Analysis of pedestrian crossing needs in the transmart shopping center area in Padang City

B B Irawan, R A Fitrah and D I S Rahmadani

Civil Engineering Department, Dharma Andalas University. Sawahan Street. No. 103 A, Padang, West Sumatra, Indonesia.

Corresponding author : bay.irawan@unidha.ac.id

Abstract. Pedestrians are an important form of transportation in urban areas. The unavailability of pedestrian facilities will have an impact on the risk of traffic accidents and traffic delays. The Khattab Sulaiman road section in the city of Padang has land uses such as settlements, offices, hotels, trade and services. These conditions affect traffic conditions, especially for pedestrians. The purpose of this study is to calculate the potential number of pedestrians in the Transmart area and the selection of locations and types of pedestrian facilities. Pedestrian facility planning uses the Pedestrian Facility Technical Planning Guide (Pd 03 - 2017 - B: 02 / SE / M / 2018: February 26, 2018). The pedestrian crossing survey results on the Khattab Sulaiman road on Saturday and Sunday (30-31 March 2019 at 14.00-18.00 WIB) obtained pedestrians who crossed an average of 278.25 people / hour. The recommended crossing facility is the People Crossing Bridge (JPO). The recommended pedestrian crossing bridge location is Point B with weight value 2.45 and coordinates 0° 54'44", 100° 21'27").

1. Introduction

Pedestrians are an important form of transportation in urban areas, many pedestrians crossing not using zebra crossing will have an impact on problems such as accidents, traffic delays. Other problems arise due to side constraints caused by the development of land use so that it influences the movement resulting in the pull of trips to a road section.

The value of V / C ratio at the Trans Mart Front point north to south on a holiday has changed from 0.71 to 0.49 and on weekdays from 0.59 to 0.41[1]. Whereas the south direction towards the north value of V / C ratio on holidays from 0.69 to 0.48 and on working days from 0.50 to 0.34. The widening of the Khattab Sulaiman road section in general is able to increase the level of performance of road services from category C to B. Although the road segment has been widened, the risk of accidents to road users, especially pedestrians, is still very high.

Based on observations, there are road users who park illegally or public transport users cross the road to Trans Mart and vice versa by not using zebra crossing. The behavior of road users who do not use road crossing facilities is a factor causing accidents. This is indicated by the existence of an accident between a road user namely a motorcycle with a motorcycle and the victim died as a result of a violation in which the motorcycle user is fighting the traffic flow [2].

The human error factor and the condition of road infrastructure together influence the occurrence of accidents at the Cipali toll road[3]. Cipali Toll Road has already had very good technical feasibility according to the shape and construction of the road, straight road contours, there are no steep bends or...
steep slopes. The causes of human error factors such as concentration and health also affect the risk of accidents. Another problem is related to the management of road infrastructure, such as: vehicle traffic accidents due to road safety infrastructure deficiencies. The design of the road network includes geometric details, pavement structures, and harmonization of road equipment facilities. If the design results are not implemented properly it will reduce the road safety aspects.

2. Literature review

Pedestrians are people who do walking activities and are one of the elements of road users, pedestrians are important transportation in urban areas. To protect pedestrians in pedestrian traffic, walk on sections of the road and cross at crossings provided for pedestrians. Pedestrians must walk on the part of the road that is intended for pedestrians, or on the pedestrian section, or on the leftmost part of the road if no part of the road is intended for pedestrians [4]. General characteristics of pedestrians include:

1. Pedestrian volume (v, pedestrian / minute / meter)
2. Crossing speed (S, meter / minute)
3. Density (D, pedestrian / square meter)

2.1. Pedestrian facilities

According to [5] in planning facilities for pedestrians including crossing facilities must pay attention to seven main targets, namely: safety, security, convenience, continuity, comfort, system integration (system coherence), and attractiveness. The seven factors are inter-related and overlapping. [6] classifies road crossing facilities into two types namely:

1. At-grade crossing.
   a. Zebra Crossing.
   b. Pelican crossing.
   c. Pedestrian Platform.
2. Segregated crossing.
   a. Pedestrian Bridge.
   b. Tunnel.

