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THE STUDY ON PEDESTRIAN BEHAVIOUR ANALYSIS FOR WALKWAY IN JALAN SULTAN ISMAIL, KUALA LUMPUR

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Abstract: *Kuala Lumpur has a distinctive tropical character, developed infrastructure, a thriving service industry, and numerous tourist attractions. The pedestrian walkway is a critical component of a city's setting. The Pedestrian Walkway provides a handy means of transportation for pedestrians. On the other hand, Kuala Lumpur is not a pedestrian-friendly city due to its inefficient design, minimal maintenance, and lack of usefulness and accessibility. Including The population of Kuala Lumpur is growing, which influences the walkway's comfortability. This study aims to characterise pedestrians based on various factors at the walkway, analyse statistical data on pedestrian speed, flow, and density, and determine the walkway's level of service (LOS) following the Highway Capacity Manual 2010. (HCM 2010). Quantitative data is the study's methodology, which requires videotaping the walkway for one hour at two different periods. The recorded pedestrian's speed was used to calculate the flow and density of the walkway. Pedestrian behaviour analysis can be accomplished by determining the pedestrian's age, gender, and tip companionship. The extracted data has been imported into SPSS for statistical analysis. SPSS analysis may be performed by analysing the relationship between pedestrian walkway speed and density. The relationship between flow and density is significant because the walkway's density increases when the flow decreases. As for Level of Service (LOS), it can be computed by referring to the speed of flow and space of the walkway.*

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The findings are compared to the Highway Capability Manual 2010 to establish a standard for the Pedestrian Level of Service concept. In Jalan Sultan Ismail. The level of Service for Speed, Flow, and Space is "E", "A", "C", and "E", "A", "B", respectively. The grade of the walkway's LOS indicates the walkway's relationship to Jalan Sultan Ismail in Kuala Lumpur.

Keywords*: Pedestrian Level of Service (PLOS), Speed, Flow, Density, Statistical Analysis.*

Introduction

Walking has been one of the essential transportations for citizens who go to work or other. Walking is considered the oldest form or mode of transportation as it exists before other vehicles (such as carts, horses, cars, etc.) were invented (Arshad et al., 2020). The pedestrian walkway allows pedestrians to walk beside a busy road with vehicles (Nasrudin et al., 2018). Kuala Lumpur has a unique tropical character and established infrastructure and service sector with various tourist attractions (DBKL, 2004). A walkway can reach shopping malls, public transport, offices, schools, etc., at Jalan Sultan Ismail. Inside Kuala Lumpur, there are high populations. There are forms of people that enter their destination using the walkway. Walkway separated from the roadway is the preferred location for pedestrians. Like safety, mobility, environment, and healthy communities, the walkway offers many benefits. Walkways eliminate other traffic accidents, in addition to diminishing walking near highway crashes.

Pedestrians use the walkway to the mall for shopping. Staff prefer to take the walkway to their workplace to head to work. There were even students who used the walkway to go to college. The infrastructure in Kuala Lumpur is well established. However, there are only a few areas that are not well managed. Pedestrian Walkway is a convenient way for people to walk. They provide safety for pedestrians at the crossing. Besides, it is incredibly costly and takes considerable development time. Several factors influence pedestrian behaviour, including age group, gender, trip purpose, luggage carrying, etc.,

Kuala Lumpur is not a pedestrian-friendly city, as it currently has inefficient design, low maintenance, and poor usability and connectivity (Zakaria & Ujang, 2015). People prefer to walk more often if better quality walkways are provided as infrastructure facilities (Rahman et al., 2015). The level of service would show the walkway's level of comfort. If comfort does not meet pedestrian users' satisfaction, the walkway needs to enhance its pedestrian implementation performance. The accessibility Pedestrian Level of Service on density, flow, speed, and volume at study locations enhances the traffic engineering infrastructure's quality of public facilities. An improper pedestrian facility and different land-use types significantly affect pedestrians' behaviour (Bansal et al., 2018).

Methodology

This study collects at a pedestrian walkway in Jalan Sultan Ismail, Kuala Lumpur. In general, the walkway raised spaces developed at the carriageway's left and right to facilitate walking. The site location was selected based on the highest pedestrian volume and based on function and width. Jalan Sultan Ismail is also known as a district, and its commercial building makes it easier for us to observe pedestrian behaviour. However, Jalan Sultan Ismail is one of the most urban places than another part of Kuala Lumpur. Fig. 1 shows the detail methodology flowchart.

