BIKE LANE DESIGN FOR BICYCLISTS AND BIKE SHARING IN BANDUNG CITY

Widyarini Weningtyas*, Qiranawangsih Aulia, Lestari H. Adriani, Arbie Nurlayla

Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Bandung, 40132, Indonesia

(Received: January 2015 / Revised: March 2015 / Accepted: April 2015)

ABSTRACT

Cycling is now growing in Bandung City, Indonesia. One of the popular programs is bike sharing which was established in 2012. Recently, the bike sharing program has revealed a plan to develop bike stations and bike lanes. Thus, the bike lane plan needs to be adjusted with the Indonesian Design Standard for Bike Lanes. The standard takes into account physical characteristics of the roads/streets. It was found that most of the roads/streets on the list are not suitable for bike lanes; only 42 out of 151 are qualified. This means in order to encourage cycling activities, although it is not included in bike sharing program, the physical characteristics of roads/streets and sidewalks need to be developed.

Keywords: Bike Lane, Bike Sharing, Cycling, Roads/streets Characteristics

1. INTRODUCTION

The presence of sustainable public transport is getting more and more important in today's life. The statement is supported by the fact that, in some developing countries, bicycles have become more popular than ever before, especially for young adults. A survey in Bandung illustrated in Figure 1 shows that about 47.42% of the bike users are aged between 17 to 25 years old. These data were taken from a bike-rent users survey in 2012.

Cycling is one way of moving efficiently in the city with low carbon emissions and low costs. Bandung City has a cycling program called bike sharing as a new form of eco-friendly public transportation. Bike sharing is also intended to be a feeder for other public transportation modes in the city. This program is considered as one of the public transportation modes which is expected to reduce the number of motorized vehicles such that the traffic and emissions in the city may be decreased. It also will affect noise pollution and people mobility. In addition, people can be healthier, happier, and have a higher level of productivity. Bike sharing also contributes to the increase in the livability index of a city that implements the program.

Bike sharing was first introduced in 28 July 1965 in Amsterdam, the Netherlands (DeMaio, 2009). The program was not successful. Inappropriate behavior patterns occurred with the shared bikes; they were being claimed as private bikes or abandoned in the river. This was known as The 1st Generation of Bike-sharing. The next improvements which took place in Denmark were in 1991, this program were called The 2nd Generation (DeMaio, 2009). It did not go so well either, bikes were being stolen, even though their ownership had been formalized with bike stations and a non-profit organization as their operator.

The 3rd Generation was on 1996 at Portsmouth University, England (DeMaio, 2009). It grew slowly until 2005 when a bike sharing program called 'Velo'v' was introduced in Lyon, France.

* Corresponding author. E-mail: reenee.filan@gmail.com

There were 1,500 bikes and 15,000 bike share members. Learning from Lyon, Paris also launched its own bike-sharing program called ‘Velib’ with 7,000 bikes, which then expanded to 23,600 bikes in the city and suburbs (DeMaio, 2009).

All these three generations have different technological applications. The first ones were just ordinary bikes; the second generation was more well-ordered with stations and a formal operator; then the third generation was smartened up with a variety of technological improvements, including electronically-locking racks or bike locks, telecommunication systems, smartcards and fobs, mobile phone access, and on-board computers (DeMaio, 2009). Bike-sharing in cities in South East Asia is less popular, possibly because of the combination of the massive promotion of private cars and motorcycles, the lack of bicycling habits and technology, and also there are no supportive rules which assure bicycle user safety precautions.

Figure 1. Bike User Percentage (The Figure Is In Indonesian)
Source: Research by Banopolis

Started in October 2011, the Mayor of Bandung City Ridwan Kamil, initiated the implementation of a bike sharing program in Bandung. The program started to operate in June 2012 with a very simple system and was funded by local residents. In two years the program succeeded in enhancing the promotion of the bike as an eco-friendly mode of public transportation, which can also be used for tourism purposes.

