Analysing Bicycle Route Potential Towards Sustainable Transport in Ipoh City

Sharinatol Akmanida Jamaludin, Muhamad Nazri Borhan, Muhamad Razuhanafi Mat Yazid, Nik Mohd Iznan Tuan Yaakub

Abstract: ***Sustainable transport has grow into an imperative goal for urban development and exploration in recent decades. Bicycle transportation as a non-motorised transport is indicate an imperative role in emerging sustainable transport. As the economy moved from unindustrialized base to industrial and amenities, the people tend to migrating at rising towns and cities. Thus, there has been an increasing of air pollution, high levels of utilization of biodiversity, isolation of city spaces, growth in the number of road traffic accidents and more urban change. The use of bicycle transportation is not only to decrease carbon but also to create the fit routine by physical movement. This research presents the bicycle route-choice model developed from Quantum Geographic Information System (QGIS) data for Ipoh town. An evaluation was through by transportation experts to collect data about the weights of the criteria and sub-criteria in this study. The consideration was prioritize the clusters by using the Analytic Hierarchy Process (AHP). The result of the study reveals that the priority factors concerned by experts in choosing bicycle route are the road characteristics (w = 0.588) and the traffic characteristics (w = 0.281). The facilities (w = 0.079) and land use characteristics (w = 0.052) are secondary considerations. These findings would encourage all interested municipalities to implement cycling as a part of transportation planning by determining key designing and planning factors to encourage cycling activities.***

Index Terms**:** ***Keywords: Analytic Hierarchy Process (AHP), Bicycle Transportation, Sustainability***

I. INTRODUCTION

Bicycle transportation is frequently the quickest way to generate a short journey within urban areas. The usage of bicycles as dynamic moving is widely held in huge capitals across the world for example in Copenhagen, Amsterdam, Uteretch, Beijing, Tokyo, Hamburg, Vienna, Paris, Helsinki, Barcelona, Singapore, Delhi, Singapore, Bangkok and many more. Additionally, in certain countries, the use of bicycles as a public transportation and bicycle-sharing concept also broadly implemented. This idea does not need high cost and it is appropriate for short distance movements not more than five kilometres. Presently, there are some bicycle tracks in Malaysia towns and cities, but the upgrading; growth of these paths might inspire more public to cycling. This improvement was presented to reduce the traffic congestion, parking difficulties, absence of access to public transport and carbon productions to the sky which contributes to ecological pollution and inequity in terms of quality of life in all-purpose movement (Nasrudin, Nor, Noor, & Abdullah, 2013; Riza Atiq O.K. Rahmat, 2015; Razuhanafi, Yazid, & Ladim, 2015).

City transport problems will never be ending in the present or future. Fast advancement in the city make sustainability fundamentally influenced. Numerous of main roads face serious congestion problem during peak hours. To solve this matter, the Malaysian government has paid attention to considerably more by expanding the significance of connections between transportation approach and supportable improvement. Thusly, a compelling method to lessen traffic blockage in furious urban areas is the ideal utilization of the bike in day-by-day exercises. Most recent town improvement and current environmental change require that the specialists need to assess and examine the progressing city advancement and executives. Streak flood, avalanche, rainstorm, extraordinary nursery impact, worldwide rising temperature, and across the board air contamination are for the most part impacts from huge environmental change. Therefore, there has been expanding in air contamination levels, abnormal amounts of utilization of regular assets, isolation of urban spaces, an expansion in the number of car crashes and progressively urban fixed status. (Shuhaili, Ihsan, & Faris, 2013; Ibrahim, Leh, Adnan, Kalsum, & Isa, 2016). For that reason, bicycle lanes separately or shared with motor vehicles have been implemented in several states such as Penang, Melaka, Shah Alam and Putrajaya.

A. Purpose of the Study

The aim of this research is to create a show utilizing GIS strategies in proposing bicycle route potential in Ipoh City. The bicycle route is supposed to connect the whole city in area of Ipoh Town 'Tin Heritage City' Action Plan (RKK). Such the bicycle route can be the support of development corridor improving the accessibility in the Ipoh city. Hence, a bike route ought to have the least undesirable impacts on the environment and ought to be secure from the unfavourable impacts that will be caused by the encompassing circumstance.

B. The Study Area

Ipoh city is a largest town in Perak located in the middle of Kinta District that is rich with heritage buildings and ecosystem that should be sustained as shown in fig. 1(a). This city population is approximately 823600 people according to Department of Statistics (2017). It occupies an

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area of 0.797 km2, which involves in Ipoh Town 'Tin Heritage City' Action Plan (RKK) core zone. Despite of notorious requirement on Perak's state governmental activities, there has been a rising digit of commercial and tourism businesses, which expressed by necessity on core zone area of the city, attend daily displacements as shown in figure 1(b). In this sense, the methodological context of section 3 is applied to anticipate a bicycle route in Ipoh City.

Fig. 2 shows the value of the air pollutant index (IPU) recorded at Ipoh based on the temperature, pressure, and humidity. Results at the beginning of the year indicate that API is at a moderate level of 51 -100. The official Air Quality Index (AQI) for Malaysia from DoE only based on PM10 from http://aqicn.org/city/ipoh/ shows that Ipoh AQI was good. For that reason, Ipoh city is the suitable place to implement cycling route since it is efficient, eco-friendly way of transport as well as being one of the healthier ways of life. At present, bicycle lane has been implement at surrounding Dr Seenivasagam Park in Ipoh as shown in figure 3.

