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Sustainability of Public Transportation in Kuching City, Sarawak

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Abstract
Progressing towards achieving Sustainable Development Goals (SDGs) in particular SDG11 on Sustainable Cities and Communities, the role of public transportation in ensuring smooth connectivity in cities is contemplated as significant in the field of urban planning. However, the increased number of population in both developed and developing countries has generated growing demands for private transportation. Urban sprawl and inaccessibility of public transportation to cater for certain segments of locality and population's needs are among the factors that has contributed to the increasing demand of private transportation. This study aims to evaluate the accessibility of public buses in Kuching City, in the context of sustainable transportation. The study adopts a mixed method approach: the quantitative approach involves using Public Transportation Accessibility Level (PTAL) based on responses collected from 140 commuters of public buses in Kuching City, while the qualitative approach uses in-depth interviews with both the commuters and public buses' providers in Kuching City to identify experiences, issues and challenges in regards to the current situation of public buses in order to provide ways to improve the current system of public buses in Kuching City. By factoring the availability of routes and frequency of public transportation services within a specific time frame into PTAL besides administering thematic analysis on the qualitative data, the results of PTAL showed that Kuching City has poor accessibility level due to long waiting time experienced by the commuters of public buses. The findings of the study thus call for immediate policy action in particular by the Sarawak State Government to invest in upgrading the current public transportation system to make Kuching City an inclusive, safe, resilient and sustainable human settlement in Borneo.

Keywords: Public transportation, Kuching, accessibility, sustainability, Borneo, PTAL

Introduction

In the pursuit of sustainable development, enhancing the efficiency and delivery systems of public transportation has been the focus of urban planners. Efficient and high quality of urban public transportation plays a crucial role in contributing to the attainment of the eleventh Sustainable Development Goals (SDG11) namely Sustainable Cities and Communities. Traditionally, the decision making in transportation sector in both developed and developing countries involved the increased supply of road infrastructure, by taking into account private vehicle mobility (Lucas & Stanley, 2013). However, critique argued that the mobility-based framework may be inadequate. For instance, Grengs et al. (2010) have argued that contrary to the acknowledgement of mobility being the main goal of transportation policies, the definite users' demand for transportation was the ability to reach destinations. Hence, it is not just about the preference for movement, but the idea of assessing the movement of passengers to achieve transportation goals should be comprehensively measured through accessibility-based framework (Grengs et al., 2010).

Growing interest in sustainable development has acknowledged the importance of accessibility as a significant indicator to evaluate urban form, density and spatial distribution of people and activities; and policies in relation to urban development (Benenson et al., 2011). Historically, the concept of accessibility has been applied in various fields of studies, namely urban geography, rural geography, health geography, time geography, spatial economics and transport engineering (Geurs et al., 2015). Accessibility is found to have a strong influence on the public transportation ridership hence contributing towards sustainable public transportation system. This study is focused on Litman's (2008) definition of transportation accessibility, which is defined as "people's ability to reach goods, services and activities". Based on this accessibility-based framework, the movement of passengers is measured through the people's overall ability to reach their desired destination (Grengs et al., 2010). This exercise includes examining a variety of attributes such as the number of activities that can be done at different destinations and the distribution of spatial services within transportation network.

This paradigm shift, from mobility oriented to accessibility oriented, is claimed to be significant as it considers a variety of impacts and options (Litman, 2015). The impacts and options include alternative modes of transportation and a more accessible land use (Litman, 2015). This shift denotes an important evolution towards transportation planning as it addresses transportation issues in a more holistic manner. As public transportation is often considered a solution to problems such as increase in private motorisation, a good public transportation should consider the aspects of accessibility, connectivity and sustainability of a transportation system (Cheng & Chen, 2015). Furthermore, the application of accessibility in transportation enables planners and decision makers with an improved evaluation on land use matters (Handy & Niemeier, 1997).

