Pedestrians' involvement on safe crossing by using facilities based on extended theory of planned behaviour

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Abstract. Malaysia is considered one of the countries experiencing rapid growth in motorization, automobile and transportation systems. Walking is a major mode of transportation in developing countries where most road user are pedestrians who spend significant time on roads and using the road facilities. Department of Road Safety (JKJR) Malaysia statistics recorded that pedestrian is the third highest category involved in traffic accident after the car and motocycle drivers. The potential cause of death to the pedestrian was lack of using crossing facilities and careless crossing. The main strategy can be used to reduce the severity of pedestrian fatalities by using proper safe crossing facilities. To have better understanding of pedestrian behaviour, extended theory of planned behaviour used to predict the behavioral intention and to increase the proper usage of crossing facilities among Malaysian pedestrians. Full structured models are proposed and to be tested so that, the significant predictor can be identified. In future works, a factor analysis, known as *Structural Equation Model* (SEM) will be used in modeling exercise. The hypothesis testing will be conducted to determine the significance of the constructs. Furthermore, it will have great significance for the future on how to better utilize and enhance the pedestrian to use crossing facilities.

1 Introduction

Pedestrians, are defined as Vulnerable Road Users (VRU), are not related to any vehicle mode. Walking is one of the most usual ways of moving for each person. Walking can be categorized as one of the main modes of transport and it is healthier for human society [1]. Day by day population of pedestrian in Malaysia also increase. In relation to this, the increase in the number of the pedestrian is also the reason of the increasing number of a traffic accident. Apart from this, walking in Malaysia becomes a very important travel mode on daily basis in human society.

Department of Road Safety (JKJR) Malaysia statistics recorded that pedestrian is the third highest category involved in traffic accident after the car and motocycle drivers. Pedestrian accidents which leading to injury, and even their death, are some serious problems in the

country. To deal with pedestrian traffic problems, various crossing facilities are designed to assist pedestrian in crossing safely, for example, crosswalk (signalized and unsignalized), pedestrian overpass, and pedestrian underpass at intersection [2]. They has many reason to cross the road, the decision taken by pedestrian about when, where and how to cross a busy road usually involve a trade-off between safety and convenience [3]. Thus, pedestrian may cross illegally rather than using crossing facilities [2]. Many of the pedestrian are unwilling to use this crossing facility because of the inconvenient crossing points or improper design of the facilities. Different environment characteristics of road section may influence the pedestrian crossing choice, thus give an impact to the utilization rate of crossing facility.

As the decision of choosing either crossing at the intersection or mid-block is made at tactical levels and change of behavior is obtained at final stage at operational level [4]. Pedestrians' crossing behavior may not always be based on a simple stimulus-response process, but may also be strongly related to human factors [5]. Behavior of pedestrian while crossing and their decision to cross represents on how their crossing the road, how they react to nearby environment, how their behavior changes while crossing, how they make their tactics to cross and how they interact with one another [1].

2 Literature review

2.1 Pedestrian

Pedestrian is defined as people who go on foot or who utilize assistive devices to facilitate them to walk. Walking can be categorized as one of the main modes of transport and it is healthier for human society. Pedestrians interact with one another as they make their crossing decisions with group behaviour. The practical consideration is that, relative to many other aspects of human behaviour, road crossing is unusually amenable to empirical study. Pedestrian are most at risk when crossing a road section with a large amount of pedestrian vehicle interaction. This is because, pedestrian is more exposed to danger when using the road.

2.2 Pedestrian Behaviour

The pedestrian crossing behavior typically gets stimulated by different factors related to pedestrian movements, pedestrian characteristics, road conditions, traffic conditions and environmental surroundings. Pedestrians' judgment about when and where to cross the road are very complicated and are usually represented by various factors such as comfort, convenience, crossing simplicity and protection. The potential cause of the death to the pedestrian was lack of using crossing facilities and careless crossing.

2.3 Pedestrian Safety

In Malaysia, there are some organization involved to improve the safety of pedestrian which is IKRAM, JKJR and MIROS. This is because, the amount of road accident including the pedestrian is recorded higher in the urban area compared with the sub-urban area even though the rate of safety is already upgraded. According to the previous study, there are some important points to suggest the facilities for safety of pedestrians included flow of vehicles and pedestrians, average of crossing time (gap and acceptance of pedestrian) and previous accident report at the suggestion crossing area. To improve pedestrian safety, transportation planners and engineers are predominantly concerned with understanding and modeling pedestrian crossing behavior so as to increase the walkability

and also to reduce the interaction between pedestrians and vehicles at signalized intersections under mixed traffic conditions.