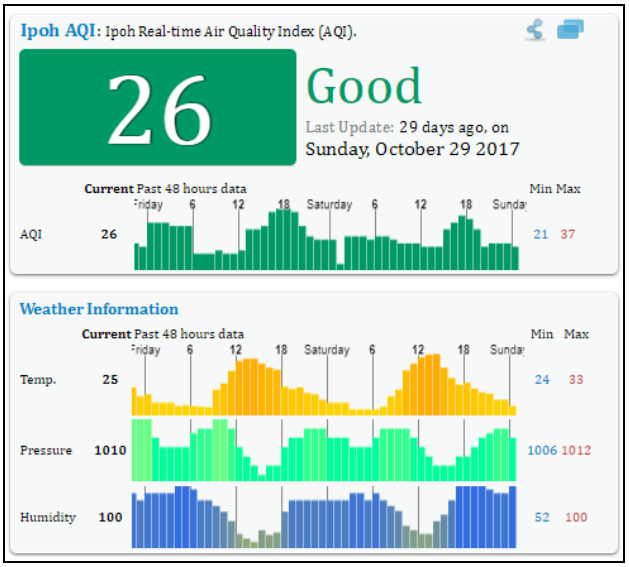

Fig. 2: Ipoh Air Pollution: Real-time Air Quality Index (AQI)

(a)

Legend:
Core Zone (79.70 Ha)
Buffer Zone (175.50 Ha)

(b)

Fig. 1: Ipoh City and its quarters

Fig. 3: Ipoh City and its quarters

II. BICYCLE TRANSPORTATION AS SUSTAINABLE APPROACH

Bicycle Transportation is increasingly acknowledge as a sustainable, unpolluted and an effective part of quality of life for sustainable urban mobile. Cycling guarantees different benefits as a short-distance trip in urban regions. It is additionally natural neighborly without carbon emanations and clamor disturbance gives compelling fetched development and offers an

opportunity for physical wellness and wellbeing by steady cycling (Britton, 2010; Lindholm, 2010; Yazid, Ismail, Rahmat, & Nazri, 2012; Nasrudin et al., 2013). Over numerous decade, arranging and arrangement judgments concerning transportation in tremendous crucial cities took put inside a structure in which the road and travel at central, with people on foot and bicyclists fair two advance components that had to be worked in each potential put. Be that as it may, the National Transformation Plan (NTP) has propelled insurgency this nation by given modern sources and subsidizing for bike and person on foot offices towards sustainability (Chamhuri Siwar, Rospidah Ghazali, Sharina Abdul Halim, 2014). Nevertheless, a few ten a long time afterward, advancing walking and bicycling whereas guaranteeing security and versatility for the by and large transportation framework, proceeds to show a challenge, particularly for huge central cities, which must adjust numerous and competing interface whereas confronting restricted space and financing. Assist, issues with restricted information in a number of ranges, counting security, design, and ought to tend utilization (Rybarczyk & Wu, 2010; Nasrudin, Rostam, & Noor, 2014).

Empowering utilize of bicycles moreover offers numerous benefits to public policy as well as to people (Litman, 2016). A bicycle can reduce traffic congestion, roadway cost savings, reduce parking problems and savings in the cost of maintaining parking, greater and more equitable transport choice. Moreover, Bicycle also can reduce social inequity and support more social interaction, and an efficient use of land. On the other hand, it also needs to be noted that bicycle has limitation, such as limited speed and mileage since this mode uses only manpower. It has to be recognize that bicycle cannot be consider in isolation as to attract people to use it in daily. Reflecting its limitation, bicycle only effective for short and moderate trip distances and it is not affordable for long trips.

Many transportation city planning put bicycle as a feeder for public transport by providing bicycle parking near with bus or train station or bus stops. The main idea is that how to make it easy for people to get to their destination without using private cars or motorcycle. Planning for bicycle transportation can be used hard and soft policies. Facilitating cyclists through providing bike line or bike path is the primary policy for attracting people to cycling. Some additional infrastructure also need to be concerned, such as bike parking and showers. Soft policies such as bike to work campaign, safe route to school, zero carbon day and car free days are the example of policies for encouraging people to bike.

A lot of research (Pucher & Buehler, 2008; Lindholm, 2010; Britton, 2010; Hsu & Lin, 2011; Wang, Zhu, Li, & Wu, 2013; Nasrudin et al., 2014; Oswald Beiler et al., 2015; Muhamad Razuhanafi et al., 2012, 2013, 2015;) has extensively examined the role of cycling for transportation. These researchers were recorded the benefits, weaknesses of bicycle transportation and encounter the influences of transportation pattern in cities. They also examining people motivation hint to take bicycle as mode of transport. Based on the research, there was taking time for shifting people from car-based transport to bicycle based, mostly in developing countries where society have a habit using private motor vehicle than bicycle. For that reason, implementation of Malaysian Urban Rural National Indicators Network for Sustainable Development (MURNInets) as database in advanced frame to degree the sustainability of the city conjointly be able to donate sustainability accomplishments of a nearby authority on an progressing basis (Research and Development Division Federal Department of Town and Country Planning Peninsular Malaysia, 2017). Therefore, sustainable transportation creates a definite offer to the cost-effective sustainability of the focus society.

