PEDESTRIAN BEHAVIOUR AT UNSIGNALISED ZEBRA CROSSING IN UNIVERSITY CAMPUS

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ABSTRAK

Kepentingan ke arah mempromosikan budaya berjalan kaki telah meningkat secara dramatik terutama di bandar dan di seluruh negara. Ini juga termasuk universiti di seluruh dunia yang telah mula mencari jalan untuk meningkatkan aktiviti pejalan kaki. Oleh itu, perancang kampus mesti menangani keperluan mobiliti dan aksesibiliti pejalan kaki di komuniti mereka untuk memastikan keselamatan, fungsi dan kehidupan yang kondusif dan persekitaran pembelajaran. Walau bagaimanapun, terdapat beberapa isu yang diambil kira dalam perancangan pembangunan fizikal yang membawa kepada kegagalan dalam mewujudkan persekitaran yang kondusif. Oleh itu, kajian ini dijalankan untuk menilai keutamaan pejalan kaki, persepsi dan tingkah laku terhadap kemudahan pejalan kaki di persekitaran universiti. Dalam skop kajian ini, kemudahan pejalan kaki iaitu lintasan zebra yang tiada lampu isyarat di UMP Gambang dan IIUM Kuantan dipilih sebagai lokasi kajian. Kajian ini dijalankan menggunakan pendekatan kualitatif dan kuantitatif melalui pengumpulan soal selidik dan pengumpulan data daripada perakam video. Kemudian Kaedah Indeks Purata dilakukan untuk menunjukkan keutamaan dan persepsi pejalan kaki ke arah kemudahan pejalan kaki. Di samping itu, analisis deskriptif tingkah laku pejalan kaki juga telah dianalisis. Dapatan menunjukkan pelajar bersetuju bahawa menggunakan lintasan pejalan kaki menjimatkan masa pejalan kaki dan lebih selamat walaupun pada waktu malam. Selain itu, pelajar IIUM kebanyakannya tidak suka menyeberang di lintasan pejalan kaki yang ditetapkan berbanding dengan pelajar UMP kerana lokasi yang tidak strategik dan bilangan lintasan penjalan kaki tidak mencukupi. Kelajuan rata lelaki pejalan kaki jauh lebih tinggi berbanding pejalan kaki wanita di kedua-dua universiti. Waktu menunggu untuk kebanyakan pejalan kaki adalah sangat cepat serendah 2 saat antara kedua-dua kampus. Purata kelajuan berjalan seseorang lebih tinggi berbanding berjalan dengan tiga orang dalam satu kumpulan atau ramai orang di antara kedua-dua kampus. Dengan menggunakan kaedah statistik t-ujian, nilai P dua ekor yang signifikan adalah kurang daripada 0.05. Oleh itu, terdapat perbezaan yang signifikan secara statistik antara UMP dan IIUM dari segi pengedaran laju.

ABSTRACT

The interest toward promoting walking culture has been increased dramatically especially in many cities across the nation. This is also includes universities worldwide that have started seeking ways to increase pedestrian activities. Hence, campus planners must address the mobility and accessibility needs of pedestrian in their communities to ensure safety, functionality and conducive living and learning environment. However, there are several issues accounted in physical development planning that lead to failure in creating a conducive environment. Therefore, this study was conducted to evaluate the pedestrian preference, perception and behaviour towards the pedestrian facilities in university environment. In this scope of this study, the unsignalised zebra crossing in UMP Gambang and IIUM Kuantan was selected as study location. This study was conducted using qualitative and quantitative approaches by means of questionnaire distribution and also movement data collection. Then the Average Index Method was performed to indicate the pedestrian preference and perception towards the pedestrian facilities. In addition, the descriptive analysis of pedestrian behavior also has been analysed. Findings shows the students agree that using a pedestrian crosswalk save pedestrian time and more safety although during at night. Besides, IIUM student mostly not prefer to cross at designated pedestrian crosswalk compared with UMP students due to the locations not strategic and the numbers of crosswalk are not adequate. The mean speed of male pedestrian is significantly higher compared to female pedestrian in both universities. The waiting time for most pedestrian was very promptly as low as 2 seconds between both campuses. The mean walking speed of an individual is significantly higher compared to the group of three or more people between both campuses. By using statistical method of t-test, the significant two-tailed P value is less than 0.05. So, there is a statistically significant difference between UMP and IIUM in terms of speed distribution.

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N	Sample Size

LIST OF ABBREVIATIONS

UMP	Universiti Malaysia Pahang
IIUM	International Islamic University Malaysia
UITM	Universiti Teknologi Mara
FFS	Free Flow Speed
BFFS	Base Free Flow Speed
HCM	Highway Capacity Manual

CHAPTER 1

INTRODUCTION

1.1 Research Background

The goal of a transportation system is to provide safe and efficient mobility and access to different modes of travel to a wide variety of travellers with diverse needs. In University transportation systems balance the needs of a variety of travel modes, but pedestrian and bicycle safety are fundamental to creating an attractive campus environment. Universities worldwide are pledging to provide conducive living and learning environments for their students and staff, and so the mobility of campus users is a challenge that many large universities must address as part of their sustainable campus initiatives. University can be seen as small town where movements of goods and peoples inside the campus are massive. Along with this university growth, the developments of the transportation system are concern, due to its significant effects on the congestion, environment, and safety issue. As all the safety issue are becoming problems worldwide, the interest toward promoting non-motorized travel options by means of walking has been increased dramatically especially in many cities across the nation.

Road accidents is major public health concern in Malaysia where based on Rizati, Azzuhana, & Rohayu (2017) mortality rate of pedestrians is the third highest after motorcyclists and car drivers. The severity of the injury sustained by a pedestrian depends on type of vehicle, impact speed, size of vehicle and age of the pedestrian (World Health Organization, 2013). According to Makki (2012) campus walkability is an important component of campus mobility because these users need to have access to a network of connected, direct and easy to follow routes, linking the hostel, faculties,

green spaces, public transport stops and other facilities that will enhance their campus experience, which is based on safety, functionality, pleasure and learning.

Walking is a key non-motorized mode of transport used by pedestrians that connects different components of a multimodal transport network and interfaces with external activity areas. Walking has many health benefits and no cost which is important for students with small budgets (Zohreh, Mehdi, & Muhammad Zaly, 2014). Pedestrian is a person travelling on foot, whether walking or running. In some communities, those traveling using tiny wheels such as roller skates, skateboards, and scooters, as well as wheelchair users are also included as pedestrians.

The pedestrian is often the most vulnerable road user of all transportation networks users, and frequently, the most overlooked. Since walking is a major contributor to a sustainable transport strategy, it requires special attention. Yet pedestrian can still claim to be the most forgotten and neglected user group. Pedestrian do not need a license to use the roads, they are a mobile group and are generally able to go almost anywhere. Pedestrians are dispersed across the road network and can be seen all time, day and night, in all weathers, and on all types of roads.

For pedestrian crossing or crosswalk is a place designated for pedestrians to cross a road. Crosswalks are designed to keep pedestrians together where they can be seen by motorists, and where they can cross most safely across the flow of vehicular traffic. Marked pedestrian crossings are often found at intersections, but may also be at other points on busy roads that would otherwise be too unsafe to cross without assistance due to vehicle numbers, speed or road widths. They are also commonly installed where large numbers of pedestrians are attempting to cross or where vulnerable road users regularly cross. Rules govern usage of the pedestrian crossings to ensure safety for example in some areas, the pedestrian must be more than halfway across the crosswalk before the driver proceeds.

To identify the existing condition of the pedestrian mode, the pedestrian characteristics for various pedestrian facilities need to be investigated. Most of the crossing inside campus is a zebra crossing. So, this study just focuses on zebra crossing near bus stop in campus.

1.2 Problem Statement

University Malaysia Pahang's campus core has a solid network of sidewalks, crosswalks, and interior walkways. The largest barriers to pedestrians that were discussed during input sessions and observed included automobile speeds, lighting issues, no pedestrian roof and a lack of crosswalks in campus (Dr. Tom V. Mathew, 2014). This investigation studies the influence pattern of the gender and age of pedestrians' behaviour and pedestrian crossing attributes at one lane position on the pedestrian crosswalk at UMP Gambang and IIUM Kuantan.

One of the common problems facing by pedestrians was the difficulty of crossing the road. As stated by Zhao & Chen (2017), crossing lane by lane indicates that pedestrians fail to complete the crossing in one sequence because of interference from vehicles, so they must stop and stand between lanes, waiting for a sufficient time gap before they continue crossing. Because of the problem that, there have been 30 crashes involving pedestrians or bicycles at Clemson University between 2001 and 2008, the most extreme in the Spring of 2007 when a student was involved in a crash with a transit vehicle while crossing the street within a crosswalk on campus resulting in severe injuries (Sarasua & Chowdhury, 2009). Therefore, this investigation attempts to investigate the crossing characteristics in UMP Gambang and IIUM Kuantan and to provide the basis for assessing pedestrian crossing safety.

1.3 Research Objective

The aim and objective of this case study is to study on pedestrian behaviour and pedestrian flow characteristics for UMP Gambang, and IIUM Kuantan. To achieve the aim of this study, the following objectives have been set as:

i. To evaluate pedestrians preference and perception towards unsignalised zebra crossing.
ii. To analyses pedestrian crossing behaviour at unsignalised zebra crossing.

1.4 Scope of Work

Data collection is conducted in Universiti Malaysia Pahang (UMP) and International Islamic University Malaysia (IIUM) campus. Universiti Malaysia Pahang (UMP) was established by the Government of Malaysia on February 16, 2002. The Gambang Campus is currently operating in an industrial estate about 30km from the city of Kuantan and it is a 2 and a half hours' drive from Kuala Lumpur, via the East Coast Expressway. The International Islamic University Malaysia (IIUM) was officially established on 20 May 1983 by the Government of Malaysia. IIUM's campuses are located in Kuantan, Jalan Sultan Ahmad Shah.

This study was focused at an uncontrolled pedestrian crossing. In UMP and IIUM campus, most of the pedestrian crossing inside campus is a zebra crossing. UMP has three zebra crossings; first from Astaka to block W, second from Kolej Kediaman 3 to block W, and third from Cafeteria to block W while in UIA just has only one zebra crossing which is from Kolej Kediaman to Faculty of Science. So, this study for UMP Gambang just focuses on zebra crossing from Kolej Kediaman 3 to block W which is near bus stop in campus.

1.5 Research Methodology

Chapter 1: Background of the study

This chapter is including of an introduction of the study, problem statement, objectives or destinations of the study, degree and confinement of the study, significant of the study, methodology, and arrangement of chapters.

Chapter 2: Literature Review

This chapter will outline the background of the study and the literature review from the secondary sources that related to the study issue. The information will comprise from the past research by other researcher and it will support the aim and destination of this study.

Chapter 3: Research Methodology

This chapter will briefly expose and explain the methodology and case work, which it will generate the information and data required to support the study in order to achieve the study objectives.

Chapter 4: Analysis and Finding

This chapter is about the data analysis and presenting the findings obtain from the study by setting out the result.

Chapter 5: Conclusion and Recommendation

This chapter will provide the conclusion of the study which the decision is made on the data analysis. From the study result, the suitable recommendation can be made to resolve the problem study and for future research.

