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Pedestrian Behavioural Intention to Use Crossing Facilities Based on Extended Theory of Planned Behaviour

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ABSTRACT

In Malaysia, pedestrian has become a regular transportation mode with major importance in human society. For pedestrians to cross the busy main road, crossing facilities is perhaps the most crucial. It is most important to establish a way of preventing a tragedy and to make the pedestrian aware of the need to perform a safety crossing in order to prevent an accident. The objectives of study are to investigate the contributing factors that affect pedestrians to use a crossing facility and to analyse the relationship between the contributing factors and a safe crossing behaviour. In this analysis, Theory of Planned Behaviour (TPB) was used to explain this outcome and decide whether characteristics and attitude influence the pedestrian's behaviour involved in the accident. For the purpose of gathering information from the respondents, a questionnaire was used as a research tool which consists a series of questions and other prompts. The collected data were analysed using descriptive statistics, correlation, factor analysis and Structural Equation Model (SEM). Results show all variables are significantly contributed to safe crossing behavior. There are two most dominant variables namely perceived consequence and expectation of pedestrian toward safe crossing behavior. TPB model is therefore capable of explaining the significant factors influencing the pedestrian's intention to safe crossing behaviour. The most dominant variable of the extended model of TPB is expectation. Pedestrian's expectation is high toward proper crossing facility, authorities should intervene with the design infrastructure to attract more pedestrians to use the crossing and there is a need to provide sufficient signal time for pedestrians to cross the street safely.

Keywords: Pedestrian; pedestrian facility; safe crossing; theory of planned behaviour

INTRODUCTION

In Malaysia, accentuation is being placed on non-motorized mode of transport; for example, walking and cycling for short trips (Johari et al. 2017). This mode of transport is healthier and ecologically well-disposed than motorized modes. Walking as a means of transport is defined as people walking or using aids to enable them to walk. When compared to other road users, on the road, pedestrians are the most vulnerable as they are always at risk on their daily trips (Goh et al. 2012).

Based on statistical reports of road accident in Malaysia 2017 by Road Safety Department (JKJR), pedestrians are the third highest involved in traffic accidents after motorcycles and car drivers. Pedestrian crashes that cause too much injury or even death are some of the country's critical issues. In this respect, the increase in the number of pedestrians is also causing an increase in the number of accidents (Nor et al. 2017). Otherwise, the significant reason for the increase number of pedestrian accidents is the lack of use of crossing facilities and the careless crossing of pedestrians (Goh et al. 2012).

In relation to the issue of pedestrian traffic, different crossing systems are designed to help pedestrians cross safely. Signalised crossing facility is a major choice of pedestrians to cross the road in a short time. Therefore, rather than using crossing facilities, pedestrians can cross the border illegally. Because of the uncomfortable crossing points or inadequate facilities design, many of the pedestrians are unlikely to use this crossing facility. Different road section environmental characteristics will influence the choice of pedestrian crossing, thereby influencing the rate of use of the crossing facility. Pedestrian behaviour when crossing and their decision to cross are all about their own lives and time, how they respond to the surrounding environment, how they change their attitude while crossing, how they make their strategies cross and how they communicate with each other.

Road infrastructure can be identified as the basic facilities, services and facilities required for road, highway and street transport to exist (Idrus et al. 2014). Road users are those who use the streets and highways, such as drivers, passengers, pedestrians, motorists, cyclists etc. Road user is important for the society to function. All road users have their own different pathway or lane in using the roads. Roads are also physical and psychological obstacles to pedestrian travel, with adverse effects on mobility and social inclusion (Anciaes & Jones, 2018). This suggests that the growth of the economy is closely linked to the development of transport. Every year, Malaysia is increasing in its population. In 2016, the total population of Malaysia was estimated at 31.7 million people, an increase of 0.5 million people as compared to 31.2 million people in 2015 with 1.5 percent population growth rate for the same period (Department of Statistics Malaysia 2016).