A. Challenges in Implementing Sustainable Transportation in Malaysia

The civilians nowadays is greatly reliant on private or public motorised transport. Individually movement using the motor vehicle expenditures greatly of energy and produce by burning fossil fuels, that cause smoke and noise and have disadvantages effects on environments also an air pollution major contributor. The use of non-motorised automobiles will decrease the influence of pollution on the atmosphere (Shuhaili et al., 2013). In Perak, average daily traffic accumulated by 77483 in the second quarter of 2016 for area AR 303; Ipoh-Gopeng as shown in figure 4 (Ministry of Transport Malaysia, 2017). This figure will remain increasing year-over-year with enlarged revenues, rural-urban migration and deficiency of well-organized public transport facilities liable on the type of transportation system applied, energy sources, level of engine technology, and the volume of energy desirable (Nasrudin et al., 2013; Horizon Gitano Briggs, 2016).

BIL. No	STESEN Station	RM	LOKASI Location	2011	2012	2013	2014	2015	2016
1	AR 101	106.6	Ipoh - Tanjung Malim (Slim River toll house)	14,039	14,431	15,328	16,501	16,736	15,187
2	AR 204	78.9	Ipoh - Lumut	23,758	25,283	25,942	23,834	26,494	25,939
3	AR 301	35.9	Ipoh - Kampar	30,311	27,697	28,520	27,126	30,592	24,654
4	AR 303	5.6	Ipoh - Gopeng	73,487	85,819	77,195	78,210	78,136	77,483
5	AR 501	30.4	Ipoh - Kuala Kangsar (500m north of Sg. Siput town)	22,500	19,251	20,478	18,578	19,895	19,936
6	AR 601	79.7	Ipoh - Batu Hampar - Changkat Jering	11,726	19,410	20,588	19,881	20,664	21,327
7	AR 603	82.1	Ipoh - Changkat Jering - Semanggol	18,646	12,586	12,938	12,531	12,949	13,919
8	AR 703	106.3	Ipoh - Teluk Intan - Simpang Empat	25,004	28,665	25,689	25,865	27,249	33,024
9	AR 801	96.6	Ipoh - Kuala Kangsar - Gerik	3,110	3,562	3,487	2,826	3,139	3,017
10	AR 803	2.4	Lebuh Raya Timur - Barat	3,148	3,944	3,796	3,636	3,293	3,818

Fig. 4. Average Daily Traffic (ADT) at Perak, Peninsular Malaysia, 2012 – 2016

Presently, issues on traffic congestion, traffic accidents, and air pollution widely occur in this country as well automobile revolution. Figure 5 shows the total motor vehicles involved in road accidents by type of vehicle from 2007-2016 in Malaysia. The statistics were growingly every year (Ministry of Transport Malaysia, 2017). Motorised vehicles is the main causative criterion to not sustain the environment as well development activities, land clearing, manufacturing industry, open air burning and power generation. Those problems mention are associated each other as significances of the rises number of vehicles. Applying sustainable transportation arises as the system to assuage those problems. The consciousness for promoting bicycle transport as a mode to create sustainable transportation based on the

previous expertise that inspiring society to cycling. Realizing this realities, researches proposed to plan the bicycle route in Ipoh for making better transportation in the cities.

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Fig. 5. Total Motor Vehicles Involved in Road Accidents by Type of Vehicle, Malaysia, 2007-2016

According to (Litman, 2016), data on number of transportation mode and fuel consumption can be used as indicators for measuring sustainable transportation in the city. From figure 5, the accidents data also presents facts that the higher proportion of private transportation in Malaysia contrast with public transportation. Most of people in Malaysia prefer to use motorcar as their transportation mode rather than public transportation. Miserably, the tenancy of bus as public facilities are the lowest usage in Malaysia. Split bicycle route may ensemble the model for entire cities later. As the economy moved from a more unindustrialized base to fabricating and administrations, the individuals tend to relocate into rising cities and towns. In this way, there has been a rise in discuss contamination, tall levels of utilization of normal assets, separation of urban spaces, an increment within the number of activity mishaps and more urban fixed status (Chamhuri Siwar, Rospidah Ghazali, Sharina Abdul Halim, 2014; Horizon Gitano Briggs, 2016).

A sustainable city development in Malaysia revolves around six dimensions criteria including competitive economy, sustainable environmental quality, sustainable communities, optimum use of land and natural resources, efficient infrastructure and transport and effective governance (Research and Development Division Federal Department of Town and Country Planning Peninsular Malaysia, 2017).