In Malaysia, the needs of the locals and the negative consequences of heavy traffic on road towards social, economy and environment are found lacking in transportation development (Kasipillai & Chan, 2008). Urban sprawl and inaccessibility of public transportation to cater for certain segments of locality and population's needs are among the factors that has contributed to the increasing demand of private transportation. This has not only imposed environmental and ecological stresses but it has also raised the concern of social equity on the accessibility, connectivity and sustainability of a transportation system among the urban population. The aim of this study is thus to evaluate the accessibility of public buses in Kuching City, the capital of Sarawak, in the context of sustainable transportation.

Literature Review

The nature and characteristics of the transportation sector are often discussed in the context of sustainable development. For example, transportation has been linked with gas emissions, accessibility and land use. The increased emission of greenhouse gases in the atmosphere today is contributed mainly by the transportation field as the rate of its discharge is faster compared to any other field in the world (United Nations, 2015). Therefore, it is critical to address the issues of transportation in a wider perspective in order to provide a holistic approach towards attaining sustainable development. According to the Centre for Sustainable Transportation (2002), transportation is sustainable when it is related to all three elements of sustainability: namely the society, the economy and the environment. Nevertheless, the diverse element related to the society is often under-researched in a holistic manner.

In the context of the society, transportation should meet the basic of human needs, permit and support human scale development and to ensure safety for the community (Centre for Sustainable Transportation, 2002). Traditionally, transportation system has been guided through maximisation of speed and mobility, travel conditions such as the roadway level-of-service, traffic and operation costs (Litman, 2015). Over the years, the evolution of

transportation sector has been associated with a number of issues, namely, urban sprawl, traffic congestion and high usage of private transportation as compared to public transportation (Squires, 2002; Arnott et al., 2005). A paradigm shift for transportation sector is needed, in which the development of transportation shall focus more on the overall efficiency and utilisation of public transportation.

Towards achieving sustainable public transportation, assessments on the current system of public transportation should be conducted. Traditionally, there were five conventional transport indicators in which it conceives mostly the conditions of motor vehicles traffic – roadway level of services (LOS), average traffic speeds, and average congestion delay measured annually per capita, parking convenience and price and crash rates per vehicle-mile (Litman, 2007). These conventional transport indicators focused more on the quality of motor vehicle while ignoring other attributes in relation to sustainable transportation (Litman, 2015) incorporating all three sustainable elements of economic, social and environment.

As we progress towards achieving Sustainable Development Goals (SDGs) by 2030 in particular SDG11 on Sustainable Cities and Communities, the role of public transportation in ensuring smooth connectivity and equal accessibility among the population in cities is imperative. Equal access is denoted as important as people should be given equal access to basic goods, services and social opportunities. Accessibility is well-related to mobility, in which it is defined as 'the ability of people to travel over distances' (O'Sullivan et al., 2000, p.86). In most literatures, the term accessibility is known to be related to locational requirement of a person or the community as a whole. It is also an important deliberation to one's desire to access to jobs, services and other engagements on the notion of other aspects of sustainable transportation, namely affordability and comfortability (Couclelis, 2000).

According to Litman (2015), accessibility includes factors such as transportation demand and activity; and connectivity. These factors were outlined as few of the most important attributes in order to analyse accessibility in a comprehensive manner. In terms of travel demand and activity, the indicators include demographic information, purpose of commuting, trip destination, and time taken to travel, travel mode and distance covered.

In regards to equity, a qualitative data analysis was conducted in a study in Quebec City to explore "the role of transportation in fostering social exclusion" by using Geographic Information System (GIS) software. This study in Quebec City aimed to give "different view of an individual's ability to adjust their activity-travel patterns, given their dependence on public transport". This study concluded that the participants which were the low-income women felt frustrated as they were not able to access to certain areas by public transportation (McCray & Brais, 2007). Though GIS is not used in the current study, the qualitative element of mixed method used in this study also tries to capture experiences, issues and challenges in regards to the current situation of public bus services system in Kuching City.

In Australia, transportation is denoted as a vital element towards social, economic and environmental sustainability. A study has been done in South East Queensland in regards to people's accessibility to public transportation in which the study aimed to discuss and assess the accessibility to transportation and issues pertaining to it. The result of this study showed that the elements of spatial location, urban and rural features, demographics, and socioeconomic status should be the most significant objectives in transportation policies (Murray et al., 1998).

