ANALYSIS ON PEDESTRIAN VOLUME PATTERN AND PEDESTRIAN INFRASTRUCTURE PROVISION IN IIUM GOMBAK CAMPUS

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ABSTRACT
International Islamic University Malaysia (IIUM) is well known for its concept of pedestrian friendly traffic movement. However, the campus expansion and its new developments led to increasing distances and thus, travel by walking becomes more challenging. The lack of pedestrian infrastructure due to campus expansion has discouraged pedestrians to walk along the walkway corridors and thus increases their dependence on vehicles. The main purpose of this paper is to analyze the level of pedestrian infrastructure provisions which facilitate pedestrian flow pattern in IIUM. The pedestrian infrastructures considered are walkway and sidewalk, crosswalk, street furnitures, amenities and roofs and shades. Two pedestrian corridors, Route 1 (KAED- Masjid Sultan Haji Ahmad Shah) and Route 2 (Walkway along Jalan Imam Al-Malik) were selected because of high volume of pedestrian movement. Pedestrian volume count was conducted at 3 different points along the selected walkway corridors. The findings showed that Route 1 has carried a higher pedestrian volume than Route 2. The results also showed that Route 1 which has a high pedestrian volume was provided with a better pedestrian infrastructure than Route 2. Lack of walkway continuity, poor walkway pavement and surface, lack of street furnitures especially lighting and benches, lack of roof and shades especially along the walkway at Jalan Imam Al Malik and safety concerns near the pedestrian underpasses are some of the common identified pedestrian infrastructure problems. The findings showed that the level of provision of pedestrian infrastructure is one of the major factors that influenced pedestrian volume at the pedestrian corridors. Finally, this paper provides recommendations on the improvement of pedestrian infrastructure for the encouragement of more pedestrians movement on campus to achieve IIUM as a pedestrian friendly campus.

KEYWORDS: Pedestrian infrastructure, pedestrian friendly campus, pedestrian volume, pedestrian flow and IIUM

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INTRODUCTION

A pedestrian is a person who moves on foot from a place to another, where the journey usually covers short distances and consumes minimum travel time. Planning a pedestrian flow in a campus requires a comprehensive network supported with infrastructure and facilities which would made accessible to the surrounding activities. It is important to increase the number of pedestrian and ensure proper utilization of the pedestrian route network. International Islamic University Malaysia (IIUM) is well known for its concept of pedestrian friendly traffic movement and Islamic-based teachings. However, the number of students driving private vehicles has increased over time and thus has changed the image of IIUM to a driving-oriented campus. Moreover, the new developments and campus expansion in IIUM to cater for the needs of expanding population has increased travel distance and disperse activities. As a result, travel by walking fom one location to another has become more daunting and challenging. According to Anisah (2009), the facilities provided in IIUM do not comply with the pedestrians' needs which lead to the low pedestrian volume along the corridors. Saliza (2011) stated that the provision of disabled infrastructure and facilities in IIUM was provided with lack of consideration regarding the limitation and barrier to the pedestrian with disability to access the whole campus. Fabian *et. al* (2010) had stated that the poor infrastructure and facilities would force people to abandon walking and shift to use motor vehicles instead. Hence, this has showed that there is a strong relationship between the infrastructure provision and pedestrian flow, which becomes the main concern of this study.

This paper addresses the analysis on pedestrian volume and pedestrian infrastructure in IIUM Gombak campus by identifying the major and minor pedestrian route corridors. In order to achieve the aim of this research, the major route corridor was selected to carry out the analysis of pedestrian flow pattern and pedestrian infrastructure survey. The study also highlighted the level of pedestrian infrastructure along the selected route corridors and the inconveniences and discomfort of the pedestrians with the increasing number of private vehicles on-campus. Finally, the relationship between pedestrian volume and the level of pedestrian infrastructure in IIUM was analyzed with the aim to improve the existing infrastructure provision to achieve the needs and satisfaction of the pedestrians. This would, eventually, encourage the pedestrians to use improved pedestrian infrastructure and it is expected to enhance the walking environment along the route corridors. The increased pedestrian flow would help to achieve the realization of pedestrian friendly IIUM campus.

LITERATURE REVIEW ON PEDESTRIAN VOLUME PATTERN AND PEDESTRIAN INFRASTRUCTURE IN CAMPUS

Sanzhez *et al.* (2010) stated that infrastructure is one of the main elements in ensuring the success of transportation. Therefore, the pedestrian infrastructure is essential in planning pedestrian flow to enhance its accessibility and mobility from one place to another. Norsyuhadah & Amiruddin (2011) pointed out that the campus administrators and planners should have a proper plan to conduct effective transportation planning based on the campus population. Balsas (2003) stated that the campuses are generating a lot of pedestrians because most of the students have no choice of transportation mode based on their age and financial constraints. As for the case in IIUM, most of the students live in campus and it is indeed very important to plan for a good and effective pedestrian network system.

Bruton (1978) identified that capabilities of transportation system is one of the factors that influence trip generation. As in the context of this study, this particular factor is

discussed in term of the availability of pedestrian network and provision of pedestrian infrastructure. According to Fabian *et al.* (2010), people willingness to access pedestrian infrastructure can vary depending on the walkability of the streets and the overall pedestrian environment.