The bike sharing system in Bandung is claimed to be the first bike sharing system in Indonesia. It is aimed to be a sustainable public transportation which plays an important role as part of a feeder system for other transportation modes. Research on Bike sharing system in Bandung is being conducted. The study includes the formulation of a mechanical and electrical system, the design of the bikes and the determination of station locations along with the formulation of the wayfinding and signage strategy. Bike sharing system must be prepared appropriately to support the original purpose of Bike sharing development as an element of public transport in Bandung. The most important thing is to establish a cycling culture. Enhancement and establishment of a cycling culture is considered the most difficult task to do since the culture might influence people’s lifestyle and it has to be supported with adequate systems.

In order to have a comprehensive system, the Bandung Bike sharing also needs infrastructure support with facilities such as bike lanes. On collector and arterial roadways,

bike lanes or wide curb lanes can encourage people to ride a bike rather than drive for short trips and moderate distances (Pennsylvania Department of Transportation and New Jersey Department of Transportation, 2008). Bike lanes are the ideal facility for accommodating basic bicyclists. By designating a space only for bicyclists, they give bicyclists a measure of comfort that motorists will not drive into their path of travel. They serve to advise motorists of the possible presence of bicyclists. The presence of bike lanes encourages bicyclists to separate themselves from parked cars more than they otherwise might, reducing the possibility of being “doored.” (Van Houten & Seiderman, 2005). Cycling lanes, when protected from cars, encourage riders who may be intimidated by traffic, and the inclusion of signage giving bikes right-of-way helps remind drivers to share the road (ITDP, 2014).

Sometimes bike lanes can be installed as the valued by-product of a “road diet” treatment, in which a four-lane roadway is converted into two through-lanes with a two-way left-turn lane and two bike lanes. The road diet – known as removing and/or narrowing travel lanes – is one of the most common traffic calming practices for arterial and collector roads. In 2005 in New Jersey, Ocean City narrowed West Avenue, an arterial, from four lanes to three lanes and added bike lanes and a wide median strip. Installed for a trial period on six blocks, the residential response was so positive that the City extended the road diet treatment to two miles (Huang, Stewart, & Zegeer, 2002). The popularity of road diets can be explained by their ability to lower speeds, improve safety, and add room for non-motorized users. A study for the Iowa Department of Transportation of 15 road diets documented a reduction in crash rates of 19%, while a study of road diets in the Seattle area found an average crash reduction of 29%. A review of 14 road diet treatments across the country indicate that eight resulted in speed reductions ranging from 1 to 5 mph, although no notable decreases were seen in six of the treatments. Road diets are particularly effective in calming aggressive motorists, since they are required to queue up in a single lane, often behind more patient motorists. (Kueper, 2007)

Table 1. Cycling Infrastructure Implemented Alongside Bike-share Systems

City	Bike Infrastructure With Bike-share System
Guangzhou, China	46 Kilometers of segregated bike lanes
Paris, France	68 kilometers of segregated bike lanes, in addition to 371 existing kilometers
London, United Kingdom	37.8 kilometers of 4 cycle superhighways
Barcelona, Spain	150 kilometers of segregated bike lanes
Boston, United States	80 kilometers of segregated bike lanes (Kaiser, 2012)
Rio de Janeiro, Brazil	300 kilometers of physically segregated (<i>ciclovias</i>), painted lanes (<i>ciclofaixas</i>) and signalized shared routes (either with either traffic or pedestrians)

Source: (ITDP, 2014)

In Bandung City, the plan to develop bike lanes is being conducted by the Bandung City Agency of Transportation. Bike lanes in Bandung will be provided both for the Bike sharing users and private bike users. Thus, the system should be integrated to meet the goals of people’s changing lifestyles, establishing a cycling culture, and sustaining an eco-friendly transportation system.

Figure 2. The Advantages of Using Bicycle (The Figure is in Indonesian)

Source: Research by Banopolis

2. OBJECTIVES

The objectives of this study is to:

1. Conduct a comprehensive study about bike lanes.
2. Review potential locations (roads/streets) of bike lanes in Bandung City.
3. Conduct an infrastructure audit for bike lane types in Bandung City to determine from road and street classification and geometrical and topographical conditions.