LITERATURE REVIEW

Walking is defined as perhaps the easiest and most common mode of transportation; and broadly speaking, an individual is called a pedestrian who walks instead of traveling in a vehicle. Pedestrians, also defined as Vulnerable Road Users (VRU), are not connected to any form of vehicles relative to other road users and are always at risk when they make their daily trips. They are endangered (more exposed) during interaction with road traffic systems, primarily in road accidents unlike other road users with 'shell' protection within vehicles, along with motorcyclists and cyclists with compulsory/ recommended crash helmets (Ariffin et al. 2009).

Road accidents occur on federal and state roads as a result of negligence or omission by any party or as an environmental factor resulting in a collision involving at least one moving vehicle that causes damage or injury to any individual, property vehicle, structure or animal as reported by the police (PDRM 2012). According to Statistical Road Accidents Reports 2017, there were 521,466 road accidents in 2016 in Malaysia (JKJR 2017). In 2016, the number of fatalities for road accidents was 7,152, which is an average of 20 deaths on the country's roads every day. The number of injuries in 2016 was 19,073 of which 4506 were seriously injured and 7415 were light or minor injured. Moreover, Figure 1 shows that Malaysia recorded more than 450 pedestrian fatalities each year (2008-2016) and by rank, pedestrian is consistently the third after motorcyclists and car occupants (JKJR 2017).

According to Ontario Traffic Manual (2010), traffic signals are provided at pedestrian crossings where the road traffic is heavy and there is a need for time-separation for safe crossing. When road users are strictly alert to the rules of traffic signals, conflicts and collisions between road users can be prevented (Cambon et al. 2009). Occasionally, however, if a person is influenced by the personal needs of a pedestrian; for example, being late for a meeting or because of weather conditions, including such heavy rain, the pedestrian can take a risk to quickly reach the destination. Pedestrian may choose to break the signals and cross the road earlier if they feel that it is safe (Koh et al. 2014).

Consideration must be given to the design and construction of pedestrian services, different features and requirements. The facilities are formed by protection, comfort, time traversing, accessibility and personal security (Anciaes & Jones 2018). Construction or upgrading pedestrian crossing facilities often becomes the closest equivalent to minimize the effect of roads on pedestrians as approaches such as reducing traffic rates or raising speed limits reach social and political opposition to their effects on the mobility of private and public motor users (Anciaes & Jones 2018).

There are currently many forms of pedestrian crossing used worldwide to ensure pedestrian safety (Junet 2013). According to Arahan Teknik Jalan 18/97 JKR, Malaysia has constructed and provided some crossing facilities to assist pedestrians to cross busy roads which include Pedestrian Bridges, Signalised Pedestrian Crossings, Zebra Crossings, School Children's Crossings and Combined Zebra and Signalised Pedestrian Crossings.

Pedestrian bridge is one of the safest and most effective ways for pedestrians to avoid collision by reducing confrontation and provide isolation on the path between pedestrians and vehicles (Kadzim 2012). Furthermore, Hamidun reported that in Malaysia, pedestrians are unlikely to use the pedestrian bridge if they have to travel more than their accepted distance. The second safety crossing facility is combined zebra and signalised pedestrian crossing. There is still a gap to improve in order to reduce pedestrian casualties even though several safety approaches are focused towards vehicle drivers and pedestrians (Ariffin et al. 2009).

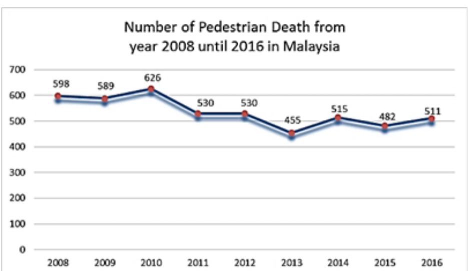

FIGURE 1. Number of Pedestrian Death from the year 2008 to 2016 in Malaysia (JKJR, 2017)

There are many factors play important roles in the choice of pedestrian crossing influence pedestrian's behaviour. Usually, the behaviour of pedestrian crossing is influenced by various factors related to pedestrian movements, pedestrian behaviour, road conditions, traffic conditions and environment. The decision of pedestrians as to when and where to cross the road is very complicated and it is typically defined by different factors such as comfort, convenience, accessibility and safety. This study analyses pedestrian's behaviour based on the extended Theory of Planned Behaviour.