Some sights can interpreted from the realities discussion. First, public transportation services such as bus and taxi are the last choice for Ipoh people to move. This elements raise as the significances of moderate services such as time schedule issues, criminal rate, expensive fare and uncomfortable. Nevertheless, public transportation did not offer an assurance for their on-time schedule and safety feature. Another reason, transportation policy in Malaysia not fully covered for public transport and active transport. This matter might be happen since private vehicle loans in Malaysia easy to approved as well as motorised production (Chamhuri Siwar, Rospidah Ghazali, Sharina Abdul Halim, 2014; Horizon Gitano Briggs, 2016)

Transportation systems create a greenhouse gases (Shuhaili et al., 2013; Ibrahim et al., 2016; Horizon Gitano Briggs, 2016; Irum et al.,2018), therefore once sustainability is implemented in transportation system, it can reduce the effect. Nevertheless, transport with little influence on the environment and involve non-motorised transport likes cycling, transit oriented development, transport systems with fuel-efficient and motivate healthy lives (Khan, Kockelman, & Xiong, 2014; Nasrudin et al., 2013, 2014). Furthermore, sustainable transport is a logical track from sustainable development used to describe modes of transport and transport development policy, that dependable with broader concerns on sustainability (Litman, 2016). Fascinatingly, sustainable transport system be present to offer social and economic networking with environmentally advantageous. According to a number of studies (Pucher & Buehler, 2008; Scheiner, 2010; Nasrudin et al., 2014; Muhamad Razuhanafi et al., 2012, 2013, 2015; Litman, 2016; Research and Development Division Federal Department of Town and Country Planning Peninsular Malaysia, 2017), a sustainable transport development and organisation should:

1. Organise the environment and resources and in a way dependable with social and health, while minimalizing the effect on the use of land and the creation of sound.
2. Concern the undersized access and growth needs of persons, enterprises, and society to meet with safety and supports fairness within and concerning following generations.
3. Runs effectively and practically by proposing choice of transportation mode, supports economical wishes, and well adjusted with district development.
4. Limitations on emissions and waste in environment with engage the facilities, renewable resources practises under the amounts of production, and non-renewable resources creation lower than the amounts of growth of renewable replacement.

B. Policy to Promote the Bicycle Transportation

Presently, transportation policy in Malaysia giving opportunity for civilian to have private car and the nation has provided many routes and highways, where the public could meet towards their destination. Accurately concerning arranging strategies for cycling route, a few studies have been developed over a long time based on differing strategies. Attention to sustainable transportation in Malaysia started from 2010 after the Economic Transformation Program (ETP) was launched. This program as initiative by the Malaysian government to transform this country into a high-income nation also turn cities around Malaysia into a liveable city by 2020. Bicycle nowadays permissible to convey inside the bus and rapid transit. Still, there are approximately limitations applies concerning carrying the bicycle to the rapid transit. As it were foldable bikes are satisfactory to bring interior the bus and rapid transit since the estimate of bike that is simple to moveable than other sorts of customary bicycles and bicycles are precluded to carry amid peak hour. In most of the bus station and rapid transit station, bicycle-parking amenities such as parking shelf are given for cyclists who are not able to carry the bike to the transport and prepare other than foldable bicycles generally in range Sri Petaling-Ampang. According to previous studies, effective

travel distance for non-motorised vehicles is 12 km (Jinyong, J., Meiping, Y., & Xiaoguang, 2009; Scheiner, 2010; Yazid et al., 2012).

There are as it were two conceivable circumstances for cycling along streets and roads which a blended activity where the cyclists are in front or behind vehicles in a controlled speed environment or cycling paths or tracks where the cyclists are close to vehicles in their possess space. In either circumstance, the anticipated position of the cyclist ought to be clear to all street clients and there must be adequate width for cycling. The outlined width of a cycle office is secured of the successful width, i.e. the space that's "usable" by cyclists, as well as the clearances that will be required completely different environment. Cyclists continuously wobble or meander from side to side in arrange to keep adjust, especially at lower speeds. An arrangement of 250mm wobble room is ordinarily adequate. Extra width ought to be considered where cyclists will be slower and wobbling more, e.g. drawing nearer intersections, at twists, or on tough areas. Where a cycle path surpasses 3.0m in width, there may be a few disarrays with activity paths and a cycle track may be distant better an arrangement. Particular arrangements for bicyclists are fundamental at intersections, both major and minor, counting carports, by giving stamp and exact colour bikeways and advanced stop line (ASL) or bike box. Cycle intersections through fundamental intersections will be estranged from vehicle paths and its plan with adequate spaces are required to suit bicyclists blending with people on foot (Department of Town and Country Planning, 2010; Iskandar Regional Development Authority, 2011).

C. Implementation of Geographical Information Systems (GIS) associated with Analytical Hierarchy Process (AHP) Analysis

Several Geographical Information Systems (GIS) software has been develop for mapping and analyse data. Open source access and user-friendly software that widely use is Quantum Geographic Information System (QGIS). QGIS was establishing May of 2002 has reached the point in its evolution where various for their daily GIS data-viewing needs are using it. QGIS supports a number of raster and vector data formats, with new format support easily added using the plugin design. Although using a QGIS already consolidated for planning cycling potential route, in numerous cases it ought to be combined with other strategies, such as AHP to pursue a better result. Many of researchers consider the using of a Geographic Information System (GIS) connected with any variables figures (Belka, 2005; Rybarczyk & Wu, 2010; Wang et al., 2013).

Through the implementation of GIS and AHP in latest ages, several writers have used both technique in studies related to bicycle Transportation. Table one shows the summarize assessment methods for bicycle transport using GIS and AHP by Guerreiro et al. (2017)

In overall, the literature review shows the presented studies use GIS and analysis techniques for bicycle transportation. Subsequently, this study moreover extraordinary to fill this crevice by applying GIS and AHP analysis technic considering road characteristics, traffic characteristics, facilities, and land use characteristics.