3. METHODOLOGY

In order to support cycling activity in Bandung City, a comprehensive study about bike lanes is needed. This paper reviewed potential locations (roads/streets) of bike lane in Bandung City. Roads and streets characteristics will affect the bike lane type. Therefore, it is important to determine bike lane specification on each one of the roads and streets before deciding on the bike lane type. There is also a limitation for the minimum width of the roads, which is stated in Table 2. There are 151 roads and streets planned to have bike lanes. Each type of road/street does not always have a continuous road function and/or classification.

Table 2 Minimum Width of Road by Function and Classification

Road Function and Classification	Min. width (m)
Primary Arterial	11
Primary Collector	9
Primary Local	7.5
Primary Surroundings	6.5
Secondary Arterial	11
Secondary Collector	9
Secondary Local	7.5
Secondary Surroundings	6.5

Table 3. Bike Lane Type Plan based on Road Function and Classification

Road Function and Classification	Highway	Middle Road	Small Road
Primary Arterial	A	A	A
Primary Collector	A	A	A
Primary Local	C	C	C
Primary Surroundings	C	C	C
Secondary Arterial	A/B	A/B	A/B
Secondary Collector	B/C	B/C	B/C
Secondary Local	B/C	B/C	B/C
Secondary Surroundings	B/C	B/C	B/C

Source: Ministry of Public Works, 2013

Notes:

A = Bike lane on the road with curb

B = Bike lane on sidewalk

C = Bike lane on the road without curb

The next steps are explained in the flowchart shown in Figure 3.

Figure 3. Bike Lane Classification Flowchart
(Source: Ministry of Public Works, 2013)

4. GEOGRAPHICAL INFORMATION

Bandung City is one of big cities in the West Java Province as well as the capital city of the West Java Province. Its coordinates are 107° east and 6° 55' south. This city is geographically located in the center of West Java. Bandung is one of the most favorite destinations for tourists due to its beautiful scenery, fresh air and the presence of many highly developed institutes. As a capital city of West Java, Bandung plays an important role to support social, economic and governmental activities. Bandung has a high level of various economic activities, such as services and trading. Consequently, Bandung faces inevitable problems related to basic infrastructure supply, such as housing, clean water, energy, transportation, and communication. This is worsened by degradation of the city environment.

Transportation is one of Bandung's most serious problems. Bandung's roads are generally congested during the morning and afternoon peak commuting hours. Currently, its total km road length is 932,701 km (www.bps.go.id, 2015). Because of limited land available for public use, it is therefore difficult to build new roads. Thus, enhancing public transportation can be considered as one potential solution to address this problem.

In 2013, the population of Bandung reached to 2,483,977 people. Over the past decade, the Bandung population growth has increased rapidly. Table 1 shows population growth in Bandung City.

Table 4. Population in Bandung City, 2004-2013

Year	Population
2004	2,239,757
2005	2,303,913
2006	2,338,359
2007	2,372,234
2008	2,400,340
2009	2,427,697
2010	2,394,873
2011	2,437,874
2012	2,461,931
2013	2,483,977

Source : West Java Statistic Data Center (2004-2012) and Bandung Statistic Data Center (2013)

5. BIKE LANE AND BIKE SHARING STATION PLANS IN BANDUNG

The AASHTO Guide for the Development of Bicycle Facilities defines a bike lane as “a portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists.”(1998).

Bike lane and bike sharing station plans, which are being developed, have created a planning map. This map contains information about the exact location of the bike sharing station plan complemented with a bike lane route plan. This plan was made based on cycling activity needs and cycling coverage areas in schools and universities, commercial areas, office areas, public areas, and residential areas. Thus, an adjustment should be made to comply with roads/streets characteristics.