Methodology

This study adopted mixed method comprising of both quantitative and qualitative analysis. The quantitative approach involves using Public Transportation Accessibility Level (PTAL) by factoring in the availability of routes, distance of bus stop from the place of origin and

frequency of public transportation services within a specific time frame based on responses collected via face-to-face interview with 140 commuters of public buses in Kuching City, while the qualitative approach uses observation and information obtained from in-depth interviews with selected commuters and the two public buses' providers in Kuching City to identify their experiences, issues and challenges with regards to the current situation of public bus services provided in Kuching City, Sarawak. City Public Link (CPL) and Sarawak Transport Company (STC) are the only two bus provider companies in Kuching city.

There are seven bus routes altogether within Kuching city and its vicinity run by these two bus companies. These routes were selected as the buses travel along the areas administered by two main city councils in Kuching namely, Kuching North City Hall and Kuching South City Council. The site is mainly surrounded by commercial and offices' buildings, public hospital, religious centres, cemeteries, open spaces and residential areas. The details of the sampled buses' routes are shown in Table 1 with the pictorial depiction in Figure 1.

Table 1: Bus Routes within Kuching City

Public Bus Provider	Bus No	Route
City Public Link	K1	Jalan Satok to Muara Tabuan
City Public Link	K5	Jalan Satok to Bandar Baru Semariang
City Public Link	K7	Jalan Satok to Taman Malihah
City Public Link	K8	Jalan Satok to Kampung Stutong Baru
City Public Link	K11	Jalan Satok to King Centre / Tabuan Dayak
City Public Link	K21	Jalan Satok to Politeknik
Sarawak Transport Company	8G	Jalan Satok to Kampung Stutong Baru

Source: Site Survey (2018)

The population of this study was sampled among bus commuters who travelled within Kuching city using either CPL or STC or both by administering purposive sampling method. Purposive sampling, which is also known as judgment sampling, is a non-probability sampling approach whereby samples were chosen based on the qualities possessed by the individuals. It is commonly applied in studies that are related to "certain cultural domain with knowledgeable experts within" (Tongco, 2007, p.147). In Kuching city, bus remains as the most used public transportation among the community comprising of the majority (85.5%) of the total public transportation ridership. Thus, bus commuters in Kuching city were chosen as respondents in this study to obtain information on the current delivery system of the public bus services in Kuching city.

In this study, a total of 140 CPL or STC or both CPL and STC commuters, i.e. a total of 20 commuters for each routes, were selected for the interviews. In addition, the operation managers representing the two public bus service provider companies, namely City Public Link and Sarawak Transport Company were also selected on the basis of their job scope as they are deemed knowledgeable on the current service delivery of public transportation in their respective companies in Kuching City. These two operation managers from both public buses' companies that ply Kuching City, namely the CPL and the STC serve as the key informants to provide viewpoints from the perspective of public bus service providers.

