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The Relation between Objective and Perceived Physical Characteristics of a Neighbourhood Environment for Older People

Nadhirah Nordin [1], Hitoshi Nakamura [2]

[1] Graduate School of Science & Technology, [2] Department of Planning, Architecture & Environment Systems,
Shibaura Institute of Technology, Japan

na17507@shibaura-it.ac.jp, nakamu-h@shibaura-it.ac.jp
Tel: +8180-8836-9979

Abstract

This paper aims to investigate the relation between objective and perceived neighbourhood walkability and its influence on the physical activity level of older adults. The relationships were used to measure older people's neighbourhood liveability, whereas physical activity relates to older people's quality of life in Johor Bahru neighbourhoods, Malaysia. The study outcomes show residents in a highly dense area with higher accessibility to facilities perceived higher walkability but showed a lower physical activity level. Residents in high intersection density areas who recognised high walkability demonstrated higher physical activity level, whereas residents in a highly dense area with higher accessibility show lower physical activity level.

Keywords: Active ageing; physical neighbourhood environment; neighbourhood liveability; quality of life

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1.0 Introduction

Malaysia, as one of the fast-developing countries in Southeast Asia, is progressing slowly towards an ageing society. Most developed nations like France experiences longer years of progressing towards an ageing society, whereas developing countries like Malaysia only took less than 20 years to advance to an aged community (Hedrich et al., 2016). Data in previous years shows that elderly percentage in Malaysia is 6.2% in 2017 and forecasted to increase to 14.7% in 2040 (Department of Statistics, 2017). The starting point for an ageing society accounts as 7% of the ageing rate, 14% as an aged society, and 21% as a super-aged society (Okamura, 2016). The gradual increase of the elderly population in Malaysia throughout the years illustrated Malaysia as experiencing a fast-paced ageing trend

2.0 Active Ageing

Active ageing is integral for maintaining a healthy lifestyle, especially among older people and retirees. This concept promotes behaviours that lead to higher life expectancies and better quality of life by becoming physically fit and active, nurturing older people well-being and active engagement in the community besides maintaining a healthy mental state (WHO, 2002). The determinants of active ageing such as social, structural and material determinants affect older people who constitute a self-sustained community. Older people especially retirees tend to have more time for themselves, where they can devote more leisure time to developing themselves physically, socially, mentally & spiritually. Recent studies have shown that older people who are more engaged in the social relationship are usually more involved in leisure activity, which in return can improve their mental health (Chang, Wray, & Lin, 2014).

The starting age of older people can be defined at the age of 65 years old in most developed countries whereas 60 years old in most developing countries, which is generally regarded as the starting of the retirement period (WHO, 2002). In Malaysia, the starting age of

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older people is categorised at the age of 60 and above (Zawawi, 2013) whereby 7.7 percent of the total population in Malaysia is comprised of older people aged 60 and above (Elsawahli, Ahmad, & Ali, 2016). Also, older people can be categorised as the young-old (65 – 74 years old), old-old (75 – 84 years old) and oldest-old (85 years old and above) (Lee et al., 2018). However, for this study, the young and late middle-aged adults (45 – 49 years and 50 – 59 years) are included as they will soon enter 60 years old and is predicted to show variation in the findings that will be discussed later on.

2.1 Liveability and Quality of Life in the Physical Neighbourhood Environment

A conducive environment which supports mobility through inclusive neighbourhood design impedes the well-being of older people from deteriorating over time. With the increasing demographic transition of older people in Malaysia, it is pertinent to address the importance of a conducive neighbourhood environment in order to facilitate older people in becoming physically active through their level of physical activity. The ability to spend time outside to perform physical and leisure activity apart from undertaking social activities help in maintaining older people's well-being (Curl et al., 2016). In an ageing population, an unsupportive environment may reduce the ability to spend time outside their homes. Conversely, good design of streets and pedestrian environments can contribute to support for healthy activity into old age and thus enhance the health and well-being of elderly people through inclusive and extensive neighbourhood planning.

Neighbourhood liveability consists of tangible elements such as public infrastructure and open spaces, as well as intangible elements such as a sense of place and strong social connections among the community living in an area (Throsby, 2005). These elements consist of objective neighbourhood environment that represents the existing land uses at present and the subjective neighbourhood environment that regards the perceived assessment of the respondents towards their neighbourhood environment. A study conducted in Subang Jaya, Malaysia demonstrated the essential dimensions of neighbourhood liveability which are social networks, physical environment, availability and access to infrastructure and services, and safety from crime (Hashim & Leby, 2010), which reflects the importance of objective and subjective neighbourhood environment.

