

Sustainable Road Concepts In The Dense Settlements of Makassar City

Agri Kusumaningrum¹, Shirly Wunas², M. Yamin Jinca³

¹Master Degree of Transportation Planning, Hasanuddin University,

²Professor, Urban and Regional Planning, Hasanuddin University,

E-mail: shirly_wunas@unhas.ac.id

³Professor for Transportation Planning, Urban and Regional Planning, Hasanuddin University,
Makassar 90245, Indonesia

Corresponding Author: Agri Ksumaningrum

E-mail: agrikusumaningrum@gmail.com

Abstract: The phenomenon of increasing population and high building density causes limited interaction space in residential areas so that the road network functions as a place to carry out activities and endanger the safety of residents due to high traffic activities. The aims of this discussion are 1) to explain the condition of the site of residential buildings and environmental roads to the comfort and safety of residents; 2) explain the occupants' daily activities in the use of roads as a public space for traffic activities on the road; 3) develop the concept of sustainable roads in dense settlements. The research design uses a qualitative and quantitative descriptive approach with the research location survey stage, which aims to obtain the accurate data and information to find out the concept of roads needed in dense residential areas. The results of the analysis show that the condition of building sites in dense residential areas is considered prone to safety for residents because they do not have a building border (23-92%) vulnerable to vehicle emission pollution. The yard is built (53-100%) so the noise level caused by vehicle traffic can be even higher. The height of the fence that exceeds the requirements (17-26%) makes the visibility of the occupants when they want to go in and out of the house is limited. Adequate accessibility in serving large, dense residential areas, but not yet equipped with road equipment. Settler activities tend to use the shoulder and the road. The amount of traffic contained in the dense residential road network has exceeded the standard (SNI-03-6967-2003) resulting in vehicle CO emissions (84959.52 g/hour) and NO (3920.81 g/hour) which had exceeded health standards. Therefore, the concept of sustainable roads in dense settlements can be done by applying environmentally friendly roads, which are to multiply plants on the side of the road to reduce emissions from the volume of vehicles that tend to increase every year and shade especially on secondary local roads 1.

Keywords: Sustainable Road Concepts, Dense Settlements, Environmentally Friendly

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I. Introduction

The phenomenon of increasing population and high building density causes limited interaction space in residential areas so that the road network functions as a place to carry out activities and endanger the safety of residents due to high traffic activities. Sustainable road management, according to the European Union Road Federation (ERF) and the Brussels Program Centre, (2009) are effectively and efficiently planned roads, designed, built, operated, upgraded and maintained with the intention of providing road users with mobility and safety. Green Roads are a sustainable road assessment agency, in the Green Roads Manual v1.5 (2011) stating that Green Road is a road project designed and implemented to a higher level of sustainability than ordinary road projects. Bryce (2008) defines green highways such as Green Street. Green highways are a road system that can reduce the negative impact around the environment to a smaller standard level than before.

Greenberg (2008) mentioned that sustainable roads consist of three aspects of design, namely movement, ecology, and community. The movement in question is the movement of road users and logistic uses all modes and all destinations and types of trips resulting in a decrease in pollution from vehicles. Ecology is a natural area in the space of road benefits along with the ecology in it, including water drainage, air that is influenced by vehicle emissions, and the value of road landscape. The community in question is social, economic, public health, culture and environment. Thus the sustainable road shows the involvement of the community and the pattern of development of a region or city. Dense settlements are residential areas with > 150 inhabitants/hectare and there is an imbalance between land and existing buildings. Article 13 of Law

Number 28 of year 2002 concerning buildings mentioned that a building must have various building clearances requirements which include building border lines and the distance between buildings.

According to Government Regulation of the Republic of Indonesia Number 34 of year 2006 concerning roads, environmental roads are public roads that function to serve environmental transportation with the characteristic of traveling to parcels/houses, the average speed is low and the number of entrances is not restricted. The housing road is one of the important structures of the urban road network system, so that this road if functioning properly can determine the quality of a city, and provide comfort and welfare for its citizens (SNI 03-6967-2003). Southworth et al., (1996) explained that roads in residential areas not only function as vehicle access, but as places of social activities including children's playgrounds and recreation areas.

