Utilization of 3D Visual Effect Crossing Facility to Enhance Pedestrian Safety

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Abstract. Pedestrian is known as vulnerable road user, therefore proper crossing facility is needed to enhance the pedestrians’ safety. This study is to determine the effect of using 3D visual crossing facility inside the campus and its functionality. This 3D visual effect crossing facility is installed at selected location. The location selection is based on the absence of crossing facility, pedestrian volume and spot speed study. Pedestrian volume was collected by manually while spot speed study was collected using speed gun Apps. The 3D visual effect road crossing then is designed by using the perspective view from the driver height sight. After the installation of road crossing, the hypothesis is tested using chi-square analysis to determine the association between the effect on 85th percentile speed, pedestrians’ behaviour and the 3D visual effect crossing facility. The results of chi-square analysis shows there is a significant (p<0.05) association between speed of vehicles and the installation of 3D visual crossing facility. The results of the analysis revealed that before the installation, the percentage of motorists slow down is 39.7% while the motorists that do not slow down is 66.7%. After 1 week installation, the drivers that do not slow down the speed decrease from 59.52% to 40.48%. As a result, the effect of 3D visual crossing facility shows that the motorists will slow down their vehicle speed, immediately after the installation. However, after familiar with the presence of this facility some motorists are driving as usual without concern to anymore.

1. Introduction
Road users normally can be categorized as car drivers, van drivers, lorry and bus drivers, motorcyclists, pedestrians, cyclist and other vehicle drivers. The road user focused in this project more in pedestrian. The global scenarios show that in 70% of road accidents which occur in developing countries, 1.17 million deaths occur each year worldwide. Among these deaths, 65% involve pedestrian. According to Malaysian Institute of Road Safety Research (MIROS), 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, consists a total of 4% of road fatalities in Malaysia [1]. 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 [1].

There are some typical problems due to conflict between the behaviour of drivers and pedestrians on the road are considered as they affect the safety of the pedestrians. For the most cases, drivers do not stop for pedestrians as there are no proper road crossings on the road. Pedestrian fatalities are averaging approximately more than 500 deaths each year [2]. According to Russo et al [3], the issue is in the public eye, after cities including Honolulu, Rexburg and other states in US states, passed legislation to fine any...
pedestrian using their cell phones when crossing the street. Pedestrians sometimes simply cross the road without using the proper facilitated zebra crossing. This group of people think that it is too much work for them to walk towards the zebra crossing and they think the cars should stop to let them cross where and whenever they want. This action is not only violate the rules, but also very dangerous to the road users [3].

In New York City, pedestrian–vehicle crashes remain a major and most concern due to the high percentage and frequency of fatalities [4]. This can be shown that the drivers often fail to yield to the pedestrian and the drivers do not notice that pedestrian safety at road crossings depends mainly on the behaviour of the drivers that including the speed of the vehicle. Therefore, this study is to identify the availability of crossing facility in main campus Universiti Tun Hussein Onn Malaysia (UTHM) and to determine the operating speed of the motorist and the effect of using 3D visual for pedestrian crossing facility.

2. Method and Material
The method of data collection in this study is using observation on pedestrian crossing behaviour and spot speed study. The location of study is inside the campus UTHM. Besides that, methods that use for data analysis are hypothesis testing such as chi square analysis.

2.1. Location of study
The study area was undertaken at the roadway inside the main campus UTHM. Most of the pedestrians are students and staffs from UTHM. The roadway in the study area has one lane in one direction and the total lanes are two for both directions. The reason for choosing this study area is because none crossing facility is provided and there is a need for pedestrian crossing facilities to be installed. Every day during the peak hour, there are a lot of pedestrians especially students will cross the road in order to reach their destination such as faculty, hostel and lecture room. In this study, the locations that are suitable to be selected are including, the road in front Faculty of Technology Management and Business (FPTP) and Faculty of Technical Education and Vocational (FPTV), the road in front the Faculty of Mechanical and Manufacturing Engineering (FKMP) and also the road in front Auto-teller Machine (ATM). Firstly, the type of existing crossing facility is identified and where is the exact location of the crossing facility inside the campus. This is very important to identify the suitable location for the crossing facility based on the distance for the pedestrians to reach the destination.