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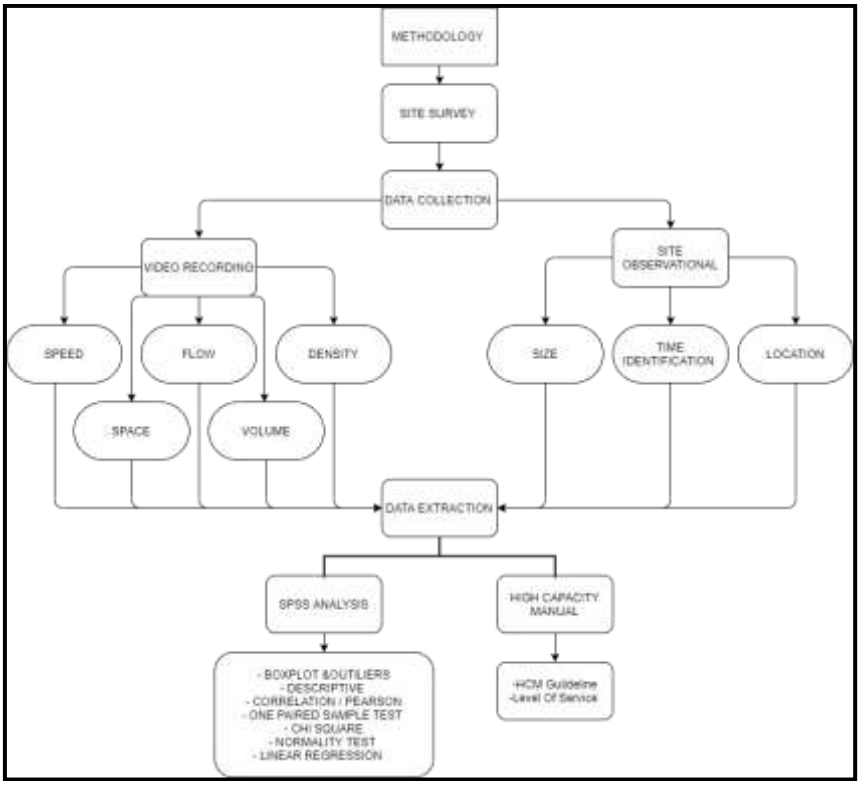

Figure 1: Detail Methodology Flow Chart

Site Survey

The site survey is identified how many and where the pedestrian walkway has been installed in the area of Jalan Sultan Ismail, Kuala Lumpur. This aspect is very important to locate a suitable location based on time allocated, environment, and others. Plus, to make sure the research gives positive results. A few criteria to decide are location near school or college, shopping complex and office building or premises, public transportation, and residential areas. The best to choose the site is based on the number of pedestrians using the pedestrian walkway. Figure 2 show the selected site location. The selected one hour on the mid-day and afternoon at a walkway near Pertama Complex and Maju Tower at Jalan Sultan Ismail, Kuala Lumpur.

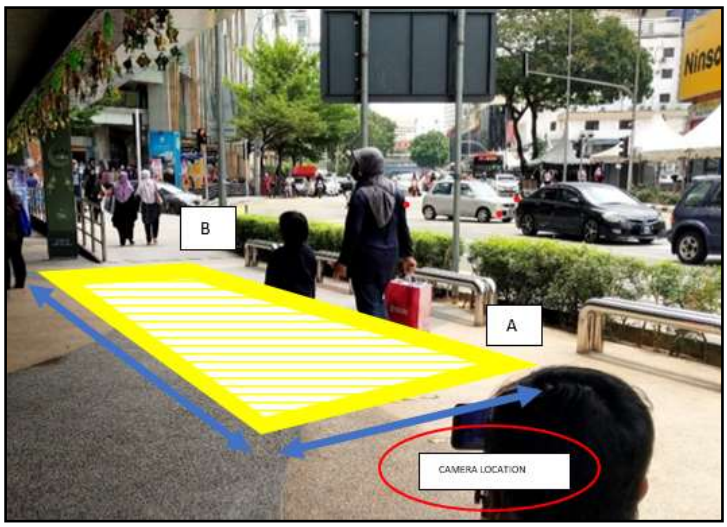

Figure 2: Selected Pedestrian Walkway

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Data Collection

The pedestrians' peak hour on the walkway of the day was found from pedestrian count's primary data. The pedestrian count should take at an interval of 15 min of 1 hour. Cameras are set up at the selected locations during the chosen observing times, and the pedestrians' video images are taken. Such a survey creates a permanent record of pedestrian activity and their contact with vehicles. The history of behaviour patterns is also obtained, which helps in analysing the crossing difficulties.

