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## A Study towards the Efficiency of Public Transportation Hub Characteristics: A Case Study of Northern Region, Peninsular Malaysia

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### Abstract

A public transport hub is a place where the passengers are exchange between vehicles or transport modes. Public transport hubs form as the areas for easily accessed by the residential. The location of hub should be close with other interconnected link. This will minimize the fare rates that need to be paid by the passenger to reach their next modes. The aim of this research to examine the efficiency of public transportation hub characteristics of Penang Central to become the integrated hub for public transportation in Northern Peninsular Malaysia and provided a deeper understanding on the hub concept of public transportation. A set of questionnaire by using the Likert-scale method been distributed to the passengers/users at Penang Central. The focus group of respondents is among students and workers. The analysed data shows positive relationship and most of respondents agree to implement the hub concept on Penang Central. The study finds that public transportation in Penang Central is growing all over the year. Despite the breadth of issue and examples covered on this study, several clear themes related to the implementation of hub public transport stand out as the conclusion. Applying the hub concept in the Penang Central appears to be a possible option for tackling the traffic congestion in that area.

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**Keywords:** Public Transport, Hub and Spoke Concept

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## 1. Introduction

Public transport hubs form as the areas for easily accessed by the residential. The location of hub should be close with other interconnected link. This will minimize the fare rates that need to be paid by the passenger to reach their next modes. Travelling using public transport is cheaper as compared to the private vehicles. For those people who face in financially challenged living in this urban area, public transportation can be the best economical vehicles to be used. A public transport hub is a place where the passengers are exchange between vehicles or transport modes. Public transport for road and waterways include bus, taxi, motorcycle, rickshaw, bicycles, ships and ferry while transport hubs include bus stations, taxi stations, bus stops and ferry terminal. The public transports capacity demand in Northern Peninsular Malaysia is rising rapidly due to the increasing in population of the State. Public transport will be chosen by the people who seek for a freedom, opportunity and those who simply cannot afford to have their own-private vehicles (Azfizan et. al, 2013).

The location of the hub and its design are important to maximize passenger convenience and ease of travel. Hub with fully functional facilities would offer significant reductions in journey times and attract passenger to use the public transport. Implementing the hub concept will offer the passengers/users with many benefits. Not even that, the hub concept allows the country to gain more revenue and good source of economy. The hub concept has been used by many other develop country such as United Kingdom, China and Japan. The hub concept also minimizing the cost of travelling and reduce the traffic congestion in the country. To become an integrated public transport hub, the location must have interconnected links with other major hub of regional (spoke) either by using the same modes or different mode of transport. Moreover, the concern on the facilities and equipment use at the hub and the nature of the operating. All this characteristics are the vital component to serving an efficient hub. Malaysian population growth too fast as most of the people wants to travel to the destination and hence the vehicle population has also boomed.

Nowadays, many hub of public transport are facing on challenges due to people shifting into their private car, economically changes and demand on public transport. Populations of people in Penang are increased from time to time and the needs of transportation also become bigger. As the cost of living also increase, people should plan to avoid the traffic congestion by shifting to public transportation during peak hour. This research project will come out with some recommendations for solving this traffic problem and increasing travel efficiency by the application of hub concept of 'hub and spoke' transport system that requires rearranging and re-planning of the transport modes and links for public transport network at Penang Central. Moreover, by using the public transport, there are no need to wasting time and return cost of transportation.

## 2. Scope Of Review

The concepts of transportation systems have evolved over the years. Less efficient systems have matured into a new development facilities like integrated link systems, hub and spokes networks and multi-modal systems. Haggett in Tony (2006), the core concept of transportation system and relationship between transport nodes, networks and demand have undergone a strategic reformation. This study will discuss the available literature on transportation network systems, exactly validating the application of the 'Hub Concept' in reorganizing transportation network in urban area. The study also highlight a general account and previous experiences on the service level of the hub to be implement in Penang Central and designing an efficient public transportation network in selected area. Penang located on the northwest coast of Malaysia, to the south of Kedah and to the north of Perak. It includes of two parts, Penang Island and Seberang Perai, with Penang Island connected to the Mainland via the Penang Bridge and the Georgetown via Butterworth ferry.

