Integrating walking and cycling facilities towards green mobility in Bandar Penggaram Batu Pahat

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Abstract. Walking and cycling facilities have huge potential in contributing to green mobility in the cities. It is important to reduce transportation emissions, such as enhancing bicycle and pedestrian infrastructure networks and encouraging users to use public transportation. The main problem in Bandar Penggaram, Batu Pahat is high carbon emissions that came from motorised transportations. The objective of this research is to identify the existing condition of walking and cycling facilities and to propose ways to improve the existing condition of walking and cycling facilities towards green mobility in Bandar Penggaram, Batu Pahat. The analysis of this research involved areas around Dataran Penggaram, Batu Pahat which focuses on the main roads that tend to produce high carbon emissions. The method that is used in this research is the mixed methods which consist of quantitative and qualitative method. The first finding of the observation shows that the focused site or development integrates pedestrian and cycling networks with other road activities. There are also bicycle parking facilities, separate bike paths parallel to major roads and dedicated lanes for walking and cycling. Secondly, the weather and distance are the limitations of residents who walk and cycle. Next, the best criteria to overcome the limitations when integrating pedestrian and cycling networks with other road activities are planting shaded trees and build roofs over dedicated lanes for walking and cycling. So, the facilities need to be maintained at this level and improve or implemented to reduce the number of private vehicles on the road. Hence, less carbon emission from motorised transportations is achieved when more private vehicles are off the road.

Keywords. Pedestrian, cycling, walking and cycling facilities, green mobility, transportation

1. Introduction
Green mobility is a way to achieve sustainable cities that need efficient and affordable solutions to prevent traffic jams, improve urban environmental degradation, and reduce CO2 emissions [1]. Walking and riding bicycles provide good exercise, reduce adverse effects on the respiratory system, and lesser traffic means saving time and energy, and improved road safety [1]. The implementation of green mobility is to provide walking and cycling facilities to support access and mobility to or from public transit nodes [2].

This study focuses on integrating walking and cycling facilities for green mobility. In the context of pedestrian facilities, it comprises of a panoply of paved and demarcated surfaces, where citizens have
exclusive rights and privilege when they temporarily interact with the auto-mobility realm [3]. The cycling infrastructure is retrofitted onto existing roads and streets with cheap materials to make spine systems of low-stress bike courses on blood vessel lanes, little private avenues, and even intercity roads [4]. The development of the cycling path networks that can supplement the public transport system also makes a significant contribution to reducing CO2 emissions. Bicycle networks should be designed to meet criteria such as security, connectivity, accessibility, direct, attractive, comfortable and integrated with the public transport system [5]. Other than that, each urban climate action plan includes goals and policy actions aimed at reducing transportation emissions, such as incentivizing the use or purchase of electric or alternative fuel vehicles, enhancing bicycle and pedestrian infrastructure networks, and encouraging residents to use public transportation [6].

In future, Bandar Penggaram is aimed to be a city that is free from carbon emission by the implementation of a car-free day and improved walking and cycling facilities. In a nutshell, this research focuses on integrating walking and cycling facilities towards green mobility in Bandar Penggaram, Batu Pahat. Green mobility addresses some of the problems that we faced with the existing transportation system. Other than that, obstacles to walking and cycling include lack of sidewalks, crosswalks, and bikeways, lack of connectivity of pedestrian or bike infrastructure, actual and perceived dangers of walking and cycling [7].

Hence, the lack of walking and cycling facilities discourages people to not want to use the bicycle or walk on foot anywhere. Two-thirds of the residents evaluated the cycling facilities of their city as adequate, but unsafe for young cyclists who do not follow traffic rules [8]. According to the residents of Preveza, the negative factors affecting cycling were insufficient infrastructure, exposure to extreme weather conditions, and safety risks [8]. Other than that, the limited walking and cycling facilities at the focused site or development do not integrate pedestrian and cycling networks nor provide continuous and shaded dedicated lanes for walking and cycling in Bandar Penggaram, Batu Pahat is also the cause of an increasing number of cars on the road.

Hence, based on the problems and gaps of this study, an effort is taken to integrate the walking and cycling facilities towards urban green mobility in the city through observation, document review and survey. The importance of this study is in line with the national target to improve carbon output in future according to the objective of the Green Technology Master Plan as the national strategic plan and implementation framework to catalyze green growth towards sustainable development and high-income nation by 2020 and to position Malaysia as a Green Technology hub by 2030 [2].

