

Implementing Transit Oriented Development Principles in Designing Light Rail Transit Station in Bandung

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Abstract

The density of transportation in Bandung has been increased every year which causes many problems and one of them is congestion. The low level of security, comfort, and long trip are the main factors of people preferring private vehicles over public transportation as a driving option. The form of public transportation that becomes a solution for Bandung city is Light Rail Transit (LRT) with the concept of transit-oriented development (TOD). TOD is an urban design in aiming to reduce mobility by integrating the role of mixed-use. This study using several variables that combined the theory of Cervero (1997) and ITDP (2014): walk, cycle, connect, transit, and design. The importance of applying TOD's principle is interconnecting between transportation and various infrastructure in the selected area, such as commercial, office, residence, etc. The implementation of the TOD principle in LRT station design is adjusted to the characteristics and policies of selected area. The result gathered from this study is the design of supporting facilities of transit area that meets TOD principles by ITDP in a way to aim walkable city for Bandung better urban mobility.

Keywords: *connectivity; LRT; TOD; transportation.*

Introduction

The increase in the number of private transportation, especially two-wheeled vehicles, has caused congestion in some major cities in Indonesia, one of which is the capital city of West Java, Bandung. The level of congestion is generated by the magnitude of the vehicle ratio rather than the width of the road segment marked by an increase in population and high mobility. In Bandung, private transportation dominates road by 94% (Iman, 2018). Therefore, Bandung is one of the most compact cities in Indonesia.

Ironically, the number of public transportation in Bandung in 2014 was 5,521 vehicles that mean 1% of a motorcycle (Harahap et.al, 2019), meaning that transportation needs for movement have not been fulfilled, so people turn to meet their needs through private vehicles that are causing a traffic jam in some areas.

Congestion that is not taken seriously will effect economic growth and a loss for the city itself. To overcome these problems, an infrastructure of urban spatial planning with different kinds of functions that are integrated is needed. Besides, the strategy as the right solution in dealing with transportation problems in Bandung is the use of public transportation in the mass transport system in large numbers (Berawi et al, 2020).

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The Department of Transportation of Bandung strives for the realization of Bandung Lancar 2031 program (Bandung Better Urban Mobility 2031) in the form of integrating Transit Oriented Development area and public transportation including monorails. The Monorail is a high-speed mode of transportation that can carry many passengers at one time. This mass transit system is based on a feeder system, which is the center of various transportation connecting residential areas with supporting areas. The general description of this rail-based transportation project is regulated in the Bandung City Transportation Department's governing document, namely the Pre-Study of the Monorail of Bandung 1 and 2.

TOD is an effort that focuses on developing the integration or connectivity of public transportation with office area., residence, trade/services, and other public services that are easily accessible just by foot. Cervero (Ayuningtyas, 2019) ideally describes TOD area consists of three aspects, including density, diversity, and design. Density is defined as density in a spatial pattern that continues to grow, diversity means a mixed function of various activities that are accommodated in one area (for example, between residence, retail, and office). Therefore, these two performance targets are the balance between population income and surrounding land use with balanced density (Tumlin, 2011.).

Literature Review

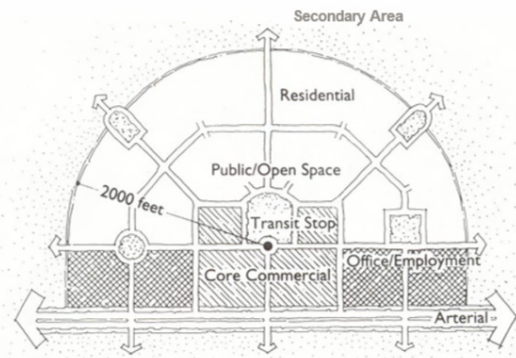
A. Concept of TOD

In 1992, San Diego city has adopted a concept of the City's Mobility Planning Program that means a concept that designed to make the efficient movement of people from one place to another that can be reached on foot from transit stops and commercial center areas. This concept came to be known as TOD (Transit Oriented Development) and continued to be developed because it proved successful in creating a mixed-used area that increased population mobility (Setiawan, 2014).

