ULTIMARCH
International Journal of Sustainable Architecture, Urban, and Multimedia Technology
e-ISSN: xxxx-xxxx, p-ISSN: xxxx-xxxx
Volume I, Issue 2 [2024]
https://ejournals.umn.ac.id/index.php/ULTIMARCH

Characterization of Corridor Space on Soekarno Hatta Arterial Road Bandung Based on Air Pollution System

Rahmi Elsa Diana[1]
[1]Architecture Department, Universitas Multimedia Nusantara, Tangerang, Indonesia
rahmi.diana@lecturer.umn.ac.id

Keywords:
Pollutant
Motorized Vehicle
Arterial Road
Green Corridor

Submitted: November 11th, 2024
Revised: December 14th, 2024
Accepted: December 23rd, 2024

Abstract

Motorized vehicles are a major contributor to air pollution, emitting both particulate matter and gaseous pollutants that pose significant health risks. To mitigate the impact of emissions from motor vehicles, the development of green corridors along roadways is essential. Road corridors have distinct characteristics that require comprehensive study and analysis, particularly in relation to pollution. Bandung is a densely populated urban area with high motor vehicle activity. Additionally, its unique topography—a basin surrounded by mountains and hills—makes it particularly susceptible to air pollution. This study focuses on Soekarno Hatta Road, specifically the section from the Cibeureum Roundabout to the Cibiru Roundabout. As the longest road in Bandung and classified as a primary arterial road, this corridor plays a crucial role in the city's transportation network. The objective of this study is to analyze road space corridors based on air pollution system. Three key road characteristics are closely linked to pollution: traffic congestion as the primary pollutant source, land use as the receptor, and green corridors as barriers. An effective green corridor is expected to aim at optimally reducing pollution, thereby maintaining air quality and safeguarding public health, particularly for pedestrians and drivers.

1. INTRODUCTION

Air pollution is primarily contributed by the transportation sector. This sector continues to grow in line with the increasing population. According to the World Bank (1997) as cited in Rima (2004), the population, especially in developing countries, is increasing rapidly. This growth is accompanied by an increased demand for motor vehicles. Indonesia, as a developing country, has experienced a significant increase in the number of motor vehicles, approximately 8-12% annually (Directorate of Traffic, 2000).

The rising number of motor vehicles leads to air pollution. Pollutants released during the combustion process include toxic gases as primary pollutants and particulate matter as secondary pollutants. Toxic gases have a wider dispersion radius compared to particulate matter. Toxic gases are prevalent pollutants that have significant health impacts on both children and adults. In children, toxic gases can result in reduced intelligence (IQ points) and impaired learning abilities. In adults, toxic gases can cause high blood pressure, heart attacks, infertility, and at very high levels, can be fatal (Abdullah, 2012).

Therefore, efforts are needed to mitigate the impact of these pollutants. One approach is to develop green infrastructure around pollution sources. In roadside areas, green infrastructure functions as a barrier to pollutants produced by motor vehicles and as an air buffer for both users and nearby residents.

Bandung is an urban area with relatively high motor vehicle activity. Additionally, the location and landscape of Bandung are unique, consisting of a basin surrounded by mountains and hills. The shape of the basin affects the air dilution capacity or, in other words, obstructs air circulation. Such topographical conditions make Bandung highly susceptible to air pollution (Adi K, 2010).

The objective of this study is to analyze road space corridors based on air pollution system. Three key road characteristics are closely linked to pollution: traffic congestion as the primary pollutant source, land use as the receptor, and green corridors as barriers. Green corridors as barriers must be able to reduce pollution optimally, thereby maintaining air quality and protecting the health of individuals working in the area, particularly pedestrians and drivers.

2. LITERATURE REVIEW

2. 1 ARTERIAL ROAD AND POLLUTION

A road is a land transportation infrastructure that includes all parts of the road, including auxiliary structures and facilities intended for traffic, located on the ground surface, above the ground surface, below the ground surface, and/or over water, as well as on the surface of the water, excluding railroads and cable roads (Law No. 38 of 2004 on Roads). According to the 2004 Law, the primary road network system is a network system that serves the distribution of goods and services for the development of all regions at the national level, connecting all distribution service nodes in the form of activity centers. An arterial road is a public road that serves the main transportation function with characteristics such as long-distance travel, high average speed, and limited access points for efficiency. According to the Ministry of Public Works (1997), the cross-section of a road consists of traffic lanes, road shoulders, medians, green lanes, pedestrian paths, bicycle lanes, and drainage channels.

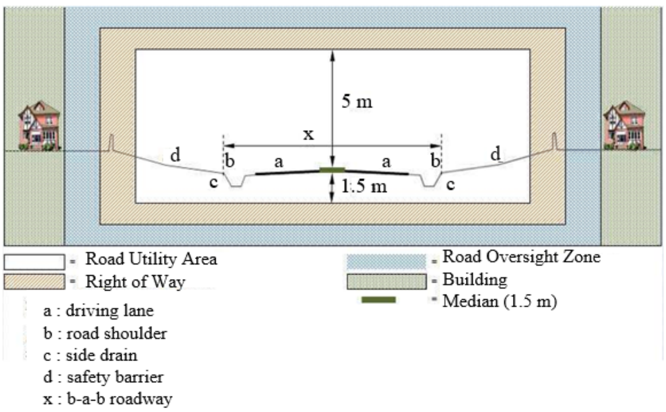

Figure 1. Road Components
(source: Ministry of Public Work, 2012)

According to the Directorate General of Spatial Planning (2004), the characteristics of a primary arterial road are as follows:

1. A primary arterial road is designed with a minimum planned speed of 60 (sixty) kilometers per hour (km/h);
2. The minimum width of the road's service area is 11 (eleven) meters;
3. The number of access points is efficiently limited; the distance between access points/direct accesses is a minimum of 500 meters, and the distance between direct land access (such as large land plots) must be over 1000 m², with utilization for residential purposes;
4. Intersections on primary arterial roads are regulated with specific measures in accordance with traffic volume and characteristics;
5. Adequate road facilities must be provided, such as signs, markings, traffic control lights, street lighting, and others;
6. Special lanes should be provided for bicycles and other slow-moving vehicles;
7. Primary arterial roads must have 4 lanes or more and should be equipped with a standard median;
8. If the distance requirements for road access or land access cannot be met, slow lanes (frontage roads) and special lanes for non-motorized vehicles (such as bicycles, rickshaws, etc.) must be provided on the primary arterial road.

