

Addressing the Pedestrian Issues in Malaysia: En Route Towards Walking Culture and Sustainable City

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Abstract: Even though pedestrianisation is still a far-off idea in Malaysia, these days it has been considered with high importance with regards to urban land use policies and road infrastructure designs. This study discusses the issues that were studied in comprehensive pedestrian research works that were carried out in Malaysia since 2010 up to these recent years. These issues are focused on many subject areas such as pedestrian safety, crossing behaviour, willingness to walk and pedestrian simulation study. Based on research evidence from the literatures that have been discussed in this study, several suggestions for future studies and actions are proposed to facilitate researchers in identifying the priority issues for the pedestrian study in Malaysia.

Key words: Pedestrian issues, walking culture, sustainable city, pedestrianisation, simulation

INTRODUCTION

A pedestrian is a person who chooses walking rather than travelling by vehicles. Most of the liveable cities such as Melbourne, Vienna, Vancouver and Toronto are all walkable cities. The designing of these cities encourages people to prefer walking for their routine activities. The concept of walking culture in a city is actually to support the low carbon footprint and green mobility agenda, in addition to reduce traffic congestion and create a more sustainable environment (Krishnan *et al.*, 2013). However, walking is not a popular mode in developing countries. In Malaysia and its neighbouring countries, there has been an increase in the number of private vehicles owing to growing population. Besides, increased production of cars in the domestic market and the influx of new imported cars to the local automotive market in Malaysia have spiked the number of vehicle registrations in the country.

Nevertheless, Malaysia also aims to reduce CO₂ emissions by 40% in 2020. Therefore, some of the new townships in the country have been developed by planning them out as a sustainable and green city. For example, Iskandar Malaysia is one of the new townships that implemented the low carbon city concept. The strategy of this city is to reduce CO₂ emissions and energy consumption in the four sectors, i.e., residential, commercial, industrial and transport. The city aims to exceed the usage of public transportation over the usage of private vehicles by 2025 (Matsuoka *et al.*,

2013). Although, the designing of this city aims to encourage the use of buses, inevitably it will also result in design and planning issues for pedestrian facilities and infrastructures. Another township known as Putrajaya which was developed in the 1990 had also considered a neighbourhood planning for cycling and pedestrian-friendly infrastructures including accessibility for people with disabilities. However, Qureshi and Ho (2011) claimed that a lot of improvements and upgrading are still required for walkability and accessibility of the pedestrian pathways in Putrajaya. Meanwhile, in the case of the Greater Klang Valley, the mass rapid transit development involved the Transit Oriented Development (TOD) concept in order to reduce the traffic congestion and the dependency on private vehicles (Ling *et al.*, 2010). This concept inevitably emphasises on the importance of underground spaces for pedestrians, especially when the train transit loop consists of several underground train stations.

However, in Malaysia, until now, the facilities and infrastructure development for pedestrians have not yet attained a satisfactory level. Therefore, it is essential to identify the characteristics and behaviours of pedestrians in Malaysia as well as to recognise other related issues that need to be tackled. The acknowledgement of pedestrian characteristics is essential in order to develop well-organised pedestrian facilities and infrastructures in the era of pedestrianisation. Therefore, this study discusses the pedestrian issues in Malaysia that have been highlighted by the researchers of this decade. The

pedestrian reviews in this study start with addressing the pedestrian safety issues followed by pedestrian walking behaviours. A brief review of pedestrian simulation studies in Malaysia has also been highlighted before concluding the study. Walkability and convenient issues of pedestrian walkways and amenities have also been discussed.

MATERIALS AND METHODS

Pedestrian safety: Pedestrians are vulnerable road users who are always at risk during their trips. In developed countries such as the US which is striving to boost the walking culture, pedestrian safety is a main issue that needs to be tackled, especially the road accidents that involve pedestrians and motor vehicles (Ewing *et al.*, 2003). Unfortunately as a middle income country, Malaysia is also facing the same situation. Table 1 shows the list of deaths and injuries in the road user’s category in 2013 that was reported in the Malaysian Road Safety Plan for 2014-2020. Although, the pedestrian deaths and injuries were recorded at the third place among the categories, it is alarming and pedestrian safety should get more attention in the nation’s Road Safety Master Plan.

