgent need for proper bus stop shelters at the existing checkpoints within the UTHM Pagoh campus to improve overall accessibility and commuter satisfaction.

Most students residing in Kolej Kediaman Pelajar (KKP Pagoh) heavily rely on bus services for their daily commutes. At Universiti Tun Hussein Onn Malaysia (UTHM), there are 5,012 students registered in the college, excluding Politeknik students living at KKP Pagoh. A significant number of these students depend on bus transportation during weekdays to travel between their residences and campus facilities. According to data presented in Table 1 on registered vehicles, in the 2023/2024 session, there were 701 motorcars and 344 motorcycles registered by students. This number increased in the 2024/2025 session, with 887 motorcars and 464 motorcycles registered, indicating that 1,351 students own personal vehicles [4]. To better understand commuting patterns and needs, this study collected data through questionnaires distributed among students, which helped identify high-demand bus stop locations where users frequently board or alight based on their travel purposes. These insights are essential for optimizing bus stop facilities and enhancing campus mobility to better serve the student community.

A software package incorporating Geographic Information System (GIS) technology was developed to manage and visualize the bus checkpoint coordinates at Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh campus. The system's database was constructed using a text layer approach, which enabled the precise plotting and labelling of each bus checkpoint station based on the data collected from campus transit points. According to past studies, GIS contains geographic data elements that use maps as references or legends to display symbols or figures accurately, making it an effective tool for spatial representation [5]. In this study, the GIS was applied to plot and label all existing bus checkpoints within the campus.

Students travel to campus for many reasons, such as attending classes, joining sports activities, visiting the library, or going to the cafeteria, which creates a high demand for bus stops. Although students have different class schedules, many use the bus during peak hours in the morning and afternoon. Currently, most students have to stand while waiting for the bus because there are no benches available, except at Block K where seating is provided. At night, poor lighting and unclear signs make it harder and less safe for students to find their way to bus stops. This affects both their comfort and safety. Well-designed bus stops should include basic features like shelters, benches, and clear signs to make waiting more comfortable and convenient [6]. A good bus stop system helps students get to their classes and activities on time, improves movement around campus, and supports students with disabilities. Making these improvements shows the university's commitment to safety and environmental care, creating a safer and more accessible campus for everyone.

Table 1 Data of registered vehicles by students

Session	Motorcar	Motorcycle
2023/2024	701	344
2024/2025	887	464

2. Methodology

This study aims to assess the demand for improved bus stops at existing checkpoints within the Universiti Tun Hussein Onn Malaysia (UTHM) campus, focusing on the absence of bus shelters. Data was collected through surveys and field observations to gather comprehensive information on current conditions and user needs. All collected data were then transferred into GIS software, which helped organize and analyze the information. Using this data, the specific areas in need of improvement were accurately pinpointed and mapped, providing a clear visual representation to support planning and decision-making for enhancing bus stop facilities on campus.

2.1 Data Collection

The survey on bus demand was conducted using questionnaires distributed to students. The collected data were analyzed to reveal bus usage patterns, preferences, and factors influencing students' decisions to use public transportation. The questionnaire, created in Google Forms, included questions about how often students use the bus, their preferred bus stop locations, and the impact of factors such as weather, convenience, and personal vehicle ownership. The responses helped identify the conditions of structures used by students at the six bus stop checkpoints. Based on these findings, bus services need to be improved to maximize the comfort and functionality of bus stop infrastructure.

2.2 QGIS Software Tool

Data from survey collected was analyzed and drafting to table for mapping into study area in QGIS. Software QGIS Desktop 3.34.14 Prizren was used to conduct throughout this study. Latitude and longitude of all bus checkpoint's location has determined at study area in Pagoh campus. One of the most important things that lead this research is the objectives. It is because objective is a goal that need to be achieved in the end of this research. The collection of data also plays a big part in this research because it will help us to make a better decision, solve problems, understand performance and improve processes [8]. Finally, a detailed analysis will help this research to reach the conclusion that we needed.

