Recent Trends in Civil Engineering and Built Environment Vol. 4 No. 2 (2023) 072-081

RTCEBE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/rtcebe
e-ISSN :2773-5184

A Review on the Effectiveness of Raised Crosswalks

Jeyasaraniya Parsuraman[1], Basil David Daniel[1]*

[1]Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

*Senior Lecturer, Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia

DOI: https://doi.org/10.30880/rtcebe.2023.04.02.009
Received 06 January 2022; Accepted 15 January 2023; Available online 20 July 2023

Abstract: Speed was considered second-highest contributing to road crashes, particularly in free flow situations in the case of road accidents. Speeding on university campuses in Malaysia is also a problem. Out of control accidents have resulted in injuries and damages are more likely to occur in campus which can be linked to a speeding problem. This study is crucial in determining the importance of installation of raised crosswalks in reducing vehicle speed and improves pedestrian safety. A review is conducted, and quantitative analysis was carried out to determine the effects of raised crosswalks on speed reduction and pedestrian safety. A number of studies were collected and sorted out according to the inclusion and exclusion criteria. Lastly, the studies were analyzed accordingly. Almost all the studies shown positive results on speed reduction and pedestrian safety. A design of raised crosswalk is also proposed for installation in several locations in Universiti Tun Hussein Onn Malaysia.

Keywords: Raised Crosswalk, Pedestrian Safety, Speed Reduction

1. Introduction

The appropriate planning and design of a road system determines the efficiency and safety of road users. Traffic calming measures were implemented to slow down vehicle speeds to create a safer traffic environment for all road users, particularly on roads without access control [1]. A considerable increase in the number of vehicles in Malaysia led directly to too many road crashes. Road crashes are one of the biggest concerns facing this country over the years [2]. Speed was considered second-highest contributing to road crashes, particularly in free flow situations in the case of road accidents, according to the Malaysian Institute of Road Safety Research (MIROS). As a result of lower speeds and reduced traffic volume, the installation of traffic calming devices has resulted in a more livable environment with improved environmental quality and road safety. On campus, road humps are employed to calm traffic by virtue of their physical qualities, which make vehicles to slow down due to encumbrances, as the roads are usually congested with pedestrians [1]. Speeding on university campuses in Malaysia is

*Corresponding author: basil@uthm.edu.my

also a problem. Out of control accidents have resulted in fatalities, which can be linked to a speeding problem. In addition to enforcement, engineering techniques are used to address speed-related issues. The well-documented link between speed and crashes has prompted the creation of a slew of interventions aimed at slowing down drivers [3]. Despite a decline in popularity, walking is still a popular mode of transportation. People of all ages, both sexes, and from all aspects of life walk, amidst steadily increasing vehicle numbers and traffic levels [4]. According to the Ministry of Transport Malaysia, pedestrians are the third most fatality group in Malaysia, after motorcyclists and car drivers/occupants. On average, pedestrian deaths claimed the lives of 542 individuals per year, or 45 persons per month. Raised crosswalks (RCW's) are speed tables that span the entire width of the road and are commonly found at midblock crossing points. Paint and/or special paving materials are used to mark the crosswalk. These crosswalks serve as traffic calming devices, allowing pedestrians to cross at street level. They can be installed individually or in a series. In the second scenario, raised crosswalks are properly spaced to moderate vehicle speed over a certain portion of a road, resulting in a further reduction in pollutant emissions as a result of the vehicles' loss of speed. These devices are especially effective when used in series and spaced 80-120 metres apart [5].

Speed is an important indicator of the road network's level of quality and safety. The pace at which a vehicle travels over a certain distance in a given length of time is referred to as speed. Speed is measured in kilometres per hour (kph) or miles per hour (mph). The time-mean speed and the space-mean speed are the two basic types of speed [6]. To describe traffic calming, it is a set of mostly physical activities intended at reducing the negative impacts of motor vehicle use in areas where these effects are a cause of decreased safety for non-motorized road users. One of the objectives of the traffic calming priority is to enhance the typical home environment by directly addressing the problems caused by vehicular traffic [5]. Pedestrian–vehicle collisions are commonly related with a lack of driver compliance, that drivers frequently fail to yield to a pedestrian, and that pedestrian safety at zebra crossings is mostly dependent on vehicle speed. As speed rises, the likelihood of a vehicle–pedestrian collision and a pedestrian fatality accident rises [7]. Therefore, it is crucial to study the effectiveness of raised crosswalks as one of the strategies to reduce the vehicles speed in Universiti Tun Hussein Onn Malaysia where there are high pedestrian activities involved.

