



Commuters' Perception of Legibility and Complexity with Respect to Path Choice in Central Business District of Kuala Lumpur

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ARTICLE INFO

Article history:

Received 13 April 2012
Received in revised form
30 June 2012
Accepted 04 July 2012
Available online
07 July 2012

Keywords:

Path choice;
Walking Behavior;
Commuter;
Perceived Legibility;
Perceived Complexity.

ABSTRACT

The effect of environmental factors on walking behavior needs to be considered based on the purpose of walking trip; whether walking for transport or walking for recreational purposes. Since everybody walks on his/her daily transport, studying walking behavior of those who walk for transport would contribute to maintain the minimum rate of physical activity. Commuters are the major group of those who walk for transport. It was found that the path choice of pedestrians can be considered to examine the effects of environmental factors on walking behavior. Introducing two environmental factors of perceived legibility and perceived complexity, it is demonstrated that the theoretical and empirical relationship between these factors and walking behavior as well as the path choice criteria, leads to define these two factors in accordance with commuter's specifications. Accordingly, both perceived legibility and perceived complexity are two important path choice criteria of commuters in CBD of Kuala Lumpur.

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1. Introduction

Path choice behavior of pedestrians is defined as the process through which pedestrians react and choose their favorite path at the decision making points such as junctions. There is a relationship between path choice and walking behavior of pedestrians in both micro and macro scale. According to the pedestrian behavior models, understanding path choice behavior would be one step of the process to understand pedestrian's behavior in urban spaces (Hoogendoorn and Bovy, 2004; Kitazawa and Batty, 2004). These models show that there is a relationship between path choice and walking behavior in micro scale; and that factors affecting walking behavior in micro scale could affect path choice of pedestrians and vice versa (Hoogendoorn and Bovy, 2004; Kitazawa and Batty, 2004) (Figure 1). On the other hand, in terms of the relationship between walking behavior in macro scale and path choice of pedestrians, Guo (2009) has studied the effects of environmental factors on path choice and walking as a mode of transport. The use of path choice contributes to reducing the effects of self-selection. Therefore, considering path choice criteria of pedestrians is one of the best ways to investigate the effects of environmental factors on walking behavior of those who want to reach their destination.

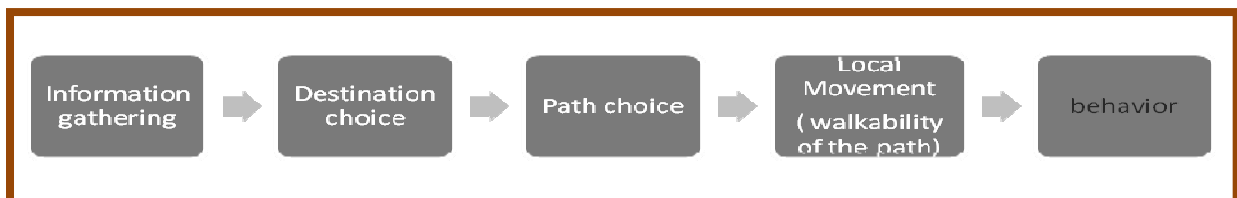


Figure 1: Concept of pedestrian behavioral model suggested by Kitazawa and Batty (2004).

Literature on both path choice and walking behavior of pedestrians mentioned that the effects of environmental factors on path choice and walking behavior needs to be considered based on the purpose of the trip whether walking to reach the destination or walking for recreation. Since everybody walks, at least for transport in daily activities, considering the factors affecting walking for transport, contribute to maintaining the minimum range of physical activity and improving the public health. For example, a recent study reveals that walking for transport has significantly contributed to the accrual of sufficient physical activity for health in Australian men (7%) and women (15%) (Cole, *et al.*, 2006). Recent reviews identify how researchers in population health (Owen, *et al.*, 2004) and in transport and urban

planning (Saelens *et al.*, 2003a; Sallis *et al.*, 2004) are examining potential environmental determinants of walking for transport. Evidences on associations between characteristics of the built environment and transport-related walking are growing (Transportation Research Board, 2005). Commuters are the major group of those who walk to reach the destination in daily basis. This paper by introducing two factors of perceived legibility and perceived complexity, in addition to show the theoretical and empirical relationship between these two factors and path choice of pedestrians as well as walking to reach the destination, makes an effort to define these two factors in accordance with path choice of commuters and their walking behavior. Finally, the results of the primary survey examining the criteria of path choice of commuters in CBD of Kuala Lumpur are presented.