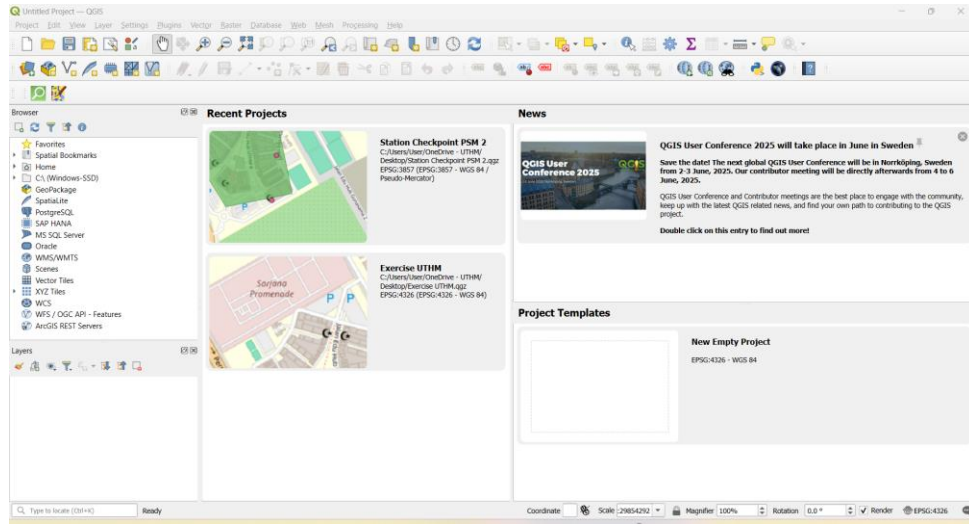


Figure 2.1: QGIS software interface

Google Earth Pro is a tool that allows for the viewing, assessment, overlay, and production of geographical data. This user-friendly website is usually a useful intermediate for students who want to learn more about GIS but would like to start with the basics. Google Earth Pro may also be used to see extremely high-resolution satellite photos, upload or download geographic data in its native interoperable file format (KML) and find people and places for example simple geocoding.

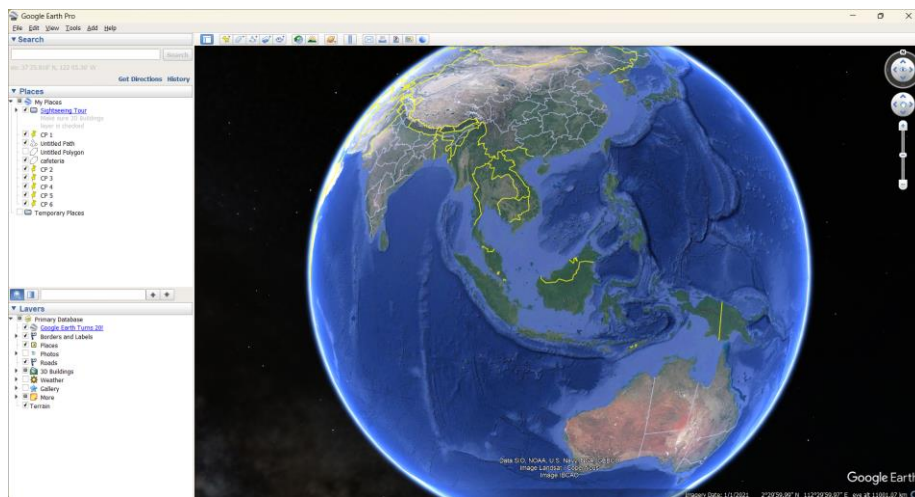


Figure 2.2: Google Earth Pro interface

3. Results and Discussions

The data was collected among students at UTHM Pagoh Campus that had experience commuting the bus along campus for many purposes. The survey of questionnaire that have been carried out to seek the top checkpoints students choose to be their destination to stop by in campus. It is also to determine their rate of satisfaction [8].

Besides that, the rate of condition currents facilities that exist in each checkpoint evaluated by respondents to their own perspective.