Safety while walking is one of the important factors that any pedestrian would consider. An increasing number of pedestrians being involved in road accidents may cause concerns regarding the risk of walking, especially for parents of the school children. Consequently, this situation could impede the struggle towards promoting the walking culture. Moreover, Oxley *et al.* (2012) stated that young children category was found to be the highest in terms of rate of serious injuries and pedestrian deaths in Malaysia, especially in the rural areas which had major roads with relatively high speed limits. Their study also supported the statistics from the Malaysian Royal Police in 2010 that 13% of pedestrian fatalities in 2009 involved children in which 124 child pedestrians aged 6-16 years were injured and seven child pedestrians died in areas near to school zones.

Recognising this issue, the Road Safety Education Program (RSEP) was initiated in 2007 in all schools in Malaysia, targeting the school children. The program targeted that by the end of 2010, every child in the primary school would have received a minimum of eight lessons in road safety education. However, the success of such education is still unidentified. In addition, Krishnan *et al.* (2013) identified that parents with high level of education tended to give better exposure on positive road safety behaviour compared to the less educated parents. Undoubtedly, it shows that road safety education from either school or parents will have an impact on a child’s road safety behaviour.

Table 1: deaths and injuries by category of road users

Category of road users	Deaths	Injuries		Total
		Major	Minor	
Motorcyclist	4,294	2,883	5,517	12,694
Pedestrian	455	281	502	1,238
Cyclist	159	78	150	417
Driver/passenger	1,399	978	1,567	3,944
Van driver/passenger	80	69	106	255
Bus driver/passenger	60	30	86	176
Truck driver/attendant	210	100	146	456
Racing driver	158	124	179	461
4 wheelers/passengers				
Other drivers	100	54	105	259
Driver/passenger				
Total	6,915	4,597	8,388	19,900

In addition, most of the pedestrian accidents mainly involved private vehicles such as cars and motorcycles. This issue motivated Oxley *et al.* (2012) to identify the driving factors of road accidents involving these types of road users. The researchers found that the overly assertive attitudes of the drivers resulted in a failure to acknowledge the rights of the pedestrians. The aggressive attitude that had been identified as a significant cause was the speeding behaviour in the areas of high pedestrian activity.

In order to understand more about the factors that affect the pedestrian crashes in Malaysia many researchers had applied statistical models as a tool to analyse the pedestrian accident cases. For example, Pour *et al.* (2012) established a relationship between vehicle-pedestrian crashes with the relevant road infrastructure and environmental features of a 543 km sample of Malaysia’s federal roads. The roadways mostly passed through the rural areas. The researchers developed four statistical models, i.e., the Poisson model, Negative Binomial (NB) model, Zero-Inflated Poisson (ZIP) model and Zero-Inflated Negative Binomial (ZINB) model. The result indicated that the ZIP model performed the best with significant factors. The ZIP model shows that vehicle-pedestrian crashes were significantly influenced by the total traffic volume, heavy traffic flow, speed limit and land use.

In addition, Malek (2010) also employed Poisson and Negative Binomial (NB) models to identify the affecting factors of pedestrian accidents at 30 different locations in Malaysia. The pedestrian accident data from 2006 until 2008 that were obtained from the Malaysian Institute of Road Safety Research (MIROS) were used for the study. The affecting variables that were measured in the analyses were the number of pedestrian accidents in each location, the location of pedestrian accidents and the time of pedestrian accidents (night-time or daytime). The purpose of the analyses was to identify the appropriate distribution to model the night-time and day-time

pedestrian accident data. The findings showed that the negative binomial distribution provided a better fit for night-time and daytime of pedestrian accident data compared to the Poisson distribution.

Meanwhile, a study carried out by Ariffin and Zahari (2013) using the logistic regression method explored the possible factors that contributed to pedestrian deaths or severe injuries in road accidents. The data were obtained from the MIROS Road Accident Analysis and Database System (M-ROADS) and were analysed using the Statistical Package for the Social Sciences (SPSS). The variables that were measured in the analyses were the pedestrian characteristics (gender, age, injury location on the body, the location of the accident and pedestrian activity during accident) pedestrian environment (day of the accident, time of the accident, traffic system, road type, road geometry, traffic condition, weather and light condition) and striking vehicle type (HGV, bus, passenger vehicles and motorcycles). The results found that male, older age, head injury, accident during weekends, road brightness and heavy vehicles such as HGV and bus were the significant factors that caused the pedestrian deaths or severe injuries in a road accident.

Pedestrian crossing behaviour: It is very important to understand the pedestrian crossing behaviour as it presents the traffic design and relates to pedestrian safety. This section will discuss the research studies that have been carried out on pedestrian crossing at signalised and unsignalised facilities in Malaysia.

