

A Brief Review: Variable for Determining the Design of Pedestrian Crossing Facilities

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Abstract

Pedestrian facilities play an important role in encouraging walking ability, which can help improve the quality of life of our citizens and livability in urban areas. Pedestrian safety needs to be an important concern because pedestrians are vulnerable to road users in traffic spaces. Variables in determining pedestrian crossing facilities have been defined in each country, but whether it can accommodate pedestrian safety needs. This study aims to inventory the variables used to determine pedestrian crossing facilities. The results obtained are that in addition to pedestrian traffic and vehicular traffic, it is necessary to consider the type of road, pedestrian speed, and speed of passing vehicles in determining recommendations for crossing facilities. In future research, it is necessary to include them in the equation to determine these recommendations.

Keywords: *Pedestrian Facilities; Pedestrian Safety; Pedestrian Speed; Road Type; Vehicle Speed*



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INTRODUCTION

Vehicle and pedestrian traffic flow dynamically. The need for facilities to accommodate traffic users to ensure smoothness and safety should also follow the existing growth. The basis for determining crossing facilities for pedestrians in urban areas in Indonesia currently still uses the base of the DPU of the Directorate General of Highways, published in 1995 (Tanan, 2011). Where the determining factor is the flow of pedestrian crossing traffic and the flow of two-way vehicle traffic, the basis for determining the condition of pedestrian and vehicle traffic in 1995 may even be before that year which must have changed dramatically with current traffic conditions, so it is necessary to the value of these indicators is reviewed and are their other indicators to create good and safe traffic for both pedestrians and motorized vehicle users. Pedestrians are the most vulnerable road users in traffic spaces, which must share spaces with different characteristics. The availability and quality of pedestrian facilities services not only impact the smooth running of pedestrian activities but can also trigger accidents (Costa and Demon, 2018). Pedestrian accidents are 30% of the number of accidents in Salatiga, 24% of the accidents in Salatiga, and 19% of the accidents in Tegal (Tjahjono *et al.*, 2021). Pedestrian crossings are critical locations in urban transportation networks, so they need to be careful because pedestrians are directly dealing with motorized vehicle traffic or are in mixed traffic (Ahmed *et al.*, 2021). Fatality in pedestrian accidents is not a random event. The factors that cause this include the number of lanes on the road, speed limits, high traffic volume, and land use (Schneider *et al.*, 2021). The criteria for determining the PV^2 pedestrian crossing facilities fail to identify the type of pedestrian crossing facilities that must be provided under certain conditions according to the type of road in Indonesia (Yulianto and Sugiyarto, 2019). This study aims to describe pedestrian crossing facilities and identify variables

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related to the determination of pedestrian crossing facilities. Thus, it can inspire researchers in determining technical analysis methods for determining pedestrian crossing facilities.

LITERATURE REVIEW

Pedestrian Safety

The main risk for pedestrians is the problem associated with various factors, including driver behavior, especially those related to driving speed, pedestrian infrastructures such as sidewalks, markings, crossings, and elevated medians (Ahmed *et al.*, 2021; Chaudhari *et al.*, 2021). Factors that affect the safety and comfort of pedestrian facilities are conflicts on pedestrian paths, security from crime, the safety of pedestrians, the behavior of motorists towards pedestrians, maintenance and cleanliness, and availability of crossing infrastructure (Erlangga Dwiki; Handayani Dewi; Syafi'i, 2020).

Criteria/Variables for Determining Pedestrian Crossing Facilities

Criteria for determining crossing facilities in Indonesia based on the DPU of the Directorate General of Highways, namely the pedestrian traffic area (P) crossing a length of 100 meters expressed in people/hour and two-way vehicle traffic flow (V) expressed in vehicles/hour (Tanan, 2011).

Table 1. The basis for Determining Crossing Facilities in Indonesia if the value of PV² is more than 108

PV ²	P	V (vehicles/hour)	Recommendation
10 ⁸	50-1100 (person/hour)	300-500 (vehicle/hour)	Zebra cross or pedestrian platform
	>1100 (person/hour)	>500 (vehicles/ hours)	Pelicans
	>1100 (person/hour)	>300 (vehicles/hour)	Pelicans

Table 2. The basis for Determining Crossing Facilities in Indonesia if the value of PV² is more than 2 x 108

PV ²	P	V (vehicles/hour)	Recommendation
>2x10 ⁸	50- 1100 (person/hour)	400-750 (vehicle/hour)	Zebra cross with waiting booth
	>1100 (person/hour)	>750 (vehicle/hour)	Pelican with waiting booth
	>1100 (person/hour)	>400 (vehicle/hour)	Pelican with waiting booth

Recent studies related to the provision of pedestrian crossing facilities in India carried out by Jain and Rastogi (2017) stated that the provision of crossing facilities is the result of PV² where P is the peak hour pedestrian flow, and V is the vehicle flow at peak hours in both directions with conditions such as in Table 3.