The design of pedestrian infrastructure may also affect the number of pedestrian volume. According to Cynecky, Largewey & Ronkin (1997) all the facilities should be accessible and located at the appropriate location; safe, continuous system and good connectivity; shortened trip, convenient access and well designed to encourage and enhance the number of pedestrian to use the route. Another study by Fabian *et al.* (2010) concluded that the walkability of the streets and the overall pedestrian environment contributed to people willingness to access pedestrian infrastructure, while the poor infrastructure and facilities forced them to abandon walking and use motor vehicle instead.

There are several elements of infrastructure that are considered in this study, which comparing the 5 best practises of campus pedestrian infrastructure planning of sidewalk & walkway; crosswalk; street furniture and amenities; roof and shades (Emory University, 2012; R.D Zande & Associates, 2006; University College Dublin, 2006; University of British Columbia, 2010; University of Queens, 2004).Hence, these studies have suggested that the provision of pedestrian infrastructure would affect the environment along the corridor as well as psychological views of a pedestrian. Therefore, a good provision of pedestrian infrastructure is indeed an important factor that influences pedestrian volume.

BACKGROUND OF STUDY AREA

The study area of this research is the International Islamic University Malaysia (IIUM) Gombak campus with the area of 710 acres with the 727,279 m² of build-up area (IIUM Development Division, 2012). The location of the campus is situated in Gombak district which is 10km away from the Kuala Lumpur city centre. The campus accommodates about 23,454 student population (IIUM Development Division, 2012). Meanwhile, the number of disabled population in IIUM is considered as the minority since according to Fadzillah (2010) there were only 16 disabled students. In 2011, Saliza stated in her article that the number of disabled students was increased to 17 students.

The IIUM campus was planned in connecting the different activities with high accessibility on foot by pedestrians. According to Anisah (2009), there are three major linkages of pedestrian walkway provided in IIUM; walkways within institutional area (kulliyahs), walkways within residential area and walkway linked between residential areas (mahallahs) and institutional areas (kulliyahs). The pedestrian route corridors within IIUM campus can be divided into two types which are minor and major. The major route accommodates high capacities of pedestrian volume and connecting various activities along the corridor while the minor route corridor carries low pedestrian volume and connecting only several activities. However, this study was only focused on the major route corridors which connected KAED - Masjid Sultan Haji Ahmad Shah and the walkway along Jalan Imam al-Malik to the centre (shown in Figure 1). These corridors regularly carry high pedestrian volume and connect major activities along the route.
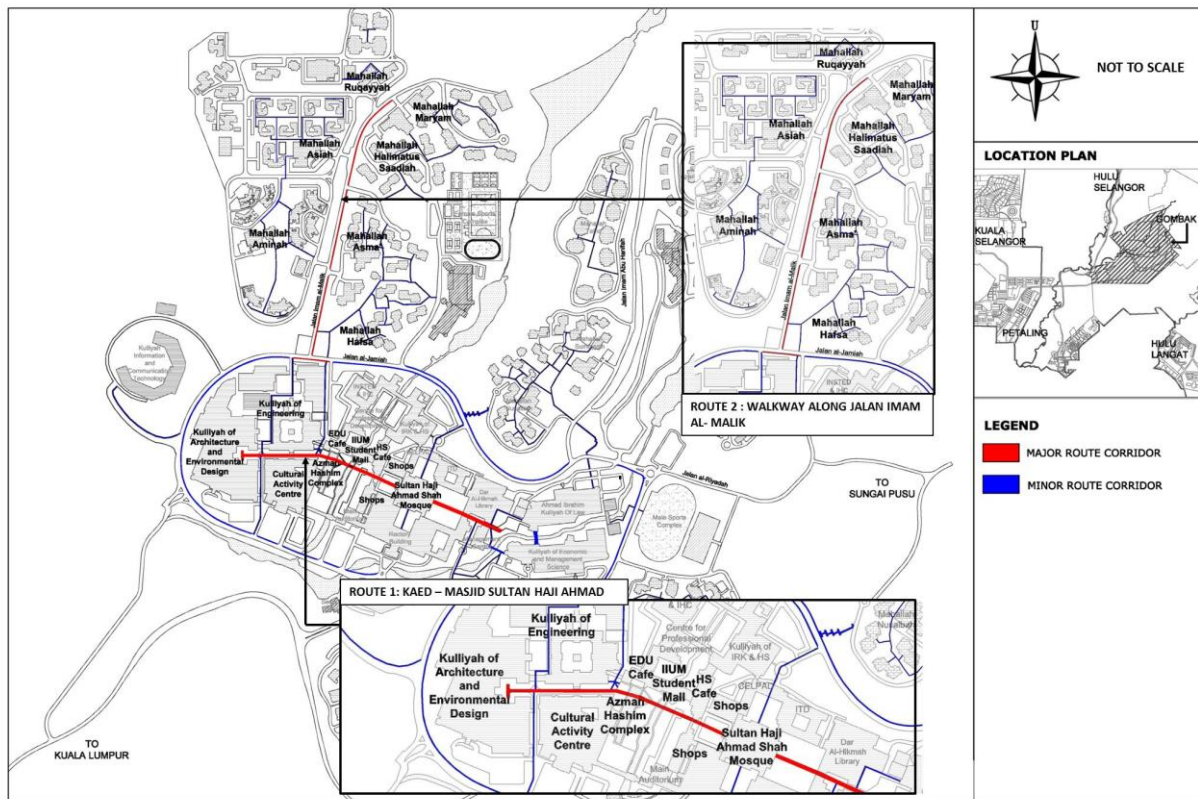
Figure 1: Pedestrian Study Routes in International Islamic University Malaysia
Source: Development Division, 2012