According to Purwantiasning (2017), TOD is defined as a mixed-use community in the average transit range of around 2000 steps between the distance of a public transport stop and a commercial center. In the TOD area there are residential, office, retail, open space, and

other public facilities with an environment that is friendly to basic to public transportation such as pedestrians, bicycles, motorbikes or cars. An illustrative scheme of the following meaning can be seen in Figure 1.

Figure 1. The Illustration of TOD Concept
Source: Calthrope (1993)



Public transportation has significant role for human life. A study proofed that the poor tend to live in the inner city (Glaeser et al, 2008). Commute time have more impact in society rather than education or crime. Public transportation is so important because it's a life lined to education, works, healthcare, and groceries. When more people use private vehicle like car, public transport makes less money, which means it either has to cut service or raise fares or both, so even fewer people will use public transportation. This is why TOD is playing an important role of cutting longer commute time to solve the problem of the city.

Principle of TOD

As a benchmark for the success of TOD development, a principle was made to implement a concept of Transit Oriented Development. Based on ITDP (Institute Transportation & Development Policy) it is stated that there are 8 TOD area principles (ITDP, 2017), including:

1. Walk

Walking is the most healthiest, and affordable mode of transportation for short distances. Therefore, walking is the basis of a sustainable transportation system. The average dimension of a pedestrian path is 2.5 meters with travel time to reach the transit area is 8.5 minutes (Ramadhani & Sardjito, 2017).

2. Cycling (Cycle)

Cycling is an emissions-free, healthy and

affordable transportation option with little space requirements, which is more efficient than motorcycle.

3. Connect (Connect)

Road network and trotoars are well connected for pedestrians and cyclist. (Wahyudi, 2018).

4. Public Transportation (Transit)

Transit area of public transportation connects and integrates urban areas that is not close for pedestrians.

5. Mixing (Mix)

Mixed use within one area will keep the roads alive and provide a sense of security, encouraging of walking and cycling activities, and forming the living neighbourhood. Commute times are also possible to be more balanced, so that public transport operations become more efficient.

6. Compact (Densify)

According to Jati et.al (2017), to be able to sustain urban growth in dense and dense spatial patterns, cities must grow vertically (densification) rather than horizontally (sprawl).

7. Close (Compact)

Compact means providing various function in units of area. This pattern minimizes the time and energy it takes to reach out to them and maximize the potential for interaction between residents. Having a high level of density means making the urban spaces integrated spatially with the public transport system.

8. Switch (Shift)

When people began to choose public transportation, or walking, and cycling, the designation of roads was transferred from private vehicles to something that was more productive from a social and economic perspective. This performance target is to reduce road space for vehicles in either form motorcycle or cars and parking spaces on the road.

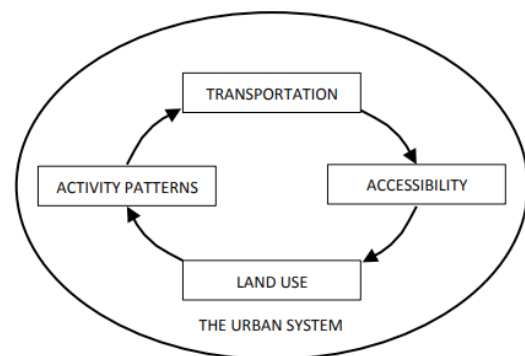
B. LRT and Land Use Connection

Light Rail Transit was created in 1972 to illustrate the transformation of a new streetcar in Europe and the United States (Higgins, Mark & Pavlos, 2014). LRT is a rail-based mode of transportation that has characteristics such as using electricity as a power source, with a passenger capacity of 700-800 passengers,

automatic control, can move at ground level, underground provided by the land, and has several frequent trips.

The basic concept of interaction or relationship between land use and transportation is accessibility. Accessibility is the ease of traveling, this could increase land prices. If land use is close to one another and the transportation relationship between land uses is in good condition, then it has high accessibility (Pengjun and Li, 2018). Transportation planning goals make the interaction of land use and transportation as easy and efficient as possible (Ewing and Cervero, 2010). LRT Station in transit area in Bandung is designed to answer transportation problems in Bandung city. With this design, the movement of Bandung people's activities efficiently can be fulfilled. Besides, the application of the TOD system and mixed-used buildings in the city is a response to reduce the movement of people and to reduce traffic jams at the core city points. An illustrative scheme of the following meaning can be seen in Figure 2.