Table 3. Chart of determining pedestrian crossing facilities in India

Road Type	No facilities	Zebra Crossing	Pedestrian Signal	Class Separate
2 way, 2 lanes	PV ² : <4.2x 10 ⁸	PV ² : 4.2 x 10 ⁸ - 3.0 x 10 ⁹	PV ² : 3.0 x 10 ⁹ - 2.1 x 10 ¹⁰	PV ² : >2.1 x 10 ¹⁰
2 way, 3 lanes	PV ² :< 8.5x 10 ⁸	PV ² : 8.5 x 10 ⁸ -6.5 x 10 ⁹	PV ² : 6.5 x 10 ⁹ - 4.9 x 10 ¹⁰	PV ² : >4.9 x 10 ¹⁰

Road Type	No facilities	Zebra Crossing	Pedestrian Signal	Class Separate
2 way, 4 lanes	PV ² : < 2.5x 10 ⁹	PV ² : 2.5 x 10 ⁹ - 2.05x 10 ¹⁰	PV ² : 2,05 x 10 ¹⁰ - 1,6 x 10 ¹¹	PV ² : > 1,6 x 10 ¹¹
2 way, 6 lanes	PV ² : < 5,6x 10 ⁹	PV ² : 5,6 x 10 ⁹ - 4,8x 10 ¹⁰	PV ² : 4.8x 10 ¹⁰ - 4.1x 10 ¹¹	PV ² : > 4.1x 10 ¹¹

Draft recommendations for installing marked crossings and pedestrian repairs in uncontrolled locations in Texas based on research from Turner and Carlson (2000). The criteria are annual average daily traffic, speed limits, and road type. In daily traffic, the average annual vehicle traffic is 9000 at a speed limit of 30 mph and 35 mph on road types 2 lanes, 3 lanes, Multi-lanes (4 or more lanes) with a raised median, Multi-lane (4 or more lanes) without The raised median needs to provide crossing facilities. In comparison, at a speed of 35 mph on Multi-lane (4 or more lanes) roads without a raised median, it is not only necessary to provide crossing facilities but also to add tools to be able to monitor the possible risk of pedestrian accidents closely.

At an average daily traffic of 9000 vehicles at a speed limit of 40 mph on 2 lanes, 3 lanes, and Multi-lane (4 or more lanes) with raised median crossing facilities are needed with added tools to be able to monitor possible risks closely. Pedestrian accidents, while for the Multi-lane (4 or more lanes) without a raised median, traffic signals with pedestrian signals are used to increase the safety of pedestrian crossings.

On average daily traffic of 9000 to 12,000 vehicles at a speed of 30 mph on 2 lanes, 3 lanes, and Multi-lane (4 or more lanes) with raised median and Multi-lane (4 or more lanes) without raised median facility that must be provided provide crossing facilities. At a speed of 35 mph on 2 lanes crossing facilities are provided. At a speed of 40 mph on 2 lanes and 3 lanes roads, crossing facilities are provided with added tools to monitor the possible risk of pedestrian accidents closely. Meanwhile, facilities must be provided for the type of road, Multi-lane (4 or more lanes) with raised median and Multi-lane (4 or more lanes) without raised median. Traffic signals with pedestrian signals to improve the safety of pedestrian crossings.

RESEARCH METHOD

This paper uses a literature synthesis method based on the principle of narrative literature review to review studies. This method begins by entering a list of keywords appropriate to the topic studied, searching the literature database, reviewing articles, and making synthesis results (Green, BN; Johnson, 2006). The contextual factors found in this study are divided into the following categories: factors related to pedestrian safety at crossing facilities and variables or criteria in determining recommendations for pedestrian crossing facilities. The results of the review will be discussed in the next section.

FINDINGS AND DISCUSSION

The criteria for determining crossing facilities in Indonesia, namely the city of Surakarta, is too excessive because it fails to identify the type of pedestrian crossing facilities, which must be provided under certain conditions, such as roads that are not suitable if following these recommendations, so it is necessary to consider traffic conditions in the area. Indonesia and types of roads (Yulianto and Sugiyarto, 2019). Various literature related to variables must be considered in determining crossing facilities. Variables in determining crossing facilities for pedestrians can be seen in Table 4.

Table 4. Variables in determining pedestrian crossing facilities in various countries

Country	literature	Indicators for determining pedestrian crossing facilities	Description
Indonesia	(Ministry of Public Works and Public Housing, 2018); (Tanan, 2011)	Pedestrian crossing vehicular traffic,	traffic flow, two-way
Texas	(Turner and Carlson, 2000)	Annual vehicular traffic volume, speed limit,	
Indian	(Jain and Rastogi, 2017)	flow pedestrians, two-way vehicular traffic flow, road type.	

Often the lack of adequate facilities or poor maintenance increases the risk of pedestrian-vehicle conflicts, which seriously threaten pedestrian safety and overall road safety (Mukherjee and Saha, 2022). In addition to the variables described in Table 4, other researchers describe several variables in determining the design of crossing facilities. Pedestrian basic diagrams, which illustrate the relationship between speed, flow, and density, are one of the key concepts for pedestrian facility design (Bosina, 2018). Vehicle speed is a variable taken into account in providing safe and comfortable pedestrian facilities (Schneider et al., 2021). Each pedestrian facility has a relationship related to space speed, flow rate, and pedestrian density (Bargegol et al., 2022). Variables that affect pedestrian accidents at crossing facilities are the location of the collision, the type of vehicle, the pedestrian's age, the road hierarchy, and ownership of a driving license (Tjahjono et al., 2021). A systemic approach to improving pedestrian safety is to identify the function of the existing road network (Schneider et al., 2021).

CONCLUSION

Based on several previous studies, the variables to determine recommendations for pedestrian crossing facilities are not only based on pedestrian traffic and vehicle traffic but also need to consider the type of road, pedestrian speed, and speed of passing vehicles to create facilities that can accommodate interests of pedestrians and the interests of other road users, as well as creating road safety.

LIMITATION & FURTHER RESEARCH

For future research, it is necessary to determine how these variables are related in determining recommendations for pedestrian crossing facilities.

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