SAFE CROSSING AMONG PEDESTRIANS BASED ON EXTENDED THEORY OF PLANNED BEHAVIOUR

KOMALA DEVI SUNDARARAJAN

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

STATUS CONFIRMATION FOR THESIS
MASTER'S DEGREE

SAFE CROSSING BEHAVIOUR AMONG PEDESTRIANS BASED ON EXTENDED THEORY OF PLANNED BEHAVIOUR

ACADEMIC SESSION: 2020/2021

I, **KOMALA DEVI SUNDARARAJAN,** agree to allow Thesis to be kept at the Library under the following terms:

1. This Thesis is the property of the Universiti Tun Hussein Onn Malaysia.
2. The library has the right to make copies for educational purposes only.
3. The library is allowed to make copies of this Thesis for educational exchange between higher educational institutions.
4. The library is allowed to make available full text access of the digital copy via the internet by Universiti Tun Hussein Onn Malaysia in downloadable format provided that the Thesis is not subject to an embargo. Should an embargo be in place, the digital copy will only be made available as set out above once the embargo has expired.
5. ** Please Mark (√)

☐ CONFIDENTIAL (Contains information of high security or of great importance to Malaysia as STIPULATED under the OFFICIAL SECRET ACT 1972) *Title and Abstract only*

☐ RESTRICTED (Contains restricted information as determined by the organization/institution where research was conducted)- *Title, Abstract and Introduction only*

☐ EMBARGO _____ until _____
(date) (date)

☑ FREE ACCESS

Approved by,

(WRITER'S SIGNATURE)

KOMALA DEVI SUNDARARAJAN

LOT 2019, BATU 6, KEDAI KOPI,
KAMPUNG KUANTAN, 45600
BATANG BERJUNTAI, SELANGOR.

Date: 18/04/2021

(SUPERVISOR'S SIGNATURE)

PROF. MADYA. Ts. DR. KAMARUDIN BIN AMBAK

FACULTY OF CIVIL ENGINEERING AND
BUILD ENVIRONMENT,
UNIVERSITI TUN HUSSEIN ONN MALAYSIA.

Date: 18/04/2021

NOTE: ** If this Thesis is classified as CONFIDENTIAL or RESTRICTED, please attach the letter from the relevant authority/organization stating reasons and duration for such classification.

This thesis has been examined on February 2021 and in sufficient in fulfilling the scope and quality for the purpose of awarding the Degree of Master of Civil Engineering.

Chairperson:
ASSOC. PROF. TS. DR. MOHD EZREE BIN ABDULLAH
Faculty of Civil Engineering and Built Environment
Universiti Tun Hussein Onn Malaysia (UTHM)

Assistant Chairperson:
DR. MOHD HANIFI BIN OTHMAN
Faculty of Civil Engineering and Built Environment
Universiti Tun Hussein Onn Malaysia (UTHM)

External Examiner:
IR. DR. MUHAMAD RAZUHANAFI BIN MAT YAZID
Department of Civil Engineering
Faculty of Engineering and Built Environment
Universiti Kebangsaan Malaysia (UKM)

Internal Examiner:
DR. BASIL A/L DAVID DANIEL
Faculty of Civil Engineering and Built Environment
Universiti Tun Hussein Onn Malaysia (UTHM)

SAFE CROSSING AMONG PEDESTRIANS BASED ON EXTENDED THEORY OF PLANNED BEHAVIOUR

KOMALA DEVI D/O SUNDARARAJAN

A thesis submitted in partial
fulfillment of the requirement for the award of the
Degree of Master of Civil Engineering

Faculty of Civil Engineering and Environmental
University Tun Hussein Onn Malaysia

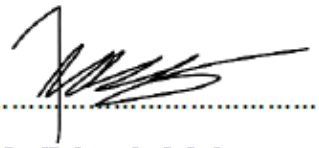
APRIL 2021

I hereby declare that this thesis entitled "Safe Crossing among Pedestrians based on Exteded Theory of Planned Behaviour" is the result of my own except as cited in references and summaries which have been duly acknowledged

Student : 

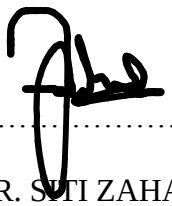
KOMALA DEVI D/O SUNDARARAJAN

Date : 06/04/2021

Supervisor : 

PROF. MADYA. Ts. DR. KAMARUDIN BIN AMBAK

Date : 18/04/2021

Co-Supervisor : 

Ts. DR. SITI ZAHARAH ISHAK

Date : 07/04/2021

DEDICATION

I dedicate this thesis

To my lovely father and mother, Mr. Sundararajan and Mrs. Mohana and also my family, who gave me endless love, their patience, trust, constant encouragement over the years, and for their prayers.

To my friends, who gave me moral support in all forms, motivates me always, love and prayers.

ACKNOWLEDGEMENT

I wish to express my deepest appreciation to all people who directly and indirectly contribute to the success of this thesis. First and foremost, I thank God almighty who provided me with strength, direction and showered me with blessings throughout my research work to complete this research successfully.

I would like to thank wholeheartedly my supervisor, Professor Madya. Ts. Dr. Kamarudin bin Ambak who had presently giving me his mentorship and invaluable guidance throughout the entire research. Under his supervision, many aspects regarding this research had been explored and with the knowledge, idea and support receive from him, this thesis can be presented in the time given. A very great thank to him again. My sincerest gratitude to my Co-Supervisor Ts. Dr. Siti Zaharah Ishak, for her continuous guidance and support.

I would like to convey my sincere gratitude to all my panels, Dr. Basil David Daniel, Dr. Mohd Hanifi Bin Othman, Dr. Nursitihazlin Binti Ahmad Termida and Dr. Nurul Hidayah Binti Mohd Kamaruddin who helped me throughout my research and been so helpful for to finish this thesis. Besides that, I would like to thank my seniors and friends for the continuous guidance during my tenure as a master research student.

With their expert guidance and immense knowledge, I was able to overcome all the obstacles that I encountered during my journey of Master's in Civil Engineering. I could not have imagine having a better advisors and mentors like them.