The theory that suggests a paradigm to be used in this sense is the Theory of Planned Behaviour (Ajzen 2011), which in turn is an extension of theory of propositional control (Forward 2009). For example, one of the TPB's advantages is its relative parsimony; it provides a simple model of proximal influences on expectations and behaviour (Leandro 2012). According to TPB, its ability to predict these behaviours has been endorsed. TPB is defined by three preceding variables, which are attitude towards the behaviour, subjective norms and perceived behavioural control (Poulter et al. 2008). In addition, this study added three variables (perceived consequence, expectation, perceived safety) which have been studied in the previous research.

METHODOLOGY

STUDY LOCATION

Johor is the second state after Selangor that has the highest road accidents and fatal accidents statistics as presented in Figure 2 and 3. In terms of pedestrian fatalities, Johor has the second highest count with 129 fatalities after the number of pedestrian fatalities in the state of Selangor (Ariffin et al. 2009). In the year 2016, Batu Pahat-Ayer Hitam-Kluang (Route FT050) was the third highest route of daily traffic average in Johor state (Transport Statistics Malaysia 2017). Jalan Kluang, Route FT050 is the main route which connects Ayer Hitam district to Batu Pahat district. The federal Route FT050 has experienced many road accidents and the percent of mortality and serious injury has increased from year to year (Transport Statistics Malaysia, 2016). The location of this study were conducted at selected signalised crossing facilities located at Jalan Kluang (route FT050), Batu Pahat area.

MEASUREMENT AND INSTRUMENT DESIGN

Samples are taken from an unreplaced group, which is a subset of a population of this case. Elements are intentionally selected as a reflection of the population of the study area. This sample size is fairly adequate to evaluate descriptive statistics, correlation analysis and structural equation model (Ambak et al. 2010). The sample size is calculated using formula as it requires level of accuracy, confidence and variability. The researcher uses the formula of Cochran that was introduced in the year 1977 since it is appropriate to be used in determining the sample of both categorical and continuous results. Based on the formula and previous study, the researcher set the minimum sample size of 250 respondents among pedestrians.

A questionnaire is a study tool that consists of such a set of questions and other information to collect data from respondents (Sisiopiku & Akin, 2003). A questionnaire was designed and there was no specific TPB crossing facility questionnaire. Questions were asked to respondents, and their responses based entirely on their self-assessment, their perspective on the crossing facilities and the general quality of the crossing facilities. For this research, the 7-point Likert scale was employed, and the respondents were asked to respond to each of the statement in terms of 7 degrees of agreement or disagreement.

DATA COLLECTION

Statistics is an applied mathematics branch that involves data collection and analysis and the use of mathematical principles to draw conclusions about the findings of hypotheses (Ha & Ha 2012). Descriptive statistics are very valuable because it would be hard to define what the analysis showed, particularly if there are a lot of them and if they simply presented the raw data (Papadimitriou et al. 2017). A descriptive analysis is the first step for the exploration of respondent's information and experience. Frequency, mean and standard deviation of descriptive analysis are used for this study. Coefficient of correlation is a statistical indication of the degree of fit of the data to a line and the type of relationship (direct or inverse) (Ha & Ha 2012).

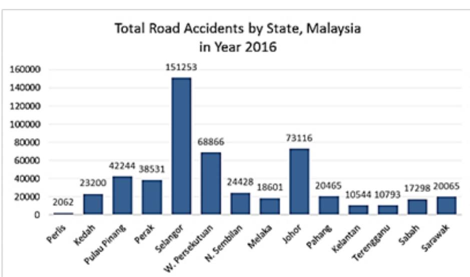

FIGURE 2. Total Road Accidents by State, Malaysia in the year 2016

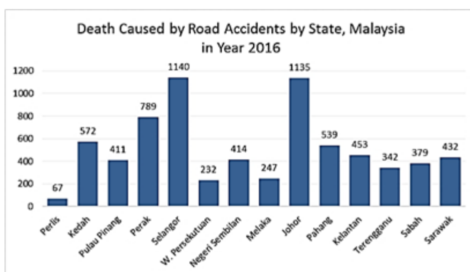

FIGURE 3. Death Caused by Road Accidents by State, Malaysia in the year 2016

The variables used to measure the correlation analysis are attitude, subjective norms, perceived behavioural control, perceived consequence, expectation, perceived safety, intention and safe crossing behaviour. The value of correlation between the variables is interpreted in Table 1.