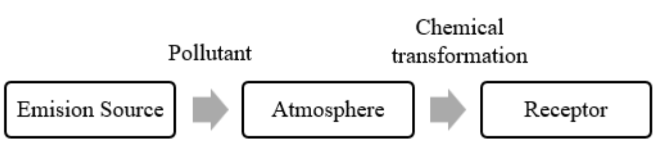

Figure 2. Air Pollution System Components
(source: Seinfeld in Achmad, 2010)

Air pollution refers to the introduction or incorporation of substances, energy, or other components into the ambient air as a result of human activities, leading to a decline in air quality to a level where the ambient air is no longer fit for use (Government Regulation No. 41 of 1999). According to Seinfeld, as cited in Achmad (2010), there are three components of air pollution: the pollution source, the transport medium, and the receptor. The interconnection between these components is illustrated in Figure 2.

Motor vehicles are anthropogenic sources resulted from human activities. Motor vehicles as a pollutant source are classified as line sources, moving sources, and continuous sources. They are considered line sources due to their alignment with roadways, and continuous sources because vehicles continuously traverse the road (Rusdianto, Yoewono & Rektivianto, 2008). Motor vehicles, as a source, emit pollutants to receptors. Before reaching the receptor, pollutants may either be deposited (lost) or diluted (reduced). These processes occur due to atmospheric resistance. Receptors can also act as barriers for pollutants from other receptors. According to Achmad (2010), the deposition process in the atmosphere is divided into two types: wet deposition and dry deposition. Wet deposition occurs at a height of 100 meters above the ground (Seinfeld, 1986). In this process, pollutants are absorbed into droplets, which are subsequently removed through precipitation. Meanwhile, dry deposition refers to the transfer of materials, either gaseous or particulate, from the air to the Earth's surface, such as land, water, and vegetation. This process occurs from ground level up to a height of 100 meters.

Air pollution in urban areas is predominantly caused by transportation activities. These activities trigger emissions from motor vehicles. According to Hoesodo (2004), motor vehicle emissions are exhaust gases resulting from the combustion of a compound, in this case, fossil fuels with oxygen. The larger the combustion process, the higher the volume of exhaust gases produced. The pollutants generated by motor vehicle emissions consist of primary pollutants in the form of gases (CO, HC, SO2, NOx) and secondary pollutants in the form of particulates. Emissions from motor vehicles contribute 60% of CO emissions, 30% of HC and NOx emissions, and 75% of particulate emissions in the environment. Hoesodo (2004) explained that exhaust emissions from motor vehicles generate gases and particulate pollutants. At certain concentrations, these pollutant gases are harmful to human health and other living organisms. The following table describes some types of pollutants and their dangers to humans.

Table 1. Types of Pollutants and Effects on Humans

No	Types of Pollutant	Effects on Human
1	CO	Decreases the blood's ability to carry oxygen, weakens thinking, causes heart disease, dizziness, fatigue, headaches, and death
2	NO_x	Worsens heart and respiratory diseases, and causes lung irritation
3	SO_2	Worsens respiratory tract diseases, weakens breathing, and causes eye irritation
4	HC	Affects the respiratory system, some types can cause cancer
5	O_3	Worsens heart and respiratory diseases, causes eye irritation, irritation of the throat, and discomfort in the chest.
6	NH_3	Irritation of the respiratory tract
7	H_2S	Dizziness (vertigo), eye and throat irritation, and toxicity at high levels
8	Metal	Causes respiratory diseases, cancer, nerve damage, and death

Source: Nukman (1998), Holper & Noonan (2000) in Ruhiyat (2009)

According to Hoesodo (2004), there are two variables that influence pollutant concentration: traffic volume and wind speed. He states that the concentration of emissions is directly proportional to traffic volume and inversely proportional to wind speed.

2.2 GREEN CORRIDOR AS ROAD INFRASTRUCTURE

Green infrastructure is a strategically planned network aimed at creating landscapes and other green open spaces to conserve ecosystem values and functions, thereby providing benefits to humans. This network is characterized by uninterrupted connectivity. According to its spatial hierarchy, green infrastructure is divided into several components: hub, site, and link. A hub consists of large urban parks, while a site refers to smaller parks, typically found in residential areas. Links are green corridors that connect hubs with hubs, hubs with sites, or sites with sites.

According to Law No. 26 of 2007 on Spatial Planning, it is stated that the proportion of green open space in a city should be at least 30% of the city's land area. Of this proportion, 20% should be provided by the government, while the remaining 10% is accounted for by privately or community-owned green spaces. Green infrastructure consists of a group of green open spaces, either in the form of areas or corridors. One form of green infrastructure is the green corridor along roads. There are several structures within road green corridors, including road verges, medians, and traffic islands.