2.2. Criteria of segregating crossing

To get the segregate crossing criteria the determination of crossing facilities refers to the Pedestrian Facility Technical Planning Guidelines [7] with the criteria for segregate crossing selection in the following conditions:

1. The facility at grade crossing has disrupted the existing traffic flow.
2. The frequency of accidents involving pedestrians is quite high.
3. On road sections with a planned speed of 70 km / hour.
4. In strategic areas, but it is not possible for road waders to cross the road other than segregate crossing.

Some provisions that must be considered in planning segregate crossing facilities:

1. Segregate Crossing must be easily accessible to people with disabilities, for example by adding ram (flattening) or by elevators.
2. The crossing facilities must be equipped with good lighting that can increase safety for pedestrians.
3. The location and building must pay attention to the aesthetic value and pedestrian needs.

2.3. Criteria for selecting pedestrian crossing facilities

1. Based on the empirical formula \((PV^2)\), where \(P\) is the flow of pedestrians who cross the road along 100 meters per hour (pedestrians / hour) and \(V\) is the flow of vehicles every hour in two directions (pcu / hour).
2. \(P\) and \(V\) are the average flow of pedestrians and vehicles during peak hours, with the initial recommendations as shown in Table 1 below.
Table 1. Criteria for determining segregate crossing facilities

| P (Pedestrians/Hour) | V (PCU/Hour) | PV² | Recommendation |
|---------------------|--------------|-----|----------------|
| > 1.100             | >750         | >2x10^8 | Segregate Crossing |

Source: Guidelines for Technical Planning on Pedestrian Facilities.

2.4. Factors affecting the use of segregate crossing
According to [6] in [8] factors that influence the use of segregate crossing facilities, sorted by the most important according to pedestrians are:
1. Distance.
2. Ease.
3. Aesthetic.
4. Environmental considerations.
5. Safety.

Cleanliness is a major factor influencing the effectiveness of JPO use [9]. According to [10], factors that influence the use of crossing bridges are safety (35.7%), comfort (29.5%), habits (18.2%) and travel time (16.6%). While technical criteria include: Bridge Width (33%), Security Posts (28%), Stair Width (20%), and Guardrail (19%).

2.5. Pedestrian crossing bridge
Pedestrian Bridge Crossing is a construction building that is located across the highway intended for pedestrian traffic that serves to provide services for the sake of smoothness, security and comfort, and safety for pedestrians who cross the road. Provisions applicable in the technical planning of pedestrian facilities according to the Guidelines for Building Construction Materials and Civil Engineering [7] are as follows:
1. Technical provisions for crossing bridge construction follow No. 027 / T / Bt / 1995 concerning Procedures for planning pedestrian bridges in urban areas.
2. Pedestrian crossing bridge is a bridge building intended to cross from one side of the road to the other side of the road.
3. Pedestrian crossing bridges must be built with construction that is strong and easy to maintain.
4. The pedestrian crossing bridge has a minimum width of 2 (two) meters and a maximum ladder slope of 20°.
5. If the pedestrian bridge is also intended for bicycles, then the minimum width is 2.75 m.
6. Pedestrian crossing bridges must be equipped with adequate fences.
7. Location and building of pedestrian crossing bridges must be in accordance with pedestrian and aesthetic needs.
8. Placement of the bridge must not reduce the effective width of the sidewalk.

A Study on the Selection of Types of Pedestrian Crossing Facilities on Jl. Emmi Saelan Depan Tatura Mall, Palu City [11]. The recommended type of crossing facility is pedestrian overpass bridge. This shows the characteristics of the location in accordance with the condition of the location of the Khatib Sulaiman road section, especially in front of the Padang City Trans Mart.
3. Methodology