RESEARCH APPROACH

The data for this study was collected by using two sources, which are primary and secondary sources with the method of data collection used depends on th type of data sources. For this study, the primary data collection methods include pedestrian volume survey, interview survey and pedestrian infrastructure survey. The pedestrian volume survey was conducted by using the manual traffic counter during a specific date and time at each route, whereas the interview survey was formulated by using a specific guideline. On the other hand, the inventory of pedestrian infrastructure was outlined by a guideline adapted from the best practise of pedestrian planning infrastructure according to the identified elements, criteria and measures of the existing pedestrian infrastructure on-campus. The main elements focused in both interview and inventory survey were walkway and sidewalk; crosswalk; street furniture and amenities; roofs and shades. Meanwhile, the secondary data was collected mainly from the related agencies and through other literary sources. The primary and secondary data was then analysed by using several method of analysis including pedestrian volume trend analysis, graphical method, cross-reference study method and weighted average analysis method.

Data collection

1.   Pedestrian volume survey

The purpose of this survey is to obtain the highest pedestrian volume to know the maximum use of pedestrian corridors with the pedestrian infrastructures provided. The survey was conducted by using a manual traffic counter. The enumerators were positioned at 3 points along each route, all of which were located at the pedestrian generation areas (Figure 2).
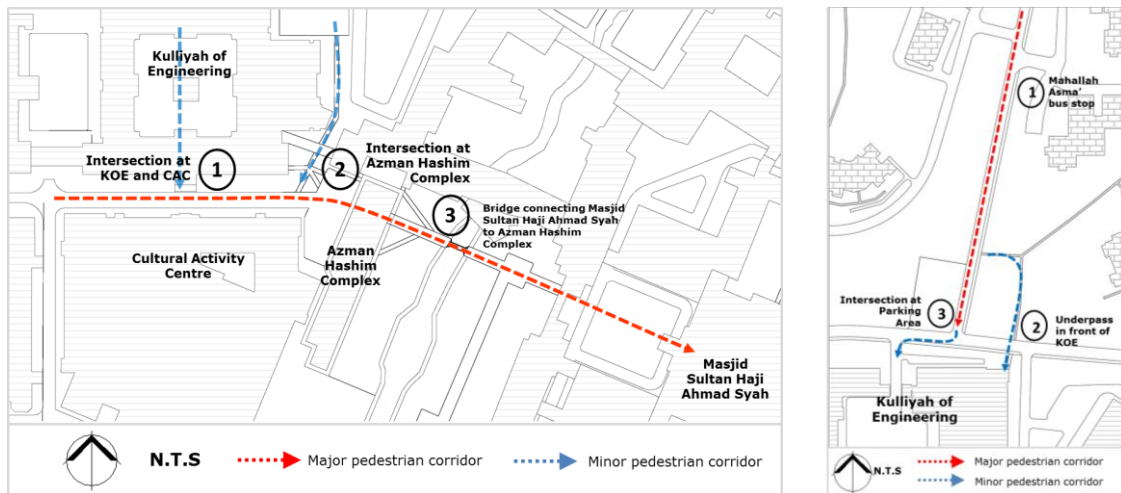

Figure 2: Location of enumerators (Route 1 & Route 2)

These positions are important to analyse the flow and movement pattern of pedestrians along the major route corridors to observe the differences in pedestrian volumes at each point. The volume count was conducted at different time periods during the long and regular semester (Table 1) along each selected route.

Table 1: Details of pedestrian volume count (Route 1 & Route 2)

Route	Date	Time
Route 1 (KAED - Masjid Sultan Haji Ahmad Syah)	15th March 2013 (Friday)	11.00am- 4.00pm
Route 2 (Walkway along Jalan Imam Al-Malik.)	12th March 2013 (Tuesday)	7.30am-12.30pm

2.   Pedestrian infrastructure inventory method

The inventory on pedestrian infrastructure was administered by using pedestrian infrastructure guidelines (Table 2) adapted from the best practise of pedestrian planning infrastructure according to the elements, criteria and measures of the existing pedestrian infrastructure on-campus. On the other hand, the study also identified any barrier-free facilities available for disabled users.

Table 2: Pedestrian infrastructure guideline

ELEMENT		GUIDELINE
Sidewalk & walkway	Width	Not less than 1500mm
	Features	1. Separated from vehicle road 2. Continuous pathway 3. Good and direct connection between activity
	Surface	Hard , smooth, stable , non-slip material
	Curb	Installation of warning surface (colour or texture contrast)
	Slope	Should not exceed 5% (1:20)
Crosswalk	Zebra crossing	1. Located at appropriate place 2. The stripping should be maintained and obviously visible from a distance. 3. Installation of signage, clear obstruction and highly visible. 4. Free from uneven level and tripping hazard
	Underpass	1. Located at appropriate place 2. Good connection and provide shorter distance 3. Installation of proper lighting and security surveillance 4. Proper drainage system
Street furniture & amenities **(lighting, signage, benches, landscape element and etc)**	Features	1. Installed at possible location along the route section 2. Sufficient provision 3. Well-maintained
Roof & shaded	Features	1. Trees shaded shall be maintained 2. Installation of roof, shades or other type of shelter at the place where trees are not suitable to be planted.