According to the Ministry of Public Works (PU) (1996), there are several main criteria to consider when selecting vegetation for road landscapes are: the root system should not damage the road construction; easy maintenance; branches and twigs should not be easily broken; leaves should not easily fall off. Each species of vegetation has distinctive visual characteristics. As a landscape element, the visual characteristics of vegetation influence its role and function in design. According to Booth (1983), the visual characteristics of vegetation are classified based on size, shape, color, and texture. Vegetation placement on road landscapes must adhere to the geometric specifications of the road. Since different parts of the road have different locations and sizes, the type of vegetation must be adjusted accordingly. The following are the vegetation placement requirements relative to road geometry:

1. For verge plantings, vegetation should be placed at the edge of the traffic lanes, between the vehicle lanes and the pedestrian sidewalk (curb). The choice of plants to be planted in this area must meet the technical criteria for plant placement and be adjusted to the width of the plant strip.
2. For median strips, the plantable area must have a minimum width of 0.80 meters, while the ideal width is 4.00–6.00 meters. The selection of plant species should consider their location, especially in intersections, U-turn areas, and spaces between intersections and U-turns. This applies to both raised and lowered medians.
3. For corners, several factors must be considered when placing and selecting plants, such as sight distance, the length of the curve, and the side clearance at the curve. Low plants (shrubs or bushes) with dense foliage and bright colors, with a maximum height of 0.80 meters, are recommended for corner areas.
4. At intersections, sight distance must remain clear to avoid obstructing driver visibility. Plant selection and placement must consider the intersection design, whether it is at-grade or grade-separated.

Referring to the Ministry of Public Works regulations on tree planting in road networks, the selection of vegetation should align with the intended function. These functions vary depending on the placement of the vegetation. Vegetation in verge green corridors does not serve the same function as vegetation in medians. Each function has specific requirements. For example, shade trees should be placed in verge green corridors (plant strips), with branches at least 2 meters above the ground, adjacent to pedestrian paths, with a non-drooping branching structure and dense foliage. In medians, shade vegetation is not necessary. Instead, the vegetation should be selected to prevent headlight glare from vehicles, and typically consists of shrubs planted closely with a height greater than 1.5 meters.

Allan Jacobs explains that one factor in creating a great street is improving the quality and character of the street. Vegetation, as an element of the corridor, can support this goal. There are four roles of vegetation in enhancing the quality of a street:

1. Green corridors are planned to address environmental issues or improve environmental quality. Vegetation, as the main element, plays a crucial role in achieving the goals of the green corridor.
2. In a corridor, vegetation can function as shade, glare reduction, pollution absorption, noise reduction, windbreaks, and boundaries. These functions support the role of vegetation in providing comfort and safety along the street.
3. Vegetation has distinctive visual characteristics, making it a key element in shaping the image of a corridor.
4. Like endemic plants that can represent a city or country, vegetation in green corridors can also symbolize a specific area.

2.3 VEGETATION AS POLLUTANT BARRIER

These green infrastructures serve as barriers for pollutants before they reach human receptors. Vegetation, as a medium for deposition, can reduce airborne pollutants. The deposition of pollutants by vegetation occurs at a height of 0 to 100 meters. Based on the Big-Leaf Resistance Model (Yang et al., in Achmad, 2010), the reduction of pollutants is directly proportional to the area and type of vegetation. A higher deposition velocity results in greater pollution reduction. Deposition velocity values are influenced by the type of vegetation. Tall trees deposit pollutants more efficiently than shorter trees, and shorter trees are more efficient than shrubs, which in turn are more efficient than grass. The higher the deposition velocity, the better the pollution barrier. In his research, Dr. Nizar measured the absorption capacity of 147 species of vegetation along road green corridors in absorbing pollutants. It was found that vegetation exhibits varying absorption capacities, which can be classified into three levels: high absorption (>30 µg/hour), medium absorption (15–30 µg/hour), and low absorption (<15 µg/hour). The following 25 species include trees and shrubs with moderate to high absorption capacity:

1. **Tree species with high absorption capacity:** dadap kuning (*Erythrina variegata*), kenanga (*Cananga odorata*), saputangan (*Brownea capitella*), flamboyan (*Delonix regia*), kapuk (*Ceiba pentandra*), kesumba (*Bixa orellana*), trembesi (*Samanea saman*), cempaka (*Michelia champaca*), and hujan mas (*Cassia multijuga*).
2. **Tree species with moderate absorption capacity:** cemara angin (*Casuarina equisetifolia*), pohon kaya (*Khaya senegalensis*), ketapang (*Terminalia catappa*), kecrutan (*Spathodea campanulata*), bunga kupu-kupu (*Bauhinia purpurea*), angsana (*Pterocarpus indicus*), mangga (*Mangifera indica*), bambu Jepang (*Arundinaria sp.*), kayu putih (*Eucalyptus alba*), and kasia golden (*Cassia biflora*).

3. **Shrub species with high absorption capacity:** kaliandra (*Calliandra surinamensis*), kembang merak (*Caesalpinia pulcherrima*), bougenvil merah (*Bougainvillea glabra*), kacapiring (*Gardenia augusta*), miana (*Coleus blumei*), and lantana (*Lantana camara*).

Mansur & Pratama (2014) conducted a study measuring the CO_2 absorption potential of 21 roadside tree species in Kota Bogor. The study categorized absorption levels into three groups: high absorption (>10 µmol/m²/s), moderate absorption (8–13 µmol/m²/s), and low absorption (<8 µmol/m²/s). Tree species with high absorption capacity included kersen (*Muntingia calabura*), bintaro (*Cerbera manghas*), dadap (*Erythrina crista-galli*), and trembesi (*Albizia saman*). Those with moderate absorption capacity included angsana (*Pterocarpus indicus*), kenari (*Canarium indicum*), tanjung (*Mimusops elengi*), and mahoni (*Swietenia macrophylla*). Meanwhile, tree species with low absorption capacity included burahol (*Stelechocarpus burahol*), saputangan (*Maniltoa grandiflora*), and damar (*Agathis alba*).