The state of Penang covers 1,065 square kilometers, with the island occupying 310 square kilometers and the mainland occupying 755 kilometers (Azfizan Aziz et.al, 2013, p.3). The recent 2013 population and housing census have recorded an overall population of 1.647 million people setting up residence in the island state (Shohaimay et.al, 2013, para. 2). Table 1 below shows Penang estimated population by Ethnic Group (Anon., 2014, para. 3). The population of the people in Penang increases every year and the need of vehicles to move from one location to another also increase. Hence, the government has planned variety of strategy in order to capture the need of people

in the urban area. One of their planned is to make Penang Central become the integrated hub for public transportation.

Table 1: Population of Penang by Ethnic Group (Anon., 2014, para. 3).

ETHNIC GROUP/ YEAR	2011	2012	2013
	'000		
<b>Malaysian:</b>	1,493.7	1,514.2	1,532.3
<b>Malay</b>	648.7	662.1	674.4
<b>Others Bumiputera</b>	6.4	6.5	6.6
<b>Chinese</b>	674.9	679.8	683.4
<b>Indian</b>	159.0	161.1	163.1
<b>Others</b>	4.6	4.7	4.8
<b>Non-Malaysian Citizens</b>	107.3	111.6	115.4
<b>Total</b>	<b>1,601.0</b>	<b>1625.8</b>	<b>1,647.7</b>

According to Table 1 above, a vast number of people setting up residence has affected the population in Penang state. Population is the important factors to development of state. The most important feature about the urban development in Penang is the urban population itself (Aldukali Salem I. Amselati et.al, 2011, p. 24). When the population growth, urban cities in developing countries need to consider on problems arrive in order to achieve sustainable transport system. It has been proving that every country that having higher trade volume and transportation frequencies will benefit on their economics activities.

### 2.1 Hub Concept Treatment

Modern transport need to be efficient, sustainable and functionally integrated to meet passenger's demand. According to Aldukali Salem I. Amselati, et.al (2011), the factors like travel time and travel cost, distance from home to public transport and distance from home to work are the factors contributing that influence the users shift from private vehicles to public transport in Malaysia. Hence, the hub transport should improve the service quality to attract more passengers shifting to public transport modes. According to Tony (2006), transportation system may include nodes, terminals and locations. These three components can be optimized, functionally linked and better managed by configuring and reorganizing the core relationship components. The most important hub transportation characteristics is that it is design to cater the need of communities from starting point of origin to other end destinations. In identifying potential transport hub location, a number of characteristics need to be considered. Those characteristics are hosts of one or more modes of transit, considered for enhances transit service, has an inter-regional destination, has market demand to attract supportive levels of mixed-use or intensive development and has land available for different types of development in and around transport hub (Woxenius J., 2002). These theories of transportation system demonstrate that nodes are essential components to be interlinked with networks. Figure1 below shows the transportation system in concepts.

