Pedestrian’s perception toward quality of sidewalk facilities
case study: UiTM Pulau Pinang

Noorul Iqhlima Najwa Ismail¹, Nurul Aishah Abd Rahman¹, Noor Safwan Muhamad¹, Ahmad Amzari Yaccob¹ and Nor Haslina Mohtar²

¹Faculty of Civil Engineering, Universiti Teknologi MARA, Pahang, Malaysia
²Student, Faculty of Civil Engineering, Universiti Teknologi MARA, Pulau Pinang, Malaysia

Email: naishah.ar@pahang.uitm.edu.my

Abstract. This paper is to study the quality of sidewalk facilities. In order to promote sustainable mobilization through public transportation, a good quality of sidewalk facilities is actually should be first been reviewed. The pedestrian sidewalk is very important to be improved. A quality sidewalk is a basic infrastructure in order to encourage public to choose public transports as their main medium of mobilization. Questionnaire survey are applied as to assess the critical dimension of current pedestrian facilities and to analyze the pedestrian perception of sidewalk quality. UiTM Pulau Pinang campus been selected as case study. The method uses in this study are qualitative and quantitative method. Qualitative method refer to observation and taking picture on the study area, meanwhile quantitative method refers to questionnaire survey distributed to 100 respondents including students, admin staffs and also lecturers. All the collected data have been analyzed by using Statistical Package for Social Science (SPSS). The result indicates that, there are 3 factor of dimension and 13 items are significant for this study area. The dimensions are Physical Facilities, Accessibility and Safety. From these 3 dimensions, the most critical dimension is Physical Facilities. Therefore, the most dissatisfaction dimension by the respondents is Physical Facilities with the gap value is -19.070. Based on the final research findings through both methods, it is found that the existing sidewalks are not in good quality. There are recommendations based on the 3 factors, which is provide the roof protection from bad weather along the sidewalk in UiTM Pulau Pinang campus, needs to increase the levels of pedestrian accessibility for sidewalk and ramps and lastly needs to provide more street lamp that in good condition along the sidewalk and more separate the sidewalk from vehicle.

1. Introduction
The transportation that widely recognized as the most environmentally friendly form is walking. Walking is a basis mode of travel that been taken easily and overlooked. However, people tend to avoid travelling by walking in long distance because pedestrian usually exposed to accident risks, adverse weather, snatch thieves and other hazard. However, Based on WHO statistics, it shows that more than 270,000 pedestrians lose their lives on the world’s roads, and globally pedestrians constitute 22% of all road traffic fatalities (WHO, 2013) [1]. The numbers of accident indicate the pedestrian was exposed to high risk using walkway.

In this situation, the sustainable transportation system become important part in providing quality sidewalks and as to support walking as a viable mode of choice and to encourage healthy physical activity, pedestrian infrastructure should in good quality [2]. The physical development planning of a
campus has a great impact on student life and affects their skill in making decision. Besides that, road safety is a serious global socio-economic problem in Malaysia. A good planning for pedestrian is obtained with correct realization from behavioural features, or also along with requirements, and aspects of passers-by, can be more involved with safety planning, and understand various solutions because of encouraged using from pavements also better safety of existing possibilities. The important points are about how ness and what ness of pavement, and which furniture is safer for it [3].

In university, students as the pedestrian is a major user of road and they become more comfort and safer having improved sidewalks. Comfort while using pedestrian sidewalk is more important for pedestrian because it can affect the students’ performance. Therefore, students will be more focus during classes and staffs also will do their work happily, thus create positive environment within the campus as well as improve good health among them.

Other than that, systematic and sustainable road facilities encourage safer road user culture among all road users. The road safety culture is vital for student as a pedestrian within the campus. They can travel by walking safely with the presence of this culture. Students able to walk more systematic and the number of accidents can be minimized whenever this culture is practiced outside the campus.

2. Literature Review

2.1. Pedestrian Zone Design
The pedestrian zone is the space between the curb and the property line which is plays an important role in providing of safe and efficient movement of pedestrian of all abilities and disabilities. Besides that, pedestrian zone provided nine qualitative parameters (enclosure of walking path by building and surrounding environment, building articulation taking account buildings flow in relation to each other, complexity and transparency of spaces relating to the ability of a pedestrian to move from public to private space, overhangs/awnings/varied rooflines, shade trees, buffer, complexity of path network and physical components/condition). [4]

According to Figure 1, it shows the proper pedestrian zone design. Which is to maintain an accessible walking path and organize the placement of element, the pedestrian zone should be organized into four distinct subzones [5]. The four subzones are suitable used at commercial area or residential area where the separation subzones are the Curb Zone, the Planting or Furnishing Zone, the Through Walk Zone and the Frontage Zone.