A Factor analysis was commonly used to classify and arrange the large number of questionnaire items in a specific structure based on an independent variable (Chua, 2014). For this study, two methods of factor analysis were used; exploratory factor analysis and confirmatory factor analysis. Exploratory factor analysis (EFA) is commonly and widely used in social science statistical method (Costello & Osborne, 2005). Confirmatory Factor Analysis (CFA) is a special case of structural equation modelling (SEM) in which relationships between latent variables are modelled as covariances/correlations rather than as structural relationships (Costello & Osborne, 2005). For SEM, there are several fitness indices representing how the model fits the results. It is recommended that each model category at least used compiled with some of the fitness index (Ahmad et al. 2016). The information concerning the level of acceptance for fitness indexes is presented in Table 2.

RESULT

This research was carried out among 274 pedestrians, with 153 (55.8 %) males and 121 (44.2 %) females. Moreover, the result showed that 104 respondents (38.0%) were in the age range between 21-30 years old. Result also reported that more than half of the respondents (187 or 68.2%) had higher education, 107 respondents (39.1%) worked at private sector and 89 respondents (32.5%) had a monthly income between RM 2001 to RM 3000. Overviews on crossing facilities among pedestrians investigated among the respondents were comfort, convenience, safety, cleanliness, and overall quality of crossing facilities. The respondents scaled the rating based on their experience when crossing the road by using the crossing facilities. Table 3 shows the mean score and standard deviation for each of the item. The highest score mean was 5.99 in which most of the respondents said the function of signalised zebra crossing is excellent.

For further detail, more people have accepted that the crossing facility is an excellent option and a great choice to cross the road safely. At the same time, some of the typical needs are based on the comfort of the facility and the quality of the design of the construction. First, the period for red and green light must be dependent on the length of the road crossing. Depending on the speed of the walker, the time duration must be considered. In addition, the level of brightness of the zebra line at the signaled crossing is also weak. Several people have expressed the opinion that the authorities must protect the visibility of the zebra row. In turn, the waiting signpost at the waiting place before crossing the road must be created with a wide area for cyclists and other road users to see the pedestrians. Alternatively, there are clear signs and directions at the crossing point. Overall, user satisfaction on the safety provided by the use of the crossing facility is good enough.

The correlation between safe crossing behaviour with intention, attitude towards behaviour, subjective norm, perceived behavioural control, perceived consequence, expectation and perceived safety was investigated. The expectation and intention have moderate positive relationship (r = 0.570) and statistically significant

TABLE 1. The strength coefficient of correlation

Correlation Coefficient (r)	Correlation Strength
.91 to 1.00 or -.91 or -1.00	Very Strong
.71 to .90 or -.71 or -.90	Strong
.51 to .70 or -.51 or -.70	Moderate
.31 to .50 or -.31 or -.50	Weak
.01 to .30 or -.01 to -.30	Very Weak
.00	No correlation

TABLE 2. Level of Acceptance of some SEM indices (Costello & Osborne, 2005)

Name of Category	Name of Index	Index Full Name	Level of Acceptance
Absolute Fit	Chisq, $\chi 2$	Discrepancy Chi Square	$\chi 2 > 0.05$
	RMSEA	Root Mean Square of Error Approximation	< 0.08
	GFI	Goodness of Fit Index	> 0.90
Incremental Fit	AGFI	Adjusted Goodness of Fit	> 0.85
	CFI	Comparative Fit Index	> 0.90
	TLI	Tucker-Lewis Index	> 0.90
	NFI	Normed Fit Index	> 0.90
Parsimonious Fit	$\chi 2$/df	Chi Square/Degree of Freedom	< 5.0