Video Recording

It needs to know the companies for distance and time to determine what the units are for speed. The length is in metres (m), and the time is in seconds (s) in this case, so the units are in metres per second (m/s). The pedestrian flow rate is the number of pedestrians crossing a dot per unit of time expressed as pedestrians per 15 minutes or pedestrians per minute. Pedestrian flow per unit of width is the average flow per unit of the pedestrians' sufficient walkway width, expressed per metre (p/min/m) as pedestrians per minute. The pedestrian density is the average number of pedestrians per unit area within a walking path. The density equation summarises pedestrians within the area at a selected time (Banerjee et al., 2018). Manual counts can provide a wealth of data, such as pedestrians' age, gender, physical impairment, and behaviour, if necessary (Robertson et al., 1994). Additionally, they are simple to set up and use (Bhuyan & Nayak, 2013).

Site Observational

Data gain is quantitative data. For the quantitative data, the fundamental pedestrian flow parameters were extracted manually from the recorded videos. Essential flow parameters from videos and manual counting methods were adopted to avoid possible errors resulting from automatic image recognition, especially in the high-density range (Das et al., 2016).

SPSS ANALYSIS

Transfer the extract data from Microsoft EXCEL to Statistical Package for Social Science Software (SPSS) to proceed with statistical analysis. SPSS software can perform many types of tests, such as descriptive statistics, which define the fundamental characteristics of the data in this research.

Level of Service (LOS)

Pedestrian LOS can be calculated based on speed flow and space. The findings obtained are referred to the Highway Capability Manual 2010 in the Pedestrian Level of Service concept to determine its standard. The Level of Services for a pedestrian is identified based on the table shown below HCM 2010 defined six levels of service for pedestrian flow, ranging from "A" to "F," with LOS "A" indicating the greatest and most comfortable conditions for pedestrian flow and LOS "F" indicating the worst and most congested conditions for pedestrian flow (Sahani & Bhuyan, 2013).

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Table 1: Standard of Pedestrian Level of Service (Highway Capacity Manual, 2010)

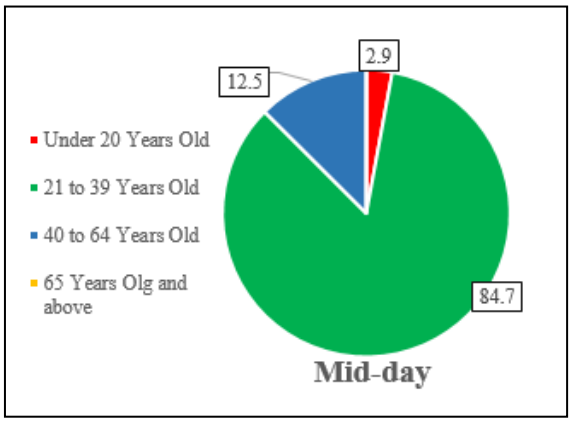
LOS	Speed (m/min)	Flow (ped/min/m)	Space (m^2/ped)	V/C Ratio
A	> 78	<16	> 5.60	<0.21
B	> 76 – 78	> 16 – 23	> 3.70 – 5.60	> 0.21 – 0.31
C	> 73 – 76	> 23 -33	> 2.20 – 3.70	> 0.31 – 0.44
D	> 68 – 73	> 33 – 49	> 1.40 – 2.20	> 0.44 – 0.65
E	> 46 – 68	> 49 – 75	> 0.75 – 1.40	> 0.65 – 1.00
F	<45	Varies	<0.75	Varies

Data analysis

For this study, the data analyses only had one part, which is quantitative. The quantitative data was obtained through the playback transferred to the spreadsheet in Excel. The data types represented pedestrians' speed, flow and behaviour, which can fulfil this study's whole objectives. Studies conducted are based on pedestrian walking speed when passing through the trap area. Independent variables such as gender and age were recorded based on video collected. According to Papadimitriou et al. (2017), pedestrian behaviour can be identified based on factors such as age group, gender and weather. Based on data by Zhao and Liang (2016), young men have the fastest and children have the most uneventful speed. The pedestrian's age also substantially influenced crossing speed with elderly pedestrians less inclined to increase their crossing speed than other age groups (Kadali et al., 2014).