![Pedestrian zone design](image)

2.2. Reliability
From survey in year 2009 by Toroyan, official statistics of death by road user category was identified that pedestrians killed in road traffic crashes account for around 10% in Malaysia [6]. Separations of pedestrians from traffic are to an adequate buffer space and improve the safety for pedestrians. Sidewalk should be delimited by a vertical or horizontal separation from moving traffic. The important of separation pedestrian walkway from traffic is to avoid pedestrian collision with any vehicles.
The design of roads can have a considerable impact on their safety. Ideally, roads should be designed keeping in mind the safety of all road users. This would mean making sure that there are adequate facilities for pedestrians, cyclists, and motorcyclists. Measures such as footpaths, cycling lanes, safe crossing points, and other traffic calming measures can be critical to reducing the risk of injury among these road users [7].

2.3. Physical Facilities
The design of a sidewalk can be described by a variety of characteristics that have a direct effect on usability. The characteristics of sidewalk are based on providing access to all pedestrians user to the maximum level. The characteristic is one important element when design sidewalk because it can affect the pedestrian friendliness of a sidewalk. The most important characteristic of a road pertaining to the safety and comfort of pedestrian is lane width and the condition of the pavement surface [8]. Usually a 1.5 meter sidewalk width is probably wide enough to accommodate pedestrian traffic in a campus area, but a much wider sidewalk would be necessary because pedestrian flow density is higher in campus compare to outside.

2.4. Safety
Surface is defined as the material on which a person walks in the pedestrian environment. Federal Highway Administration emphasize that slip resistance surface are provide enough friction counterforce to the forces exerted in ambulation to allow effective travel for pedestrian. Usually, the surface of sidewalk is designed using interlocking blocks as shown in Figure 2 or cobblestone and the amount of work required for movement are increase. Changes in level often happen at interlocking blocks and cobblestone surface, which are the cause of tripping hazards for pedestrian at sidewalk.

![Figure 2. Sidewalk surface by interlocking blocks](image-url)

2.5. Complexity
The complexity is referring to the visual richness of a place and depends on the variety of the physical environment, specially the numbers and types of building, architectural diversity and ornamentation landscape elements, street furniture, signage and human activity [9]. The complexity or also known as a vertical clearance requires the minimum unobstructed vertical passage space needed along the way of sidewalk. It is often limited to the pedestrian by obstacles such as building overhangs, tree branches, signs, streetlight and awnings. In the Figure 3 (a) and (b) shows the type of obstruction at the sidewalk. According to Davis & Huxford (2009), specifies of height for porch roofs, awnings, balconies or other building elements should not less than 2.6 m [10].
Figure 3(a). Street light and tree at the middle of sidewalk

Figure 3(b). Incentives to provide awnings and other elements that improve the comfort and appearance of the sidewalk by using the vertical clearance specification

3. Methodology

Figure 4 below shows the research methodology conducted in this study.

Collect information through the journals, internet and geometrical layout

Preparation of Questionnaires Paper Design

Select the area for case

Data Collection

Qualitative Method
- Site observation and taking pictures
  - Geometrical Layout from Department of Facilities UiTM Pulau Pinang branch.
  - Sidewalk location
  - The condition of sidewalk surface

Quantitative Method
- On-street Questionnaire survey is distributed to the pedestrian in UiTM Pulau Pinang branch
  - The perception or the pedestrian’s view toward quality of sidewalk facilities.
  - Pedestrian expectation for sidewalk facilities.

Analyze the data using Statistical Package for Social Science (SPSS) software tool

Result and discussion

Conclusion

Figure 4. Flow chart of research methodology
4. Result and Discussion

4.1. Site Observation and Taking Picture

Based on the observation, there are many sidewalk infrastructure and facilities provided by UiTM Pulau Pinang branch at certain area. Facilities provided such as straight lighting, curb extension, pedestrian crossing, surface of sidewalk, road sign and other as shows in Figure 5 (a), (b) and (c).

Figure 5 (a). The Street light along the road and sidewalk at Zone 4; (b). The pedestrian crossing sign at Zone 1; (c). Provide good surface of sidewalk condition inn front Dewan Besar at Zone 3

The condition of sidewalk surface was evaluated to determine the level of sidewalk safety to the users. Every sidewalk in UiTM Pulau Pinang branch usually used interlocking blocks as the design for the sidewalk surface. There are many advantages using interlocking blocks for sidewalk surface compare to other materials. First of all, the reason using interlocking blocks is to serve the pedestrian a safety journey as interlocking block can carry grates load of burden. Second, the using of interlocking blocks is eco-friendly because in addition to being made from all natural materials, interlocking blocks are usually salvaged, cleaned and reused. The spaces between the interlocking blocks allow more rainwater to absorb into the soil. Therefore the amount of puddles formed and standing water can be reducing around the sidewalk.