Furthermore, highly walkable neighbourhoods show a significant relationship with higher physical activity among its dwellers (Lu, Xiao, & Ye, 2017; J. F. Sallis et al., 2012). This signifies the neighbourhood environment as an essential element in promoting residents to walk. Thus, it is pertinent to promote walking to older people since their daily routine includes walking for leisure activities that help facilitate their physical activity (Mobily, 2014) which in return will improve their quality of life. Consequently, the association between the physical environment and the subjective evaluation by the population in a settlement plays a distinctive role in determining the quality of life, especially among older people. The high-density neighbourhood does not necessarily mean high walkability, where the perception of its residents functions as an essential role that also affects their level of walkability.

The main objective of this paper is to investigate the relationship between the physical components of the neighbourhood environment (ONE) and the perception of the neighbourhood environment by the residents (PNE) and how these relationships affect older people's level of physical activity. There is quite a large number of literature discussing on the suitable neighbourhood environment for older people in Malaysia and how the housing policy can help improve the neighbourhood environment (Tobi, Fathi, & Amaratunga, 2017). However, until recently, there is limited research conducted to investigate the relationships between ONE and PNE that can influence older people's level of physical activity. The outcome of this paper is to examine briefly how these relationships may have affected the trends of total physical activity among the respondents in the chosen study area.

3.0 Methodology

The purpose of this study was to evaluate the objective and perceive measures of the neighbourhood environment to analyse their combined relationships among elderlies in Johor Bahru, Malaysia. The present study involved an analysis of three similar neighbourhoods in Johor Bahru, Malaysia, each of which consists of two-storey terraced houses and several storey apartment buildings: Taman Perling, Taman Nusantara and Taman Selesa Jaya. The land use maps for each neighbourhood can be seen based on Figure 1, 2 and 3 in the next page.

A questionnaire survey was administered to 280 elderly respondents (aged 45 and above) in the three neighbourhoods to measure perceived measures of the neighbourhood walkability. The questionnaire combines demographic attributes, perception of neighbourhood walkability and physical activity. The first part includes respondent's demographic characteristics, the second part consists of 4-Likert scales of perceived physical neighbourhood measures based on the Neighbourhood Environment Walkability Scale (NEWS-A) questionnaire which was developed by Saelens & Sallis (2002), and the third part consists of physical activity measures based on a widely recognised questionnaire to measure physical activity level which was the International Physical Activity Questionnaire (IPAQ) developed by (Craig et al., 2003). Respondents with the age of 45 are included as they are regarded as young, middle-aged people who will soon enter the late-middle-aged which is 50 years old. Besides, late middle age respondents from 50 – 59 years old are also included in this study since they will soon enter 60 years old. These age groups are considered since they are expected to show significant results later in the future which is not for this study. Table 1 shows the simple summary of demographic attributes which consists of gender and age items as well as the housing types of the respondents. Among the respondents aged from 45 years old to 75 and above, the average age for the three neighbourhoods are about 60 years old, where the highest portion represents residents from the age group of 60 - 64 based on Table 1 in the next page.

Table 1. Questionnaire items on the study population and their respective housing types based on the three neighbourhoods, *N (%)*

Part A: Demographic Attributes	Taman Perling (n = 139)	Taman Selesa Jaya (n = 57)	Taman Nusantara (n = 84)	Total respondents *(n = 280)*
Gender				
Male	80 (57.55)	40 (70.18)	54 (64.29)	174 (62.14)
Female	59 (42.45)	17 (29.82)	30 (35.71)	106 (37.86)
Age (years), mean, SD	59.62 ± 4.09	62.16 ± 1.53	59.71 ± 2.96	60.16 ± 6.96
Age				
45 – 49	8 (5.76)	0	1 (1.19)	9 (3.21)
50 – 54	21 (15.11)	4 (7.02)	18 (21.43)	43 (15.36)
55 – 59	38 (27.34)	15 (26.32)	18 (21.43)	71 (25.36)
60 – 64	42 (30.22)	20 (35.09)	31 (36.9)	93 (33.21)
65 – 69	18 (12.95)	11 (19.3)	10 (11.9)	39 (13.93)
70 – 74	9 (6.47)	6 (10.53)	4 (4.76)	19 (6.79)
75+	3 (2.16)	1 (1.75)	2 (2.38)	6 (2.14)
Housing types, *N (%)*				
High-rise apartment	0	2 (3.51)	0	
4-storeys flats	49 (35.25)	0	0	
5-storeys flats	9 (6.47)	0	0	
6-storeys flats	1 (0.72)	0	0	
1-storey low cost terrace	1 (0.72)	55 (96.49)	0	
2-storeys low cost terrace	79 (56.83)	0	84 (100.00)	