Fahia, Baskara, & Sitawati (2015) analyzed the ability of 15 shrub species in road medians to absorb lead (Pb). Three species categorized as high-absorption shrubs were *Plumbago auriculata*, *Pachystachys lutea*, *Iresine herbstii*, and *Rhododendron obtusum*. Shrubs with moderate absorption capacity included *Pseuderanthemum reticulatum*, *Excoecaria cochinchinensis*, *Codiaeum variegatum*, and *Tabernae corymbosa variegata*. Meanwhile, low-absorption shrubs included bougenvil (*Bougainvillea spectabilis*), andong (*Cordyline fruticosa*), dracaena tricolor (*Dracaena marginata tricolor*), dracaena refleksa (*Dracaena reflexa*), kayu kuning (*Osmoxylum lineare*), pucuk merah (*Syzygium oleina*), and taberna (*Tabernae corymbosa*).
.

3. METHOD

The scope of this study is limited to the Soekarno Hatta road, specifically from the Cibeureum roundabout to the Cibiru roundabout. This road is the longest in Bandung city, with a length of 18.46 km (www.bandung.go.id). The study area is also limited to the right of way, from the construction safety boundary (parcel fence) of one plot to the construction safety boundary of the next plot. This paper refers to three components of air pollution: the source of pollutants, the medium, and the receptor. There are at least three characteristics of the corridor related to pollution:

1. **Characteristics of Traffic Congestion Along Soekarno-Hatta Road as a Source of Pollution** Traffic data is presented in tabular form, derived from Google Maps snapshot data. The data was collected over a one-week period accessed on September 19th, 2013. Subsequently, the data was interpreted into a congestion characteristic map.
2. **Characteristics of Land Use Along Soekarno-Hatta Road as an Indicator of Pollution Receptors** The data consists of a reinterpretation of land use functions based on Google Maps pinpoint scanning from 2014.
3. **Characteristics of Existing Green Spaces and Corridors Along Soekarno-Hatta Road as Pollution Barriers** The data was obtained through direct observation and field surveys conducted along Soekarno-Hatta Road. Observations were carried out on October, 2014. The results are presented in tabular form and subsequently interpreted into a green space characteristic map.

By using a qualitative approach through mapping and observation, the author aims to characterize and identify the corridor space along the Soekarno Hatta road.

4. RESULT AND DISCUSSION

According to its function, Soekarno Hatta road is classified as a primary arterial road, which serves regional traffic with a minimum speed of 60 km per hour. It connects the western and eastern parts of Bandung in the southern area of the city. In addition to connecting the western and eastern parts of Bandung, Soekarno Hatta road also connects residential complexes and vital parts of the city, such as the city center (Alun-alun), the Cibaduyut shoe craft center, the main Leuwi Panjang terminal, Caringin and Gedebage central markets, and the toll road. Residential complexes are connected through secondary arterial roads to Soekarno Hatta road, while vital city areas are connected through primary collector roads. The toll road is connected through the primary arterial road.

Each connecting road forms an intersection with Soekarno Hatta road, resulting in 7 important intersections and 2 roundabouts. Eight of these intersections and rounabouts are signalized, while one is a non-signalized roundabout i.e Cibiru roundabout. These two roundabouts mark the western and eastern ends of Soekarno Hatta road.

Table 2. Soekarno Hatta Road Segment and Intersection Signal

No	Road Segment	Length (m)	Inter-section	Traffic Signal
1	Cibereum Roundabout (CBR) – Pasirkoja (PK)	1.477	Cibereum	Yes
			Pasirkoja	Yes
2	Pasirkoja (PK) – Kopo (K)	2.353	Kopo	Yes
3	Kopo (K) – Cibaduyut (CD)	642	Cibaduyut	Yes
4	Cibaduyut (CD) – M. Toha (MT)	1.577	M. Toha	Yes
5	M. Toha (MT) – Buahbatu (B)	2.678	Buahbatu	Yes
6	Buahbatu (B) – Kiaracondong (KC)	983	Kiara-condong	Yes
7	Kiaracondong (KC) – Gedebage (G)	5.721	Gedebage	Yes
8	Gedebage (G) – Cibiru Roundabout (CR)	2.790	Cibiru	No

Source: Author, 2014

Figure 3. Soekarno Hatta Road Condition at 12pm (Author, 2014)

Top (left to right): Cibaduyut Intersection; Segment 7 KC – G,
Down (left to right): Gedebage Intersection; Cibiru Roundabout.

The pollution characteristics can be observed from the vehicle congestion points along the road. Observations show that the most frequent congestion occurs at intersections and around the Leuwi Panjang terminal. The longest vehicle queues occur at segments 3 and 6 due to the short distances between intersections. Secondary data from Google Maps snapshots indicate that the most significant congestion occurs in segments 3 to 6, from the Kopo intersection to the Kiaracondong intersection. The average congestion occurs during commuting hours, specifically between 06:30 – 09:00, 12:00 – 13:00, and 16:00 – 19:00. The congestion data is presented in Table 3. The data is reinterpreted into a map in Figure 4 to illustrate the daily average vehicle density on Soekarno-Hatta Road.