Table 2. Weighing Criteria for determining location of Pedestrian Crossing Bridge

| No | Reference                          | Category                                |
|----|------------------------------------|-----------------------------------------|
| A  | Departemen PU (1995)               | 1                                        |
|    | When the zebra cross and pelikan  | Existing facilities are often not used  |
|    | cross disturbing the traffic       | Facilities with the needs of road users | Existing facilities do not suit the needs of pedestrians |
|    |                                    | Road users who obey and understand the  |
|    |                                    | use of facilities                        | Traffic volume that tends to fluctuate                      |
|    |                                    |                                         | There are no supporting facilities that guarantee pedestrian safety |
|    | On road sections can result in     | Road users who obey and understand the  |
|    | the frequency of accidents         | use of facilities                        | Traffic volume that tends to fluctuate                       |
|    | involving increased pedestrian     |                                         | The average speed of traffic is <60 km / hour               |
|    | volumes.                           |                                         |                                                          |
|    | On roads that have high pedestrian | Road users who obey and understand the  |
|    | currents and high-speed vehicle     | use of facilities                        | Traffic volume that tends to fluctuate                       |
|    | flows.                             |                                         |                                                            |
|    |                                    |                                         |                                                            |
| B  | O'Flaherty (1997)                  | 1                                        |
|    | Distance (Pedestrian willingness   | Difficult access for pedestrians to the |
|    | chooses the route to be passed)    | destination                              | Easy access for pedestrians to the destination             |
|    |                                    |                                         | Very Easy access for pedestrians to the destination        |
|    | Ease, (Facilities that can support | The route that results in humans having  |
|    | efforts for pedestrians to cross   | the risk of accidents                    |                                                            |
|    | the road)                          |                                         |                                                            |
|    |                                    | The route is sometimes difficult to pass |
|    |                                    | because of intense human activity         |                                                            |
|    |                                    | The route is easy to reach and is not    |
|    |                                    | obstructed by anything                    |                                                            |
|    | Aesthetic (Existing facilities,    | The need for renewal of old facilities   |                                                            |
|    | have complemented the needs for    | Lighting that is often broken / lost     | Design the facility in accordance with community needs     |
|    | pedestrians)                       | at the facility                           |                                                            |
|    | Environmental Consideration        | Road users do not think about the        |                                                            |
|    |                                    | surrounding conditions                   |                                                            |
|    | Safety                             | Pedestrians rarely use existing facilities|                                                            |
|    |                                    | Traffic lanes that are often used for    |
|    |                                    | pedestrians to walk                      |                                                            |
|    |                                    | Pedestrian space is separate from the    |
|    |                                    | vehicle traffic lane and has a different height |                          |

The method used in this study can be described as follows:

1. Data Collection
   Data collection consist of primary data and secondary data, with the following details:
   - Primary Data: Pedestrian Volume and Geometric paths
     Data on the number of pedestrians is obtained through a direct enumeration survey of pedestrians crossing in front of the trans mart. Road geometric data is obtained by measurements in the field.
   - Secondary data: Traffic Volume
     Traffic volume data is used data from research conducted by [1].

2. Analysis:
   The analysis conducted in this study includes:
   - Pedestrian Volume Calculation
This analysis aims to calculate the potential number of pedestrians during peak hours that will use pedestrian facilities and as a consideration in the calculation and determination of the type of facility to be used.

- **Calculation of Empirical Formulas (PV²)**
  This formula is the multiplication of the number of pedestrians with past volumes.

- **Analysis Location of the Crossing Facilities**
  This analysis aims to provide an assessment of the location of the facilities for crossing people. The parameters used in determining this location are based on [6,12]. Based on these parameters, translation and weighting are carried out according to each parameter of the available alternative locations.

4. **Result**

4.1. **Calculation of traffic volume**
Research on the Khatib Sulaiman Road section was carried out by [1] on Analysis of the Impact of Road Widening on the Performance of the Khatib Sulaiman Road in Padang City. The results of the traffic volume survey are presented in Table 3 below.

| Direction      | Day     | Peak Hour       | Traffic Volume |
|----------------|---------|-----------------|----------------|
| (North-South)  | Weekend | 19:45-20:45     | 1759           |
|                | Weekday | 16:45-17:45     | 1463           |
| (South-North)  | Weekend | 14:15-15:15     | 1705           |
|                | Weekday | 13:30-14:30     | 1229           |

4.2. **Calculation of pedestrian volume**
The volume of pedestrians is obtained through pedestrian surveys that cross the Khatib Sulaiman road precisely in front of Transmart Padang. A pedestrian survey from West to East on holidays with peak hours of 19:45 to 20:45 is 415 pedestrian/hour. The recapitulation of the survey results on weekdays and holidays at the Front Transmart location is presented in Table 4 below.