Source: Author's Findings

Figure 1: Land use map for Taman Perling
Source: GIS Data from Iskandar Malaysia Regional Development Authority (2012)

Figure 2: Land use map for Taman Selesa Jaya
Source: GIS Data from Iskandar Malaysia Regional Development Authority (2012)

Figure 3: Land use map for Taman Nusantara

Source: GIS Data from Iskandar Malaysia Regional Development Authority (2012)

3.1 Perception of Neighbourhood Walkability (PNE)

Neighbourhood Environment Walkability Scale (NEWS-A) questionnaire was used to explore the resident's perception of neighbourhood design features that can influence their level of physical activity (Saelens & Sallis, 2002). Consequently, level of walkability was associated with an increase of physical activity level (Mena et al., 2017). An explanation of the PNEs items and the sub-items in the combined questionnaire as reflected in Table 2

Table 2: Items in the NEWS-A questionnaire (PNEs)

Part 2: Perceived Measures based on NEWS-A questionnaire	Sub-items
A. Residential density	Types of residence: Bungalow, Terrace, Semi-detached, Apartment 1 – 3 stories, Apartment 4 – 6 stories, Apartment 7 – 12 stories, Apartment more than 13 stories
B. Diversity of land use mix	Distance to each destinations (minutes): Grocery store, supermarket, worship places, bus stop, coffee and restaurant, clinic, food stall, park and playground, community hall, night market, wet market
C. Accessibility	'Stores are within walking distance from home', 'Many places to go within walking distance from home', 'Walking to bus stop from home is easy'
D. Street connectivity	'Distance between traffic intersections are 100 or less' 'There are many alternative routes to get from place to place'
E. Infrastructure for walking and cycling	'Presence of sidewalks on most of the streets', 'Presence of grass strips that separates the streets from the side', 'Neighborhood streets are well lit at night', 'Residents can easily observe pedestrians and bikers on the streets', 'Presence of crosswalks and pedestrian signals'
F. Aesthetics	'Presence of trees along the streets', 'Many interesting things to look at while walking', Many attractive natural sights and good landscaping', Many attractive building and homes'
G. Safety from traffic hazards	'Heavy traffic makes it difficult to walk in the streets', 'Traffic speed on the street near home is slow 25km/h', 'Most drivers exceed the posted speed limits while driving in the neighbourhood'
H. Safety from crime	'High crime rate in the neighborhood', 'Crime in the neighborhood makes it unsafe to walk in the day', 'Crime in the neighborhood makes it unsafe to walk in the night'

Source: Neighbourhood Environment Walkability Questionnaire (NEWS-A), (Saelens & Sallis, 2002)

The objective of item A is to measure resident's perception of residential density, based on the scoring weightage of NEWS-A (J. Sallis, Black, & Chen, 2002). Higher numbers of residential density constitute higher walkability. For the other items, the scale range consists of 'Strongly Disagree, Disagree, Not Sure, Agree, and Strongly Agree'. Several additions are included in the questionnaire item B to adapt to the Malaysian neighbourhood environment such as places of worship, night markets, wet markets and clinics (M & Lee, 2018). Furthermore, food stalls in the neighbourhood area are also included since it is logical to regard this as a component supporting social liveability in a Malaysian neighbourhood based on the pilot survey performed previously. Before the detailed results of the questionnaire

Table 3. Questionnaire items on the study population and their respective housing types based on the three neighbourhoods, *N (%)*

