Assessment of walkability and public transport services in Luyang, Kota Kinabalu

Lillian Gungat, Nicole Justin, Fauziah Mohd Said#, Nurmin Bolong, Mohd Azizul Bin Ladin

Civil Engineering, Faculty of Engineering, University Malaysia Sabah, Kota Kinabalu, MALAYSIA.
#Corresponding author. E-Mail: fauziahmohdsaid@ums.edu.my; Tel: +6088-320000

ABSTRACT Excessive carbon dioxide emission is becoming one of the main concerns of the world in recent years. To reduce adverse impacts, walking is the best method as it greatly aids in the reduction of carbon emission released from motorized vehicles. Walkability has always been related to environmental issues around the world. This study investigates the improvement indicators of walkability and public transport service at Luyang, Kota Kinabalu as it has a high concentration of pedestrians especially during morning markets. The study was conducted via field observation and questionnaire distribution and then analyzed by using Analytical Hierarchy Process to determine the safety, connectivity and comfortability indicators with their respective weightages and ranking. It has been found that the most concerning and bothersome factor is comfortability as there are lack of comfortability aspects in Luyang. The most concerning issue regarding the services of bus in Luyang was the amount of bus stops within 800m radius of the boundary area, followed by the frequency of bus and lastly the comfort aspects of public transport services. Along with that, the walkability index in Luyang is satisfactory as they are higher than 0.5, with the highest walkability index of 0.758. Therefore, the walkability index evaluation has been found successful and the factor that should be focused to improve the walkability shall be the comfortability of Luyang.

KEYWORDS: Comfortability; connectivity; pedestrians; public transport; walkability index.
Received 12 April 2023 **Revised** 15 August 2023 **Accepted** 25 August 2023 **Online** 6 September 2023
© Transactions on Science and Technology
Original Article

TRANSACTIONS ON SCIENCE AND TECHNOLOGY

INTRODUCTION

Walkability is gaining more attention due to the benefit of it and is being researched more to help reduce the inclining usage of private vehicles, which increases the rate of carbon dioxide emission due to the traffic density (Arslan *et al.*, 2018). However, walking is an ancient method of transportation and existed historically since ancient times and had slowly developed due to the mass innovation and rapid modernization of areas in the world, slowly decreasing in implementation as cars were massively introduced back in the 1950s (Baobeid *et al.*, 2021).

Comfort, connectivity, and safety are three of the factors that are important in making a place pedestrian-friendly or "walkable". To encourage walkability, the aim is to make the environment sustainable, which comprises several factors that make up for it (Nasution, 2020). In terms of safety, one of the factors affecting the preferences of pedestrians to walk is a risk of accidents happening. On a connectivity basis, intersections that are dense give more options for pedestrians to have different route choices in a shorter distance (Ojo, 2019). More options give room for more road links, resulting in connectivity of roads to various locations, which will provide a much better environment as all roads are directed to a lot of different places. Hence, in an effort of promoting walkability, the pedestrian's safety and comfortability which all linked to another attempt of reducing private motorised vehicles usage and public transportation. The use of public transport such as the bus holds numerous advantages than what using private vehicles could offer, such as the economic impact and positive change in the environment (Reisi *et al.*, 2019). To promote walking, factors are to be analysed especially in Malaysia and in Sabah, as a developing country. Therefore, this study presents the factors of walkability in the study area, Luyang and the connectivity of their public transportations and finally determines the Walkability Index (WI) of Luyang, Kota Kinabalu.

METHODOLOGY

Data collection is done in the means of two methods, which are quantitative analysis (survey questionnaire) and site inspection and monitoring.

Case Study Area: Luyang

Luyang is a locality in Kota Kinabalu, Sabah, a busy area located in the middle of the city with some notable attractions which are the Foh Sang Commercial Centre, Damai Plaza and Lintas Square. Some residential areas are located quite near to the shop areas and some private colleges and Hospitals are located at Luyang as shown in Figure 1.

Figure 1. Aerial view of Luyang.