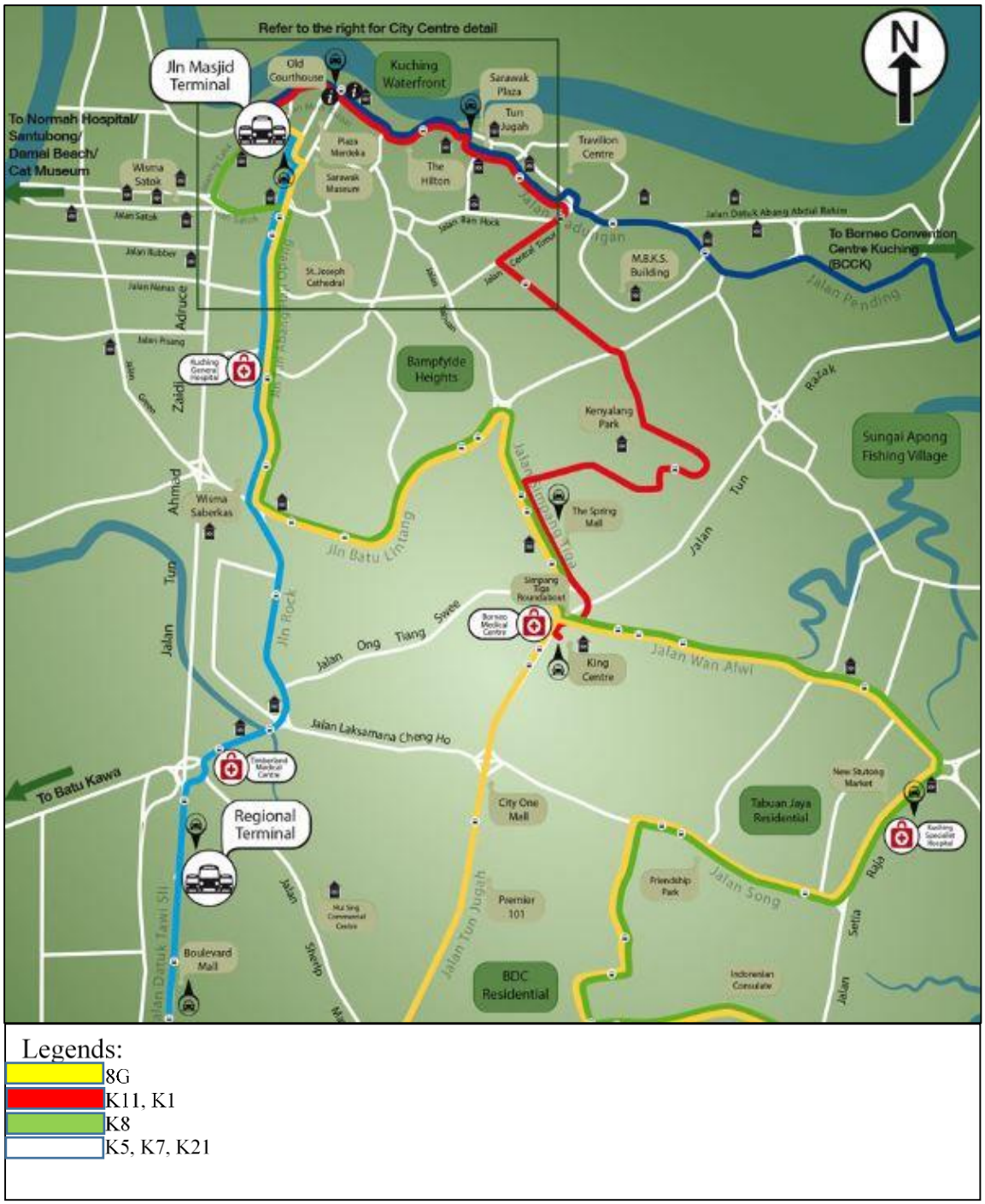

Figure 1: Kuching Bus Routes in the Study Area
Source: Kuching In and Out (2018)

In this study, accessibility was measured specifically using Public Transport Accessibility Levels (PTAL). The Public Transport Accessibility Levels approach was initially developed by the London Borough of Hammersmith and Fulham in 1992 to measure accessibility. This measure was chosen as it provides detailed and accurate measure of accessibility from the public transportation network point of view. In fact, Public Transport Accessibility Levels is a standard method for calculating public transportation access by taking into account, among other factors, walking time from the place of origin to the public transportation access points,

the waiting time at the access points, and bus frequency within a specific time frame. Six accessibility items as tabulated in Table 2 below were assessed in PTAL.

Table 2: Items in Accessibility Element Used in the Study

Element	Description	Items
Accessibility	The accessibility dimension is assessed through Public Transportation Accessibility Level (PTAL). It measures the service quality based on the frequency and average waiting time on access point.	1. Place of origin 2. Location of the bus stop 3. Walking time to the nearest bus stop 4. Distance from the place of origin to the bus stop before departure 5. Waiting time at the bus stop 6. Frequency of the bus in an hour

In addition, this Public Transport Accessibility Levels method was adopted in this study as it is widely used to assess public transportation services both in developed and developing countries. Studies that adopted similar PTAL measure include those done in Northern Ireland by Wu and Hine (2003), in Melbourne by Saghapour et al. (2016), and also in developing nation like India by Rajendran et al. (2013).

