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IJIE

Journal homepage: http://penerbit.uthm.edu.my/ojs/index.php/ijie
ISSN : 2229-838X e-ISSN : 2600-7916

The International Journal of Integrated Engineering

A Case Study of Malaysian Pedestrian Walking Speed at Shopping Malls in Kuala Lumpur, Malaysia using Human Behaviour Simulator (HBS)

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DOI: https://doi.org/10.30880/ijie.2019.11.04.025

Received 8 August 2019; Accepted 26 August 2019; Available online 31 August 2019

Abstract: Rate of pedestrian walking speeds are influenced by some factors such as gender, age and location. Numerous research had been conducted to deepen the understanding of pedestrian walking speed because it is one of the keys in understanding the pedestrian walking behaviour. This case of study was conducted at two shopping malls in Kuala Lumpur namely MyTown Shopping Centre and Sunway Velocity Mall, with two main objectives which are i) To determine the average walking speed of pedestrian by considering the factors of age and gender; and ii) To compare the average walking speed that considered age as the factor of comparison between the pedestrian walking speed at shopping malls and crosswalk. Demographic factors of pedestrian walking speed in this study are on the basis of gender (male and female) and 7 groups of age categories consist of children, adult men and women, senior adult men and women, over 70 and disabled person. A camcorder was used to obtain the data of experiment by making video recording of the movement of people that were walking and roaming around at the main atriums of the shopping malls for 30 minutes. Hence, data analysis was completed by using a software named Human Behaviour Simulator (HBS) for analysing the data that were extracted from the video. The result of this study was male pedestrian walked faster than female with the average walking speed of 0.93m/s and 0.81m/s respectively. Also, people in shopping malls walked slower compared to pedestrian who were walking at crosswalk.

Keywords: Malaysian pedestrian, walking speed, traffic, gait, shopping malls, crosswalk

1. Introduction

Walking is a mode of short trips transportation by foot that transfers a person from different locations [5]. The ability to walk in each person may vary due to the reason of people will choose to walk at the speed that they find most suitable with their body conditions most of the time. Nowadays, the urbanization is getting more progressive especially in Kuala Lumpur, Penang, Kota Kinabalu, Kuching and other major cities in Malaysia. Urbanization may contribute to traffic congestion due to the use of many vehicles that keep increasing each year and it may cause many kinds of pollution such as air and sound pollution.

Moreover, the Road Safety Department of Malaysia (JKJR) has reported the number of death of Malaysian pedestrian that were killed in 10 years basis from 2007 to 2016 was 5,472 and 511 cases recorded in 2016 alone [9] in which the rank of pedestrian fatalities was at the third rank after motorist and motorcyclist. The significant factor of pedestrian fatalities usually caused by hit-and-run accidents [11] and the other possible contributing factor to that

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incident is people are sometimes carelessly crossing the busy roads. In order to overcome such issues, pedestrianization has become an essential part of the well-planned modern urban design [12] and as an option to the government to plan the cities' environment in Malaysia to be more pedestrian-friendly.

Therefore, the studies of pedestrian walking behaviour that consists of walking speed, psychological distance and walking pattern have gotten more attention from many researchers in line with the consideration on many aspects such as the design of pathway for pedestrian, time allocated for the crosswalk, evacuation process and town planning. Hence, this study was conducted by concentrating on the shopping malls scope with the aim to contribute more relevant and reliable information on pedestrian walking behaviour specifically in Malaysia due to differences of walking speed rate in different places.

2. Literature Review

Pedestrian walking speed is influenced by the factors of age and gender [3], [4], [12]. As reviewed by [3], there are contrasts in terms of view and preferences in both male and female while walking. Also, the natural traits between genders can affect and give impact to the gait ability in terms of body size, skeletal alignment and muscle strength [6]. This can be proven by the findings of [1] whereby the average walking speed for male pedestrian was 1.5 m/s which was 0.3m/s faster than the average walking speed for female that was obtained as 1.2 m/s.

Furthermore, based on the previous studies for Malaysian pedestrian case, [2] had concluded that the walking speed for Malaysia case at a crosswalk in Penang was 1.16m/s which was slower than 1.22 m/s (4 ft/s) as what has been recommended by the Public Work Department as the walking speed that is embraced from other country counterparts [7]. On the contrary, [7] had carried out the same experiment for Malaysia case but in different location which was Kuala Lumpur that is more developed than Penang, and the authors had found that the mean walking speed of pedestrian was 1.39 m/s which was higher than the recommended walking speed by the JKJR. Another factor that may affect the walkability of a pedestrian are location and walkway facilities as reported by [12], the authors had conducted a research on pedestrian walking speed at three different locations in Dhaka, Bangladesh namely i) Commissioner's Market Sidewalk; ii) Kazi Nazrul Islam Avenue; and iii) Mirpur road and, they have obtained three different rate of walking speed which are 1.10 m/s, 1.20 m/s and 1.17 m/s respectively. Also, the fact that walking speed may differ not only in term of location in a particular country, but also differ in every countries by referring to Table 1 as reported by [7], [12].

