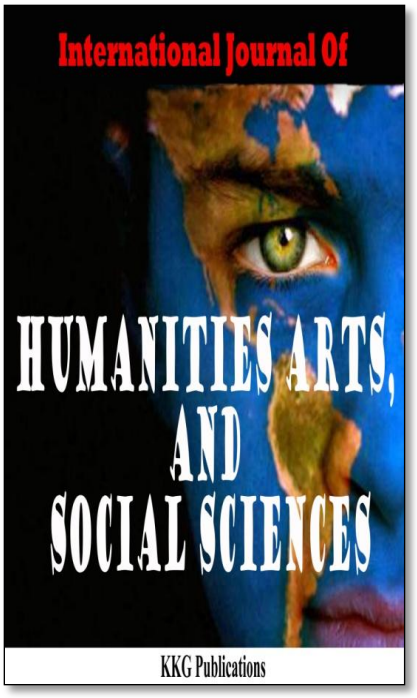

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TOWARDS PREDICTING THE WALKABILITY OF PEDESTRIAN RAIL COMMUTERS IN KUALA LUMPUR CONURBATION

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Abstract. The issue of climate change and global warming has brought significant impact on human lives. One industry that contributes to the present global warming is the transportation industry. The increase in the demand for travel in urban areas has led to the increase in the number of private vehicles thereon leading to the further increase in the amount of greenhouse gas emissions particularly that of carbon dioxide (CO2). In line with this and towards increasing the public transport patronage, there need to be more focus on a more environmental-friendly form of transportation. For the pedestrian commuters who walk to the rail stations and continue their work trip by rail, good quality walkways and weather also play an important role towards influencing their travel decisions and their willingness to walk. Accordingly, the main objective of this study is to measure the extent of the relationship of physical environment, weather, safety and the rail level of service to the walkability of rail pedestrian commuters to transit station. This cross-sectional study examines the travel behaviour of the commuters who walk from their apartments to the commuter stations located within the Transit Planning Zone (TPZ) area of the Kuala Lumpur Conurbation (KLC). By conducting a purposive sampling on 301 respondents and through regression analysis, the study found that rail level of service makes the largest impact on walkability followed by weather, safety and last physical environment. Only rail level of service was a significant predictor of the walkability. It is hoped that with these findings, the planning of the future TPZ concepts will allow a better incorporation of the needs of pedestrians and its influence on the demand of rail services thereby leading to a more sustainable and integrated form of transport system.

INTRODUCTION

Walking is a basic form of transportation. Almost all journey trips constitute a distance of walking such as from home to transit stop, from parking space to transit station and from transit station to office buildings. This kind of non motorized transport (NMT) form which consists of walking and cycling yields it owns benefits such as mitigate the congestion level in the city centre, lessen the carbon footprint from motor vehicles, accidents and reduce travelling stress to achieve optimum productivity of a worker.

Walking as a physical activity not only decreases the urban transport problems, but also helps to curb the health related problems that are commonly faced by everyone such as obesity, stress, diabetes, heart disease and tiredness.

With new technologies in vehicles that make journey faster from one place to another, this form of basic transportation is however losing its popularity.

Further to that, the concept of land use that separates housing areas with working places where people need to travel longer distance to reach their work place, creates dependency on private vehicle especially in major urban areas around the world. Due to the high bad impact of environmental degradation created by the huge volume of cars on the roads, researchers and other environmental conscious stakeholders have come out with the evidences on the benefits of walking and continue to study on the factors relating to the propensity to walk.

This study accordingly attempts to address the issue towards increasing the share of the rail based public transportation via good walkability environment.

Kuala Lumpur Transport System

Being the main economic region of the Peninsula Malaysia, the 504,000 hectare of the Kuala Lumpur Conurbation (KLC) covers the major cities and the core urban areas within the west coast of the peninsula.

It is expected that the KLC will represent a total population of 8.46 million or 32.0% of the Peninsular Malaysia by the year 2020 (Ministry of Housing and Local Government (MHLG),