Pedestrian safety and vehicle speed is correlated and affects one another. Higher vehicle speeds would increase the probability of road accidents to occur, and pedestrian safety is threatened too. According to the researchers, traffic calming measures are proven to reduce vehicle speed and increase pedestrian safety. However, the implementation of traffic calming measures such as, road humps, RCW's, raised intersections and textured pavements need lots of proven results, financial budget, and years maintenance. Comparisons between all the traffic calming measures show that raised crosswalks are budget friendly and easy to be installed. Overall, traffic calming measures are effective in reducing sped and improving both pedestrians' and road user's experience on the road. Besides that, speed management techniques such as speed limits, penalties for road bullies, speed zones, speeding cameras and law enforcement would also help to curb speeding issues as well as reduce the number of road accidents.

2. Materials and Methods

The methodology part, often known as the materials and methods section, explains all of the information required to produce the study's results.

2.1 Research question and solution

In this section, a several research questions were highlighted to achieve the research objectives. And solutions were provided based on the questions. The research questions and its solution will be very helpful for further studies to run the experiment as guidelines to complete the research. Table 1 are the summary of research questions and solutions.

Table 1: Question and solution related to the objective of this study

OBJECTIVES	QUESTION	SOLUTION
To evaluate the effectiveness of raised crosswalks towards the speed of the vehicles.	Will raise crosswalks reduce the speed of vehicles?	A systematic analysis was conducted to collect data on the positive and negative impacts of raised crosswalks.
To analyse the impacts of raised crosswalks on pedestrian safety.	Will raised crosswalks improve pedestrians' safety?	

2.2 Literature Search

Journals and articles for the systematic reviews are obtained from databases such as Scopus, Elsevier, ScienceDirect, PDX Scholar, Google Scholar and Research gate. For two years, the Scopus and Elsevier databases were meticulously constructed in collaboration with 21 academic institutions and over 300 researchers and librarians. The librarians' and researchers' verbal and behavioural input was regularly analysed and used to enhance the product, putting this database in the top tier. [8].

The process of collecting and analysing numerical data is known as quantitative research. It may be used to look for trends, calculate averages, predict, analyse causal linkages, and extrapolate results to a wider group. In both correlational and experimental research, statistics may be used to formally test hypotheses or predictions. Depending on the sampling approach used, the results may be generalised to a larger population. To discover and track a behaviour or occurrence of interest in its natural surroundings, a systematic observation strategy was adopted [9]. 21 studies were chosen to review in the sense of the title or the abstract of the report and when keywords such as "raised crosswalks", "vertical deflections", "elevated pedestrian crosswalks" and "high visibility crosswalks" were present.

After reviewing the studies, 11 studies were potentially identified suitable for the inclusion. The studies excluded from the study were based on several reasons; two studies did not include the effectiveness of raised crosswalks on the pedestrian safety and speed reduction of vehicles which are the objectives of this research, two other studies were based on the geometrical design of raised crosswalks and how the designs specifically influence the behaviour of road users which were not related to this research, two studies were merely about traffic calming measure where raised crosswalks were involved. However, there were no specific method carried out measuring the speed of vehicles or safety of pedestrians. These studies were more onto the advantages and disadvantages, two journals were excluded because it was about basic crosswalks with no elevations or raise which was totally irrelevant to this research, the last two journals were excluded because there no analytical data involved and merely a review study.

2.3 Inclusion Criteria

The inclusion criteria of this study include the period since the journals are published and maximum 10 years range is fixed. In order to provide a sufficient basis for evidence-based research, it is necessary to perform a comprehensive search that includes as many publications as possible that meet the inclusion and exclusion criteria. Inclusion criteria should be based on the study's objective and are necessary to achieve it. If the inclusion criteria are determined appropriately, the study's external and internal validity will be increased, its practicality will be improved, its costs will be lowered, and ethical issues will be minimized [10].