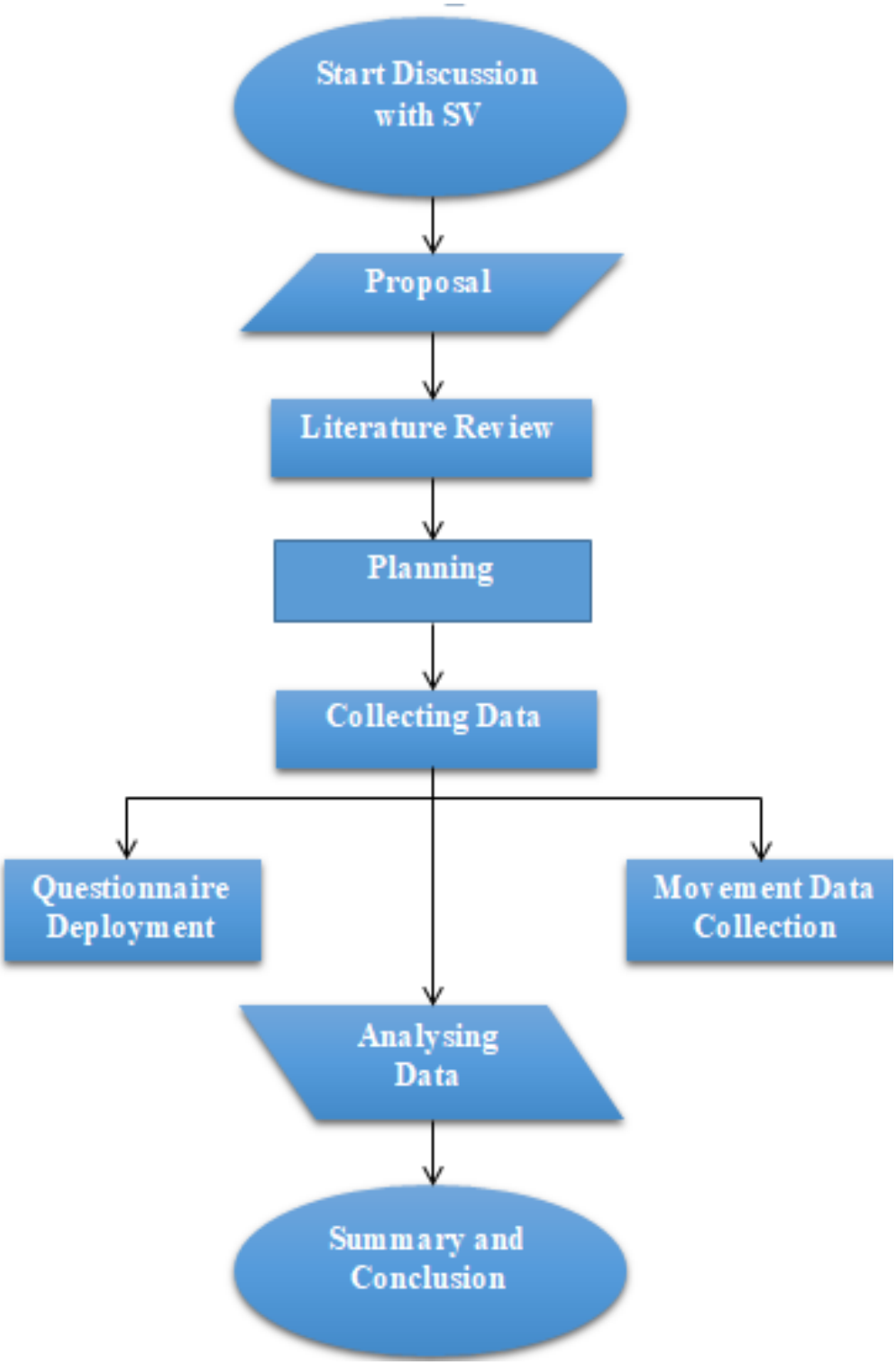


Figure 1.1**:** Research Methodology Flow Chart

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, we will discuss about pedestrian study. A safe walking environment is key to protecting pedestrians and encouraging physical activity (D. Alex, Thomas D., Linda Ng, J.Jaime, Brian D., & Beth E., 2014). A pedestrian is a person travelling on foot, whether walking or running. In some societies, those traveling using tiny wheels such as skateboards, scooters and roller skates, as well as wheelchair users are also comprised as pedestrians. In modern times, the term usually refers to someone walking on a road or pavement, but this was not the case historically. The pedestrian behavioural studies are one of the scopes covered in pedestrian safety, pedestrian crossing, pedestrian speed and pedestrian space. This is because the behaviour of pedestrians, especially during the execution of road crossing is an important elements in pedestrian safety related issue. Understanding the behaviours of pedestrian while crossing a road section is part of a road safety challenge. Pedestrian behaviour cannot be assumed to be consistent. Different characteristics, crossing facility provided, traffic environment and different culture would affect the behaviour of pedestrians. Age factor might have an influence to the pedestrian behaviour as declining of cognitive abilities in old pedestrian would affect their judgement in road crossing task and gap selection. In addition, behaviour of pedestrians might varies according to the factor like gender. This can be notice when research found that male tend to violate signal more frequently, while female more likely to jaywalk. Looking to the effect of gender to safety margin, male tend to adopts lower safety margin.

2.1.1 Jaywalking

Jaywalker seems like a word that must have originated in New York City, since so many pedestrians of that metropolis seem to have no regard for crossing the street at the appointed time or place. Jaywalking occurs when a pedestrian walks in or crosses a roadway illegally. The term originated with "jay-drivers", people who drove horse-drawn carriages and automobiles on the wrong side of the road, before taking its current meaning. Pedestrian jaywalking behaviour is commonly observed in the field, especially within an environment with high levels of pedestrian activities (Yinan, Lily, Thomas, & Bastian, 2016). The meaning of jaywalker is different than it was when it first began to be used. The word was formed in imitation of a slightly older word, the jay-driver. This initially referred to a driver of horse-drawn carriages or automobiles who refused to abide by the traffic laws in a fairly specific way: they drove on the wrong side of the road.

2.2 Pedestrian Safety: Pedestrian Crash Scenario

In the recent five years, the number of road related fatalities have been at a plateau at a figure of approximately 6700 deaths a year. Although a majority of this figure belongs to the motorcyclist's group (60%), it is important to note that the most vulnerable road users, the pedestrians, consist a total of 4% of road fatalities in Malaysia (RMP, 2012). Pedestrians form the second largest group of vulnerable road users killed on Malaysian roads, an average of 13% of all pedestrian casualties caused by motor vehicles each year. Figure 2.1 shows number of pedestrian casualties and from the year 2007 to the year 2011. Between the year 2010 and 2014, an average of 500 pedestrians were killed on roadways in Malaysia. This represents approximately 28%-38% of the pedestrian casualties in Malaysia within the past five years. Figure 2.2 shows the percentage of pedestrian-related casualties in Malaysia between the years 2010 to 2014 by pedestrian movement. Although data obtained revealed that only 10% of injury related crashes involving pedestrians occurred for pedestrians 'Not Using Pedestrian Crossing', a large majority (more than 50%) of movement behaviour was reported to be 'Careless Crossing' (RMP, 2010-2014). Providing safe crossings is a priority for many agencies, where the determination of appropriate crosswalk treatment for specific contexts is often a feat.

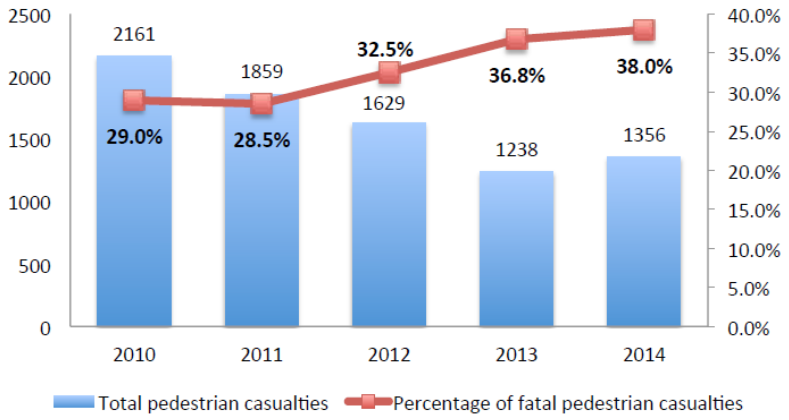


Figure 2.1: Number Of Pedestrian Related Crashes from 2010 - 2014

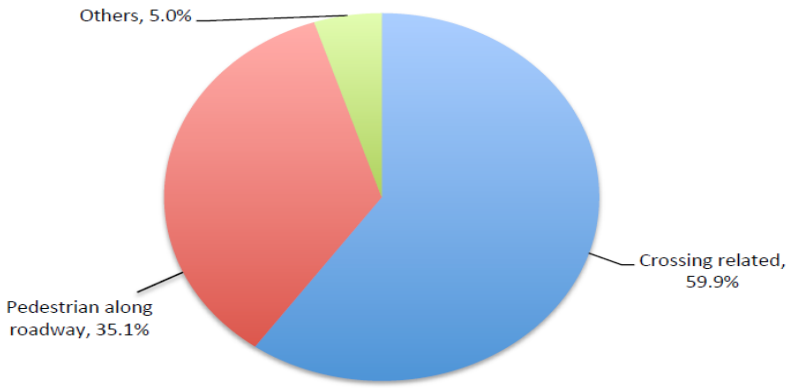


Figure 2.2: Percentage of Pedestrian Casualty from 2010-2014

Study by Mohd, Baba, & Nur, 2017 revealed that 15% of pedestrian's accident occurred because they lacked attention. Distraction has negative effects on traffic behaviour. Pedestrian's distraction can be defined as those wearing headphones, talking on a cell phone, eating, drinking, smoking, or talking with another pedestrians as they crossed the street (Amy & Alexia, 2015). Those examples potentially increase due to lift up of lifestyle and it is aligned with advance telecommunication. Distracted pedestrians usually at high risk during crossing which the process needs cognitive (e.g., road user focuses more on phone conversation rather than walking activity), cautionary behaviour (e.g., looking before crossing a road), auditory (e.g., road user listens to the music via headphone) and motor coordination judgment to minimize the risk (Nasar & Troyer, 2013).

In UITM Shah Alam, there were a total of 268 accidents with 67 accidents per year in campus (Amir, Ahmad, Sundara, Chua, & Kamaruddin, 2016). Figure 2.3 below shows the trend of road accident in UiTM Shah Alam from 2009 until 2012.

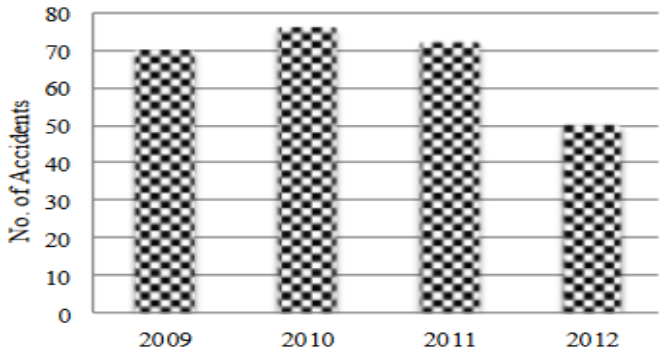


Figure 2.3: Road accident in UiTM Shah Alam from 2009 until 2012

Year / User	2009	2010	2011	2012	TOTAL
Student	40	42	38	34	154
Staff	27	29	33	16	105
Outsider	3	5	1	0	9
Total	70	76	72	50	268

Figure 2.4: Distribution of Road Users Involved In Accidents

Year / Vehicle	2009	2010	2011	2012	TOTAL
Motorcycle	55	67	78	45	245
Car	34	54	56	38	182
Lorry	4	3	4	4	15
Pedestrian	2	4	-	-	6
Bus	3	3	3	4	13
Total	98	131	141	91	461

Figure 2.5: Type Of Vehicles involved In Accidents

2.3 Pedestrian Crossing Facility

Pedestrians need facilities that serve to protect pedestrians from conflicts with motor vehicles, thereby increasing the sense of security for both pedestrians and motorists. The crossing pedestrian facility is part of road which shows by difference surface path, difference textures, or different colours in order to make it contrast so it is easily to recognize by pedestrians or vehicles rider. Basically, pedestrian crossing facilities are divided into two types, there first is pedestrian crossing at grade and the second is overpass/underpass pedestrian crossing. The choice of pedestrian crossing facilities should also consider pedestrian needs factors, which consist of internal factors such as age, gender, or willingness to using pedestrian facilities (Hidayat & Edwin, 2012).

According to Arahan Teknik (Jalan) 8/86 by the Public Works Department (PWD, 1986), the pedestrian crossings (whether level, overpass or underpass) should be provided where pedestrian volumes, traffic volumes, intersection capacity and other conditions favour their use. They may be war-ranted in areas of heavy peak pedestrian movements such as factories, schools, athletic fields or control business districts or where abnormal hazards or inconveniences to pedestrians would otherwise result. Table 1 gives the general guidelines for determining the type of crossing that is required. Where the pedestrian and vehicle volume does not fit into any of the category shown, judgement is needed in the assessment of the type of crossing required.

Pedestrian Volume at peak hour	Traffic Volume (1 way) at peak hour	Type of Crossing
< 50	< 1000	Ordinary level crossing
50 - 100	100 - 2000	Signalised level srossing
> 100	> 2000	Overhead crossing / underpass

Figure 2.6: Guideline for Type of Crossing Required

Pedestrians are part of the physical element of urban design. Each pedestrian needs to walk on the road safely, and is fun, hence its needed pedestrian infrastructure to walking along the road i.e. pedestrian sidewalk and pedestrian crossing. The pedestrian facilities were built to provide for pedestrians in order to improve the smoothness safety, and comfort of pedestrians. A pedestrian facility in this study is an uncontrolled pedestrian crossing that has a marking which is zebra crossing.

2.3.1 Zebra Crossing

A zebra crossing is a type of pedestrian crossing used in many places around the world. Its distinguishing feature is alternating dark and light stripes on the road surface, resembling the coat of a zebra. Besides, a zebra crossing typically gives priority to rights of way to pedestrians. The zebra crossing consists of a conventional zebra crossing supplemented with zigzag lines, yellow flashing lights sometimes called flashing beacons or simply flashers, and an improved advance warning sign. Based on Ishaque & Noland, (2006) approaching a zebra crossing drivers were obliged to give precedence to pedestrians.

The zebra-crossing often characterizes a crossing, which provides a safe area for pedestrians to cross the road reminds vehicles to reduce their speed and pays attention to safety (Mingli, Hua, & Yihui, 2016). The similarity of these markings to those of a zebra gives the crossing's name. The light colour is usually white and the dark colour may be painted in which case black is typical or left unpainted if the road surface itself is dark. The stripes are typically 40–60 cm (16–24 in) wide. The lines of a zebra crossing are commonly laid down by a road marking machine. Because the width of crossing lines is wider than other traffic lines, the marking shoe of a zebra cross marking machine is accordingly wider. The machine is hand pushed. The crossing is characterised by longitudinal stripes on the road, parallel to the flow of the traffic, alternately a light colour and a dark one.