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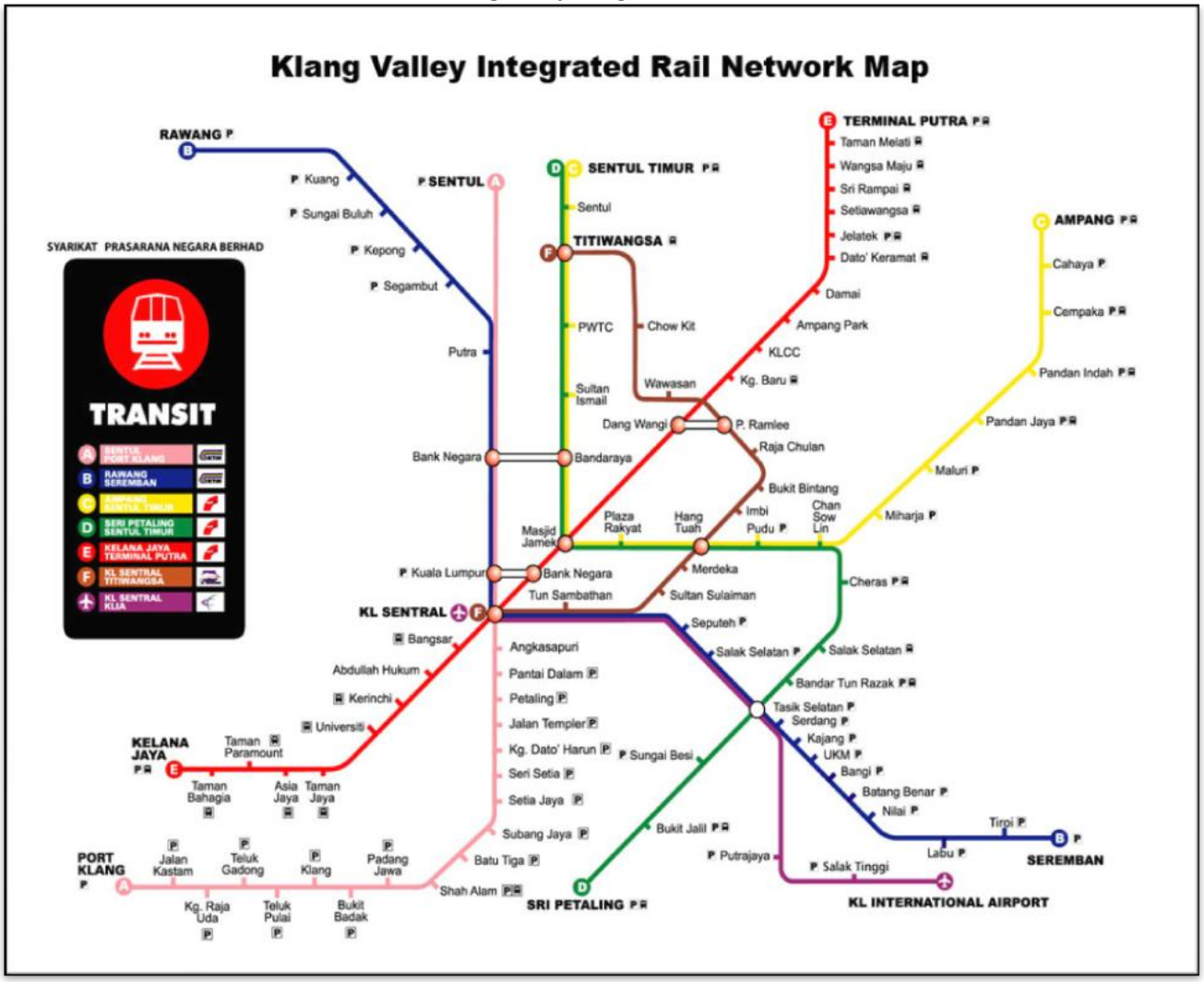
2005) of both the rail-based and the bus-based transportation system. Figure 1 below illustrates the transport network for (KLC, 2010). A geographic region of such rapid development inevitably has the country's main transportation hub comprising

FIGURE 1
Klang Valley Integrated Rail Network



Source: Kuala Lumpur City Hall (KLCH) (2005)

Public transportation in KLC is mainly wholly-owned by the government company known as Prasarana Malaysia Berhad (Prasarana). Currently Prasarana is the asset owner and the operator of the country's two LRT networks (the Kelana Jaya and the Ampang LRT line) as well as the KL Monorail, in addition to the bus services of RapidKL, RapidPenang and RapidKuantan. Another main rail transport operator is KTM Komuter, under the entity of the Keretapi Tanah Melayu Berhad (KTMB). It serves the country's 157 km rail commuter services through 50 stations. KTM Komuter provide services that consist of two lines, namely Sentul–Port Klang and Rawang-Seremban. The commuter services serve population that live farther away from city centre via rail services and can be considered as important transport services to access the city centre. Table 1 shows the features of the existing KLC rail network. KTM Komuter serves population that live farther away from city centre via rail services and can be considered as important transport services to access the city centre.

The land transport system that encompasses both the road and rail-based as well as that of the public and private sector is governed by the Land Public Transport Commission (LPTC) (2011) (Suruhanjaya Pengangkutan Awam Darat–SPAD) that was set up in 3rd June 2010. The main aim of SPAD is to achieve safe, reliable, efficient, accessible and sustainable form of

transport system. SPAD provides framework for the development of land transportation for the Greater Kuala Lumpur/Klang Valley region which is one of the National Key Result Area (NKRA) in the Government Transformation Programme (GTP).

TABLE 1
Existing Rail Network

Rail Line	General Rail Category	Route Length	No. Of Stations	Peak Hour Headway	Current Daily Ridership
KTMB Komuter	Suburban Rail	157 km	50 Stations	15 min	95,000
Kelana Jaya (Putra) LRT1	Urban Rail/Metro	29 km	24 Stations	3 min	160,000
Ampang (Star) LRT2	Urban Rail/ Metro	27 km	25 Stations	3-6 min	141,000
Monorail	Urban Rail/ Metro	8.6 km	11 Stations	5 min	57,500
KLIA	Suburban Rail/ Airport Express	57 Km	5 stations	15 mins	11,000
Total		278.6 km	115 stations		464,500

Source: LPTC (2011)

The Concept of Transit Oriented Development (TOD) and Transit Planning Zone (TPZ)

Transit Oriented Development (TOD) is gaining its popularity as the best transport planning strategy to reduce number of urban traffic problems. TOD supports smart growth development and is proven to be able manage urban mobility efficiently. TOD can be defined as 'moderate to higher density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment and shopping opportunities designed pedestrian without excluding the auto. TOD can be new construction or redevelopment of one or more buildings whose design and orientation facilitate transit.

