

Land Ecological on Public Transport Infrastructure Development In Indonesia

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Abstract. The development of public transport infrastructure in Indonesia has been growing rapidly since the last five years. The utilization of area as public transport infrastructure, for example bus depot, bus Station and terminal requires wide area and influences many elements, such as land ecological quality, water supplies, power supplies, and environmental balance. However the development of public transport infrastructure now days is less considering on environmental approach, especially for green and catchment area for water conservation (water balance). This paper aims to propose the concept of Public Transport Infrastructure using green concept. The green design concept is using GBCI (Green Building Council Indonesia) standard, which contains seven categories: land ecological enhancement, movement and connectivity, water management and conservation, solid waste and material, community wellbeing strategy, building and energy, and also innovation and future development. The result is, by using the GBCI standard for the green design of Public Transport Infrastructure, the land ecological impact could be decreased. The effective areas that required are at least 5000 m², from which the green areas for public increase 36% and 76% of areas could be used as catchment area for water conservation.

1. Introduction

Urban transportation is a complex system on land use planning and urban design. The provision of transportation systems has a large influence on the form of the built environment and people's quality of life. Sustainable transport development concepts include some point such as vehicle design, vehicle operational, transport system sewage, quality of land use, and reduce capacity (volume). This concept design is to support human ecosystem activity, flora and fauna in the future. Sustainable transport is a transportation that does not cause harmful effects on public health or ecosystems and could support the existing mobility consistently, and is considering to: (a) the use of renewable energy resources at a lower rate from the regeneration rate; and (b) the use of non-renewable resource at a lower level from the development of alternative renewable resources level. (Organization for Economic Co-Operation and Development (OECD), 1994). Concerning on sustainability, the public transport development has given environmental impacts that can impose economic, social and ecological costs. Global air pollution, the durable effects of manufactured toxins, degrades natural resources such as fresh water and fisheries, and the cross-border nature of many environmental problems which all highlight the need to view human impacts from a broad perspective.

Floods are one of the types of disasters more frequently occurring, compared to earthquakes, volcanic eruption, drought and landslides. Floods are even occurring more frequently in the present days. Floods are not only caused by rain that consequently causes the overflowing of surface (run-off) water, but also by the change of land usage, for example forest/land clearing and development in the water absorption area. A number of studies has even shown that human is the main cause of flood, compared to nature itself.

On early 2014, there has been flood disaster in Indonesia. Floods occurred in six provinces, i.e. DKI Jakarta (capital city of Indonesia), Banten, West Java, Yogyakarta, Central Java, and South Sulawesi. Based on United Nations Office for the Coordination on Humanitarian Affairs (OCHA) report, for the last two weeks, Jakarta and outlying areas have experienced continued rains causing river overflows and inundation since 12 January 2014. Thousands of houses, buildings, roads have



been flooded. The Provincial Agency for Disaster Management (BPBD) DKI Jakarta reported that as of 21 January 2014, approximately 134,662 persons or 38,672 households in 100 urban villages are directly affected by floods. Twelve casualties have been recorded. At least 62,819 persons are displaced who are sheltered in 253 displacement centers. Floodwaters had blocked some major roads. Flood water levels were vary from 0.2 m up to 1.2 m and around 2 m at the river bank.

The development of public transport infrastructure in Indonesia has been growing rapidly since the last five years. The utilization of area as public transport Infrastructure, for example bus depot, bus Station and terminal requires wide area and influences many elements, such as land ecological quality, water supplies, power supplies, and environmental balance. However the development of public transport infrastructure now days is less considering on environmental approach, especially for green and catchment area for water conservation (water balance). Area terminals and bus depot are usually using flexible pavement or rigid pavement, which this pavement can't absorb rainwater, and the drainage using open drainage system. It can cause ecological impacts from urban land use. The aim of this research is to propose the concept of Public Transport Infrastructure using green concept.

Limitation from this research focuses on public transport infrastructure development for terminals and bus depot. Sample of terminals and bus depot is only in Jabodetabek area, and the analysis is using Green Building Council Indonesia (GBCI) standard.

2. Literature Review

Two major environmental concepts influence contemporary thinking about sustainable development. The traditional concept is on of "environmental services", those beneficial functions (such as maintenance of water-flow patterns and recycling of waste) that natural area perform, the full range of genetic diversity (plant and animal species and population) and ecosystem (in which plants and animals exist).