Factor Affecting Pedestrian Behaviour

The pedestrian's age also substantially influenced crossing speed, with elderly pedestrians less inclined to increase their crossing speed than other age groups (Raghuram Kadali et al., 2014). The study categorized pedestrians into five age groups, namely, under 20 years old (children/adolescents), 20–39 years old (young), 40–64 years old (middle), over 64 years old (old) (Park & Bae, 2020). Fig. 3 below shows the percentage of the pedestrian's age as a factor affecting pedestrian behaviour. The majority of the pedestrian was adult with the range of 21 to 39 years old for both mid-day and afternoon with 84.7% and 78% respectively.



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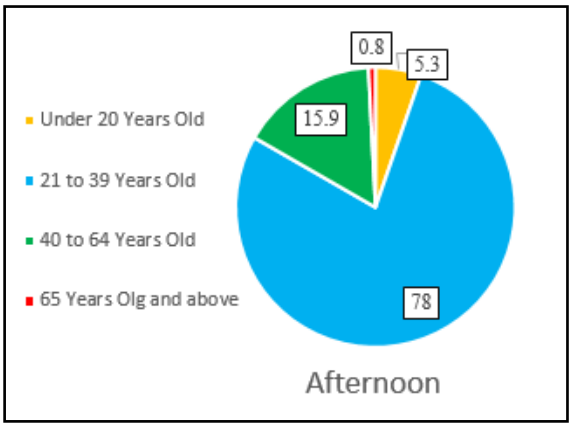

Figure 3: Age Percentage for Mid-day and Afternoon

Gender is classified into male and female Fig. 4 indicates the volume of the pedestrian corresponding to the gender of the pedestrians. For both mid-day and afternoon, females have higher and mount with 66.8% and 55.2%, respectively. The pedestrian packed with females is because the location nearly shopping, which interests most pedestrians, especially females, to go shopping during both mid-day and afternoon.

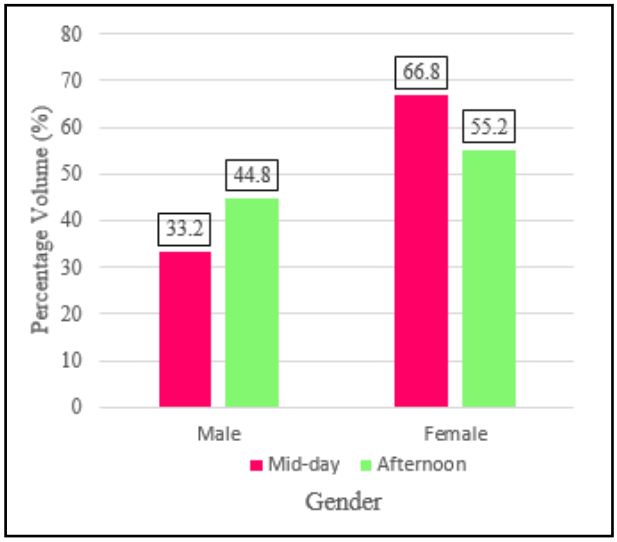

Figure 4: Percentage Volume Corresponding to Gender

Trip Companionship has been one of the factors considered as a factor affecting pedestrian behaviour. Walking in-group will affect the speed of the pedestrian and automatically caused to affect flow density at the walkway. Fig. 5 indicates the percentage volume corresponding to trip companionship. The majority of the walkway happened to walk along by themselves with the comfortability of their speed. Also, pedestrians walk in pairs, three people and four persons in a group for mid-day and afternoon. Group in pairs has second-highest percentage for both mid-day and afternoon with 40.8% and 35% respectively. However, the least people that walked in a group 4 person in a group which usually families. The percentage for both mid-day and afternoon is 3.1% and 3.2%, respectively.