TOD concept has been successful in curbing urban sprawl in the city centre and has improved transit patronage. Numerous researches has been done in proving the successfulness of TOD in metropolitan area where rail transport has become the most accessible mode like US (Cervero & Gorham, 1995; Renne, Wells, Voorhees & Bloustein, 2005). Hong Kong and Singapore. Research by Cervero and Gorham (1995) in a TOD neighborhood demonstrates that people who live within quarter to half mile from transit station is five times higher to use the public service compared to other neighbourhood. Renne et al., (2005) conducted a study on 12 TODs regions in United States and has revealed that public transit share in these areas increased by 11 percent compared its surrounding regions that showed decrease in transit commuting by 63 percent. Similar study also demonstrated that vehicle ownership among TOD region is lower (37.3 percent) compared with household in non-TOD (55.3 percent) owned two or more cars. One of the core aspects of TOD is good pedestrian network where residents live within 450 metres from rail station and can easily access to the public transport. In other words, the concept must create an environment that encourages walkability and increase transit users. Along with TOD is the concept of Transit Planning Zone (TPZ). The Draft KL City Plan 2020 refers Transit Planning Zone

(TPZ) as areas located within 400m radius of a transit station that encompass the a light rail transit (LRT), KTMB Komuter, monorail or a bus rapid transit (BRT) station. According to the plan, within 400m radius, the immediate 250m radius is called Priority TPZ. The concept of TPZ must reflect the features of TOD where it must be dense, with mix land use and good pedestrian environment. The Draft KL City Plan 2020 (KLCH, 2005) has stated the following key guidance of TPZ namely:

(a) land use activities should be transit supportive;

(b) mixed use activities are encouraged within TPZ with street level activities to promote vibrancy and safety in the TPZ;

(c) higher intensity development to support the transit system; and

(d) good urban design that is pedestrian priority.

To date, there are 66 rail network and transit stations in KLC designated as TPZ and Priority TPZ. However not all areas with transit stations are TPZ, this is especially so for established housing areas and conservation areas where land for new development are limited or not available. Most of the gazetted TPZ rail stations within KLC are identified as District Commercial Centres and key employment centres. In has been stated in the GTP Annual Report by PEMANDU (Prime Minister's Department (PMD), 2011) that 72 percent of people

lives within 400 metres from public transport network. The concept of living near rail transit station has contributed a wide range of benefit in terms of economic and social. From economic point of view, the benefits arise in reducing Vehicle Mile Travelled (VMT), low transport expenses, reduce vehicle operating cost and save time. Social benefits can be capitalized in terms of increase liveability and quality of surrounding areas/neighborhood and increase accessibility to job opportunities especially to low and middle group.

The Challenges within the Transport System

Public transport in KLC has been viewed as poor in terms of facilities, service delivery and quality. The fact is reflected in the modal share of public transport to private vehicle of 17:83. Even though the government has introduced a number of sophisticated public transport system namely, LRT, monorail and KTM Komuter but the rail transport service still underutilized (KLCH, 2005). As in the case of the KTM Komuter, statistics indicate that the ridership of KTM Komuter is decreasing for the previous five years as complaints and passengers' dissatisfaction increase towards the services. The rail commuter service currently suffers from frequent breakdown, delay in service and low frequency and availability. Poor accessibility from the surrounding areas, low frequency, slow journey time and poor service delivery are the common problems faced by KTM Komuter users (KLCH, 2005). Despite the many improvements made to the public transport system, the market share of the public transport is nevertheless still low with a ratio of 17:83 compared to that of the private vehicle (KLCH, 2005). KTM Komuter appears to suffer in gaining the patronage even though the number of rail transit stations along its routes very high (50 stations) compare to LRT Kelana Jaya Line (24 stations) and LRT Ampang Line (25 stations). The number of daily ridership for KTM Komuter is only 95,000 compared to Kelana Jaya Line (160,000) and Ampang Line (141,000) (KLCH, 2005). Assessment of public perception towards public transportation in Klang Valley (KV) showed that more than 60 percent of the users are satisfied with the LRT services but only 30 percent are satisfied with the KTM Komuter services (KLCH, 2005). The rail services provided by KTM Komuter have been recorded to have received the highest number of complaints from its users.

Poor accessibility from the surrounding areas, low frequency, slow journey time and poor service delivery are the common problems faced by KTM Komuter users. In addition to all of the above issues, trips to the city centre for both the morning and the afternoon rush hours are being monopolized by the private vehicles. It is reported that 3 million private vehicles from the surrounding areas enter the city centre during peak hour daily and that there will be an increase of about 500,000 private vehicles in KLC in by 2020 (KLCH, 2005). Influx of commuters is also very strong from suburban areas of Klang, Shah Alam and Petaling Jaya to Kuala Lumpur where the figure can reach at 170,000 in morning peak hour. This situation has led to severe traffic congestion on the roads. These challenges will be further added with the expected increase in the population of the Klang Valley by 10 million in 2020, from 6.3 million in 2010 (LPTC, 2011) in the Greater Kuala Lumpur/Klang Valley–Land Public Transport Master Plan. Suburban areas such as Shah Alam, Klang and Petaling Jaya are expected to have relatively high population growth then.

To overcome the current phenomenon in the urban traffic problem, the government has introduced the National Land Public Transport Framework and discussed in the Government Transformation Programme (GTP) as one of the NKRA. To achieve quality public transport delivery the NKRA has aimed on these goals, namely to:

1. Raise modal share
2. Improve reliability and journey times
3. Enhance comfort and convenience
4. Improve accessibility and connectivity

Rail transportation will become the most prominent and efficient mode of transport to manage the mobility of people in KLC especially during peak hour. In 2020, according the Kuala Lumpur Structure Plan 2020 on Greater KL/Klang Valley Region, the government will give priority to enhance the accessibility to public transport via more extension of rail network. KTM Komuter will be given priority since its serves longer distance to the suburban areas. It is targeted that with the extension of the service will enhance the service quality, frequency and journey time. It is also expected the headway for KTM Komuter is about 5 minutes.