2.4 Pedestrian Crossing Facilities

Pedestrian crossing facilities are the most important facilities in part of crossing the road with safely. The facilities needed in the area such as school, offices, shopping complex, industrial and residential area. There are some facilities for pedestrian crossing in Malaysia that included Pedestrian Bridges, Signalised Pedestrian Crossings, Zebra Crossings, School Children's Crossings and Combined Zebra and Signalised Pedestrian Crossings. This facilities are needed to reduce the pedestrian fatalities and the traffic conflict between vehicles and pedestrians.

2.5 Behavioral Sciences Theories

Behavioral and social sciences theories and models have the potential to enhance efforts to reduce unintentional injuries [6]. The behavioral sciences or social psychological theories such as Theory of Planned Behavior [7], Health Belief Model [8] and Technology Acceptance Model [9] provide a potentially fruitful framework to understand in prediction of behavioral intention. Nowadays, there are many studies in transportation and traffic safety using behavioral science and social science theories. Previous study aimed to investigate the usefulness of the Theory Planned Behavior (TPB) in explaining pedestrian behavior. Theory Planned of behavior [7] can be successfully used as a frame of reference to explain and predict pedestrian behaviors. Zhou et al, study using TPB to examine pedestrians' self-reported violating crossing behaviour intentions by applying the theory of planned behaiour [10]. This study reported that applications of such behavior sciences theories or models (TPB) are able to predict and explain the significant predictor. Diaz, study Based on the theory of planned behavior, pedestrians' attitudes towards traffic violations and self-ratings of violations, errors and lapses [11]. The evaluation of the TPB model is reported violations, errors and lapses appear causally related to the intention to violate regulations, and this in turn with positive attitudes, subjective norm and perceived behavioral control. Therefore, based on previous studies, behavioral science or model theories are useful to predict the behavior of human being. Behavioral science when combined with engineering, epidemiology and other disciplines creates a full picture of the often fragmented injury puzzle and informs comprehensive solutions [12, 13].

2.5.1 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is an extension of the Theory of Reasoned Action (TRA). Ajzen, extended his earlier work with Fishbein [7] to include an explanation of all behaviors, not simply those under voluntary control by including measures of perceived behavioral control [14, 15]. Theory of Planned Behaviour is a social psychological model that has been successfully used to predict a wide range of health behaviour and intentions [16]. According to the theory of planned behavior people's attitude towards the behavior, their subjective norm, and their perceived behavioral control determine their behavior indirectly via their intentions [17]. Attitudes are to evaluations of a behaviour, which could be favourable or unfavourable [18, 10] while subjective norm, the belief about certain people that are important to the individual may approve or disapprove the behaviour[18, 10]. In addition, perceived behavioral control was people's perceptions of ability to perform a given behaviour [18, 10]. Whether a variable significantly contributes to the intention to perform

the behavior depends on the type of behavior assessed and the target population [7]. Studies have demonstrated the use of predictive utility of TPB to better understand the decision making process of the people who violate traffic rules [18, 10]. Studies by Evans and Norman, found that the three components of the theory were significant predictors of pedestrians' road crossing intention, but perceived behavioral control emerged as the strongest predictor, indicating that people were more likely to engage when the behavior was perceived to be easy [19].

Extended theory of planned behaviour was TPB has been coupled with other factors in this study to determine the behavioral intention towards using safe crossing behaviour. There are perceived consequence and perceived safety. Perceived consequence is defined as factors that may predict experiencing more positive or negative consequences. While perceived safety is defined as the degree to which an individual believes that using a facility will affect his or her well-being point [20]. This study conducted to explore the effect of the factors on pedestrians crossing behaviour.

2.5.2 Structural Equation Model (SEM)

Structural Equation Modeling (SEM) is a family of statistical techniques permitting researchers to test such models and as a hybrid of factor analysis and path analysis that researchers can test hypothesized relationships between constructs [12]. The development of structural equation modeling (SEM) methods and software has proceeded rapidly since the 1970s [21]. An SEM is an extremely flexible linear-inparameters multivariate statistical modeling technique and it has been used in modeling travel behavior and values since about 1980s [22]. Also, SEM is a technique used for specifying and estimating models of linear relationships among variables. Variables in a model may include both measured variables and latent variables. Latent variables are hypothetical constructs that cannot be directly measured [21]. SEM is a relatively new method and most applications have been in psychology, sociology, the biological sciences, educational research, political science, market research and travel behavior [22].

An SEM has two primary components: the measurement model and the structural model. The measurement model describes the relationships between observed variables (e.g., instruments) and the construct or latent variables are hypothesized to measure. In contrast, the structural model describes interrelationships among constructs. When the measurement model and the structural model are considered together, the model may be called the composite or full structural model [23]. Figure 1 shows a basic example of component in structural equation model.