Hamidun *et al.* (2014) reported that the pedestrians in Malaysia were less likely to use the pedestrian bridge if they needed to travel more than their acceptable distance. Thus, they would likely to cross the road directly without considering that the pedestrian bridge offered more protection while crossing the roads. However, the findings also showed that the percentages of using the pedestrian bridge in the schools and residential areas were high compared to the business and amenity areas. Other factors like fence installation, directional flow of the traffic, the presence of median on the road, vehicle volume and the distance of the facility from the pedestrian main location discouraged the use of the pedestrian bridge.

A study that had been performed by Leh *et al.* (2013) towards the pedestrians on the ampong road revealed that pedestrians preferred to use the signalised crosswalk compared to pedestrian bridges or the underground pedestrian crossing. However, the situation might change once the Transit Oriented Development (TOD) concept is implemented in the urban planning. This is because the TOD concept includes more options of pedestrian access to ease the pedestrian mobility from residential areas to the transit areas such as train stations or bus stops.

According to Goh *et al.* (2012) the types of pedestrian crosswalks, either signalised or non-signalised, act as a contributing factor of the pedestrian crossing speed. Pedestrians at non-signalised crosswalks were found to be walking faster (with an overall mean speed of 1.39 m/sec) than those at signalised crosswalks (with an overall mean speed of 1.31 m/sec). This study also claimed that the current design of the traffic signal at signalised crosswalks with 1.22 m/sec does not provide sufficient time for pedestrians to cross safely. It is also being proved by Mustafa *et al.* (2014) in a study that evaluated the pedestrian crossing speed during peak hours and non-peak hours at a signalised intersection in Shah Alam. The study found that the average speed of walking during the peak hour was 1.39 m/sec and meanwhile the walking speed during the non-peak hour can be as slow as 1.34 m/sec. However, factors such as gender, loading, group or single pedestrian may have significant influences on the walking speed.

However, the provision of signalised pedestrian crossing facilities may not promise the total safety of a pedestrian due to reasons such as traffic violation and unsafe signal phasing. Hamidun *et al.* (2014) identified the risk of crossing behaviour at a signalised intersection with the data that were extracted from the cameras placed at four different intersections in Kuala Lumpur. The researchers investigated the pedestrian crossing flow by using the Extended Deterministic Stochastic Petri Nets (EDSPNs) which is a mathematical tool for dynamic simulation within a short period. The findings from the study showed that the riskiest situation in the signalised pedestrian crossing occurs when a pedestrian still tends to cross the road despite the light turning red while the waiting vehicles already start their aggressive move.

It shows that the risk while crossing is not just dependent on the conflict between the pedestrian and other vehicles but also on the risky behaviours of the pedestrians themselves. Hanan *et al.* (2015) conducted an interesting study to investigate the behaviour of using mobile phones while crossing the road. The study revealed that pedestrians have a low risk perception with regards to talking/texting in the mobile phones while crossing. Most respondents in the study claimed that they were able to cross the road even while using the mobile phone. However, this study did not report the types of crossing that were involved. For further understanding, future studies will be required to investigate the types of crossing facilities that were more dangerous when crossing with distraction (e.g., mobile phones, talking).

Factors affecting willingness to walk: In order to commit to the national policy for carbon reduction it is imperative

to reduce emissions from motor vehicles. This means that motor vehicle users should start to shift their mode to low carbon transports such as walking and cycling. The question here is are Malaysian societies ready to make active mode, especially walking as a culture? This subtopic will discuss the findings regarding the willingness to walk in Malaysia.

Many factors such as hot weather, long walking distance, less convenient infrastructures, inadequate facilities for pedestrians and attitude towards or perception about walking activity were found to have significant influences on the willingness to walk in Malaysia. In addition, Malaysia is a tropical country with an average temperature ranging between 27 and 30°C throughout the year. According to Ariffin and Zahari (2013), good weather conditions were found as one of the factors that could encourage people who live in the urban residential area to walk in Malaysia. However, if the point location was located farther than their acceptable walking distance, Malaysians preferred to use their private vehicles to travel. Furthermore, the fluctuations in climate in Malaysia were claimed as one of the factors that discouraged the willingness to walk.