3. Results and Discussion

The materials collected were filtered by the inclusion and exclusion criteria as stated in Table 2. The table below listed out the material collected after the screening process. The materials are then categorized into three types according to the methods used to carry out the studies. The three types are defined as follows:

Type 1: The method used in the study was “before and after” study method.

Type 2: A systematic review study was conducted for data collection and analysis.

Type 3: Spot speed study is conducted to collect data in the study.

Table 2: Studies included for the research

Title	Author	Type
Changes in road-user behaviours following the installation of raised pedestrian crosswalks combined with preceding speed humps, on urban arterials.	Gitelman et al., 2017	3
Impact assessment of speed calming measures on road safety.	Jateikienė et al., (2016)	1
A Series of Vertical Deflections, a Promising Traffic Calming Measure: Analysis and Recommendations for Spacing	Acebo, et al., (2020)	3
Effects of traffic calming measures in different urban areas	Ordena et al., (2018)	3
The influence of the construction of raised pedestrian crossing on traffic conditions on urban segments.	Garunović et al., (2020)	3
Raised crosswalks efficacy on the lowering of vehicle speeds	Pratelli et al., (2011)	3
Safety Effectiveness of Pedestrian Crossing Enhancements	Christopher et al., (2017)	2
The Effectiveness of Selected Devices to Reduce the Speed of Vehicles on Pedestrian Crossings	Kruszyna & Pisarek (2021)	2
The Effect of Road Humps and Raised Crosswalks on Vehicles Speed	Mohd Roslan (2018)	3
Safety Effectiveness Evaluation of Raised Pedestrian Crossings in Ho Chi Minh City	Vuong (2021)	3
Effects of Traffic Calming Measures on Pedestrian and Motorist Behaviour	Huang & Cynecki (2012)	1

3.1 Discussions

Based on the studies above, no outlaying data or exceptions were found as all the studies recorded minimal at least 8% of speed reduction after the installation of raised crosswalks. The highest percentage of speed reduction recorded was 57.6%. Besides that, the crashes involving pedestrians has maximum improvement of 65% and minimum value of 38%. The analysis of data is presented in Table 3.

Table 3: Summary of results

Title	Methods	Results	Type	Conclusion
Impact assessment of speed calming measures on road safety.	Before and after study based on number of crashes involving pedestrians	65% of reduction in accidents. 83% of reduction in fatality and 68% of reduction of injured victims involving pedestrian crashes.	1	The analysis of fatal and injury accident data on road sections with RCWs revealed a considerable reduction in fatal and injury accidents after these measures were installed.
Effects of Traffic Calming Measures on Pedestrian and Motorist Behaviour	Before and after study based on: -Average pedestrian waiting time -Number of pedestrians using crosswalks -Motorists yield time for pedestrians	38% of increase in these three parameters.	1	More pedestrians are likely to cross within the crosswalk if junctions are raised and refuge islands are present. Thus, the safety of pedestrian is improved.
Safety Effectiveness of Pedestrian Crossing Enhancements	Systematic Review Study	52% of crashes before installation reduced to 48% after the installation	2	Construction of a raised pedestrian crosswalk at this spot had a positive effect on the pedestrian traffic conditions. This improvement is reflected in the reduction of pedestrian delays, and in an increase in the level of service offered to pedestrians.
The Effectiveness of Selected Devices to Reduce the Speed of Vehicles on Pedestrian Crossings	Systematic Review Study	14% of speed reduction according to the studies conducted in Ton Duc Thang Street. -43% of data showed positive impacts and rated	2	The reduction of speed has direct impact on the safety of pedestrians and in this case, it has positive effects.