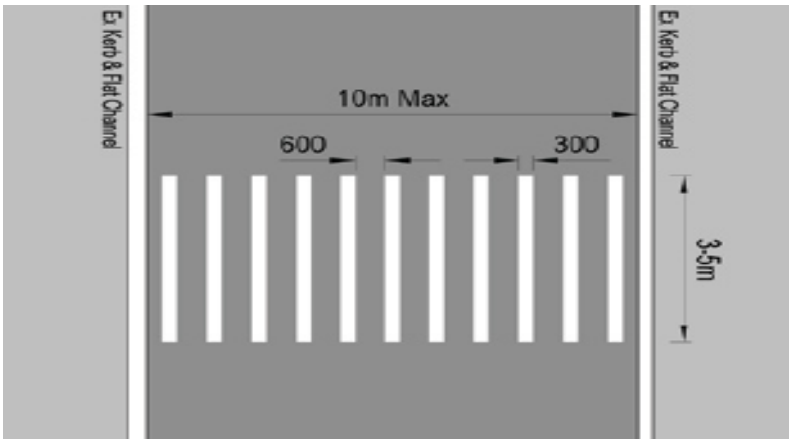


Figure 2.7: Zebra Crossing Markings

2.3.2 Zebra Markings

Zebra markings usually fade away with time, traffic, environmental condition, and other factors Smadi, Souleyrette, Ormand, & Hawkins, (2008) making them difficult to see at sufficient distance. Transverse pavement (zebra) markings are intended to define the area where a pedestrian can cross the road legally, in a way; pedestrians are channelled and guided into the proper path. They help the driver to see the crossing well in advance. The combination of these two features is expected to improve the safety of pedestrians using the crossing. Zebra markings visibility depends on roadway geometric design, marking material reflectorization property, weather, and road maintenance level & practice. Based on Ekman, (1988) that despite the well-known fact that most of the accidents where pedestrians have been hit by a car in urban areas occur either at a zebra crossing or at a signalized intersection; this has not changed the opinion by many people about the zebra crossing being a safer place to cross the roadway.

2.3.3 Pedestrian Behaviour

From a safety point of view, most pedestrian injuries tend to occur when people cross the road no safety gap between vehicles. Unlike drivers, who need to go to certain routes, pedestrians are free to move further. It shows that pedestrians, as consumers, are not really governed by regulations, and their behaviour is often unpredictable. According to Rankavat, Tiwari, & Singla, (2013) looked at pedestrians' attitudes when

faced with danger and sought to explain gender and age-related differences in exposure to risk. By comparing the pedestrian intention to crossing the road in different situations, they show that results are not taken according to the perceived risk, but the results are to cross the road according to the situation when it is safe. This factor is found that pedestrian perception and priority towards facilities are a very important factor to be taken care of while planning and more secure when using existing facilities.

2.3.4 Pedestrian Preference

Pedestrian preference is to enhance the safety of our own by utilizing the available facilities, although it takes a long time to cross the road. The option to cross far from the specified intersection facility increases the risk of vehicle and pedestrian collisions but is often chosen as it is the fastest and most direct way to reach the destination. The preference for particular facilities also depends on their design and maintenance, which are associated with perceptions about crime and concerns about aesthetics and hygiene (Sinclair & Zuidgeest, 2016). Stated preference surveys can be applied to elicit preferences among alternative measures that might be provided to improve the ease of crossing the road. The most radical and most effective of these measures are to build a road tunnel, so that pedestrians can walk ‘over’ the road, at grade. Estimated preferences for traffic calming measures in terms of reductions in traffic speed, noise, aesthetics, and time to cross the road. However, for certain individuals, priorities are determined not only by the crossroads and features of intersections, but also for the distance to access them.

2.3.5 Pedestrian Perception

Convenience and time saving are the most commonly followed perception factors. Therefore, pedestrians who want to save time do not use existing facilities, they cross the road before the presence of zebra crossing when the driver is slowing down the vehicle. In addition, inadequate signage, vehicle breaking speed, and no road crossbar signage may be associated with pedestrian accidents and increased calming traffic enforcement can help prevent this accident. However, it is very likely that pedestrians will not use the facilities provided, as they often increase walking distance compared to the intersections. Already studied the use of pedestrian bridges and

underpasses in London and noted tentatively that roughly 80% of pedestrians would use the safe path, if it takes the same time as across the road. Later, showed that no pedestrians used the bridge if the travel time was 1.5 times or higher compared to the travel time at level crossing (Rankavat, Tiwari, & Singla, 2013).

2.4 Pedestrian Crossing Behaviour

There is variety forms of studies conducted about Pedestrians' crossing behaviour. These studies usually used unobtrusive observation or simulation. Characteristics such as walking speed, spatial needs, waiting time, pedestrian platoon and accessibility concerns, are all important factors considered for pedestrian facilities (Gabe Dobbs, 2009). The traffic safety of a pedestrian who is crossing a street is influenced by many factors. Therefore research on pedestrian behaviour is usually detailed, deterministic, traffic and environment oriented. There are three scenarios when a pedestrian attempts to cross. If pedestrian crosses when there are no vehicles around, then he or she will be definitely safe. If the pedestrian wishes to cross a street when there are vehicles passing by, he or she can either wait for a safe gap to occur, for a vehicle to slow down or stop for him or her, or just walk out into traffic and make the traffic flow stop. In the case of the pedestrian jumps in road, the driver has two choices; he/she will stop or he or she will not brake. Sometimes driver will even accelerate to show that he will not give way to the pedestrian.

Pedestrians' behaviours, with characteristics such as age and gender, will provide important insights into understanding their safety. In this research, the influence of pedestrian characteristics on behaviour is studied specifically at Universiti Malaysia Pahang (UMP) and International Islamic University Malaysia (IIUM) crossing. The study also focuses on this context, as these present the most volatile areas of interaction between pedestrians and motor vehicles. The goal of this research is to fill a gap in the current knowledge of pedestrian behaviour due to its implications for pedestrian safety. The following literature review will first examine the most pertinent behavioural factors regarded as dependent variables. It will then detail past researches on the independent variables (gender and age). The extensive literature on pedestrian crossing behaviour has used a wide variety of methods; including self-completed questionnaires (Bernhoft

& Carstensen, 2008). These sections will examine the pertinent factors in general and not necessarily in this context.

Dependent behavioural variables chosen for this study include pedestrian delay time, utilization of available crossing treatments, and conflicts between pedestrians and motor vehicles. Based on Guo et al., (2012) pedestrian delay is an important variable to study because pedestrians frequently become impatient while waiting to cross the street. If a pedestrian becomes impatient and unwilling to wait for a shorter vehicle gap, then he or she is more likely to enter a risky situation while crossing the roadway. Similarly, pedestrians who do not use the available crossing infrastructure are also more likely to enter risky situations. Although the safety benefits of crosswalks and other similar pedestrian treatments have been called into question by past researches, people that are willing to disobey established rules are more likely to dispose themselves to risk during their crossing. This increases the likelihood of poor safety outcomes. The final dependent variable used for this analysis is conflict between pedestrians and vehicles. Gender and age are analyzed in relation to the aforementioned dependent variables. A specific theory that has been supported in past researches to predict pedestrian behaviour is of particular interest to the current study. Based on Holland & Hill, (2010) the Theory of Planned Behaviour is a method of predicting pedestrian behaviour based on the intentions of the users of the system. The theory is a good predictor of intentions, and shows that pedestrian behaviour, especially with respect to safety, can be predicted and accounted for. This supports the goal of this paper, which is to help predict pedestrian behaviour based on specific characteristics, in order to improve the safety of transportation systems. Just as past researchers have shown the feasibility of predicting pedestrian behaviours through the Theory of Planned Behaviour, it is hopeful that the results of this study will also aid in predicting pedestrian behaviours.

2.4.1 Gender

Past research has shown that the gender of a pedestrian is an important characteristic in determining pedestrian behaviours such as waiting time and proclivity towards risk. In particular, it has been shown that male pedestrians are more willing to violate regulations and make unsafe crossing decisions. They are also less likely to perceive risk when crossing a roadway in the presence of motor vehicles. Based on

Nicholas, (2016) male pedestrians also tend to wait for shorter amounts of time than female pedestrians when crossing a roadway. Correspondingly, male pedestrians have significantly faster walking speeds than their female counterparts, possibly relating to their shorter waiting times. As is expected, males comprise up to 80% of pedestrian fatalities. In addition to pedestrian behaviour being strongly dependent on biological gender, as shown in past researches, it has also been found to depend on the psychological masculinity of an individual (M.A. Granié, 2009).

2.4.2 Age

Along with gender, the pedestrian characteristic of age is a significant variable in relation to pedestrian behaviour. Higher pedestrian age correlates with decreased risk perception, larger minimum gap acceptance, and longer waiting times when crossing a street. Pedestrian speeds are also significantly related to pedestrian age, and the speeds of pedestrians are slower as they get older. Past researchers have found that pedestrians between 21 and 30 years of age are the fastest age group (Nicholas, 2016). There remains some ambiguity regarding the relationship between pedestrian age and actual risk and conflict. While younger pedestrians are more willing to violate regulations, older pedestrians make more unsafe decisions (Holland & Hill, 2010). Such unsafe decisions are primarily related to older pedestrians' difficulties in interpreting the situation. Having a clearer understanding of this relationship, especially at midblock crossings in developing countries, will greatly aid the understanding of pedestrian behaviour, and therefore support the overall safety of third world transportation systems.

2.4.3 Waiting Time

Waiting time is one of the most important factors that need to be studied if pedestrian crossing behaviour is examined. Waiting time is an influencing factor on unsafe pedestrian crossing. Waiting time is the time elapsed between the pedestrian reaches the zebra crossing and the point when she/he starts crossing (Gowri & Chandra, 2016). Reducing waiting time of pedestrians would probably decrease the chance of pedestrian being crashed by vehicle. The existing studies in the literature classify pedestrians into categories; the pedestrians in different categories behave differently for

street crossings during the red-man phase. In this research we follow this approach and classify pedestrians into two broad categories, risk averse and risk taking, according to whether or not the effective critical headway is greater than the minimum headway. Risk-averse pedestrians have a higher average level of effective critical headway, so they tend to wait until they are sure it is safe to cross. This category includes those who tend not to trade safety with time and those who have less mobility.

In addition, the pedestrians are more law-abiding at traffic signals if they are accompanied by children or their mobility is impaired or they have heavy luggage. On the other hand, risk-taking pedestrians have a lower average level of effective critical headway, so they tend to cross the street whenever possible. This category includes individuals who value their time highly and thus tend to take risks during street crossings. For instance, most commuters fall into this category. That pedestrian who frequently use a certain crossing and who live nearby are likely to reduce their waiting times by accepting higher risk. Younger and/or male pedestrians also tend to be risk-takers.

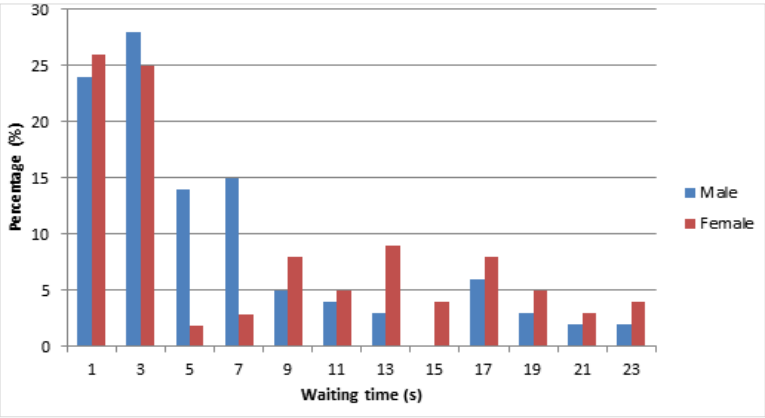


Figure 2.8: Waiting Time for the Pedestrians at Zebra Crossing

2.4.4 Pedestrian Speed

Pedestrian speed is probably the most important characteristics of a pedestrian facility that is affected by individual pedestrian behaviour and habit (Dr. Tom V. Mathew, 2014). Other than that, pedestrian speed is the average pedestrian walking speed, generally expressed in units of meters per second. Among several factors that influence walking speed are density, gender, size of platoon, percentage of elderly

population and handicapped pedestrian population. Based on Highway Capacity Manual, (2000) an average walking speed of 1.2 m/s is appropriate for typical groups of pedestrians and the amount of space required by a queued or standing pedestrian is 0.75 m^2.

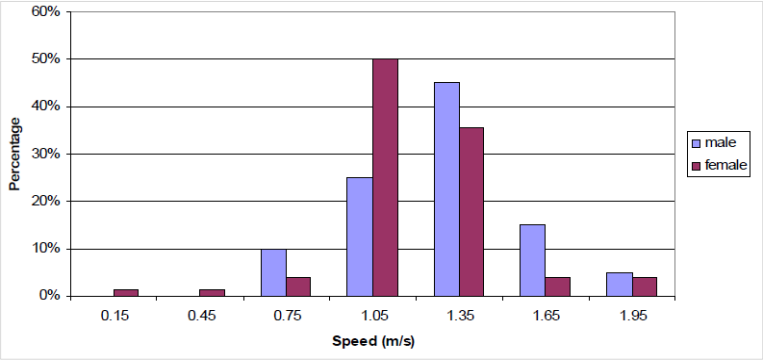


Figure 2.9: Pedestrian Speed of Males and Females

2.4.5 Pedestrian Crossing Time

Crossing time is measured by the time difference between the starting time of the crossing and the ending time of the crossing minus waiting time at the median since the crossing speed is zero while waiting (Pelin & Yalcin, 2017). Pedestrians can safely cross an intersection as long as there are not any conflicting movements occurring at the same time. According to Akash, Ankit, & Rajat, (2014) reported that approaching traffic volume and vehicle speeds are instrumental in determining the number of crossing attempts. Few studies revealed that gap acceptance of pedestrians is a function of waiting and crossing time, crossing speed, age, gender, crossing pattern of pedestrians, speeeds and type of vehicles.