Unfortunately, mostly sidewalks surface is a big problem in this campus. This is because more defect can be determine during observation and many interlocking blocks at sidewalk are gone from their original position. Other than that, the levels of sidewalks are not flat. As strong evidence, Figure 6 (a) and (b) shows the sidewalk condition in this campus.

Figure 6(a). The interlocking block is gone at certain part; (b). The level of sidewalk is uneven
In addition, the protection of pedestrian from bad weather when using sidewalk in this campus is also in critical condition. All sidewalks in this campus not have roof protection as shown in Figure 7. This problem will affect all pedestrian’s performance when raining and hot weather.

**Figure 7.** No roof protection facilities at Zone 1 and Zone 4

### 4.2. Description Analysis

#### 4.2.1. Demographic Analysis

The female respondents are higher than male respondents as shown in Table 1 which is 56 respondents (56%) and 44 respondents (44%), respectively. In term of age, it shows that the majority is between 22 to 25 years old which consists 76%. This is because most pedestrians in the study area are students. Thus, the minority is between 30 to 33 years old and 34 to 37 years old, where both have the same percentage which is 2%. The occupation of respondents which is student is 94% compare to staff and business which is 2% and 4%. From this survey, it is found that 58% of respondents did not have transportation while 30% have motorcycle, 11% have car and lastly 1% have bicycle. This is because most of the respondents are students and stay at college in UiTM Pulau Pinang branch. This has proven that sidewalk facilities is a vital infrastructure for non-transportation users as refer to 58% respondents do not have transportation.

| Item        | Demographic | Frequency | Percentage (%) |
|-------------|-------------|-----------|----------------|
| Gender      | Male        | 44        | 44.0           |
|             | Female      | 56        | 56.0           |
| Age         | 18-21       | 11        | 11.0           |
|             | 22-25       | 76        | 76.0           |
|             | 26-29       | 9         | 9.0            |
|             | 30-33       | 2         | 2.0            |
|             | 34-37       | 2         | 2.0            |
| Occupation  | Student     | 94        | 94.0           |
|             | Staff       | 2         | 2.0            |
|             | Business    | 4         | 4.0            |
| Transportation | None    | 58        | 58.0           |
|             | Motorcycle  | 30        | 30.0           |
|             | Car         | 11        | 11.0           |
|             | Bicycle     | 1         | 1.0            |

#### 4.2.2. Pedestrian Characteristic

Based on the Table 2, majority respondents chose walking as a mode of transportation to arrive at the destination in UiTM Pulau Pinang which is 81%, then follow by driving (13%) , cycling (4%) and the
lowest percentage is by taking a bus (2%). Secondly, the distance from home to destination shows less than 50 meter is the higher (50%), followed by the distance around 51 to 200 meter (22%), distance between 201 to 400 meter (16%) and more than 401 meter the percentage is 12%. It shows that most respondents are students and college resident. Hence, from the finding, it indicates that 81% respondents would use sidewalk as medium of transportation within the campus. This reflects to the significance of this study and improvement quality of sidewalk is a compulsory measure.

Table 2. Analysis Percentage of Pedestrian Characteristic

| Item                                      | Criteria          | Percentage (%) |
|-------------------------------------------|-------------------|----------------|
| How do you go to destination              | Walking           | 81.0           |
|                                           | Cycling           | 4.0            |
|                                           | Driving           | 13.0           |
|                                           | Bus               | 2.0            |
| Distance from home to destination         | 0-50 m            | 50.0           |
|                                           | 51-200 m          | 22.0           |
|                                           | 201-400 m         | 16.0           |
|                                           | >401 m            | 12.0           |
| How long do you walking to go to destination | 1-5 minutes   | 32.0           |
|                                           | 6-15 minutes      | 60.0           |
|                                           | >20 minutes       | 2.0            |
| The propose of using sidewalk             | To work place     | 2.0            |
|                                           | School/Collage/University | 90.0 |
|                                           | Business          | 5.0            |
|                                           | Walking           | 2.0            |
|                                           | Shopping          | 1.0            |
| Reason for choosing walking as a mode of transportation | More safe      | 9.0            |
|                                           | Easy and Comfortable | 14.0     |
|                                           | No parking at destination | 21.0 |
|                                           | No driving licence | 2.0            |
|                                           | No transportation | 24.0           |
|                                           | No alternative    | 30.0           |

4.3. Factor Analysis
In detail, Table 3 presents the result of the KMO test and Bartlett's Test for respondent’s perception. The KMO test shows the value is 0.838, which is greater than 0.5. Therefore the factor analysis for respondent’s perception is justified. At the same time, Table 4 presents the result of the KMO test and Bartlett's Test for respondent’s expectation. As can be seen, the KMO test shows the value is 0.893. Obviously the value is greater than 0.5, so the factor analysis is justified. The result of Bartlett’s Test for both respondent’s perception and expectation shows value P is less than 0.05, and forthwith the correlation between the items is good enough to do factor analysis.