Table 3. The Congestion in Soekarno Hatta Road

Day	Time	Road Segment							
		CBR - PK	PK - K	K - CD	CD - MT	MT - B	B - KC	KC - G	G - CB
Mon	8am	red / white	green	green	white	yellow	green	green / yellow	green
	12pm	red / white	yellow	red	green	green / red	yellow	yellow / green	green
	5pm	red / white	white	yellow	white	white	yellow	yellow	yellow
Tue	8am	white	white	white	yellow	yellow	white	yellow / green	green
	12pm	red / white	green	yellow	green	green / yellow	red	red / green	green
	5pm	red / white	white	red	yellow	yellow	yellow	yellow / green	green
Wed	8am	white	yellow	white	yellow	yellow	green	yellow / green	green
	12pm	white	green	green	white	yellow	green	yellow / green	green
	5pm	white	white	white	green	green	yellow	yellow / green	green
Thur	8am	white	yellow	yellow	green	green	green	green / yellow	yellow
	12pm	white	white	red	green	green	red	red / yellow	yellow
	5pm	red / white	white	green	yellow	yellow	red	red / green	green
Fri	8am	red / white	white	white	green	green	red / yellow	green / yellow	green
	12pm	white	white	red	green	green	red	red / yellow	yellow
	5pm	red / white	white	green	yellow	yellow	red	red / green	green
Sat	8am	red / white	white	white	green	green	red / yellow	yellow / green	green
	12pm	white	green	yellow	yellow	yellow	yellow	yellow / green	green
	5pm	red / white	yellow	green	yellow	yellow	yellow	yellow / green	green
Sun	8am	red / white	green	yellow	green	green	green	green	green
	12pm	red / white	green	red	green	green	red	red / yellow	green
	5pm	red / white	green	yellow	green	green	red	red / yellow	yellow

Legends: heavy (red) medium (yellow) light (green) no vehicle (white)
Source: googlemaps snapshot, reinterpreted by Author (2014)

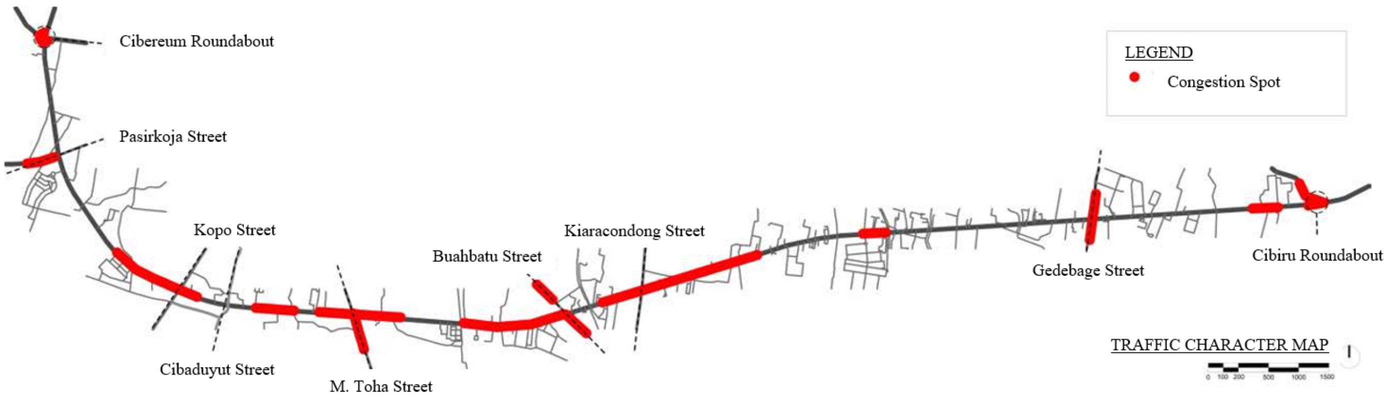

Figure 4. Soekarno Hatta Road's Traffic Character Map (Author, 2014)

The size of Soekarno Hatta road is influenced by the width of the right of way. The width of each segment varies depending on the building density and the width of the land that can be cleared. The width of the road decreases as one moves westward. In the western part, the traffic lanes consist of two directions with four lanes. In the eastern part, the traffic lanes are wider and consist of two directions with two types of lanes: fast lanes and slow lanes. Each of the fast and slow lanes consists of two lanes. Thus, the eastern part of Soekarno Hatta road has a total of eight lanes. The concept of land use is closely tied to the character of the road, particularly the facades of existing buildings that directly face the road. These facades contribute to the visual character of the space for both drivers and pedestrians. The variety of land uses along Jalan Soekarno Hatta includes industrial, commercial, service, and government functions (see Figure 5). The distribution of these land uses creates a spatial typology that affects the quality of the green corridor along the road. In general, there are four character types based on land use along Jalan Soekarno Hatta:

1. **Cibeureum Roundabout to Kopo Intersection (CBR – K)**: Industry and services.
2. **Kopo Intersection to Kiaracondong Intersection (K – KC)**: Commercial and services.
3. **Kiaracondong Intersection to Gedebage Intersection (KC – G)**: Commercial, government, and services.
4. **Gedebage Intersection to Cibiru Roundabout (G – CB)**: Industry and green space.

The vegetation density along Soekarno Hatta Road varies across segments, influenced by building density and land use functions. From west to east, vegetation density tends to increase. The vegetation density can be categorized into three distinct segment based on their characteristics:

1. **Segment A** (Segments CBR–CD): From the Cibeureum roundabout to the Kopo intersection, the vegetation density is relatively sparse.
2. **Segment B** (Segments CD–KC): From the Kopo intersection to the Kiaracondong intersection, vegetation is more abundant and planted at higher densities.
3. **Segment C** (Segments KC–CB): Vegetation is planted very densely along the roadside greenways and medians.

The types of existing vegetation and its location compared to the literature and the ability to absorb the pollutant are detailed in Table 4 and Table 5.