ABSTRACT

Malaysia is considered one of the countries experiencing rapid growth in motorization, automobile, and transportation systems. Pedestrian in Malaysia has become a very important road user on a daily basis in human society. Creating awareness for the pedestrian to take a safety crossing behaviour is very important to prevent the number of pedestrian accidents and fatalities. This study aimed 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. Furthermore, this study also proposed improvement in crossing facilities to ensure pedestrians cross roads with safe behaviour. In understanding this output, an extension of the well established variables of Theory of Planned Behaviour (TPB) which include Attitude (ATT), Subjective Norm (SN), Perceived Behavioural Control (PBC), Perceived Consequence (PC), Expectation (EX) and Perceived Safety (PS) was used in this study toward using crossing facilities. A questionnaire was designed and distributed to 274 respondents in Batu Pahat. The data were analyzed by Structural Equation Modeling (SEM) using SPSS 20 and AMOS. Goodness of fit for the revised structural model showed GFI, CFI, TLI and NFI were greater than 0.90 and AGFI was less than 0.90. The findings showed that hypothesis testing of all the variables had significant relationship and positive impact on behavioural intention among pedestrians. Therefore, TPB model with extended variables is suitable to predict the behavioural intention towards safe crossing behaviour. As the third objective, researcher have proposed improvements in crossing facilities as "Solar Zebra crossing warning light (SZCWL)" and it was accepted by majority of the respondents (86.1%).

ABSTRAK

Malaysia dianggap sebagai salah satu daripada negara yang mengalami pembangunan pesat dalam infrastruktur, perusahaan kenderaan, dan system pengangkutan. Pejalan kaki di Malaysia menjadi pengguna jalan raya yang amat penting di kalangan masyarakat setiap hari. Mewujudkan kesedaran kepada pejalan kaki untuk mengambil tingkah laku lintasan keselamatan adalah sangat penting untuk mengurangkan jumlah kemalangan di kalangan pejalan kaki. Kajian ini bertujuan mengkaji faktor penyumbang yang mempengaruhi pejalan kaki menggunakan kemudahan lintasan dan menganalisis hubungan antara faktor yang menyumbang kepada tingkah laku lintasan yang selamat. Tambahan pula, kajian ini mencadangkan konsep reka bentuk lintasan yang baharu untuk memastikan pejalan kaki menyeberang jalan raya dengan selamat. Dalam memahami kajian ini, pemboleh ubah lanjutan daripada Teori Tingkah Laku Dirancang (TPB) termasuk Sikap (ATT), Norma Subjektif (SN), Persepsi Kawalan Tingkah Laku (PBC), Persepsi Kesan (PC), Jangkaan (EX) dan Persepsi Keselamatan (PS) telah digunakan di dalam kajian ini terhadap pengunaan kemudahan lalu lintas. Soal selidik telah direka dan diedarkan kepada 274 responden di Batu Pahat. Data dianalisis berdasarkan Model Persamaan Struktur (SEM) menggunakan SPSS 20 dan AMOS. *Goodness-of-fit* untuk model struktur yang disemak menunjukkan GFI, CFI, TLI dan NFI adalah lebih besar daripada 0.90 dan AGFI kurang daripada 0.90. Hipotesis kesemua pembolehubah menunjukkan hubungan yang signifikan dan kesan positif terhadap niat tingkah laku di kalangan pejalan kaki. Oleh itu, model TPB dengan pemboleh ubah lanjutan didapati sesuai untuk meramalkan niat tingkah laku terhadap keselamatan lalu lintas. Sebagai objektif ketiga, penyelidik telah mencadangkan penambahbaikan dalam kemudahan penyeberangan sebagai Amaran Solar Cahaya Zebra (SZCWL)" dan ia diterima oleh majoriti responden (86.1%).

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AMOS	-	Analysis of Moment Structure
CFA	-	Confirmatory Factor Analysis
EFA	-	Exploratory Factor Analysis
ETPB	-	Extended Theory of Planned Behaviour
JKJR	-	Jabatan Keselamatan Jalan Raya Malaysia
KSI	-	Killed or Serious Injured
PCA	-	Principal Component Analysis
PDRM	-	Polis Diraja Malaysia
SEM	-	Structural Equation Model
SPSS	-	Statistical Package for Social Science
SZCWL	-	Solar Zebra Crossing Warning Light System
TPB	-	Theory of Planned Behaviour

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Globally, pedestrians constitute 22% of all road deaths, and this proportion is as high as two-thirds in some countries (Syazwan *et al.*, 2017). The magnitude of pedestrian fatalities in ASEAN counties alone was very high especially in Mynmar, Philippines and Singapore with more than 15 percent, while the rate ranged from 7 to 13 percent in Malaysia, Thailand, Indonesia, Cambodia, Brunei and Indonesia. It is noted that Lao DPR, Vietnam and Timor-Leste data are unavailable might due to insufficient accident data. It is noted that if compared with motorcyclist fatalities, pedestrian deaths are considered low for each country. Table 1.1 describes the fatalities involving pedestrian in the Southeast Asia countries in the year of 2015, as reported by the World Health Organization (WHO) (WHO, 2015).

Malaysia is known to be one of the fast-growing countries in motorisation, manufacturing and transport systems. Transportation plays a crucial role in Malaysia's economic contribution, having a wide range of options for commuters – Keretapi Tanah Melayu (KTM), Light Rail Transit (LRT), Mass Rapid Transit (MRT), KLIA Transit, Rapid Bus, and many more. In Malaysia, the emphasis is placed on a non-motorised mode of transport, e.g. walking and cycling for short trips (Johari *et al.*, 2017). This mode of transport is safer and environmentally sound than motorised modes. Walking is described as a means of transportation by people who walk on foot or use aids to allow them to walk.

When compared to other road users, pedestrians are the most vulnerable on the road, and they are always at risk on their daily journeys (Goh *et al.*, 2012).

