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ASSESSING PEDESTRIAN FACILITIES ON CROSSING BRIDGES

Rian Wulan Desriani and Inge Komardjaja
Research Center for Human Settlements, Bandung, Indonesia
rianwulan@gmail.com
inge@bdg.centrin.net.id

ABSTRACT : In 2003, seven pedestrians were killed and 41 pedestrians injured in collisions with motor vehicles when pedestrians crossed the roads in Bandung City. In order to reduce such casualties, there are some alternative road crossings, such as the pelicans, zebra crossings, toucan crossings and pedestrian bridges. From these alternatives, big cities in Indonesia tend to construct pedestrian bridges because of the tax that is obtained from the billboards that hang on both sides of these bridges. The planning of these bridges was based only on the number of vehicles that pass the road from both directions, and the number of pedestrians who cross the road. This study identifies location factors of the existing pedestrian bridges in Bandung City. The field study is done by collecting data from different attributes and compare them with the use rate of each bridge. The analysis of the data focuses on the characteristics of activities, pedestrians, and roads .The purpose of the study is to inform planners and designers about the location factors to increase the use rate. In reality, the average use rate of the sixteen pedestrian bridges in Bandung City is low (25,22%). Many pedestrians continue to cross the roads at-grade by risking their lives, rather than having to walk the extra distance to the bridge, which they perceived as a waste of time and energy. In the planning of pedestrian crossing bridges other factors have to be considered, apart from the traffic volume and the number of pedestrians. In the layout design, the accessibility to the bridges have to be heeded. But, it is strongly suggested that constructing pedestrian bridges will be the last choice of crossing the roads.

Keywords : pedestrian bridges, crossing roads, pedestrians, use rate

1.0 INTRODUCTION

The Bandung Metropolitan Area (BMA) has an estimated population of over 6.5 millions which is predicted to increase to almost 12 million by the year 2030 or 77% of the estimated maximum population of 15 million. The avaliable land is sufficient to accommodate a population of around 15 million with a normal density. The proportion of the population in the inner area of Bandung is estimated to decrease slightly from 80% in 1995 to 79% by 2030. The rate of growth is expected to increase as the economy flourishes and infrastructure becomes more developed. (Ofyar, 2005)

As a service city, Bandung has rapidly developed infrastructures and building areas to serve a large number of people who travel to densed centers of attraction. Centers of attraction in Bandung are the industrial areas, universities and research institutes, historical monuments, public facilities, and shopping centers. But the expansion of the attractions develops in a linear form along the road. Most activities of Bandung is centered on thoroughfares and major roads which cause difficulties for people to cross the road.

With heavy traffic flows on major roads, crossing the roads is a serious problem. Pedestrians have to thread their way through the moving vehicles, which may lead to traffic accidents. In Bandung, crossing the roads has been a nightmare because in 2003, seven pedestrians were killed and 41 pedestrians injured in collisions with motor vehicles when they were crossing the roads. In congested areas, such as shopping centers, people cross the road in a large numbers and at a wide range of roads as wide as the densed areas causing excessive delays in the traffic.

Against the above explanation, the government has provided crossing facilities as amenities to give access and easier mobility to pedestrians and motor vehicles. There are some alternative road crossings, such as the pelicans, zebra crossings, toucan crossings and pedestrian bridges.

In many places the existing pedestrian bridges are inadequate because of the low use rate. Many pedestrians keep crossing the roads and ignore the existence of pedestrian bridges. The analysis on ten pedestrian bridges in 2004, pointed out that the unnecessary additional of time and energy due to the inappropriate location of a bridge was the main reason, pedestrians did not use the bridge. Another reason was the safety of a bridge. Many beggars and idle people sat on the bridge, and the billboards that covered the two sides of the bridge block the lighting to enter. (Rian, 2004)

Even so, pedestrian bridges are still being constructed in dense areas. One of the reasons is because of the tax that is obtained from the billboards that hang on both sides of these bridges. Now in 2008, Bandung officials have constructed more pedestrian bridges in shopping area. The total number of pedestrian bridges is now sixteen.