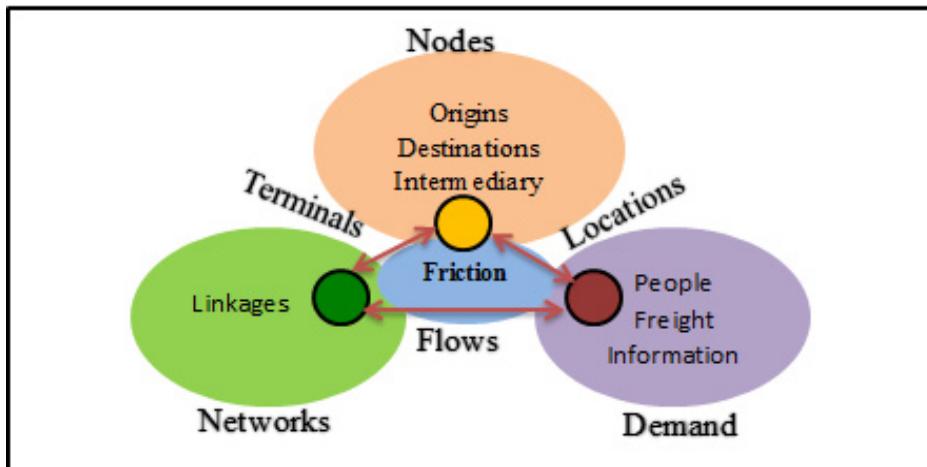


Figure 1: Transportation System in Concept

Figure 1 (Tony, 2006, p. 29) shows the three core relationships components of transportation system and friction. According to Tony (2006), locations are defined as the place where socio-economic activities exist. The demand for movements and traffic arise in this area. The access links to these areas may face friction, which in general is a function of the accessibility to nodes to the demands they cater to (p. 29).

## 2.2 Hub Concept for Public Transport

Many cities in this world have in place well planned integrated transport facilities. Heathrow Hub is one of the most representatives of ‘hub and spoke’ arrangement of air transport network which maximizes Heathrow Airport’s connectivity to existing and future rail network. Moreover, China is also ranked among the busy and efficient hub (Tony, 2006.). In Malaysia, the KL Sentral has already served the largest railway station in Southeast Asia and also designed as intermodal transportation hub. Figure 2 (Woxenius in Tony, 2006, p.32), gives a diagrammatic representation of a ‘point-to point’ and ‘hub and spokes’ concept applicable to road public transport. Users who using their own private vehicles in everyday life plying the concept of a direct connection or ‘point-to- point’ while users that using public transportation already practiced the use of ‘hub and spokes’.

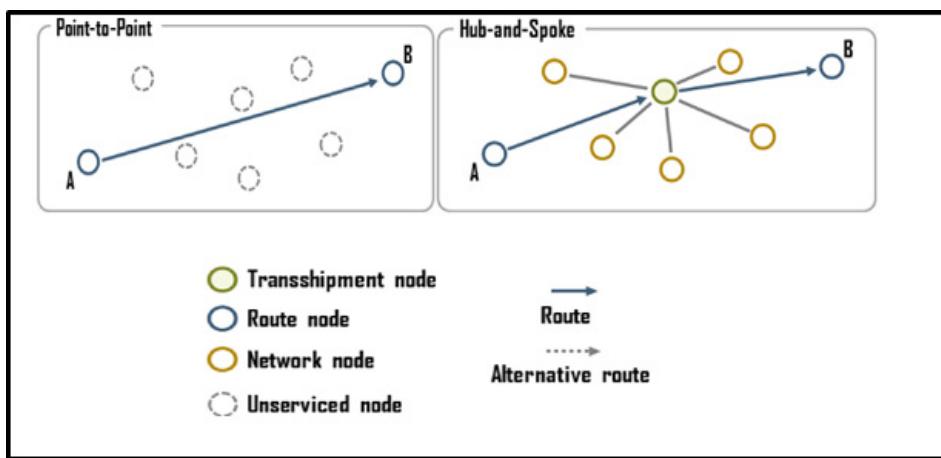


Figure 2: Point-to-Point vs. Hub and Spoke Systems

A point-to-point concept connects different places in direct ways and there are number of links which results in increasing the traffic congestion. In application of hub system, the direct links are split into separate connections in order to increase accessibility for the public transportation such as buses and taxis. By using those public transport users may get the benefit in reduction of travel cost and helps in minimizing the traffics congestion and pollution. A transport hub is a key location where several routes and means of transport converge and diverge (Starkey P., 2007). For example, when travelling from point A to B, the point-to-point concept gives a direct connection. On the other hand, from point A to B under the hub and spoke system, user needs to travel to central point first and then change over to go to point B. A study is conducted in selected area of research in Northern Peninsular Malaysia, a user was decided to travelled from Kuala Kedah (as point A) to Penang Island (as point B) was examined. Along her journey from Kuala Kedah, she is travelling using bus. After arriving bus terminal which is in Penang Central (as central point), user needs to change over to ferry to go to Penang Island. Thus, users often used direct connection needs to be convinced about the reliability, efficiency and costs of the hub options. This may change their mind to use from direct route to hub journey.