Table 1.1: Vehicle, Population, Road Traffic Deaths and Proportion of Pedestrian Casualties by Country in Southeast Asia, 2015 (WHO, 2015)

Southeast Asia Country	Registered Vehicles (Count)	Population for 2015 (Count)	Reported Road Traffic Fatalities (Count)	Death by Pedestrian Category (Proportion)[1]
Laos DPR	1,439,481	6,769,727	910	10%
Malaysia	**23,819,256**	**269,716,965**	**6,915**	**7%**
Myanmar	4,310,112	53,259,018	3612	26%
Philippines	7,690,038	98,393,574	1,513	19%
Singapore	974,170	5,411,737	159	27%
Thailand	32,476,977	67,010,502	14,059	8%
Vietnam	40,790,841	91,679,733	9,156	-
Cambodia	2,457,569	15,135,169	1950	13%
Brunei	304,432	390,056	54	9.2%
Indonesia	104,211,132	249,865,610	26,460	21%
Timor-Leste[2]	63,553	1,132,979	74	-

Note:
- Data Not Available
[1] Proportion of pedestrian deaths per reported road traffic fatalities
[2] Not ASEAN country

Pedestrians are a vital component of the public transport system and are probably one of the major transport modes in an urban environment. Despite a growing literature that highlights the impact and consequences of traffic interventions in pedestrian behaviour, there is a lack of knowledge on the connection between pedestrian behaviour and traffic conditions, which is to determine the extent of the barrier effects experienced by pedestrians (Ibrahim, Karim & Kidwai, 2005). Based on the 2019 Malaysian traffic injury statistics survey, the Malaysia Road Safety Department (JKJR) revealed that pedestrians are the third most involved in road accidents after motorcycles and car drivers. The one of the main reasons that have been related to the high number of pedestrian accidents are due to lack of use of crossing facilities and the reckless movement of pedestrians (Goh *et al.*, 2012). Additionally, pedestrian collisions that have caused too much injury, or even killed, are some of the country's critical issues. In this relation, the increasing number of pedestrian accidents is due to the increase in the number of pedestrians (Nor *et al.*, 2017).

Notwithstanding the numerous advantages to the walking mode of transport, a hazardous activity is still taken into consideration. Even though in Malaysia, pedestrian incidents account for less than 10% of general road accidents (PDRM, 2012), pedestrians are the most vulnerable road user category in road safety statistics. Increased exposure to vehicle traffic reduces the occurrence of the pedestrian fatality on the roads, especially during the crossing; and the lack of ability of the pedestrians' bodies to take effect in the case of crashes (Johari *et al.,* 2017).

Malaysia's government has made significant investments in the development of pedestrian crossings. Hopefully, this work would impact safe road crossings; thus, it will be essential to predict the benefits that pedestrians will gain from them. Therefore, a study on intervention for safe crossing among pedestrians based on the Extended Theory of Planned Behaviour is needed to identify the factors that influence the behaviour of pedestrians to cross the road safely.

1.2 Problem Statement

In Malaysia, road injuries and fatalities are major issues, with more than 6,000 involved in fatal accident and over 10,000 in minor and major incident yearly. Involvement in accidents in Malaysia is also alarming 71% road death and approximately 11% are pedestrians (Nasrudin, 2020). Pedestrian death rate per 100,000 populations in Malaysia can be considered among the highest in Southeast Asia region. Records consistently have shown that fatal road traffic injuries among elder (<60 years old) are increasing from 24.4% (2006) to 44.2% (2013) of the total pedestrian's fatalities. In term of incident occurred, it is statistically shown that straight road contributed more than 60% fatalities followed by junction-type of road (RMP, 2010). Since the number of pedestrian's fatalities in Malaysia create media attention, this issue need to be addressed.

Malaysia Road Safety Depatment, 2018 has analysed that road user category in Malaysia which pedestrians were consistently third place after motorcyclists and car drives. Figure 1.1 indicates that Malaysia pedestrian fatalities are averaging approximately more than 400 deaths each year (2008-2018). Based on Road Safety Statistics Book (2019), the Malaysia Road Safety Department announced that after the two main

categories of car drivers and motorcyclist, the third primary class of road fatalities were pedestrians, 407 of whom died in road accidents in 2018 (JKJR, 2019).

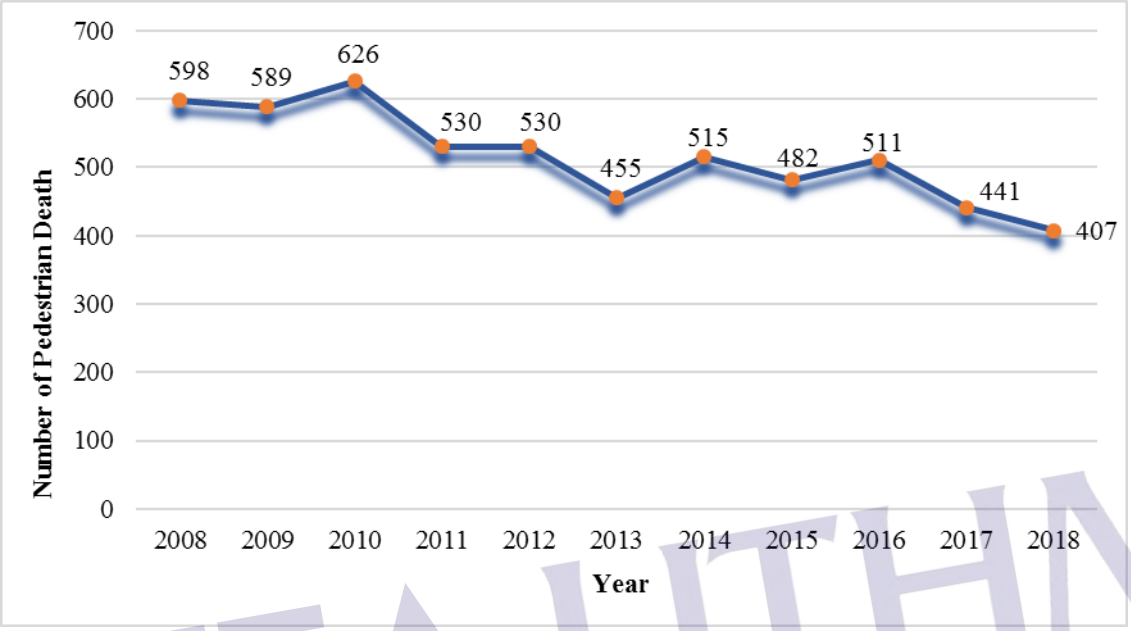


Figure 1.1: Number of Pedestrian Death from the year 2008 until 2018 in Malaysia (JKJR, 2019)

Furthermore, Johor is the second state to have the highest road accident and death rates after the state of Selangor. In the case of pedestrian fatalities, Johor had the second-highest count with 129 fatalities after the number of pedestrian fatalities in the state of Selangor (Ariffin *et al.*, 2012). In the year 2017, 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). Prasetijo *et al.* (2020) confirmed that Batu Pahat, Parit Raja and Ayer Hitam were identified as having regular traffic accidents, which involving car drivers, motorcycle drivers, pedestrians and others.