		"good" for RCWs'.		
The influence of the construction of raised pedestrian crossing on traffic conditions on urban segments.	Spot speed study	Vehicle velocity was reduced by approximately 50 % after the rehabilitation.	3	Construction of a raised pedestrian crosswalk at this spot had a positive effect on the pedestrian traffic conditions.
A Series of Vertical Deflections, a Promising Traffic Calming Measure: Analysis and Recommendations for Spacing	Spot speed study	-Average speed ranges from 36.1 to 41.1 km/h -Conveys about 54.6% of speed reduction	3	Raised intersections provide safe crossings due to the speed reductions and provided a safer atmosphere for urban intersection.
Effects of traffic calming measures in different urban areas.	Spot speed study	-37.9% of speed reduction	3	Raised crosswalks act as a timely traffic calming technique, and they have been shown to have a favourable effect when placed near the city's edge.
Raised crosswalks efficacy on the lowering of vehicle speeds	Spot speed study	-8% of speed reduction	3	Raised crosswalks that are installed in a series have a higher efficacy than those that are installed individually.
The Effect of Road Humps and Raised Crosswalks on Vehicles Speed	Spot speed study Questionnaire survey	-49.7% of speed reduction -69% of female and 70% male students agreed that RCWs' are effective.	3	Drivers are more inclined to slow down when they approach steep RCWs' than they are when approaching moderate humps.
Changes in road-user behaviours following the installation of raised pedestrian crosswalks combined with preceding speed humps, on urban arterials.	Spot speed study	-50% of reduction to the west and 57.6% to the east routes were recorded.	3	Correlates with the pedestrian behaviours to use the RCWs' ensuring the safety of pedestrians.

3.2 Design Proposal

Design proposal is made for raised crosswalks installation in University Tun Hussein Onn Malaysia.Several locations with high pedestrian activity were chosen for this proposal. The locations chosen were: Along Jalan Tun Gaafar Baba where the 5 faculties are located, opposite the Kompleks Dewan Kuliah, near Dewan Peperiksaan (F2), connecting route between Arked and G3 and route connecting G2 and Kolej Kediaman Tun Dr Ismail. All the locations are labelled in the map and pictures are attached. A height of 75mm, width of 2000mm with a gradient of slope 1:20 is proposed. The length of the crosswalk would depend on the roads itself. The Austroads, 2016; Guide to Traffic Management Part 8: Local Area Traffic Management [11] and JKR (2018) Road Markings and Delineation. Arahan Teknik (Jalan) 2D/85: 1/39 was used to design the crosswalk [12].

Figure 1 and 2 below show the proposed raised crosswalk in University Tun Hussein Onn Malaysia. The locations are labelled in a map shown in Figure 3.