Figure 2. Transportation and Land Use Connection
Source: Handy (2005)



Methodology

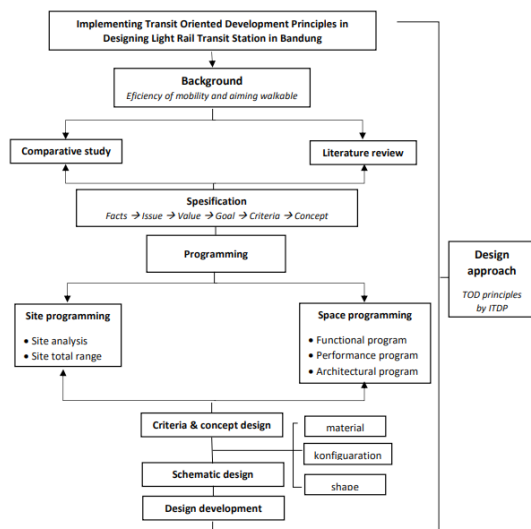
The design approach strategy of designing LRT station in TOD area used is the glassbox method with consideration the results of the design approach that is logical, rational, and can be tested for truth. The glassbox method is a method that is done rationally and logically by the designer of the work he made. Concept design did not come spontaneously, but through stages that carried out with certain considerations which results can be traced from the initial process to the final process.

Setting the background begins by describing the problems, potentials, opportunities and

gaps associated with the design idea, namely an LRT Station project in the TOD area in Bandung, West Java. After describing the problems, potentials, opportunities, and gaps, argumentation of the urgency of the project will be obtained or what can be termed the essence of the LRT Station project in the TOD area in Bandung, West Java.

Design criteria and concepts can be formulated based on the conclusions from the site program and space program. The conclusions from the site program will produce design criteria and site design concepts, while conclusions from the space program will produce building design criteria and concepts. The site and space program is obtained from data analysis that has been compiled from literacy, interviews, site design regulations and comparative studies of similar building functions. The result of data analysis is a function analysis, activity analysis, and analysis of space that can be drawn into data synthesis. Data analysis is used to transform data that has been collected in compiling project specifications.

Figure 3. Schematic approach to designing light rail design in tod area using the Glassbox method



Result and Discussion

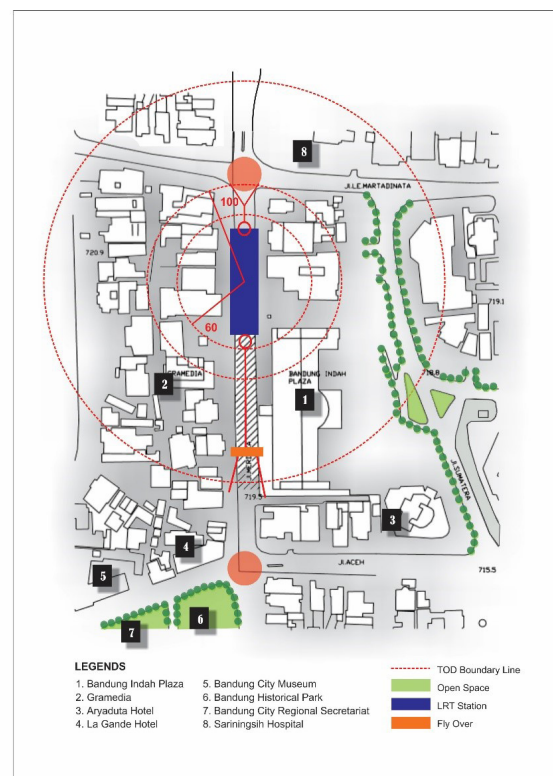
1. Transit Area Location

The location of the transit-oriented area is planned along Jalan Merdeka, Citarum, Kec. Bandung Wetan, the city of Bandung with a transit point between the buildings with the most populous activities, namely BIP (Bandung Indah Plaza) and Gramedia. The object of the area is located in the city center

and government functions so that the office functions are dominated. Traffic congestion on protocol roads is very congested, resulting in a high level of traffic congestion which hinders pedestrian access. Besides, bus stops and taxi waiting areas trigger traffic congestion because stops are piling up and take too long. The number of trees is very limited, including the unavailability of public open space.