3.1 Analysis Data

Data was collected from students at UTHM Pagoh Campus who have experience commuting by bus for various purposes. The survey results showed which bus checkpoints students most often choose as their stops on campus. Respondents also evaluated the condition of the existing facilities at each checkpoint based on their own views. According to figure 3.1, 50.6% of respondents said they use the bus daily, 38.4% use it a few times a week, and 9.8% use it occasionally. The highest percentage of students use the bus daily for their own reasons, indicating a strong reliance on campus bus services for commuting between college and other campus locations. Those who use the bus less frequently likely have their own transportation. Overall, the results show that most UTHM Pagoh students depend heavily on the bus service for attending classes and other activities.

5. How often do you use the bus services within the UTHM campus?

510 responses

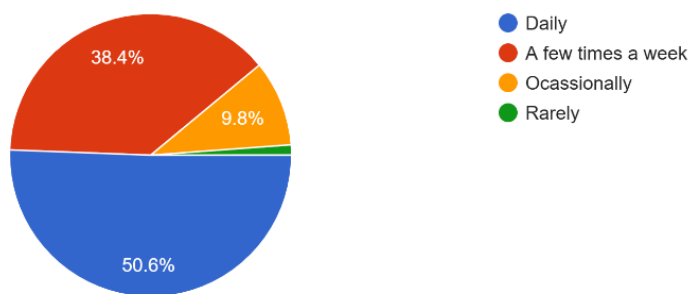


Figure 3.1: Analysis on using bus service

Based on the results in Figure 3.2, checkpoints 1, 2, and 5 are the top three bus stops most students choose. Checkpoint 1 is the starting point of the bus route from the college to the campus, which explains its popularity. Checkpoint 2, located at Block K, was selected by 60.7% of respondents because it is close to the classrooms and the cafeteria at Block A. Checkpoint 5, near the shared facilities area, is also a popular choice due to its proximity to the auditorium used for classes, the library, and various sports facilities such as the Aquatic Centre Edu Hub Pagoh, badminton hall, basketball court, and mini stadium. It is also a top destination during final exam weeks. Given the large number of students using these stops, providing proper bus shelters at these key checkpoints is essential to improve comfort and convenience.

6. Which bus checkpoint(s) do you use most frequently? Refer figure below for references.

511 responses

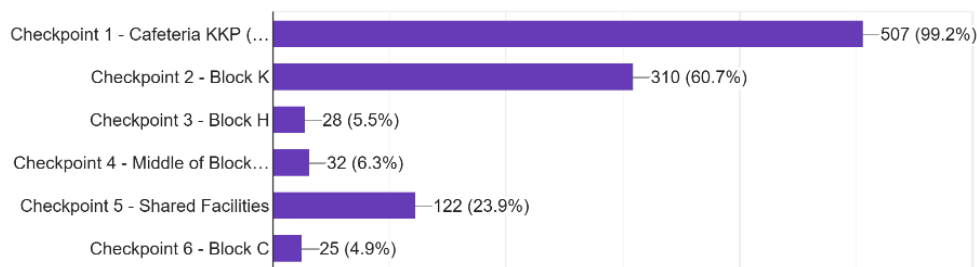


Figure 3.2: Analysis bus checkpoint

Based on Figure 3.3, the top improvement students want is the installation of shelters to protect against weather, with 99.4% support. Adding seating and rest areas is also highly desired, with 98.6% of respondents choosing this. These improvements should be the main focus at bus checkpoints. Better signage and route information received 66.3% support, while 28.4% of students want improved lighting and safety features. Overall, these improvements will help make bus stops safer, especially for students attending night classes. The survey collected responses from 511 student bus users, representing about 14% of the student population who do not own personal vehicles and rely on bus services.