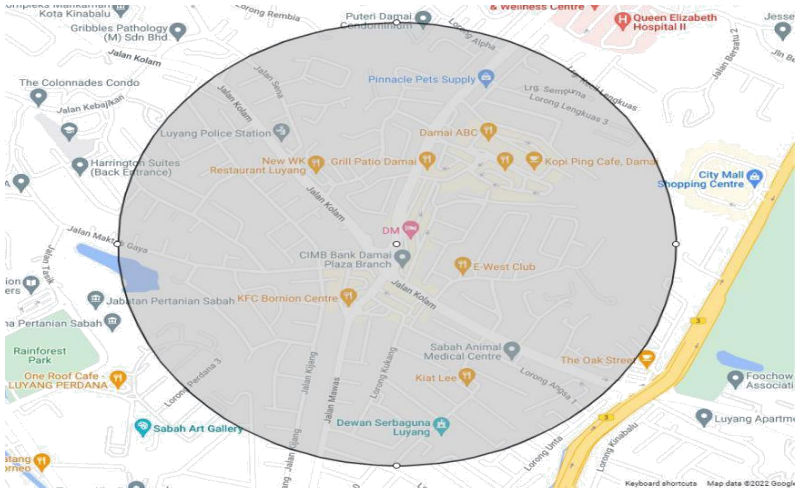

Figure 2. Boundary area of study.

Site Inspection

Real-life data is collected by monitoring the site and gathering information regarding the conditions of amenities present in the study area. The data gathered during site inspection include the availability of pedestrian crossings, barriers or fences, clear signage, condition of walkway or pavements, roofed walkways or trees, and the presence of bus stops within 800m radius as shown in Figure 2. All these indicators were obtained from literature reviews of past research (Aye *et al.*, 2019). Scores were attributed to the amenities; 0= does not exist, 1= exists but does not follow

guidelines, and 2=exists and following guidelines as adopted from (Fisal *et al.*, 2020). Figure 3, Figure 4 and Figure 5 show the condition of pavement, bus stop and pedestrian crossings in Luyang.

Figure 3. Route to bus stop at Luyang.

Figure 4. Pavement condition of walkway at Luyang.

Figure 5. Pedestrian crossings at Luyang's junction.

This study collected the data of bus services during peak hour from 7:00am to 9:00am in the morning at the bus stops at Luyang, Kota Kinabalu for five days, which are on Tuesday, Wednesday, Thursday, Saturday and Sunday. The time chosen is also suitable as there is large-scale event

ongoing in the morning market nearby the case study area. The data collection is taken via video camera to determine the pedestrian count at the study area. Based on the data obtained in site inspection, indicators are ranked based on pedestrians' concerns, while data for bus services is tabulated in accordance with the quality of bus stops and efficiency of bus services in relation to the walkability. The assessment of connectivity and accessibility of bus services is sampled by gathering data that are relevant for the evaluation. These indicators are divided into these categories: transit services (frequency), built environment (number of inhabitants served), level of comfort (bus stop quality) (Vabalas *et al.*, 2019). Within an 800m radius, there are six bus stops found in the boundary area at Luyang as shown in Figure 6.

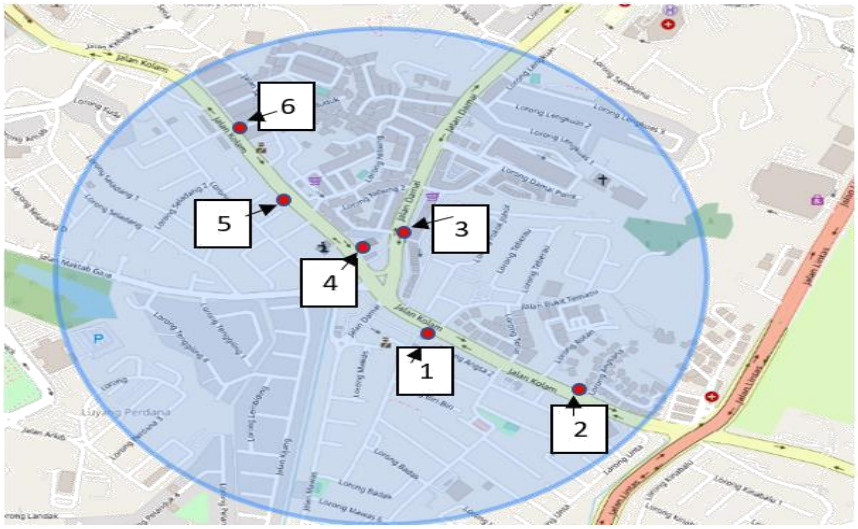

Figure 6. Bus stop locations at study area.