The report on Greater Klang Valley/Kuala Lumpur Public Transport Master Plan (LPTC, 2011) has identified that one of the main problems relating to the use the public transport in residential areas even among the TPZ neighbourhood is very poor accessibility. This evidence is supported in the findings in Kuala Lumpur Structure Plan 2020 that there are a major deficiency of pedestrian linkage and generally lack of walking amenities in city centre. In many places within the city centre the pedestrian link between the major road and rail infrastructure is disconnected even though it is physically close but virtually inaccessible to each other.

The rail-based public transport is far less accessible than bus services and ability to service patrons in a single trip from origin to destination is very limited. A study undertaken by (Almselati, Rahmat & Jaafar, 2011) has validated that transport facilities in Malaysia is still very poor due to improper planning and design and that less consideration is given especially to pedestrian and non-motorization aspect.

Accordingly, this study attempts to examine the aspect of accessibility of people living within the 400 metres from rail transit stations. The general objective then of this study is to examine the walkability of the neighbourhood around the rail stations in accessing the rail transport service with particular

attention to KTM Komuter services while the specific objective of this study is to examine the extent of influence of environmental attributes (physical, weather, safety and rail level of service) on walkability to transit stations.

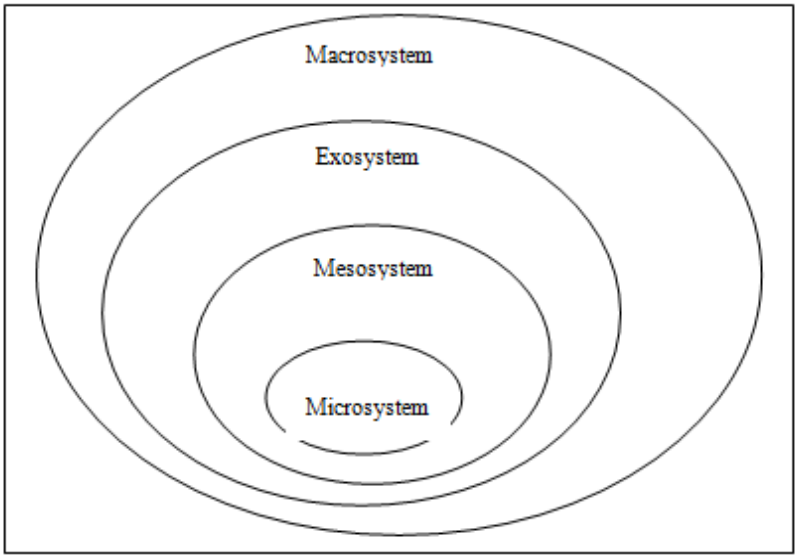
PREVIOUS FINDINGS

The Concept of Walkability

Within the public health field, walking is indeed very much related to physical activity. Accordingly, this study is grounded on the Ecological Model as an essential guide to design the effective attributes to increase physical activity. Bronfrenbrenner (1994) introduced the Ecological Model in 1970's, and the theory thereon has developed and evolved as an extended theory. In 1994, the model was established and has been widely used in research relating to human development. Brenfrenbrenner (1994) stressed that to understand human development and behaviour, one must consider the entire ecological system within the human growth. The system is composed of microsystem, followed by mesosystem that focus on the person as a central core, exosystem and lastly macrosystem. Figure 2 illustrates the model.

Microsystem is a pattern of activities, social roles, and interpersonal relations experienced by

FIGURE 2
The Ecological Model



Source: Bronfrenbrenner (1994).

the developing person in a given face-to-face setting with particular physical, social, and symbolic features that invite, permit, or inhibit engagement in sustained, progressively more complex interactions with, and activity in, the immediate environment such as family or workplace setting. Mesosystem comprises of the linkages and processes that take place between two or more settings containing the developing person eg between home and work place. Exosystem comprises of the linkages and processes that take place between two or more settings, at least one of which does no contain the developing person, but in which events occur that indirectly influence processes within the immediate setting in which the developing person lives. The final layer called the macrosystem consists of the overarching pattern of micro, mesosystem and exosystems characteristics of a given culture or subculture, with particular reference to the belief systems, customs, life-styles and life course options that are embedded in each of these broader systems. It may be regarded as a societal blueprint for a particular culture or subculture. Sallis et al. (2006) in her work, has developed a framework of an active living (recreation, transportation, occupation and household) based on the Ecological Model with the aim of examining the characteristics of environmental attributes that encourage or deter ones physical activity. The model represents the multi level of influence around few main components namely interpersonal factors (demographic and family situation influenced by its surrounding perceived environment such as accessibility, convenience, perceived time, attractiveness and safety that reflect the level of physical activity of an individual), intrapersonal factors (eg. social support) as well as social and cultural environments.

Victoria Transport Planning Institute (VTPI, 2011) describes walkability as reflecting the overall walking conditions in an area. It takes into account the quality of pedestrian facilities, roadway conditions, land use patterns, community support, security and comfort for walking. Litman (2011) on the other hand describes 'walking' as the action and 'walkability' refers to the quality of

walking conditions including factors such as the existence of walking facilities and the degree of the walking safety, comfort and convenience. Past studies measured walkability in two ways; high walkability or low walkability of the neighbourhood. This can be done objectively and subjectively. Objective measure uses Geography Information System (GIS) while the subjective measure uses survey to find the perception and preference of the rail commuters' walk from home to transit station.

Walkability also can be measured based on the purpose of the walking, such as walking for transport, walking for recreation or walking as an exercise. A study by Schlossberg, Agrawal, Irvin, and Bekkouche (2007) revealed different reasons why people walk to transit stations. Among the reasons included for relaxing, for health reasons and because walking is the most convenient mode of travel and the cheapest way to travel. Results from the same study also found that morning commuters who walked to rail stations walked longer distance than the conventional planner view (400 metres), tended to search direct routes to minimize distance and time, highly reacted to their safety and walking environment and often followed the similar routes.