2. Materials and Methods

The method used in this study is based on the analysis of data gathered through reviewed literature. Firstly, through reviewing literature the most important environmental factor for path choice and walking behavior of commuters would be extracted. Then, definition of legibility and its application to different environmental studies would be discussed. Then, the relationship between legibility and path choice of pedestrians as well as walking to reach the destination would be illustrated. Next, the proper definition of perceived legibility in accordance with path choice and walking behavior of pedestrians (commuters) would be presented. Such an explained process would be implemented for perceived complexity in relation with path choice and walking behavior of pedestrians (commuters). Finally, the results of primary survey on the main criteria of path choice of commuters in CBD of Kuala Lumpur would be presented.

3. Results and Discussion

3.1 Path choice behavior of pedestrians (commuters) and related effective environmental factors

Path choice behavior is influenced by both external factors (e.g. Presence of obstacles, stimulation of the environment), and internal (or personal) factors (age, gender, attitudes of the pedestrian) (Hoogendoorn and Bovy, 2004; Hoogendoorn and Bovy, 2005). Based on the

behavioral model on pedestrians' behavior, pedestrians minimize the disutility of the path. As mentioned by Hoogendoorn and Bovy (2004), disutility of the path depends on the following factors:

1. Distance or travel time between origin and destination,
2. Presence of obstacles such as number of crossing along the path,
3. Number of sharp turns and rapid directional changes (Path directness),
4. Expected number of interactions with other pedestrians,
5. Stimulation of environment, and attractiveness.

Empirical studies indicate that the most important external factor is the shortest path which can be interpreted as shortest distance and the least time of the trip between an origin and a destination (Hill, 1982; Golledge, 1995). Hill (1982) founded that direction is the most usual criteria for choosing a particular path. The directness of the path is related not only to the length of the path but also to its complexity in terms of direction's change (Hill, 1982). Golledge (1995) argued that in addition to shortest distance and least time, there are some other criteria for path choice such as paths with fewer turns and most aesthetically appealing path. Bovy and Stern (1990) have emphasized on pleasantness along the path as an important criterion for path choice. Other important factors in path choice behavior are habit, number of crossings, pollution and noise levels, safety and shelter from poor weather conditions, and stimulation of the environment (Hoogendoorn and Bovy, 2004).

However, the effects of environmental variables on path choice behavior depend on the purpose of the trip, consisting of recreational trips, and work-related walking trips (Bovy and Stern, 1990). For instance, scenery is important for recreational trips but it plays no role in work-related walking trips (Bovy and Stern, 1990). Therefore, the purpose of the trip should be taken into account in the studies on path choice behavior of pedestrians. For the commuters who want to reach the destination in the shortest time, the distance could be the most important factors; and as mentioned by Bovy and Stern (1990), scenery and aesthetic factors along the path could be the least important factors for their path choice. Since commuters need to have an easy movement toward their destination, some environmental factors which influence their easy movement such as the number of people along the path and the number of the crossings of the street could be taken into account as important factors on path choice behavior of commuters.

The studies using pedestrian behavior model on the basis of pedestrian flow suggest that among the environmental variables along the path visibility along the path is the most influential factor on walking volumes (Desyllas, *et al.*, 2003). Since path choice of pedestrians, especially in the areas with alternative pathways between origin and destination points, would contribute to pedestrian flow in different pathways, visibility along the path could be taken into account as a criterion in path choice of pedestrians. It also needs to be mentioned that path choice of pedestrians is being occurred in their navigation toward destination. From the studies focusing on the navigation of pedestrians it can be extracted that the legibility of the pathway is a significant factor for navigation toward destinations. Legibility of the path is the quality of path which helps the pedestrians to feel their location along the path. It also would help the pedestrians for easy conduction toward their destination. However, there is a need to define the proper definition of legibility in relation to path choice of pedestrians.