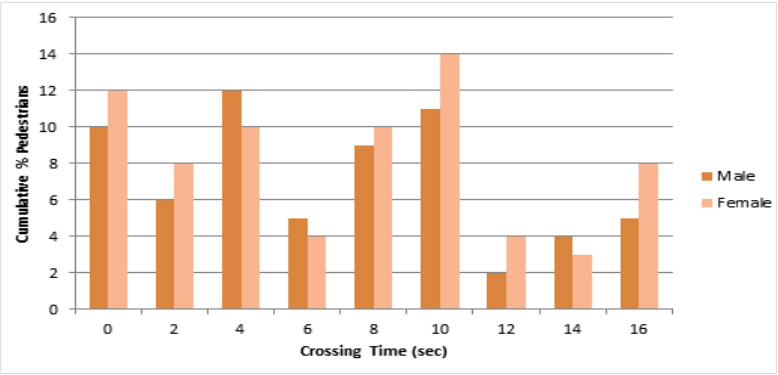


Figure 2.10: Pedestrian Crossing Time of Males and Females

2.4.6 Pedestrian Volumes Studies

As a way to explain the current status of the transportation system, engineers are required to collect diverse data and information (Roess, et al., 2004). In this manner, focus is set in collecting data related to the volume of pedestrians in the system. The data can have several applications, for example it can help to perform safety analysis studies, look for modifications in infrastructure, and forecast future trends in society, business development, among others (Schneider, 2008). The collected data is the basis for obtaining the information needed for the planning, designing and decision-making processes.

It is important to know the actual behaviour of pedestrians so future projects can be proper developed. For example, if the pedestrian's concentration zones are known, future bus/trams/metro stops could be created in order to distribute better the volumes.

In traffic engineering, volume studies are most of the time needed, for example to measure demand or usage of pedestrians. Roess, et al. (2004) defines volume as "the number of persons passing a point during a specified time period.

2.4.7 Gap Acceptance

Gap acceptance or in other words safety margin is simply idea of the further the car, the safer to cross. The size of the gap to cross in traffic will differ from pedestrian to pedestrian as a function of their individual factors (walking speed, fatigue) and environmental factors. In this study it was found that, in gap acceptance have include number of vehicles, vehicle speed, pedestrian distance and number of pedestrians simultaneously crossing. Time gap is defined as the time taken by the pedestrian so that it starts crossing the road without conflicting the approaching vehicle just coming to start point (Akash, Ankit, & Rajat, 2014).

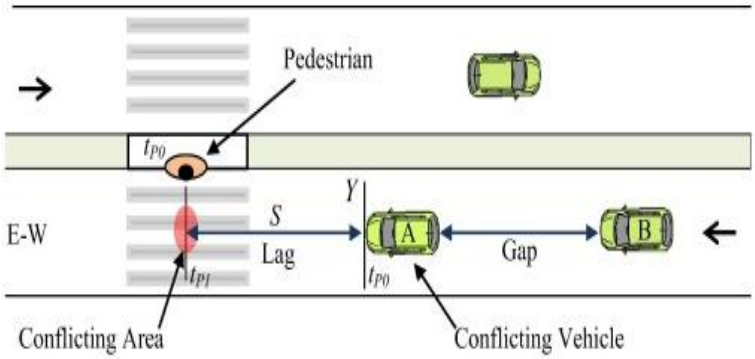


Figure 2.11**:** Pedestrian Safety Gap

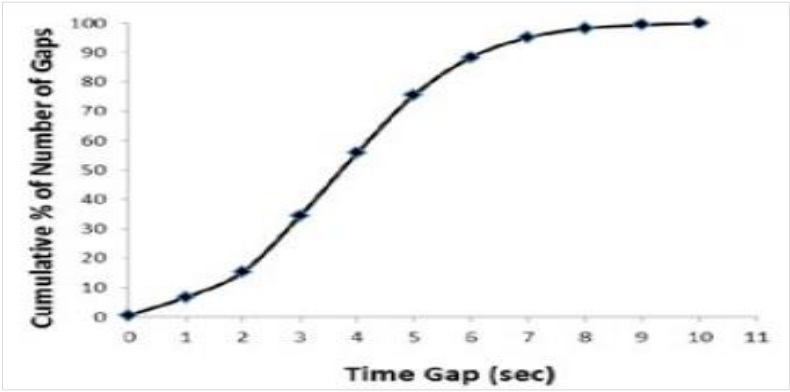


Figure 2.12: Cumulative Curve for Gap Acceptance

2.4.8 Platoon

Platoon refers to a number of pedestrians walking together in a group, usually involuntarily, as a result of signal control and other factors. According to Highway Capacity Manual, (2000) for most situations where platoons are prevalent, this study does not recommend the use of walking speeds lower than 1.2 m/s (1.0 m/s for large elderly populations). However, based on Virkler, (1997c) described in the Literature Review for Chapter 13, Pedestrians, of the Highway Capacity Manual, this study recommends increasing the minimum signalized intersection crossing time when typical platoons exceed 15 people. This report details several crossing time computational methods later. This study also cautions the analyst to consider impairments to full usage of the crosswalk. These may include: lack of a stop bar, lack of high-visibility crosswalk markings, crosswalks misaligned with the natural flow of the sidewalk, and corner obstructions.

2.4.9 Pedestrian Flow

Based on Dr. Tom V. Mathew, (2014) pedestrian flow rate is the number of pedestrians passing a point per unit of time, expressed as pedestrians per 15 min or pedestrians per minute. Point refers to a line of sight across the width of a walkway perpendicular to the pedestrian path.

Pedestrian flow per unit of width is the average flow of pedestrians per unit of effective walkway width, expressed as pedestrians per minute per meter (p/min/m). Pedestrian density is the average number of pedestrians per unit of area within a walkway or queuing area, expressed as pedestrians per square meter (p/m2).

2.4.10 Pedestrian Space

Pedestrian space is the average area provided for each pedestrian in a walkway or queuing area, expressed in terms of square meters per pedestrian. Pedestrian and vehicle dominant spaces across the road right-of-way will be separated vertically. Both road users; pedestrians and vehicle drivers should give and take as well as alert with the spaces such as the travelled way. This is the inverse of density, and is often a more practical unit for analyzing pedestrian facilities.

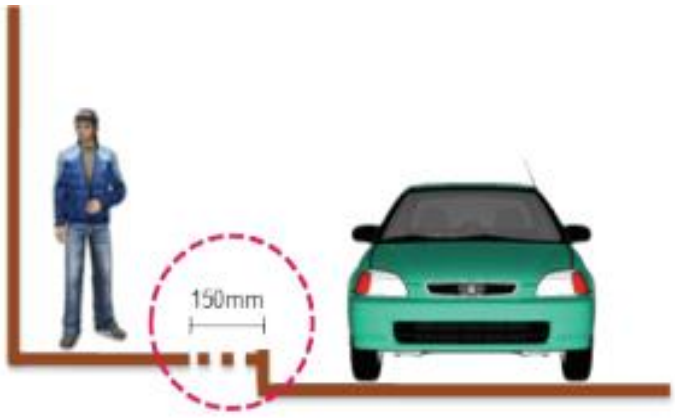


Figure 2.13: Pedestrian and Vehicle Vertical Separation

2.5 Driver Behaviour

In traffic, the possibilities to communicate are restricted but a driver can more or less deliberately, shows his or her intentions to other road users by selection of speed and position on the road. For example, driver can slow down or stop to show that they will give way, or maintain the speed or accelerate to show that they do not intend to give way to other road user. According to Björklund & Åberg, (2005) formal observations of drivers at a campus revealed that most of drivers never came to a complete stop when a pedestrian was in the crosswalk and 43% of the drivers did not stop. Driver yield behaviour has been commonly observed when interacting with street-crossing pedestrians and may significantly affect the interactions as well as pedestrian operations at unsignalized intersections /midblock crossings (Salamati, Schroeder, & Rouphail, 2011). The yield rate varies under different conditions. For example, it was found that the drivers were more likely to yield with low vehicle travelling speed, travelling in a platoon within an environment with higher pedestrian activities.

The present study was aimed to examine the driver's braking behaviour while approaching zebra crossings under different safety measures. More specifically, a configuration of zebra crossing without treatment (baseline condition) and three safety measures, such as curb extensions, parking restrictions, and advance yield markings that are characterized by low cost, simple installation and high potential effectiveness on driver behaviour, were investigated. The speed reduction time, defined as the elapsed time between the initial speed value (i.e., the speed value when the driver releases the accelerator pedal or starts to brake in response to a pedestrian crossing) and the minimum speed value when the driver yields to the pedestrian, was the variable used to describe the driver's behaviour.

The width of the interval time taken by the driver to pass from the initial speed to the minimum speed highlights if the driver receives an information that is more or less clear about the pedestrian crossing and, therefore, if he can yield to the pedestrian with a gradual maneuver. In other words, a small speed reduction time reveals an inappropriate driver's braking behaviour indicating that the driver needs to modify his speed in a short time in response to a crossing pedestrian, and therefore, he adopts abrupt maneuver. The speed reduction time was modeled by the use of a parametric

duration model, also called “survival model” or “hazard-based duration model”, to compare the effects on driver’s braking behaviour of vehicle dynamic variables and different countermeasures (Francesc & Manuel, 2016).

2.5.1 Speed Limit

According to Arahan Teknik (Jalan) 8/86 by the Public Works Department (PWD, 1986), the earlier steps have provided a list of possible safe speed corresponding to the various criteria above. By comparing these speeds, select the lowest speed available and this speed shall be the appropriate speed limit for the section of road concerned. A speed zone is an area where a speed limit has been established by law, or by regulation, after an engineering and traffic investigation has been made in accordance with established traffic engineering practices. In general, speed zones are town areas and those residential areas that are adjacent to rural or high-speed open highways. The following section describes, in order, the traffic signs that are used in conjunction with speed zones. The understanding of the behaviour to exceed speed limits may be also useful for the development of the necessary regulations to reduce inappropriate speed choice (De Pelsmacker & Janssens, 2008). Consequently, the opinion and self-reported behaviour of drivers on speeding is a serious matter that must be taken into account in setting and enforcing speed limits.

2.5.2 Free Flow Speed

Generally, the free speed is defined by the speed of driver when the driver is not influenced by other road users. The free speed is influenced by vehicle, the driver, the road, and (road) conditions such as weather and traffic rules. The appropriate driving speed is set for each type of road or road section according to the road design (Mannering, Washburn, & Kilaresk, 2009). But speed is also affected by the drivers’ social and psychological situation on driving time and other human factors. Estimation of the free speeds and the free speed distribution is not a straightforward task. Drivers can be in two states; car-following or driving at their free speed. The Highway Capacity Manual 2010 (HCM2010) suggests an indirect method for field measurement of FFS based on the operating conditions of the highway in terms of base free flow speed (BFFS) and geometric features regarded as factors influencing FFS.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, we discussed the method in which the study was conducted and data collection methods to get more detailed information. According to Jamil (2013), based on the research objective, methodologies have been identified at an early stage of to help the as guidelines for research. In general, there were two methods of carrying out the research which is qualitative methods and quantitative methods but there is some research that carries both methods. In this research, the author uses quantitative methods and qualitative methods in which the authors provide a questionnaire sample and work on site by planting the devices to get data. The data was very useful to the author to gain more information. This study involves the observation and analysis with respect to the characteristics of the pedestrian. It also describes the equipment required and the use, the location of study, the statistical and mathematical analysis and equations used.

3.2 Research Planning

In this study, the first step was to provide a flow chart of the study to implementation of the study. It helped to make this research effective. This allows for the smooth research operations. Part of designing a research was to identify the flow of research methods. Figure 3.1 below shows the flow of research methodology in this study. At the beginning of this study, related research has been studied to find the scope of case study which is related with this topic. The location of the study determined before doing the project. The next process is a prepare sample of questionnaire and a set

of data from metro-count that is needed in this study. Then determine the appropriate method of observation and observation of work done on site. Results of observation data gathered and analysed. After analysis, the analysis of the study was discussed and finally conclusions and recommendations made. After the entire previous step was done, the writing process began and hence the project was completed.