Part 2: Perceived Measures based on NEWS-A questionnaire	Taman Perling *(mean, S.D.)*	Taman Selesa Jaya *(mean, S.D.)*	Taman Nusantara *(mean, S.D.)*
A. Residential density	245.56, 77.25	422.16, 93.55	196.93, 0.65
B. Diversity of land use mix	2.29, 0.88	1.82, 0.32	3.05, 1.31
C. Accessibility	3.05, 0.37	2.74, 0.58	2.48, 0.63
D. Street connectivity	2.91, 0.53	2.79, 0.38	2.24, 0.95
E. Infrastructure for walking and cycling	2.84, 0.39	2.87, 0.18	2.42, 0.45
F. Aesthetics	2.79, 0.56	2.60, 0.37	2.27, 0.49
G. Safety from traffic hazards	2.71, 0.52	2.34, 0.37	0.84, 0.34
H. Safety from crime	1.84, 0.57	2.17, 0.66	1.96, 0.57

Source: Author's Findings

3.2 Objective Measures on Neighbourhood Environment (ONE)

Geographic Information System (GIS) datasets such as land use, transportation networks, and public facilities were combined and analysed to assess the objective physical measures of the neighbourhood environment. The analysis covered items such as population density, the proximity of neighbourhood attractions, and accessibility of traffic and pedestrian networks. The population density in Johor Bahru City is based on the Johor Census Data obtained from the Department of Statistics, Johor. The data can be illustrated through smaller sub-districts. According to an existing ArcGIS project on population density in Iskandar Malaysia (a broader region that includes Johor Bahru City), the highest range of population density would preferably be from 30,000 to 150,000 people per square kilometre. A moderately high population density range would be 7000 people per square kilometre and above, whereas a slightly high-density range would be from 5,200 people per square kilometre. Medium and low population density range starts from 3,330 and 1,500 people per square, respectively (Bell, 2017).

To measure accessibility, distance from each respondent's road address to three types of common facilities in the three neighbourhoods were analysed using ArcGIS. The basic facilities include worship places such as mosques and temples, schools, and playgrounds. The distance of facilities was categorised into six categories, which are 0 – 100m, 101 – 200m, 201 – 300m, 301 – 400m, 401 – 500m, 501 - 600m and more than 600m. On the other hand, the density of intersections was analysed using ArcGIS to measure accessibility. The density of intersections is computed as the total number of intersections excluding cul-de-sacs per unit of the area from the centre of the location. A buffer of 200 meters from respondents' homes was assigned for this study. Higher intersection density denotes higher connectivity in the specified area (Dill, 2003).

Table 4 shows a simple summary of objective measures for the three neighbourhoods; namely population density, accessibility of neighbourhood attractions measuring the distance of various facilities to the respondent's homes, and permeability of road network measuring the intersection density.

Table 4. Objective measures of the neighbourhood environment in the three neighbourhoods (ONE)

Objective measures (PNEo)	Taman Perling *(mean, s.d., max, min)*	Taman Selesa Jaya *(mean, s.d., max, min)*	Taman Nusantara *(mean, s.d., max, min)*
A) Population density (population/sq km)	8917.31, 6393.45, 30133.3, 773.3	11453.64, 4004.63, 18669.69, 2413.27	5157.2, 1349.4, 6688.4, 2861.7
B) Distance to facilities (meter)			
Mosque	338.0, 187.12, 1219.7, 82.51	438.06, 247.91, 1023.2, 134.44	803.28, 328.48, 1368.82, 140.14
School	550.22, 283.93, 1615.92, 66.15	500.38, 234.0, 1259.7, 25.48	1279.56, 540.84, 2128.43, 211.72
Playground	337.38, 177.65, 665.97, 29.27	317.68, 208.11, 920.22, 27.09	329.89, 211.2, 790.9, 36.74
C) Intersection Density (No. of real nodes/area)	461.69, 207.61, 1277.78, 150.79	164.98, 70.42, 297.48, 42.0	151.77, 96.65, 427.21, 33.0

Source: Author's Findings

The last step of the GIS analysis is locating and establishing a spatial reference for each respondent based on their home's road address obtained from the questionnaire interview. The questionnaire datasets containing the demographic attributes of respondent, PNE and PA were layered with the analysis of ONE which includes population density, accessibility of road networks measuring the distance of various facilities, and permeability measuring intersection density in the three neighbourhoods.