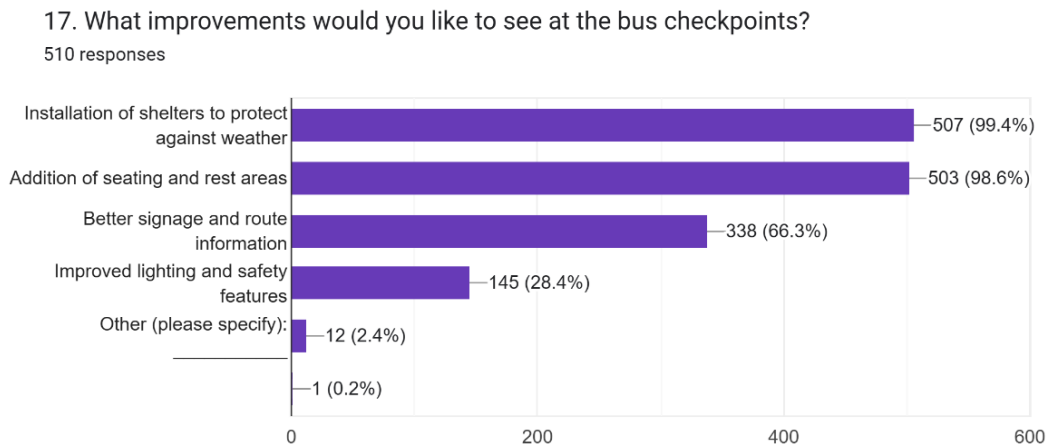


Figure 3.3: Analysis improvements bus checkpoints

3.2 GIS Mapping Data

Data coordinates of checkpoints 1 to 6 has been collected at study area within KKP Pagoh and around campus UTHM Pagoh. The data transferred to the QGIS software for mapping process. Table 1 shown the results of data collected that consists of coordinates bus checkpoints and number of respondents at respective

Table 1 Data collected

Station	Latitude (°)	Longitude (°)	Respondent
Station 1	2.1451861	102.7291920	507
Station 2	2.1476161	102.7323919	310
Station 3	2.1494250	102.7325585	28
Station 4	2.1509622	102.7314669	32
Station 5	2.1536401	102.7314779	122
Station 6	2.1500589	102.7296782	25

The process of mapping the six bus checkpoint locations was successfully completed using the Data Source Manager plugin in QGIS. The data file used for mapping was in CSV format, which contained the longitude and latitude coordinates for each checkpoint. Figure 3.4 shows that each station was accurately pinpointed on the map and labeled as 'Station,' allowing clear identification of all bus stops within the UTHM Pagoh campus. This approach follows standard QGIS procedures for importing CSV files with coordinate data, ensuring precise spatial representation of the bus checkpoints on the campus map.