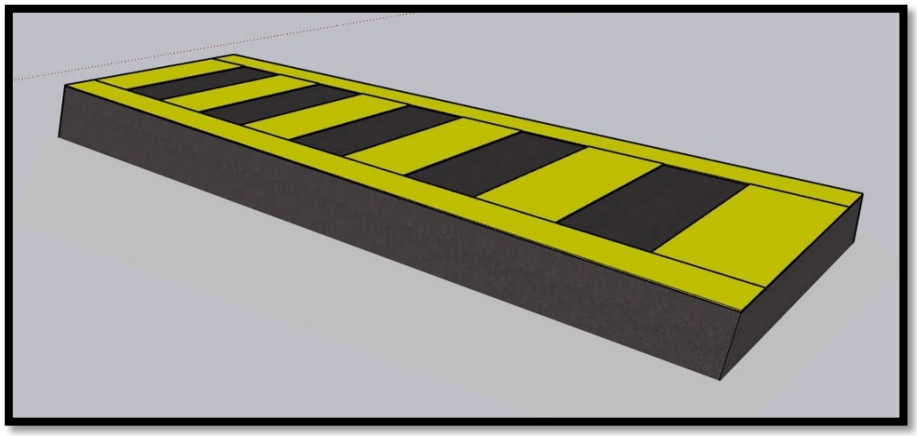

Figure 1: Dimension View of Crosswalk

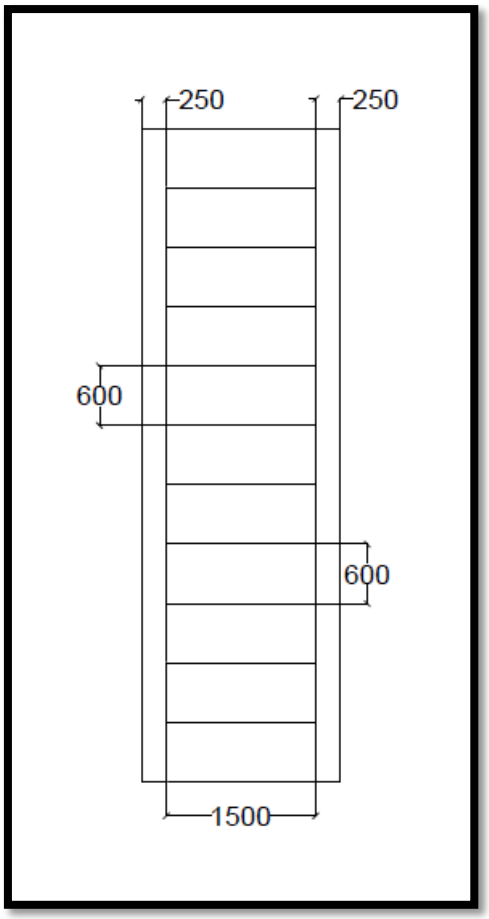

Figure 2: Top view of the crosswalk

Figure 3: The proposed locations (Google Earth. 2021)

4. Conclusion

In conclusion, raised crosswalks can be considered to reduce speed of vehicles and improve pedestrian safety. Based on the findings, it shows that vehicles slow down reaching raised crosswalks giving the pedestrian time to cross safely. The findings also show that the design of raised crosswalks also play a crucial role in speed reduction. The installation of raised crosswalks also help to improve the pedestrian safety because of the correlation of speed reduction and improvement of pedestrian safety. The highest percentage of speed reduction recorded was 57.6%. Besides that, the crashes involving pedestrians has maximum improvement of 65% and minimum value of 38%.

References

[1] Min, Ting Hui, & Che Ros Ismail (2016). Performance of Different Types of Road Humps in Universiti Teknologi Malaysia (Doctoral dissertation, Thesis. Universiti Teknologi Malaysia, Malaysia).

[2] Azwari, Nur Farhanatul Syasya Mohd & Abdul Azeez Kadar Hamsa. (2021). Evaluating Actual Speed against the Permissible Speed of Vehicles During Free-Flow Traffic Conditions. *Jurnal Kejuruteraan*, *33*(2), 183-191.

[3] Makhtar, Ahmad Khushairy, Mohd Sukri Ismail, & Mohd Nor Azmi Ab Patar (2012). A study on the effect of intelligent speed adaptation to bus drivers. Procedia engineering, 41, 1426-1431.

[4] Martin, Allison (2016). Factors influencing pedestrian safety: a literature review (No. PPR241). Wokingham, Berks: TRL.

[5] Pratelli, Antonio, R. Pratali, and M. Rossi (2011). Raised crosswalks efficacy on the lowering of vehicle speeds. WIT Transactions on the Built Environment, 116, 541-552.

[6] Roshandeh, Arash Moradkhani, Mahmood Mahmoodi Nesheli, & Othman Che Puan (2019). Evaluation of traffic characteristics: a case study. International Journal of Recent Trends in Engineering, 1(6), 62-68.

[7] Bella, Francesco & Manuel Silvestri. (2015). Effects of safety measures on driver's speed behaviour at pedestrian crossings. Accident Analysis & Prevention, 83, 111-124.

[8] Gopalakrishnan & Ganeshkumar. (2013). Systematic Reviews and Meta-analysis: Understanding the Best Evidence in Primary Healthcare, 9-14.

[9] Boland, Angela, Gemma Cherry & Rumona Dickson (2017). Doing a Systematic Review: A Student′s Guide (Second ed., Vol. 1). SAGE Publications Ltd.

[10] McLaren & Shaun J (2018). A Meta-Analysis: The Relationships Between Internal and External Measures of Training Load and Intensity in Team Sports, 48(3):641-658.

[11] AUSTROADS 2016. Guide to Traffic Management Part 8: Local Area Traffic Management

[12] JKR (2018) Road Markings and Delineation. Arahan Teknik (Jalan) 2D/85: 1/39