In the transit area of Jalan Merdeka, there are several central building objects which include the government office building in Bandung, educational facilities, shopping, residential, hotels, and worship. In the area the land is used for commercial purposes such as office buildings, hotels and shopping centers. The modes of transportation provided on Jalan Merdeka, such as city transportation, bicycles, damri, and buses. With the variety of types and quality of development in the region at present, the area of mixed functions has become very limited around the LRT station, is shown in Figure 4.

Figure 4. Transit Area Location



2. TOD (Transit Oriented Development) Principles

According to Tumlin (2011), a transit area is an area within a city that is intended as a

blend of transit functions between human needs, buildings, and public spaces. A transit area that is functional for its users is that which meets basic requirements such as comfort, fast, regular, and affordable (Ratner & Goetz, 2013). Therefore, in the arrangement of the transit area needed the principles of use as a benchmark for the development of the area. There are 8 TOD principles (ITDP, 2017) including mixed functions, high density, connectivity, public space, social justice, environmental sustainability, infrastructure resilience, economic renewal.

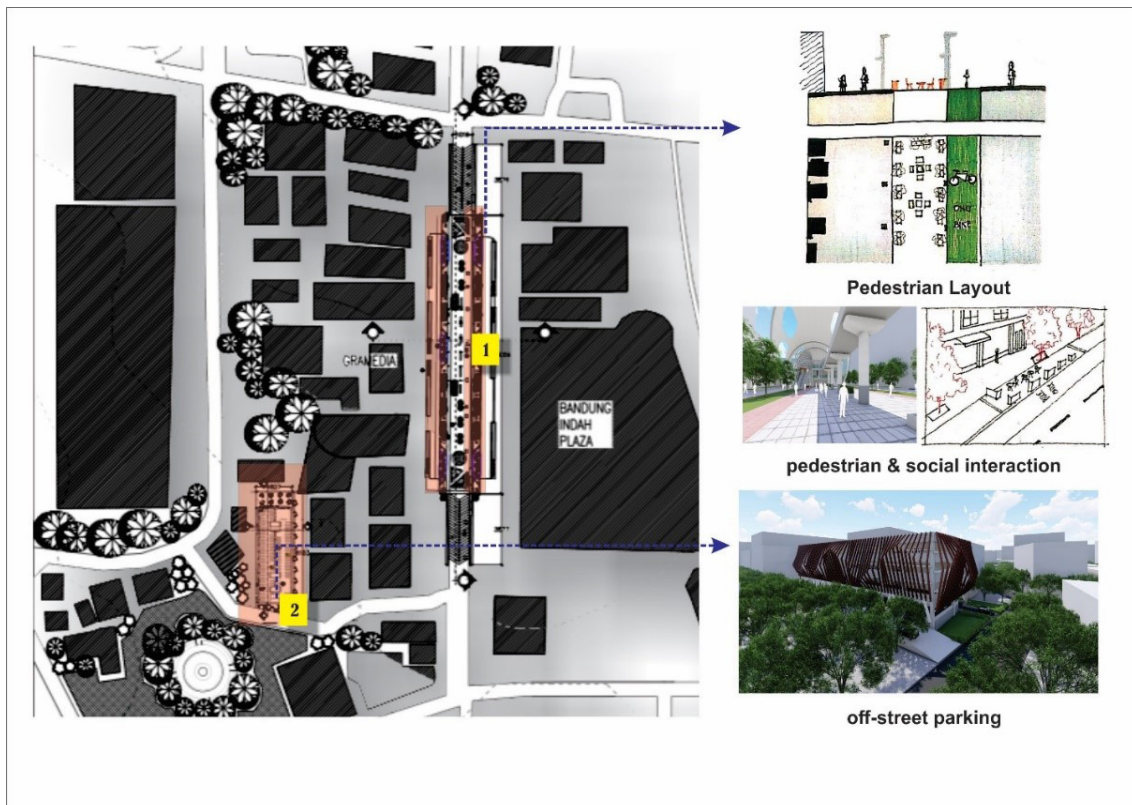
From the principles mentioned, there are 3 principles that are the main focus in designing LRT stations in transit-oriented areas on Merdeka street, including regional connectivity, public space, decreasing carbon footprint, and the focus of development near the public transport network. Some strategic steps in designing stations in the transit area include: the

provision of secure connectivity infrastructure, the maximum utilization of land, the provision of public areas, the restructuring of the area in order to improve the quality of life.

