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Walking and Bicycling Suitability Assessment in Bandar Tangkak

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Abstract

This study investigates the walking and bicycling infrastructure in Bandar Tangkak, Johor, focusing on two neighbourhoods, namely Taman Sentosa and Taman Tangkak Jaya. As each town continues to grow in both population and traffic, evaluating the suitability of its pedestrian and cyclist facilities has become increasingly important. Using the Walking and Bicycling Suitability Assessment (WABSA) framework and Average Annual Daily Traffic (AADT) data, along with responses from a resident questionnaire. The study provides a comprehensive overview of current conditions. The findings indicate that residents tend to walk or cycle for short distance trips of less than 1.0 km. In contrast, for longer distances, they generally prefer to use private vehicles. Contributing factors include high traffic volumes, lack of continuous sidewalks, poor lighting and the absence of dedicated bicycle lanes. Many roads, especially in high-traffic areas, are either unsafe or uncomfortable for non-motorized users. The analysis points to a clear need for improvements in infrastructure to encourage more active and sustainable forms of transportation. Key recommendations include constructing safer sidewalks, developing continuous bike lanes, enhancing street lighting and improving connections between residential areas and key facilities such as schools and shops. These upgrades would not only support healthier lifestyles and reduce reliance on cars but also help create a safer and more environmentally friendly.

1. Introduction

The process of determining whether a place or path is appropriate for walking and bicycling is known as the Walking and Bicycling Suitability Assessment. Factors including infrastructure, safety, connectivity, and accessibility are important considerations in evaluating how effectively an area supports walking and bicycling as modes of transportation. Such assessments can be conducted at different scales, ranging from neighbourhoods to cities or regions. This process helps identify areas that require improvement while also highlighting locations that are suitable for pedestrians and bicyclists [1]. In urban planning and transportation, the benefits of walking and bicycling as a cost-effective, space-saving, pollution-free, and healthful alternative are becoming even more apparent.

Bandar Tangkak in Johor, Malaysia, has experienced a significant increase in both population and traffic. This growth has increased the needs to evaluate whether the infrastructure is suitable for cyclists and pedestrians. Encouraging walking and bicycling as modes of transportation can ease traffic, enhance public health, and build a more sustainable environment. Walking and cycling are environmentally friendly forms of transportation that also have advantages like lowering air pollution, encouraging social interaction, and improving locals' standard of living in general [2].

Comprehensive studies on the infrastructure for bicyclists and pedestrians are still lacking in Bandar Tangkak. The lack of facilities, such as inadequate bike lanes, badly designed pedestrian walkways, and safety issues, makes it challenging for people to use these forms of transportation [3]. This will be addressed by conducting an evaluation to determine whether walking paths are appropriate and to offer useful recommendations for enhancing these amenities.

The University of North Carolina at Chapel Hill created the Walking and Bicycling Suitability Assessment (WABSA), which aims to evaluate and enhance infrastructure while encouraging active transportation to improve community health [4]. In this study, WABSA is used to assess the suitability of Bandar Tangkak's few walking paths, considering that all public amenities, including schools and hospitals, are within a one-kilometer radius. The WABSA method is useful in both urban and suburban environments because it integrates physical infrastructure assessments with actual user experiences to support walking and bicycling evaluations [5]. Other than that, questionnaires were handed out to residents in the selected location to gather their input and better understand their experiences and perspectives.

2. Methodology

Information for this study were gathered through questionnaire responses and investigations. To complement these findings, best practices were examined through a literature review and documented case studies which helped in practical recommendations for improvement. Based on the collected data, a clear and structured framework was developed to address the previously outlined objectives. The overall research process is illustrated in the flow chart to provide a clear view of each step involved. Fig. 1, shows the flow chart that outlines the key stages of the research process. It begins with a literature review to build a strong understanding of the topic and highlight its importance. This was followed by discussions on selecting suitable study locations and determining the appropriate methods for collecting information and data.