2.2. Data collection
First of all, the observation of the pedestrians’ and the motorist’s behaviour was carried out to know the movement of the pedestrians and the motorists so after that it is easier for the next stage to do the analysis. By using this method, the movement and behaviour of the pedestrians and motorists when crossing the road and approaching the crossing facility can be determined. This method only needs less observation. In this observation, the time chosen was at the peak hour that is from 7.00 a.m. to 9.00 a.m. This was the time where the students and staffs in UTHM start to enter the class or office. The number of pedestrians then was recorded in a spread form.

For the conducting of the pedestrian volume study, the counting is manually done by record the data in a tally marking sheet. Normally, most of the manual count method requires small sample of data in the chosen location. And the time for the study must be the same in all locations. In this study, 15 minutes is chosen into count for two hours observation. Every single number of pedestrians that are counted is recorded in form. The spot speed data was collected from sample size of 180 vehicles in a selected location. The tool used in this study was the smart phone Apps which called Smart Tools (speed gun). The operation is by selecting a moving vehicle by touching the screen in the Apps. The average speed has been calculated and determined from the data that is presented in a form.

2.3. Construction of 3D visual effect crossing facility
Maksiov [5] has explains and demonstrates how to construct a 3D visual effect on the level surface. Using such technique and method, to construct this 3D crossing facility, firstly, the rectangular shape is fixed. This is to grab the painting on the pavement and also to determine the perspective scale. The
volume of pedestrians is determined and the spot speed study is conducted to decide where to install this 3D visual effect crossing facility. There are few procedures that have been taken to install this 3D visual effect crossing facility. The final product of this 3D visual crossing facility is shown in Figure 1.

i. The overall size of 3D visual effect crossing facility is determined using scale and ratio. The ratio in this study is approximately 1:22. For example, the length of in the A4 drawing was 9 cm while in the real road, the size was 1.98 m.

ii. Before start the construction, the surface of the road is cleared of obstacles. The surface is also dry and smooth.

iii. The dimension is then measured by the measuring tape.

iv. The frame of the 3D visual effect crossing facility is helped by the adhesive tape. The use of this tape is to make sure the dimension and size followed the scale that had been design and the paint is not out of the frame.

v. Finally, 4 colours (white, light grey, dark grey and black) of paint are applied on the road followed the frame that has been prepared.

(Front view)                             (Side view)

Figure 1. Finish product of 3D visual effect crossing facility.

2.4. Chi-square test
Chi square test is carried out to involve a clear connection to the speed of the vehicle. Besides the installation of 3D visual effect crossing facility that can affect the speed of the vehicle, there are other external factors that affect the speed itself and can be seen through this test. This test was conducted on the relationship of the variables before and after the reaction of the motorists. This test will also prove the hypothesis whether accepted or not and might support the relationship of all the data and thus achieve the desired objectives.

3. Results and discussions
The results of the data analysis were performed at the selected location and identify the effectiveness of the use of 3D visual effect crossing facility to enhance the pedestrian safety. The analysis was conducted to test the reliability of the observation data which subsequently supported the effectiveness of this crossing facility in reducing the speed of the vehicle before approaching the zebra crossing

3.1. Pedestrian volume
The volume of pedestrian that cross the road in front of each faculty (FKMP and FPTP) and library Tunku Tun Aminah (PTTA) was recorded. Total numbers in FKMP is the lowest that is only 92 while the number pedestrians in front the FPTP is the highest that is 167 respectively.

3.2. Spot speed study
Spot speed study was conducted during peak hour in the morning by duration of 15 minutes daily before and after the installation of 3D visual effect crossing facility. Since the road from FPTP to Faculty of Civil and Environmental Engineering (FKAAS) is same stretched, then the spot speed study is combined into one. Before the installation of 3D visual effect crossing facility, spot speed study was conducted to decide where to locate this crossing facility. For the FKAAS, FPTP FPTV, FKMP and library, the average speed in each class of vehicle result is shown in Table 1. In overall, the result of spot speed
study for each location is shown in Table 2 The mean speed in FPTP is the highest that is 43.1 while the lowest mean speed is 36.1 at library (PTTA).