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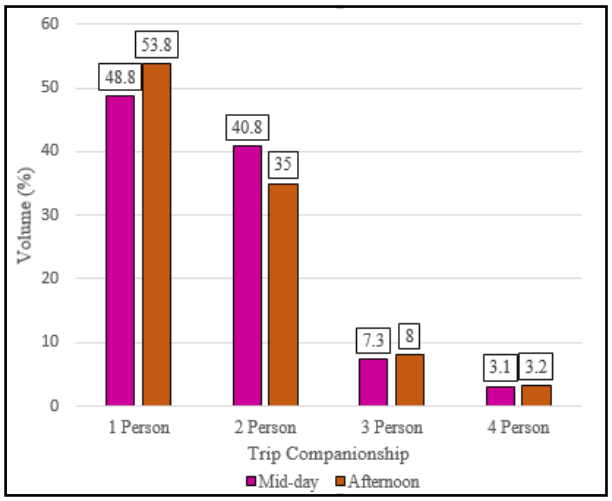

Figure 5: Percentage Volume Corresponding to Trip Companionship

Table 2: Speed, Flow and Density Value

		Mid-day	Afternoon
Speed	Mean (m/min)	46.651	43.632
	Standard Deviation	0.0678	0.0687
	P-Value	0.102	0.003
Flow	Mean (Ped/min/m)	6.55	6.283
	Standard Deviation	1.665	0.944
	P-Value	0.126	0
Density	Mean (m^2/ped)	3.445	3.776
	Standard Deviation	0.249	0.131
	P-Value	0	0

Table 2 shows the speed flow and density of the pedestrians. The standard deviation for speed has a smaller value compared to flow and density indicates the smaller range. Speed is more usual compared to Flow and density. The P-value indicates the significancy of speed flow and density. During Afternoon, all three has a lesser value than 0.05 which makes speed flow and density are significant.

SPSS Analysis

The Fig. 6 and 7 shows the regressions equation for predicting the pedestrian speed to flow, density. The pedestrian was given by the Y equation. The highest R^2 for both mid-day and afternoon is on Flow-Density relation, 88.17% and 100%. It means that this relationship has strongly significant corresponding to the relationship compared to the other three relationships. It indicates a strongly negative linear relationship between flow and density at the walkway in Jalan Sultan Ismail, Kuala Lumpur. It shows that when flow increases, the density decreases. Also, Afternoon has moderately significant since the R^2 is 0.516 which within the range of 0.75 to 0.5 in linear regression.

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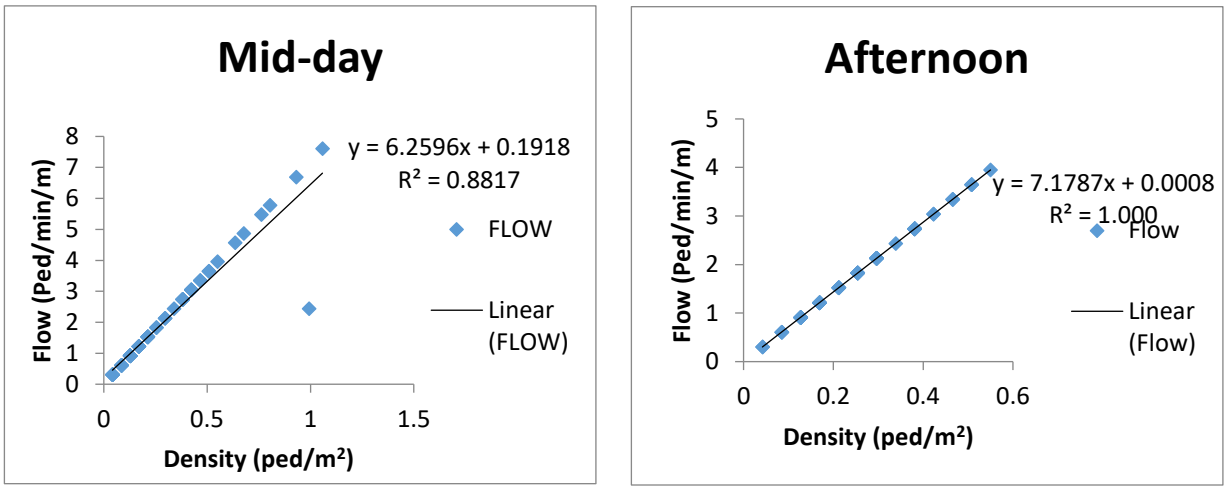