The steps involved in order to calculate the Public Transport Accessibility Level (PTAL) according to Transport for London (2015) are as follows:

i. Define the origin or point of interest;
ii. Calculate the walk access time from the origin to the nearest public bus stops;
iii. Calculate average waiting time at the bus stop;
iv. Calculate minimum total access time;
v. Calculate the total access time or Equivalent Doorstop Frequencies (EDF) by including the walking time from origin to nearest public buses and waiting time at the bus stops.

According to Transport for London (2010), the point of interest represents the public buses stops in which the services are delivered. In the context of this study, the point of interest are the origins of the bus commuters, in which it refers to the commuters' home or starting point before walking to the bus stop. Meanwhile, the walk access time are calculated from the point of interest or origins to the access point.

Total access time for public buses is the total walking time of the commuters from the point of interest to access point and the average waiting time while waiting for the buses to arrive. For each of the routes selected, the waiting time is determined as the interval between the services (half of the journey), hence the standard waiting time is 0.5 * (60/frequency). This calculation is based on the frequencies of the buses under 60 minutes.

In order to gain the accessibility index, the Equivalent Doorstep Frequency (EDF) is therefore calculated. EDF is defined as the availability of the route at the "doorstep" of the point of interest. EDF is calculated as EDF = 30/Total access time in minutes, with buses as the dominant transportation mode. Hence, for a single transportation, the Accessibility Index (AI) is determined by the summation of maximum EDF and halves of all other EDFs.

Therefore, the calculation are as follows:

Total access time = Walking time from the origin + average waiting time at the bus stop

EDF = 30/Total access time (minutes)

AI = EDF (Max) + (0.5* All other EDFs)

Besides the above calculation, content and thematic analysis was also carried out for the qualitative data obtained in the study to provide explanation to the PTAL index calculated.

Results and Discussion

In order to analyse the accessibility level of public buses in Kuching City, the total access time of the commuters are calculated in each route. The total access time are calculated from the sum of walking time and average waiting time for each of the routes travelled by the public bus commuters. The average waiting time is determined by 0.5*(60/frequency), in which, 0.5 represents the waiting time during the interval of the journey (half of the travel journey) in 60 minutes.

Accordingly, Equivalent Doorstop Frequency (EDF) is therefore calculated. The EDF is defined as the access time from the commuters' 'doorstep' which is determined by calculating the walking time of the commuters from the origin point to the bus stop. The EDF of each route is measured in order to determine which route has the highest and lowest accessibility level within Kuching City. In this study, the EDFs are calculated based on the average waiting time while waiting for the arrival of the buses at the "doorstep" or point of interest. The results of these analysis are tabulated in Table 3.

Table 3: Accessibility Level for Public Buses in Kuching City

Bus Route	**Walking Time (minutes)**	**Average Waiting Time [0.5*(60/Frequency of Buses)]**	**Total Access Time (Walking time + Average waiting time)**	**Equivalent Doorstop Frequency (EDF) (30/Total Access Time)**
K1	2	15	17	1.76
K5	3.7	15	18.7	1.6
K7	2.45	30	32.45	0.92
K8	2.5	15	17.5	1.71
K11	3.3	15	18.3	1.64
K21	3.2	30	33.2	0.9
8G	2.25	15	17.25	1.74
	Accessibility Index [EDFmax + (0.5*all other EDFs)]			**6.02**

Source: Site Survey (2018)

The accessibility of each route is determined by its EDF, in which a high number of EDF shows that the route is more accessible compared to the others. Based on Table 3, K1 route which travelled along Jalan Masjid to Muara Tabuan has the highest accessibility of 1.76, while K21 route which travelled along Jalan Satok to Politeknik has the lowest EDF.

From the secondary data obtained from the bus company, it was also found out that among all the routes studied, Route K21 has the longest time of interval between each bus arrival due to the low number of commuters travelling within the route. This might partly explain the lowest EDF among all the bus routes studies in Kuching city.

Table 4 below shows the summary of eight different categories of levels of accessibility of public buses in Kuching City. Band 1 (1a and 1b) represents a low level of accessibility and 6 (6a and 6b) represents high level of accessibility. A value of 0 hence indicate that there is no access to the public transport network within the area.