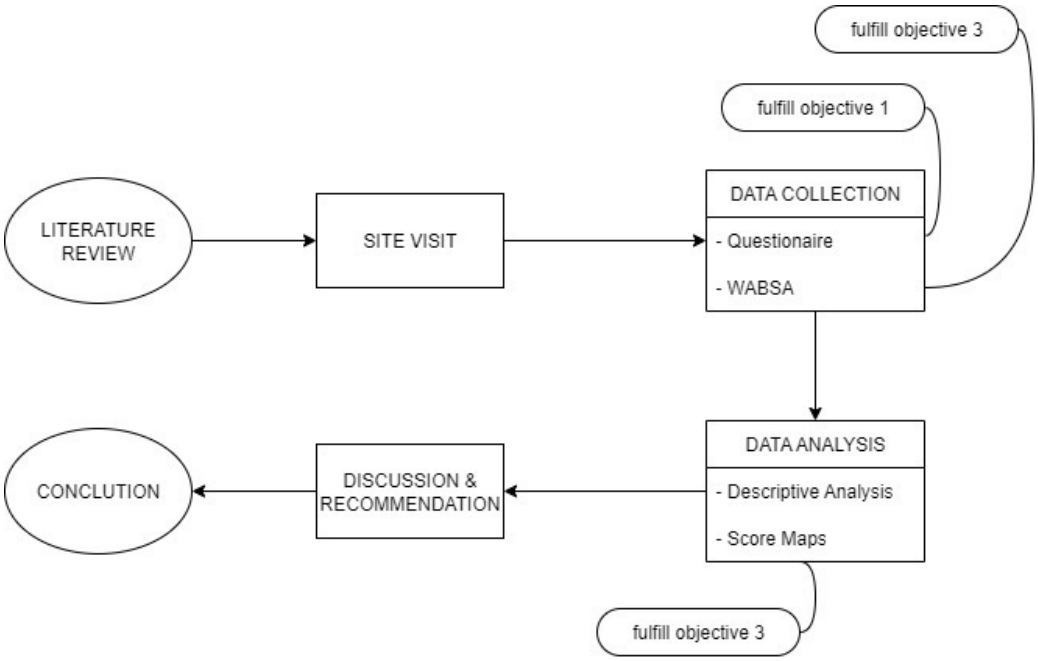

Fig. 1 *Flowchart of the overall methodology*

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2.1 Questionnaire Survey

This questionnaire was conducted to evaluate the current quality of walking and cycling facilities in Taman Sentosa and Taman Tangkak Jaya, Bandar Tangkak. Walking and cycling are essential for promoting healthier lifestyles and contributing to a cleaner environment. The survey aimed to identify strengths, challenges and areas for improvement in the existing infrastructure based on residents' feedback. It specifically targeted residents of Bandar Tangkak, particularly those residing in Taman Sentosa and Taman Tangkak Jaya. A total of 201 respondents participated in the survey, providing valuable input to support enhancements in safety, comfort and accessibility for all users.

2.2 Walking Suitability Assessment In WABSA

The Walking and Bicycling Suitability Assessment (WABSA) is important for identifying how well an area supports safe, comfortable with the of accessible walking and bicycling. Well-designed walking and bicycling environments encourage healthier lifestyles, reduce traffic congestion and lower environmental impacts [4]. By assessing factors such as safety, connectivity and ease of use, local authorities and planners can better understand the strengths and weaknesses of existing infrastructure. This helps in making informed improvements that benefit all users including vulnerable groups like children, the elderly and people with disabilities [4], [6]. Overall, WABSA plays a key role in promoting sustainable and inclusive transportation systems.

Table 1 shows how walking suitability is rated using the WABSA scoring system. Each score range is linked to a level of walkability and a colour to make it easier to understand. Scores below 3.0 are marked in blue and indicating the area is “Very Good” for walking with safe and pleasant paths. Scores between 3.0 and 5.9 are green and rated “Good”, meaning the area is walkable but may need small improvements. Scores from 6.0 to 8.9 are yellow and marked as “Fair”, showing that walking is possible but may have issues like poor safety or connectivity. Scores between 9.0 and 26.0 are orange and labelled “Poor”, meaning the area has weak pedestrian facilities. A score of 99.0 is pink and means there is no sidewalk on a quiet street while scores above 99.0 are red and show no sidewalk on a busy street which is more dangerous. This colour system helps planners quickly see which areas need improvements to make walking safer and easier for everyone.