Source: Adopted from best practise of pedestrian infrastructure on campus
(University of Queen's, Ontario(2004), University of British Columbia, Vancouver(2010), West Virginia University, US (2006), Emory University, US (2012), University College Dublin, Ireland(2006).

3. Interview survey

The interview survey includes key assessment on each pedestrian infrastructure (sidewalk & walkway, crossing, street furniture & amenities, roof & shades) by Likert scales (Table 3). The administration of this survey is to gain reliable results on the provision of infrastructure by the targeted respondents. The respondents were asked to rate the level of pedestrian infrastructure by using scales such as "very poor", "poor", "fair", "good" and "very good". The respondents for the interview were selected along Route 1 and Route 2 corridors. The sample size is 30 respondents which is corroborated by Saiful (2010) who stated that the sample size larger than 30 and less than 500 are appropriate for most research. The sampling method used for this study was 'convenience sampling' because there was no suitable sampling frames of the population available or time and cost restriction making the survey dispersed population impractical (David and Sutton, 2004).

Table 3: Interview survey guideline

ELEMENT	FACTOR		ELEMENT	FACTOR	
1.Sidewalk & walkway a)The existing space to walk (sidewalk width)	1	Not following guideline; Narrow space leads to walking difficulties, limited access especially to disabled user.	b)The direct connection between activities along corridor	1	Complex route design leads user to walk on desired lane , feel inconvenient, and maybe long distance,
	2	Not following guideline; Less narrow space leads to walking difficulties, allow restricted access.		2	Less complex route design and lead user to walk on desired lane
	3	Sufficient space to walk		3	Direct route design
	4	Follow the minimum guidelines required; has wide space.		4	Direct route design and give convenience to the user
	5	Follow the minimum guidelines required; has wide space and allows free movement.		5	Direct route design, give convenience and allow route choice to the user in shorter distance
c)The continuity of walkway	1	The walkway discontinued in the middle of journey leads the user to walk on grass or road way.	d)The existing pavement and maintenance	1	Major damages, inconsistent, uneven paving and slippery material that may lead to hazardous movement
	2	The walkway journey is not consistent		2	Minor damage, inconsistent, uneven paving and slip material that not lead to hazardous movement
	3	The walkway is continuous along corridor		3	The acceptable condition of pavement and level of maintenance
	4	The walkway is continuous and connects the activity along corridor		4	Stable, smooth, firm and slip resistant that leads to convenience of the user.
	5	The walkway continuous along the entire journey		5	Stable, smooth, firm and slip resistant that leads to convenience of the user and consistently maintain
e)The walkway slope	1	Not following guideline, peak slope that lead high user's energy and difficulties to the disable also may lead hazardous to the user.			
	2	Not following guideline, peak slope that lead high user's energy and difficulties to the disable			
	3	Satisfactory slope installation and follow the minimum guideline			
	4	Follow the minimum guideline and allow access by different type of users			
	5	Follow the guideline, allow access by different type of users and lead to convenience.			
2. Crosswalk *(if applicable)* a)The suitability of crosswalk location	1	Located at non-strategic area, Connects the minor activities and has longer distance.	b)The level of accessibility and easiness to use the underpass	1	The access is very limited and only one route available to connect the underpass
	2	Located at non-strategic area, connect the minor activities		2	The access is limited and only few routes are connected to the underpass
	3	Located at suitable location		3	The access is connected to the several route
	4	Suitable location and connect the activities in medium distance		4	The access is connected by many choices of routes
	5	Strategic location, connect the major activities in shorter distance		5	The underpass is open and accessible by any choices of routes.