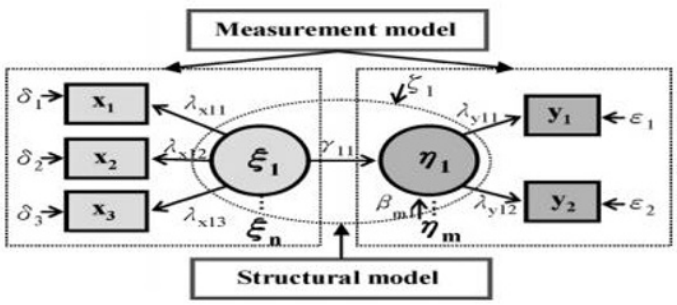

Fig. 1. A basic example of SEM component [23].

The measurement model is expressed as:

$$X_{1,\ldots,n} = \lambda_{x1,\ldots,xn}\ \xi_{1,\ldots,n} + \delta_{1,\ldots,n} \quad (1)$$

$$Y_{1,\ldots,n} = \lambda_{y1,\ldots,yn}\ \eta_{1,\ldots,n} + \varepsilon_{1,\ldots,n} \quad (2)$$

The structural model is expressed as:

$$\eta_{1,\ldots,n} = \gamma_{y1,\ldots,yn}\ \xi_{1,\ldots,n} + \zeta_{1,\ldots,n} \quad (3)$$

where,
X = Vector of observed exogenous variables
Y = Vector of observed endogenous variables
ξ = Vector of latent exogenous variables
η = Vector of latent observed endogenous variables
δ = Vector of measurement error terms for observed variables X
ε = Vector of measurement error terms for observed variables Y
λ = Coefficients of observed variables
ζ = Vector of the error terms in structural model
β = Coefficient of expected changes after a unit increases in η or ξ

2.5.3 Hypothesis

The construct in TPB was used to know the relationship between attitude toward behavior, subjective norm, peceived behavirol control, perceived consequence, expectation and perceived safety against exogenoues variable which is (behavioral intention to safe crossing behavior) that can affect the safec rossing among pedestrian. Therefore, the hypothesis will test to know the significance of this constructs. H1: Attitude toward the behavior are positively related to intention of safe crossing among pedestrian. H2: Subjective Norm is positively related to intention of safe crossing among pedestrian. H3: Perceived Behavioral Control is positively related to intention of safe crossing among pedestrian. H4: The Intention is positively related to safe crossing behavior among pedestrian. H5: Perceived Consequence is positively related to intention of safe crossing among pedestrian. H6 : Perceived Safety is positively related to intention of safe crossing among pedestrian.

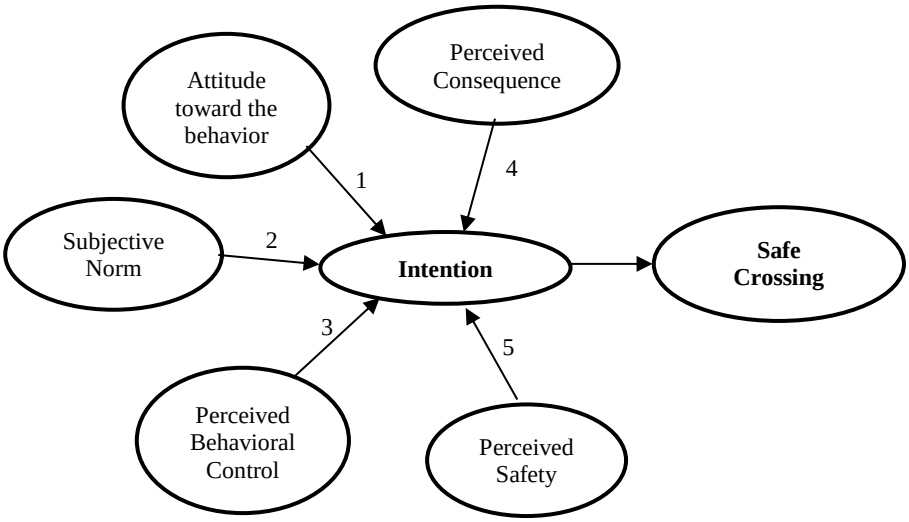

Fig. 2. Pedestrian Extended Theory of Planned Behavior (TPB).

3 Methodology

3.1 Instrument and measurement

This study utilized the survey questionnaire form as the main data instrument. A questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents. The questionnaire was designed based on Extended Theory of Planned Behaviour (TPB) and adapted from a few previous literature. The questionnaire consists of four parts. A seven likert point scale was used to examine the agreement of respondents toward the usage of pedestrian crossing facilities.

3.2 Data Collection

The quantitative data will collect by self-administered questionnaire form that distribute among pedesrian in school, residential and shopping complex areas in Kluang and Batu Pahat, Johor. Each pedestrian that chosen must be completing the questionnaire and return it to the distributor. However, before the questionnaire were distributed to pedestiran, only respondents who do not abide by the rules only be taken such as not willing and willing to used the crossing facilities are selected as research respondents. If there have a respondents who did not want to cooperate, other respondents volunteered only be approached to fill out the survey form.