Figure 4. Bike Station Site Plan

Figure 5. Bike Lane Plan

6. BIKE LANE TYPES

The bike lane standard in Indonesia are based on physical characteristics of existing roads/streets. Bike lane types are divided into three types, namely: Type A for an on-street lane with a curb lane, Type B for an on-sidewalk lane, and Type C which is an on-street without a curb lane. All these lane designs depend on road function and road class of the desired bike lane. A guideline titled, “*Pedoman Perancangan Fasilitas Lajur dan Jalur Sepeda*” (Ministry of Public Works, 2013) explains clearly about how to design a bike lane.

The first step of the design is to identify road function and road classification where the bike lane will be located. This is shown in Table 3.

Figure 6. Type A Bike Lane (Left) and Type C Bike Lane (Right)

Figure 7. Type B Bike Lane

Table 5. Bike Lane Type A in Bandung City Roads

No	Street/Road Name	Bike lane Type	No	Street/Road Name	Bike lane Type
1	Jl. A. Yani	A	12	Jl. Lengkong Besar	A
2	Jl. BKR	A	13	Jl. Lengkong Kecil	A
3	Jl. Buah Batu	A	14	Jl. Otista	A
4	Jl. Cibeureum	A	15	Jl. Pajajaran	A
5	Jl. Cicendo	A	16	Jl. Pasir Kaliki	A
6	Jl. Cimindi	A	17	Jl. Pelajar Pejuang 45	A
7	Jl. Dr. Junjuran	A	18	Jl. Pungkur	A
8	Jl. Gardu jati	A	19	Jl. Raya Cimahi	A
9	Jl. Jamika	A	20	Jl. Sukajadi	A
10	Jl. Jend. Sudirman	A	21	Jl. Terusan Tol	A
11	Jl. Laswi	A		Cileunyi	

Table 5. Bike Lane Type B in Bandung City Roads

No.	Street/Road Name	Bike lane Type
1	Jl. Ir. Haji Juanda	B
2	Jl. R.A.A Martanegara	B
3	Jl. Sunda	B
4	Jl. Supratman	B

Table 6. Bike Lane Type C in Bandung City Roads

No	Street/Road Name	Bike lane Type	No	Street/Road Name	Bike lane Type
1	Jl. Banda	C	10	Jl. Surya Sumantri	C
2	Jl. Belitung	C	11	Jl. Sadakeling	C
3	Jl. Cendana	C	12	Jl. Sentot Ali Basyah	C
4	Jl. Citarum	C	13	Jl. Sukabumi	C
5	Jl. Diponegoro	C	14	Jl. Sumatera	C
6	Jl. Gurame	C	15	Jl. Tamansari	C
7	Jl. K.H. Dahlan	C	16	Jl. Tamblong	C
8	Jl. Kebon Kawung	C	17	Jl. Turangga	C
9	Jl. Leuwi Panjang	C			