Unsafe pedestrian behavior is one of the major factors that contribute to pedestrian injuries and fatalities (Nasrudin, 2020). Pedestrian crossing behaviour is influenced by various internal and external factors. Several research on the influencing factors of road

crossing behaviour have been carried out. One of the main reasons that have been attributed to a higher number of pedestrian accidents is the lack of care. This is due to a shortage of time, cross-sensitivity or certain unforeseen causes (Goh *et al*., 2012). If the pedestrian decides to walk, they cross the road somewhere in the middle of the block, and the action of the pedestrian changes dynamically. Pedestrians are continually changing their behaviour concerning environmental characteristics. Human factors including individual characteristics and mood are associated with pedestrian red-light crossing behaviour (Yang *et al.,* 2015). Some other studies have tried to identify factors affecting pedestrian behaviour, including sudden decisions affecting the characteristics of pedestrian walking, such as whether to accelerate or slow down walking speed, stop or wait, and where to cross the road (Kadali & Vedagiri, 2013).

From these reports, traffic-crossing facilities are the central part of the structure to make a safe road for pedestrians. Pedestrians are the group that is most likely able to identify potential solutions and treatments to bring about the creation of a desirable, safe, and sound environment. They can also identify the possible options that would increase their likelihood of proper use of designated pedestrian facilities. (Anciaes & Jones, 2016). Two key issues have been proven by previous study, such as Anciaes and Jones (2016), in which the first issue is that pedestrians choose to cross the road informally without any special provision (under different scenarios of road facilities design and traffic characteristics) and to travel additional minutes to the position where the path is covered. In the second issue, the respondents indicated whether they would cross a road without pedestrian's provision in order to have access to a cheaper store or bus stop on the other side of the road.

This research therefore defines the issues based on the Extended Theory of Planned Behaviour (ETPB) on the basis of the research objectives, with additional determinants that lead to behavioural intervention and enhance the pedestrian crossing facility to increase the reasonable.

1.3 Research Questions

The pedestrian activity has been observed for decades; however, it has been addressed in many respects. Existing research has focused on contributing factors, pedestrian behaviour studies and creative intersections that will affect the pedestrian decision whether or not to comply with traffic signals. Many issues need to be discussed and addressed in this research:

i. What are the effects of the contributing factors of pedestrians when crossing the road?
ii. Is pedestrian crossing behaviour being influenced by road user and environmental factors?
iii. Does modification or improvement of crossing facility assist pedestrians to cross the road safely?

1.4 Research Objectives

The aim of this work is to evaluate a novel intervention model using external variables of Theory of Planned Behaviour in order to improve pedestrian safety while crossing the road. The objectives of this study are:

i. To investigate the contributing factors that affect pedestrians to use a crossing facility.
ii. To analyse the relationship between the contributing factors and safe crossing behaviour.
iii. To propose improvements in crossing facilities to ensure pedestrians cross with safe behaviour.

REFERENCES

Abeysekera, I., & Kamaruddin, K. (2013). *Intellectual Capital and Public Sector Performance.* Emerald Group Publishing.

Ahmad, S., Zulkurnain, N. N. A., & Khairushalimi, F. I. (2016). Assessing the fitness of a measurement model using Confirmatory Factor Analysis (CFA). *International Journal of Innovation and Applied Studies*, *17*(1), 159–168.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In *Action control*, 11-39. Springer, Berlin, Heidelberg.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211.

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology & Health*, *26*(9), 1113–1127.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Alliance, R., & Kong, H. (2002). Legislative Council Panel on Transport Electronic Audible Traffic Signal. *Transport Bureau*, *2*(4), 1–5.

Ambak, K., Ismail, R., Abdullah, R. A., & Borhan, M. N. (2011). Using Structural Equation Modeling and the Behavioral Sciences Theories in Predicting Helmet Use. *Proceeding of the International Conference on Advanced Science, Engineering and Information Technology*, *1*(6), 639-645.

Ambak, K., Mustakim, F., & Daniel, B. D. (2006). Accident Investigation, Blackspot Treatment and Accident Prediction Model At Federal Route FT50 Batu Pahat-Air Hitam. *4th National Technical Post Graduate Symposium (TECHPOS 2006)*.

Anciaes, P. R., & Jones, P. (2016). How do pedestrians balance safety, walking time, and the utility of crossing the road? A stated preference study. *Economic & Social*

Research Council, *8*, 1–19.

Anciaes, P. R., & Jones, P. (2018). Estimating preferences for different types of pedestrian crossing facilities. *Transportation Research Part F: Traffic Psychology and Behaviour*, *52*, 222–237.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*(3), 411–423.

Arabian Business. (2018). Dubai's RTA expands smart pedestrian signals project after trial. *ArabianBusiness.* Report: United Arab Emirates.

Ariffin, A. H., Jawi, Z. M., Isa, M. H., Kassim, K. A. A., & Voon, W. S. (2012). Pedestrian Casualties in Road Accidents – Malaysia Perspective. *Conference Paper*, 280–289.

Avineri, E., Shinar, D., & Susilo, Y. O. (2012). Pedestrians ' behaviour in cross walks : The effects of fear of falling and age. *Accident Analysis and Prevention*, *44*(1), 30–34.

Awang, Z. (2012). *The Second Order Confirmatory Factor Analysis (CFA)*. A Handbook on SEM 2nd Edition. Universiti Sultan Zainal Abidin.

Bagozzi, R.P., and Yi, Y. (1988). On the evaluation of structural equation models. Academy of Marketing Science. *Journal of the Academy of Marketing Science* 16 (1), 74–94.

Barton, B.K., Kologi, S.M. & Siron, A. (2016). Distracted pedestrians in crosswalks: An application of the Theory of Planned Behavior. *Transportation research part F: traffic psychology and behaviour*, *37*, 129-137.