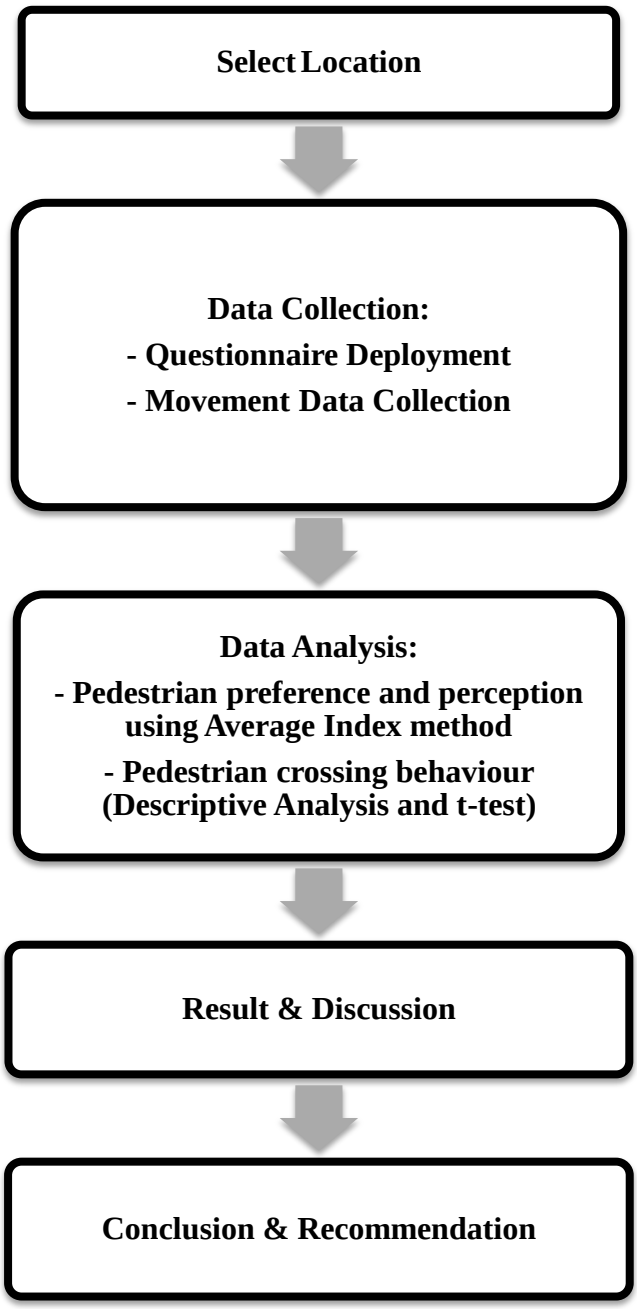


Figure 3.1: Pedestrian and Vehicle Vertical Separation

3.3 Site Location

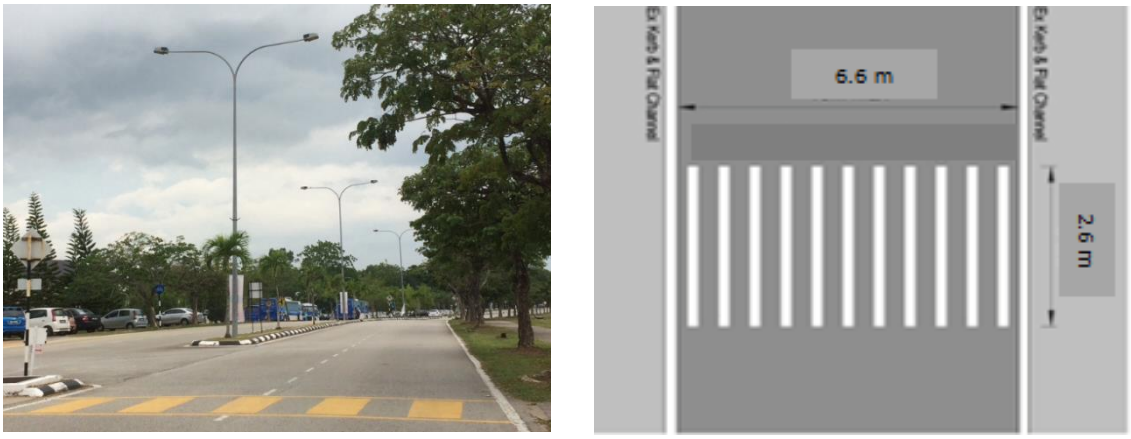
To accomplish research objectives, several uncontrolled pedestrian crossings was selected from universities campuses around Kuantan, Pahang such as Universiti Malaysia Pahang Gambang, and International Islamic University Malaysia Indera Mahkota. The selection criteria of the pedestrian crossings are: (a) selection of suitable site for field survey must offer pedestrian crossing so as to investigate the pedestrian behaviour and driver compliance at facilities; (b) all pedestrian crossing must be uncontrolled crosswalk marked which is zebra crossing; and (c) the presence of high pedestrian activity to reduce the time required for data collection. The speed limit of UMP is 35km/h while speed limit of IIUM is 30 km/h. All streets were on level terrain with moderate traffic volumes.

Figure 3.2: The location of study at Universiti Malaysia Pahang (UMP)

Figure 3.3: The location of study at International Islamic University Malaysia (IIUM)

3.3.1 Description of the Study Area

This study was conducted at two locations of educational institution in Kuantan, Pahang. First location selected is Universiti Malaysia Pahang, Gambang, while second location selected is International Islamic University Malaysia, Kuantan. These two locations of education institutional were selected as shown in Figure 3.4 and Figure 3.5. Based on the figure, it shows the different size of zebra crossing between two locations.



(a) (b)

Figure 3.4 (a), (b): Designated pedestrian crosswalks at UMP Gambang

(a) (b)

Figure 3.5 (a), (b): Designated pedestrian crosswalks at IIUM Kuantan

3.4 Data Collection

In this research used both qualitative and quantitative approaches to achieve the study's aim. Data collection was carried out to identify pedestrian preference and perception towards pedestrian crossing facilities in the universities campuses in Kuantan which are UMP and IIUM. This research will be conduct by distributing sets of questionnaire randomly to the respondents consisted primarily of undergraduate and graduate students whom frequently used pedestrian facilities. This survey is important to specifically identify pedestrian issues that currently interrupted the daily movements of students and staffs in these campuses. This survey is important to specifically identify pedestrian issues that currently interrupted the daily movements of students and staffs in these campuses. A group of enumerator shall be involved in completing this survey.

Moreover, in analysing the pedestrian waiting time, and pedestrian walking speed the data will be collected through direct observation of pedestrian and vehicular activities using video cameras.

3.4.1 Questionnaire Deployment

The questionnaire will be covered on the following areas of interest: (PartA) pedestrian's background (age group, gender, and frequency of use of the facility); (Part B) consists of pedestrian inventory performance and pedestrian perceptions with respect to right-of-way and safety (crossing location, conditions, compliance. Part B was made up of likert scale questions to indicate drivers perception with the statement in the questionnaire ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was formulated in such a way that it is easy to understand, direct and clear where terms and terminologies are used in simple English.

3.4.2 Movement Data Collection

Movement data collection is conducted in order to obtain the pedestrian waiting time, pedestrian walking speed, pedestrian volume and pedestrian platoon. The data will be collected through analysis of the field data by video recording. The video camera will be set up at locations on sidewalks along the study site. The final data set offered from this video recording included waiting time, walking speed, pedestrian volume and pedestrian platoon.

3.5 Data Analysis

The data from questionnaire will be analyses using average index analysis to gather the level of driver's perception towards the pedestrian crossing facilities at the study area. Average index scale has been proposed by Abd Majid and McCaffer (1997) based on agreement attributes and frequent index as shown on Table 3.1.

Table 3.1: The Index Attributes

5 points Likert Scale	Attributes of Indexes	Average Index
5	Strongly Agree	4.5 < Average index < 5.0
4	Agree	3.5 < Average index < 4.5
3	Neutral	2.5 < Average index < 3.5
2	Disagree	1.5 < Average index < 2.5
1	Strongly Disagree	1.0 < Average index < 1.5

Furthermore, the data collected particularly on movement data of pedestrian will be analysed using descriptive analysis for testing whether there were any significant differences in affecting the pedestrians crossing behaviour at unsignalised pedestrian crossing facilities between various campuses.

3.5.1 Average Index Method

The data of the questionnaire was analysed in order to gain the answers to the questions in this research study. The data will be analysed by using the average index method. Frequency of the respondent chooses is used to analyse the data. The purpose of frequency analysis is analysed the percentage and frequency of the answer by the respondents related to the variable in the research studies.

Average index analysis was also used to analyse the data gathered. The purpose of using average index is to accumulate the level of significance of data to get the ranking of the variables. Below shows the formula how to calculate average index:

$$\text{Average Index Method: } \frac{1(X1)+2\,(X2)+3\,(X3)+4\,(X4)+5\,(X5)}{X1+X2+X3+X4+X5}$$

Whereas: X1 = Number of Respondents for Strongly Disagree
X2 = Number of Respondents for Disagree
X3 = Number of Respondents for Neutral
X4 = Number of Respondents for Agree
X5 = Number of Respondents for Strongly Agree

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter shows the analysis and results that had been done and obtained. After going through the literature review in Chapter 2 and the methodology of study in Chapter 3, the study was carried out at the selected area. The results were then interpreted and analysed based on the formulated objectives. In this section the result of pedestrian crossing behaviour had been analysed and reported from the pedestrian crosswalks. Other than that, the questionnaire surveys are also been carried out which involved 50 males and 50 females from each university. This is a perfect way to improve the problem of crosswalks.

4.2 Demographic Data of Respondent

The objective of this study is to identify the pedestrian preference and perception towards pedestrian crossing facilities in UMP and IIUM campus. This research was conducted by distributing sets of questionnaire randomly to the respondents consisted of primarily of undergraduate and graduate students whom frequently used pedestrian facilities. The questions are divided into two sections. It was covered on the following areas of interest: (PartA) pedestrian's background (age group, gender, and frequency of use of the facility); (Part B) consists of pedestrian inventory performance and pedestrian perceptions with respect to right-of-way and safety (crossing location, conditions, compliance).

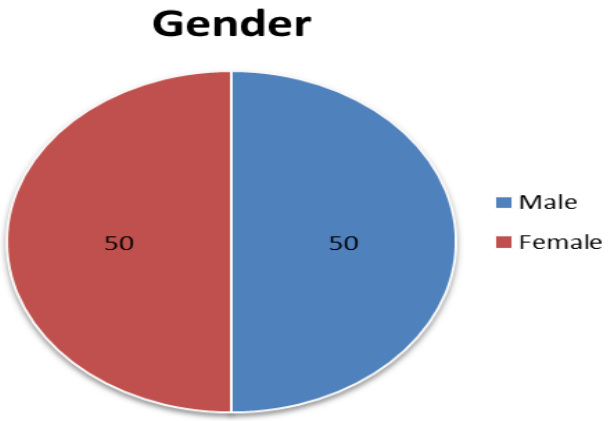
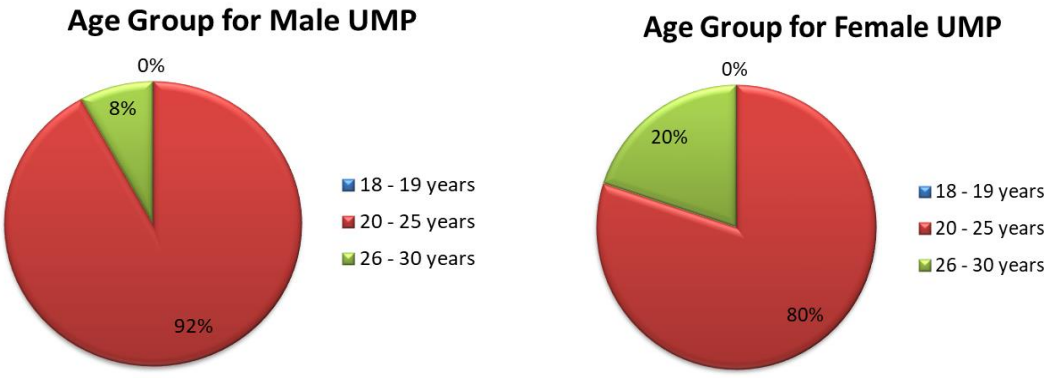


Figure 4.1: Total Respondents for UMP and IIUM Campus

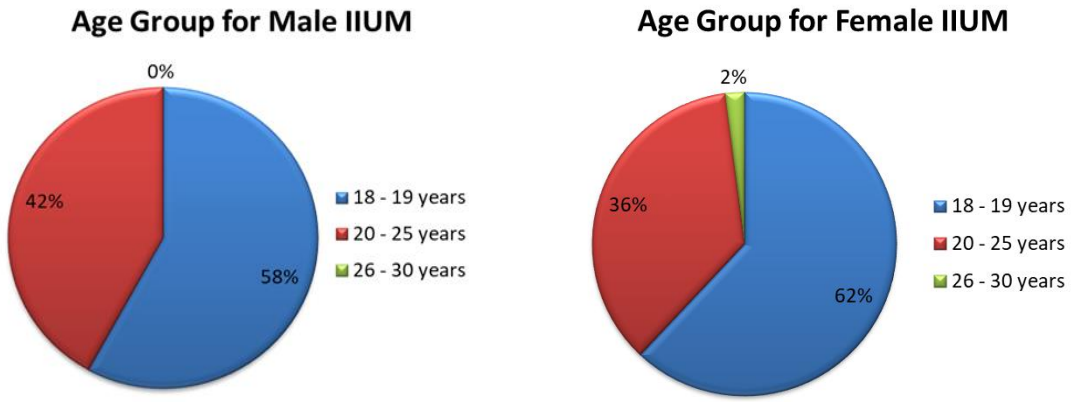
Based on Figure 4.1, these questionnaires was distributed to a total of 200 respondents which are 100 sets of survey forms for Universiti Malaysia Pahang and another 100 sets for International Islamic University Malaysia Kuantan. It is distributed according to the classification of gender which is 50 sets for males and 50 sets for females. Where samples are to be broken into subsamples; (males/females, juniors/seniors, etc.), a minimum sample size of 30 for each category is necessary (Uma Sekaran, 2015). Fortunately, all the survey forms were returned back after distributed. Below shows the results that has been analysed.



(a) (b)

Figure 4.2 (a), (b): Percentage of Age Group for Males and Females in UMP

Based on Figure 4.2 (a) and (b), the highest percentage of respondents from UMP are those aged between 20-25 years old. This shows that most students that stays in college are more likely been using these designated pedestrian crosswalk.