Table 1 *Walking suitability level with scores*

Scores	Walking suitability level	Colour
< 3.0	Very Good	
3.0 – 5.9	Good	
6.0 – 8.9	Fair	
9.0 – 26.0	Poor	
99.0	(No sidewalk on quite street)	
> 99.0	(No sidewalk on busy street)	

2.3 AADT Measurement

This assessment uses AADT (Average Annual Daily Traffic) to find out how many vehicles use a road each day on average over a year. It includes both busy and quiet times to give a full picture of traffic conditions. This helps show where road safety can be improved especially for people walking or bicycling since high traffic can make them feel unsafe [4]. In this study, vehicles were counted by watching the road and recording how many passed in both directions. The count was done over 15 minutes or 5 minutes if needed. The results were then used with a simple formula to estimate AADT for roads in Taman Sentosa and Taman Tangkak Jaya [4].

1) 15 Minute Count Conversion

When the number of vehicles is recorded over a 15-minute interval, the following steps are taken to project the 24-hour traffic volume:

- Hourly Estimation: Multiply the observed number of vehicles by a factor of 4 to scale up to an hourly count.
- Daily Estimation: Multiply the hourly estimate by a factor of 12.5 to approximate the 24-hour volume.

$$\text{Estimated 24-hour volume} = (\text{Number of vehicles}) \times 4 \times 12.5 \quad (1)$$

2) 5 Minute Count Conversion

When the number of vehicles is recorded over a 5-minute interval, the conversion process is as follows:

- Hourly Estimation: Multiply the observed number of vehicles by a factor of 12 to estimate the number of vehicles per hour.

- Daily Estimation: Multiply the hourly estimate by 12.5 to obtain the projected 24-hour traffic volume.

$$\text{Estimated 24-hour volume} = (\text{Number of vehicles}) \times 12 \times 12.5 \quad (2)$$

These conversion factors are based on standard traffic engineering practices and assume relatively uniform traffic distribution unless local adjustment factors are applied.

3. Results and Discussion

The results of this study are discussed in detail below.

3.1 Travel Mode Selection

Table 2 presents the travel mode choices of 201 respondents from the town of Tangkak. Most people tend to walk or cycle only if the distance is less than 1.0 km. For longer journeys, they prefer using private vehicles or public transport. This pattern is likely influenced by the hot weather, which can make walking over longer distances uncomfortable. Providing shaded or covered walkways could help encourage more people to walk, even for slightly longer trips.

Table 2 *Travel mode selection among respondents*

Travel Mode	< 1.0km	1.0-1.9km	2.0-2.9km	3.0-3.9km	> 4.0km
Walk	46.3%	10.4%	3%	1.5%	1.5%
Bicycle	11.9%	19.4%	9.5%	2.5%	1%
Motorcycle	27.4%	38.3%	35.3%	20.9%	11.9%
Car	14.4%	30.8%	49.8%	71.6%	83.6%
Bus	0%	1%	2.5%	3.5%	2%

3.2 AADT Measurement

In this study, the roads in Taman Sentosa and Taman Tangkak Jaya were divided into several segments to allow for a more detailed analysis of traffic volume and pedestrian infrastructure conditions. Each segment represents a specific section of road defined by key points such as intersections, junctions, or changes in the surrounding area (for example, from residential areas to commercial areas). This segmentation method enables the identification of variations in traffic flow and walkability levels along the road network.