Table 4: PTAL in Kuching City

PTAL	Range of Index	Description
1a	0.01 - 2.5	Very poor
1b	2.51 – 5.00	Very poor
2	5.01 – 10	Poor
3	10.01 – 15	Moderate
4	15.01 – 20	Good
5	20.01 – 25	Very good
6a	25.01 – 40	Excellent
6b	40.01	Excellent

Source: Adopted from London Borough of Hammersmith and Fulham (2018)

This Public Transportation Accessibility Levels adopted from London Borough of Hammersmith and Fulham (2018) is used to provide the indicators on accessibility level in Kuching City by taking into account service frequency, time taken and walking time to access the public transportation by the bus commuters. From the analysis obtained, it was found that the Accessibility Index calculated for bus services provided in Kuching City has an index of 6.02 which indicates poor accessibility, which corresponds to PTAL level 2.

The poor accessibility is mainly due to the long waiting time experienced by the bus commuters in an hour, in which it took 30 to 45 minutes for the public buses to arrive. Based on the findings of this study, the PTAL for Kuching City is low mainly due to the long waiting time at the bus stop and low service frequency available in an hour. However, there is no issue of walking time experienced by the bus commuters to the nearest bus stop. The responses of the public bus commuters generally show that long waiting time that does not closely follow the bus schedule is a common issue experienced by the public bus commuters. Nevertheless, almost all respondents indicated that there was no other better alternative and thus they learned to be patient hoping for the improvement to be done by the bus companies.

These results correspond to the findings of similar study conducted in Christchurch, New Zealand in which it was aimed to determine the quality of public transportation through accessibility. The analysis of the study shown that the bus services performed poorly in New Zealand in terms of its public transportation accessibility (Abley & Williams, 2008). Similarly, another accessibility assessment was conducted in Melbourne, Australia by Saghapour et al. (2016) to measure public transportation accessibility in metropolitan areas. The result of this study showed that poor accessibility may prevent access to different facilities and main areas hence creating social weaknesses such as inequalities in health, education and employment.

However, it was discovered that the PTAL assessment does not comprehensively capture another factor of accessibility, namely the travel time completed by the buses in a journey. In order to measure accessibility of public transportation in a comprehensive manner, another indicator adopted by Mavoa et al. (2012) which is the travel time of public buses is also incorporated in this study. This is calculated in the accessibility score to complement the PTAL index which does not include travel time element of public buses as shown in Table 5.

Table 5: Accessibility Score

Accessibility Score	Travel Time (min)
0	> 60
1	40-60
2	20-40
3	10-20
4	0-10

Source: Mavoa et al. (2012)

For each of the route, the travel time are classified based on an hour journey. As shown in Table 5, a score of 0 indicates a travel time that is more than 60 minutes per journey, while 4 being the highest accessibility with travel time between 0-10 minutes per journey. In Kuching city, most of the travels made are within 20-40 minutes of duration, with an accessibility score of 2 hence denoted as poor accessibility.

The findings of the study on the accessibility analysis of public bus services in Kuching City have highlighted important issues that must be dealt with immediately in order to ensure sustainability of the public bus services in Kuching town. The poor accessibility of bus commuters in Kuching implicated that there is social inequality among the population in Kuching city. Most of those bus commuters interviewed were having less financial capability or resources. This group of low-income or no income population have no choice but opt to use public bus to commute from one place to another place either to access to various social amenities or economic centres. Some use public buses to go to their work place, hospitals, schools, colleges, government offices, commercial centres to carry out their daily livelihoods or to get their supplies of goods and services needed to sustain their lives. As they could not afford to have their own transport, they have no choice but to wait long time to get to their destination even if it implies loss of time resources for other more valuable activities. Some even risk their livelihoods as they might lose their job when they have to reach their workplace late due to the unexpected delay in public buses.

Hence, appropriate policies need to be formulated in order to improve the efficiency of current public buses services delivery if we were to aim towards sustainable transportation. Public policies should be devised to make this public transportation sector more sustainable and more attractive if we were to ensure no one is left behind in enjoying various social and economic opportunities to enhance their well-being. A revision on the schedule by the bus companies is probably needed to ensure provision of an efficient public transportation delivery for all in long run. This is crucial as we do not want too many private cars in the city which causes high congestion and subsequently imposes other social and environmental cost to the state.