Table 1: Summarize Assessment Methods for Bicycle Transport using GIS and AHP

Purpose and Variables	Sources
Develop a road selection procedure based on origin-destination aggregated data and a gravity model to define cycling routes of Berkeley City, California	Huang and Ye (1995)
Determine the characteristics of 397 actual routes used by cyclists to compare them with the shortest path routes designed using a GIS software (ArcInfo) between each origin-destination pair at Guelph (Ontario, Canada)	Aultman-Hall et al. (1997)
Considering the location of trip generators, proposed a methodology that integrated a Geographic Information System (GIS) with Remote Sensing (RS) resources to plan a cycling transportation system.	Yamashita et al. (1998)
Synthesis the supply and demand measures for planning cycling infrastructures, considering main trip generators	Rybarczyk and Wu (2010)
A planning procedure of a cycling network (using a shortest path algorithm considering traffic zones) and an evaluation of existing roadways using a Fuzzy Analytic Hierarchy Process.	Hsu and Lin (2011)
Proposed and adopted a methodology to establish a potential cycling network for the city of Maringá, Brazil.	Neri (2012)
Proposed a method to design a cycling infrastructure for the city of Montreal, Canada.	Larsen et al. (2013)
A GIS for spatially locating disaggregated data obtained from an origin-destination survey in the proposal of a cycling network to access university campus.	Guerreiro et al. (2013)
Combining Global Positioning System (GPS) with a GIS for a comparative analysis of cycling trips in the city of São Carlos.	Segadilha (2014)
Locate eight trip generators, combined with evaluation criteria and weights obtained from groups of cyclists and researchers.	Milakis and Athanasopoulos (2014)
Used aggregated population data in administrative districts, the number of trips between the districts, and desired lines between each origin-destination pair.	Lovelace et al. (2015)
Trip generators to propose a generic procedure for defining cycling networks.	Sousa and Sanches (2015)
Combined data of a mobile sports tracking application used, the platform Open Street Map and algorithms for providing automatic route suggestions for bicyclists.	Bergman e Oksanen (2016)
The Cycling Accessibility Index (CAI) that measuring cycling accessibility levels in terms of diversity of different land uses, number of activities in statistical areas,	Saghapour et al. (2017)

and the travel impedance between origins and destinations.	
Developed an approach that surveys cyclists concerning level of stress along routes ridden	Boettge et al. (2017)

III. METHODOLOGY/MATERIALS

The study conducted in Ipoh City in area of Ipoh Town 'Tin Heritage City' Action Plan (RKK). The research methodology involves several levels ranging from data collection methods, spatial analysis, and AHP applications in the determination of road conformity to bicycle routes in Ipoh. There are four main methods in the implementation of the study: field research, questionnaire, library references and data acquisition and information from agencies involved. Subsequently, analytical process was carried out on the routes adaptability variables such as road characteristics, traffic characteristics, facilities and land use characteristics.

A. Application of the potential route with the QGIS

Belka (2005) reckon that geographical information system (GIS) is successfully utilized for examination assignments, determination of the reasonable corridor or assessment of the choices. Until presently, the GIS is acknowledged, that the corridor proposition needs to assist point by point advancements in arranging to meet the planning and generation necessities. The most excellent of appraisal components was to a few expand related to the data availability. Still, adaptability of GIS-based strategy makes it simple to coordinated extra information sources and for creating extra assessment measures once required.

The Quantum Geographic Information System (QGIS) 2.12.3 has been used to build a database in accessing the potential of the road network for bicycles in Ipoh as shown in Figure 6. First, the scope of the study area was determined. The data of each indictor was collected and every input as a map–layer into QGIS. Then the QGIS system gets established using the data of the road network. For each line, point and polygon of the network and area, the data for each indicator was collected. Using the evaluation model built into the QGIS system, the data analysis process involves two main data models of raster and vector data. The interpolation technique in QGIS is used to analyse the data and to determine the aptness of the bicycle routes. Additionally, by comparing the layer and attributes, the most appropriate street and ideal bicycle routes can be identified.

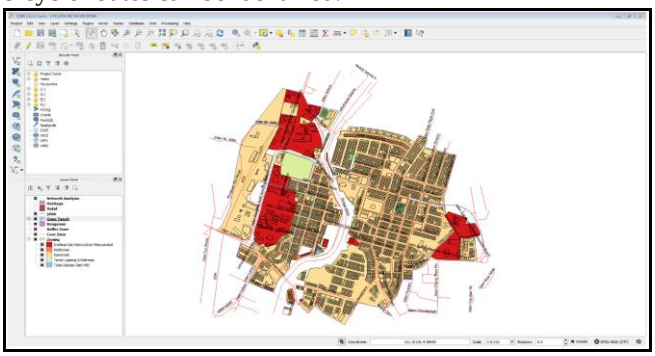

Fig. 6. Application on QGIS for Bicycle Route Potential Model

B. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process may be a strategy to bolster multi-criteria choice making, and was initially created by Prof. Thomas L. Saaty. AHP determines proportion scales from matched comparisons of criteria and permits for a few little irregularities in judgments. Inputs can be genuine estimations, but too subjective conclusions. As a result, needs (weightings) and a consistency proportion will be calculated. Universally AHP is utilized in a wide extent of applications, for a case for the evaluation of providers, in extend administration, within the enlisting handle or the assessment of company executives. Scientifically the strategy is based on the arrangement of an Eigenvalue issue. The results of the pair-wise comparisons are organized in a lattice. The primary (prevailing) normalized right Eigen vector of the network gives the proportion scale (weighting), the Eigen esteem decides the consistency proportion (Saaty, 2013).