Green mobility is a way to achieve sustainable cities that need efficient and affordable solutions to prevent traffic jams, improve urban environment degradation, and reduce CO2 emissions [1]. The modes of green transportation are electric cars, pedestrian, bicycles and public transportation [1]. Regarding the level of carbon dioxide (CO2) emissions, non-motorised transport modes are preferred over motorised transport modes, and public transportation modes preferable to private transportation modes [9].

2. Methodology
The survey was carried out using the mixed methods methodology which consists of quantitative and qualitative research design. In a quantitative method; the questionnaire is used. In the observation, a checklist is used to identify the existing conditions of walking and cycling facilities. After that, we analyse the questionnaire that we had collected. For the qualitative method, document review is used at Majlis Perbandaran Batu Pahat (MPBP) to collect the data using the existing documents.

| Table 1. Summary of the Research Objectives and Adopted Methodology |
|--------------------|--------------------|
| Research objective | Adopted method     |
| 1) To identify the existing of walking and cycling facilities in Batu Pahat. | Do a check-list based on observation at 11 roads |
2) To propose improvements and implementation on the existing facilities for walking and cycling infrastructure toward green mobility in Bandar Penggaram Batu Pahat.

2.1. *Quantitative Approach*

The quantitative approach is defined as a method where the quantity and amount become the benchmark of evidence and information to be acquired [10]. The quantitative approach is usually applied where there is a time constraint and resource.

2.2. *Qualitative Approach*

A qualitative approach is an approach which behaved ‘subjective’ in nature [11] and emphasised on quality as the source in information collection [10]. Qualitative research is based on non-numerical examination and interpretation of the observation. Information collection for a qualitative approach can be obtained from face-to-face interviews, observations and further discovery from existing documents [12].

2.3. *Mixed-Method*

Mixed methods research involves the use of qualitative and quantitative data in a single research project [13] and its central premise is that the use of quantitative and qualitative approaches, in combination provides a better understanding of research problems than either approach alone [14]. The characteristics of mixed methods research are collecting and analysing both quantitative and qualitative data, mix two forms of data in different ways, give priority to one or both forms of data and can be in a single study or in multiple phases of a study [15].

2.4. *Participants for Questionnaire, Sampling and Population Technique*

The data was conducted for two months and collected using a survey where the samples were selected randomly to answer the questionnaire given. According to the statistics from [16], the number of residents that live in Bandar Penggaram, Batu Pahat under Low Carbon City (LCC) area is 10,269. The sample size is 370 residents.

The non-random sampling technique was used where some elements of the population have no chance of selection or where the probability of selection cannot be accurately determined. The non-probability sampling should meet the conditions of the sufficient response rate.

2.5. *Document Review*

The document review is to guide how to make an observation of the case study and to conduct a questionnaire to formulate questions. The documents that need to be reviewed are the previous and current plan or policy regarding walking and cycling facilities, data of the existing walking and cycling facilities and current walking and cycling facilities at 11 chosen roads in Bandar Penggaram, Batu Pahat. After reviewing the existing documents to collect all the data, the results of the data collection are analysed in the report based on the Integrating Walking and Cycling Facilities in Bandar Penggaram, Batu Pahat.

2.6. *Observation*

Observation is done by using the checklist on the existing condition of walking and cycling facilities at the 11 chosen roads as mentioned above. After all the roads have been observed, the researchers combine all the data and the result of the data collection in the checklist is analysed in a report.

2.7. *Questionnaire*
Respondents will be asked to complete a questionnaire by ticking in the given box regarding their profile and knowledge in general as well as their socio-demographic information. Respondents will answer the questions by circling the scale. The data collected is analysed through SPSS software in each category.

2.8. Pilot-Test
A pilot test is a pre-test or a mini version of full-scale research or experiment that conducts extensive research in preparation [17]. It helps to improve the reliability of the survey questionnaires and the minimum value for inter-item of respondents to conduct a pre-test is 30 [18]. A total of 30 residents will be involved in this pre-test. And then, the questionnaire was distributed to employees at the 11 chosen roads.

| Cronbach’s Alpha | Internal consistency       |
|------------------|---------------------------|
| α ≥ 0.9          | Excellent (High-Stakes testing) |
| 0.8 ≤ α < 0.9    | Good (Low-Stakes testing)   |
| 0.7 ≤ α < 0.8    | Acceptable                 |
| 0.6 ≤ α < 0.7    | Questionable               |
| 0.5 ≤ α < 0.6    | Poor                       |
| α ≤ 0.5          | Unacceptable               |