Conclusion

The PTAL index calculated in this study for public buses in Kuching City is six, which unveils that Kuching City has poor level of accessibility as compared to other developing countries such as India. In other words, the findings of the study indicated that the population of Kuching City could not access to public buses easily, efficiently and effectively. The low PTAL index was mainly contributed by the long waiting time experienced by the public buses' commuters which was primarily caused by infrequent number of buses available within an hour. In addition, relatively long travel journey of each trip taken by the bus commuters also contributed to the low accessibility level of public buses in Kuching City.

As mentioned in the study by Ceder et al. (2013), travel and waiting time experienced by the commuters of public transportation services should be as minimum as possible; with an ideal maximum waiting time of 15 minutes for public buses' mode. However, it was found out in the current study that bus commuters took on average 30 to 45 minutes of waiting time before embarking a particular journey. It should be noted that majority of the commuters are low income earners in the Bottom 40 (B40) (Bottom 40 percent of the overall population by household income) category. Thus, these bus commuters have no other options but to rely solely on public buses as their only or main option of transportation to travel from one place to another. Therefore, necessary improvement is needed probably in terms of revision of buses' schedule in order to increase the efficiency of these public buses. As promulgated by Tribby and Zandbergen (2012), an increase in the number of public transportation services within a stipulated time frame is significant towards ensuring an accessible public transportation.

The findings of this study also unveiled the fundamental social and economic inequality issues among the members of society in Kuching city. The poor accessibility to public transportation among this group of city population also indicates poor urban planning. It also indicates that this group of urban population has higher possibility to be deprived from other socio-economic opportunities. If this issue is left unchecked, the problem might exacerbate to widen the socio-economic gaps between the rich and the poor. Moving towards achieving Sustainable Cities and Communities under SDG11, immediate action needs to be taken to attain sustainable transportation system in urban planning in Kuching city.

Furthermore, enhancing accessibility of public transportation in city also indicates that societal imbalance is reduced towards ensuring inclusive and sustainable human settlements. However, as the scope of the study does not cover the underlying reason of inefficient services of the public bus providers, future studies are recommended to explore the underlying factors to enhance public buses' system in Kuching City. This is important so that more appropriate schemes and propositions could be recommended towards enhancing public transportation system in the city in future. The study has found out that the longer waiting time is a crucial attribute contributing towards the poor accessibility level in Kuching City. In addition, future study is also recommended to explore other element of sustainability in the delivery of public transportation services so that a more holistic framework and recommendation could be made to ensure sustainability of public transportation in cities.

In order to ensure that the transportation sector is sustainable, traffic studies during both peak and off peak hours can be done by examining the current traffic flow in cities. This study did not cover traffic study in Kuching city. By carrying out traffic studies in future, the characteristics and level of traffic can be analysed and evaluated. Hence, this allows a better movement of traffic accessibility to be promoted in order to ensure smooth traffic in the cities towards sustainable transportation system.

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References

Arnott, R., Rave, T., & Schöb, R. (2005). *Alleviating Urban Traffic Congestion*. United States: MIT Press Books.

Abley, S., & Williams, R. (2008). Public Transport Accessibility Levels. IPENZ Transportation Group Conference, 1(2), 2-5.

Benenson, I., Martens, K., Rofé, Y., & Kwartler, A. (2011). Public Transport Versus Private Car GIS-Based Estimation of Accessibility Applied to the Tel Aviv Metropolitan Area. *The Annals of Regional Science, 47*(3), 499-515.

Ceder, A., Chowdhury, S., Taghipouran, N., & Olsen, J. (2013). Modelling Public-Transport Users' Behaviour at Connection Point. *Transport Policy, 27*(1), 112-122.

Cheng, Y.H. & Chen, S.Y. (2015). Perceived Accessibility, Mobility, and Connectivity of Public Transportation Systems. *Transportation Research Part A: Policy and Practice, 77*(1), 386-403

Couclelis, H. (2000). From Sustainable Transportation to Sustainable Accessibility: Can We Avoid a New Tragedy of the Commons? In *Information, Place, and Cyberspac*e (pp 341-356). Springer Berlin Heidelberg.