3.2 Walking behavior of pedestrians (commuters) and related effective environmental factors

Literature on walking behavior reveals that different environmental factors effect walking behavior based on the purpose of the walking whether walking for recreation or walking to reach the destination. The studies which focused on walking behavior for those who want to reach a destination, several significant environmental factors have been clarified. Access to destinations which include proximity to destination or distance to destination has been shown to be positively correlated with walking for transport (Frank *et al.*, 2003; Handy *et al.*, 2002; Saelens *et al.*, 2003; Owen *et al.*, 2004). Craige *et al.* (2002) who studied the effects of different environmental factors on walking to work place in several neighborhoods, found that except the factors of visual interest and visual aesthetic, different environmental factors including number and variety of destinations, existence of accessible walking route, continuity of walking route, traffic threat, safety from crime, obstacle, inclusive or exclusive of pedestrians and complexity of stimulus, are significant factors on walking behavior of those who want to walk toward their workplace. Owen, *et al.* (2004) found that workplace proximity was the most significant contributor to transport-related walking, especially among women. Addition to accessibility to destination, convenience of facilities for walking (sidewalks, trails) and perceptions about traffic and roads were found to be associated with

walking for reaching to a destination (Owen, *et al.*, 2004). Leow (2002) who has studied about improving the situation of walking for commuters in CBD of Singapore found that factors such as rainy weather ease of way finding, crowdedness, safety, and directness of the route are important in order to improve the walking situation of commuters in CBD of Singapore.

3.3 Legibility, its Definition and Components along the Path, based on relevant literature

According to Nasar (1988), legibility is an environmental factor that lets man to discover his surroundings extensively without getting lost. Lynch (1960) explains them as noticeable parts of the city in an orderly and eases to organize them. He has emphasized the importance of the legibility of the environment, of which visual access is one part and the complexity of spatial layout might be another. As a result, reading in architectural milieu is a quality that enables one to recognize the contents of objects by grouping them meaningfully. According to Norberg-Schulz (1980) there are two factors affect reading: the tangible existing physical elements and intangible mental elements. Physical ones belong to environment while the others belong to man. Therefore, reading is a variable of man, while legibility is an environmental variable that man use to read the environment around him (Erem and Sener, 2008). Legibility of the environment is also defined as the degree to which the environment facilitates the ability of users to find their way within it (Weisman, 1981; O'Neill, 1991; AIG, 2007)

Legibility of the city is affected by the ease to recognize five elements of a city: paths, nodes, landmarks, borders and districts (Lynch, 1960). However, the levels of importance of these elements may differ. Researches in planning environments show that the most important element is node; and others are: landmarks, paths, borders, and districts in the order of legibility (Banai, 1999). However, nodes, landmarks, and paths play key roles in the legibility of any part of a city (Erem and Sener, 2008). On the other hand, legibility of the environment is affected by the geometrical configuration of the physical components (Lynch , 1960;. Erem and Sener, 2008). This configuration may be simple or complex. So the level of reading is absolutely influenced by the complexity of the environment (Erem and Sener, 2008). As it was mentioned earlier, Erem and Sener (2008) found that the relationship between legibility and complexity of the path in relation to the perception of pedestrians is reversed through which increasing in one of them causes the reduction in the other one and vice versa.

3.4 Relationship between legibility and path choice of pedestrians (commuters) as well as walking behavior

Literature on path choice and walking behavior of commuters provide the empirical evidence on the importance of legibility as a determining factor in path choice and walking behavior of commuters. Path choice of commuters is one of the steps on forming their mobility in urban areas. Urban designers frequently argue that the legibility and the shape of the local streets' pattern play a key role in pedestrian mobility in urban areas (Crane and Crepeau, 1998). On the basis of definition of legibility in the studies on path choice of pedestrians inside and outside of the buildings, legibility is defined as the degree to which the environment facilitates the ability of users to find their way within it (Weisman, 1981; O'Neill, 1991; AIG, 2007). Therefore, legibility is the main important factor for path choice or wayfinding of pedestrians in different environments.