Barton, B. K., & Schwebel, D. C. (2007). The Roles of Age , Gender , Inhibitory Control , and Parental Supervision in Children ' s Pedestrian Safety. *Journal of Pediatric Psychology*, *32*(5), 517–526.

Bernhoft, I. M., & Carstensen, G. (2008). Preferences and behaviour of pedestrians and cyclists by age and gender. *Transportation Research Part F: Traffic Psychology and Behaviour*, *11*(2), 83–95.

Bilau, A. A., Witt, E., & Lill, I. (2018). Research methodology for the development of a framework for managing post-disaster housing reconstruction. *Procedia Engineering*, *212*, 598–605.

Bilema, M. A. M., Haurula, M. M., & Rahman, R. (2017). The Study of Relationship Between Pedestrian and Safety based on the Theory of Planned Behaviour at Batu Pahat , Johor. *MATEC Web of Conferences 103, 08010*, 1–8.

Byrne, B. M. (2010). *Structural Equation Modeling with AMOS*. Second Edition. Taylor and Francis Group.

Cambon, B., Lavalette, D., Tijus, C., Poitrenaud, S., Leproux, C., Bergeron, J., & Thouez, J. (2009). Pedestrian crossing decision-making : A situational and behavioral approach. *Safety Science*, *47*(9), 1248–1253.

Cantillo, V., Arellana, J., & Rolong, M. (2015). Modelling pedestrian crossing behaviour in urban roads: A latent variable approach. *Transportation Research Part F: Traffic Psychology and Behaviour*, *32*, 56–67.

Castanier, C., Deroche, T., & Woodman, T. (2013). Theory of planned behaviour and road violations : The moderating influence of perceived behavioural control. *Transportation Research Part F: Psychology and Behaviour*, *18*, 148–158.

Chan, A. P. C., Darko, A., Olanipekun, A. O., & Ameyaw, E. E. (2018). Critical barriers to green building technologies adoption in developing countries: The case of Ghana. *Journal of Cleaner Production*, *172*(March 2019), 1067–1079.

Chen, L., Chen, C., & Ewing, R. (2014). The relative effectiveness of signal related pedestrian countermeasures at urban intersections - Lessons from New York City case study. *Transport Policy*, *32*, 69-78.

Chen, B., (2016). Identification and overidentification of linear structural equation models. In *Advances in neural information processing systems*, 1587-1595.

Chua, Y. P. (2014). *Kaedah dan Statistik, Uian Regresi, Analisis Faktor dan Analisis SEM*. Buku 5: Malaysia. The Mc Graw Hill.

Cochran, W. G. (1977). *Sampling techniques (3rd ed.)*. New York: John Wiley & Sons.

Connelly, L. M. (2008). Pilot studies. *Medsurg Nursing, 17(6)*, 411-2.

Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis : Four Recommendations for Getting the Most From Your Analysis. *Practical Assessment, Research & Education*, *10*, 1–9.

Daniel, B. D., Lay, C. S., Ambak, K., & Abdullah, A. E. (2007). Pedestrian Level of Service Model for Crosswalks At Signalized Intersections. *National Seminar on Civil*

Engineering Research (SEPKA).

Davis, F.D., Bagozzi, R. P., & Warshaw, P.R., (1989). User acceptance of information computer technology: a comparison of two theoretical models. *Management science,* 35(8), 982-1003.

Demi, B., Ozkan, T., & Demir, S. (2019). Pedestrian violations: Reasoned or social reactive? Comparing theory of planned behavior and prototype willingness model. *Transport Research Part F: Psychology and Behaviou, 60,* 560-572.

Department of Statistics Malaysia. (2016). Statistician Malaysia Department of Statistics, Malaysia.

DeVellis, R.F. (2012). *Scale development: Theory and applications*. Los Angeles: Sage. pp. 109–110.

Diaz, E. M. (2002). Theory of planned behavior and pedestrians' intentions to violate traffic regulations. *Transportation Research Part F: Traffic Psychology and Behaviour*, *5*(3), 169–175.

Dommes, A., Cavallo, V., Vienne, F., & Aillerie, I. (2012). Age-related differences in street-crossing safety before and after training of older pedestrians. *Accident Analysis & Prevention, 44(1),* pp. 42-47.

Drasgow, F., & Dorans, N. J. (1982). Robustness of Estimators of the Squared Multiple Correlation and Squared Cross-Validity Coefficient to Violations of Multivariate Normality. *Applied Psychological Measurement, 6(2),* 185–200.

Evans, D., & Norman, P. (1998). Understanding pedestrians' road crossing decisions: An application of the theory of planned behaviour. *Health Education Research*, *13*(4), 481–489.

Evans, D., & Norman, P. (2003). Predicting adolescent pedestrians' road-crossing intentions: An application and extension of the Theory of Planned Behaviour. *Health Education Research*, *18*(3), 267–277.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior.* Reading, MA: Addison-Wesley.

Forward, S. E. (2009). The theory of planned behaviour : The role of descriptive norms and past behaviour in the prediction of drivers ' intentions to violate. *Transportation Research Part F: Psychology and Behaviour, 12*(3), 198–207.

Gallagher, M., & Brown, T. (2013). Introduction to Confirmatory Factor Analysis and Structural Equation Modeling. *Handbook of Quantitative Methods for Educational Research*, *5*(revision C), 289–314.

Garrison, V. (2012). ' Smart ' Crosswalks Headed To East Hampton ' s Main Street. *East Hampton Village*. Report: New York.

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference*. 11.0 update (4th ed.). Boston: Allyn & Bacon.

Ghozali, I. (2008). *Konsep Aplikasi dengan Program AMOS 16.0*. Indonesia: Badan Penerbit-Undip.

Goh, B. H., Subramaniam, K., Wai, Y. T., & Mohamed, A. A. (2012). Pedestrian Crossing Speed : The Case of Malaysia. *International Journal for Traffic and Transport Engineering*, *34(595)*, 323–332.

Golob, T. F. (2003). Structural equation modeling for travel behavior research. *Transportation Research Part B: Methodological*, *37*(1), 1–25.

Granie, M. A., Abou-Dumontier, A., & Gueho, L. (2012). How gender influences road user behaviors: The bringing-in of developmental social psychology. *Advances in Human Aspects of Road and Rail Transportation*, 754–763.