AADT shows the average number of vehicles passing through a road daily over a year, as presented in Table 3 and Table 4 for Taman Sentosa and Taman Tangkak Jaya. In Taman Sentosa, Segment 7 recorded the highest traffic with 16,500 vehicles, followed by Segment 3 with 15,000, while most other segments had below 7,000 vehicles per day. In Taman Tangkak Jaya, Segment 2e had the highest AADT with 18,000 vehicles, followed by Segments 2d (16,200) and 2b (14,850). Segment 7 also showed high traffic at 16,500 vehicles, representing the same road as Segment 7 in Taman Sentosa, indicating its role as a major connector between the two areas and the Tangkak town centre. These AADT values help identify heavily used roads that may require improvements in traffic management and enhanced pedestrian safety measures.

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Table 3 *AADT at all segments in Taman Sentosa and Taman Tangkak*

Road Segment	AADT (vehicles)	Location
1	150	Taman Sentosa
2	800	
3	15000	
4	150	
5	250	
6	3950	
7	16500	
8	6750	
9	3800	
1	4500	Taman Tangkak Jaya
2a	9000	
2b	14850	
2c	10800	
2d	16200	
2e	18000	
3a	8250	
3b	9150	
4	1300	
5a	3000	
5b	3000	
6	3000	
7	16500	
8	2000	

3.3 Walking Suitability Assessment

The data obtained for walking suitability assessment results are shown in Table 4. Referring to Tables 4 as well as Fig. 2, Segments 1, 2, 4, 5, and 6 are categorized in pink, which indicates quiet roads without any sidewalks and reflects a serious lack of pedestrian infrastructure. Meanwhile, Segment 3 falls under the orange category, representing poor walking conditions. In contrast, Segment 9 showed the most suitable environment for walking, as it is categorized in blue, indicating very good walkability. On the other hand, Segments 7 and 8 are in the red category, highlighting notable deficiencies in pedestrian infrastructure, although not as severe as the segments with no sidewalks.

Table 4 *Score obtained using the WABSA in Taman Sentosa*

Segment	1	2	3	4	5	6	7	8	9
Annual Average Daily Traffic (AADT)	0	0	2	0	0	0	2	0	0
Posted Speed (km/h)	0	0	2	0	0	1	2	1	0
# of thru lanes	0	0	0	0	0	0	0	0	0
Sidewalk	99	99	3	99	99	99	3	99	0
Material	-	-	0	-	-	-	0	-	0
Surface Condition	-	-	0	-	-	-	1	-	1
Sidewalk width	-	-	0	-	-	-	0	-	0
Buffer width	-	-	0	-	-	-	0.5	-	0.5
Curb ramps	4	4	2	4	4	2	2	2	0
Adequate Lighting	0	0	0	0	0	0.5	0	0.5	0
Isolated Problem Spots?	N	N	Y	N	N	N	Y	N	N
Total Score	103	103	9	103	103	102.5	10.5	102.5	1.5
Colour Score	Pink	Pink	Orange	Pink	Pink	Pink	Red	Red	Blue

Based on Table 5 as well as Fig. 2, Segments 1, 4, 5a, 5b, 6, and 8 are marked in pink, indicating quiet roads with no sidewalks, which highlights a major lack of pedestrian infrastructure. In contrast, Segments 2a, 2b, 2c, 3a, and 3b are categorized in red, representing busy roads with serious pedestrian safety concerns. Meanwhile, Segment 2d, shown in yellow, reflects moderate walking conditions, whereas Segment 2e, marked in green,

indicates good walkability. Additionally, Segment 7 is categorized in orange, showing poor but less critical conditions compared to the red segments.

Table 5 *Scores obtained from the WABSA in Taman Tangkak Jaya (Segment 1 to Segment 3a)*

Segment	1	2a	2b	2c	2d	2e	3a
Annual Average Daily Traffic (AADT)	0	1	0	1	2	2	1
Posted Speed (km/h)	0	1	2	2	2	2	1
# of thru lanes	0	0	1	1	0	0	0
Sidewalk	99	99	99	99	0	0	99
Material	-	-	-	-	0	0	-
Surface Condition	-	-	-	-	0	0	-
Sidewalk width	-	-	-	-	2	1	-
Buffer width	-	-	-	-	0.5	0.5	-
Curb ramps	4	2	4	4	0	0	2
Adequate Lighting	0	0	0	0	0	0	0
Isolated Problem Spots?	N	N	Y	Y	N	N	N
Total Score	103	103	106	107	6.5	5.5	103
Colour Score	Pink	Red	Red	Red	Yellow	Green	Red