However it seems that the legibility of the path, by providing the best navigation along the path, is the urgent quality for those with lower familiarity, but it also could be important for path choice of pedestrians with high familiarity such as commuters. It seems that legibility of the path would help the commuters as the pedestrians with higher familiarity, to have better feelings in order to change the location along the pathways by easier trace of the pathways toward destinations. From the studies on walking behavior, Leow (2002) examining the effective factors on walking of commuters in CBD of Singapore, found that the ease of path choice is one of the important factors determining the rate of walking of commuters in pathways of CBD. Moreover, the legibility is the quality of the path associating with easier and better path choice in CBD. It was previously mentioned that visibility along the path could be taken into account as a criterion in path choice of pedestrians. On the other hand, visibility along the path is one of the main factors contributing to providing the legibility of the pathways (Lynch, 1960). Therefore such a common factor with strong correlation with path choice of commuters as well as their walking behavior and also a strong correlation with the perception of legibility along the pathways can imply about the relationship between perceived legibility and path choice of pedestrians as well as their walking behavior (Figure 2).

3.5 Definition of perceived legibility in accordance with commuter's behavior in pathways of CBD

Legibility is an environmental factor that lets man to discover his surroundings extensively without getting lost (Nasar, 1988). Legibility of the path depends on the perception of the users of the path on how they read and clarify the different parts of the pathways. Reading is a variable of man, while legibility is an environmental variable that man uses to read the environment around him (Erem and Sener, 2008). From studies on path choice choice of pedestrians it could be realized that the legibility of the path is an environment variable which not only prevents the pedestrians to get lost along the pathways, but also would help them to conduct toward their destination. Thus, there are two basic functions of legibility in each path. Firstly, it would help the pedestrians to remember their location along the path; and secondly, it would help the pedestrians to lead toward their destinations.

Legibility of the path depends on the familiarity of the users with pathways. It seems that legibility is one of the basic and necessary qualities of the path, especially for those with low familiarity. Because it provides such situation in which better navigation toward destination could be run. This is while for commuters who have a high familiarity with the pathways, legibility of the path- as the quality of the path- is defined in terms of the degree to which the pathway provide the better sense of direction toward the destination. Indeed this quality of the path would help the commuters to feel changing of locations along it in a better way and to provide the better sense of direction toward the destination. The importance of legibility of the pathways for path choice of pedestrians would be highlighted while it is approached between station points and workplaces in CBD, where there are several alternative pathways between station points and workplaces to be used by commuters.

3.6 Complexity, its definition and components along the Path

A study by Heaps and Handel (1999) defines complexity as the degree of difficulty in providing a verbal description of an image. However, Venturi (1977) described complexity as a mixture of asymmetry, duality, disorientation, lack of hierarchy, and chaos. Kaplan and Kaplan (1982) who have studied visual preference in the environment, mention that presence of enough complexity in the scene keeps the environment occupied by people. Rapaport (1990) argues that the complexity is related to the number of notable differences through

which the viewer is exposed per unit time. Handy and Ewing (2009) have referred to complexity as the visual richness of a place. Due to Erem, complexity is described as “a condition of being hard to understand and to be formed of many numbers of related pieces” (Erem, 2003 p. 59). For instance, an environment with a large number of different possible states which come and go over time is considered as a complex environment.

In an effort to find out the environmental variables related to complexity, it should be mentioned that complexity in the urban environments could be generated by configurational complexity (Krafta, 1997). The number of nodes or junctions is the physical feature which contributes to the configuration complexity (Krafta, 1997). While the number of stops or crossings created by facing the pedestrians with streets is another physical feature in relation with the configuration of the path (Krafta, 1997). And the number of turns as another feature, affecting configuration of the path, could be taken into account to generate the complexity of the path (Erem and Sener 2008). Finally, the number of people, the number of urban furnitures such as street lights, and the number of buildings along the path could be taken into account as the factors contributing to the perception of complexity (Ewing and Handy, 2009).