| Direction      | Day     | Peak Hour       | Volume of Pedestrians |
|----------------|---------|-----------------|-----------------------|
| (West-East)    | Weekend | 19:45-20:45     | 415                   |
|                | Weekdays| 16:45-17:45     | 236                   |
| (East-West)    | Weekend | 14:15-15:15     | 325                   |
|                | Weekdays| 13:30-14:30     | 137                   |

4.3. **Calculating empirical formula**
The calculation of the empirical formula (PV²) is obtained from the P value is the pedestrian current that crosses a road segment along 100 meters per hour (pedestrian/hour) and the value of V is the vehicle flow every hour in two directions (pcu/hour). In general, the value of PV² obtained exceeds that required is equal to $> 2 \times 10^8$. The calculation results are presented in Table 5 below.
### Tabel 5. Calculating value of PV²

| Pedestrian Volume (Pedestrian/Hour) | Traffic Volume (PCU/Hour) | PV²     |
|------------------------------------|---------------------------|---------|
| P 415                              | V 1759                    | 1.28 x 10⁹ |
| 236                                | 1463                      | 5.05 x 10⁸ |
| 325                                | 1705                      | 9.44 x 10⁸ |
| 137                                | 1229                      | 2.06 x 10⁸ |

### 4.4. Analysis of pedestrian crossing bridge placement

![Figure 1. Location Pedestrian Crossing in Khatib Sulaiman Street in Front of Trans Mart](image)

#### Tabel 6. Analysis of determining the location of the Pedestrian Crossing Bridge with the Weighting Method

| No | Reference                      | Percentage Weight | Location A | Location B | Location C |
|----|--------------------------------|-------------------|------------|------------|------------|
|    |                                |                   | Scale      | Point      | Scale      | Point      |
| A  | Departement of Public Works (1995) |                  | 15%        | 3.0.45     | 2.0.3      | 3.0.45     |
| 1  | When the zebra cross and pelikan cross disturbing the traffic | 15%        | 3.0.45     | 2.0.3      | 3.0.45     |
| 2  | On road sections can result in the frequency of accidents involving increased pedestrian volumes. | 20%        | 3.0.6      | 3.0.6      | 3.0.6      |
| B  | O’Flaherty (1997)              |                  | 10%        | 2.0.2      | 3.0.3      | 2.0.2      |
| 1  | Distance                       | 10%               | 2.0.2      | 3.0.3      | 2.0.2      |
| 2  | Ease                           | 10%               | 1.0.1      | 3.0.3      | 2.0.2      |
| 3  | Aesthetic                      | 10%               | 1.0.1      | 1.0.1      | 3.0.3      |
| 4  | Environmental Consideration    | 10%               | 3.0.3      | 2.0.2      | 1.0.1      |
| 5  | Safety                         | 10%               | 2.0.2      | 2.0.2      | 2.0.2      |
|    | TOTAL                          |                   | 2.30       | 2.45       | 2.35       |

Analysis of Pedestrian Crossing Bridge location placement is determined based on guidelines issued by [6,12] of the 3 locations as follows:

1. Location A is located at the entrance of Transmart, where the existing crossing facilities such as zebra crossing are not available.
2. Location B is in the middle in front of the Transmart where existing zebra crossings are available.
3. Location C is at the Transmart exit where there are no crossing facilities available, such as zebra crossing.

Based on the parameters, the location determination analysis is done using the weighting method. The weighting analysis results obtained the recommended pedestrian bridge crossing location at location B (coordinates 0° 54 '44", 100° 21 '27" E). The weight of location B is 2.45.

The weighting analysis is presented in Table 6 and the location of the Pedestrian Crossing Bridge facility planning can be seen in Figure 1.

5. Conclusion

Based on the analysis of the calculations, the conclusions are:
1. The potential for pedestrian volume in the Transmart area that crosses is 278.25 (people / hour).
2. The recommended crossing facility is the People Crossing Bridge.
3. The Pedestrian Bridge Crossing location is recommended at location B with weight value 2.45 and coordinates 0°54'44", 100° 21'27"E.

6. Reference

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