(a) (b)

Figure 4.3 (a), (b): Percentage of Age Group for Males and Females in IIUM

Based on Figure 4.3 (a) and (b), the percentage of 18 – 19 years in IIUM is the highest respondents compared to others age group. It is because at IIUM, there are many Foundation Studies students (formerly known as Matriculation Centre) who've been using designated pedestrian crossing to classes. For information, most foundation students do not have a mobility to attend classes. So they are more likely to use the designated pedestrian crossing to attend classes. Meanwhile, students aged 20 years old and above used their own transportation to go to class which either by cars or motorcycles.

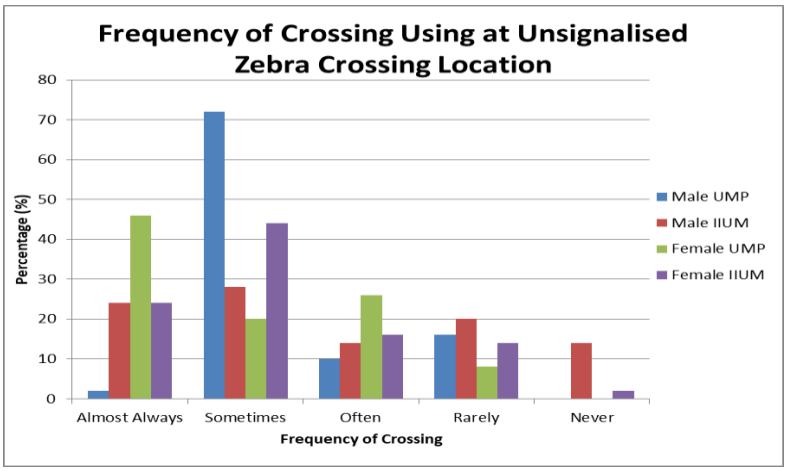


Figure 4.4: Frequency of Crossing at Unsignalised Zebra Crossing Location

Based on Figure 4.4, about 91% and 72% pedestrian in UMP and IIUM replied that they sometimes cross at unsignalised zebra crossing. The least replied never cross at unsignalised zebra crossing about 14% in IIUM. It shows that most pedestrian in UMP has been using zebra crossing compared to IIUM.

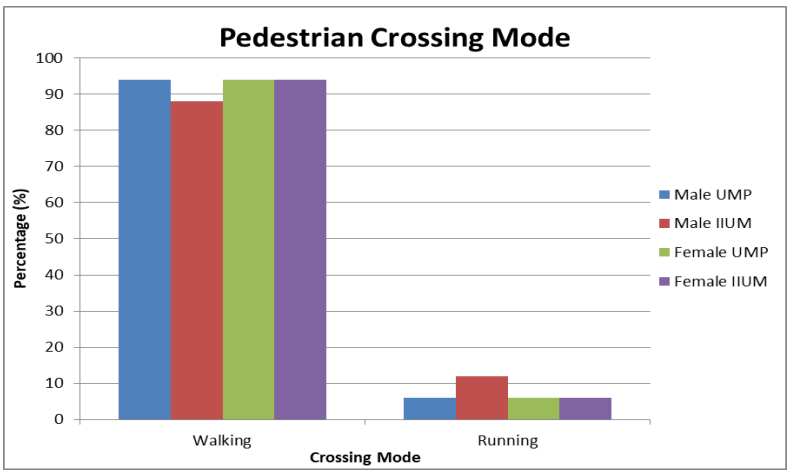


Figure 4.5: Pedestrian Crossing Mode

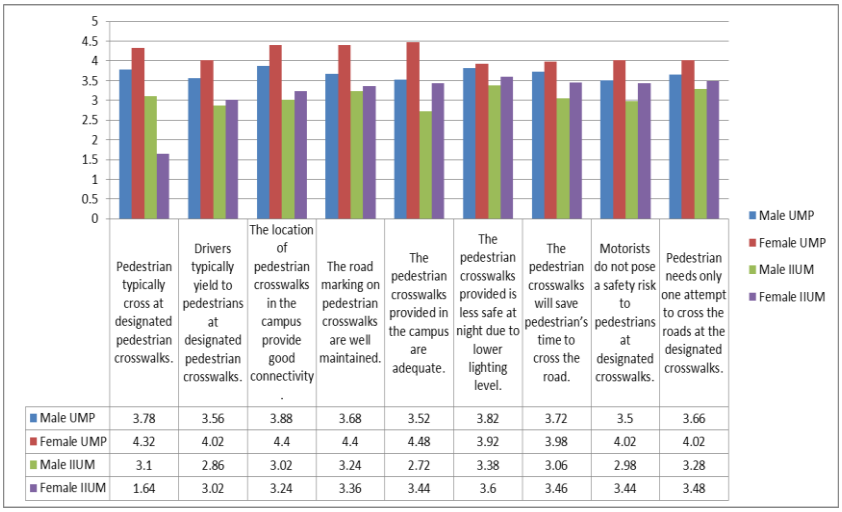
Based on Figure 4.5, majority 80% pedestrian crossing mode in both universities prefer walking than running while crossing. About 10% shows pedestrian crossing mode was running. This shows that traffic flow in both campus are not congested.

4.3 Pedestrian Preference and Perception towards Unsignalised Pedestrian Crosswalk

Pedestrian preference is to enhance our safety by using the available facilities, although it might take some times to cross the road. The option to cross far from the specified intersection facility increases the risk of collisions between vehicles and pedestrians but it is often chosen as it is the fastest and most direct way to reach the destination.

Convenience and time saving are the most commonly followed perception factors. Therefore, pedestrians who wanted to save time do not use existing facilities,

they cross the road before the presence of zebra crossing. The data was analyses by using average index method as shown in Figure 4.6.



	Pedestrian typically cross at designated pedestrian crosswalks.	Drivers typically yield to pedestrians at designated pedestrian crosswalks.	The location of pedestrian crosswalks in the campus provide good connectivity.	The road marking on pedestrian crosswalks are well maintained.	The pedestrian crosswalks provided in the campus are adequate.	The pedestrian crosswalks provided is less safe at night due to lower lighting level.	The pedestrian crosswalks will save pedestrian's time to cross the road.	Motorists do not pose a safety risk to pedestrians at designated crosswalks.	Pedestrian needs only one attempt to cross the roads at the designated crosswalks.
Male UMP	3.78	3.56	3.88	3.68	3.52	3.82	3.72	3.5	3.66
Female UMP	4.32	4.02	4.4	4.4	4.48	3.92	3.98	4.02	4.02
Male IIUM	3.1	2.86	3.02	3.24	2.72	3.38	3.06	2.98	3.28
Female IIUM	1.64	3.02	3.24	3.36	3.44	3.6	3.46	3.44	3.48

Figure 4.6: Preference and perception of UMP and IIUM students on zebra crossing facilities

Based on Figure 4.6, both universities have a consistent agreement towards question given. Based on the question about pedestrian typically cross at designated pedestrian crosswalks, male and female respondent in UMP agree with Average Index (A.I) 4.32 and 3.78 meanwhile for respondent from IIUM shows that male pedestrian neutral with AI 3.1 while female respondent disagree with AI 1.64. From the observation, it shows that most of IIUM's respondents do not use the designated pedestrian crosswalk as the location of zebra crossing is not strategic.

Meanwhile, respondents in UMP shows that male respondent agree with AI 4.02 and female respondent neutral with AI 3.56 meanwhile for respondent IIUM shows that male respondent disagree with AI 2.86 and female respondent neutral with AI 3.02 regarding matters about the drivers typically yield to pedestrian at designated pedestrian crosswalks. This shows that male pedestrian in IIUM disagree about this as most motorist do not stopped when they saw pedestrian cross at unsignalised zebra crossing. A pedestrian generally has the right of way over all vehicles while at the curb of or in a crosswalk. This means that cars and other vehicle traffic must slow down or stop in front of a crosswalk when a pedestrian is using or is about to use a crosswalk. This

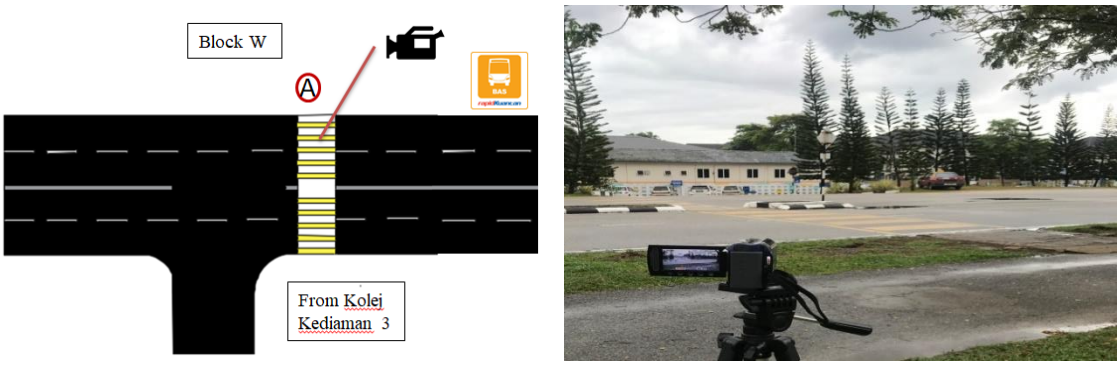
shows that from my finding which is similar with Nik Ibtishamiah & Farhan (2005), 32% drivers won't stop when see the pedestrian at pedestrian facility in UM campus.

Moreover, for respondent in UMP shows that male and female respondent agree with AI 3.52 and AI 4.48 meanwhile for respondent in IIUM shows that male and female respondent neutral with AI 2.72 and AI 3.44 about the pedestrian crosswalks provided in the campus are adequate. It is because in IIUM there are only one zebra crossing inside the campus.

Furthermore, most pedestrian in both UMP and IIUM agreed about the designated pedestrian crosswalk provided is less safe during night due to lighting problem. It is not safe for pedestrians to walk in darkness with no street light available. I find that, which similar with Steve (2017), results suggested that the risk of a female pedestrian being involved at a crossing after-dark compared with daylight was greater than the risk for a male pedestrian. Therefore, it is important to provide safe walking environments to avoid pedestrians from danger and to reduce a perceived barrier for walking by making the roads feel safer to walk on.

4.4 Pedestrian Crossing Behaviour

In this part, the pedestrian movement data are used to analyses pedestrian crossing compliance behaviour at the study crosswalk. An element in pedestrian behaviour was pedestrian volume, pedestrian movement characteristics, speed, waiting time, and pedestrian platoon. The element in pedestrian behaviour was collected by using video camera. The video camera was installed at one point which is the view of the camera was focused on the designated pedestrian crosswalk as shown in Figure 4.7 and Figure 4.8 shows the real situation of video recorder is placed.



(a) (b)

Figure 4.7 (a), (b): The condition of video recorder placed at UMP

(a) (b)

Figure 4.8: The condition of video recorder placed at IIUM

Based on Figure 4.7 and Figure 4.8, the video recorder is only recorded the designated pedestrian crosswalk to get the exactly time of pedestrian waiting time and pedestrian walking speed. The UMP's pedestrian movement was recorded in two hours between 7.30am – 8.00am, 9.30am – 10.00am, 1.30pm – 2.00pm, and 3.30pm – 4.00pm for six days (Tuesday, Wednesday and Thursday). For IIUM's pedestrian movement was recorded in two hours between 7.30am – 8.00am, 9.30am – 10.00am, 1.30pm – 2.00pm, and 3.30pm – 4.00pm for three days (Tuesday, Wednesday and Thursday). There were 4729 pedestrians and 1378 pedestrians observed and recorded at designated pedestrian crosswalk location at UMP Gambang and IIUM Kuantan respectively. Then, the data were procured from the videos in the following method. From that, the graph of pedestrian volume and characteristics, speed, waiting time, and pedestrian platoon were developed.

4.4.1 Pedestrian Volume

The distribution of pedestrian volumes during the day can be generalized in a similar was to vehicular flow distribution, so that the daily average can be deduced from short counts. By representing volume and time in the graph, the maximum and minimum pedestrian volume are clearly visible and easily identified as shown in Figure 4.9 below.

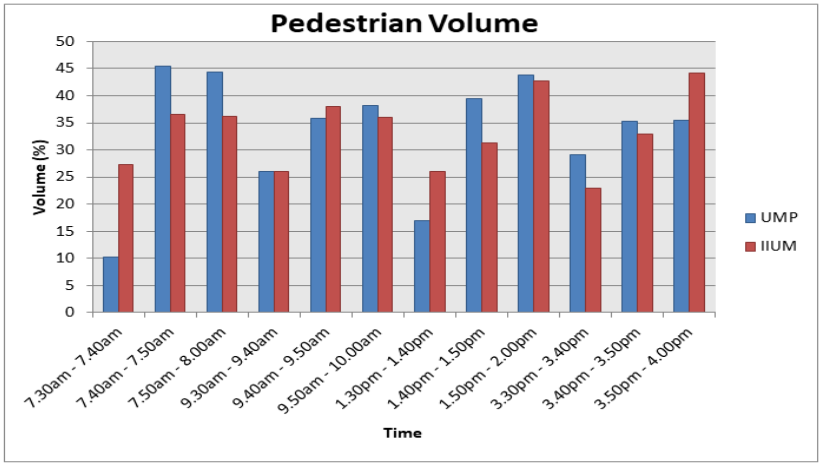


Figure 4.9: Distribution of pedestrian volume

Data distribution of pedestrian volume by AM peak and PM peak can be seen in Figure 4.9. From the result, 2-hour pedestrian volume survey range from 7.30am – 8.00 am, 9.30 am – 10.00 am, 1.30 pm – 2.00 pm and 3.30 pm – 4.00 pm for weekdays (Tuesday, Wednesday and Thursday) is being analysed. From observation at AM peak, early in the morning at 7.30 am pedestrian rarely use this facilities compare to 7.50 am. The percentage of pedestrian volume at 7.40 am to 7.50 am which carries 45% in UMP and 37% in IIUM is higher compared to 7.50 am to 8.00 am which carries 43% in UMP and 36% in IIUM. Then, the percentage of pedestrian volume at 9.30 am to 9.40 am shows the same pattern which carries 26% in both universities.