Environmental service are the economically valuable benefits to society that natural area provide. These include creation and protection of soil, stabilization of water-flow patterns, amelioration of climate, breakdown of pollutants, recycling of waste, provision of fish nurseries, and protection against weather damage.

The major sources of negative environmental impacts from urban land use are: (1) displacement or damage of natural areas by intruding development; and (2) pollution of environmental media (air, water and land) by such urban residuals as stormwater runoff or automobile and industrial emissions [7].

Terminals or terminal areas are generally made at the ends or beginning of bus lines, the major transfer point and, generally, areas where buses stop for longer periods of time while still in service. As such, they differ significantly from simple bus stops in that they cover larger areas and accommodate many buses and greater numbers of passengers. They are relative simple, mostly in the open-air structures comprising loading berths, shelters and sidewalks for pedestrians. They are also generally smaller than sophisticated bus stations which usually covered within buildings including shops, restaurants and other facilities. The layout and size bus terminal, depends on the number of bus movements that it will accommodate, the number of passengers, the availability of space, the general effects on the surroundings etc. the critical elements in the design of a bus terminal are therefore : the determination of capacity and the number of loading berths, the geometric characteristics and horizontal layout of these berths, the determination of capacity and the geometric characteristics of the walkways for the movement of pedestrians [5]. Based on Minister of Transportation regulation in Indonesia, classification of bus terminals based on the service is divided into three categories : terminal type A, terminal type B and terminal type C.

Bus depot is a garage where buses are stored / parked at night, which is also used to perform maintenance or repair the bus. This depot became the starting point of the bus trip in the morning and the end of the trip at night [4]. The facilities on bus depot include: bus barking area, bus refueling for natural gas and diesel fuels, bus washing area, bus servicing and maintenance facilities, and management building. The activities of a bus depot and workshop can have a significant impact on the

environment. Some steps to improve the quality on bus depot area are: rain water collected and will be used to wash down buses and flush toilets, recycling waste oil, using porous well, and recycling bus wash water.

Porous well is the infrastructure to collect and absorb rainwater (surface run-off) into the ground (SNI 03-2453-2002). One of effective method for food mitigation is porous wells. Porous wells is wells or holes made to collect rain water or surface run-off into ground water. By using the porous well could increasing groundwater levels and reducing surface run-off (rain water) [8].

Green Building Council Indonesia (GBCI) is an independent organization established in 2009 by professionals in design and construction industry who concern about green building practices. The main focus of GBC Indonesia is to pursue the socialization and transformation of sustainable green principles, particularly in building construction industry in Indonesia. Rating tools in green buildings is tools for assessing building level that achieve sustainable concept. For the green building benchmarks in Indonesia, GBC Indonesia issued a rating tool titled GREENSHIP. GREENSHIP is developed by Green Building Council Indonesia (GBC Indonesia) by considering the conditions, natural character and regulations as well standards that apply in Indonesia. GBCI (Green Building Council Indonesia) for neighborhood, contains seven categories: Land Ecological Enhancement, Movement and connectivity, water management and conservation, solid waste and material, community wellbeing strategy, building and energy, and also innovation and future development.

3. Research Methodology

The research method used is as follows:

3.1 Collecting data

This research collects data from secondary data sources. The data are collected by using significant source such as books, journals, internet sources, Indonesia government standard, government database and also from developing theoretical reviews and case study. The data that used in this research are land use map, sample of terminals and bus depots area, and rain intensity.

3.2 Method of Analysis

The steps of this research are : literature study and the research method uses GBCI (Green Building Council Indonesia) standard, which contains seven categories: Land Ecological Enhancement, Movement and connectivity, water management and conservation, solid waste and material, community wellbeing strategy, building and energy, and also innovation and future development.

4. Research Analysis

Research area is Jabotabek area, with the area consist of: DKI Jakarta, Bogor, Tangerang, and Bekasi. Figure 1 presents the map of Jabotabek area for public transport network.