c) Appropriateness of staircase at the underpass	1	The staircase consist of too many steps and inappropriate height of tread that lead to the high user's energy	d) The existing lighting provision at night	1	Only a few lighting installed and create darkness most of the time
	2	The staircase consist of many steps and that lead to user's inconvenience		2	The insufficient installation of lighting causing dim lights
	3	The staircase consist of acceptable number of steps		3	The adequate installation and provide enough lighting
	4	The staircase consist of relevant number of steps that lead to user's convenience		4	The adequate installation of lighting providing bright area.
	5	The staircase consist of relevant number of steps and appropriate height of tread that lead to user's convenience		5	The comprehensive installation of lighting and make the area wider and brighter.
e)The level of security at the underpass (day time & night time)	1	The underpass space maybe dangerous to the pedestrian (crime, chased by dog and etc.)	f)The existing drainage system at the underpass	1	Improper drainage system leads to flood , causing bad odour and obstruct pedestrian to access
	2	The underpass space may lead pedestrian to feel anxious, fear, and being threaten.		2	Improper drainage system leads to stagnant water and limit the pedestrian access
	3	The underpass space lead pedestrian feel safe		3	Satisfactory drainage system and there is water stagnation but not limit the pedestrian access
	4	The underpass space may lead to the pedestrian to feel free from anxious, fear, and being threaten.		4	Proper drainage system, no water stagnation
	5	The underpass space may lead to pedestrian to feel free from anxious, fear, and being threaten as surveillance facilities are well provided		5	Proper drainage system and making the area free from water stagnation.
g) The level of maintenance	1	The authority does not maintain the underpass component and may lead to accident			
	2	The authority does not frequently maintain the underpass component to function and operate properly.			
	3	The authority satisfactorily maintaining the component and element.			
	4	The authority frequently maintains the underpass component to function and operate properly.			
	5	The authority regularly maintains the underpass component to function and operate properly.			
3.Street furniture & amenities a) The existing level of street furniture & amenities Provision (landscape, benches, signage, lighting)	1	Only a few installations of street furniture & amenities	b)The level of maintenance	1	The authority does not maintain the component and element which can lead to inconveniences
	2	The insufficient installation of street furniture & amenities and located only at certain area.		2	The authority does not frequently maintain the component and element to function and operate properly.
	3	The adequate installation of street furniture and amenities.		3	The authority satisfactorily maintaining the component and element.
	4	The adequate installation of street furniture & amenities and		4	The authority frequently maintains the component and element to

		located at major activities area			function and operate properly.
	5	The comprehensive installation of street furniture & amenities and located at major and minor activities area		5	The authority regularly maintains the component and element to function and operate properly
4.Roof & shades a)The level of convenience	1	The respondent had severe sweating or has been drenched by rain while waking.	b)The level of maintenance	1	The authority does not maintain the component and element which can lead to inconveniences
	2	The respondent feels discouraged to walk along the pathway because of few roof & shades installed		2	The authority does not frequently maintain the component and element to function and operate properly.
	3	The adequate roof and shades installation. Fulfilling the respondent expectation		3	The authority satisfactorily maintaining the component and element.
	4	The respondent feels encouraged to walk along the pathway because of adequate roof & shades installed		4	The authority frequently maintains the component and element to function and operate properly.
	5	The respondent feels encouraged to walk along the pathway because of comprehensive roof & shades installed with aesthetic value added.		5	The authority regularly maintains the component and element to function and operate properly.

Source: Generated from best practise of pedestrian infrastructure guideline on campus
(University of Queen's, Ontario(2004), University of British Columbia, Vancouver(2010), West Virginia University, US (2006), Emory University, US (2012), University College Dublin, Ireland(2006), Marryland SHA Bicycle and Pedestrian Design Guideline(2009), A study on the facilities for disabled within IIUM: Gombak

Data analysis

After the data collection was completed, the data were analysed by using graphical method, pedestrian volume trend analysis, cross-reference analysis and weighted average analysis method.

1. Graphical method

In this study, the graphical method was used in analysing the pedestrian volume survey and pedestrian infrastructure survey by using maps, graphs and figures.

2. Pedestrian volume trend analysis

This method was used in analysing the 5-hour pedestrian volume survey. By representing volume and time in the graph, the maximum and minimum pedestrian volume are clearly visible and easily identified.

3. Cross reference study

This method was done by comparing the 5 best practises of campus pedestrian infrastructure planning from University of Queens, University of British Columbia, Emory University, West Virginia University, and University College Dublin. This analysis was done due to the limitation of obtaining the specific pedestrian guideline in campus in Malaysia. Even though these universities have different climate , culture, values and belief compare to IIUM campus, however, this analysis only revolves on the common and application of best guideline adapted by the most of the universities. This method of analysis was also used, as the reference, to assess and conduct pedestrian infrastructure inventory survey to categorize the level of pedestrian infrastructure provision along the major route corridors.

4. Weighted average analysis

The weighted average method was used to analyse data on the level of pedestrian infrastructure provision along the major route corridors on-campus. According to Anisah (2009) the use of this scale is also known as positive scaling in which a high score is given for a positive answer. This method of analysis will also provide a better competent result. According to Amalraj (2011), the formula for calculating weighted average is:

$$\bar{x} = \frac{\sum wx}{\sum w}$$

Where $\bar{x}$ is the weighted arithmetic mean,

$x=$ the variable value i.e : $x1, x2....xn$

$w=$ weight attached to the variable values i.e $w1, w2....wn$

ANALYSIS AND FINDINGS

The findings of this research are mainly served to assist in answering research objectives. The findings based on the data analysis are described in the following sections:

1. Pedestrian volume

From the survey, there was only one pedestrian with disability who used Route 1 at Point 3 (bridge connecting Azman Hashim Complex to the Masjid Sultan Haji Ahmad Syah) at 11.00-11.30am which indicate a low number of pedestrian with disability using these corridors. It can be explained by the low number of disabled pedestrians, as according to Saliza (2011) there were only a few number of students with disabilities in IIUM. Moreover, the survey findings on the disabled pedestrians are due to the number of counting hours (5 hours) considered in this study. Overall, the survey showed that the pedestrian volume along Route 1 was higher than Route 2.