Survey Questionnaire

An online survey questionnaire was constructed in accordance with the indicators being studied in this research as previously mentioned. The question varies from demographics to perception of pedestrians towards their safety, connectivity and comfort while walking in Luyang, and the services of buses in the area. The survey questionnaire was distributed mainly for people residing in Luyang, where a total sample of 60 was collected and sufficient for a pilot study (Casson *et al.*, 2019) and then analysed using Microsoft Excel.

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a complex method of analysis used to determine the solution of problems by considering all the parameters given (Al-Ghamdi *et al.*, 2021). The application of AHP as the method of analysis is suitable as the inconsistency of survey responses can be determined through the value of Consistency Index (CI). As the value of CI approaches zero, it indicates that the inconsistency is low. Priorities of indicators are assigned based on weights obtained using the Pairwise Comparison Matrices (PCM). PCM is done by comparing the criteria considered by giving a score out of nine.

For ease of study, a free online based software, Analytic Hierarchy Process-Online Software (AHP- OS) is used to compute the weightage of each criterion. This software is an easy approach that gives a computerised sheet for the calculation of data inserted, and all parameters are directly calculated, including the weightage of each individual criteria.

RESULT AND DISCUSSION

Participant Demographics

Table 1 shows the demographic information of participants involved in the study. Among the 60 participants, 58.3% of them are female. Majority of the respondents are within the age of 20-29 years old and most of them are Kadazan/Dusun/Murut. Approximately 49.2% of the participants are employed.

Table 1. Demographic information for survey participants.

Description	Variable	n (%)
Gender	Male	41.7
	Female	58.3
Age	Below 20	3.3
	20-29	50.8
	30-39	32.8
	40-49	9.8
	50-59	3.3
Race	Malay	13.1
	Chinese	23
	Kadazan/Dusun/Murut	49.2
	Others	14.7
Employment status	Unemployed	34.4
	Employed	49.2
	Self-employed	9.8
	Others	6.6

Analysis of Factors Affecting Walkability

Figure 7 shows the analysis of pedestrians' perception on the walkability indicators in terms of safety, connectivity and comfortability based on the survey while Figure 8 shows the scores given to the amenities present based on the CIDB guidelines (CIDB, 2011). Based on Figure 7, the comfortability aspect shows higher concern as it ranked lowest among all indicators. For connectivity, two out of three indicators which are provision of shortcuts and roads heading to different destinations and provision of bus stops within 800m radius received a top three ranking which indicates that those are not matters of concern by pedestrians in Luyang. However, the condition of the walkway and pavement received a 7 in terms of ranking. For safety reasons, provisions of clear pedestrian crossings receive a high ranking, which indicates that the pedestrian crossings available can be easily seen and is not a cause of concern. However, provisions of fences or barriers separating car lanes and walkways receive a 5 in terms of ranking, which indicates that this is a median in terms of pedestrians' concerns.

Figure 8 presents the walkability ranking based on weightage for amenities observed during site inspection. From Figure 8, connectivity indicators prove to have the highest rank compared to the other, followed by safety and finally comfortability. It is proven that most of the elements in safety were given scores of 2 as it exists and following guidelines while provision of sun-shades and barriers were given a 0 due to its non-existent. Elements of walkway and pavement condition, along with the provision of bus stops are each given a score of 1 due to its condition that does not follow the guideline (not well maintained).