Table 3. Level of mean measurement [19]

| Mean score | Scale |
|------------|-------|
| 1.00 – 2.49 | Low   |
| 2.50 – 3.50 | Moderate |
| 3.51 – 5.00 | High  |

3. Result and Discussions
The results of this research are obtained from the data collection. The document that needs to be reviewed is the previous and current plan or policy regarding walking and cycling facilities and data of the existing walking and cycling facilities at the chosen roads in Bandar Penggaram, Batu Pahat.

3.1. Initiative 1 - Preparation of the bicycle routes in the Batu Pahat Municipal Council area
Bicycle and pedestrian trails in the study area are mostly at the shoulders of roads and close to recreational areas. Therefore, to connect the green network within the urban area, plans to establish a comprehensive cycling and pedestrian network within the urban area should be emphasized to ensure that the urban green network is accessible and user-friendly.
The main plan of bicycle paths in Batu Pahat is only at Phase 1A and 1B, while others are under construction and a new route suggestion. Phase 1A bike path on Tasik Y which covered 1,500m (1.5km) of two-lane roads is a bicycle route sharing with a pedestrian route, vehicle route has a zebra crossing for a bike path, a bicycle station and signage for bicycle parking. While Phase 1B bicycle route consists of Jalan Zaharah, Jalan Kabong and Jalan Asam Paya. Phase 1B already has bicycle route signage sharing with vehicle route, a symbol of bike lane in the vehicle lane, bicycle route information board and bicycle parking.

3.1.1 Suggestion Bike Path - Shared bike paths with pedestrian paths

![Figure 2. Jalan Dagang – Jalan Asam Paya](image2)

![Figure 3. Jalan Kabong – Jalan Zaharah](image3)
3.2. Initiative 2 - Provision of pedestrian walkways in the area of Batu Pahat Municipal Council

![Figure 4. Planning of City Walkways in the Landscape Master Plan](image)

MPBP has taken the initiative to implement phases using existing spaces to build pedestrian networks such as upgrading monsoon trenches and building pedestrian walkways, building pedestrian walkways around Batu Pahat Stadium and Dataran Penggaram and using it as an alternative to connectivity pedestrian network.

The overall pedestrian-friendly concept of the city was laid back and relaxing, in keeping with the dense and vibrant urban setting. The pedestrian route also includes the existing infrastructures that still exist in the city centre such as post offices, grocery stores and bus terminals where there are still residents walking and cycling from one node to another.

3.3. Observation

From our observation, at Jalan Pejabat, almost all the facilities have fulfilled the criteria provided. The criteria that have 4-star rating was the bicycle parking facilities, the dedicated lanes for walking and cycling, the integrated pedestrian and cycling network with other activities and provided separate bike paths parallel to major roads. The public bicycle-sharing system at Jalan Pejabat and special traffic lights for pedestrian and cycling paths is not implemented yet at this road.

At Jalan Zaharah, the highest rate for walking and cycling facilities was the bicycle parking facilities, the connection with public transport, rest or seating area at a certain distance along the walking and cycling paths, dedicated lanes, integrated pedestrian and cycling network with other activities, separate bike paths parallel to major roads and the existence of CCTV on the road. There are shops like Guardian, Watsons, a bank, Avon and also a lot of food stalls around Batu Pahat Walk. The criteria that are fully fulfilled at this area such as being well lit at night, has bus stop which ease of connection with public transport, integrates pedestrian network with other activities, has CCTV to prevent theft or accidents on the road and has shaded trees for pedestrians along the walking path.

The walking paths at Jalan Rahmat which is known as Batu Pahat Walk is a commercial area. The criteria are fully fulfilled at this area such as lighting for night, bus stop integrates pedestrian network, CCTV and shaded trees along the walking paths.
Although there are 11 roads included in the Low Carbon City (LCC) area, 8 roads did not have walking and cycling facilities. They are Jalan Tanjong Laboh, Jalan Masjid, Jalan Mohd Salleh, Jalan Mohd Akil, Jalan Sultanah, Jalan Zabedah, Jalan Ampuan and Jalan Syahbandar.