Table 6 *Scores obtained from the WABSA in Taman Tangkak Jaya (Segment 3b to Segment 8)*

Segment	3b	4	5a	5b	6	7	8
Annual Average Daily Traffic (AADT)	1	0	0	0	0	2	0
Posted Speed (km/h)	1	0	0	0	0	2	0
# of thru lanes	0	0	0	0	0	0	0
Sidewalk	99	99	99	99	99	3	99
Material	-	-	-	-	-	0	-
Surface Condition	-	-	-	-	-	1	-
Sidewalk width	-	-	-	-	-	0	-
Buffer width	-	-	-	-	-	0.5	-
Curb ramps	2	4	4	4	4	2	2
Adequate Lighting	0.5	0	0	0	0	0	0.5
Isolated Problem Spots?	Y	N	N	N	N	Y	N
Total Score	103.5	103	103	103	103	10.5	101.5
Colour Score	Red	Pink	Pink	Pink	Pink	Orange	Pink

The final categorization of the roads along the route from Taman Sentosa and Taman Tangkak Jaya to Bandar Tangkak according to their group is shown in Fig. 2 (see Appendix A).

3.4 Bicycling Suitability Assessment

The roads from Taman Sentosa and Taman Tangkak Jaya to Bandar Tangkak are currently not suitable for cycling due to the absence of dedicated bicycle lanes and supporting infrastructure. These routes are frequently used by residents, but cyclists are forced to share the road with vehicles, especially in areas with high traffic and varying speed limits, increasing accident risks. Narrow or missing road shoulders and a lack of signage further reduce safety. The absence of continuous bike lanes, proper lighting, and clear separation from traffic makes the cycling experience unsafe and uncomfortable [7]. To promote cycling as a safe and sustainable transport option, local authorities should develop dedicated and connected bicycle lanes along these key routes.

4. Conclusion

Based on this study, the assessment carried out in Bandar Tangkak emphasizes the need to upgrade infrastructure to support walking and bicycling, as the town experiences ongoing growth in both population and traffic levels. By using the WABSA (Walking and Bicycling Suitability Assessment) method, the study assessed the suitability of two main areas which are Taman Sentosa and Taman Tangkak Jaya for active transportation. Although some residents do walk or cycle for short trips under 1 kilometer, there is still a majority of residents that rely on private motorized vehicle due to limited infrastructure for walking and bicycling, safety concerns and convenience. The WABSA analysis supported these findings, showing that many roads in both areas lack the

necessary features to ensure a safe and pleasant walking or cycling experience, especially in high-traffic areas [8]. Making changes that includes building safer sidewalks, creating dedicated bike lanes, improving street lighting, and strengthening links between residential zones and key public facilities would not only promote healthier lifestyles but also support environmental goals and ease traffic problems [9], [10].

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Conflict of Interest

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

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. *The authors confirm contribution to the paper as follows:* ***study conception and design:*** *Mohd Erwan Sanik, Nur Nadia Batrisya Mohd Nazri;* ***data collection:*** *Umi Amirah Fauzi, Nur Imanina Syahrul Azhar;* ***analysis and interpretation of results:*** *Nur Nadia Batrisya Mohd Nazri, Umi Amirah Fauzi, Nur Imanina Syahrul Azhar;* ***draft manuscript preparation:*** *Nur Nadia Batrisya Mohd Nazri, Umi Amirah Fauzi, Nur Imanina Syahrul Azhar. All authors reviewed the results and approved the final version of the manuscript.*

Appendix A

(a) **(b)**

Fig. 2 *Road colour section according to the score and level (a) Taman Sentosa; (b) Taman Tangkak Jaya*

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