It is not overstated when we agreed that the pedestrian walkways and public spaces in Malaysia (including those in the universities) are mostly less shady with no rooftop, lack safety concerns have poor pavement surface and lack street furniture, especially near the pedestrian underpasses (Raidine *et al.*, 2014). Afsar (2015) had investigated the types of convenient environments that a pedestrian required in order to walk or use the walkways in tropical campus in Malaysia. Based on the questionnaire survey, most of the respondents in his study claimed that hot weather is the barrier for them to walk. The respondents suggested that the installation of canopies and bus stop shelters can make the pedestrian paths shadier and will make them more convenient to walk. This is actually in parallel with what is stated by Ladin *et al.* (2014) in his study on the needs of planting trees along the pedestrian pathways. The findings showed that the pedestrians were willing to walk from 400-800 m if there were shades from the planted trees that covered them from the hot weather. Meanwhile, Rostam and Noor (2014) also supported that weather is a barrier for walking at the residential compound in urban areas.

For example, in a pedestrian's travel pattern case study conducted by Bachok *et al.* (2004) at the Tunku Abdul Rahman Street and the Central Market, Kuala Lumpur, it was found that the facilities or furniture along the street can obstruct the pedestrian movements which in turn can reduce their speed as they have to avoid these facilities. If these facilities are located at an appropriate

place, the pedestrian conflict can be avoided. This will help in smoothing pedestrian movements which will subsequently increase the level of comfort of walking.

According to Makki *et al.* (2012), in order to improve the design of pedestrian facilities, four important criteria connectivity, accessibility, safety and comfort ability were focused. These four criteria were based on the study conducted in the University Kebangsaan Malaysia that focused on the student's perspectives towards the walkways. In the survey, most respondents claimed that the connectivity is the most important factor that influences their willingness to walk because it will allow smooth movements and assure the safety of pedestrians.

In addition, the continuity issue of pedestrian pathways is also being considered in other countries such as Brazil. Shah and Rodrigues Da Silva in their study that compared the assessment method for the quality of pedestrian infrastructure between Brazil and Malaysia, found that both countries were considering different parameters in their methods. In the Malaysian method, the continuity of the pedestrian walkways is considered based on the total road length. Meanwhile, the Brazilian method focuses more on the width and the locations of the pedestrian walkways.

The lack of connectivity and continuity in the pedestrian walkways could discourage the willingness to walk. The findings of Shamsuddin *et al.* (2013) indicated that the pedestrians in Kuala Lumpur City Centre claimed to be tired during walking owing to the lack of appropriate facilities. However, this is contradicted by Zakaria and Ujang (2013) who performed a study to investigate the satisfaction level of pedestrian infrastructures at tourism areas in the Kuala Lumpur City Centre including Merdeka Square, Petronas Twin Towers, Jamek Mosque and the Central Market. The respondents in the study comprised 54% local visitors and 45% tourists. The respondents needed to rate their level of satisfaction on comfort ability, connectivity, accessibility and safety of the pedestrian walkways and infrastructure at the study areas. The findings showed that most of the respondents were satisfied with the infrastructure that was provided. However, the results are questionable because they could be biased in terms of the number of respondents from local visitors compared to the tourists.

A study by Bahari *et al.* (2012) on the sidewalks within the commercial area of Kuala Lumpur that focused on the elderly pedestrians revealed that the infrastructure for pedestrians still needs to be upgraded. The findings from this study highlight that vulnerable groups such as the elderly and people with disability are to be considered when designing the walkways. It is because mostly these groups depend on the facilities that are provided on the sidewalks to stroll along the path. The elderly

respondents in this study claimed that they needed more comfortable and convenient sidewalks. It was different from that of the younger respondents who stressed more on the safety aspects of sidewalks including crossing facilities. However, both groups agreed that they chose to walk as they believed that the safety of the sidewalks is acceptable.

Furthermore, Khan *et al.* (2015) proved that developers and planners of the housing estates in Malaysia did not consider infrastructures or environment for pedestrians in their housing development models. This resulted in less social interactions among the residents and less pedestrian activities and also reduced the freedom to play and do outdoor activities for the children in the residential areas. In addition, the pedestrian walking behaviour and willingness to walk were found to have a strong relationship with the land use form and types of pedestrian activities.

There is a study on the behavioural observation of street liveliness in the Meldrum walk in Johor Bahru by Lamit *et al.* (2012). The methodology used in this study involved pedestrian traffic counting surveys and behavioural mapping at selected streets. Pedestrian traffic counting surveys focused to attain the number of walking people and the characteristics of walking behaviour. Meanwhile, mapping activities were carried out by observing the types of walking activities at a specific time. More opportunities and social activities in the walking street make it livelier with activities for pedestrians in different age groups and with different capabilities. Moreover, this will help promote the street environment conditions to make it a liveable city.