Accordingly, this study focuses on how to asses pedestrian bridges by analyzing the right location and the layout of pedestrian bridges. The purpose of this study is to inform planners and designers about the proposed site and dimensional layout of a pedestrian bridge to increase the use rate.

2. METHODOLOGY

The provision of crossing facilities in Indonesia is now regulated by the Director General Land Transportation. According to the standard, the method to identify the crossing facilities is the PV^2.

P = the number of pedestrians who cross the road with a length of 100 meter every hour

V = the number of vehicles that pass the road from both directions every hour.

PV^2 is the degree of conflict between pedestrians and vehicles of a road length of 100 meter. The higher PV^2 the more pedestrians are on the road causing traffic jam or even casualties. There are some levels of crossing facilities to separate pedestrians from zebra cross to pedestrian bridges.

Table 1. Crossing Facilities

PV^2	P (ped/hour)	V (vec/hour)	Crossing facilities
$> 10^8$	50-1100	300-500	Zebra Cross
$> 2x10^8$	50-1100	400-750	Zebra Cross with ped refuges
$> 10^8$	50-1100	>500	Pelican
$> 10^8$	>1100	>500	Pelican
$> 2x10^8$	50-1100	>700	Pelican with ped refuges
$> 2x10^8$	>1100	>400	Pelican with ped refuges
$> 2x10^8$	>1100	> 750	Or Speed > 70 km/hour; pedestrian bridges

(Source : Directorate General of Land Transportation, 1997)

Every city in Indonesia uses this standard to asses crossing facilities. But it seems that this standard is not enough to facilitate pedestrians with crossing at grade to pedestrian bridges.

A model for assessing pedestrian bridges was developed based on location factors that influence the use rate of pedestrian bridges. The location factors are land use, types of activities, types of pedestrians, sidewalk, pathway, barriers and time to cross. Location of pedestrian bridges is the first to consider whether or not to use pedestrian bridges, apart from the dimensional design such as material, structure and appearance of pedestrian bridges. The use rate was calculated by the number of pedestrian using the bridge compared with the total number of crossing pedestrian. The use rate counting took place at 16 pedestrian bridges in Bandung City in every peak time. Usually, there are three peak times: morning, noon and evening.

After counting and observing, the compiled data are analyzed with an emphasis on the relation between location factors and the use rate. This analysis provides additional considerations on assessing pedestrian crossing process and the right proposed site of pedestrian bridges.