Development Area

The development of areas near stations that interact directly with LRT stations will be directed towards the development of high-density areas and the potential for long-term development. Limited and very valuable city space can be diverted from the allotment of roads and unnecessary motor vehicle parking segments, to be reallocated to more productive uses in terms of social and economic aspects. One of the principles of shifting is to turn away from the mobility of private vehicles with parking restrictions (in Figure 5) and road use policies (Black, 1995). The road is part of civil engineering which is not the only function as an access but as a social experiment of urban space (Hadinata, 2017).

Figure 5. TOD Area Development



Off-street parking inside the building is provided for users, LRT station managers, and the surrounding community within 10 minutes on foot. The parking area design has an area of 1000 m² that can accommodate 50 four-wheeled vehicles and 100 two-

wheeled vehicles. The diversity of modes of transportation that is convenient and easily accessible to these users has a positive impact on society, namely the shift from the use of private transport to public transportation. So that one of the goals of TOD area development

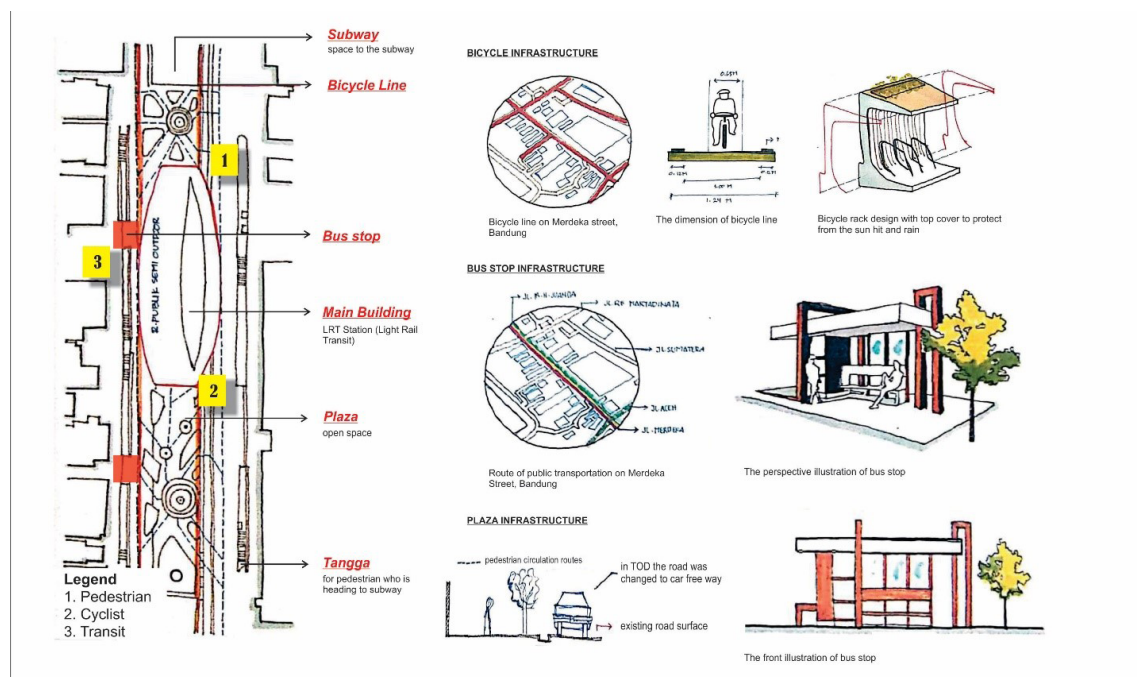
is achieved, namely reducing traffic congestion in big cities by minimizing human mobility. The transit area on Jalan Merdeka was designed with the management of its mass transportation, such as the construction of the MRT and LRT lines.