However, for PM peak, the percentage of pedestrian volume at 1.50 pm to 2.00 pm which carries 44% in UMP and 43% in IIUM is higher compared to 1.40 pm to 1.50 pm which carries 39% in UMP and 31% in IIUM. Next, the percentage of pedestrian

volume at 3.50 pm to 4.00 pm, carries 32% in UMP and 49% in IIUM is higher compared to 3.40 pm to 3.50 pm, carries 31% in UMP and 33% in IIUM.

From the survey, there was a low number of pedestrian between various campuses at time 7.30 am to 7.40 am, 9.30 am to 9.40 am, 1.30 pm to 1.40 pm and 3.30 pm to 3.40 pm. From this situation, it was considered that the reason of the pedestrians do not come early to class.

4.4.2 Pedestrian Movement Characteristics

This study collected pedestrian movement and perception data by direct observations of pedestrian behaviours from video recorder. Pedestrian movement data are used to analyse pedestrian crossing compliance behaviour at the crosswalks. Crossing compliance is defined as the number of pedestrians who crossed the road in compliance with the location of a crosswalk. The following environmental and exposure factors are considered: population density, type of pedestrian crossing, traffic control used at the crossing, surrounding land use type, highway facility type, vehicle traffic speed, vehicle volume and pedestrian volume (V.P Sisiopiku, 2003).

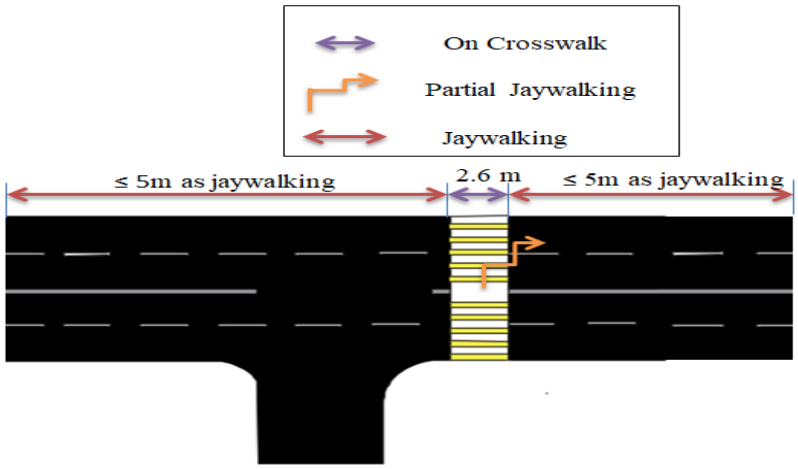


Figure 4.10: Definition of pedestrian movement on pedestrian crosswalk in UMP

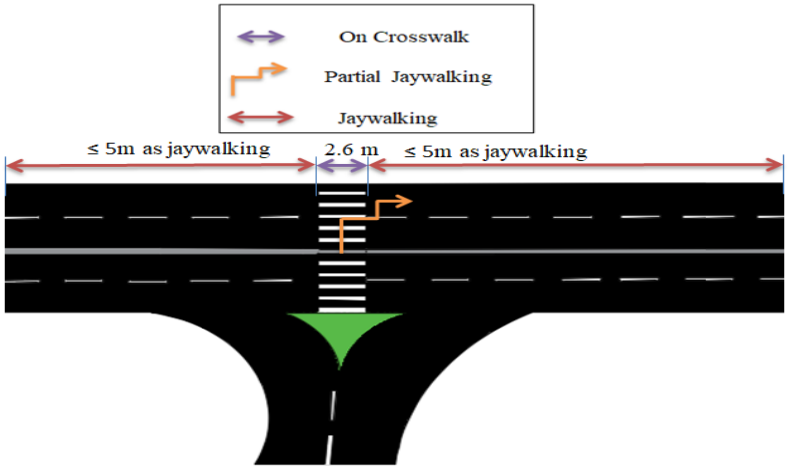


Figure 4.11: Definition of pedestrian movement on pedestrian crosswalk in IIUM

Based on Figure 4.10 and Figure 4.11 shows that the pedestrian crossing mode on the designated crosswalk area. Jaywalkers are the ones who do not comply with the crosswalk location. The arrow in purple colour is the pedestrian crossing on crosswalk, arrow in orange colour is the partial jaywalking meanwhile arrow in red colour is the jaywalking. If the distance less than or equal to five metre from outside zebra crossing, it is considered as jaywalking. The pedestrian was fail use pedestrian crosswalk it is called jaywalking (V.P Sisiopiku, 2003).

Table 4.1: Data summary sheet for designated pedestrian crosswalk

	On-crosswalk	**Partial Jaywalkers**	**Jaywalkers**	**Total**
Regular users (UMP)	4639	90	0	4729
Regular users (UIA)	1115	54	209	1378

According to Table 4.1, shows the data collected based on observations from video recording. The following types of data were recorded for the analysis of pedestrian movements which were number of pedestrians who started crossing the street during pedestrian walk (regular users): partial jaywalkers, jaywalkers and number of pedestrians crossing on the pedestrian crosswalk area. From the results, the total jaywalking in IIUM is higher than compare to UMP. It shows that mostly pedestrian in

UMP use unsignalised zebra crossing compare to pedestrian in IIUM as shown in Figure 4.12 and Figure 4.13.

Figure 4.12: Pedestrian movement characteristic at UMP's pedestrian crosswalks

Figure 4.13: Pedestrian movement characteristic at IIUM's pedestrian crosswalks

4.4.3 Speed

Pedestrian crossing speed is the crucial parameter in designing the pedestrian facilities. The walking speed, is the length of zebra crossing over the time pedestrian's walking speed whereas the point when she/he starts crossing until the end of pedestrian crosswalks. The average pedestrian crossing speed were analysed as shown in Figure 4.14 and Figure 4.15 below.

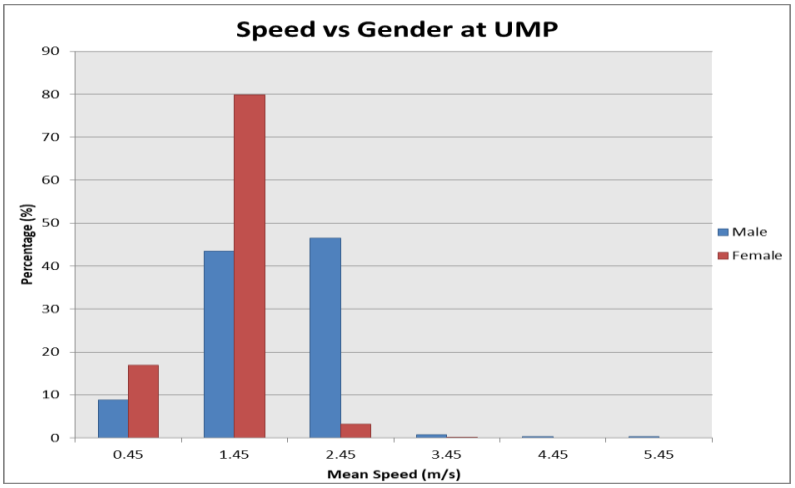


Figure 4.14: Speed Distribution of Males and Females at UMP

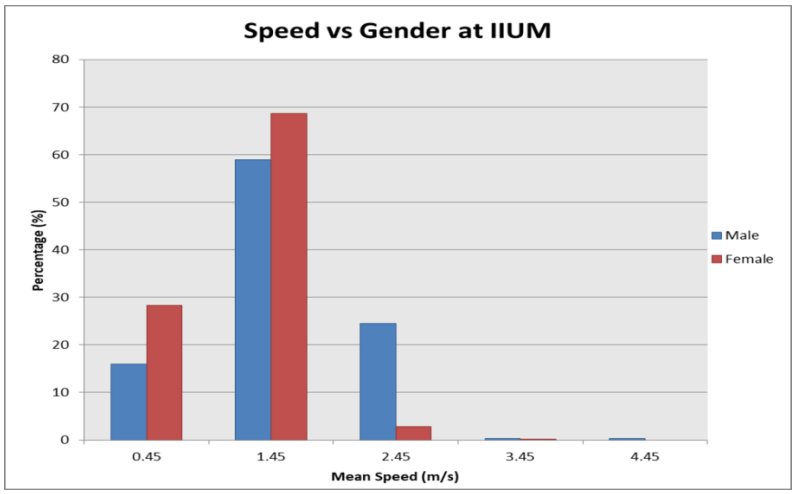


Figure 4.15: Speed Distribution of Males and Females at IIUM

Based on Figure 4.14 and Figure 4.15, the pattern of speed vs gender consist of similar where the percentage of female pedestrian is higher than male pedestrian at 0.45 m/s until 1.45 m/s in both universities. The percentage value for male pedestrian is 9%, and female pedestrian is 17% in UMP meanwhile the percentage value for male pedestrian is 16%, and female pedestrian is 28% in IIUM at 0.45 m/s. It shows that, the percentage of female pedestrian is higher compared to male pedestrian at 0.45 m/s.

Furthermore, the percentage value for male pedestrian is 43%, and female pedestrian is 80% in UMP meanwhile the percentage value for male pedestrian is 59%,

and female pedestrian is 69% in IIUM at 1.45 m/s. It shows that, the percentage of female pedestrian is higher compared to male pedestrian at 1.45 m/s.

Moreover, the percentage value for male pedestrian is 47%, and female pedestrian is 3% in UMP meanwhile the percentage value for male pedestrian is 24%, and female pedestrian is 3% in IIUM at 2.45 m/s. It shows that, the percentage of male pedestrian is higher compared to female pedestrian at 2.45 m/s.

Then, the percentage of male pedestrian is higher compared to female pedestrian in both campuses at various crossing speed ranging from 2.45 m/s until 5.45 m/s. It shows that, the speed of male pedestrian is faster compared to female pedestrian. On the other hand, male pedestrians walk faster than female pedestrians because of the traffic volume, physical differences, weather conditions and cultural differences. According to Tanaboriboon & Guyano (1991), taller pedestrians have longer footsteps, thus their movement length are greater in distance compared to those who are shorter. Inconvenient, dressing such as, traditional custom could also influence the walking speed of pedestrian in terms of free movement of both steps. It shows that, from my finding similar with Chien-Yen & T. Hugh (2011), the mean walking speed of a male is significantly higher than that of a female.

4.4.4 Waiting Time

Waiting time is one of the most important factors that need to be studied if pedestrian crossing behaviour is examined. Waiting time is an influencing factor on unsafe pedestrian crossing. The waiting time, is the time elapsed between the pedestrians reach the designated pedestrian crosswalks and the point when she/he starts crossing. The average pedestrian waiting times were analysed as shown in Figure 4.16 and Figure 4.17 below.

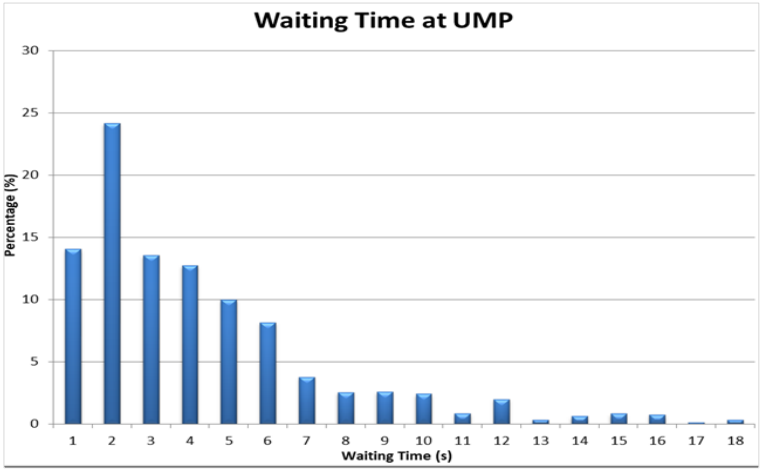


Figure 4.16: Waiting Time Distribution at UMP

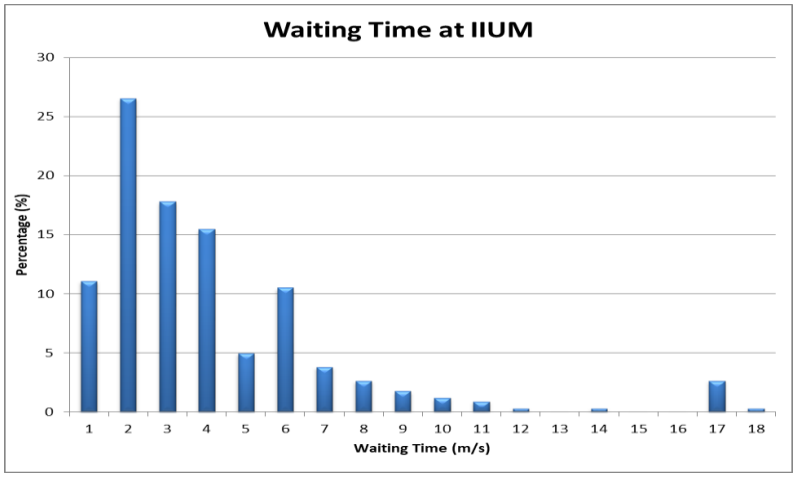


Figure 4.17: Waiting Time Distribution at IIUM

Based on Figure 4.16 and Figure 4.17, the pattern of waiting time looks similar in both universities. Most pedestrian in both campuses took about two seconds of waiting time to start crossing. The percentage of pedestrian took two seconds which is 24% and 26% in UMP and IIUM. This shows that the conditions in both campuses were not seriously congested. It is found that for the majority of pedestrians, the waiting time varies from 1 to 6 seconds. More than 80% of the pedestrians have to wait for less than 7 seconds in both universities. Some pedestrians have to wait as long as 18 seconds. Because the motorists move in platoons condition less willingness to give a way to pedestrians. It shows that from my finding similar with Nik Ibtishamiah & Farhan (2005), most pedestrian at Universiti Malaya took about three second of waiting time to start crossing.