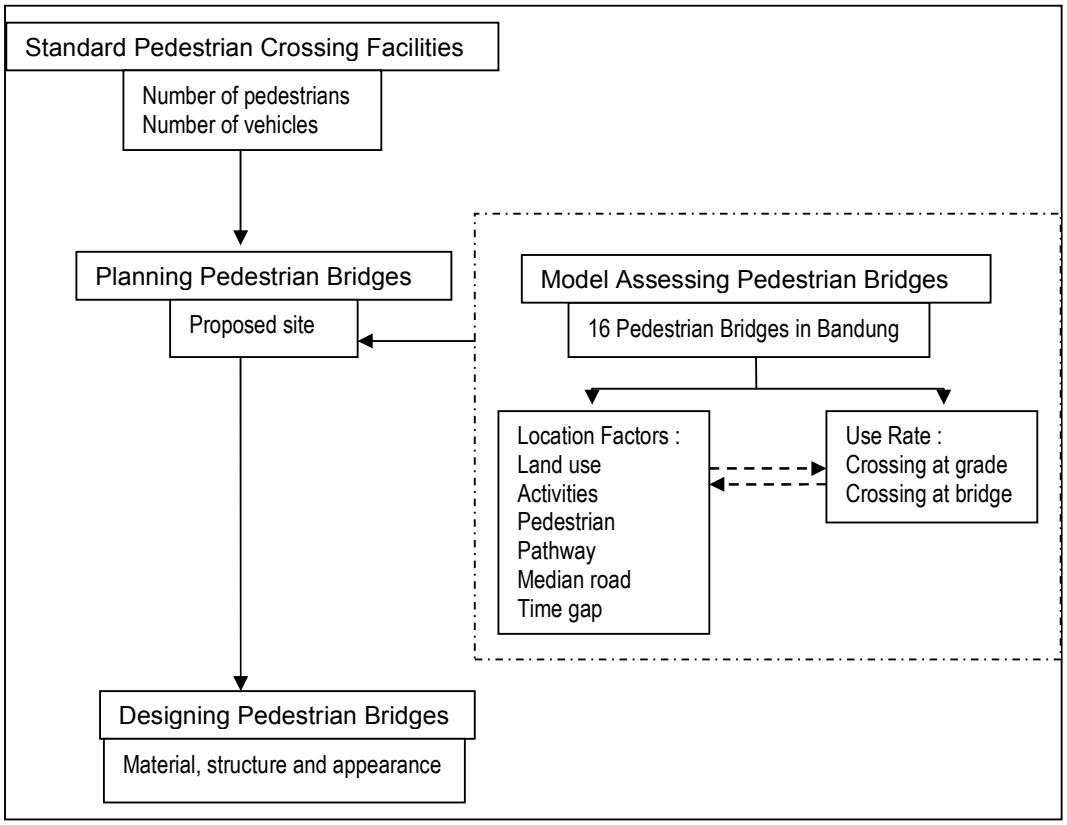


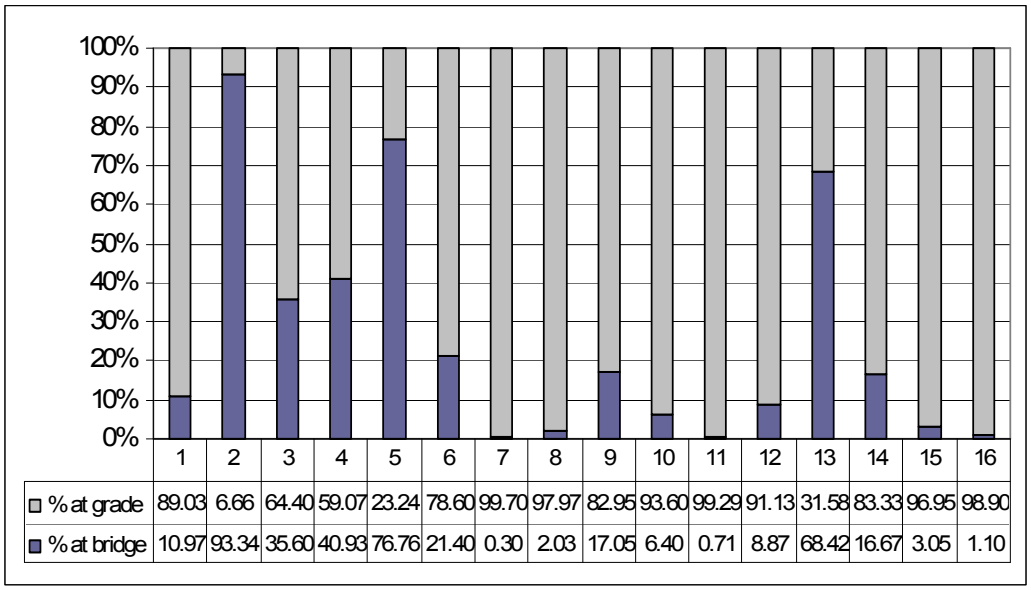
Figure 1. Pedestrian Bridges Approaches

2.1 Comparison Between Standard and Use Rate

By using the formula of PV^2, all pedestrian bridges in Bandung meet the requirements, even if the number of pedestrians is less than the standard. This happens because the average traffic volume of the road where the bridge is located, is 3.676 vehicles per hour. The average number of people who cross the road near the bridge is 641 pedestrians per hour, while the requirement is 1.100 pedestrians per hour. The standard of construction of a pedestrian bridge with a traffic speed of >70 km per hour does not apply to the roads of alll pedestrian bridges in Bandung. The average speed is 23,8 km per hour. This traffic condition is caused by the high number of private vehicles in Bandung which is not compatible with the number of roads and the width of roads.