Therefore, in order to provide an appropriate design for pedestrian facilities, the implementation of Pedestrian Level of Service (PLOS) is claimed as a baseline factor that improves the design. However, Malaysia still lacks a PLOS study to come out with suitable guidelines for pedestrian facilities, considering the factors that have been discussed in the above paragraphs.

RESULTS AND DISCUSSION

Pedestrian simulation: Currently, pedestrian studies that are related to the use of simulation are increasingly needed in Malaysia. In the future, it will be all the more essential when the TOD and compact city concept is well accepted and applied. These new concepts of urban designing have boosted mobility from one destination to another destination through transit and walking. Therefore, to equip with these new urban design concepts, the preparation for pedestrian infrastructure and facilities must be undertaken at an appropriate level.

In order to understand pedestrian movements at confined spaces such as train stations, simulation studies are required. It is not only to assure that the evacuation process is provided at the specific time given but also to identify the effective path routes for emergency evacuation which can be determined through the simulation. According to Rahman, pedestrian simulation is important because it will assist the railway operators, planners and architects to shape the best design for future planning, operation and maintenance of the train stations. The simulation also helps calculate the design capacity, best routes for pedestrians, appropriate queuing patterns at the ticket window and also important features of the evacuation procedures.

For example, Mustafa and Ashaari (2015) did an assessment on the pedestrian movement characteristics in the Masjid Jamek train station. The researchers found that the behaviour of the pedestrians was affected by the space available in the station during either emergency or non-emergency situations. In addition, Bohari *et al.* (2016) claimed that male pedestrians in the Masjid Jamek train station walked faster than female pedestrians, especially on the straight path routes. Therefore, during an emergency evacuation, the different capabilities of both genders need to be acknowledged. Both of the above studies employed SimWalk Software for the simulation. The importance of pedestrian emergency evacuation has also been highlighted by Tajedi *et al.* (2016) in their framework of study for evacuation at the train station. The researchers stated that Malaysia should have its own standard guidelines for evacuation in the train station because the design of the current stations is using the NFPA standard criteria that differ from the walking environment in Malaysia.

On the other hand, building evacuation issues are also another focus point that holds high significance in the pedestrian evacuation study. The building evacuation usually considers group behaviours, wayfinding and social culture in order to identify the ideal evacuation time. Therefore, it is very important to observe the evacuation behaviour in a fire drill to identify the sense of risk or danger during a real incident in a building. For example, Mustafa *et al.* (2013) use a SimWalk software to simulate the emergency evacuation in an eight-level building in a university that includes lecture rooms and small offices. The findings of the study showed that bottleneck conditions at the exit facilities such as stairways caused a delay in the evacuation. Aik (2012) stated that the bottlenecks that occurred during the evacuation were actually caused by the wayfinding behaviours of the pedestrians.

In addition to the emergency evacuation, pedestrian evacuation during a disaster is also important. Malaysia has also been facing several disastrous events such as the tsunami and floods. Abustan *et al.* (2012) stated that the simulation study can support the emergency disaster risk management plan. The researchers had developed a new crowd behaviour simulator identified as Crowd Behaviour Simulator for Disaster Evacuation (CBS-DE) which enables tracking individual behaviour during an evacuation. In this simulator, pedestrian behaviours such as avoidance of collision and alignment between adjacent pedestrians are well reproduced in the contraflow behaviour. The evacuation simulation is also capable of showing the effect of the self-evasive agent on the crowded evacuation behaviour. This CBS-DE was used to perform the evacuation process during the tsunami disaster at the Teluk Batik beach.

CONCLUSION

This study reviews topics related to pedestrian safety issues, crossing behaviours, willingness to walk and pedestrian simulation studies in a Malaysian context. It has been found that it is not easy to encourage the walking culture in Malaysia as the roads are mostly designed for motorised vehicles. However, it is still not impossible to modify the design of the existing road networks but the cost will be inevitably high. This will also call for the cooperation of all authorities and local municipals.

As a country that is still booming with land use development, it is essential that Malaysia focuses on its strategic planning for pedestrian pathway connectivity and safety elements in the new townships and residential areas. For example, many of these new townships will comprise schools, offices and parks in their planning which will necessitate the connectivity of walkways not only for pedestrian access but also for safety purposes. This study suggests several future studies and actions that can be performed to boost the walking culture in Malaysia.