Grimnes, S., & Martinsen, O. G. (2007). Chapter 9: Data and Models. In *Bioimpedance and Bioelectricity Basics*. Second Edition. Academic Press.

Gupta, U., Tiwari, G., Chatterjee, N., Fazio, J. (2010). Case study of pedestrian risk behaviour and survival analysis. *Journal of the Eastern Asia Society for Transportation Studies, 7*, 1-17.

Ha, R. R., & Ha, J. C. (2012). *Integrative Statistics for the Social and Behavioral Sciences*. University Of Washington: Sage Publications.

Hamidun, R., Roslan, A., Harun, N. Z., Megat Johari, N., Shabadin, A., & Siti Zaharah, I. (2017). *Evaluation of Midblock Crossing : Effect on Pedestrian and Vehicular Traffic*. Research Report. Malaysian Institude of Road Safety Research.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis*. 7th Edition. New Jersey: Prentice Hall.

Hill, R. (1998). What sample size is "enough" in internet survey research? Interpersonal Computing and Technology. *An Electronic Journal for the 21st Century*, 6(3-4).

Holland, C., & Hill, R., 2007. The effects of age, gender and driver status on pedestrians' intentions to cross the road in risky situations. *Accident Analysis & Prevention, 39*, 224–237.

Ibrahim, N. I., Karim, M. R., & Kidwai, F. A. (2005). Motorists and pedestrian interaction at unsignalised pedestrian crossing. *Eastern Asia Society for Transportation Studies*, *5*, 120–125.

Isaac, S., & Michael, W. B. (1995). *Handbook in research and evaluation. A collection of principles, methods, and strategies useful in the planning, design, and evaluation of studies in education and the behavioral sciences*. 3rd Edition. San Diego, CA, US: Edits publishers.

Ismail, R., Hafezi, M. H., & Nor, R. M. (2013). Passengers preference and satisfaction of public transport in malaysia, part II: A comparative analysis of Komuter and LRT network. *Research Journal of Applied Sciences, Engineering and Technology*, *6*(8), 1450–1456.

Jain, A., Gupta, A., & Rastogi, R. (2014). Pedestrian Crossing Behaviour Analysis At Intersections. *International Journal for Traffic and Transport Engineering*, *4*(1), 103–116.

Jiangang, S., Yanyan, C., Futian, R., & Jian, R. (2007). Research on pedestrian behaviors and traffic characteristics at unsignalized midblock crosswalk: a case study in Beijing. *Transportation Research Record 2038(1)*, 23-33.

Johari, N. M., Khaidir, N. M., Hamidun, R., Ishak, S. Z., Hoong, A. P. W., & Voon, W. S. (2017). *Vehicle Speed Approaching Zebra Crossing on Federal Roads*.

Julious, S. A. (2005). Sample size of 12 per group rule of thumb for a pilot study. *Pharmaceutical Statistics*, 4, 287-291.

Junet, N. A. (2013). *User Nebefit Analysis of Main Pedestrian Bridges*. Universiti Malaysia Pahang: Bachelor's Degree Thesis.

Kadali, B. R., & Vedagiri, P. (2013). Modelling pedestrian road crossing behaviour under mixed traffic condition. *European Transport - Trasporti Europei*, (55), 1–17.

Kadzim, N. H. (2012). *A study on Effevtiveness of Pedestrian Bridge Utilization*. Universiti Malaysia Pahang: Bachelor's Degree Thesis.

Khalifa, M., & Ning Shen, K. (2008). Drivers for transactional B2C m-commerce

adoption: Extended theory of planned behavior. *Journal of Computer Information Systems*, *48*(3), 111–117.

Kim, E., Lee, J. A., Sung, Y., & Choi, S. M. (2016). Predicting selfie-posting behavior on social networking sites: An extension of theory of planned behavior. *Computers in Human Behavior*, *62*, 116–123.

Knoke, D., Bohrnstedt, G. W., & Mee, A. P. (2002). *Statistics for Social Data Analysis*, 4th Itasca: F. E. Peacock Publishers.

Koh, P. P., Wong, Y. D., & Chandrasekar, P. (2014). Safety evaluation of pedestrian behaviour and violations at signalised pedestrian crossings. *Safety Science*, *70*, 143–152.

Krosnick, J. A., & Presser, S. (2009). *Question and Questionnaire Design. Handbook of Survey Research.* 2nd Edition. San Diego, CA: Elsevier.

Kumar, D. (2012). Application of Structural Equation Modeling (SEM) to Explain Online Purchasing Intention - An Extension of Theory of Planed Behaviour (TPB) Application of Structural Equation Modeling (SEM) to Explain Online Purchasing Intention - An Extension of The. *Industrial Engineering Letters*, *2*(6), 33–41.

Lars, A., & Walle, H. (2006). Drivers ' decision to speed : A study inspired by the theory of planned behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, *9(6)*, 427-433.

Lee, H. S. (2016). Examining neighborhood influences on leisure-time walking in older Korean adults using an extended theory of planned behavior. *Landscape and Urban Planning*, *148*, 51–60.

Lee, J. Y. S., & Lam, W. H. K. (2008). Simulating pedestrian movements at signalized crosswalks in Hong Kong. *Transportation Research Part A*, *42*(10), 1314–1325.

Leh, O. L. H., Zamri, Z., Amin, M. Z. M., & Marzukhi, M. A. (2013). User's Preference and Perception on the Pedestrian crossing in Malaysia: The case study of Ampang Road, Kuala Lumpur. *Journal of the Malaysian Institute of Planners*, *XI*, 85–96.

Leuzzi, L. (2015). Lights Art Action. *Long Island Advance*. Report: Patchogue, New York.

Levy, P. S & Lameshow, S. (2008). *Sampling of Population Methods and Application*. Fourth Edition. Canada: John Wiley & Sons, inc., Publication.

Light Guard Systems. (2018). Smart Crosswalk™ In-Roadway Warning Light (IRWL) System. *LightGuard Systems*. Report: California.

Loose, F. (1995). Research Foundation for Psychology and the Behavioral Sciences. New York. Harper Collins College Publisher.