2. Pedestrian flow trend

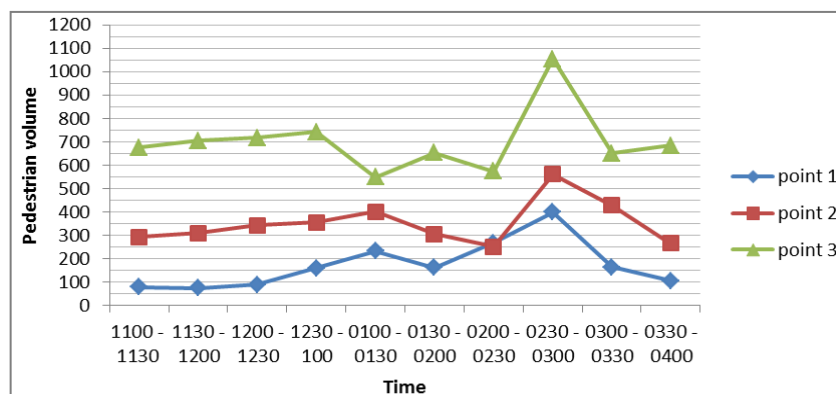## Route 1(KAED- Masjid Sultan Haji Ahmad Syah)

Figure 3: Pedestrian flow pattern at Route 1
Source: Pedestrian volume surve,2013

Figure 3 shows the pedestrian volume trends along route 1. The pedestrian volume trend shows variation in the number of pedestrian using this particular route. The maximum volume of pedestrian, as shown in figure 3, is 1055 at point in the evening hours from 2.30 pm to 3.00 pm. The high number of pedestrians along this route is due to the presence of various pedestrian dominated activities such as banks, post offices, stationary shops, cafeterias and telephone shops. Moreover, the survey at Route 1 was conducted on Friday where the pedestrian returned from attending and performing Friday prayer. Other than that, from the observation, it was found that the pedestrians who used this route were not only the IIUM community, but also the students of International Islamic School and British Malaysian Institute as they also performed their Friday prayer at Masjid Sultan Haji Ahmad Shah.
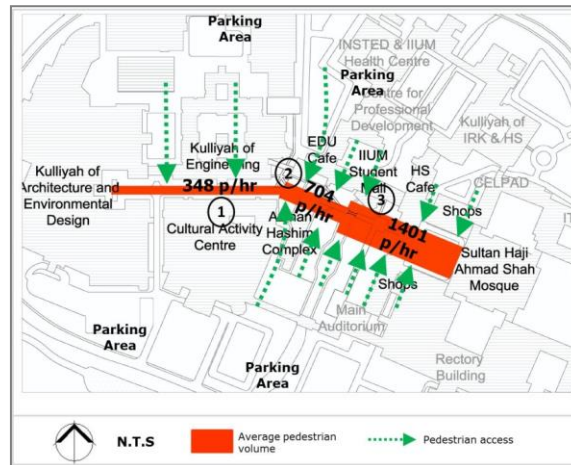

Figure 4: Average Pedestrian volume at Route 1

Source: Pedestrian volume surve,2013

Figure 4 shows that the average number of pedestrian volume per hour gradually increased from Point 1 (348 persons per hour) to Point 2 (704 persons per hour) and Point 3 (1401 persons per hour) which represented the movement pattern of pedestrian from KAED towards Masjid Sultan Haji Ahmad Shah. The Masjid is located at the centre of IIUM and surrounded with high pedestrian-oriented activities such as Banks, cafeterias, shops, offices, and etc. These activities including Masjid had attracted the movement of pedestrians to the central areas.

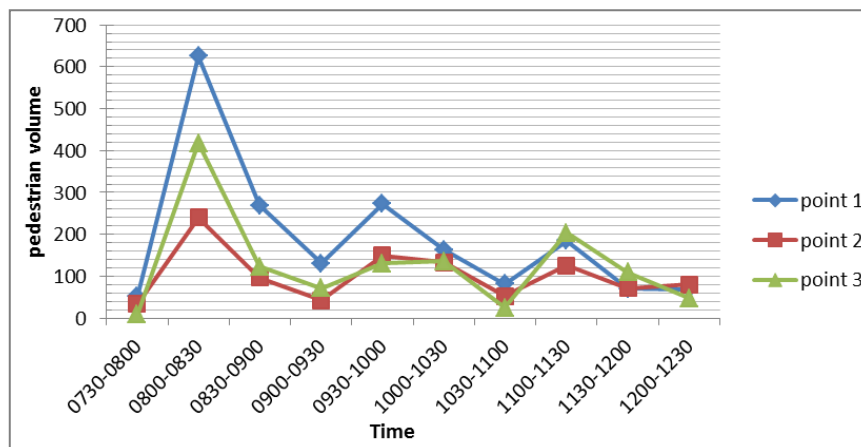**Route 2 (walkway along Jalan Imam al-Malik)**