Figure 6: Flow-Density Relationship

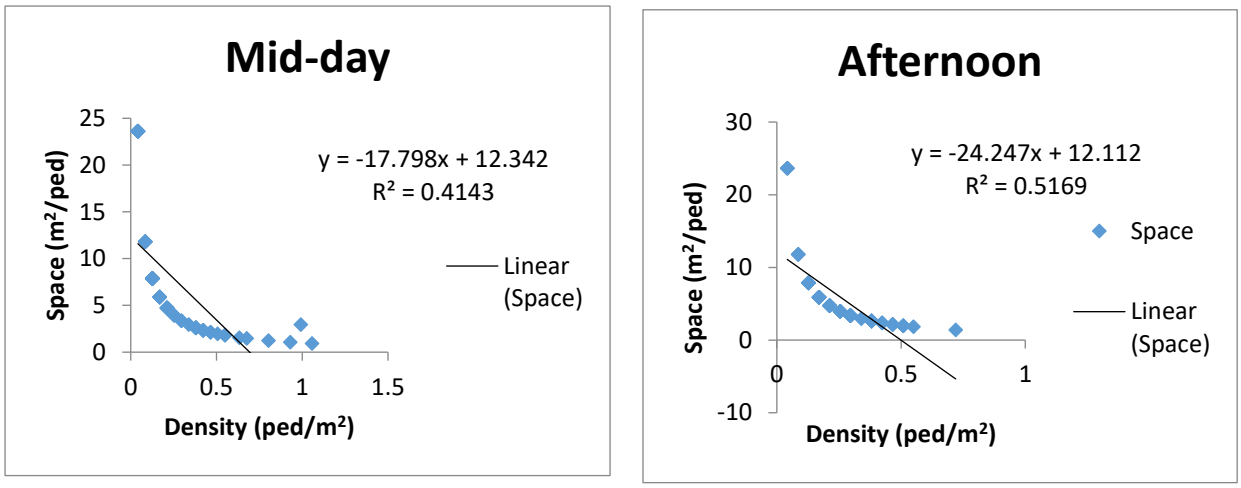

Figure 7: Space-Density Relationship

Level of Service

To compare the level of service (LOS) for the pedestrian Speed, flow, and space at the walkway of the platform at Jalan Sultan Ismail, Table 3 were tabulated to determine the level of service (LOS) for the pedestrian flow. This table also showed the pedestrian speed, flow and space at Jalan Sultan Ismail, Kuala Lumpur, compared to the Level of Service (LOS).

Table 3: Pedestrian Level of Service Of The Walkway

Level of Service			
	Speed	**Flow**	**Space**
Mid-day	46.651	6.55	3.445
HCM 2010	> 46 – 68	≤16	>2.20-3.30
LOS	E	A	C
Afternoon	43.632	6.283	3.76
HCM 2010	> 46 – 68	≤16	>3.70-5.60
LOS	E	A	B

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Conclusion and Recommendation

In conclusion, it was found that Age, Gender and Trip Companionship have categorised the characteristic. Based on the characteristics of speed, flow and density were affected in term of walking speed during both mid-day and afternoon. The relationship between pedestrian Flow-Density and Space-Density Relationships are corresponding significant since both of are strong (1.0 – 0.75) and moderate (0.75 – 0.50) respective when running regression test on SPSS Analysis. For speed, the walkway pedestrian is critical since it scored E for Level of Service (LOS) for both during mid-day and afternoon. However, the flow does not affect the walkway's speed since both times have scored A in LOS. Meanwhile, different results show on the LOS score for the space. The LOS for space for Mid-day is lower compared to afternoon due to time effectiveness. The afternoon managed to score B. Meanwhile, during the Mid-day has only Score C in LOS.

The following are recommendations are as below:

i. To continue with the investigation for the pedestrian flow and its relationship with speed and density.
ii. To recommend collecting data at the different walkways but the similar size of the walkway and similar amount of pedestrian walk through the walkway.
iii. To recommend collecting the data on different days or different times.
iv. To recommend analysing the data with a different factor that will affect the pedestrian characteristics.
v. To propose a reliable way for the walkway to improve the pedestrian space and upgrade the facilities at the walkway when the population increases

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