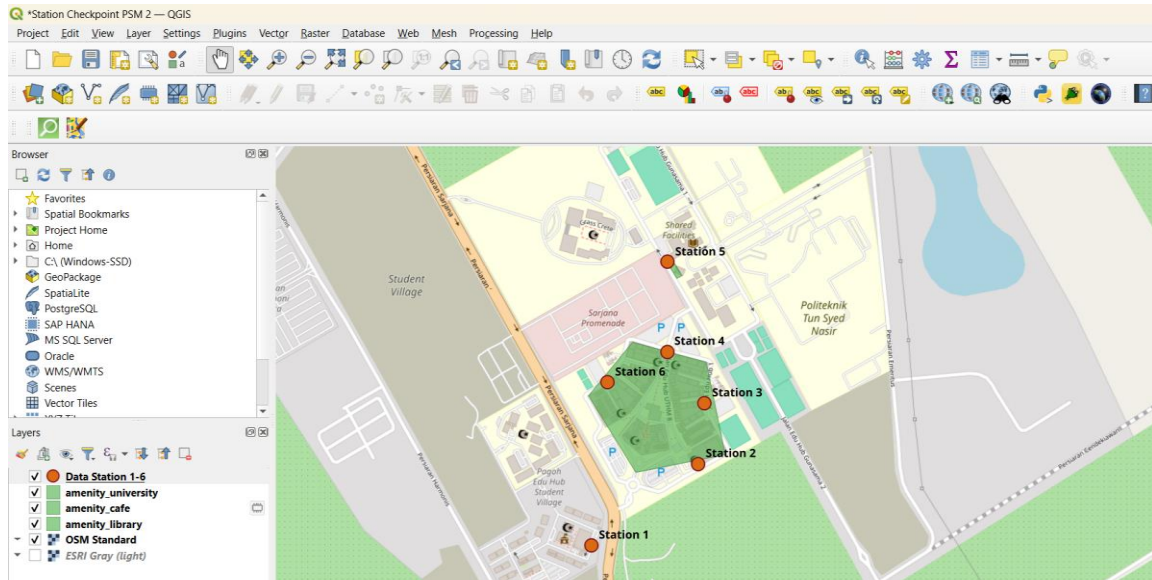


Figure 3.4: Bus checkpoints locations in QGIS map

Figure 3.5 shows a new polygon shape generated after analysis in QGIS using the Python Console plugin. The process was completed successfully when the message "Successfully created UTHM Pagoh bus checkpoints polygon and points!" appeared below the map canvas. This polygon was created based on the data and analysis performed within QGIS, focusing on the UTHM Pagoh campus area. However, the results indicate that the polygon is not suitable for identifying new bus stop locations, as the coordinates do not accurately represent the real-time plotted areas of the campus. Despite this, the analysis process was successfully carried out using QGIS tools and supported by the Python plugin, demonstrating the capability of these tools for spatial data processing and mapping tasks.

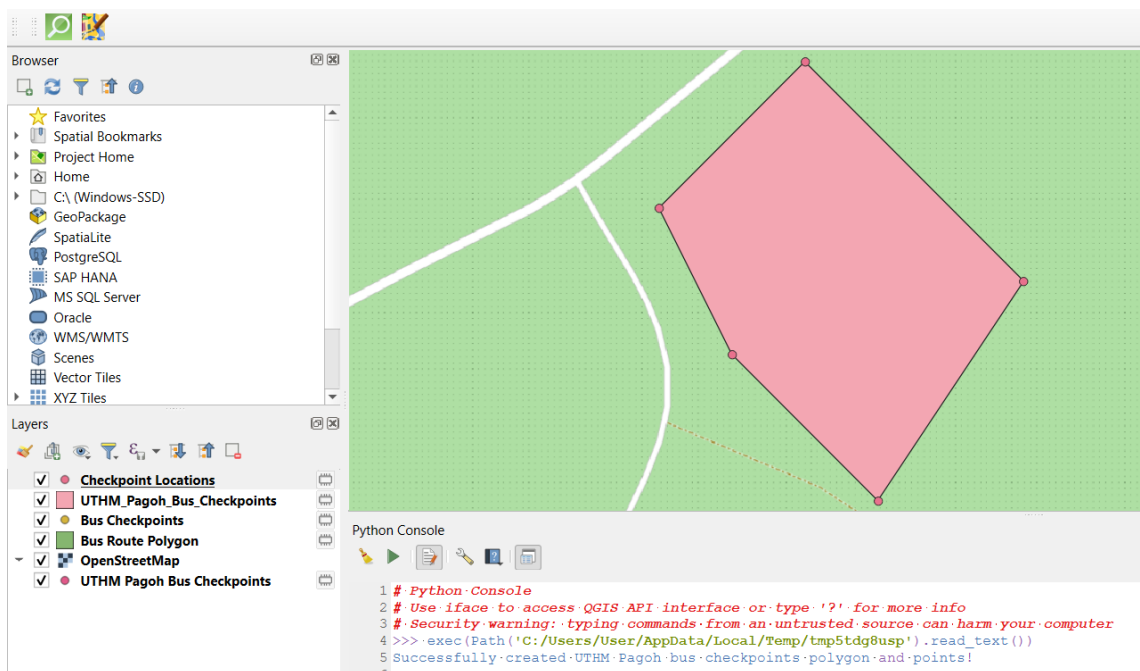


Figure 3.5: Polygon shape digitized after analysis process

3.3 Bus Stop Design

A medium-sized bus stop shelter is an ideal choice for the UTHM Pagoh campus, based on standard design guidelines for stops serving 50 to 300 passengers per day. The components follow the criteria needed to install at bus stop must be functionally on users especially in campus that widely used by students [9]. To comfortably