The construction of pedestrian bridges meets the standard due to the high number of vehicles, but based on the calculation of the use rate, only three from sixteen pedestrian bridges which have use rate over 50%. The purpose of pedestrian bridges to move pedestrian crossing at grade to bridges is therefore not achieved. The lowest use rate is at Merdeka Bridge, which is a shopping

area. The three highest use rates are in different characteristic area. This points out that we need to add other factors in assessing pedestrian bridges in a way to increase the use rate.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
% at grade	89.03	6.66	64.40	59.07	23.24	78.60	99.70	97.97	82.95	93.60	99.29	91.13	31.58	83.33	96.95	98.90
% at bridge	10.97	93.34	35.60	40.93	76.76	21.40	0.30	2.03	17.05	6.40	0.71	8.87	68.42	16.67	3.05	1.10

1. Persib Bridge
2. Cicaheum Bridge
3. Gatsu Bridge
4. Metro Bridge
5. Banjarsari Bridge
6. Wastu Bridge
7. Merdeka Bridge
8. Dago Bridge
9. Asia Afrika Bridge
10. Setiabudi Bridge
11. Otista Bridge
12. Darul Hikam Bridge
13. Pasteur Bridge
14. Padjadjaran Bridge
15. Kosambi Bridge
16. ITC Bridge

Figure 2. The Use Rate of Pedestrian Bridges

2.2 Determining Location Factors

A. Land Use, Activities and Pedestrians

The land surrounding bridges are used for a shopping mall, school, residential houses and a mosque. The use rate of the bridges near the shopping mall are low, such as the Merdeka bridge (0,30%), Pasar Baru bridge (0,71%), Kebon Kelapa bridge (1,1%), Kosambi bridge (3,05%), and Asia Afrika bridge (17,05%). Pedestrians who cross the road are shoppers. They tend to stroll the shopping area. Some of them walk with their bags in the hands. This type of area has two peak time a day, at noon and evening. Kosambi bridge, however, has another peak time, that is in the morning, because between 5 and 7 am, the traditional market opens along the road. Since the volume of traffic is low, conflict between pedestrians and vehicles did not occur. The peak time in a week is on Saturday and Monday.

In the school area, there is a differences between elementary school and high school. The capability of children to cross the road is lower than the capability of adults and thus, children use the bridge. This happens at Banjarsari bridge,

Darul Hikam bridge and Persib bridge with the use rates of 76,76%; 8,87% and 10,97% the Elementary School. Dago bridge, where a High School is located, has a very low use rate: 2,03%. Even so, only Banjarsari bridge has the use rate of over 50%. One of the reasons is that the traffic speed at Banjarsari is higher than the others; 22,75 km per hour is hard for children to cross. The other reason is that the crossing pedestrians are mostly student. Almost no other type of pedestrians crosses the road because there is no activity which generates the movement of pedestrians.

Unlike school areas, residential areas have different kind of pedestrians. They are general people, street vendors and bicyclists. This answers why the use rate of Darul Hikam bridge and Persib bridge are lower than Banjarsari bridge. Near these two bridges, except for the school area, there is a residential area which cause not all pedestrians to cross the road.

A residential area has low use rate, such as Setiabudi bridge (6,4%), Padjadjaran bridge (16,67%), Gatot Subroto bridge (35,6%), and Metro bridge (40,93). The use rate is not lower than the use rate of the shopping area. This is because not many people carry loads with their hands and are not in a hurry. Such location has the potential for a pedestrian bridge because the peak time of crossing pedestrians is at the same time when heavy traffic occurs. This could generate conflict between them.

Some residential areas have a certain type of pedestrians. There is an institution for blind people in front of Padjadjaran bridge. The bridge has ramps but still the use rate did not reach 50%. It turns out that very few blind people cross the road. The majority of pedestrians who cross the road were general people moving to and from an alley in residential area. The gate of the alley is located 100 meters from bridge. That makes them not to use the bridge.