Table 1 - Comparison of pedestrian walking speeds in different countries

Country	Mean Walking Speed (m/s)
Asia	
Riyadh, Saudi Arabia	1.08
Madras, India	1.20
Hong Kong	1.20
Thailand	1.22
Singapore	1.23
Colombo, Sri Lanka	1.25
Israel	1.31
Bangladesh	1.20
Malaysia	
Kuala Lumpur	1.39
Penang	1.16
United States	
New York	1.35
Columbia	1.32
Pittsburgh	1.47
England	
United Kingdom	1.47
Austria	1.54
Calgary, Canada	1.40
Jordan	1.34

In age case, some researchers have found that the walking speed of pedestrian declines as they get older and this is supported by what was claimed by [10] that the most consistent finding is that walking speed decreases as the age

getting older, and research has shown the reduced step length with increased time in double support has explained that the reduction in the preferred speed in older adults. In other case, [7] had reported in their research of pedestrians at the age of 55 years old were the slowest among the groups of pedestrians to walk in public area.

3. Methods

A camcorder was used as the equipment for the photographic procedure of video recording the pedestrian that were roaming and walking around the main walkway inside the two selected shopping malls in Kuala Lumpur and the process took place for 30 minutes. The obtained videos were then converted into sequence of images as data of pedestrian movement that have been used for analysis stage. Data analysis was established using a software named Human Behaviour Simulator (HBS) that was installed into Autodesk Maya software. The video was converted from (avi.) format to (jpeg.) format by using Adobe after Effects CS4 software.

The image sequences at the basis of 1 second per frame were transferred to Autodesk Maya software and had gone through analysis as shown in Fig. 1 whereby each white circle inside the red circle represents the coordinates position of the movement that took place for 8 seconds as interpreted in Fig. 2 and for an example, the coordinates of the first white circle are x-axis = 16.0235, y-axis = 15.0809. The value of 0.379 is the standard diameter of a human [2] that was set in the HBS software. The calculation of the walking speed among the selected pedestrian by using the coordinates that was obtained from HBS and Autodesk Maya was done by using Microsoft Excel. During the data collection, no pedestrian was aware of the observation in order to obtain the original walking speed. Therefore, the age groups were classified photographically based on the physical appearance in terms of height, behaviour and attire. Also, the demographic factors of pedestrian walking speed in this research are on the basis of gender (male and female) and 7 groups of age categories including disabled person as shown in Table 2.

Table 2 - Age categories.

Category	Age description
Children	Below 9 years old
Adult Men	From 10 to 39 years old
Adult Women	
Senior Adult Men	From 40 to 69 years old
Senior Adult Women	
Elderly	Over 70 years old
Disabled person	All range of age (unusual gait)