**Table 4.** Statistics of the limitation for walking and cycling

| Limitation for Walking and Cycling | Mean | Std. Deviation | Valuation |
|-----------------------------------|------|----------------|-----------|
| 1) Lack of infrastructure         | 3.54 | 0.998          | High      |
| 2) Absence of cycling path (on or off road) | 2.75 | 1.164          | Moderate  |
| 3) Distance limitation            | 3.97 | 0.786          | High      |
| 4) Hot and rainy weather          | 4.31 | 0.731          | High      |
| 5) Slow travelling speed          | 2.74 | 0.826          | Moderate  |
| 6) Felling insecure               | 3.40 | 0.685          | Moderate  |
| **Overall**                       | **3.45** | **0.865**      | Moderate  |

**Table 5.** Statistics of the criteria of walking and cycling facilities

| Criteria of Walking and Cycling Facilities | Mean | Std. Deviation | Valuation |
|--------------------------------------------|------|----------------|-----------|
| 1) Has lighting at the night               | 3.16 | 0.974          | Moderate  |
| 2) Has bicycle parking facilities          | 2.80 | 0.707          | Moderate  |
| 3) Ease of connection with public transport| 3.00 | 0.785          | Moderate  |
| 4) Has public bicycle-sharing system       | 2.41 | 0.805          | Low       |
| 5) Providing rest area or seating at certain distances along the walking and cycling paths | 3.21 | 0.701          | Moderate  |
| 6) Has continuous dedicated lanes for walking and cycling | 3.63 | 0.546          | High      |
| 7) Has bike lane network out of the city   | 2.77 | 0.671          | Moderate  |
| 8) Has bike lane network in of the city    | 2.90 | 0.823          | Moderate  |
| 9) Providing separate bike paths parallel to major road | 2.67 | 0.746          | Moderate  |
| 10) Integrates pedestrian and cycling networks with other activity | 4.40 | 0.735          | High      |
| 11) The existence of CCTV to prevent theft or accident on the road | 3.70 | 0.915          | High      |
| 12) Provides special traffic lights for pedestrian and cycling paths | 3.63 | 0.546          | High      |
| 13) Have shaded trees and roof over dedicated lanes for walking and cycling | 4.34 | 0.646          | High      |
| 14) Place for bicycle parking at the entrance of the public administration buildings, offices and shopping centre | 2.28 | 0.857          | Low       |
| **Overall**                                | **3.21** | **0.747**      | Moderate  |

4. Conclusion

This work presented findings from mixed methods which consist of qualitative and quantitative research design. For example, document review, observation and survey. Limitations of walking and cycling and the criteria for walking and cycling facilities are highlighted. Adults and the senior citizens’ current transportation mode, the knowledge of walking and cycling facilities and opinions were considered. These findings form a strong basis to develop quantitative and qualitative studies to measure the current condition of walking and cycling facilities and to propose suggestions for walking and cycling facilities at the chosen roads. Based on the observation at the existing walking and cycling facilities, Jalan Pejabat and Jalan Zaharah must implement a bicycle-sharing system and special traffic light for pedestrian and cyclist for their safety. While for Jalan Rahmat, MPBP should build a cycling path due it being in a commercial area and there are only walking paths provided. For other roads that did not have walking and cycling facilities, Jalan Masjid and Jalan Ampuan are most suitable to
implement the walking and cycling paths, and the other roads are not suitable due to busy roads and limited space.

Based on the results from respondents, most of the residents in Batu Pahat are not walking and cycling because of the weather. Thus, MPBP must implement or improve the infrastructure such as planting shaded trees and construct roofs over dedicated lanes at the walking and cycling paths which is supported by [20]. Next, the respondents mostly agreed that the facilities must integrate pedestrian and cycling network with the other economic activities to allow direct travel and the network has to link major trip generation and places of attraction and has to be within a reduced walking distance and accessible to the rest of the city parts [5]. Other than that, MPBP should also improve and implement the shaded trees and roof over dedicated lanes for walking and cycling, provide CCTVs to prevent thefts or accidents on the road, provide continuous dedicated lanes shading [21] and special traffic lights for pedestrian and cycling which is supported by [22]. In conclusion, the main objective of this research is to identify the existing condition of walking and cycling facilities and to propose recommendations that can improve the existing condition of walking and cycling facilities towards green mobility in Bandar Penggaram, Batu Pahat. This research has successfully achieved its research objectives. Hopefully, this research will contribute to extending information and be useful for future research in a similar scope.

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