Other type of pedestrians such as street vendors with a cart and bicyclist need special attention, because they need more time to cross the road. They are at risk if the speed of a vehicle is high. On the other hand they can not use the existing pedestrian bridges because there is no ramp. This happens on Metro bridge and Pasteur bridge.

If a mass of people cross the road occasionally, the bridge will be out of function. This happens on Wastukencana bridge in front of a mosque; the bridge is only used on Fridays. At that time, the bridge use rate is only 36%, or 118 pedestrians in one hour. Other days and hours, the average number of pedestrians is 74 people per hour with a use rate 19%. Even though Asia Afrika bridge is placed near the mosque, the number of crossing pedestrians at Asia

Afrika bridge reach 300 pedestrian per hour when peak time, which is higher than at Wastukencana bridge. It is because of shopping area surroundings generate more pedestrian to cross.

Table 2. Activities Descriptions

Activities	Shopping center	School	Residential	Mosque
Pedestrians	Shoppers	Student	General people Sheet vedors Peda cyclist	Congregation
Peak time	2 peak / day 2 days / week	2 peak / day 5 days / week	2 peak / day everyday	1 peak / week
Use rate	Very low	Low	depends	low

B. Pathway

Pedestrian bridges in Bandung have a gap between 50 and 100 meters from the bridge to the site where most people usually cross. But because the width of the street relatively narrow, only 7-12 meters wide, pedestrians usually cross at the usual path. The narrow width of the road reduces the effort to do detour. It generates a very low use rate of many pedestrian bridges.

In order for pedestrian bridges to be well-used, authorities need to build bridges right where people usually cross. And if this is not applicable, a condition should be created to encourage people to use the bridge.

The example is Otista bridge, which located at shopping area. There's a very intensive movement of pedestrian crossing the road, with the average flow reach 1700 pedestrian per hour. Almost all of them are going to and from one building: Pasar Baru. The Pasar Baru bridge isn't a suitable pedestrian bridge because of its location at 100 meter from building entrance, and the direction of stairs are not in pathway of pedestrian. It caused the use rate of this bridge only reach 0.71%.

Pedestrians can be encouraged to use a footbridge by the usual pathway because crossing is part of the pedestrian routes. So, pedestrian bridges site and stairs have to be a part of pedestrian route, or at least, create a new path way for pedestrian to access the bridge.

To propose the site for pedestrian bridges, one should first look at the movement of pedestrian. Which could be building to building, site to site across the street, site to site not inside alley way, and site to site inside alley way. For building to building or site to site across the road, it is difficult to crossing at grade, especially Bandung has less width road. If the origin and destination site

of pedestrian located inside alley way, pedestrian bridges could be use but with direction of the stairs directing to alley way.

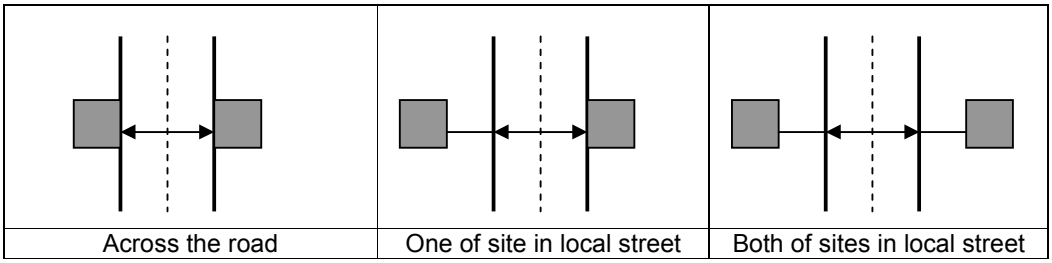


Figure 3. Movement of Crossing Pedestrians

To access the bridge, using ramps or stairs, shall be as short and direct as possible, preferably on the line of the main pedestrian flow, avoiding long detours and unnecessary climbing. If there are two building with intensive crossing pedestrians, they may build an elevated walkway among buildings. An example of this typical site is at Merdeka street, because the existing bridge is not on the pathway of pedestrians. Other layout of pedestrian that could be use is one of the stairs located on the entrance of the building. If enclosed areas generate crossing pedestrians, then one of the stair could located inside the area like at Banjarsari Bridge.