On the other hand, as mentioned by Krafta (1997), urban spatial complexity is usually associated with other expressions such as variety, scale (size), intensity, and density. Therefore, in addition to above physical features, the qualitative factors such as several spatial qualities related to the concept of density and variety should be considered as indicators of complexity along the path. It includes several spatial qualities such as architectural diversity and variety of buildings (Erem and Sener, 2008; Ewing and Handy, 2009), density of human activities and vehicles (Erem and Sener, 2008), variety of texture and colors (Ewing and Handy, 2009), variety of signage (Nasar, 1988, Jacobs, 1993) and variety of landscape elements (Arnold, 1993; Jacobs, 1993). In an effort to find other factors that affect the complexity of the path, it was found that perception of visual complexity is likely to be depended on the familiarity with the scene (Heylighen, 1997; Erem and Sener, 2008). Therefore, it seems that in addition to the environmental variables along the path, contributing to generation of complexity, familiarity with the alternative path is also a variable which affects perceived complexity of the pathways.

3.7 The relationship between perceived complexity and path choice of pedestrians (commuters) as well as walking behavior

From the studies on path choice behavior, Hill (1982) found that time and distance are the most important factors in the path choice of pedestrians. But the complexity of the pathways in terms of the number of turns along the path is another important factor for path choice of pedestrians. Golledge (1995) also found the importance of the number of turns for path choice of pedestrians. Accordingly, the number of turns is one of the most important factors in path choice of pedestrians. On the other hand, as mentioned by Erem and Sener (2008), the number of turns is one of the features contributing to the perception of complexity in urban pathways. As it was previously mentioned based on theoretical models of pedestrians behavior, factors such as interaction with other pedestrians and crossing of the streets as two affective factors on easy movement of pedestrians, could be taken into account for path choice behavior of pedestrians (Hoogendoorn and Bovy, 2004). Based on different environmental studies, the later factors plus the number of turns are other affective factors on perception of the complexity of the pathways (Heye and Timpf, 2003; Erem and Sener, 2008).

By reviewing the literature on walking behavior of those who want to reach destination, especially commuters, it was found that the proximity of destination including distance and time of the trip, is the most important factors for walking to reach the destination. The environmental factors including convenience of facilities for walking (sidewalks, trails), perceptions of traffic and busy roads, existence of accessible walking route, continuity of walking route, traffic threat, safety from crime, inclusive or exclusive of pedestrians, and complexity of stimulus (number and variety of different stimuli such as details of the building) have been demonstrated to be the significant factors on walking behavior of those who want to walk toward their workplace (Craig, *et al.*, 2002). From above-mentioned factors, Perception of busy roads, interaction with other pedestrians, and complexity of stimuli are the factors related to the perception of complexity of pathways by pedestrians (Erem and Sener, 2008) (Figure 2). Therefore, reviewing the literature on path choice and walking behavior of commuters; and also the studies on defining and applying complexity, it was found that some factors affecting path choice and walking behavior of commuters are common with those factors contributing to the perception of the complexity (Figure 2). In fact, it shows the relationship between perceived complexity and path choice of pedestrians as

well as walking behavior of pedestrians along the pathways.