### Table 1. Average speed for class vehicle (km/h)

| Vehicle Class              | FKAAS, FPTP and FPTV | Library | FKMP |
|----------------------------|----------------------|---------|------|
| Class 1 (Motorcycles)      | 42.6                 | 35.8    | 41.2 |
| Class 2 (Cars)             | 45.3                 | 37.3    | 44.7 |
| Class 3 (van and small trucks) | 45.5                | 33.9    | 40.2 |
| Class 4 (Buses)            | 38.6                 | 34.4    | 34.9 |

### Table 2. Overall speed data in each location

|                      | FKAAS, FPTP and FPTV | Library | FKMP |
|----------------------|----------------------|---------|------|
| Minimum speed (km/h) | 21.2                 | 22.8    | 20.0 |
| Maximum speed (km/h) | 73.4                 | 48.7    | 63.4 |
| Mode speed (km/h)    | 40.0                 | 40.0    | 40.0 |
| Mean speed (km/h)    | 43.1                 | 36.1    | 41.2 |

### 3.3. Spot speed analysis

Table 3 shows the average speed, standard deviation, maximum speed and 85 percentile obtained from 180 samples conducted on the road in front FPTP. Through the analyzed data, the average speeds slightly decrease after the installation of 3D road crossing. The average velocity of 4 types of vehicles passing through the road is 40.3 km/h for class 1 (motorcycle), 43.1 km/h for class 2 (car), 42.7 km/h for class 3 (vans and medium trucks) and 37.1 km/h for class 4 (bus).

### Table 3. Average data in front FPTP (n=180)

|                      | Before | After |
|----------------------|--------|-------|
| Average Speed (km/h) | 43.1   | 40.7  |
| 85\textsuperscript{th} percentile speed (km/h) | 49.0 | 44.0 |
| Standard Deviation   | 10.5   | 9.0   |
| Maximum Speed (km/h) | 73.4   | 66.1  |

### 3.4. Chi-square test (after installation of 3D visual effect crossing )

Table 4 shows the reaction of motorists towards the 3D visual effect road crossing. Result shows that before the installation, the percentage of motorists slow down is 39.66% while the motorists that do not slow down the speed is 66.7%. After the installation of this road facility, the percentage of motorists slow down the speed rise up to 60.34% that is from 23 to 35 motorists (p<0.05). Result shows that with this installation will cause some of the motorists to slow down the speed.
Table 4: Chi square test after the installation of 3D visual effect road crossing facility in day-1 (n=100)

| Condition       | Before                  | After                   | Total |
|-----------------|-------------------------|-------------------------|-------|
| Slowing down    | 23 (39.66%)             | 35 (60.34%)             | 58 (100%) |
| Not slowing down| 38 (66.67%)             | 14 (33.33%)             | 42 (100%) |

(χ²=13.955, df=1, p=0.000)

Table 5 shows the reaction of motorists towards the 3D visual effect road crossing after 1 week. Result shows that before the installation, the percentage of motorists slow down is 44.83% while the motorists that do not slow down the speed is 59.52%. After 1 week of the installation of this road facility, the percentage of motorists slow down the speed rise up a bit to 55.17% that is from 26 to 32 motorists. The corresponding probability is between the 0.1 and 0.9 probability levels. That means that the p-value is above 0.05. That means it is fail to reject the null hypothesis. In other words, motorists that slowing down the speed is independent of this 3D visual effect road crossing facility after 1 week of installation.