3.3 Physical Activity of Older People (PA)

The third part of the combined questionnaire contains physical activity measures, including walking activities, moderate activities and vigorous activities. Based on the IPAQ scoring protocol (Forde, 2005), these activities are computed using Metabolic Equivalent Rate (MET) whereby a median of MET-minutes per week was preferred to compare different values. The data are then categorised as high, medium and low total physical activity based on the three neighbourhoods. Table 5 depicts the simple summary of total physical activity level among the respondents in the three neighbourhoods. Respondents in Taman Nusantara showed the highest total MET-minutes for walking MET and moderate MET, followed by respondents in Taman Selesa Jaya and Taman Perling for both types of MET.

Table 5: Descriptive analysis based on total physical activity level among residents in the three neighbourhoods

Part 3: Physical activity based on IPAQ Questionnaire Items Score	Taman Perling, *N = 139* *(mean, S.D.)*	Taman Selesa Jaya, *N = 57* *(mean, S.D.)*	Taman Nusantara, *N = 84* *(mean, S.D.)*
1. Time spent on walking activities in a week (Walking MET) E.g.: Walking for purpose or recreation	(117.87, 152.21)	(146.76, 202.68)	(282.66, 295.55)
2. Time spent on moderate activities in a week (Moderate MET) E.g.: Recreation & sports activities, leisure activities, community activities	(243.17, 287.07)	(392.28, 408.48)	(502.62, 745.32)
3. Time spent on vigorous activities in a week (Vigorous MET) E.g.: Recreation & sports activities, work-related activities, cycling activities	(660.14, 2612.73)	(519.3, 2320.45)	(675.24, 1442.05)

Source: Author's Findings

Since the aim of the NEWS-A integrated questionnaire is to explore the respondent's perception towards neighbourhood walkability, their daily physical activities need to be understood as well. This is to distinguish how the significant relationships of ONE and PNE may influence the level of total physical activity performed daily in the three neighbourhoods. To find the significant relationships between the objective measures and the perceived measures, chi-square analyses are performed based on the cross-tabulations of each variable of ONE and PNE. The scores for PNE are categorised into low, medium and high scores based on the 25th, 50th and 75th percentiles. The significant relationships are explained in Table 6 in the next section.

4.0 Findings & Discussions

The results of the chi-square analysis show several significant relationships between ONE and PNE as well as similar trends of these relationships across the three neighbourhoods, which can be seen from Table 6. These relationships are among the critical factors that may influence the level of physical activity among the respondents. Based on the findings obtained, further adjusted residual analysis was done to investigate more on the nature of the significant relationships. All three measures of ONE showed substantial results with three measures of PNE, which are resident's perception towards residential density, diversity of land use mix, and street connectivity. Commonly, the residents living in a densely populated area tend to perceive their neighbourhood as having high residential density, as well as the opposite.

Several significant relationships resulted in typical trends of ONE and PNE. For example, it is widely understood that residents living in a highly-populated area tend to perceive only a moderate level of residential density and street connectivity. This scenario is typical especially in low-cost properties specifically affordable housing flats in Malaysian neighbourhoods where Malaysian developers would usually plan to locate affordable housings at the fringe of the neighbourhood boundary to locate medium and high-cost properties in a higher accessible area. Interestingly, the significant relationship demonstrated in Taman Selesa Jaya shows residents living in high population density tend to perceive high street connectivity. This signifies that residents living in strata properties tend to experience higher connectivity when compared to residents living in non-strata properties, where higher connectivity in a highly-populated area can influence the resident's level of physical activity (Cerin et al., 2017) where it is a vital characteristic in most walkable neighbourhood environment (Chiang, Sullivan, & Larsen, 2017).

An unusual trend was observed where residents living further to the school perceived high residential density in Taman Perling. This illustrated respondents living in a highly dense area which are usually in affordable housings might be located further to the school compared to residents living in a less dense area, which may inhibit walking activities among the respondents. Also, residents living nearby to the mosque and playground in Taman Perling and Taman Nusantara tend to perceive low diversity of land use mix and street connectivity. It may be because residents living very near to the mosque may experience barriers within the pedestrian network from their homes to the nearest mosque. Other than that, the presence of longer length of residential terrace blocks where residents may have to walk further to get to an adjacent road can also be an essential factor that contributes to the low perception of street connectivity

which confirms a previous study done by (Voorhees et al., 2010) as well as contradicts findings of an earlier study (Oakes, Forsyth, & Schmitz, 2007).