First, studies on pedestrian planning should involve a joint venture between researchers and the municipal councils. Many of the findings in the academic studies should be shared with the authorities as this may be useful in the planning of a city. Furthermore, the study without the involvement of both parties could lead the researchers to solve the real needs of the authorities inappropriately.

Second, it is important to start with the assessment of the connectivity of the current pedestrian walkways in the town or city. The information regarding the walkway

accessibility can be visualised by using an online map which can also be used in the city planning, especially the one involving the development of a new township. The pedestrian network mapping can be done in various ways, such as by using GIS (Azmi and Ahmad, 2015). Apart from this, the data gathered from the assessment can be transformed into web and mobile applications to enable the pedestrians to use the information for wayfinding or route choice. In addition, the most important thing is to prepare a platform for the pedestrians to report the status of the walkway connectivity and give rating, suggestions and opinions through the applications (Quercia *et al.*, 2015). The usage of information technology applications for pedestrians is also a move to encourage the walking culture. Besides, the feedback from the pedestrian is useful for the authorities to maintain or upgrade the pedestrian facilities.

Third, it is very beneficial to emphasise the use of the guidelines for pedestrian walkway designs, especially for new townships and residential areas. For example, the federal department of town and country planning issues a guidebook for the installation of bollards and guardrails in order to segregate the pedestrians from the motor vehicles. The purpose of the railing is not only to decrease the risk of pedestrian crash with other vehicles but also to reduce the risk of snatch thefts. Meanwhile, Stoker *et al.* (2015) also suggested that facilities such as marked crossing, pedestrian overpasses and underpasses can reduce the pedestrian exposure to the traffic.

Fourth, another part of the study that can be explored is the walkability and accessibility of the vulnerable groups such as children and people with disability in the built environment. Although, there are few studies that focus on the accessibility of people with disabilities to the pedestrian facilities including the access to buildings and pedestrian walkways (Hussein and Yaacob, 2012; Bashiti and Rahim, 2016) there is still plenty of room to investigate whether these access and walkways, especially in the residential areas are considering the needs of these people such as the suitable width for wheelchair or appropriate pavement for people with visual impairment. Furthermore, Yusof and Jones (2013) reported that the understanding of the universal design is still low in Malaysia, especially in the responsible parties who are involved in urban planning and designing of a city.

Similarly, the importance of pedestrianisation design must take into account the needs of children as pedestrians. Safe design for walking and crossing facilities is important for the children. This is because road accidents that involve children happen mostly during the crossing activity. Therefore, this matter highlights the safety issues of the current crossing

facilities in Malaysia. Hassan *et al.* (2014) suggested some insights into traffic signal improvement. The researchers recommended using a puffin crossing instead of a pelican crossing at signalised crosswalks. This type of signalised crossing is effective in reducing the risk of conflict between pedestrians who walk at a slow pace while crossing (e.g., the elderly, children and people with disabilities) and the vehicles that start to stop or move in front of the crossing area.

Lastly, it is important to address the pedestrian behaviour through a pedestrian simulation study. For example, microscopic traffic simulation is used to understand the complexity of pedestrian interaction with the vehicular traffic network. The findings from the simulation will not only benefit the engineers but also the urban planners and the authorities in making decisions. In addition, the pedestrian simulation study is also important in the early stage of design and construction of buildings, transit hubs such as airports, train stations, bus terminals, jetty or any infrastructures that involve any pedestrian movements. It is not only beneficial to evaluate the peak-hour conditions but also very important in designing the emergency evacuation plan. Although, there are few studies that have been carried out in this subject in Malaysia it still calls for more extensive simulation studies.

To conclude, several suggestions highlighted in this study are expected to lead to future research works that are related to pedestrians, not only in Malaysia but also in other developing nations that face difficulties in dealing with pedestrian issues. It is not easy to prompt the auto-oriented society to accept the walking culture. However, to bequeath a sustainable environment for the future generation, something needs to be done from now. Moreover, walking is beneficial for the mental and physical health which increases the quality of life of the society.