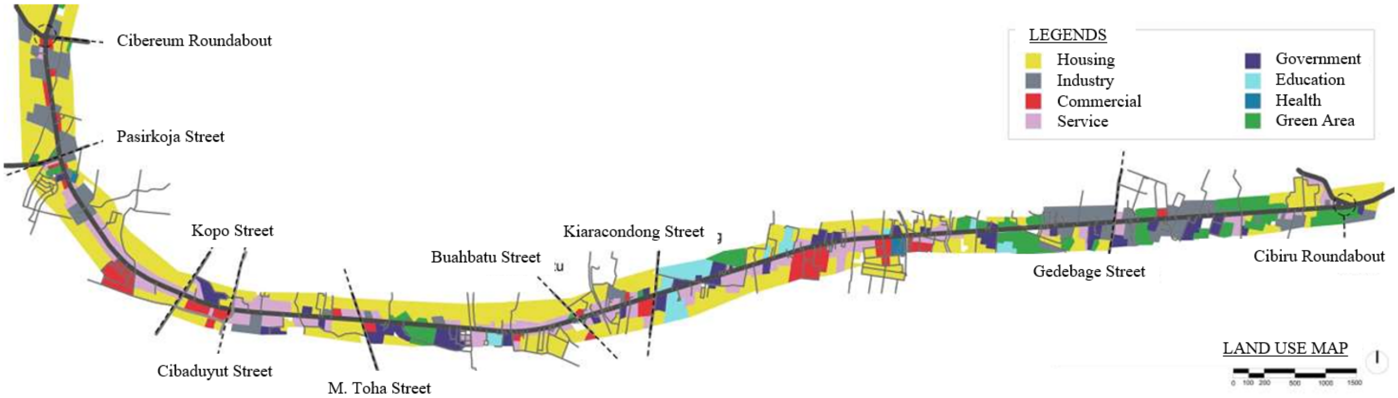

Figure 5. Soekarno Hatta Road's Land Use Map (googlemaps Reinterpretation, 2014)

Figure 6. Existing Tree in Corridor
Left to Right: Top (Segment A – B);
Swietenia macrophylla & *Filicium decipiens,*
Down (Segment B – C): *Ficus lyrate* & *Pterocarpus indicus*
(Author, 2014)

The average width of the roadside green corridor varies across different segments. In Segment A, the green corridor is relatively narrow and merges with the pedestrian lane. The average distance from the building edge to the pedestrian lane is 1.6 meters. The limited width of the roadside green corridor restricts tree growth, preventing optimal development. The existing vegetation types along Soekarno-Hatta Road exhibit significant variation from west to east. From the Cibeureum Roundabout to the Kopo Intersection, mahogany (*Swietenia macrophylla*) is the dominant species in the roadside greenway. These trees have an average height of 3–6 meters and a trunk diameter of approximately 0.5–0.8 meters. Due to their relatively small size and the planting intervals of 8–15 meters, this segment appears barren. Meanwhile, the median is exclusively planted with oleander (*Nerium oleander*). In some areas, shrubs have been planted on the paved sections of the median, which contradicts the road landscaping guidelines set by the Ministry of Public Works and Housing (PUPR).

Table 4. Comparison between Existing Tree Species and Literature

No	Existing		Literature			
	Vegetation	Current Location	Apro-priate Location	Height (m)	Canopy (m)	Absorp-tion
1	*Swietenia macrophylla*	A – C, Corridor	Corridor - shade	25		CO_2 – mod
2	*Filicium decipiens*	A – B, Corridor	Corridor - shade	6 – 10.5	6	CO – mod
3	*Muntingia calabura*	B, Corridor	Corridor - shade	3 – 12		CO_2 – high
4	*Bixa Orellana*	B, Corridor	Corridor - shade	6		NO_x – high
5	*Pterocarpus indicus*	B – C, Corridor	Corridor - shade	40	2	NO_x – mod
6	*Ficus lyrate*	B – C, Corridor	Corridor - shade	12 – 15		
7	*Leucaena leucocephala*	C, Median	Corridor - shade	6 – 15		
8	*Erythrina cristagalli*	C, Median	Corridor - shade	10 – 15	2 – 3	CO_2 – high
9	*Polyalthia longifolia*	C, Median	Corridor - guide	9 – 13.5	2.4 – 3	NO_x – low
10	*Dialium indum*	C, Median	Corridor - shade	40		
11	*Elaeocarpus grandifloras*	C, Median	Corridor - shade	25		

mod = moderate

Analyze from various sources (2024)

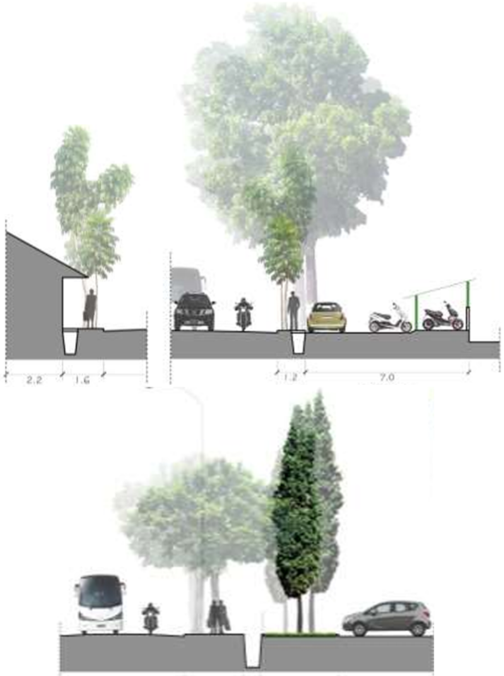

Figure 7. Sketch of the Existing Green Edge Corridor
Left to Right: Top; Segment A & Segment B
Down; Segment C (Author, 2014)