Table 3. KMO and Bartlett’s Test for Respondent’s Perception

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | 0.838 |
|-----------------------------------------------|-------|
| Bartlett's Test of Sphericity                 |       |
| Approx. Chi-Square                           | 788.306 |
| Df                                            | 78.000  |
| Sig.                                          |       |
Table 4. KMO and Bartlett’s Test for Respondent’s Expectation

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | 0.893 |
|-----------------------------------------------|-------|
| Bartlett’s Test of Sphericity                  |       |
| Approx. Chi-Square                            | 502.451 |
| Df                                            | 21.000 |
| Sig.                                          |       |

4.3.1. Factor Loading
In detail, the Table 5 shows the factor loading for each 3 factors for respondent’s perception. The highest factor is Physical Facilities (0.832) with 2 items in this factor, followed by Accessibility (0.830) with 3 items and the last factor is Safety (0.734) which is have 8 items. Besides that, all items for each factor with their factor loading were described in Table 4.7 below. The factor loading for both respondent’s perception and respondent’s expectation can be calculate by using Eq. (1).

\[
\text{Factor Loading} = \frac{\sum \text{Factor Loading each items}}{\text{No. of items}}
\]  

(1)

Table 5. Factor Loading with 3 Factors and 13 Items for Respondent’s Perception

| Factor          | Item                                                                 | Factor loading |
|-----------------|----------------------------------------------------------------------|----------------|
| Physical Facilities (0.832) | 18. Pedestrian protection from bad weather | 0.861          |
|                  | 17. Maintenance of the sidewalk in UiTM Pulau Pinang                  | 0.803          |
| Accessibility (0.830) | 12. Access of distance to the destination                             | 0.901          |
|                  | 14. Time taken during walking to the destination                       | 0.894          |
|                  | 13. Walking place or situation to reach the destination                | 0.694          |
|                  | 20. Personal safety while using the sidewalks                          | 0.856          |
|                  | 23. Sidewalks free from any obstruction                                | 0.822          |
|                  | 19. Sidewalks width that can be used by two pedestrians in one time    | 0.791          |
| Safety (0.734)   | 24. Overall specify the level of satisfaction with the sidewalk quality in UiTM Pulau Pinang campus | 0.770          |
|                  | 21. Condition of the sidewalks surface for walking                     | 0.707          |
|                  | 16. Separation of pedestrian walkways from vehicle traffic            | 0.683          |
|                  | 15. Presence of sidewalk in UiTM Pulau Pinang                          | 0.632          |
|                  | 22. Cleanliness and attraction of landscape at sidewalks surrounding    | 0.614          |

The factor loading for respondent’s expectation as shown in Table 6 is applying only one critical factor and there are 7 items significant to this factor. The critical factor among 5 factors is Physical Facilities (0.803) that consist the 7 items. All the items were described in with their factor loading. From this analysis, the highest factor loading is pedestrian protective roof facilities along sidewalk. From the respond, respondents strong hope that the pedestrian protective roof along the sidewalk will be created in the future.
Table 6. Factor loading with 1 Factor and 7 Items for Respondent’s Expectation

| Factor | Item                                                                 | Factor loading |
|--------|----------------------------------------------------------------------|----------------|
|        | 31. Pedestrian protective roof facilities along sidewalk              | 0.921          |
|        | 30. Street lighting facilities along sidewalks                        | 0.883          |
|        | 28. More separation from vehicle traffic between pedestrian and vehicle | 0.882          |
|        | 26. More sidewalks in UiTM Pulau Pinang                              | 0.830          |
|        | 27. Improvement of sidewalks connection                               | 0.825          |
|        | 29. The frequency of sidewalk maintenance by the university          | 0.825          |
|        | 32. Education about pedestrian at university/school                   | 0.453          |

Physical Facilities (0.803)

4.4. Service Quality Gap

Based on Table 7, the analyses were done at the 0.05 level of confident. The value of t for factor 1 is -19.01. For the second factor, the t value is 6.270 and the last factor is 12.30. The result shows that the gap between respondent’s perception and expectation for factor 1 is negative value. Since the dimension of Physical Facilities is a critical factor among the factor loading for respondent perceptions, therefore this negative value indicates that the service quality of sidewalk facilities is unsatisfactory from the respondent.