### 3. Methodology

The research was done in order to test the hypotheses made. In order to identify the efficiency of the selected area as hub transportation system, discussions about the method used in future to gather data and information. The sample for this research focused on workers and students in the Penang state who travelling using public transport on weekday basis. Figure 3 below shows the population and sample for research area.

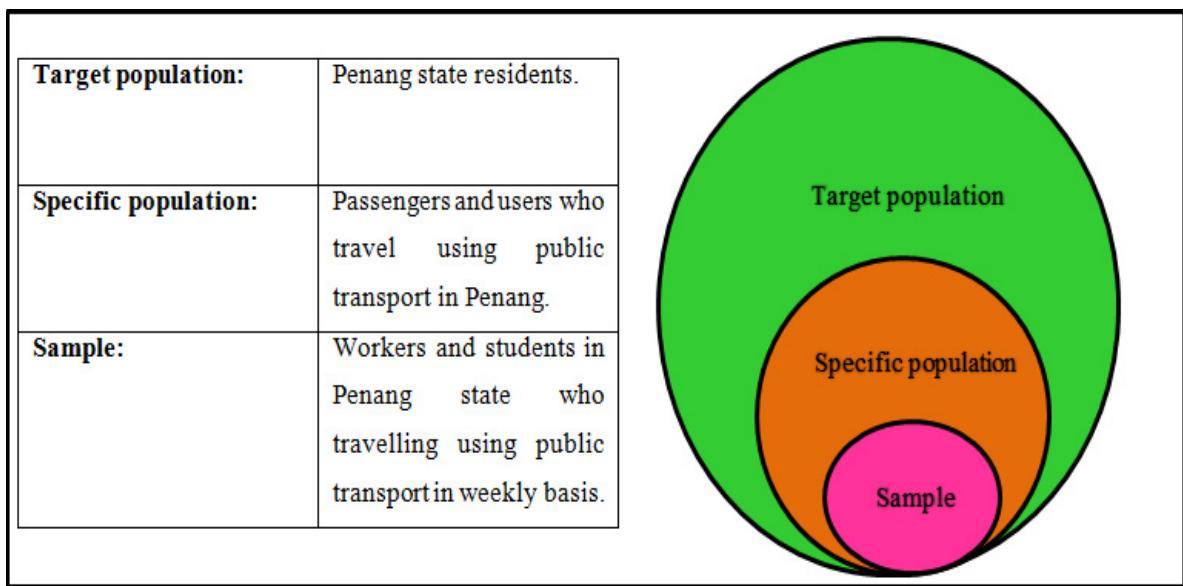


Figure 3: Populations and sample for research area

This quantitative research used questionnaire in order to get research background and to find the feasibility of the selected hubs for public transport. The questionnaires for this research were distributed randomly to workers and students that use the public transport to their destination on weekday basis in Penang Central. The questionnaire was prepared in dual language, English and Bahasa Melayu. The research result analyzed by using the Statistical Package for the Social Sciences (SPSS) methods. In this method, correlation analysis was used to investigate two variables to measure the relationship between them. Two variables were tested to identify the relationship. If two variables are related to each other, then the variables are said to be correlated. It was used to discover the possibility of a link between variables prior to the research outcome. This analysis may help in deriving the degree and the direction of the relationships. The two variables that been tested using the correlation analysis is as follows:

## “Correlation between Characteristics of Penang Central (X) and Transportation Links Connected (Y)”

Hypothesis for Correlation analysis (determine the strength of relationship between variables):

- i. Ho (Null): ( $P \leq 0.05$ ) There is no relationship between the factors in becoming hub for public transportation.
- ii. H1: ( $P > 0.05$ ) There is relationship between factors in becoming hub for public transportation.(CLAIM)

Table 2: Correlation Result

		Transportation Links Connected	Characteristics of Penang Central
Transportation Links Connected	Pearson Correlation	1	.661**
	Sig. (2-tailed)		.000
	N	50	50
Characteristics of Penang Central	Pearson Correlation	.661**	1
	Sig. (2-tailed)	.000	
	N	50	50

\*\*. Correlation is significant at the 0.01 level (2-tailed).