Figure 8. Existing Vegetation in Median
Left to Right: 1st Row: *Leucaena leucocephala, Erythrina cristagalli, Elaeocarpus grandifloras*
2nd Row: Caesalpinia pulcherrima, Polyalthia longifolia, Nerium oleander
3rd Row: Euphorbia milii, Cordyline fruticosa (Author, 2014)

In Segment B, the roadside vegetation is more diverse. In addition to mahogany, other tree species include *Filicium decipiens*, *Muntingia calabura*, *Bixa orellana*, *Pterocarpus indicus*, and *Ficus lyrata*. This segment has a relatively wider space between the building edge and the roadside due to the presence of parking areas. In some locations, tree species are used as barriers between private parking areas and the right-of-way. However, the green corridor within the right-of-way remains narrow and continues to merge with the pedestrian lane, with an average combined width of 1.2 meters. Meanwhile, vegetation on the median is very sparse, appearing only near intersections, with species including *Cordyline fruticosa* (hanjuang), bougainvillea (*Bougainvillea spp.*), and oleander (*Nerium oleander*). Segment C features a wide roadway with eight lanes. The width of the roadside green corridor varies, with an average of 2.7 meters. The roadway is also equipped with a median strip measuring 2–3 meters in width. The vegetation on the median displays a high level of diversity. In some areas, trees have been planted in the center of the median, which is not recommended according to the planting guidelines established by PUPR. The vegetation on the median can be seen in Figure 8. Vegetation has the potential to act as a pollutant barrier. Several plant species along Soekarno-Hatta Arterial Road exhibit high pollution absorption capacity, such as *Muntingia calabura* and *Erythrina cristagalli* to CO_2, *Bixa Orellana* and *Caesalpinia pulcherrima* to NO_x. Next, certain species, including *Swietenia macrophylla, Filicium decipiens*, *Pterocarpus indicus, Nerium oleander,* and *Bougenvillae sp* have the ability to absorb different substances (gasses or particle) at a moderate level. The rest, *Polyalthia longifolia*, *Cordyline fruticose*, and *Lantana Camara* have low absorption capacity. However, these plants can serve as visual barriers in the road median. The details of each species' absorption capacity are presented in Table 4 and Table 5.

Table 5. Comparison between Existing Shrub Species and Literature

No	Existing		Literature			
	Vegetation	**Location**	**Appro-priate Location**	**Height (m)**	**Canopy (m)**	**Absorp-tion**
1	*Nerium oleander*	A, C – Median	Highway median	1.5 – 3		NO_2 – mod
2	*Cordyline fruticosa*	A – Intersection	Median		3.5	Pb – Low
3	*Euphorbia milii*	B – Median	Median			
4	*Bougenvillae sp*	B, C – Median	Median (height <1m), Highway median	0.9 – 6		NO_2 – mod, Pb – low
5	*Lantana Camara*	B – Median	Intersection & U-turn	0.9 – 1.2	0.3 – 0.9	NO_x – low
6	*Caesalpinia pulcherrima*	C – Median	Highway median	2 – 4	3	NO_x – high

mod = moderate

Analyze from various sources (2024)

Table 6. General Characteristics of Soekarno Hatta Road

Type	Road Segment	Length (m)	Traffic Lane	Congetion Distribution	Land Use	Typical Vegetation
A	Cibereum Roundabout – Kopo Intersection	3.830	2 ways, 4 lanes	Large	Industry and Service	*Swietenia macrophylla* (mahoni) & *Nerium oleander*
B	Kopo Intersection – Kiaracondong Intersection	5.880	2 ways, 4 lanes	Extreme	Commercial and Service	*Swietenia macrophylla* (mahoni)
C	Kiaracondong Intersection – Cibiru Roundabout	8.511	2 ways, 8 lanes	Uneven	Commercial, Government, Service, Industry & Green Area	*Ficus lyrate* (biola cantik)

Source: Analysis, 2014

The varying density and types of existing vegetation across different road segments define the characteristics of Soekarno Hatta Road. Broadly, there are three distinct characteristics that divide the road into three segments: from the Cibereum roundabout to the Kopo intersection, from the Kopo intersection to the Kiaracondong intersection, and from the Kiaracondong intersection to the Cibiru roundabout.

1. The first characteristic, Type A is dominated by mahogany and oleander with low vegetation density.
2. The second, Type B is characterized by medium-density mahogany.
3. The third, Type C is defined by dense plantings of fiddle leaf fig trees *(Ficus lyrata).*

5. CONCLUSION

Air pollution consists of three main components: pollutant sources, transmission media, and receptors. In this study, the primary pollutant source is vehicle exhaust emissions along Soekarno Hatta Road. The transmission medium refers to the atmospheric conditions surrounding the road, while the receptors include road users—such as pedestrians and drivers—as well as occupants of buildings near the roadway. A vegetative barrier is required along the road corridor. Vegetation plays a crucial role in facilitating the deposition of air pollutants originating from motor vehicle emissions. At least three characteristics of the road are closely related to pollution:

1. **Traffic congestion patterns** along Soekarno Hatta Road as the pollution source.
2. **Land use patterns** along Soekarno Hatta Road. The building function characteristics are used to analyze the potential for additional green spaces.
3. **Existing green spaces and corridors** along Soekarno Hatta Road as pollution barriers.

Based on congestion patterns, land use, and vegetation, Soekarno Hatta Road can be categorized into three main characteristics, corresponding to the segments (see Table 6):

- **Segment A**: From the Cibeureum roundabout to the Kopo intersection, covering 3,830 meters. This segment consists of two lanes and four sub-lanes and is characterized by frequent traffic congestion points. The predominant land use in this segment is industrial, with mahogany as the signature vegetation in the roadside greenways and oleander in the median.
- **Segment B**: From the Kopo intersection to the Kiaracondong intersection, spanning 5,880 meters. This segment also has two lanes and four sub-lanes, with near-continuous traffic congestion along the route. The dominant land use in this area is commercial and services, with mahogany as the primary roadside greenway vegetation.
- **Segment C**: From the Kiaracondong intersection to the Cibiru roundabout, the longest segment at 8,511 meters. It features a wider road profile with four lanes and eight sub-lanes. This segment experiences fewer and more unevenly distributed congestion points. Land use is varied, including commercial, government, and services. Fiddle leaf fig trees are the characteristic roadside greenway vegetation.