Physical Environment

Walking is very much affected with the condition of the built environment of a place. Handy, Boarnet, Ewing and Killingsworth (2002) in her work defines the built environment as consisting of three general components namely land use patterns, the transportation system, and design. Land use pattern refers to the spatial distribution of human activities while transportation system refers to the physical infrastructure and the service that make up the transportation system and that provide the spatial links–or 'connectivity'–between the activities. Design on the other hand refers to the aesthetic qualities of the built environment and overlays both land use pattern and the transportation system, particularly in terms of the design buildings and the design of the streetscape. Design here comprises of the visual details of the built environment, the styles, textures, color, and ornamentation of physical structures.

Pikora, Corti, Bull, Jamrozik and Donovan (2003) has developed a framework for assessing the environmental determinants of walking and cycling. She suggested that there are two factors that might influence walkability in neighborhood namely physical environment and individual. Physical environment consists of functional, safety, aesthetic and destination whereas individual factors include motivation, interest, social/family support and health status. Findings from the study revealed that the most influencing attributes on walkability for transport are continuity, street design, other access point, lighting, surveillance, crossing aids, cleanliness and pollution. Cerin, Saelens, Sallis and Frank (2006) confirmed that the factors the presence of diversity of destination, residential density, walking infrastructure, aesthetics, traffic safety and crime all were positively related to walking for transport related purposes. Among the successful indicator of public transport performance was easy accessibility to the stations. Mode to access the rail transit station varies from those who ride a bus, drive private vehicle, park and ride, feeder service to those who walk. Since walking is the most common mode of transport to access transit station, thus distance has been found to be a very significant factor to rail transport commuters.

In many studies relating to walking to access public transport, it is shown that distance is the primary function in choosing to walk to a transit station. Handy et al. (2002) concluded that distance is more important than design for active transport individuals. Zhao, Chow, Li, Ubaka and Gan (2003) stated that the closer the proximity to transit station, the more likelihood of the residents to use the public transport. Most research commonly accepted that the walking distance to the transit station is 0.25 mile (400 metres). But walking to access rail transport is longer than distance travelled to access bus service. Olszewki and Wibowo, (2005) indicated the distance travelled by most MRT service in Singapore is 608 metres. Study by Fillone (2008) on the other hand found that 50% of LRT commuters who walked to station travelled less than 500 metres. Distance is also used to determine the service area in accessing rail transit stations. Short walking distance from home to transit station can be achieved with grid-pattern route landscape. Gallimore, Brown and Werner (2011) demonstrated in their study that people are more likely to walk to transit station if they live in a block that has more walkable design features. Pikora et al. (2003) conducted a research on neighbourhood environmental factors and correlated it with walking near home. It was found that distance plays an important role in walkability. Respondents who live within 400m in a mixed uses, closed to shops, public transport, local amenities and services are two times higher in terms of their walkability for transport as compared to those who live in less compact area. The work of Koh and Wong, (2013) to some extent concurs with the above previous researchers. Their study explored the factors that influence the decision making to walk to access the MRT stations in Singapore. It was found that the environmental attributes associated with one's decision to walk are distance, infrastructural compatibility factors and personal factors and that distance is the most influential factor. This finding concur with the previous works of (Agrawal & Shimek, 2007). Infrastructural compatibility factors relates to perceive factors, comfort, weather protection, stairs or slope, detour, crowded walkways, security, risk of traffic accident, number of road crossing, scenery and availability of directional sign.

Natural Environment–Weather

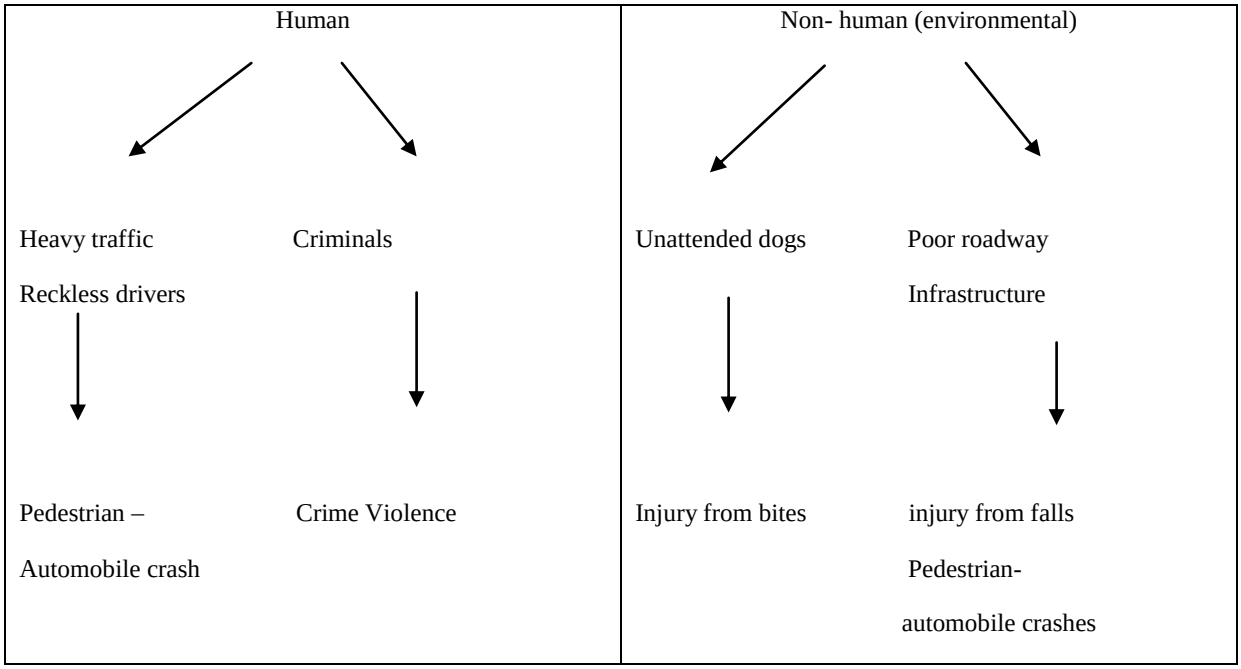
Weather has been indicated to give influence on the physical activity although the effect is not straightforward (Tucker & Gilliland, 2007). According to Nankervis (1999) weather is defined by rainfall and climate variable refers to temperature and precipitation. Alfonzo (2005) stated that people that live in a region that has temperate climate are more motivated to walk as