accommodate waiting students, the shelter should measure approximately 3 to 4 meters (10 to 13 feet) in length, 1.5 to 2 meters (5 to 6.5 feet) in width, and about 2.4 meters (8 feet) in height. The proposed design, shown in Figure 3.6, includes important features such as wheelchair-accessible space to ensure inclusivity. For safety and convenience, the shelter should also be equipped with a trash can, a route map, and sufficient lighting. Solar panel uses as to support power for lighting that indicates sustainability elements in bus stop design. This size is practical and comfortable for daily use by students, especially during long waits for the next bus. If needed, the shelter can be expanded, or additional benches can be added to further improve comfort. Overall, this design balances functionality and accessibility following on improvements that demand by students based on data survey collected indirectly enhance the campus bus stop experience. Hence, bus stop features would not be problem if the facilities equipped are in good conditions and friendly use by users [10].

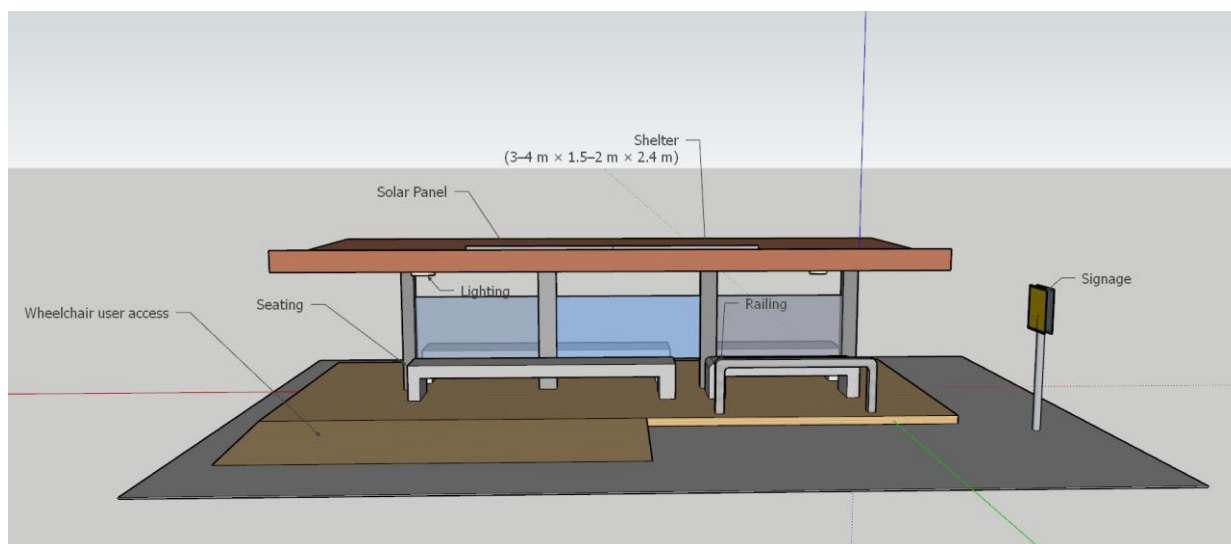


Figure 3.5: Bus stop design features

4. Conclusion

This research study highlights the critical issue of insufficient bus stop amenities for students at UTHM Pagoh campus. Using GIS tools, surveys, and field observations, the study found that all current bus checkpoints lack adequate shelters and basic facilities, which causes discomfort and safety concerns, especially during severe weather. The study identified high-demand areas and gathered valuable feedback from students, emphasizing the urgent need for improved infrastructure to enhance commuting experience and encourage greater use of campus bus services. The poor condition of bus stops has created uncomfortable waiting spaces, which may lead some students to walk between the campus and college instead of waiting for the bus, particularly in hot weather. Improving bus stop facilities is essential to provide students with a safer, more comfortable, and convenient transit environment, supporting the university's commitment to sustainable and accessible campus transportation.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Syuhada Suzana Suhaimi, Abd Sukor Sarif; **data collection:** Syuhada Suzana Suhaimi; **analysis and interpretation of results:** Syuhada Suzana Suhaimi, Abd Sukor Sarif; **draft manuscript preparation:** Syuhada Suzana Suhaimi, Abd Sukor Sarif. All authors reviewed the results and approved the final version of the manuscript.*

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