According to the test, Pearson's  $r$  is 0.661, which it is close to 0 rather than 1. The variables used are “Characteristics of Penang Central” and “Transportation Links” is seen to be correlated to each other. There is **Moderate Positive** relationship between these two variables. It means that need to reject Ho (Null) and accept the H1. Both factors of Characteristics and Transportation Links have a significant relationship that affect the possibility of Penang Central to become public transportation hub.

## 4. Results and Discussion

The result for the hub characteristics is recorded below.

- Research Objective : To examine the efficiency of public transportation hub characteristics on Penang Central those make it as alternative transportation hub in Northern Peninsular Malaysia.
- Research Question : What are the characteristics of Penang Central to service as the regional hub in the Northern Peninsular Malaysia?

Table 3 below shows the selected questions used in order to achieve the Research Objective.

Table 3: Selected Questions from Research Question.

No.	Question	Mean	Std. Deviation	Preferred Scale with Percentage
1	The location is easy access from your home.	3.30	.839	Agree (42.0%)
2	The location is easily to find by using the maps or Global Positioning System (GPS).	3.62	.855	Agree (44.0%)
3	The Information Kiosk always provided enough guidance and information to passengers.	3.32	.957	Agree (38.0%)

4	The amount of benches is enough to support passengers waiting during peak hours.	3.02	1.000	Agree (40.0%)
5	The uses of digital communicated technology for calling times are fully managed.	3.36	.827	Moderately Agree (44.0%)
6	Pedestrian access to different terminal (stairways, walkways).	3.48	.762	Agree (52.0%)
7	The drivers of the public transport always treating their passengers in a good manner.	3.42	.810	Moderately Agree (42.0%)
8	Ticket collector always treat passenger in good manner.	3.34	.848	Moderately Agree (60.0%)

Table 3 above shows the Mean, Standard Deviation and preferred scale with percentage for each question selected. The total 8 from 13 questions for Section C of the survey form is chose to support the Research Objective. Question 1 until 8 have strongly positive to support the Research Objective stated for this research. Question 1 and 2 supports the characteristics of Penang Central to become transport hub. In order to become a hub, the place locate for the hub must be strategic and easy access. Question 3 also supports the function of Penang Central. The existence of Information Kiosk is important as it provide beneficial information for the user/passengers. Moreover, the facilities situated also enough to support the characteristics of a hub. Question 4 shows that for about 40% of users agree with the facilities of benches situated at Penang Central. Not only that, the uses of technology for calling passengers had been used for about two years ago. The digital calling system had minimized the energy used for workers to call the passenger to embark the vessels. The preferred scale of respondents shows the ‘Moderately Agree’ on the Question 5. Question 6 also supports the characteristics to become a hub. The efficiency of a hub not only fall under the facilities provided but it also involve on the behaviour of operators/workers that served the passengers on the hub. They also give a big influence to attract users to use their services. Question 7 and 8 shows that respondents preferred to answer ‘Moderately Agree’ with the services performed by the operators. Moreover, the hypothesis also been tested to determine the greater hub facilities and services and the possibility of Penang Central to become hub for public transportation is shown below:

#### Step 1: State of hypothesis and identify claims

H0:  $\mu \leq 3$ , most of respondents do not agree with the characteristics of Penang Central to service as the regional hub in the Northern Peninsular Malaysia.

H1:  $\mu > 3$  most of respondents agree with the characteristics of Penang Central to service as the regional hub in the Northern Peninsular Malaysia. (Claim)

Rejection Region:

Reject the null hypothesis if  $Z > +1.960$

Or

Reject the null hypothesis if  $p\text{-value} < 0.05$ .

#### Step 2 = Compute the test value

Table 4: One Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Mean for Research Question	50	3.37	.553	.078

$$Z = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$$

$\bar{x}$  = sample mean  
 $\mu$  = population mean  
 $\sigma$  = population standard deviation  
 $n$  = sample size

Figure 4: Formula for the Z test.