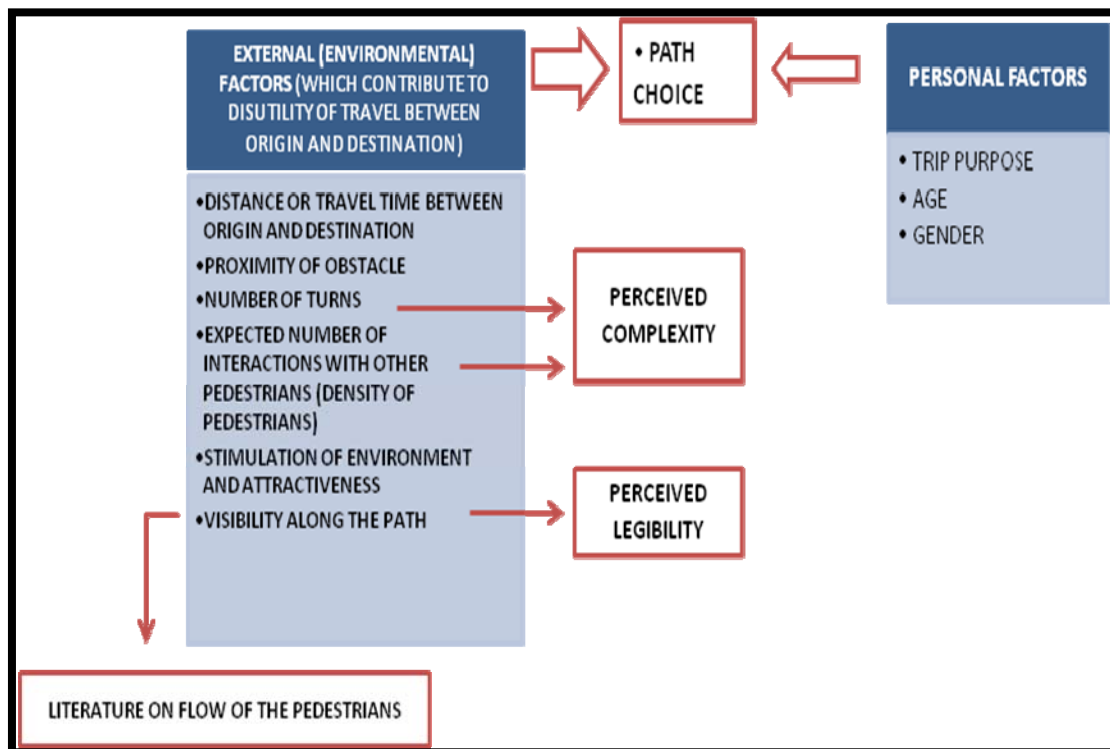


Figure 2: Theoretical Framework on Relationship between Path Choice of Pedestrians and Perceived Legibility as Well as Perceived Complexity.

3.8 Definition of perceived complexity in accordance with commuter's behavior in pathways of CBD

Complexity in the different environmental studies is defined as the factor implying on variety and density of different visual elements. Studies on visual preference and several urban design studies defined complexity as the visual richness of the place. According to mentioned studies, complexity is introduced and defined as the certain visual quality of the place. Commuters are the major group who transports every day in CBD. Indeed, they are doing the necessary activity which is walking between station points and workplaces in CBD. According to Gehl (1987), people do the necessary activities with no attention to the qualities of the environment. So perceived complexity -as the visual quality of the place- could not be correlated with path choice and walking behavior of commuters unless it is related to some important aspects of walking of commuters such as the situation of movement of commuters along the pathways. Here; the question is that how the perceived complexity of the pathways

could be defined and applied in accordance with path choice of commuters in order to be introduced as the important relevant factor in path choice and walking behavior of commuters?

Since commuters are the major daily traveler in CBD and they walk for transport, path choice of commuters is a step to realize the travel behavior of commuters. Heye and Timft (2003) represent perceived complexity as one of the main criteria of path choice by those who walk for transport. Path decision by human is often made based on other criteria than minimum distance or time. For instance, a traveler might not be able to choose between two routes unless another criterion is introduced into the decision making process. Due to them, one criterion which could be taken into account by pedestrians in their path choice is called perceived complexity of the path, i.e. The perception of how difficult a chosen path will be. Thus, from the different physical characteristics, street to cross and visibility of destination points are important factors to perceive the complexity by traveler (Heye and Timft, 2003). Since commuters are the groups of pedestrians who walk in pathways of CBD to reach their destination, pathways of CBD should provide the situation in which they walk toward their destination more easily. Perceived complexity as an effective factor in path choice of commuters should be correlated with situation of movement of commuters along the pathways. Therefore, the perceived complexity of the path -as an effective factor in the behavior of commuters- is defined in terms of the degree to which the visual and configuration elements of the pathways would increase the level of difficulty regarding commuter's movement.