compared to residents who live in a more frigid climate region. Tucker and Gilliland (2007) in their study on Texas where the population experienced hot and humid temperature reported that there was a decrease in physical activity during summer as compared to winter. In developing countries, although weather is indicated as a barrier to walk (Hook, 2000), the study however found that the average temperature in most Asian cities are about the same as summer in Europe, where walking and cycling are very popular at this time. Thus the streets in hot region need to be shaded and protected from the sun heat (Hook, 2000). Tucker and Gilliland (2007) noted that there is still limited study on the effects of weather on physical activity due to differences ingeographical climate. Hence it is important to encompass this factor in physical activity related research.

Safety

According to Alfonzo (2005), safety refers to whether a person feels safe from the threat of crime. Ross (2000) indicates that people who feel afraid in their neighbourhood are significantly less likely to walk. Loukaitou-Sideris (2005) however noted that perceived risk and fear leads to feelings of lack of safety and might constrain an individual be physically active in their neighbourhood. In the similar article, Loukaitou-Sideris (2006) explained the different sources of dangers from human or non human (environmental) factors that affect an individual decision to walk, as demonstrated in Figure 3 below.

FIGURE 3
Perceived Risks for Pedestrian and Cyclist



Source: Loukaitou-Sideris (2005)

According to Loukaitou-Sideris (2005), pedestrians and cyclists view human factor in terms of heavy traffic and reckless drivers on the road might cause accident and create the risk of crime and violence. From non human factor, fear might come from unattended dogs on the street or walkways that might attack the pedestrians and cyclists and injuries due to poor maintenance of the road infrastructure that might create accident.

Alfonzo (2005) found that environmental attributes that might affect the level of safety among the residents in a particular neighbourhood are from urban form (existence of graffiti, litter, vandalism and poor housing condition), particular land use and the presence of groups hanging around in the streets.

According to Loukaitou-Sideris (2005) incivilities relate to the factor that contributed to perception of risk and fear. Physical incivilities appear when there are abandoned buildings, litter and graffiti. Social incivilities on the other hand occur when there are presence of beggars, panhandlers, homeless and public drunks. In socio demographic factors, gender gives a significant impact towards the propensity to walk. Women are less likely to walk due to them having a higher level of fear (than men) in their surrounding neighbourhood and are likely to be picked up and dropped off especially involving night trips (Kim, Ulfarsson & Hennessy, 2007).

Pikora et al. (2003) and other researchers have found that one of the most important features in physical activities is the link between safety and walking.

Although the results are still inconsistent due to the differences in population and methodology employed in the research (Loukaitou-Sideris, 2005), walking related research activity is still crucial in evaluating the needs of the physical environment in enhancing neighbourhood safety and encouraging walkability.

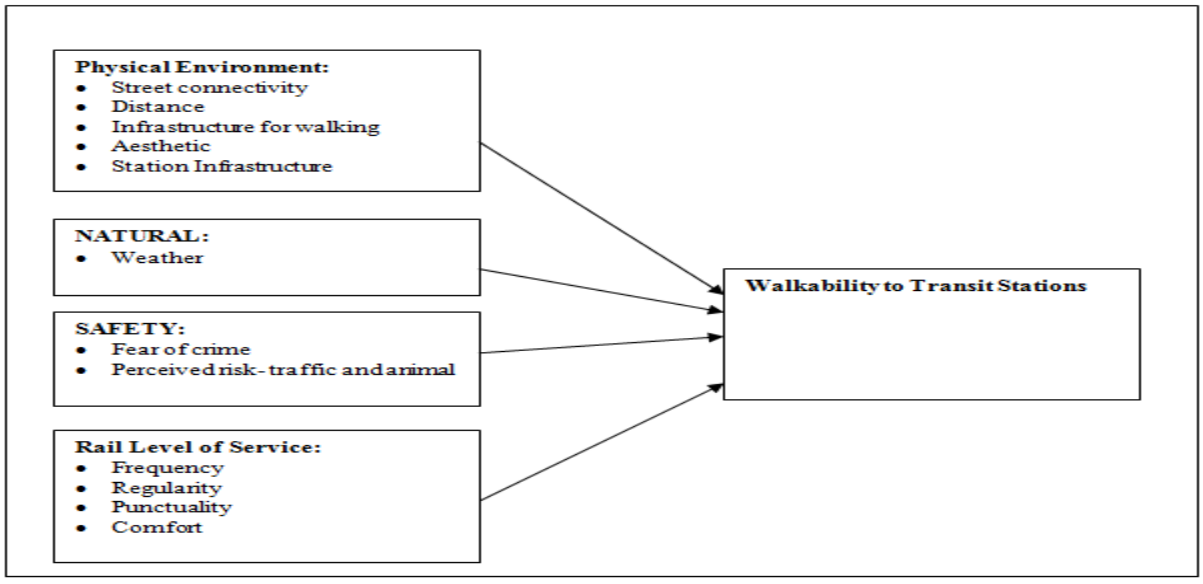
Rail Level of Service

Demand for public transport is very much influenced by fares, quality of service and income and car ownership (Alfonzo, 2005; Pauley et al., 2006). According to their study, fares elasticity has a direct effect on public transport demand and that it varies significantly with mode, time and purpose of journey. Similar study also revealed that the effect of quality of service is dominant with the demand for public transport. These attributes include access time to boarding point and egress time from alighting point, service frequency, waiting environment, reliability, information provision, effect of vehicle and time spent on board the vehicle.