**Step 3:** By using a manual calculation method, the Z test is computed as bellows:

$$\begin{aligned} z = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} &= \frac{3.366 - 3}{\frac{0.553}{\sqrt{7.071}}} = \frac{0.36}{0.078} \\ &= \underline{\underline{4.603}} \end{aligned}$$

**Step 4** = Find the *P*-value. Using Table E in Appendix, find the corresponding area under the normal distribution for  $z = 4.603$  is 0.9999. Subtracting this value for the area from 0.5000, one gets  $0.5000 - 0.9999 = -0.0001$ . The *P*-value is 0.0001 for the right-tailed test.

**Step 5** = Make the decision. Since the *P*-value is less than 0.05, the decision is to reject the null hypothesis. See Figure 5 below:

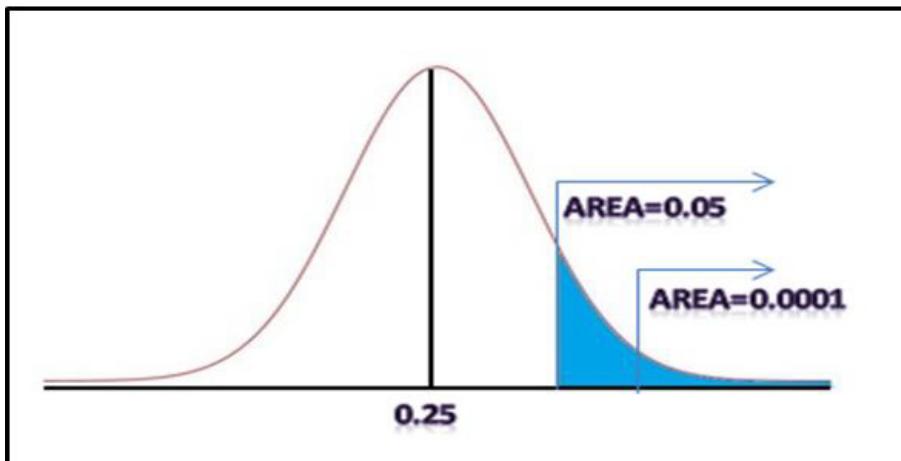


Figure 5: Normal Distribution Curve.

**Step 6** = Summarize the results. There is enough evidence to support the claim that the respondent agree in research questionnaire are greater than 3.

Table 5: SPSS tabulation of data by using one sample data.

	Test Value = 3					
	z	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Characteristics of Penang Central	4.682	49	.000	.366	.21	.52

Since z- value (4.682) is greater than the critical value (1.960),  $4.682 > 1.960$  the decision is to reject the null hypothesis. There is enough evidence to support the “Characteristics of Penang Central to become Hub for Public Transportation”.

The result shows that the facilities served by Penang Central are good. Most of respondents agree or satisfied with the facilities provided by Penang Central. Beside, Penang Central already adopted with the advanced technology equipment to serve the operation. The location of Penang Central is easy to reach as it located in between two modes that are land and waterways. For example, passengers which traveling from Perak by bus will need to shift to another bus to the next destination. So Penang Central area might be busy with users that come from various states. The uses of advanced technology not only minimize the use of operators but it also provides clear information to the users/passengers. This strengthens the main idea of this research to implement the hub function at Penang Central. From the Literature Review of the characteristics of hub, Penang Central can be concluded as the suitable place to become the integrated hub for public transportation. In order to become the hub, Penang Central had always served their users/passengers with efficient services and also user friendly automatic information systems.

## 5. Conclusion

The study finds that public transportation in Penang Central is growing all over the year. Despite the breadth of issue and examples covered on this study, several clear themes related to the implementation of hub public transport stand out as the conclusion. Applying the hub concept in the Penang Central appears to be a possible option for tackling the traffic congestion in that area. This study also provides the relevant hub concept treatment that can implement at Penang. Based on the data that had been analyzed, there are a strong positive that Penang Central is capable to become the hub for the public transportation. As the population of the Penang area growth by the year, the needs of transportation to move become important. The area will benefit the investor as it already performed an entire fundamental logistics solution and facilities and services on air, land and sea. Last but not least, the study firmly indicates the need for integrated and sustainable public transportation system for northern Peninsular Malaysia. The need of advanced technology in servicing the operations of the hub also important as it will increase user's accessibility. The use of technology will minimize the waiting time in queuing when buying the tickets from the operators.

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