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REFERENCES

- Abustan, M.S., E. Harada and H. Gotoh, 2012. Numerical simulation for evacuation process against tsunami disaster at Teluk Batik in Malaysia by multi-agent DEM model. *Proc. Coastal Eng. JSCE.*, 3: 56-60.
- Afsar, B., Y.M. Yunus and J.M. Yusof, 2015. Assessing essential facilities for daily walking in a tropical campus. *Adv. Environ. Biol.*, 9: 76-78.
- Aik, L.E., 2012. Microscopic dynamics of a large-scale pedestrian evacuation model. *Int. J. Phys. Sci.*, 7: 182-190.
- Ariffin, R.N.R. and R.K. Zahari, 2013. Perceptions of the urban walking environments. *Procedia Soc. Behav. Sci.*, 105: 589-597.
- Azmi, D.I. and P. Ahmad, 2015. A GIS approach: Determinant of neighbourhood environment indices in influencing walkability between two precincts in Putrajaya. *Procedia Soc. Behav. Sci.*, 170: 557-566.
- Bachok, S., S.H. Anuar and N.Z. Harun, 2004. Light-rail transit stations and pedestrianisation: case studies of travel patterns and behaviours at tunku abdul rahman street and the central market, Kuala Lumpur. *Proceedings of the Paper Presented Walk21-V Cities for People: The Fifth International Conference on Walking in the 21st Century*, June 9-11, Copenhagen, Denmark, pp: 1-19.
- Bahari, N.I., A.K. Arshad and Z. Yahya, 2012. Pedestrians perception of the sidewalk facilities in Kuala Lumpur's commercial area. *Int. Sustain. Civ. Eng. J.*, 1: 28-36.
- Bashiti, A. and A.A. Rahim, 2016. Physical barriers faced by people with disabilities in shopping malls. *Procedia Soc. Behav. Sci.*, 111: 414-422.
- Bohari, Z.A., S. Bachok and M.M. Osman, 2016. Simulating the pedestrian movement in the public transport infrastructure. *Procedia Soc. Behav. Sci.*, 222: 791-799.
- Ewing, R., R.A. Schieber and C.V. Zegeer, 2003. Urban sprawl as a risk factor in motor vehicle occupant and pedestrian fatalities. *Am. J. Public Health*, 93: 1541-1545.
- Goh, B.H., K. Subramaniam, Y.T. Wai, A.A. Mohamed and A. Ali, 2012. Pedestrian crossing speed: The case of Malaysia. *Int. J. Traffic Transport Eng.*, 2: 323-332.
- Hamidun, R., S.Z. Ishak and I.R. Endut, 2014. Pedestrian crossing scenario model using petri nets. *Procedia Soc. Behav. Sci.*, 129: 406-413.
- Hanan, S.A., N.F. Said, A.A.M. Kamel and S.A.F. Che, 2015. Factors that influences pedestrian intention to cross a road while using mobile phone. *Int. J. Econ. Financial Issues*, Vol. 5,
- Hassan, S.A., O.C. Puan, N. Mashros and N.S.A. Sukor, 2014. A review into traffic signal improvement at pedestrian signalised crossings. *J. Technol.*, 70: 27-31.
- Hussein, H. and N.M. Yaacob, 2012. Development of accessible design in Malaysia. *Procedia Soc. Behav. Sci.*, 68: 121-133.
- Khan, T.H., A.D. Isah, E. Anjomshooa and S. Sabri, 2015. Users perceptions on pedestrian prioritized neighborhoods: A study on terrace row housing estates in Malaysia. *Int. J. Built Environ. Sustainability*, 2: 29-38.