Connectivity Area

A connectivity area should consist of office area, landmarks, or other attractions, especially benchmark sites are placed in a way transit station are located closest to commercial

and working areas (Berawi et.al, 2019). Infrastructure designed to support connectivity in transit-oriented areas is pedestrians, bicycles, and public transportation. Figure 6 shows infrastructure for pedestrians, such as sidewalks, park benches as a medium of social interaction, and shade trees. The design of the transit area provides a specific bicycle lane on the sidewalk design that connects almost all the places in the area. Various types of cycling infrastructure, including bicycle lanes on-road bodies and on-street parking.

Figure 6. The Infrastructure of Connectivity Area



The subway design in the transit area has a transit circulation that connects to 5 existing modes of transportation. The area makes it easy for users to integrate one mode of transportation with another mode of transportation, as well as to reduce congestion and safety for pedestrians. The design has had a positive impact in the form of increased connectivity, social equality, economic regeneration, and infrastructure security.

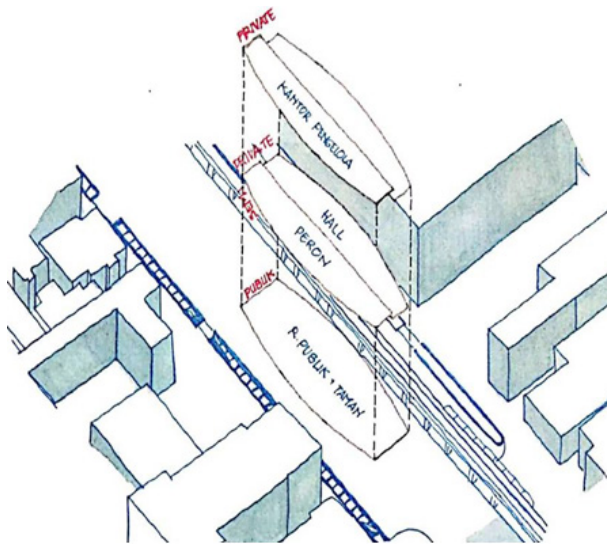
Accessibility of public transport and its use in LRT station design supports dense spatial planning and development patterns. The maximum distance to the nearest monorail station recommended for transit-oriented development is 1 kilometer or 15 to 20 minutes travel time on foot. Density in the transit area provides an opportunity for city developers to develop an area capable of providing multi-

functional buildings or public spaces that accommodate human activities therein.

Public Space Area

Based on the National Defense Agency in Permen ATR BPN No. 16 of 2017 it is stated that the design of public space in terms of area development is carried out such as making plazas (open areas), parks, and streetscape [2]. This development is useful as an increase in living standards and environmental resilience in the city of Bandung. The subway and plaza design shown in Figure 7 makes the sidewalk a safe walking network and connects every building and destination. The LRT station transit area design facilitates pedestrian circulation including persons with disabilities, such as providing escalators, elevators, and ramps for wheelchair users. In addition to pedestrians, the streetscape on the shoulder of the road is

Figure 7. Open Public Space in LRT Station



designed for cyclists.

Infrastructure designed for bicycles, such as bicycle lanes is designed with a width of ± 1.5 m and uses green as a differentiator with pedestrian markers. One of the available onstreet parking is a portable parking rack available on the roadside with a capacity of 6-7 bikes with an inverted U-shaped design. This parking lot is available in large quantities and has protection against the weather. Bicycle parking facilities are located outside the pedestrian circulation room or other vehicles and are located within a radius of 100 meters from the entrance of the LRT station.

Conclusion

The LRT station design in the transit area applies the TOD (Transit Oriented Development) principles set forth by ITDP. TOD is a concept created to reduce user mobility with the density and diversity of land functions in an urban area. Some things that are implemented in this study are; walk, cycle, transit, and shift. Of the four principles, the density of land and building uses, mixed land use, pedestrian and cyclist infrastructure, and the availability of parking as a form of land-use efficiency. Meanwhile, in the spatial structure plan, the development of a network of cyclists and pedestrians is an alternative strategy to establish a pedestrian and cyclist-friendly environment. Another suggestion that can be taken is to develop open public spaces. The existence of open public space plays an important role in the progress of the city as an entertainment tool or

the aspirations of its people.

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