Maichum, K., Parichatnon, S., & Peng, K.-C. (2016). Application of the Extended Theory of Planned Behavior Model to Investigate Purchase Intention of Green Products among Thai Consumers. *Sustainability*, *8*(10), 1077.

Malaysia Road Safety Department (JKJR). (2017). Buku Statistik Keselamatan Jalan Raya. Malaysia: Jabatan Keselamatan Jalan Raya.

Malaysia Road Safety Department (JKJR). (2018). Buku Statistik Keselamatan Jalan Raya. Malaysia: Jabatan Keselamatan Jalan Raya.

Malaysia Road Safety Department (JKJR). (2019). Buku Statistik Keselamatan Jalan Raya. Malaysia: Jabatan Keselamatan Jalan Raya.

Masirin, M. I., Mohamad, N. A., & Samsuddin, N. (2014). Analysis of Road Infrastructural Audit Along Jalan Batu Pahat- Kluang Malaysia : A Case Study. *International Integrated Engineering Summit (IIES 2014)*, 1–7.

Mcardle, J. J., & Kadlec, K. M. (2013). The Oxfard Handbook od Quantitative Method. *Oxford Libraryof Psychology*, (2).

McGlaun, S. (2017). *LED road surface aims to detect pedestrians and warn of road hazards*. 1–8.

Mulyadi, M. A. (2018). Pedestrian Perception about Facility of Pedestrian Crossings. *MATEC Web of Conferences*, *147*(264), 1–6.

Nasrudin, N., Ismail, H., Abdullah, Y. A., & Khalid, N. S. (2020). Pedestrian Crossing Behavior MOdel BAsed on HUman Factor. Case Study: Shah Alam City, Malaysia. *International Conference on Quality of Life.*

Nardi, P. M. (2006). *Interpreting Data, A guide to Understanding Research.* Pitzer College: Pearson Education, Inc.

Nasrudin, N., Hashim, H., Khalid, N. S., Osman, N., & Hashim, S. F. (2020). Analysis of Pedestrian Crossing Behavior at Pedestrian Crossing in Shah Alam City, Malaysia. *International Journal of Psychosocial Rehabilitation, 24* (2), 1475-7192.

Nor, S.N.M., Daniel, B.D., Hamidun, R., Al Bargi, W.A., Rohani, M.M., Prasetijo, J.,

Aman, M.Y. and Ambak, K., (2017). Analysis of Pedestrian Gap Acceptance and Crossing Decision in Kuala Lumpur. *MATEC Web of Conferences*, *103*. EDP Sciences.

Ontario Traffic Manual, (2010). *Guide and Information Signs*. Ontario: Ministry of Transportation.

Oxley, J.A., Ihsen, E., & Fildes, B.N. (2005). Crossing roads safely: an experimental study of age differences in gap selection by pedestrians. *Accident Analysis & Prevention 37 (5)*, 962-971.

Palat, B., Paran, F., & Delhomme, P. (2017). Applying an extended theory of planned behavior to predicting violations at automated railroad crossings. *Accident Analysis and Prevention*, *98*, 174–184.

Papadimitriou, E., Lassarre, S., & Yannis, G. (2017a). Human factors of pedestrian walking and crossing behaviour. *Transportation Research Procedia*, *25*, 2007–2020.

Papadimitriou, E., Lassarre, S., & Yannis, G. (2017b). Human factors of pedestrian walking and crossing behaviour. *Transportation Research Procedia*, *25*, 2007–2020.

Papadopoulos, V., & Giovanis, D. G. (2018). Reliability analysis. *Mathematical Engineering*, *8057*, 71–98.

Park, J. Y., Chiu, W., & Won, D. (2017). Sustainability of exercise behavior in seniors: An application of the extended theory of planned behavior. *Journal of Physical Education and Sport*, *17*(1), 342–347.

Parsons, W. (2009). The Hawaii Pedestrian Crosswalk Safety Chronicles: Innovative Solution for Crosswalk Safety. *Honolulu Personal Injury Lawyer*, 1–5.

Piazza, A. J., Knowlden, A. P., Hibberd, E., Leeper, J., Paschal, A. M., & Usdan, S. (2019). Mobile device use while crossing the street: Utilizing the theory of planned behavior. *Accident Analysis and Prevention*, *127*, 9-18.

Polis Diraja Malaysia (PDRM). (2012). Laporan Tahunan PDRM 2012 (Royal Malaysia Police Annual Report, 2012). Kuala Lumpur, Malaysia.

Prasetijo, J., Rahaman, N. A., HAmid, N. B., Sulaiman, N. A., Isradi, M., Mustafa, M. A., Jawi, Z. M., & Zaidie, Z. (2020). Investigation of Road Crash Rate at FT050, JAlan Batu Pahat - Kluang: Pre and Post Road Median Divider. *International Journal of Road Safety*, *1*(1), 16-19.

Pramesti, G. (2011). *SPSS 18.0 Dalam Rancangan Percobaan. Indonesia*: PT Elex Media Komputindo.

Rahman, M. M., Lesch, M. F., Horrey, W. J., & Strawderman, L. (2017). Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accident Analysis and Prevention*, *108*(September), 361–373.

Ramayah, T., Lee, J.W.C., & Lim, S. (2012). Sustaining the environment through recycling: An empirical study. *Journal of Environmental Management, 102*, 141-147.

RMP (2010) Statistical Report of Road Accidents Malaysia 2010. *Royal Malaysia Police*, Traffic Branch, Bukit Aman, Kuala Lumpur.

Rosenstock, I. M. (1974). The Health Belief Model and Preventive Health Behavior. *Health Education Monographs*, *2*(4), 354–386.

Rosli, N. B. (2017). *An Intervention for Motorcycle Helmet usage based on Technology Acceptance Model*. 1–149.

Rosson, M. B., Maass, S. & Kellogg, W. A. (1987). Designing for designers: analysis of design practice in the real world. *Conference Proceedings, Human Factors in Computing Systems and Graphics Interface, 18(4),* 137-141.

Rotter, J.B., (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 80 (I. Whole No. 609).

Samuels, P. (2016). Advice on exploratory factor analysis. *ReserchGate Wokring Paper*.

Shahin, M.M. (2006). Pedestrian Behavior with Mixed Traffic in Developing Countries, *Traffic Engineering and Control, 47(8)*, 303-309.