Table 6: Significant results from the chi-square analyses of different cross-tabulations of the measures

ONE x PNE	Taman Perling, *N = 139, p > 0.05*	Taman Selesa Jaya, *N = 57, p > 0.05*	Taman Nusantara, *N = 84, p > 0.05*
A)Population Density (PD)			
Population density x Score A (Perception on residential density)	X^2 *(8, N = 139) = 65.8* **very high PD, medium A*		-
Population density x Score B (Perception on diversity of land use mix)	X^2 *(8, N = 139) = 19.54* **medium PD, high B*	-	-
Population density x Score D (Perception on street connectivity)	X^2 *(8, N = 139) = 16.17* **medium PD, low D/high PD, medium D*	X^2 *(8, N = 57) = 14.2* **low PD, medium D High PD, high D (preferred)*	-
Population density x Score H (Perception on safety from crime)	X^2 *(8, N = 139) = 17.32* **medium PD, high H*	-	-
B) Distance to facilities (Dist)	Taman Perling *N = 139, p > 0.05*	Taman Selesa Jaya *N = 57, p > 0.05*	Taman Nusantara *N = 84, p > 0.05*
Distance to school x Score A (Perception on residential density)	X^2 *(12, N = 139) = 31.35* **long Dist, high A*		X^2 *(8, N = 78) = 64.0** **long Dist more than walking dist, low A*
Distance to school x Score F (Perception on aesthetics)		X^2 *(12, N = 57) = 11.51* **long Dist, low F*	
Distance to school x Score G (Perception on safety from traffic)	-		X^2 *(8, N = 78) = 323.13** **long Dist, high G*
Distance to mosque x Score A (Perception on residential density)	X^2 *(12, N = 138) = 33.13** **short Dist, high A*	-	-
Distance to mosque x Score B (Perception on diversity of land use mix)	X^2 *(12, N = 138) = 157.29** **short Dist., low B*	-	-
Distance to mosque x Score D (Perception on street connectivity)	X^2 *(12, N = 138) = 20.93** **short Dist, low D*	-	-
Distance to play ground x Score A (Perception on residential density)	X^2 *(12, N = 135) = 46.88** **short Dist, high A*	X^2 *(12, N = 57) = 10.95* **long Dist, medium A*	-
Distance to play ground x Score B (Perception on diversity of land use mix)	-	-	X^2 *(12, N = 79) = 88.67** ** short dist, low B*
Distance to play ground x Score C (Perception on accessibility)	-	X^2 *(12, N = 57) = 15.35* **short Dist, low C*	X^2 *(6, N = 79) = 13.0** **short Dist, low C*
Distance to play ground x Score D (Perception on street connectivity)	X^2 *(12, N = 135) = 43.69** **long Dist, low D*	-	-
C) Intersection Density (ID)	Taman Perling *N = 139, p > 0.05*	Taman Selesa Jaya *N = 57, p > 0.05*	Taman Nusantara *N = 84, p > 0.05*
Intersection density x Score A (Perception on residential density)	X^2 *(4, N = 139) = 10.25* **Very high ID, low A*	-	-
Intersection density x Score B (Perception on diversity of land use mix)	-	-	X^2 *(4, N =84) = 10.07* **Very high ID, medium B*
Intersection density x Score D (Perception on street connectivity)	X^2 *(4, N = 139) = 16.2* **low ID, low D*	X^2 *(4, N = 57) = 12.86* **low ID, medium D*	X^2 *(4, N = 84) = 12.33* **high ID, high D (preferred)*
Intersection density x Score G (Perception on safety from traffic)	-	X^2 *(4, N = 57) = 10.47* **very high ID, low G Low ID, medium G*	-

Source: Author's Findings (*denotes some respondents who are not accessible to facilities; **adjusted residual relationship

The relationship between very high intersection density and low perception on residential density indicates that respondents are living in an area where there are less diversity of housing types and may also suggest that land use distribution in that area consists of a mixture of residential, commercial or facilities. Road network in commercial land uses usually have more intersections with an accessible entrance, exits as well as connected back lanes and side lanes that are usually comprised of parking facilities. In line with a previous study (Leslie et al., 2007), an outstanding trend was observed where residents living in high intersection density area perceived high connectivity road network in Taman Nusantara by which it is one of the preferred features of a walkable neighbourhood.