Figure 5: Pedestrian flow pattern at Route 2

Source: Pedestrian volume surve,2013

The findings, as shown in Figure 5, indicate a decreased and low trend of pedestrian movements along route 2 in the morning hours. The peak pedestrian volume was 625 at point 1 from 8.00 am to 8.30 am. This trend of pedestrian volume was obviously influenced by the weather change and level of pedestrian infrastructure along the major route corridor. According to Anisah (2009), the walkway along this route was not covered by a roof and also subjected to lack of trees and landscape shades. The weather was extremely hot at noon, which makes pedestrians to feel discomfort to walk. They prefer to walk along this route either early in the morning or choose another mode of transport for their journey.
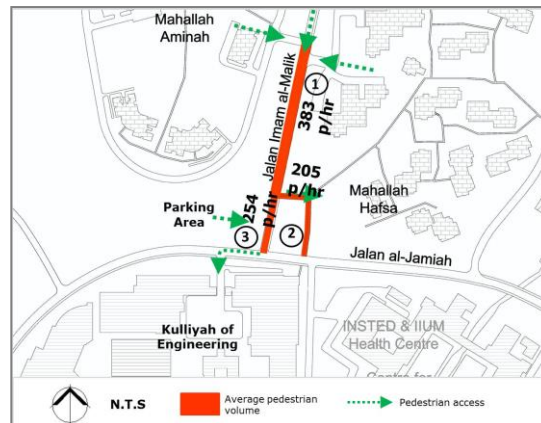

Figure 6: Average Pedestrian volume at Route 2
Source: Pedestrian volume surve,2013

Figure 6 shows the average pedestrian volume per hour along Route 2 which indicates the volume generated at Point 1 (383 persons per hour), was further decreased at Point 2 (205 persons per hour) and slightly increase at Point 3 (254 persons per hour). The results of pedestrian volume along this route corridor was found contrary to the expected volume despite this route is connected with major pedestrian generation areas.

3. Pedestrian infrastructure

The data collection on the pedestrian infrastructure was carried out by interview and inventory survey along the major route corridors. The inventory survey was assessed by using specific guidelines on pedestrian infrastructure (Table 2 and 3) resulting from cross-reference analysis on the best practices of pedestrian infrastructure guideline among universities abroad. The guidelines on the pedestrian infrastructure in the overseas universities were used because of no specific guidelines on pedestrian infrastructure on-campus in Malaysia is available. The summary of the pedestrian infrastructure findings at both Route 1 and Route 2 is shown in table 4.

Table 4: Summary of pedestrian infrastructure findings

Element of pedestrian infrastructure	Route	The respondent rating on pedestrian infrastructure	The inventory on pedestrian infrastructure	The level of pedestrian infrastructure
Sidewalk and walkway				
Width	1*	Satisfactory	The walkway provides wider space (>2 metre)	Good
	2*	Satisfactory	The walkway provides adequate space (2 metre)	Satisfactory
Continuity	1*	Satisfactory	Good continuity	Good

	2*	**Satisfactory**	**The walkway is continuous from Mahallah Maryam and stop at the main road**	**Poor**
Direct connection	1*	Satisfactory	The walkway provides direct connection to all activities along the route corridor	Good
	2*	**Poor** **Less complex route design and lead user to walk on desired route.**	**The walkway provides direct connection to several mahallahs along corridor, however the gate entrance to the Mahallah Halimah was closed, lead to longer distance for the residents by using the entrance of Mahallah Maryam.**	**Poor**
Pavement and surface	1*	Satisfactory	Good pavement and non-slip material of walkway surface.	Good
	2*	**Satisfactory**	**There were several minor damages, inconsistent, uneven paving and that may lead difficulties to the wheelchair user.**	**Poor**
Walkway slope	1*	**Poor** **The peak walkway slope leads high use of energy and difficulties to the wheelchair user.**	**The walkway slope connecting Azman Hashim Complex to the bridge leads to high use of energy and difficulties to the wheelchair user.**	**Poor** Continue
	2*	Satisfactory	The walkway slope allowed access to all type of pedestrian.	Satisfactory Continue
Crosswalk				
Route 1 – zebra crossing	**Location ***	**Poor** **The zebra crossing located at non-strategic area**	**There was no provision of zebra crossing at HS square to Masjid square which indicated high pedestrian volume crossing the road jeopardize their safety.**	**Poor**
	Highly* visible	**Poor** **There was insufficient lighting at the zebra crossing that limits the pedestrian visibility at night.**	**The crosswalk was poorly facilitated by lighting to improve on pedestrian visibility especially at night.**	**Poor**
	Maintenance *	Satisfactory	There was good maintenance of stripping mark to ensure the vehicle driver sees it from distance.	Satisfactory
Route 2 - Underpass	Location *	Satisfactory	The underpass located at strategic location which connected from the walkway along Jalan Imam Al-Malik to the Kulliyah of Engineering	Satisfactory
	The * appropriateness of staircase, accessibility and good connection	Satisfactory	The underpass connects activities in shorter distance and provides good accessibility through slope walkway and staircase.	Satisfactory
	Drainage system *	**Satisfactory**	**There was stagnant water at the entrance of underpass especially during heavy rain that lead to bad odour and inconvenience to the pedestrian**	**Poor**
	The * lighting provisio	**Poor** **There was insufficient**	**There was bright lighting at the underpass however dark walkway connecting to the underpass.**	**Poor**