Based on definition suggested by Krafta (1997), complexity in urban environments -in addition to visual elements- could also be referred to the elements of urban configuration such as number of pathways and number of destinations. Therefore, it could be realized that the complexity in urban environments could be related to the variety and density of some visual via configuration elements. While the complexity of one pathway along the street between origin and destination is going to be considered, all configuration factors such as the number of crossings with other streets and the number of turns and also all the visual spatial elements such as the number of people and signage along the path, would be taken into account in perception of complexity by commuters. In this regard, all of these visual and configuration factors along the path based on their correlation with difficulty of movement of commuters

along the path contribute to the perception of complexity by commuters. Accordingly, the routes connecting station points and workplaces in CBD representing alternative pathways to be used by commuters between origin and destination points are the best locations for testing the relationship between perceived complexity and path choice of commuters as well as their walking behavior.

3.9 Results of the survey

The criteria of path choice of commuters in CBD of Kuala Lumpur have been empirically surveyed. Regarding the survey context, firstly, by considering the typology of heritage zones of Kuala Lumpur which covered almost 75 percent of the entire CBD, some areas of CBD were marked. And due to the designed procedure, some zones have been selected from each area. Each zone represents following characteristics:

- Origin point which is a station point;
- Destination point which is the workplace around the station point;
- The distance between origin point and destination point should be almost 500 meters;
- There should be some clear alternative pathways between origin and destination points.

As the results of zone selection process, nine zones were selected for further studies. In this regard, the total numbers of 323 commuters from mentioned zones have been surveyed. And explaining the perceived complexity and perceived legibility for commuters, the importance of these factors on path choice of commuters were examined. On the basis of the definition of perceived legibility as well as perceived complexity, I assume the commuters to choose the pathways with the highest perceived legibility presenting by a stronger sense of direction toward the station and lower perceived complexity presenting by less difficulty of movement along the walkways. As the results, both of the high perceived legibility and low perceived complexity are important criteria for path choice of commuters. However, low perceived complexity is more important comparing to high perceived legibility for path choice of commuters. Almost 8% of the commuters found high perceived legibility as a very important factor in their path choice. This percentage for low perceived complexity is 10% of the commuters. Similarly, about 25% of commuters have mentioned high perceived legibility as an important factor for their path choice. This is while 27% of the commuters have expressed low perceived complexity as their important path choice criteria. On the other hand, there are

few people who have mentioned the high perceived legibility and low perceived complexity are unimportant for their path choice. Due the results, almost 7% of the commuters found high perceived legibility as unimportant factors for their path choice and 3% mentioned that low perceived complexity is unimportant factor for their path choice (Figure 3).