Sharpe, D., (2015). Chi-Square Test is Statistically Significant: Now What?. *Practical Assessment, Research, and Evaluation*, *20*(1), 8.

Smart Cities World. (2017). LED Road Surface. *Street crossing of the future.* Report: London.

Stangor, C. (2007). *Research Method for the Behavioral Sciences*. Third Edition. : New York.

Suhr, D. D. (2006). Exploratory or confirmatory factor analysis? *SAS Users Group International Conference*, 1–17.

Suraji, A. & Tjahjono, N. (2012). Confirmatory Factor Analysis of Accidents Caused By the Motorcycle Aspect in Urban Area. *International Journal for Traffic and Transport Engineering*, *2*(1), 60–69.

Syazwan, M. S., Deros, B. M., Zarifah, N. H., Hafeez, A. A., & Faradila, N. P. (2017). Prevalence of distracted pedestrians while crossing: a study of Malaysia's situation. *MATEC Web of Conference, 90.*

Syazwan, M. S., Baba, M. D., Aqbal, H. A., Azhar, H., Zulhadi, M., & Allyana, S. S. (2018). Revisiting Pedestrian Casualties in Malaysia and The Escalating New Threats. *Malaysian Journal of Public Health Medicine*, 18(*2)*, 104–110.

Tan, C. L., Hassali, M. A., Saleem, F., Shafie, A. A., Aljadhey, H., & Gan, V. B. (2015). Development, test-retest reliability and validity of the Pharmacy Value-Added Services Questionnaire (PVASQ). *Pharmacy Practice*, *13*(3), 598–598.

Transport Statistics Malaysia. (2016). *Statistik Pengangkutan Jalan 2016*. Malaysia: Kementerian Pengangkutan Malaysia.

Transport Statistics Malaysia. (2017). *Statistik Pengangkutan Jalan 2017*. Malaysia: Kementerian Pengangkutan Malaysia.

Treece, E. W., & Treece, J. W. (1982). *Elements of research in nursing*. 3rd Edition. St. Louis, MO: Mosby.

Trifiletti, L.B., Gielen, A.C., Sleet D.A. and Hopkins, K. (2005). Behavioral and social sciences theories and models: Are they used in unintentional injury prevention research?. Health Education Research, 20(3), 298-307.

Uttley, J., & Fotios, S. (2017). The effect of ambient light condition on road traffic collisions involving pedestrians on pedestrian crossings. *Accident Analysis and Prevention*, *108*(March), 189–200.

Van Belle, G. (2002). *Statistical rules of thumb.* New York: John Wiley.

Wang, S., Pan, H., Zhang, C., & Tian, Y. (2014). RGB-D image-based detection of stairs, pedestrian crosswalks and traffic signs. *Journal of Visual Communication and Image Representation*, *25*(2), 263–272.

Weston, R. & Gore Jr, P.A. (2006). A Brief Guide to Structural Equation Modelling. *The Counselling Psychologist, 34* (5), 719-751.

Winston. F. K., & Jacobsohn. L. (2010). A practical approach for applying best prevention practices in behavioural interventions to injury. Injury Prevention, 16, 107-112.

World Health Organization (WHO) (2015). *Global Status Report On Road Safety.*

Yang, X., Abdel-Aty, M., Huan, M., Peng, Y., & Gao, Z. (2015). An accelerated failure time model for investigating pedestrian crossing behavior and waiting times at signalized intersections. *Accident Analysis & Prevention*, *82*, 154–162.

Yong, A. G., & Pearce, S. (2013). A Beginner' s Guide to Factor Analysis : Focusing on Exploratory Factor Analysis. *Tutorials in Quantitative Methods for Psychology*, *9*(2), 79–94.

Zhou, H., Romero, S. B., & Qin, X. (2016). An extension of the theory of planned behavior to predict pedestrians' violating crossing behavior using structural equation modeling. *Accident Analysis & Prevention*, *95*, 417–424.

Zhou, J., Guo, Y., Dong, S., Zhao, L., & Yang, R. (2016). Structural Equation Modeling for Pedestrians' Perception in Integrated Transport Hubs. *Procedia Engineering*, *137*, 817–826.

Zhou, R., Horrey, W. J., & Yu, R. (2009). *The effect of conformity tendency on pedestrians ' road-crossing intentions in China : An application of the theory of planned behavior*. *41*, 491–497.

Zhu, M., Zhao, S., Coben, J. H., & Smith, G. S. (2013). Why more male pedestrians die in vehicle-pedestrian collisions than females : a decompositional analysis. *Injury Prevention*, *19*(4), 227–231.

LIST OF PUBLICATIONS

Sundararajan, K. D., Ambak, K., Daniel, B. D., Prasetijo, J., & Ishak, S. Z. (2018). Pedestrians' involvement on safe crossing by using facilities based on extended theory of planned behaviour. *MATEC Web of Conferences*. 250:02005. (Indexed by Scopus)

Sundararajan, K. D., Ambak, K., & Ishak, S. Z. (2019). Safe Crossing Behavior among Pedestrians by using Facilities Based on Extended Theory of Planned Behaviour. *Malaysian Universities Transport Research Forum Conference (MUTRFC 2019).*

Sundararajan, K. D., Ambak, K., Daniel, B. D., Sukor. N. S., & Ishak, S. Z. (2020). Willingness to Use Overhead Bridge Facilities Based on Theory of Planned Behavior. *International Journal of Integrated Engineering*, *12*(4), 232-240. (Indexed by Scopus)

Sundararajan, K. D., Ambak, K., Daniel, B. D., Ishak, S. Z. & Putranto, L. S. (2020). Pedestrian Behavioural Intention to Use Crossing Facilities Based on Extended Theory of Planned Behaviour. *Jurnal Kejuruteraan 32*(3), 167-174. (Emerging Sources Citation Index)

A. Samah, N. Z., Ambak, K., Rosli, N., & Sundararajan, .K. D. (2020). Bab 1: Kecenderungan Pejalan Kaki terhadap Penggunaan Telefon Bimbit Semasa Berjalan atau Melintas. *Analisa Komprehensif Pengangkutan Darat.* Batu Pahat, Johor: Penerbit UTHM.