Based on the vegetation assessment, several species were found to be planted in unsuitable locations, such as on road medians and paved surfaces. Planting on paved surfaces can cause root damage and potentially disrupt vehicular traffic. Therefore, careful consideration is required in the planting and maintenance of vegetation within the road geometry.

Furthermore, the road character studies can be utilized to support the design of green corridors. The studies on congestion patterns and land use will strengthen site analysis and highlight the urgency for green corridor planning. The study on green space characteristics along the road edges can serve as a basis for developing guidelines for green space management, particularly as pollution barriers.

ACKNOWLEDGMENT

This paper is part of a design thesis research conducted by the author for the Master's Program in Architecture at Institut Teknologi Bandung in 2014. The author extends gratitude to Dhian Damajani and Dian Heri Sofian as advisors, as well as to all parties who have supported the research process that cannot be individually mentioned.

REFERENCES

[1] Adi K, Bimo dkk (2010), Simulasi Penyebaran NO2 dari Emisi Kendaraan Bermotor di Bandung dengan Menggunakan TAQM, Meteorology Study Program ITB
[2] Achmad, Iqbal Maulana (2010), Perancangan Ruang Luar untuk Mereduksi Pm10 di Pemukiman Sekitar Jalan Layang Pasupati, Architecture Master Program *(landscape)* ITB
[3] Booth, Norman K (1983), Basic Elements of Landscape Architectural Design, Elsevier, New York
[4] Departemen Pekerjaan Umum Direktorat Jenderal Bina Marga (1992), Standar Perencanaan Geometrik untuk Jalan Perkotaan Departemen Pekerjaan Umum
[5] Diana, R. E. (2014), Perancangan Koridor Hijau untuk Mengurangi Kadar Polutan Gas (NOx) Jalan Soekarno Hatta Bandung, Architecture Master Program *(landscape)* ITB
[6] Direktorat Jenderal Bina Marga (1996), Tata Cara Perencanaan Teknik Lansekap Jalan Departemen Pekerjaan Umum

[7] Direktorat Jenderal Bina Marga (1997), Tata Cara Perencanaan Geometrik Jalan Antar Kota
[8] Departemen Pekerjaan Umum Direktorat Jenderal Bina Marga (2007), Undang undang Penataan Ruang
[9] Direktorat Jenderal Penataan Ruang, Departemen Permukiman dan Prasarana Wilayah (2004), Kriteria Pemanfaatan Ruang dan Pengendalian Pemanfaatan Ruang di Sepanjang Jalan Arteri Primer Antar Kota
[10] Ebenezar dkk (2006), Pengaruh Bahan Bakar Transportasi terhadap Pencemaran Udara dan Solusinya, UGM
[11] Fathia, L. A. N., Baskara, M., Sitawati (2015). Analisis Kemampuan Tanaman Semak di Median Jalan dalam Menyerap Logam Berat Pb (Capability Analysis of Shrub Plant to Absorb Pb in Median Roadside). Jurnal Produksi Tanaman Vol. 3 No. 7 pp 528 – 534.
[12] Hamonangan, Esrom (2010), Dicari : Udara Bersih untuk Pernafasan, Beranda Pusarpedal Vol.2
[13] Hoesodo, Djoko (2004), Permodelan Pencemaran Udara Akibat Lalu Lintas Jalan Arteri (Studi Kasus Ruas Jalan Soekarno Hatta di Kota Bandung), Environmental Science Master Program, Diponegoro University
[14] Jacobs, Alan B (1995), Great Streets, The MIT Press, USA
[15] Karliansyah dkk (2015). Petunjuk Teknis Penanaman Spesies Pohon Penyerap Polutan Udara. Jakarta: Ministry of Environment and Forestry of Indonesia.
[16] Mansur, M., Pratama, B. A. (2014). Potensi Serapan Gas Karbondioksida (CO_2) pada Jenis-Jenis Pohon Pelindung Jalan (Potential Absorption of Carbon Dioxide (CO_2) in Wayside Trees). Jurnal Biologi Indonesia 10(2): 149-158 (2014)
[17] Nizar, Dr (2000), Vegetasi Pereduksi Polutan, Faculty of Agriculture IPB
[18] Undang-undang nomor 34 tentang Jalan Peraturan Pemerintah Republik Indonesia (1999)
[19] Undang-undang nomor 41 tentang Pengendalian Pencemaran Udara
[20] Rima, Yunita Dwi (2004), Studi Kualitas Udara di Persimpangan Jalan Berkaitan dengan Antrian Kendaraan Bermotor di Kota Padang, Environmental Science Master Program, Diponegoro University
[21] Ruhiyat, Yayat (2009), Model Prediksi Distribusi Laju Penyebaran Sulfur Dioksida (SO2) dan Debu dari Kawasan Industri (Studi Kasus di Kota Cilegon), Environmental Engineering Master Program IPB
[22] Rusdianto, Yoewono, Rektivianto (2008), Simulasi Dispersi Polutan di Cekungan Bandung Menggunakan Model Meteorologi Skala Meso (MM5) dan Model Kualitas Udara (TAQM), Environmental Engineering Master Program ITB
[23] www.maps.google.com accessed on 19-09-2013