Furthermore, population density and perception of residential density showed the highest significant relationship for Taman Perling only. A strong correlation was found for distance to mosque and perception towards diversity of land use mix in Taman Perling, and distance to school and perception towards safety from crime in Taman Selesa Jaya. Moreover, Taman Selesa Jaya and Taman Nusantara displayed preferred characteristics of walkable neighbourhood environment where high population density and high intersection density contributes to a high perception of street connectivity, further promoting walking activities among the respondents.

These notable trends further justify the relationship between ONE and PNE and how it influences the total PA level of respondents in the three neighbourhoods. Overall, Taman Nusantara which is constituted as having walkable environment displayed higher level of physical activities for walking, moderate and vigorous activities among its respondents, followed by respondents in Taman Selesa Jaya and Taman Perling (shown in Table 5).

5.0 Limitations of the study

Upon conducting the questionnaire survey, the respondents consisting of older people and younger older people might give a biased answer since the total time taken to interview a respondent takes about 20 to 30 minutes. Even so, the interviewees managed to interview all the items in the questionnaire with no missing response. Furthermore, when combining ONE data and PNE data simultaneously in ArcGIS, ONE analyses only concerns within the specified areas where the respondent's locations were obtained from their road address across the neighbourhoods.

Besides, when performing distance analysis to facilities in ArcGIS, some respondents are not accessible to facilities such as the school and playground. This is because some parts of the neighbourhood are not thoroughly connected by the road networks and are separated by a highway where the u-turn ramps are located outside the neighbourhood boundary, making it a limitation of this study when performing distance analysis in ArcGIS. Plus, we can only assume that the significant outcomes of this research paper only concern a small sample size population in several districts in the three neighbourhoods and it would be biased to consider the meaningful relationships obtained as a representation for one whole neighbourhood. Plus, future chi-square analyses could be conducted to explore the detailed connections between ONE and PNE with the different types of physical activity among the respondents in the three neighbourhoods.

6.0 Conclusion & Recommendations

To conclude, this research paper resulted in desired outcomes of several significant relationships between ONE and PNE. The common trends were observed between population density, accessibility and permeability (ONE), with residential density, diversity of mix land uses and street connectivity (PNE). Nonetheless, significant correlations were observed, especially between high population density with high street connectivity, which confirms to previous researches of walkable neighbourhood characteristics. The study outcomes show residents living in neighbourhoods with higher population density and accessibility to various facilities perceived higher neighbourhood walkability but showed less total physical activity which is largely due to various factors such as the usage of motorised vehicles and significant correlation with perception towards the safety of crime. The outcomes of this study further demonstrate a liveable neighbourhood and quality of life in terms of significant correlations between ONE and PNE as well as a total physical activity performed by older adults. The outcomes of this paper further contribute to the existing field of research by conforming to the trends of ONE, PNE and PA in other countries that will help improve Malaysia's housing policy and guidelines in the future. Extensive spatial planning for neighbourhood environment that is proved to facilitate older people in Malaysia in improving their well-being and quality of life.

References

Bell, J. (2017). Iskandar Malaysia Population Density.

Cerin, E., Nathan, A., van Cauwenberg, J., Barnett, D. W., & Barnett, A. (2017). The neighbourhood physical environment and active travel in older adults: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1–23. https://doi.org/10.1186/s12966-017-0471-5

Chang, P.-J., Wray, L., & Lin, Y. (2014). Social Relationships, Leisure Activity, and Health in Older Adults. *Health Psychology*, *33*(6), 516–523. https://doi.org/10.1002/cncr.27633.Percutaneous

Chiang, Y. C., Sullivan, W., & Larsen, L. (2017). Measuring neighborhood walkable environments: A comparison of three approaches. *International Journal of Environmental Research and Public Health*, *14*(6), 1–12. https://doi.org/10.3390/ijerph14060593

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., … Oja, P. (2003). International physical activity questionnaire: 12-Country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Curl, A., Thompson, C. W., Alves, S., & Aspinall, P. (2016). Outdoor Environmental Supportiveness and Older People's Quality of Life: A Personal Projects Approach. *Journal of Housing for the Elderly*, *30*(1), 1–17. https://doi.org/10.1080/02763893.2015.1087925

Dill, J. (2003). Measuring Network Connectivity for Bicycling and Walking. *Transportation Research Board 83rd Annual Meeting*, (1), 1–21. Retrieved from http://reconnectingamerica.org/assets/Uploads/TRB2004-001550.pdf