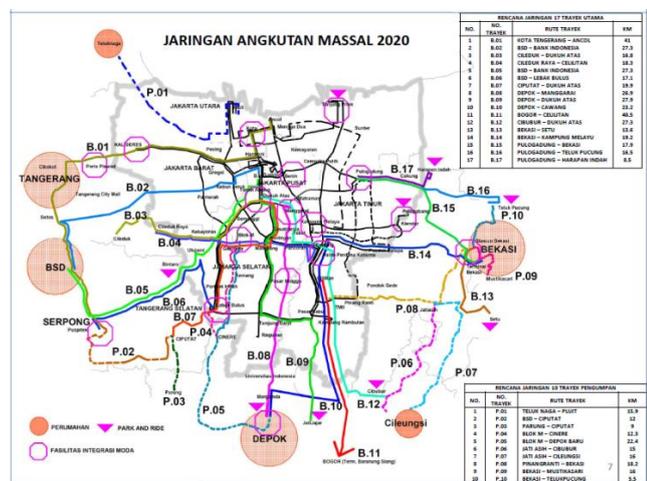


Figure 1. Public Transport Network Masterplan for Jabotabek Area 2014-2030
 Source : *Minister of Transportation Regulation* [11]

The number of terminal in Jabotabek area is shown in the Table 1 below:

Table 1. Terminals in Jabotabek

Type of Terminal	Quantity
Terminal Type A	15
Terminal Type B	16
Terminal Type C	1

Source : BPTJ, 2016

Bus depot sample, inventory survey result, shown in the Tabel 2 below :

Table 2. Bus depot in Jabotabek area

Name of Bus Depot	Area (m2)	Name of Bus Depot	Area (m2)
PPD		Transjakarta	each ± 7.000
1. Ciputat	67.875	1. Cawang	
2. Depok	7.000	2. Kramat jati	
3. Pulogadung	7.344	3. Pinang Ranti	
4. Bekasi	17.860	4. Cakung	
5. Tangerang	3.371	5. Kampung Rambutan	
6. Cakung	12.000	6. Perintis Kemerdekaan	
7. Cawang	9.251	7. Pesing	
Mayasari Bhakti		Sinar Jaya (Cibitung)	
1. Pasar rebo			
2. Cibitung			

Jabotabek regional development masterplan, includes : monitoring the distribution of population growth, restriction of the development in catchment area in the South, especially in Bogor area, recommendation for linear development along the East-West track (Bekasi-Tangerang), and the development priorities in the financial sector, trade and Jakarta tourism. The existing distribution of bus depots and terminals in Jabotabek based on development zoning is shown in the Figure 2.

As shown in the Figure 2, the distribution of bus depots and terminals are located on urban high density residential area, it means, it can give the environmental impacts from urban land use such as : (1) displacement or damage of natural areas by intruding development; and (2) pollution of environmental media (air, water and land). The analysis for Greenship neighborhood categories as follow:

4.1 Land Ecological Enhancement

Some points on land ecological enhancement are: basic green area, green area for public, habitat conservation, land revitalization, and micro climate. The goals are to protect the harmony and the ecological balance of the environment and to improve the quality of healthy environment (public health), to encourage interaction with providing green area, to minimize the impact of development of balance and biodiversity natural species, to avoid the development in green areas and opening new land, and to improve the quality of the microclimate around the area of the region and reduce the Urban Heat Island (UHI). Trinanda [9] using Greenship from GBC Indonesia proposed the bus depot could be design with area 149.121 m² (the bus depot capacity is 500 buses), from which 66% is effective areas and 34% is green area. The GBC Indonesia criteria for minimum area is 5000 m² and green area for public 25% from land area, it means the effective land and green area are fulfill requirement, even green areas for public increase 36%.