Geurs, K. T., De Montis, A., & Reggiani, A. (2015). Recent Advances and Applications in Accessibility Modelling. *Computers, Environment and Urban Systems, 49*(1), 82-85.

Grengs, J., Levine, J., Shen, Q. & Shen, Q. (2010). Intermetropolitan Comparison of Transportation Accessibility: Sorting Out Mobility and Proximity in San Francisco and Washington, D.C. *Journal of Planning Education and Research, 29*(4), 427-443.

Handy, S. L., & Clifton, K. J. (2001). Local Shopping as a Strategy for Reducing Automobile Travel. *Transportation, 28*(4), 317-346.

Handy, S.L., & Niemeier, D.A. (1997). Measuring Accessibility: An Exploration of Issues and Alternatives. *Environment and Planning, 29*(7), 1175-1194.

Kasipillai, J., & Chan, P. (2008). Travel Demand Management: Lessons for Malaysia. *Journal of Public Transportation, 11*(3), 41-55.

Litman, T. (2015). Developing Indicators for Sustainable and Livable Transport Planning. *Victoria Transport Policy Institute, 2007* (1), 1-100.

Litman, T. (2008). Evaluating Accessibility for Transportation Planning. *Victoria Transport Policy Institute*. Victoria, Canada: Victoria Transport Policy Institute.

Litman, T. (2007). Developing Indicators for Comprehensive and Sustainable Transport Planning. *Transportation Research Record: Journal of the Transportation Research Board, 2007*(1), 10-15.

Lucas, K., & Stanley, J. (2013). Achieving Socially Sustainable Transport in the Development Context. *13th World Conference on Transport Research* (pp 1-18). Rio de Janeiro: Unicast.

Mavoa, S., Witten, K., McCreanor, T., & O'sullivan, D. (2012). GIS Based Destination Accessibility via Public Transit and Walking in Auckland, New Zealand. *Journal of Transport Geography, 20*(1), 15-22.

McCray, T., & Brais, N. (2007). Exploring the Role of Transportation in Fostering Social Exclusion: The Use of GIS to Support Qualitative Data. *Networks and Spatial Economics, 7*(4), 397-412.

Murray, A. T., Davis, R., Stimson, R. J., & Ferreira, L. (1998). Public Transportation Access. *Transportation Research Part D: Transport and Environment, 3(*5), 319-328.

O'Sullivan, D., Morrison, A., & Shearer, J. (2000). Using Desktop GIS for the Investigation of Accessibility by Public Transport: An Isochrone Approach. *International Journal of Geographical Information Science, 14*(1), 85-104.

Rajendran, P., Bindhu, B. & Sanjay Kumar, V. (2013). Public Transport Accessibility Index for Thiruvananthapuram Urban Area. *Journal of Mechanical and Civil Engineering, 7*(4), 61-66.

Saghapour, T., Moridpour, S., & Thompson, R. G. (2016). Public Transport Accessibility in Metropolitan Areas: A New Approach Incorporating Population Density. *Journal of Transport Geography, 54*(1), 273-285.

Squires, G. D. (2002). *Urban Sprawl: Causes, Consequences, & Policy Responses*: The Urban Institute.

Sustainable Transport Action Network (SUSTRANS). (1996). [online] Available at: https://www.sustrans.org.uk/ [Accessed 22 Feb. 2021].

Tongco, M. D. C. (2007). Purposive Sampling as a Tool for Informant Selection. *Ethnobotany Research and Applications, 5*(1), 147-158.

Tribby, C.P., & Zandbergen, P.A. (2012). High-Resolution Spatio-Temporal Modeling of Public Transit Accessibility. *Applied Geography, 34*(2012), 345-355.

United Nations. (2016). Sustainable Development Knowledge Platform. [online]. Available at: https://sustainabledevelopment.un.org [Accessed 22 Feb. 2021].

Wu, B. M., & Hine, J. P. (2003). A PTAL Approach to Measuring Changes in Bus Service Accessibility. *Transport Policy, 10*(4), 307-320.