Table 7. Roads in Bandung City Not Feasible for Bike Lanes

No.	Street/Road Name	Bike lane Type	No.	Street/Road Name	Bike lane Type
1	Jl. ABC	Not Feasible	32	Jl. Dipati Ukur	Not Feasible
2	Jl. Abd. Raden Saleh	Not Feasible		Jl. Dr. Cipto	
3	Jl. Abd. Rivai	Not Feasible	33	Mangunkusumo	Not Feasible
4	Jl. Aceh	Not Feasible	34	Jl. Eijkman	Not Feasible
5	Jl. Asia Afrika	Not Feasible	35	Jl. Elang	Not Feasible
6	Jl. Banceuy	Not Feasible	36	Jl. Ganesa	Not Feasible
7	Jl. Banda Cimandiri	Not Feasible	37	Jl. Gang 4	Not Feasible
8	Jl. Bojong Soang	Not Feasible	38	Jl. Garuda	Not Feasible
9	Jl. Bp. Husen	Not Feasible	39	Jl. Gatot Subroto	Not Feasible
10	Jl. Braga	Not Feasible		Jl. Gatot Subroto	
11	Jl. Burangrang	Not Feasible	40	(Cimahi)	Not Feasible
12	Jl. Caringin	Not Feasible	41	Jl. Gede Bage	Not Feasible
13	Jl. Cemara	Not Feasible	42	Jl. Gegerkalong Hilir	Not Feasible
14	Jl. Cibeunying	Not Feasible	43	Jl. Gudang Utara	Not Feasible
15	Jl. Cibolerang	Not Feasible	44	Jl. Holis	Not Feasible
16	Jl. Cigondewah	Not Feasible	45	Jl. Ibu Inggit Ganarsih	Not Feasible
17	Jl. Cihampelas	Not Feasible	46	Jl. Jakarta	Not Feasible
18	Jl. Cijerah Raya	Not Feasible	47	Jl. Jawa	Not Feasible
19	Jl. Cikawao	Not Feasible	48	Jl. Jurang	Not Feasible
20	Jl. Cikutra	Not Feasible	49	Jl. Kalipah apo	Not Feasible
21	Jl. Cileunyi	Not Feasible	50	Jl. Kapt. Tatanegara	Not Feasible
22	Jl. Cipaganti	Not Feasible	51	Jl. Karang Sari	Not Feasible
23	Jl. Ciroyom	Not Feasible	52	Jl. Karapitan	Not Feasible
24	Jl. Cisaranten Kulon	Not Feasible	53	Jl. Katamso	Not Feasible
25	Jl. Cisarua	Not Feasible	54	Jl. Kebon Jati	Not Feasible
26	Jl. Ciserung	Not Feasible	55	Jl. Kopo	Not Feasible
27	Jl. Ciumbeluit	Not Feasible	56	Jl. Kopo Sayati	Not Feasible
28	Jl. Ciwastra	Not Feasible	57	Jl. Lembong	Not Feasible
29	Jl. Dalem Kaum	Not Feasible	58	Jl. Leuwigajah	Not Feasible
30	Jl. Derwati	Not Feasible	59	Jl. Lodaya	Not Feasible
31	Jl. Dewi Sartika	Not Feasible	60	Jl. Lombok	Not Feasible

No.	Street/Road Name	Bike lane Type	No.	Street/Road Name	Bike lane Type
61	Jl. Margacinta	Not Feasible	83	Jl. Sancang	Not Feasible
62	Jl. Merdeka	Not Feasible	84	Jl. Sarijadi	Not Feasible
63	Jl. Moh. Ramdan	Not Feasible	85	Jl. Seram	Not Feasible
64	Jl. Moh. Toha	Not Feasible	86	Jl. Siliwangi	Not Feasible
65	Jl. Naripan	Not Feasible	87	Jl. Sindang Laya	Not Feasible
66	Jl. Pagarsih	Not Feasible	88	Jl. Sulanjana	Not Feasible
67	Jl. Palasari	Not Feasible	89	Jl. Sumatra	Not Feasible
68	Jl. Pasir Koja	Not Feasible	90	Jl. Sumbawa	Not Feasible
69	Jl. Pasteur	Not Feasible	91	Jl. Suniaraja	Not Feasible
70	Jl. Perintis Kemerdekaan	Not Feasible	92	Jl. Surapati	Not Feasible
71	Jl. Peta	Not Feasible	93	Jl. Telaga Bodas	Not Feasible
72	Jl. PHH Mustofa	Not Feasible	94	Jl. Terusan Buah Batu	Not Feasible
73	Jl. Prof. DR. Sutami	Not Feasible	95	Jl. Terusan Holis	Not Feasible
74	Jl. Purnawarman	Not Feasible	96	Jl. Terusan Jakarta	Not Feasible
75	Jl. Purwakarta	Not Feasible		Jl. Terusan Jend Gt.	
76	Jl. Rajawali Barat	Not Feasible	97	Subroto	Not Feasible
77	Jl. Rajawali Timur	Not Feasible		Jl. Terusan Kiara	
78	Jl. Raya Cibiru	Not Feasible	98	Condong	Not Feasible
79	Jl. Raya Cipadung	Not Feasible		Jl. Terusan Prof. DR.	
80	Jl. Raya Sumedang	Not Feasible	99	Sutami	Not Feasible
81	Jl. Raya Ujung Berung	Not Feasible	100	Jl. Veteran	Not Feasible
82	Jl. Rumah Sakit	Not Feasible	101	Jl. Wastu Kencana	Not Feasible