3.4.1 Pilot Study

A pilot study also called as pilot experiment which is a small scale preliminary study conducted and gather information prior to a larger study, in order to improve the quality and efficiency of the questionnaire. In this study, will distribute some questionnaire as a pilot study for the public who use crossing facilities. Then decide that need to redesign the questionnaire. A pilot study can reveal design questionnaire weakness such as the question

hard to understand, the poor instruction and procedure. The result will measure by alpha cronbach. Table 1 show the level measurement of alpha Cronbach (α).

Table 1. Level measurement of alpha Cronbach (α).

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

3.3 Sampling Method and Sample Size

This study used the stratified random sampling method approach to obtain the sample of respondents. The population was chosen among people live in Johor state. To determine the sample size for this study, the Formula of Cochran (1977) was used because this formula is suitable to determine the sample size with having the data categorical and continuous data. The total minimum of sample size required from the Cochran's formula calculation is 118. However, this study chosen 300 respondents as a sample size. This is because Weston and Goore [24] has stated that minimum sample size required for Structural Equation Modelling is 200. Then, the questionnaire were processed with the aid of SPSS while for the Structural Equation Modelling AMOS software will used to test the structural model.

3.4 Data analysis and tools

3.4.1 Descriptive Statistics

Descriptive statistics provide simple summaries about the sample or data collection that have been made. Such summaries may be either quantitative, such as summary statistics, or visual, and for example simple-to-understand graphs. These summaries may either form the basis of the initial description of the data as part of a more extensive statistical analysis, or they may be sufficient in and of themselves for a particular investigation. All the data will be analyzed using Statistical Package for Social Science (SPSS) by researcher.

3.4.2 Correlation Analysis

The coefficient of Pearson correlation measures the strength and direction of a linear relationship between the two variable. This particular type of analysis is useful when a researcher wants to establish if there are possible connections between variables. The symbol for the Person correlation coefficient if **r**. Pearson's coefficient is the measurement of correlation and ranges (depending on the correlation) between +1 and -1. +1 indicates the strongest positive correlation possible, and -1 indicates the strongest negative correlation possible. Therefore the closer the coefficient to either of these numbers the stronger the correlation of the data it represents. On this scale 0 indicates no correlation, hence values closer to zero highlight weaker or poorer correlation than those closer to +1/-1. In this

research, the variable that used to measure correlation are attitude, subjective norms, perceived behavioral control, perceived consequence, expectation, perceived safety, intention and safe crossing behavior.

3.4.3 Factor Analysis

The two main factor analysis techniques are Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Exploratory factor analysis (EFA) is a widely utilized and broadly applied statistical technique in the social sciences [25]. EFA is designed for the situation where links between the observed and latent variables are unknown or uncer- tain. The analysis thus proceeds in an exploratory mode to determine how, and to what extent, the observed variables are linked to their underlying factors. EFA procedures are more accurate when each factor is represented by multiple measured variables in the analysis. Confirmatory factor analysis (CFA) is a powerful and flexible statistical technique that has become an increasingly popular tool in all areas of psychology including educational research [26]. The objective of confirmatory factor analysis is to test whether the data fit a hypothesized measurement model. This hypothesized model is based on theory of planned behavior (TPB). The CFA is solved using the Structural Equation Modeling (SEM). Structural Equation Modeling (SEM) is a statistical methodology that takes a confirmatory for example hypothesis testing approach to the analysis of a structural theory bearing on some phenomenon [27]. CFA was conducted in the software SPSS, using principle component analysis (PCA) as the extraction method. Model fit measures could then be obtained to assess how well the proposed model captured the covariance between all the items or measures in the model.

Table 3. Index Category and Their Level of Acceptance [27]

Name of Category	Name of Index	Index Full Name	Level of Acceptance
Absolute Fit	Chisq	Discrepancy Chi Square	P > 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	> 0.90
	CFI	Comparative Fit Index	> 0.90
	TLI	Tucker-Lewis Index	> 0.90
	NFI	Normed Fit Index	> 0.90
Parsimonious Fit	Chisq/df	Chi Square/Degree of Freedom	< 5.0

4 Futurework

This paper presents part of method for on going research to develop a behavioral intention model toward safe crossing behaviour among pedestrian by using Extended Theory of Planned Behaviour. The questionnaire has been designed. Researcher will distribute the questionnaire to respondent and will analysis the data. For safe crossing between pedestrian a new intervention model will be introduce to increase use of crossing facilities. A proper intervention will be used in order to predict that system could influence pedestrians' behavior

and their acceptance. Hopefully, this research may contribute a significant finding and method that be able to mitigate current problem in the country regarding pedestrian safety.

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