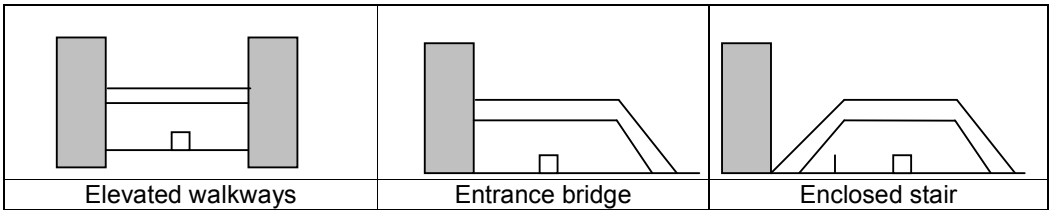


Figure 4. Layout of Pedestrian Bridges

C. Barriers

The highest use rate of pedestrian bridges is at Cicaheum Bridge. Almost 100% pedestrian choose to use the bridge rather than cross at grade. This happens because there are barriers at median road. The barriers are fences, 100 meters along the median road. Only 6,66% pedestrian decided to jump over the fences to short the time and distances.

The other type of barriers is barriers within the roadside in form of fences or trees. But those barriers will not work if it does not continue along roadside. This

makes the opportunity for pedestrian to cross at grade. It happens at Merdeka Bridge and Padjadjaran Bridge.

D. Time to Cross

Pedestrians who jump over the fences at Cicaheum bridge, showed that many pedestrians made ”time to cross” as their first priority. Time to cross is when pedestrians stop at the curb and start to look at the traffic until they arrive accros the curb. As it is human nature to take a shortcut wherever possible, pedestrians tend to cross the street following a direct line on the road, halting the traffic rather than crossing to the pedestrian bridges. Time to cross related to the speed traffic to create enough time and space through the traffic.

Fourteen pedestrian bridges in Bandung have time to cross at bridge longer than cross at grade. Two other bridges, Metro Bridge and Padjadjaran Bridge, have time to cross one minute shorter than the rest. This two bridges have a high vehicle traffic speed (50 and 30 km per hour) and the road width is more than 18 meters. Result from an interview with local at Metro area, there have been few accidents before the bridge located there. So it is important to locate pedestrian bridges in high traffic speed and long width road to reduce any casualities.

3. CONCLUSION

The conclusion taken from analyzing 16 pedestrian bridges in Bandung, Indonesia, is that bridges should only be provided when other forms of crossings, such as zebra cross or pelican are deemed to be unsuitable. The need is to prevent the low use rate of the pedestrian bridges and make the bridges ineffectively. Although the standard degree of conflict between pedestrians and vehicles (PV^2) provide a basis for assessing the need for a pedestrian crossing, but all the other factors set out in this study must also be taken into account. To assess pedestrian facilities on crossing, the authority need to consider the right proposed site for pedestrian bridges. The proposed site of pedestrian bridges must be determined by the type of pedestrians, peak time and time to cross. The type of pedestrians which affected the use rate of pedestrian bridge is school children, whether at the school area or at their pathway. Pedestrian bridge that has only one peak time per week will make it not useful at other time, especially when heavy traffic only meets high crossing pedestrians for 1 hour per week. Time to cross related to the speed traffic and width of road. If the time to cross at grade is less than to cross at bridge, then the pedestrian bridge should not be provided. At shopping area, shoppers tend to cross

at grade because they don't want to have extra energy by using stairs of bridges. So it must consider for applying pedestrian precincts at shopping area for avoiding conflict with vehicle.

But when it comes to build pedestrian bridges in some circumstances, there are one attribute in planning the bridges before coming to the design. That is accessibility to the bridge. It contains three elements that must to apply, following the usual pathway of pedestrian, creating direction of the stairs to the shortened detours and creating the barriers.

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