The development of AHP Model for Bicycle Route Potential criteria and sub criteria were shown in table 2 and figure 7. From table 2, the criteria that has been elected for this study are road characteristics, traffic characteristics, facilities and land use characteristics. From these criteria, the sub criteria added to the suitable criteria characteristics for analysing process. All finalize criteria and sub criteria has distributed to the transportation experts for ranking survey in selecting the best route.

Next, the result from the experts will be export to Microsoft Excel software to generate the weighting value to ranking the best route. The center of AHP is the comparison of sets rather than sorting (positioning), voting (e.g. relegating focuses), or the free task of needs. Approval of the strategy in viable testing appears shockingly great understanding with real measured values. AHP has been utilized successfully in numerous teach and companies. In spite of the fact that the strategy is so around the world, it is still straightforward sufficient to actualize in Exceed expectations. The AHP's extraordinary returns are the capacity to utilize it to gather choices, in which all members assess sets and the bunch result is decided as the numerically ideal agreement. In practice, the arrangements arrived at by the strategy are well acknowledged, since the comes about is objective and free of political impact (Wang, Zhu, Li, & Wu, 2013; Goepel, 2013;2017).

Table 2: Criteria and Sub-criteria of Bicycle Route Potential

Criteria	Sub-criteria	Information
Road Characteristics	Slope	Considering safety and convenience of cyclists on the slope
	Surface Condition	Improve security through ensure sufficient width of the bike lane

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	Bicycle lane existence	Purpose of bicycle usage for activities with government office, cultural facilities, leisure, sport, shopping, etc.
	Motor Vehicle Traffic Volume	Determine the level of transportation service through the ratio of traffic compared with lane
Traffic Characteristics	Traffic Calming Enforcement	Elements that are indirect threat to cyclists and accident probability increasing
	On road parking availability	Consider convenience parking for cyclists with the motorised parking area
	Security	Effect on accident probability of motorised vehicles
	Accessibility	Consider accessibility of bicycle such as government office, cultural facilities, shopping, etc.
Facilities	Bicycle Parking	Space availability to provide the bicycle parking
	Bike on public transit area	Linkage of public transportation such as bus or rails
	Signage	Good signage in informing public about cycling area
Land Use Characteristics	Compliance with historic pattern	Good accessibility with any land use area as starting and arrival point to iconic area
	Compliance with urban and transportation plan	Purpose of bicycle lane policies and guidelines as sustainable transport