Table 8. Roads in Bandung City which are Not Continuously Feasible for Bike Lanes

No.	Street/Road Name	Bike lane Type
1	Jl. Astana Anyar	A to Not Feasible
2	Jl. Cibadak	C to Not Feasible
3	Jl. Cibaduyut	C to Not Feasible
4	Jl. Kiara Condong	A to Not Feasible
5	Jl. Pahlawan	C to Not Feasible
6	Jl. R.E Martadinata	B to Not Feasible
7	Jl. Setiabudi	A to Not Feasible
8	Jl. Soekarno Hatta	A to Not Feasible

Table 9. Bike Lane Classification Resume

Bike lane Type	Total
A	21
B	4
C	17
Not feasible for bike lane	101
Not continuously feasible	8

7. CONCLUSION

It seems that the type of bike lane is based on road width and sidewalk conditions. Apparently, roads/streets with planned bike lanes will require sufficient width and good conditions of the road or sidewalk. As a result, from 151 artery and collector roads in Bandung, only 42 of them met the requirements/standards for the bike lane facility.

Most of the roads in Bandung are not suitable for bike lanes although in main roads such as Jl. Ir. H. Juanda, Jl. Supratman, and Jl. Jend. A. Yani a bike lane is allowed to be built. Integrated with the bike lane plan of the bike sharing program, several numbers of

roads/streets were not allowed to be built. Another study should look into possibility of road/street widening and sidewalk rehabilitation to complement the design plan for a bike lane facility.

It is questionable how to adjust roads and streets in Bandung to meet the criteria of bike lane development. Due to limited land and the growing motor-vehicle traffic, bike lanes seem to become the last priority. A technical approach alone cannot make the bike lane program possible. Thus, a more humanly-inspired method can be supportive, such as greater promotion of bicycling and bike sharing programs and green transport campaign, etc. are recommended to improve the sustainability of the city environment.

8. ACKNOWLEDGEMENTS

We would like to thank Bandung City Government and Banopolis as the local consultant for bike sharing for their time and support in this study.

REFERENCES

- AASHTO, (1998). Guide for the Development of Bicycle Facilities.
- Bandung Statistic Data Center (2013). Bandung City. Retrieved from: <http://bandungkota.bps.go.id/> (Accessed February 2015)
- DeMaio, P. (2009). Bike-sharing: History, Impacts, Model of Provision, and Future. *Journal of Public Transportation*, Vol. 12, No. , 41-56.
- Huang, H. F., Stewart, J. R., & Zegeer, C. V. (2002). Evaluation of Lane Reduction "Road Diet" Measures on Crashes and Injuries. *Transportation Research Record* 1784, 80-90.
- ITDP. (2014). *The Bike Share Planning Guide Institute for Transportation and Development Policy*. New York: ITDP.
- Kueper, D. (2007). Road Diet Treatment in Ocean City, NJ, USA. *ITE Journal*.
- Ministry of Public Works (2013). *Pedoman Perancangan Fasilitas Lajur dan Jalur Sepeda. Indonesia*
- Pennsylvania Department of Transportation and New Jersey Department of Transportation. (2008). *Planning and Designing Highways and Streets that Support Sustainable and Livable Communities*. Pennsylvania: Penndot and NJDOT.
- Van Houten, R., & Seiderman, C. (2005). How Pavement Markings Influence Bicycle and Motor Vehicle Positioning: A Case Study in Cambridge, MA. *Transportation Research Board Annual Meeting*. Cambridge: Transportation Research Board.
- West Java Statistic Data Center (2004-2012). Bandung City. Retrieved from: <http://jabar.bps.go.id/> (Accessed February 2015)