- Krishnan, T.H., S. Kulanthayan, M.H. Juni and S.M. Said, 2013. Predictors of parental pedestrian safe road behaviour in rural areas in Malaysia. Executive Editor, 4: 140-140.
- Ladin, M.A., A. Ismail, R.A.A.O. Rahmat and S.I. Albrka, 2014. Developing a model for planting trees along the walkway. J. Technol. Sci. Eng., 69: 107-110.
- Lamit, H., A. Ghahramanpouri and S.S. Nia, 2012. A behavioral observation of street liveliness in meldrum walk, johor bahru of Malaysia. Int. Transaction J. Eng. Manage. Appl. Sci. Technol., 4: 3-14.
- Leh, O.L.H., Z. Zamri, M.Z.M. Amin and M.A. Marzukhi, 2013. User's preference and perception on the pedestrian crossing in Malaysia: The case of ampong road, Kuala Lumpur. Plann. Malaysia J., 11: 85-96.
- Ling, H.L.O., K.H. Ting, O. Dasimah, A. Jamalunlaili and T.S. Fong, 2010. Transit oriented neighbourhood for better environmental health. Proceedings of the 2010 International Conference on Science and Social Research, December 5-7, 2010, IEEE, Shah Alam, Malaysia, ISBN:978-1-4244-8986-2, pp: 516-521.
- Makki, S., M. Surat, A.I. Cheani, H. Farkisch and H.R. Mokhtarian, 2012. The importance of design characteristics in walking from student's perspective: A case study in Universiti Kebangsaan Malaysia. J. Build. Perform., 3: 42-49.
- Malek, A.H., 2010. Modelling on pedestrian accidents in Malaysia. Ph.D Thesis, Universiti Teknologi MARA, Shah Alam, Malaysia.
- Mustafa, M. and Y. Ashaari, 2015. Assessing Pedestrian Behavioral Pattern at Rail Transit Terminal: State of the Art. In: InCIEC 2014, Hassan R., M. Yusoff, A. Alisibramulisi, A.N. Mohd and Z. Ismail (Eds.). Springer, Berlin, Germany, pp: 1245-1254.
- Mustafa, M., N. Baser and Y. Ashaari, 2014. Evaluating pedestrian crossing speed distribution: A case study of Shah Alam. Proceeding of the 5th Brunei International Conference on Engineering and Technology, November 1-3, 2014, IET, Shah Alam, Malaysia, ISBN: 978-1-84919-991-9, pp: 1-5.
- Mustafa, M., Z.A. Rahman and S. Bachok, 2013. Agent based simulation for pedestrian movement during panic situation. Master Thesis, Universiti Teknologi MARA, Shah Alam, Malaysia.
- Oxley, J., A. Jamaludin and M. Johnson, 2012. Analysis of child pedestrian deaths and serious injuries in Malaysia. J. Australas. Coll. Road Saf., 23: 30-37.
- Pour, M.H., J. Prasetijo, A.S. Yahaya and S.M.R. Ghadiri, 2012. Modeling vehicle-pedestrian crashes with excess zero along Malaysia federal roads. Procedia Soc. Behav. Sci., 53: 1216-1225.
- Quercia, D., L.M. Aiello, R. Schifanella and A. Davies, 2015. The digital life of walkable streets. Proceedings of the 24th International Conference on World Wide Web, May 18-22, 2015, ACM, New York, USA., ISBN: 978-1-4503-3469-3, pp: 875-884.
- Qureshi, S. and C.S. Ho, 2011. Towards putrajaya green city 2025 implementing neighbourhood walkability in Putrajaya. Ph.D Thesis, University of Technology, Malaysia, Johor Bahru, Malaysia. <http://www.asialeds.org/sites/default/files/resource/file/Towards-Putrajaya-Green-City-2025-Implementing-Neighbourhood-Walkability-In-Putrajaya.pdf>
- Raidine, N.S., K. Hamsa and A. Azeez, 2014. Analysis on pedestrian volume pattern and pedestrian infrastructure provision in IIUM gombak campus. Proceedings of the International Conference on Urban and Regional Planning, May 9-11, 2014, IREP Co Ltd, Japan, pp:1-17.
- Rostam, K. and H.M. Noor, 2014. Barriers and motivations for sustainable travel behaviour: Shah alam residents perspectives. Procedia Soc. Behav. Sci., 153: 510-519.
- Shamsuddin, S., N.R.A. Hassan and S.F.I. Bilyamin, 2013. Walkable in order to be liveable. J. Asian Behav. Stud., 3: 111-121.
- Stoker, P., C.A. Garfinkel, M. Khayesi, W. Odero and M.N. Mwangi *et al.*, 2015. Pedestrian safety and the built environment: A review of the risk factors. CPL. Bibliography, 30: 377-392.
- Tajedi, N.A.A., S.A. Sukur, S.M.S.S.M. Ismail and H.M. Isa, 2016. Analysing the simulation model of risk perception based of the pedestrian behaviour at underground station in Malaysia: A framework paper. ARPN. J. Eng. Appl. Sci., 11: 5409-5412.
- Yusof, M.L. and D. Jones, 2013. Universal housing: Malaysian architect's perception on its implementation. Proceedings of the International Conference on Asia Pacific Network for Housing Research, August 20-22, 2013, Deakin University, Geelong, Victoria, ISBN: 978983445034, pp: 1-7.
- Zakaria, J. and N. Ujang, 2015. Comfort of walking in the city center of Kuala Lumpur. Procedia Soc. Behav. Sci., 170: 642-652.