4.4.5 Pedestrian Platoon

Platoon flow is defined as the grouping or bunching of pedestrians because of internal or external traffic impendences. This group was characterized by increasing behavioural consistencies manifested in the adoption of prevalent group speed and positioning arrangement.

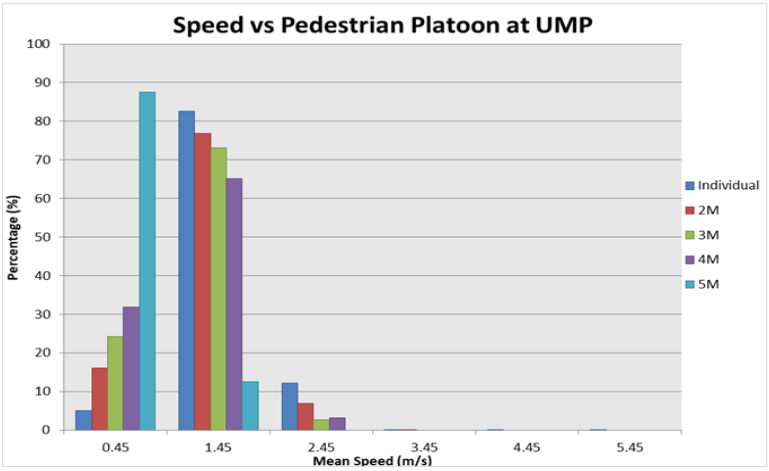


Figure 4.18: Speed Distribution of Pedestrian Platoon at UMP

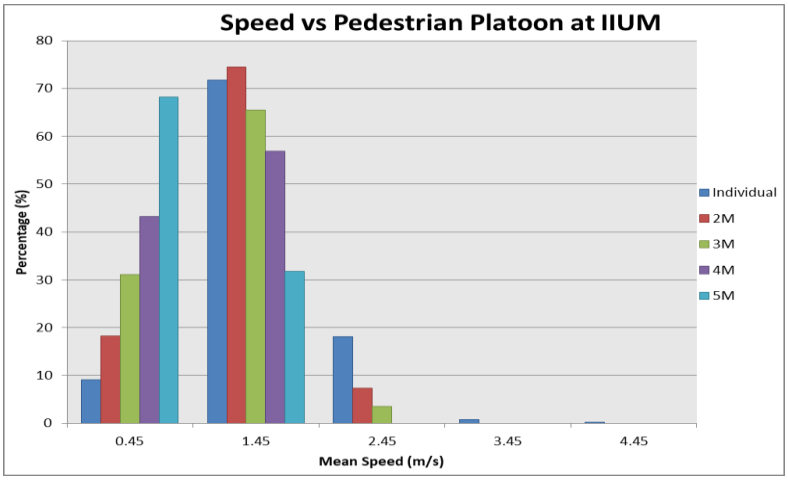


Figure 4.19: Speed Distribution of Pedestrian Platoon at IIUM

Based on Figure 4.18 and Figure 4.19, the pattern of speed vs pedestrian platoon seems similar where the percentage of group is higher compared to individual at 0.45 m/s in both universities. The percentage value for individual is 5%, group of two

members is 16%, group of three members is 24%, group of four members is 32% and group of five members is 88% in UMP meanwhile the percentage value for individual is 9%, group of two members is 18%, group of three members is 31%, group of four members is 43% and group of five members is 68% in IIUM at 0.45 m/s. It shows that, the percentage of walking in group is higher compared to individual at 0.45 m/s.

Furthermore, the percentage value for individual is 83%, group of two members is 77%, group of three members is 73%, group of four members is 65% and group of five members is 13% in UMP meanwhile the percentage value for individual is 72%, group of two members is 74%, group of three members is 66%, group of four members is 57% and group of five members is 32% in IIUM at 1.45 m/s. It shows that, the percentage of walking in group is lower compared to individual at 1.45 m/s. According to research studies by Rajat & Satish (2011), the reduction in walking speeds for groups of three to five is more or less the same (11–22%) on wide sidewalk and precincts. So, this shows that the greater the number of pedestrians in a group, the slower the walking speeds.

Moreover, the percentage value for individual is 12%, group of two members is 7%, group of three members is 3%, group of four members is 3% and group of five members is 0% in UMP meanwhile the percentage value for individual is 18%, group of two members is 7%, group of three members is 3%, group of four members is 0% and group of five members is 0% in IIUM at 2.45 m/s. The percentage of walking individually is higher compared to walking in the group in both campuses at various crossing speed ranging from 2.45 m/s until 5.45 m/s. It shows that, the speed of walking individually is faster compared to walking in the group. From my finding similar with Chien-Yen & T. Hugh (2011), the mean walking speed of an individual is significantly higher than that of a group of three or more people.

4.5 T-test

Pedestrian crossing behaviours are analyzed using student t test to investigate the differences between both campuses at unsignalised zebra crossing. All tests are performed in IBM SPSS Statistics 20 software at 95% confidence interval. SPSS calculates the t-statistic and its p-value under the assumption that the sample comes

from an approximately normal distribution. If the p-value associated with the t-test is small (0.05 is often used as the threshold), there is evidence that the mean is different from the hypothesized value. If the p-value associated with the t-test is not small ($p > 0.05$), then the null hypothesis is not rejected and can conclude that the mean is not different from the hypothesized value. The statistical results are shown in Table 4.2 and Table 4.3.

Table 4.2: Group Statistics

	N	Mean	Std. Deviation	Std. Error Mean
UMP	4729	1.9122	0.48379	0.00704
UIA	1378	1.8353	0.56759	0.01529

Table 4.3: Samples Test

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
UMP	271.816	4728	0.000	1.91224	1.8985	1.9260
UIA	120.031	1377	0.000	1.83527	1.8053	1.8653

The null hypothesis is $\mu_{UMP} = \mu_{IIUM}$ and one alternative hypothesis is $\mu_{UMP} \neq \mu_{IIUM}$. According to Table 4.3, the significant level is 0.05. Probability $p = 0.000 < 0.05$ for UMP and $p = 0.000 < 0.05$ for IIUM, therefore the null hypothesis is rejected and concluded that the mean is different from the hypothesized value. By conventional criteria, this difference is considered to be extremely statistically significant. From the result, there is a statistically significant difference between UMP and IIUM. This might be because of the influenced of the different dimension of the zebra crossing which was 6.6 m in UMP meanwhile for IIUM was 7 m. In addition, the speed limit imposed also was slightly differ between both campuses. In UMP the speed limit imposed was 35 km/h meanwhile in IIUM was 30 km/h. As been discussed in previous study, the speed limit also may attribute to the crossing behaviour of the pedestrian. Based on Gang & Wang (2011), has examined factors that influence the road-crossing behaviours of pedestrians, including the physical environment, road user variables and social factors.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter will summarize the studies that have been conducted and concluded based on the analysis and the results already obtained. Through the collected data from the group of respondents in UMP Gambang and IIUM Kuantan, the results and discussions are being conducted and various findings and results are obtained. Analysis based on pedestrian crossing behaviour at UMP Gambang and IIUM Kuantan has been done. Each pedestrian takes different waiting time and walking speed to cross a road. This happen because there was an influenced by physical factors at surrounding area and driver behaviour. In addition, the problems faced during the study were presented and some suggestions to improve the study of the future will also be made.

5.2 Conclusion

This objective was done to study on pedestrian behaviour and pedestrian flow characteristics for UMP Gambang, and IIUM Kuantan. As stated before in chapter one, the objective of this study were:-

i. To evaluate pedestrians preference and perception towards unsignalised pedestrian crosswalk.
ii. To analyses pedestrian crossing behaviour at unsignalised pedestrian crosswalk.

It can be conclude that this study was achieved all of the objectives. This research studied pedestrians' perceptions behaviour, preference and perception toward the zebra crossing. The essence of zebra crossing on the road is primarily to maintain a peaceful and safe interaction between pedestrian and vehicular traffic, since it has not

been possible to maintain a perfect and complete segregation between these two important road users. The results from the respondents surveyed were determined using Average Index Method. The result shows, students agree that using a pedestrian crosswalk save pedestrian time and more safety although during at night. Besides, IIUM student mostly not prefer to cross at designated pedestrian crosswalk compared with UMP students due to the locations not strategic and the numbers of crosswalk are not adequate.

Based on the analysis that was discussed before in chapter four, pedestrian crossing behaviour has been explored from video observation. Data on pedestrian user and movement characteristic shows that most of the pedestrian in UMP use zebra crossing compared to IIUM. Pedestrian crossing speed of male pedestrian is a faster than that of a female pedestrian at various crossing speed ranging from 2.45 m/s until 5.45 m/s. Male pedestrians walk faster than female pedestrians because of the traffic volume, physical differences, weather conditions and cultural differences.

The waiting time for most pedestrian was very promptly as low as 2 seconds between both campuses. Some pedestrians have to wait as long as 18 seconds. Because the motorists move in platoons and there is less willingness to give a way to pedestrians. Pedestrian crossing speed of walking individually is faster compared to walking in the group. It shows that the greater the number of pedestrians in a group, the slower the walking speeds. From this situation, as walking in the group, they tend to talk with each other compared than walking alone.

On the other hand, by using statistical method of t-test are shows that the significant two-tailed, P value is less than 0.05. So, there is a statistically significant difference between UMP and IIUM in terms of speed distribution. As been discussed in previous study, the speed limit also may attribute to the crossing behaviour of the pedestrian. Based on Gang & Wang (2011), has examined factors that influence the road-crossing behaviours of pedestrians, including the physical environment, road user variables and social factors.

5.3 Recommendation

During the analysis, there were some problems that been faced in obtaining the data. Pedestrian crossing decision-making not only be impacted with their own characteristics, but also be affected by the surrounding pedestrian and traffic environment, therefore, there were few recommendations for future study purposes that stated below:-

i. The pedestrian movement observation using video camera need to place on the right place that can see the overall pedestrian that might be easier to measure the pedestrian waiting time and pedestrian walking speed.
ii. Universities responsible to promote awareness to the students regarding the pedestrian safety.
iii. Universities conduct a preliminary study on pedestrians to make sure the location for pedestrian crosswalk designed at the right area. For example at IIUM, Average Index 1.64 shows the students disagree for the placement of the pedestrian crosswalk.

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APPENDIX A
SAMPLE APPENDIX 1

Dear participant,

This questionnaire is designed to study the pedestrian perceptions towards pedestrian crosswalks facilities in campus. The information you provide will help to better understand the quality of the facilities. Thank you for your time and cooperation.

PART A

User Profile

a) Gender

- ☐ Male
- ☐ Female

b) Age Group

- ☐ 18 – 19
- ☐ 20 – 25
- ☐ 26 – 30

c) How often do you cross at designated pedestrian crosswalk in the campus

- ☐ Almost always
- ☐ Often
- ☐ Sometimes
- ☐ Rarely
- ☐ Never

d) Crossing mode

- ☐ Walking
- ☐ Running

PART B

Perceptions towards pedestrian crosswalks facilities in campus.

Choose the statement that you think is most accurate and round the scores on each of the questions provided.

1-strongly disagree 2-disagree 3-neutral 4-agree 5-strongly agree

No	Description	1	2	3	4	5
1	Pedestrian typically cross at designated pedestrian crosswalks.	1	2	3	4	5
2	Drivers typically yield to pedestrians at designated pedestrian crosswalks.	1	2	3	4	5
3	The location of pedestrian crosswalks in the campus provide good connectivity.	1	2	3	4	5
4	The road marking on pedestrian crosswalks are well maintained.	1	2	3	4	5
5	The pedestrian crosswalks provided in the campus are adequate.	1	2	3	4	5
6	The pedestrian crosswalks provided is less safe at night due to lower lighting level.	1	2	3	4	5
7	The pedestrian crosswalks will save pedestrian's time to cross the road.	1	2	3	4	5
8	Motorists do not pose a safety risk to pedestrians at designated crosswalks.	1	2	3	4	5
9	Pedestrian needs only one attempt to cross the roads at the designated crosswalks.	1	2	3	4	5

Thank you for completing the survey.