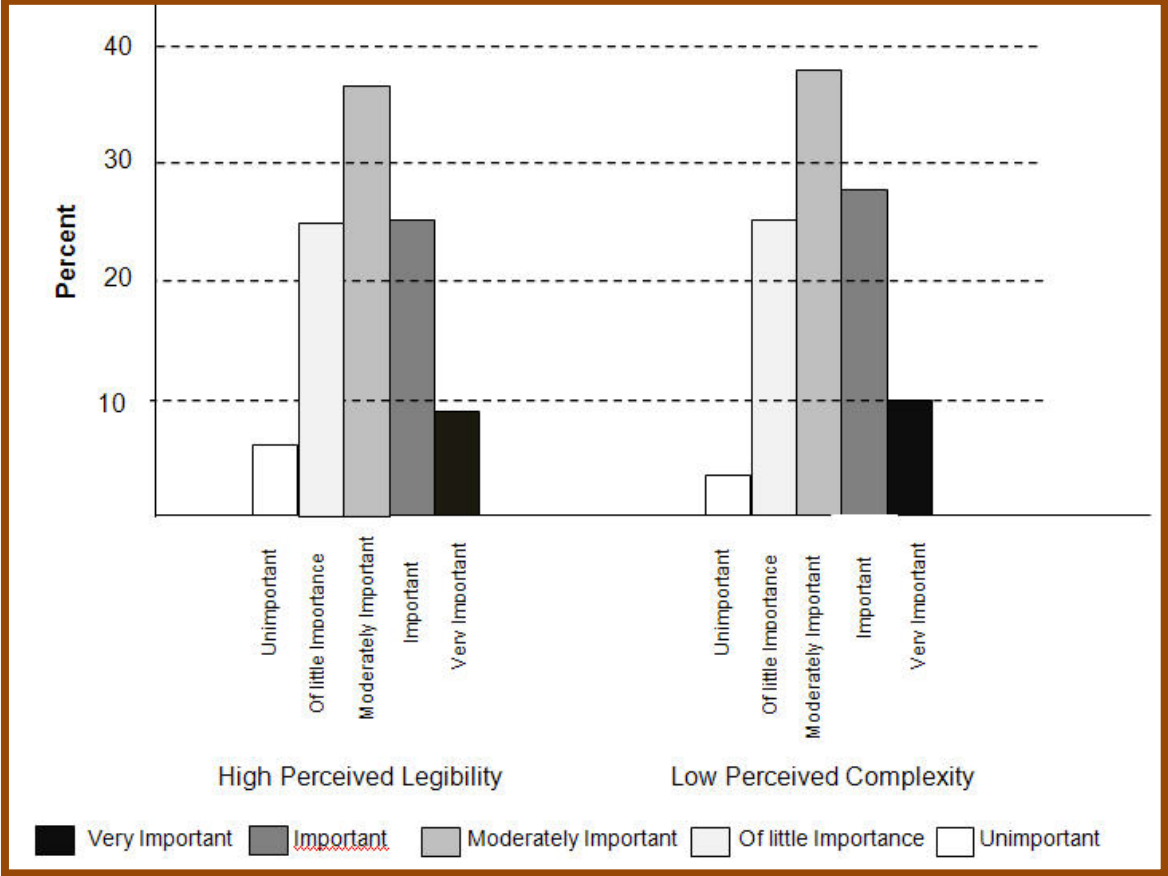


Figure 3: The Importance of Perceived Legibility and Perceived Complexity for Path Choice of Commuters in CBD of Kuala Lumpur.

4. Conclusion

It was demonstrated that there are theoretical and empirical supports on the relationship between perceived legibility and path choice of commuters as well as their walking behavior. Such theoretical and empirical relationship also exists in terms of the relationship between perceived complexity and path choice of commuters as well as their walking behavior. In accordance with path choice and walking behavior of commuters, perceived legibility of the path (as the quality of the path) is considered through the degree to which the pathway provide the better sense of direction toward the destination. On the other hand, perceived complexity of the path is defined in terms of the degree to which the visual and configuration

elements of the pathways would increase the level of difficulty regarding commuter's movement. It was demonstrated that some visual and configuration factors along the pathways based on their correlation with difficulty of movement contribute to the perception of complexity by commuters.

Results of the survey on the relationship between high perceived legibility and path choice of commuters in CBD of Kuala Lumpur, demonstrates the importance of high perceived legibility on path choice of commuters. Similarly, low perceived complexity has been found to be the most important criteria for path choice of commuters. It should be mentioned that low perceived complexity is highlighted to be a more important criteria comparing to high perceived legibility for path choice of commuters in CBD of Kuala Lumpur. As discussed earlier, on the basis of the relationship between path choices and walking as a mode of transport for commuters, both high perceived legibility and low perceived complexity should be taken into account as the factors contributing to increase the walking rate of commuters and maintaining the minimum rate of physical activity for them as those who have the daily regular walks in the area of CBD.

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Peer Review: This article has been internationally peer-reviewed and accepted for publication according to the guidelines given at the journal's website. Note: This article was accepted and presented at the 2nd International Conference-Workshop on Sustainable Architecture and Urban Design (ICWSAUD) organized by School of Housing, Building & Planning, Universiti Sains Malaysia, Penang, Malaysia from March 3rd -5th, 2012.