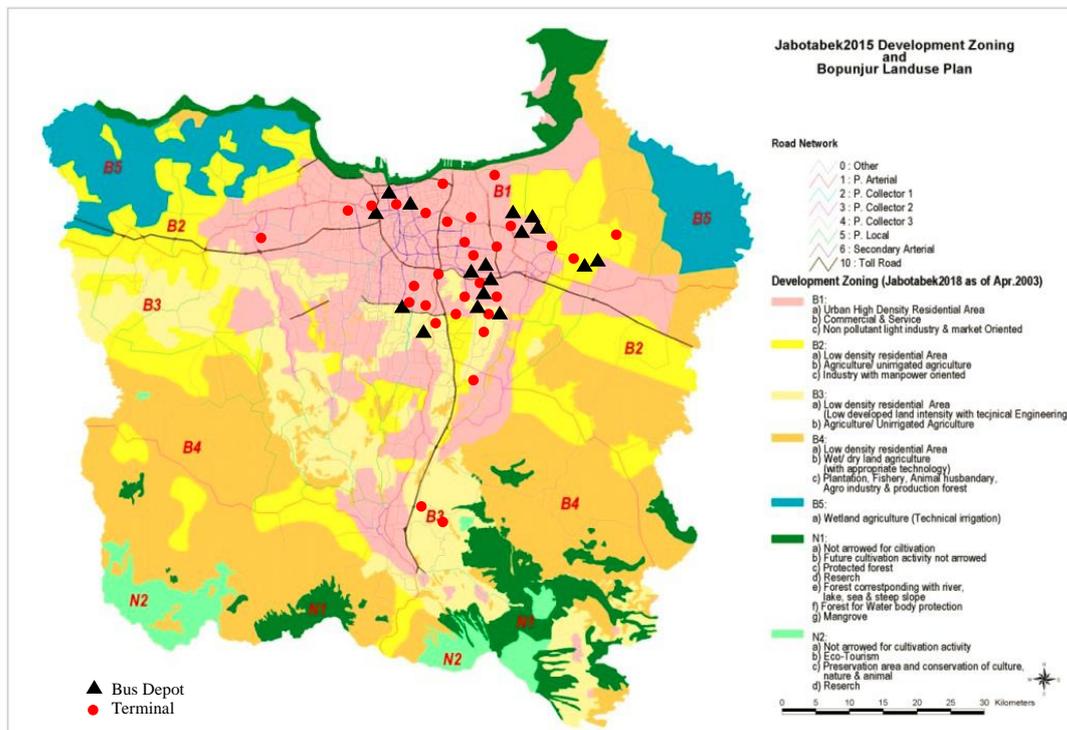


Figure 2. Bus depots and terminals in Jabotabek
 Source: Jabotabek Transportation Masterplan with author analytical drawing added, 2016

4.2 Movement and connectivity

Based on movement and connectivity, the accessibility is necessary, it starts from pedestrian network and facilities, people and goods movement analysis, connected area and walkway strategy, public transportation, public utilities and facilities, universal accessibility, bicycle network and storage, and public car park area. The goals are to ensure their accessibility planning, for the movement of people, goods and vehicle, to make the pedestrian become the priority, to open access from the inside area to the outside area, to apply the principle of connectivity, accessibility, safety, comfort and attractive on a pedestrian path. Jehosua, Santosa and Novita [6] proposed the concept of movement and connectivity bus depot shown in the Figure 3 below:

4.3 Water management and conservation

On Bus depot and terminal, water consumption becomes very important, so it should concern on water consumption at the area, to use of alternative water (besides ground water and PDAM water), to design the rainfall management system, and the waste water management. Trinanda [9] propose for Depok area, bus depot with area 149.12 m² required 28 units porous wells. Each porous well could collect 14,5m³ rain water, it means 406 rain water could be collected and 76% of areas could be used as catchment area for water conservation.

4.4 Solid waste and material

In this case, there are several things should be concerned : reduce the negative impact on the environment through solid waste management (garbage), extend the life cycle and add value to the benefits of waste through processing environmental friendly waste, reduce waste taken to landfills

(TPA), using environmental friendly materials, and recycled and reuse materials for road infrastructure.

The main potential problems at terminals and bus depots are traffic congestion caused by buses entering and leaving the area, pollution from exhaust fumes and excessive noise from the vehicles themselves and from other workshop activities. Less visible, but often more serious on bus depots, is environmental damage caused by waste oil or spilled fuel entering the drainage system or polluting nearby rivers. A vehicle workshop generates a considerable quantity of waste oil and if this is not disposed of properly it can cause serious pollution. These environmental problems can be minimized with good design of the facilities, proper maintenance, and good discipline and housekeeping.



Figure 3. Movement and Connectivity at bus depot area
Source: Jehosua , Santosa and Novita [6]

4.5 Community wellbeing strategy

Provide public facilities for public activity, make the society became priority, increase awareness, knowledge and participation of the society about the concept sustainability, create an area (neighborhood) safe and comfortable.

4.6 Building and energy

Darmanto and Wiguna (2013) suggested that there are some criteria of green building: alternative water resource, thermal comfort, visual comfort (SNI 16-7062-2004), natural lighting , water use reduction (SNI 03-7065-2005), environmental tobacco smoke control and energy measure (SNI 03-6389-2000).

4.7 Innovation and future development

In this case, sustain the implementation of sustainability concept in the area, create the innovation for the environmental sustainability.

5. Conclusion

The result of this reseachare, by using the GBCI standard which contains seven categories: Land Ecological Enhancement, Movement and connectivity, water management and conservation, solid waste and material, community wellbeing strategy, building and energy, and also innovation and future development. The green design concept of Public Transport Infrastructure for bus depot and terminal, the land ecological impact could be decreased. The effective areas that are required at least

5000 m². The green areas for public increase 36% and 76% of areas could be used as catchment area for water conservation.

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