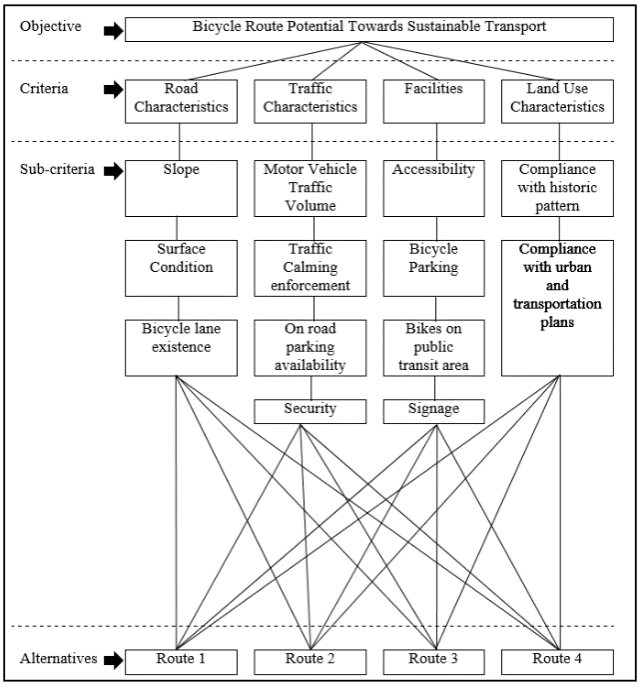


Fig. 7. AHP Model for Bicycle Route Potential

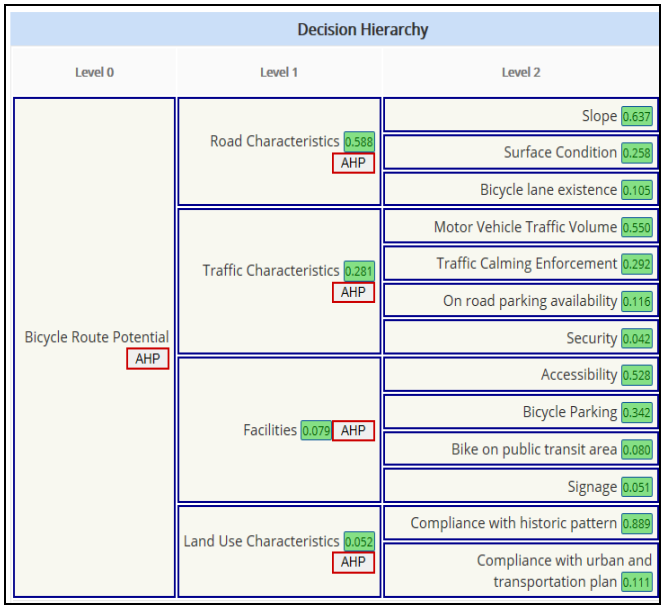


Fig. 8. AHP Software Model for Bicycle Route Potential

C. Section headings

The weight of each assessment marker recognized by implies of a master judgment overview and the Analytic Hierarchy Process (AHP), as appearing in table 3. The technique of AHP in this consider takes after Saaty (1980) and point by point talk in Saaty (2013) and Guerreiro et al. (2017). The Consistency Index (CI) and Consistency Ratio (CR) were utilized to count the degree of irregularity of expert's pairwise comparisons. CR of less than 0.1 (10%) is measured satisfactory; something else the expert's comparisons will be reexamined to move forward the assessment consistency. The strategy of finishing the group's judgment proposed by Saaty (1989) was hone by utilizing the geometric cruel strategy. The strategy was utilized to summative judgments from specialists. As it were dependable expert's judgments were numbered. For the assessment of judgmental consistency of the bunch, the Group Consistency Index (GCI) and Group Consistency Ratio (GCR) were calculated. In this study, specialists from the transportation range were asked to make pairwise comparisons by replying survey. The data of specialists are summarized in Table III.

Table III: Summary of Transportation Expert's

Position/Job Description	Number of Experts	Working Experience (Years)
Transportation Planning Section	3	5-15
Transportation Engineers	5	5-8
Academician	4	10 - 20
Local Authority	1	20

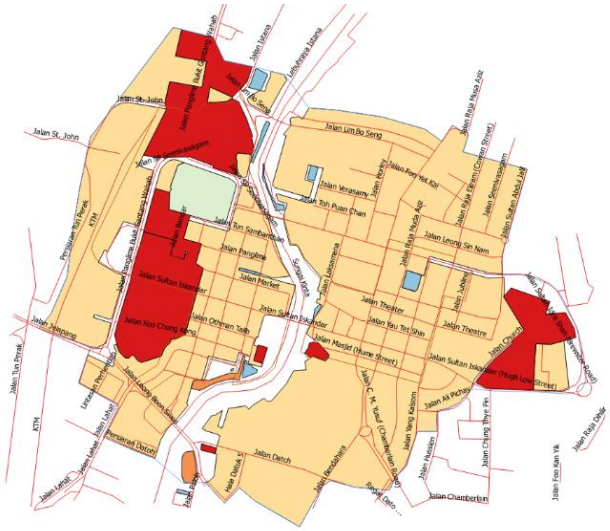
IV. RESULTS AND FINDINGS

In examining, the conceivable changes feasible through modal move the genuine effectiveness of each conceivable transportation mode ought to be measured. Within the non-appearance of such information on a nation particular level, a few of the

information assembled from the different non-Malaysian sources and adjust; it to locally known data also can be used.

A. QGIS mapping and analysis

After mapping the comprehensive shape file for every attributes, the potential bicycle route in Ipoh is illustrated with the level in different colours in Figure 9a and 9b. Most of the streets less suitable for riding bicycle. The streets are from Class 2 to Class 3 based on Public Work Department (PWD) Specification (2014).



(a)

(b)

Fig. 9. Result of Priority Assessment by Transportation Experts

B. AHP Application and Ranking

Formerly detailed sub-criteria associated with the criteria are determined as shown in figure 7, relative importance of those sub-criteria have to be projected. In this level, the AHP method is engaged and the overall hierarchical structure is illustrated the figure 8.

The result of study from table IV revealed that the most significant factors concerned by experts in choosing bicycle route are the road characteristics (w = 0.588) and the traffic characteristics (w = 0.281). The facilities (w = 0.079) and land use characteristics (w = 0.052) are secondary considerations. All Group Consistency Ratio results showed that the combined evaluations by the group of experts were all logically reliable.

Table IV: Font Specifications for A4 Papers

Criteria	Sub-criteria	Weight
Road Characteristics **(0.588)**	Slope	0.637
	Surface Condition	0.258
	Bicycle lane existence	0.105
Traffic Characteristics **(0.281)**	Motor Vehicle Traffic Volume	0.550
	Traffic Calming Enforcement	0.292
	On road parking availability	0.116
Facilities **(0.079)**	Security	0.042
	Accessibility	0.528
	Bicycle Parking	0.342
	Bike on public transit area	0.080
	Signage	0.051
Land Use Characteristics **(0.052)**	Compliance with historic pattern	0.889
	Compliance with urban and transportation plan	0.111