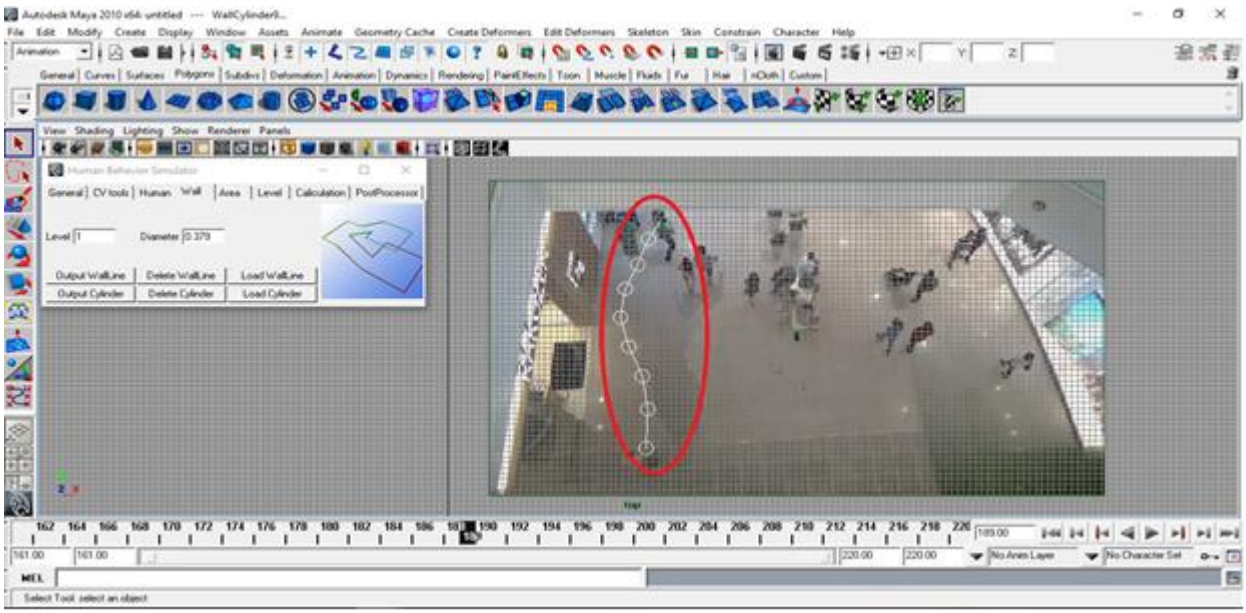

Fig. 1 - Pedestrian data sample

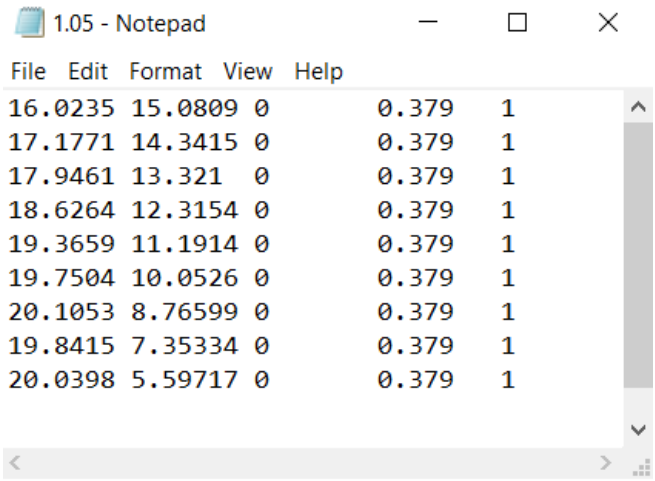

Fig. 2 - Coordinates of pedestrian movement.

4. Results and Discussion

A total of 426 data of pedestrian walking speed were obtained at two shopping malls in Kuala Lumpur, Malaysia as interpreted in Table 3 as no data available for disabled people. The most obtained data sample was in the category of female adult with 150 data and followed by male adult with 147 data samples that was only slightly difference than female adult and then followed by female senior adult with 44 data samples, child with 43 data samples and male senior adult with 42 data samples. From these categories, it can be concluded that both male and female adult are the main groups of people that are usually visiting shopping malls. From Table 3, the highest average of walking speed was obtained by the male adult category with the speed of 1.01 m/s which is 0.1 m/s faster than female adult with the average walking speed of 0.91 m/s. In comparison between the two groups of senior adults, male walked with the average speed of 0.85 m/s which was 0.14 m/s faster than female with the walking speed of 0.71 m/s. These findings have proven that male pedestrian usually walks faster than female due to the gait difference between these two genders with the differences in terms of interests and also physical characteristics, and this can be supported by the previous study that was conducted by [8] among the elderly hospitalized cardiac inpatients, the respective sex-related differences was found by the author in in terms of gait speed and step count of 1.72 m/s, 4037.3 steps/day in the male samples and 1.39 m/s, 2651.3 steps/day in the female samples. Additionally, the other investigations conducted by [1], [2], [3], [5], [6], [10] and [12] also had concluded the difference in walking speed between male and female.

Table 3 - Average walking speed of Malaysian pedestrian.

Category	Total Data	Walking Speed (m/s)	Standard Deviation (m/s)
Children	43	0.77	0.26
Male adult	147	1.01	0.28
Female adult	150	0.91	0.28
Male senior adult	42	0.85	0.12
Female senior adult	44	0.71	0.15
Average	-	**0.85**	0.22
Total	**426**	-	-