Table 7. Paired Sample T-Test on Finding of Gap Values for 3 Factors of Service Quality

| Paired Differences | Mean | Std. Dev. | Std. Error of Mean | 95% Confidence Interval of the Difference | t | df | Sig. (2-tailed) |
|--------------------|------|-----------|--------------------|-----------------------------------------|---|----|----------------|
|                    |      |           |                    | Lower                                   |   |    |                |
| F1 Physical Facilities (P) – Physical Facilities (E) | -19.010 | 3.529 | 0.352 | -19.710 – 18.309 | -53.867 | 99 | 0.000 |
| F2 Accessibility (P) – Accessibility (E) | 6.270 | 1.462 | 0.146 | 5.979 – 6.560 | 42.876 | 99 | 0.000 |
| F3 Safety (P) – Safety (E) | 12.300 | 3.641 | 0.364 | 11.577 – 13.022 | 33.775 | 99 | 0.000 |

5. Conclusion and Recommendation

This study can be concluding that some of quality of sidewalks facilities in UiTM Pulau Pinang are seem unsatisfactory. According to the result of factor analysis, there are 3 critical factors from 7 factors and all 13 items are significant to this factor. The 3 critical factors are including Physical Facilities (0.832), Accessibility (0.830) and Safety (0.734). Base on the factor loading, Physical Facilities is the most strong factor with has 2 items. Besides that, Physical Facilities also known as critical dimension of current pedestrian facilities in this study area.
Quality of sidewalk facilities is measure from the different between respondent’s perception and respondent’s expectation. From all 3 significant factors, the most unsatisfactory factor by the respondents is dimension Physical Facilities with the gap value is -19.01. Therefore, the quality of sidewalk facilities is considered as a poor quality because the mean value indicates the negative value. Physical Facilities is referring to the pedestrian protection from the bad weather and the maintenance of the sidewalk. Base on the survey, most respondents did not agree with the physical condition of sidewalk. Therefore, through both qualitative and quantitative method, it is found that the existing sidewalks are not in good quality. UiTM Pulau Pinang branch needs to provide the roof protection from bad weather along the sidewalk in this campus. Other than that, the frequency of maintenance is important to make sure the quality of sidewalk stay in a good condition.

Some of the recommendations are suggested to produce better transportation infrastructure as well increase the satisfaction among the pedestrian for their improvement quality of sidewalks facilities. For the accessibility, UiTM Pulau Pinang branch needs to increase the levels of pedestrian accessibility for sidewalk and ramps. The design of the sidewalk must suitable for the disabled people. It will help disabled people use the sidewalk with more safe and easy. For the safety, UiTM Pulau Pinang branch needs to provide more street lamp that in good condition along the sidewalks and more safety elements for pedestrians that using the sidewalk from vehicles.

Acknowledgments
This research was supported by Universiti Teknologi MARA.

References
[1] World Health Organization (WHO) 2013 Pedestrian Safety: A road safety manual for decision-makers and practitioners.
[2] Frackelton A, Grossman A and Castrillon F 2013 Measuring Walkability : Development of an Automated Sidewalk Quality Assessment Tool Suburban Sustainability 1 1.
[3] Movahed S, Azad S P and Zakeri H 2012 A Safe Pedestrian Walkway; Creation a Safe Public Space Based on Pedestrian Safety Proc. Social and Behavioural Sciences 35 575-85.
[4] Elvezia M C, Federico M and Paloma G R 2018 Level of service of pedestrian facilities: Modelling human comfort perception in the evaluation of pedestrian behaviour patterns J. Transportation Research Part F: Traffic Psychology and Behaviour 58 365-81.
[5] National Association of City Transportation Officials (NACTO) 2009 Pedestrian Facility Design: Access Minneapolis Design Guidelines for Streets and Sidewalks.
[6] Toroyan T 2009 Global status report on road safety. World Health Organization 15 4 pp.286.
[7] World Health Organization (WHO) 2018 Road Traffic Injuries.
[8] JKR 2000 A Guide on Geometric Design of Roads (Arahan Teknik (Jalan) 8/86) p 2000.
[9] Richa S 2016 Factors affecting walkability of Neighbourhoods Proc. Social and Behavioural Sciences 216 643-54.
[10] Davis C and Huxford R 2009 Manual for Streets. Proc. of the Institution of Civil Engineers-Municipal Engineer vol 162 (Thomas Telford Publishing).