Elsawahli, H., Ahmad, F., & Ali, A. S. (2016). Demographic transition and sustainable communities in malaysia, (V), 39–48. https://doi.org/10.21837/pmjournal.v14.i5.191

Forde, C. (2005). Scoring the International Physical Activity Questionnaire (IPAQ) Exercise Prescription for the Prevention and Treatment of Disease, (2005). Retrieved from https://ugc.futurelearn.com/uploads/files/bc/c5/bcc53b14-ec1e-4d90-88e3-1568682f32ae/IPAQ_PDF.pdf

Hashim, A. H., & Leby, J. L. (2010). Liveability dimensions and attributes: Their relative importance in the eyes of neighbourhood residents. *Journal of Construction in Developing Countries*, *15*(1), 67–91. Retrieved from https://www.researchgate.net/publication/46817848

Lee, S. B., Oh, J. H., Park, J. H., Choi, S. P., & Wee, J. H. (2018). Differences in youngest-old, middle-old, and oldest-old patients who visit the emergency department. *Clinical and Experimental Emergency Medicine*, *5*(4), 249–255. https://doi.org/10.15441/ceem.17.261

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. *Health and Place*, *13*(1), 111–122. https://doi.org/10.1016/j.healthplace.2005.11.001

Lu, Y., Xiao, Y., & Ye, Y. (2017). Urban density, diversity and design: Is more always better for walking? A study from Hong Kong. *Preventive Medicine*, *103*, S99–S103. https://doi.org/10.1016/j.ypmed.2016.08.042

M, W. A. M. W., & Lee, Y. Y. (2018). Reliability and validity of the neighbourhood environment walkability scale (news) – malay version, *5*(1).

Mena, C., Sepúlveda, C., Ormazábal, Y., Fuentes, E., & Palomo, I. (2017). Impact of walkability with regard to physical activity in the prevention of diabetes. *Geospatial Health*, *12*(2), 175–183. https://doi.org/10.4081/gh.2017.595

Mobily, K. E. (2014). Walking among older adults. *World Leisure Journal*, *56*(2), 130–140. https://doi.org/10.1080/16078055.2014.903725

Oakes, J. M., Forsyth, A., & Schmitz, K. H. (2007). The effects of neighborhood density and street connectivity on walking behavior: The Twin Cities walking study. *Epidemiologic Perspectives and Innovations*, *4*(February). https://doi.org/10.1186/1742-5573-4-16

Saelens, B. E., & Sallis, J. F. (2002). Neighborhood Environment Walkability Scale (NEWS). *American Journal of Public Health*, *93*(9), 78–81. https://doi.org/10.1016/j.ypmed.2009.07.011

Sallis, J., Black, J., & Chen, D. (2002). Scoring procedures and preliminary psychometrics for the Neighborhood Environment Walkability Scale (NEWS). *Behavioral Medicine*, *24*, S139.

Sallis, J. F., Floyd, M. F., Rodríguez, D. A., & Saelens, B. E. (2012). Role of Built Environments in Physical Activity, Obesity, and Cardiovascular Disease. *Circulation*, *125*(5), 729–737. https://doi.org/10.1161/CIRCULATIONAHA.110.969022

Throsby, D. (2005). Cultural heritage as financial asset in strategies for urban development and poverty alleviation. *Paper for International Conference for Integrating Urban Knowledge & Practice, Gothenburg, Sweden, 29 May–3 June, 2005*, (May 2005), 2–14.

Tobi, S. U. M., Fathi, M. S., & Amaratunga, D. (2017). Ageing in place, an overview for the elderly in Malaysia. *AIP Conference Proceedings*, *1891*(October). https://doi.org/10.1063/1.5005434

Voorhees, C. C., Ashwood, J. S., Evenson, K. R., Sirard, J. R., Rung, A. L., Dowda, M., & McKenzie, T. L. (2010). Neighborhood Design and Perceptions: Relationship with Active Commuting. *Med Sci Sports Exerc.*, *42*(7), 1253–1260. https://doi.org/10.1371/journal.pone.0178059

WHO. (2002). Active Ageing: A Policy Framework. *The Aging Male*, *5*(1), 1–37. https://doi.org/10.1080/713604647

Zawawi, R. H. (2013). " Active Ageing in Malaysia ." *The Second Meeting of the Committee on "International Cooperation on Active Ageing,"* 1–18.