Waerden, Timmermans and Berenos (2008) published their findings where 76.5 percent of the total respondents that traveled by car (longer distance) or bike (short distance) are willing to change to public transport after the implementation of certain measures. The finding concur with the earlier study carried out by (Kingham, Dickinson and Copsey, 2001) on the employees who commuted by bicycle and car in two different companies in Hertfordshire, England. The study concluded that the significant factors that might influence car drivers to shift to public transport to work are quality and efficiency of the service. Improvements in the aspects of frequency, reliability, better connection and convenient drop off point might interest private car users to switch to public transport. On the other hand, comfort and security has lesser interest in the view of the respondents in the study.

Above all, the most important reason as to why private vehicles still out numbered on the road is due to driving own car is too convenient compared to commuting by public transport (Curtis & Headicar, 1997). But similar study reported one would give up their car if improvement is made to tackle the issues of frequency, reliability and cost of public transport. Future research suggested the ease and frequency of availability of transit service is important in walkability study as it is a critical aspect in the travel choice decision (Maghelal, 2007). Based on the above findings, hence the research framework for this study is as shown in Figure 4 below.

FIGURE 4
Research Framework



METHODOLOGY

Research Design

The study is undertaken to identify the demographic profile of rail pedestrian commuters in Kuala Lumpur Conurbation and to examine the correlational relationship between the environmental attributes which consists of physical, weather, safety and rail level of service among the rail pedestrian commuters from their home to the nearest rail station and the walkability of the pedestrian commuters to the transit stations. Prior to that, a pilot study was carried out based on the fifty samples from the selected rail station to ensure the adequacy of the questionnaire is appropriate and correct. This is a study with the main purpose to examine the extent of the relationship between the related variables. It was done within a non-contrived setting, in a natural environment and

on a cross-sectional basis. As the objective of the study is to examine the travel behavior of the pedestrian rail commuters pertaining to the walkability of their first mile, thus the unit of analysis are those respondents who walk from their home (apartments) to the rail stations for the purpose to work or to college and the respondents must be in the age group 18 to 60 years old.

Sampling Design

In terms of sampling design, the population made up all those who stay at the apartments within the TPZ and those who walk to the TOD rail stations with compulsory trips purposes. The study does not have any specific sampling frame and has adopted a purposive sampling technique towards fulfilling the research objectives. The final sample size was 301 respondents.

Instrument

The instrument was designed to evaluate the rail pedestrian perception on the walkability attributes based on their walking experience. The questionnaire consists of two main sections. Section A covers the demographic profile of the respondents while section B evaluates the factors affecting walkability. The items in the questionnaires were assessed based on the 5-point Likert scale with 5 being strongly agree to 1 being strongly disagree. As in the pilot study, the respondents generally also took approximately ten minutes to complete the questionnaire.

Data Collection

Data was collected within three weeks that covered seven stations of the KTM Komuter network on both lines. The actual field study had been carried out involving 350 respondents from selected rail station of the KTM komuter rail network, namely, Batu Kantomen, kampong Batu, Sentul, Segambut, Pantai Dalam, Petaling and Salak Selatan.

Data Analysis

Principal component analysis (PCA) is used to extract dimensions/factors from items used. Table 2 shows the five dimensions or factors extracted fulfilled the requirements for PCA. Firstly, the Cronbach alpha for all variables in each factor is well above the acceptable level of 0.6 (Sekaran & Bougie, 2009). Secondly, Kaiser-Meyer-Olkin (KMO) test which indicates the sufficiency of sample size, is above 0.5 which is deemed acceptable by (Field, 2013). Furthermore, all results from Bartlett's Test of sphericity are significant which indicate the suitability of the data for factor analysis. Finally PCA revealed that all the factors extracted explained between 29 to 42 percent of the variation.

These factors together with selected demography variables are then used in regression analysis to determine the walkability of the pedestrian rail commuters.

TABLE 2
Results from Principal Component Analysis

Variables	Items	Cronbach Alpha	KMO Test	Bartlett's Test of Sphericity X2 (df)	Percentage of Variance Explained
Walkability	16	0.8992	0.901	2140 (120)	42.42
Physical Environment	30	0.8816	0.870	2961 (435)	28.65
Weather	6	0.6384	0.670	226 (15)	35.76
Safety	12	0.7001	0.728	560 (28)	32.44
Rail Level of Service	21	0.8393	0.898	1967 (210)	32.67

FINDINGS AND ANALYSIS

Background of Respondents

Slightly less than three quarters of 301 respondents interviewed are female and only about one third of them are more than 30 years old. About one fifth of them reported that they do not have any income with about half of them earn less than RM2000 per month. A third of them earn between RM2000 to RM4000 per month. This reflects the normal economy background of Malaysian train commuters which are normally from lower income group. At the same time only one third of them reportedthat they are currently not working. Although, two thirds of respondents reported they are working but only about 27

percent of them own a private car. In term of walking to transit rail station, only about a quarters of them are walk more than once a week. Majority of them only walk to the transit rail station once a week or once in two weeks. Nevertheless, majority of respondents (74 percent) and the rest of them are using some form of public or private vehicles to reach their final destination.