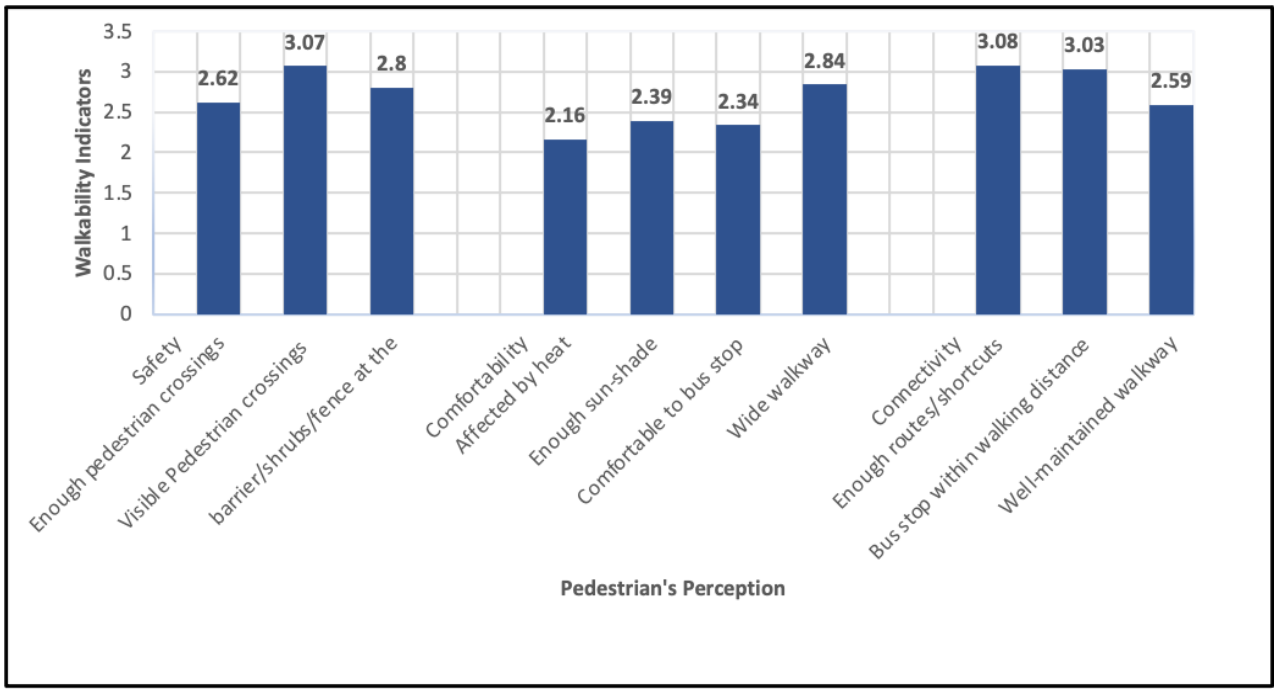

Figure 7. Pedestrian's perception on walkability indicators.