TABLE 3. Mean and Standard Deviation of items

Items	Mean Score	Standard Deviation
Function of signalised zebra crossing.	5.99	1.061
Duration of red light to wait at the signalised before crossing the road.	5.01	1.174
Duration of green light signal when crossing the road.	4.93	1.232
Road distance is ideal for crossing the road.	4.89	1.213
The level of brightness on the yellow or white line of zebra crossing.	3.23	1.516
Comfortable signal waiting location before crossing the road.	2.77	1.063
The location of signalised zebra crossing facility is suitable to cross the road.	5.16	1.222
Suitable environment around the crossing facility.	5.19	1.328
Signage and instructions are found at the place of crossing facility.	5.76	1.121
Satisfied with security provided when using the crossing facility.	5.11	1.331

($p<0.01$). Other than that, the correlation between perceived consequence and intention variables showed a very weak negative relationship ($r = -0.287$) but statistically significant ($p<0.01$). Positive weak correlation coefficients (but statistically significant $p<0.01$) were found consecutively between perceived behavioural control and intention ($r = 0.499$), perceived safety and intention ($r = 0.459$), subjective norm and intention ($r = 0.396$). The correlation between attitude toward behaviour and intention variables showed a very weak positive correlation ($r = 0.281$) but statistically significant ($p<0.01$). Lastly, the correlation relationship between intention and safe crossing behaviour variables showed positive high moderate ($r = 0.645$) and statistically significant relationship ($p<0.01$). Typically, this indicated that crossing points should be more natural and more comfortable for pedestrians to cross the road as to encourage the development of better traffic and engineering networks to draw more pedestrians.

FACTOR ANALYSIS

EXPLORATORY FACTOR ANALYSIS (EFA)

Kaiser-Meyer-Olkin (KMO) and Bartlett's test for extended TPB model were analysed. KMO is a coefficient explaining the level of relationship adequacy of all variables (Suraji & Tjahjono, 2012). Factor analysis is suitable when the value of KMO is greater than 0.50 (Chua, 2014). The result analysis showed that KMO measure of sampling adequacy was 0.899. The KMO value of 0.899 stated that the data did not have any serious problems with multi collinearity, and all items were adequate for factor analysis. The aim of Exploratory Factor Analysis (EFA) is to use fewer variables to define a multidimensional data set. In general, the elements that make up these factors (or components) should be more associated with each other than the factors with each other (Samuels, 2016). Based on the result obtained, EFA values for all variables were above 0.5 which showed that the Variance of Extracted calculates by its latent variable (factor) in each indicator variable.

CONFIRMATORY FACTOR ANALYSIS (CFA)

Based on the analysis, this model is overidentified. Overidentified model means that the model has a number of distinct parameters to be estimated which are less than the number of distinct sample moment and resulting into positive degree of freedom (Number of Distinct parameters < Number of distinct sample moment) (Ghozali, 2018). Table 4 shows the CFA result of goodness of fit indexes model such as GFI, CFI, TLI NFI and RMSEA of first order, second order and full structural model. All the CFA results showed acceptable and good measurement model fit for the data (except the AGFI's which were marginally below the level of acceptance).

HYPOTHESIS TESTING

Figure 1 shows the full structural model of extended TPB. Basically, hypothesis 1 (H1) was the relationship between attitude towards behaviour and intention. Based on the results, attitude towards the behaviour is significant and has positive impact on the intention among pedestrians ($p<0.05$, $\beta= 0.25$). Hypothesis 2 (H2) was the relationship between subjective norm and intention. The relationship between subjective norm is significant and has positive impact on the intention among pedestrians ($p<0.05$, $\beta= 0.16$). Hypothesis 3 (H3) was the relationship between perceived behavioural control and intention. The β values ($p<0.05$, $\beta=0.17$) between perceived behavioural control has a significant relationship and positive impact on the intention among pedestrians. Hypothesis 4 (H4) was the relationship between perceived consequence and intention. Based on the findings, perceived consequence has a significant relationship and positive impact on the intention among pedestrians ($p<0.05$, $\beta=0.30$). Next, hypothesis 5 (H5) was the relationship between expectation and intention. Based on the figure, the β value ($p<0.05$, $\beta=0.44$) between expectation has a significant relationship and positive impact on the intention among pedestrians. Hypothesis 6 (H6) was the relationship between perceived safety and intention. The β value ($p<0.05$, $\beta=0.23$) between perceived safety has a significant relationship and positive impact on the intention among