	n	lighting at the underpass		
	The level of security *	**Poor** **The respondent felt anxious, fear and threatened while crossing the underpass**	**The poor level of security at the underpass walkway**	**Poor**
Street furniture & amenities				
Landscape	1*	Satisfactory	There was sufficient installation of beautiful landscape especially at the square area.	Satisfactory
	2*	**Satisfactory**	**There were very few landscape installation and create the walkway less attractive**	**Poor**
Signage	1*	Satisfactory	Provide good installation of signage along the route corridor however there was hardly visible at night due to poor lighting infrastructure.	Satisfactory
	2*	Satisfactory	The signage was located at the intersection of main road and at the mahallah gate entrance.	Satisfactory Continue
Lighting	**1***	**Satisfactory**	**There was insufficient installation of lighting along the route lead to pedestrian feel anxious and fear at night.**	**Poor**
	2*	**Satisfactory**		**Poor** Continue
Benches	**1***	**Poor** **Insufficient installation of benches and located at certain area.**	**Most of the benches located at non-strategic spot area that had not sheltered and lead to discomfort to the user.**	**Poor**
	2*	Satisfactory	The benches were provided at the 3 transit stops at the distance of approximately 200m along the walkway that allowed pedestrian to stop and take a break.	Satisfactory
Level of maintenance	1*	Satisfactory	There was a poor maintenance of lighting provision	Satisfactory
	2*	Satisfactory	There was a good maintenance of street furniture and amenities	Satisfactory
Roof & shades				
Azman Hashim to Masjid Sultan Haji Ahmad Syah	1●	Satisfactory	There were a few shade trees installed along the walkway	Satisfactory
KOE walkway	1●	Satisfactory and good	There was a good covered pedestrian walkway	Good
CAC walkway	1●	Satisfactory		Good
Road in between CAC and KOE	1●	Satisfactory	There were sufficient shade trees installed	Satisfactory
Maryam to main road.	**2●**	**Poor** **The walkway discourage pedestrian to walk along the pathway because few roof and shades installation**	**The long open walkway along Jalan Imam Al-Malik did not shade properly and uncovered**	**Poor**
Level of maintenance	1 & 2 ●	Satisfactory	Satisfactory	Satisfactory

Source: Interview and pedestrian infrastructure survey, 2013

(Number of respondent (n) for each route represented by symbol ● n=30, * n=15)

From Table 4, it can be seen that the level of pedestrian infrastructure along Route 1 was better than Route 2. Route 1 accommodates various pedestrian-oriented activities such as banks, post office, cafeteria, stationary shops, and telephone shops. On the other hand, Route 2 only provides walkway connecting mahallahs to kulliyahs. The concentration of different pedestrian-oriented activities along route 1 corridor has attracted high number of pedestrians which requires improved pedestrian infrastructural facilities.

4. Relationship between pedestrian volume and level of pedestrian infrastructure

The findings of the relationship between pedestrian volume and level of pedestrian infrastructure along route 1 and route 2 are shown in Table 5.

Table 5: Summary of pedestrian infrastructure average score findings

Route	Pedestrian infrastructure average score								Hourly Average Pedestrian volume
	Sidewalk and walkway	Crosswalk	Street furniture and amenities	Roof and shades	Overall pedestrian infrastructure	Total Average score	Rating	Ranking	
1*	2.76	2.71	2.83	3.01	2.87	2.84	Fair	1	2453
2*	2.80	2.58	2.72	2.32	2.67	2.61	Fair	2	842

Source: Interview survey, 2013
(number of respondent (n) =15)*

From the results, Route 1 has a high total average score and pedestrian volume compared to Route 2. This can be explained by the differences in the ranking of the respondents on most of the elements especially "roof and shades". The level of pedestrian infrastructure is considered as one of the major factors that contribute to the increase in pedestrian volume. The high level of pedestrian infrastructure will influence high pedestrian volume whereas the good provision of pedestrian infrastructure will lead to high level of comfort to the pedestrians. This finding is further supported with the study by Anisah (2009) stating that the provision of pedestrian facilities and infrastructure in IIUM does not comply with the pedestrian needs and thus lead to the low pedestrian volume in IIUM, Gombak campus.

RECOMMENDATIONS AND CONCLUSIONS

The findings showed that there exists a relationship between pedestrian volume and level of pedestrian infrastructure. This had proven the early hypothesis that pedestrian infrastructure is one of the major factors that influenced the volume of pedestrian along the corridors. From the findings, it was found that the Route 2 (walkway along Jalan Imam Al-Malik) had a poor level of pedestrian infrastructure which consequently led to the low volume of pedestrian along this corridor compared to Route 1 (KAED- Masjid Sultan Haji Ahmad Syah).

The problems related to the pedestrian infrastructure that can be identified are: 1) lack of walkway continuity, 2) the poor walkway pavement and surface, 3) the lack of street

furniture especially lighting and benches; 4) lack of roof and shades especially at the walkway along Jalan Imam Al Malik and 5) unsafe underpasses.

Some of the recommendations to overcome the aforementioned issues are: improving pedestrian infrastructure and facilites on-campus especially along pedestrian-oriented areas, making the walkways continuous between pedestrian nodes, improving pedestrian walkway pavements and surfaces and planting more trees for conducive walking environment. These suggestions are expected to increase the pedestrian volume and decrease the vehicle travel in campus. At the same time, it will create IIUM as a pedestrian friendly campus practicing a healthy and active lifestyle for IIUM community.

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