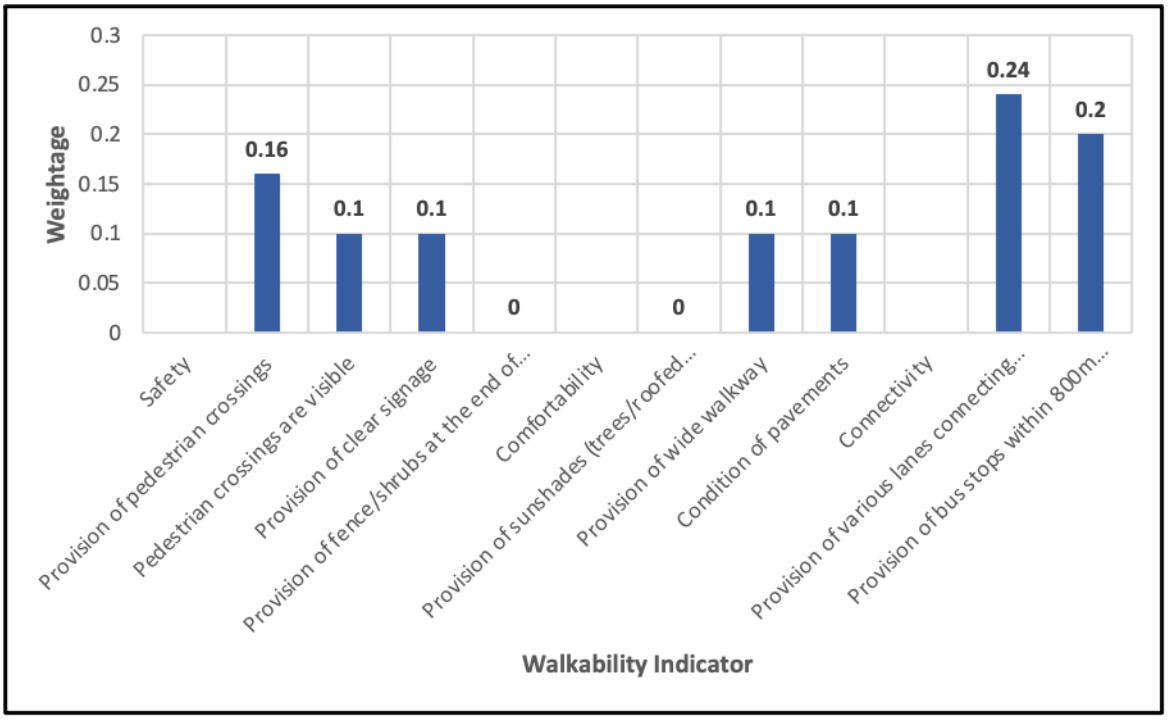

Figure 8. Walkability ranking based on weightage for amenities.

Accessibility and Connectivity of Bus Services

Figure 9 shows the analysis of data for bus frequency and passenger boarding the bus at six bus stops within 800m radius. Based on Figure 9, the highest number of buses arriving is at bus stop 1, while the lowest is at bus stop 5. Since bus frequency is often associated with quality of bus services, it is plausible to say that the bus arriving at bus stop 1 is of best quality among the other bus stops. The number of pedestrians boarding the bus at bus stop 2 is the highest among the others, while bus stop 1 fall second. Bus stops 4, 5 and 6 obtain the lowest number of pedestrians boarding the bus.

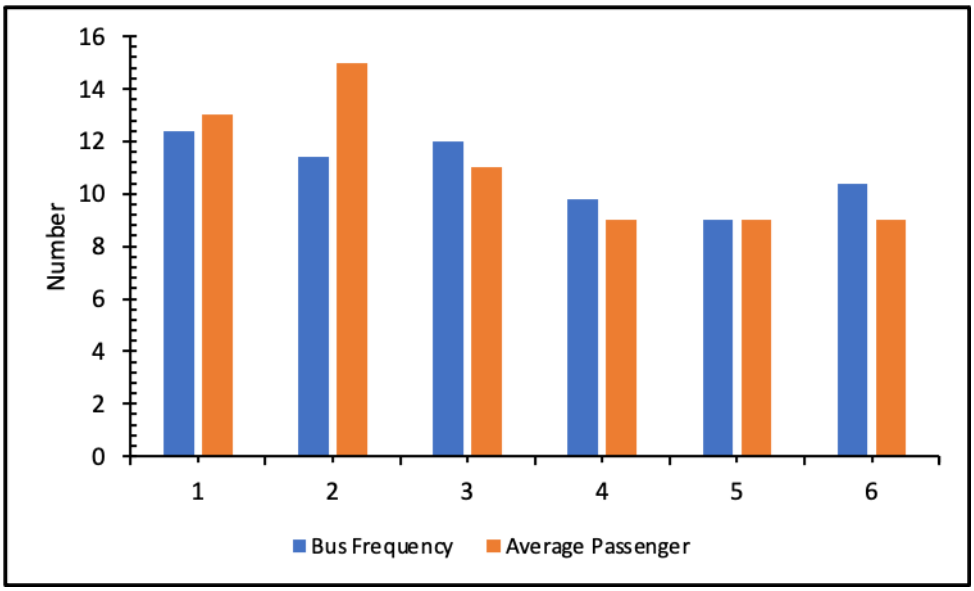

Figure 9. Bus frequency from 7 a.m. to 9 a.m. and average passenger.