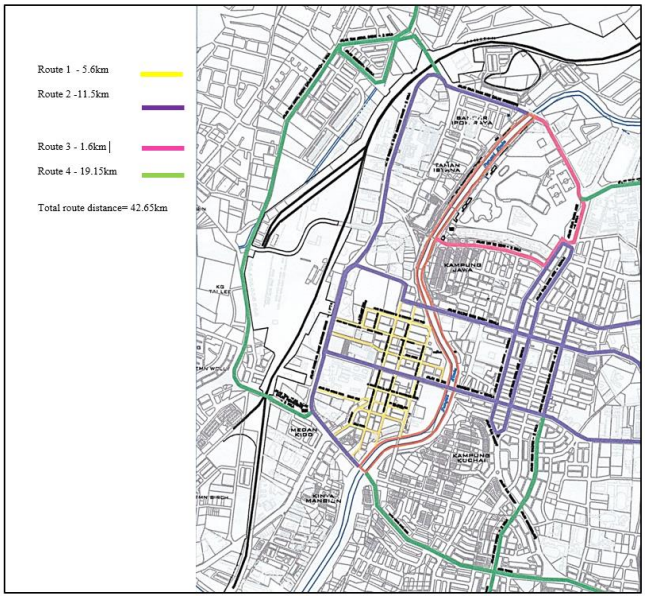


Fig. 10. Result of Priority Assessment by Transportation Experts

From Figure 10, a study area is used to illustrate the application of AHP in this study. Travel destinations in the study area consist of heritage buildings, commercial area, an office building, a residential building, community area, and a public park. Four potential locations of bicycle routes (1, 2, 3, and 4) are compare using the AHP model developed. Each routes is relatively at equal distance away from travel destinations in the zone. Moreover, the amount of available space at each route is relatively equal and at least enough to set up bicycle facilities. Characteristics of each potential route for the bicycle network are given in Table V.

Table V: Characteristics of Potential Routes for the Best Routes of Bicycle Transportation

Potential Routes	Type of Routes	Access to Bicycle Route		
		Distance (km)	Width (m)	Riding Quality
Route 1	Class 3	5.6	30	Smooth + Mixed Traffic
Route 2	Class 2 and Class 3	11.5	26	Rough + Mixed Traffic
Route 3	Class 2	1.6	18	Smooth + Mixed Traffic
Route 4	Class 2 and Class 3	19.15	20	Rough + Mixed Traffic

The result of applying AHP to this think about in Table 6 appeared that Route 1 is the foremost ideal street for bike organize. Routes one, two, three, and four have been positioning the choices independently. Route one and two were given higher needs over course three and four. Clearly, this can be since route one and two give way better get to other attractive quality area and adjacent goals by bicycle. From the result of the expert's assessment, these two components are the foremost critical components concerned in the proposed bike path. Also, Route one is more best than Route two since it gives way better get to the community and the commercial region which is more best. Furthermore, route three and four are comparable in more viewpoints. In any case, route three is ideal since it is in the boundary of Recreation Park.

Table VI: Ranking of Potential Road for Bicycle Route by AHP Weights

Potential Routes	Contributions to Total Weight					
	Road Characteristics	Traffic Characteristics	Facilities	Land Use Characteristics	Total Weight	Rank
Route 1	0.567	0.276	0.117	0.040	0.573	1st
Route 2	0.520	0.268	0.149	0.063	0.259	2nd
Route 3	0.509	0.314	0.133	0.044	0.120	3rd
Route 4	0.635	0.220	0.098	0.047	0.048	4th

V. CONCLUSION

This paper tried to contribute for changing traffic activities for bicycle transportation in Ipoh city. In relieving the weight of motorised transportation on society and the environment, cycling facilities need to engage with road on urban areas. By proficient land utilize arranging, activities including work, shopping and recreation were brought together. This would decrease travel distance by bicycle and a foot in the town. To facilitate this, urban centres need to offer more attractive and the quality of urban living upgraded.

A. Discussion

Developing an inclusive model for bicycle transportation plan would reducing carbon footprint and congestion also challenging in supporting bicycle usage and health purpose in time ahead (Khan et al., 2014). The potential routes must be able to convert the existing street framework in terms of bike utilize. It moreover must conduct a course determination for interfacing the root and goal based on the bike travel request (Hsu & Lin, 2011). In this paper, developing route potential for cycling in Ipoh city will be applied. The colossal contrast between the most limited way and a bike reasonable way demonstrates that various sum of remaking work will be required to make strides the streets and make the bike transportation appropriate (Razuhanafi et al., 2015). This work can be distinguished utilizing the arranging demonstrate created in this paper. In future considers, extra subtle elements around the assessment records can be given, as well as how to produce more reasonable remaking ventures to move forward bike appropriateness of the street arrange by including more assets.

B. Recommendation

Four routes in Ipoh City selected as proposed sites for bicycle route, with 1755000 m2 buffer of area. The criteria to choose the efficient routes were road characteristics, traffic characteristics, facilities and land use characteristics. By using QGIS and AHP four routes selection are based on road characteristics and traffic characteristics. The length of route one equals to 5.6 km, route two equals to 11.5 km, route three equals to 1.6 km and route 4 equals to 19.15 km .The route can be extended to reach new places that will be important and compactly populated in the future. Based on the result, the following recommendations are proposed:

1. Improved bicycle Facilities. Creating a committed bicycle lane increased the safety of cyclists along this bike travel route.
2. Improved bicycle safety. Bicycle safety could improve at a signal crosswalk at Ipoh Street by creating a centre refuge island. Creating boulevards where possible, the city separated cyclist from vehicle traffic. Bicycle lanes also buffered cyclists from cars.
3. Reduced vehicle speeds. Landscaped medians and fewer vehicle lanes means slower traffic speeds. Adding centre medians and constructing lanes less wide reduces accidents and motor vehicle speed.
4. Changes to street parking. Congestion was reduced by removing limited evening parking on one side of the street. Time limited parking on both sides will help nearby businesses.
5. Creating a safe and liveable environment, with supporting transport infrastructure.
6. Dedicated budget allocation needed for active mobility infrastructure.
7. Support health literacy and awareness of health benefits of active mobility among citizens.

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