TABLE 3
Background of Respondents

	Percentage	Frequency
Age		
Less than 20 years old	22.6	68
21 to 30 years old	51.5	155
31 to 40 years old	16.9	51
More than 40 years old	9.0	27
Gender		
Female	71.1	214
Male	28.9	87
Income Group		
No Income	19.3	58
Low Income Group	45.5	137
Middle Income Group	30.6	92
High Income Group	4.7	14
Work Status		
Not Working	28.6	220
Working	71.4	81
No	73.1	220
Yes	26.9	81
Frequency of Walking to Transit Rail Station		
Rarely	15.0	45
Once in one or two weeks	59.5	179
2 to 3 times a week	16.3	49
More than 3 times a week	9.3	28
Walking to final destination		
Walking	73.8	222
Vehicle assisted	26.2	79
Total	100	301

TABLE 4
Determinants of Walkability to Transit Stations

	Model 1	**Model 2**
Physical Environment	0.011	0.003
	(0.088)	(0.089)
Weather	0.206	0.178
	(0.137)	(0.144)
Safety	0.139	0.119
	(0.107)	(0.114)
Rail Level of Service	0.472	0.487
	(0.095)**	(0.098)**
Gender (0=female. 1= male)		0.101
		(0.317)
Working Status (0=non working; 1 = working)		0.667
		(0.554)
Own a Car (0=No; 1 =Yes)		0.305
		(0.377)
Walking to final destination (0= Walking, 1= vehicle assisted)		-0.504
		(0.306)
Age–21 to 30 years old @		-0.572
		(0.422)
Age–31 to 40 years old @		-0.097
		(0.585)
Age–Above 40 years old @		-0.745
		(0.648)
Low income @		-0.145
		(0.521)
Middle Income @		-0.836
		(0.641)
Higher Income @		-0.100
		(0.872)
Frequency of walking to Rail Station–Once in every 1 or 2 week @		0.440
		(0.535)
Frequency of walking to Rail Station–2 to 3 times a week @		0.521
		(0.371)
Frequency of walking to Rail Station–More than 3 times a week @		0.546
		(0.609)
Constant	-0.066	-0.220
	(0.142)	(0.419)
Observations	211	211
R-squared	0.41	0.44

Notes:

I) Robust standard errors in parentheses

II) + significant at 10%; * significant at 5%; ** significant at 1%

III) @ The control group for Age is aged below 20 years old, for income is no income, and the control group for frequency of walking to rail station is very rarely.

IV) The total complete cases are only 211 although total respondents are 301.

Using regression analysis (Table 4), the results from model 1 (which only include four factors) and model 2 (which include selected demography variables into the four factors) show that the only rail level of service is significant in influencing the walkability of commuters.

This is probably due to the fact that majority of the commuter users who walk to train station rely mainly on rail transport as their sole means of transport due to their economy and financial background. Therefore if the rail level of service is deemed the most important factor influencing rail commuters' decision to walk to rail stations, hence it not surprisingly to note that neither weather and safety nor physical environment plays any significant roles in influencing walkability. Furthermore model 2 shows that none of the selected demography variables have any significant impact on walkability.

DISCUSSION

This paper examined the travel behavior of the pedestrian rail commuters relating to the walkability of their first mile being those who walked from their home (apartments) to the Transit Planning Zone (TPZ) rail stations that are located within the Kuala Lumpur Conurbation (KLC) of the Transit Oriented Development (TOD) range. This study targeted those who were on compulsory trips to the city centre i.e for work purposes or to college/universities and the respondents were in the age group of 18 years ole to 60 years old.

Seven (7) selected stations within the TPZ were chosen as the study area. The four main dimensions relating to the study are the physical environment, the weather, the safety aspects from the apartment to the rail stations including within the station area while the dependent variable is the walkability of the pedestrian commuters who walk from their home (apartment) to the nearby transit station.

This study found out that the rail level of service gave the most significant influence on the walkability of the pedestrian commuters. This concur with the findings of the study by Maghelal (2007) that indicated the rail level of service in terms of ease and frequency of of the transit service as important in walkability study as it influence one's travel choice decision. This may perhaps be attributed to the fact that rail is considered the most convenient form of transportation relative to other modes of transport. The fact that rail has the characteristics of having its own right-of-way itself indicates that there is no congestion on the part of the railway services to its destination. As compared to the bus services, they are subjected to the relatively severe congestion on the roadways and highways. This is particularly so for the fact that two thirds of the total respondents are working pedestrian commuters.

The factors on safety can be considered relatively safe in most of the TPZ and the stations as most terminal points now have the presence of security guards, CCTV and reasonably good street design that accommodates safety and security features. Most Malaysians are used to bracing through the tropical weather of rain and shine, hence the no significant aspect of the physical attributes and the weather.

This study was based on a relatively small sample size. Although the sample may not be representative of the general population, it included a cross-section of the pedestrian commuters within the TPZ area of the dominant parts of the TOD within the KLC. Future studies may consider covering more of the TPZ stations with a relatively larger sample size.

CONCLUSION

This study has attempted to explore the extent of the relationship between the physical environment, the weather, safety and the rail level of services and the walkability of the pedestrian commuters of the TPZ station areas within the KLC TOD area. The findings of this study would provide an important aspect towards the future planning of the rail stations as well as the land use aspects of the TPZ within the Kuala Lumpur conurbation of the Transit-Oriented Development scope.

The enhancement towards the rail level of service would undoubtedly further encourage more pedestrian commuters in the future to take rail as their preferred mode of travel to work as compared to using their private vehicles. This would inevitably support the government's agenda towards a more sustainable form of transportation and eventually provide the whole community a better environment to live.

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