Evaluation of Walkability Index

The application of AHP-OS had produced the result shown in Table 2 of the Pairwise Comparison Matrices (PCM) output, which is done to obtain ranking. As shown in Table 2, the walkability index was calculated by summing all the weightage for three criteria being studied. The walkability index for road segment 1 is higher followed by road segment 2 and finally road segment 3 as shown in Table 3.

Table 2 Pairwise comparison matrices output.

Criteria	Comfortability	Safety	Connectivity	Weight	Rank
Comfortability	1.000	0.333	0.111	0.07336	3
Safety	3.000	1.000	0.250	0.19996	2
Connectivity	9.000	4.000	1.000	0.72668	1

Table 3. Walkability index based on safety, connectivity, and comfortability.

Road Segment	Bus stops	Criteria			Walkability Index	Ranking
		Safety	Connectivity	Comfortability		
1	1	0.89	0.72	0.1	0.70851	2
	2	0.81	0.81	0.1	0.75791	1
2	3	0.86	0.61	0.1	0.62257	3
3	4	0.7	0.5	0.1	0.51065	5
	5	0.64	0.5	0.1	0.49865	6
	6	0.74	0.5	0.1	0.51865	4

CONCLUSION

The factors of safety, connectivity, and comfortability of walkability and public transport services in Luyang had been assessed. As ranked, comfortability received the lowest among other indicators, which serves to show that the comfortability aspect such as trees and shaded areas are to be improved in Luyang. The six bus services assessed show that the bus stop 1 has the best quality in relation to its high pedestrian count and the number of buses while the quality of bus stops 5 and 6 needs to be improved. Finally, the walkability index assessment obtained shows the highest value of index (0.75791) in road segment 1 and the lowest in road segment 3 (0.49865). 90% of the road

segment investigated has reached a walkability index of more than 0.5, which shows satisfactory. However, further improvement of infrastructures in road segment 3 should be done to increase its walkability. In conclusion, the walkability index evaluation is successful, and it can be concluded that Luyang has a satisfactory level of walkability, but further actions should be taken to encourage a car-free environment.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support from all individuals that directly and indirectly contributed to this research.

REFERENCES

[1] Arslan, T. V., Durak, S., Gebesce, F. D. & Balcik, B. 2018. Assessment of factors influencing walkability in shopping streets of tourism cities: case of Bursa, Turkey. *International Journal of Tourism Cities*, 4(3), 330-341.

[2] Baobeid, A., Koç, M. & Al-Ghamdi, S. G. 2021. Walkability and its relationships with health, sustainability, and livability: elements of physical environment and evaluation frameworks. *Frontiers in Built Environment*, 7(September), 1–17.

[3] Campisi, T., Basbas, S., Tesoriere, G., Trouva, M., Papas, T. & Mrak, I. 2020. How to create walking friendly cities. A multi-criteria analysis of the central open market area of Rijeka. *Sustainability*, 12(22), 9470.

[4] CIDB. 2011. *Quality assesment system for completed road works (CIS-19: 2011)*. Construction Industry Development Board.

[5] Nasution, M. A. 2020. Walkability in Banda Aceh: An approach in urban mobility development. *IOP Conference Series: Earth and Environmental Science*, 452, 012148.

[6] Ojo, T. K. (2019). Quality of public transport service: An integrative review and research agenda. *Transportation Letters*, 11(2), 104-116.

[7] Reisi, M., Nadoushan, M. A. & Aye, L. 2019. Local walkability index: Assessing built environment influence on walking. *Bulletin of Geography*. *Socio-economic Series*, 46(2019), 7–21.

[8] Sukor, N. S. A. & Fisal, S. F. M. 2020. Safety, connectivity, and comfortability as improvement indicators of walkability to the bus stops in Penang Island. *Engineering, Technology & Applied Science Research*, 10(6), 6450–6455.

[9] Vabalas, A., Gowen, E., Poliakoff, E. & Casson, A. J. 2019. Machine learning algorithm validation with a limited sample size. *PloS one*, 14(11), e0224365.