In other case of age factor, male adult walked 0.16 m/s faster than male senior adult while female adult walked 0.20 m/s faster than female senior adult. These two comparisons have shown that walking speed of pedestrian decreases with age due to their health condition and their body stamina. This finding is supported by the previous research that was conducted by [3] with the sample of 3,145 older adults that were divided into 46% male and 54 % female. The author had discovered that 93% of women and 84% of men aged ≥ 65 years either could not walk 8 feet safely or their normal walking speed was too slow to cross the road in time in which was referred to the recommended 'normal' walking speed of 1.2 m/s that is practiced internationally as the standard for pedestrian crossing timings whereby 0.2 m/s slower than recommended by the JKJR as explained in the literature review. Also, [7] had found that the elder pedestrians with the age of 55 years old and above were the slowest to walk in a public area in comparison with the other group of pedestrians. In children case, the average walking speed of this group was 0.77 m/s which was slightly faster than female senior adult by 0.06 m/s. However, children walked slower than male adult, female adult and male

senior adult. The same condition of finding was found by [2], children category was the fourth faster to walk at pedestrian crosswalk with the speed of 1.06 m/s, in comparison with the other categories of age.

On the contrary, [7] had concluded that children walked faster than the other age categories by claiming that children are energetic and move fast compare to adults. In this case, the difference of walking speed happened in children category because of the range of age for children category was different in which [7] had classified children as the group of people starting from the age of 20 and below, and this range of age is recognised by United Nations Children's Fund (UNICEF), which was totally different than what was categorized by [2] whereby children category started at the age of 9 years old and below, the same range as in this research.

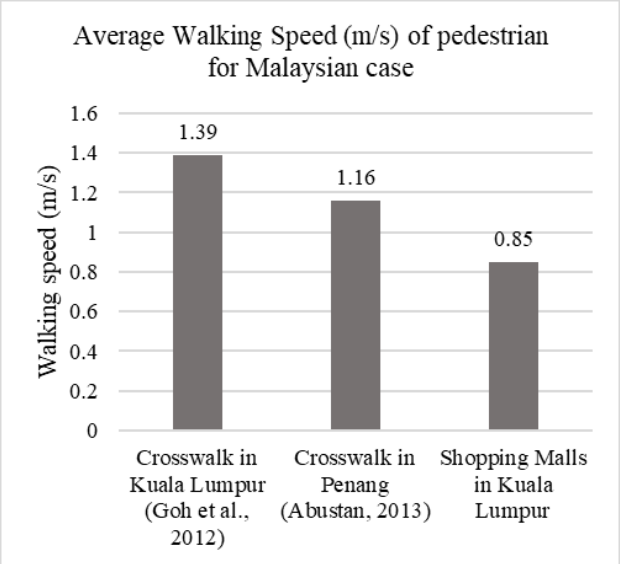

Fig. 3 - The comparison of Malaysian pedestrian walking speed.

In overall, there are differences in the average walking speed for Malaysian case as what had been investigated by [2], [7], and this research in which the average walking speed for these three different studies are 1.39 m/s, 1.16 m/s and 0.85 m/s respectively as interpreted in Fig. 3.

5. Conclusion

In this study, the selected city was Kuala Lumpur specifically at shopping malls, the same city as [7] but in different location which was pedestrian crosswalk. Therefore, the scope of studies between these two investigations were different. Moreover, [2] had conducted the same investigation as [7], which was to determine the walking speed of pedestrian at crosswalk. However, the selected cities between these two cases were different. Moreover, the number of samples among the three researches of pedestrian walking speed for Malaysian cases were different with the total samples of 1,579 by [7], 1,092 by [2] and 426 samples as obtained in this research. All of these aforementioned differences are contributing to various walking speed results. Additionally, time constrain can be taken as a factor that influences the rate of pedestrian walking speed at crosswalk to be higher than the pedestrian walking speed at shopping malls. This is because most pedestrian at crosswalk tend to walk faster that may include running, to avoid the vehicles and also because of the hot or rainy weather which is different than the covered area like shopping malls where people inside the building are feeling more comfortable to walk without even concerning about the weather condition. Besides, people have different intentions in both shopping malls and crosswalk whereby people inside shopping malls are more to leisure purpose while people crossing the crosswalk are more focusing on walking towards their destination as soon as possible. In conclusion, more investigation on Malaysian pedestrian walking speed must be established in various locations with high number of pedestrian mainly in the major cities in Malaysia to have more reliable and relevant understanding on that matter so that more contribution and improvement can be made to increase the number of pedestrian-friendly facilities in Malaysia to encourage more Malaysian to walk for better benefits in terms of health, friendly-environment and well town planning.

Acknowledgement

This research is financially supported by the Ministry of Higher Education (MOHE) of Malaysia under Fundamental Research Grant Scheme (FRGS) (Vot 1526) in line with the 11th Malaysia Plan (RMK-11) part 7 which is to strengthen the infrastructure to support economic growth.

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