TABLE 4. Goodness of fit indexes for extended TPB

Name of Index	Level Acceptance	First Order	Second Order	Full Structural Model
Chi square	P > 0.05	240.403	289.341	331.644
RMSEA	RMSEA < 0.08	0.053	0.051	0.047
GFI	GFI > 0.90	0.917	0.911	0.906
AGFI	AGFI > 0.90	0.885	0.877	0.876
CFI	CFI > 0.90	0.973	0.971	0.973
TLI	TLI > 0.90	0.967	0.963	0.967
NFI	NFI > 0.90	0.941	0.933	0.932
Chisq/df	Chisq / df < 5.0	1.755	1.755	1.594

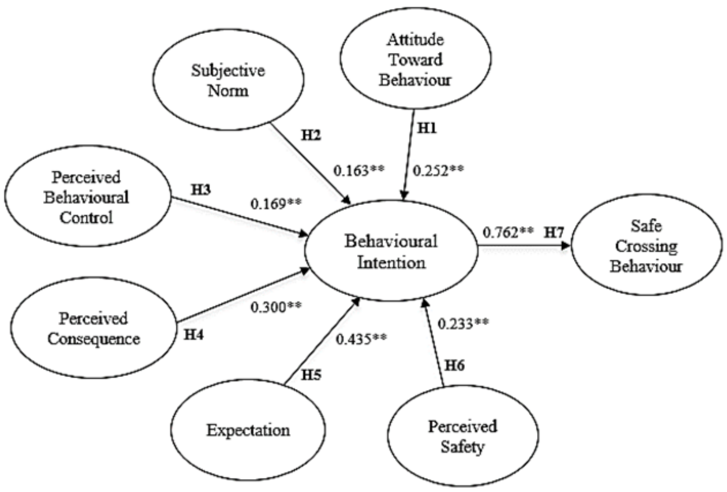

FIGURE 4. The full structural model of extended TPB

pedestrians. Lastly, hypothesis 7 (H7) was the relationship between intention and safe crossing behaviour. Based on the result, the β value ($p<0.05$, $\beta=0.76$) between intention has a significant relationship and positive impact on safe crossing behaviour among pedestrians.

CONCLUSION

Pedestrians' accident and fatality trend in road crashes has been improving in recent years although it remains third in rank behind motorcyclists and car occupants. Many studies have been conducted to discover the behaviour of pedestrians towards the use of crossing facility. There were many prior studies of pedestrian behaviour research used the actual model of Theory of Planned Behaviour and only some studies focused on the extended Theory of Planned Behaviour. Therefore, this study was conducted to investigate safe crossing behaviour among pedestrians, to determine the significant factors of intention and developed structural equation modelling based on the extended Theory of Planned Behaviour.

This research would examine the contributing factors that influence the use of crossing facility by pedestrians. The contributing factors were analysed based on actual variables of TPB (Attitude, Subjective Norm and Perceived Behavioural Control) followed by additional variables (Perceived Consequence, Expectation and Perceived Safety). The study examined the intention of pedestrians toward safe crossing behaviour for all variables. Most of the respondents considered that signalised crossing were the best choice for pedestrians to cross the road in busy traffic, but they need some structural refurbishment for safety, comfort and convenience purposes. Some people gave opinion that none of the facilities are being used by pedestrians because there was no appropiate reason to use it and the installations was not built in strategic locations and therefore not many individuals need to cross the road.

In addition, the second objective of this study was to analyse the relationship between the contributing factors and safe crossing behaviour. The outcome of this section showed that all factors were significant in the direction of intention towards safe pedestrian crossing behaviour. The extended TPB model is therefore capable of explaining the significant factors influencing the pedestrian's intention to safe crossing behaviour. The most dominant variable of the extended model of TPB is expectation. Since people's expectation is high toward crossing facility, authorities should intervene with the design infrastructure to attract more pedestrians to use the crossing and there is a need to provide sufficient length of signal time for pedestrians to cross the street safely. Lipovac et al (2013) finding in this matter can be followed. According to their results of the research in Doboj in Bosnia and Herzegovina, the installation of countdown timer can statistically significant reduce larger number of pedestrian offenders compared to the signal without countdown timer.

DECLARATION OF COMPETING INTEREST

None.

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