Table 5: Chi square test after the installation of 3D visual effect road crossing facility within 1 week (n=100)

| Condition       | Before                  | After                   | Total |
|-----------------|-------------------------|-------------------------|-------|
| Slowing down    | 26 (44.83%)             | 32 (55.17%)             | 58 (100%) |
| Not slowing down| 25 (59.52%)             | 17 (40.48%)             | 42 (100%) |

(χ²=2.105, df=1, p=0.7)

3.5. Discussions
The speed of the vehicles those approaching before and after the installation of the 3D visual effect crossing facility was analyzed. Maximum speed and percentage that motorists slow down the speed is shown in the spot speed study for each class of vehicles. The 85th percentile speed is generally and widely accepted to quantify the definition of operating speed [6]. In front the road FPTP, the speed limit of 40 km/h was posted. However, before the installation of this 3D visual effect, 85 percent of motorists in UTHM normally will drive at 49 km/h that is slightly exceeded the speed limit. After the installation of this crossing facility, 85th percentile speed reduced to 44 km/h. In a comparison, there are some factors that influence the 85th percentile speed. The first one is of course the presence of the new crossing facility. Anciaes and Jones [7] reported the study result to understand the preferences of pedestrians towards a wide variety of road crossing facility. The 3D visual effect crossing facility attracts the attention of the motorists when they drive along the road.

The results of the motorists slowing down the speed before and after the installation of 3D visual effect crossing facility are analyzed by the Chi square test. Pedestrian is one of the factor that let the motorists slowing down the speed when approaching them. Elliot, McColl and Kennedy [8] also showed that the presence of the pedestrian will cause the motorists to reduce the speed. The results showed that once finished the installation of this 3D visual effect road crossing, the percentage of motorists slowed down the speed rose up to 60.34% that is from 23 to 35 motorists (p < 0.05). Also, Ambak et al [9] studied on 3D visual effect for speed hump showed there was significant association on 85th percentile speed before and after the installation. Results demonstrate that the 3D visual effect installation is one of the approaches to enhance the safety of the pedestrian on the road. The motorists are tended to brake when approach this crossing facility regardless of the presence of the pedestrians. But somehow, there
are some changes after 1 week, some of the drivers might familiar with to this facility and never again slow down the speed when approach this road crossing. This might lead to the reduction of the attraction towards this effect. Besides, do not deny that there are some drivers that do not pay attention while driving. Those distracted drivers will take longer time to road sign and hazards, this cause them to react slowly when approaching this road crossing [10]. Furthermore, there are also drivers tried to exceed speed limit where they realise they were late to class or behind schedule [11]. Nevertheless, there are still drivers will slow down the speed at this moment when there are pedestrians crossing the road.

Behaviour of the drivers and the obstruction on the road normally affect the speed of the vehicles. Besides, pedestrian’s behaviour such as take risk to cross the high speed road at undesignated location will lead to accident [12]. After the installation of this 3D visual effect crossing facility and based on the result of the analysis, positive impact is the reduction of the speed of a vehicle. The highest speed limit in Malaysia is 100 km/h in expressway and 60 km/h for state roads and these speed limits decreased from time to time to cooperate with the festive season in Malaysia [13].

4. Conclusion

The number and behaviour of the pedestrians are observed and recorded to determine where to locate this 3D visual effect crossing facility. The speed of the motorists was recorded and the mean speed, 85th percentile speed and the standard deviation are calculated. The numbers of pedestrians are also calculated in different location to decide where to install the 3D visual effect crossing facility. Then, the effect of this 3D road crossing is analysed before and after the installation. Based on the data analysis, there are few motorists do not slow down the speed when they drive through this 3D visual effect road crossing due to some reasons. After one week of installation, motorists who are familiar with this optical illusion effect, they would probably no longer reduce the speed when they pass through. It will become a hazard if the driver unsure whether to slow down or continue moving on the road. There is some limitation that out of the expectation throughout this research. After the sketching of the 3D visual effect road crossing, there is no more choice to get the sticker as the big size of the sticker is not supplied by the workshop. The solution is replaced by the paint because if compare to the sticker, the paints can be easily found and not easily torn due to the flow of the traffic. Motorists might reduce the speed because they just want to turn into the faculty. Last but not least, the appropriate distance for the driver to see and tend to stop or slow down the speed after the installation of the 3D visual effect crossing is not really perceived. Therefore, the utilization of the 3D visual effect for pedestrian crossing facility seem not to be effective approach as permanent facility but might suitable for temporary and attractive only.

5. References

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