Jacobs (1993) said that roads are not only intended as a means of public utilities and the main facilities for city residents who have vehicles but also have an important role in providing facilities as a place for a group of people to interact and communicate. The aims of this study are 1) to explain the condition of the residential building site and the environmental road to the comfort and safety of residents. 2) Describes occupants' daily activities in road use as a public space for traffic activities on the road. 3) Compile the concept of sustainable roads in dense settlements that are able to accommodate the needs of the community in interacting, conducting activities, providing comfort, health and safety of settlers to the surrounding traffic.

II. Materials And Methods

Location and design of the research

The research was conducted in Sambung Jawa Village, which had the highest population in Mamajang Subdistrict (10,912 people) and the population density was 363.73 inhabitants/hectare. Mamajang Subdistrict is one of five sub-districts in Makassar City with high population density (Makassar Central Bureau of Makassar, 2018). The research design uses a qualitative and quantitative descriptive approach with the research sites survey stage, which aims to obtain accurate data and information to find out the concept of roads needed in dense residential areas.

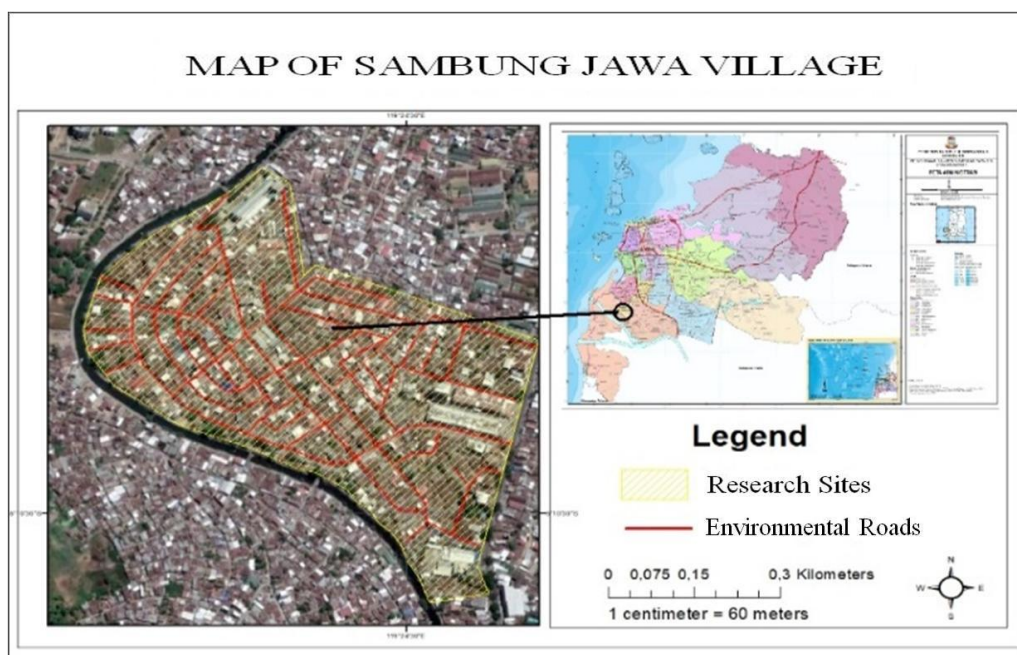


Figure 1. Research Sites

Population and sample

The population in this research was all residents in the dense settlements of Sambung Jawa Village. Respondents who are part of the study population are family heads who live along local roads/neighborhoods/aisles based on the road hierarchy. The sampling technique in this study was carried out in a non probability sampling deliberately (purposive sampling).

Method of collecting data

Data collection is done by systematic recording of research subjects. Data on building site characteristics, road network and occupants' daily activities are carried out by observation. The observation

process is equipped with tools in the form of visual recorders (digital and CCTV cameras), tape recorders, laser meters, and notebooks). The questionnaire is used to identify occupational activity data on roads while the interview to obtain information from respondents.

Data Analysis

Comparative analysis is used to compare the suitability of standards with existing conditions in the field regarding the building site and road network. Analysis of daily activities of residents of dense settlements on traffic activities on road networks using the Indonesian Road Capacity Manual analysis (IRCM, 1997).

III. The Results

Analysis of the Building Site

The building site analyses identify the influence of existing buildings on traffic activities.

Table 1. Classification of roads and conditions of density residential buildings

Road classification criteria	Distance of the house (%)		Yard Conditions (%)		Fence Height (%)
	Without GSB	According to the GSB	Awakened	Not awakened	> Terms
Secondary Local Roads 1	23	15	86	14	26
Secondary Local Roads 2	10 - 47	7 - 80	57 - 100	0 - 43	18
Secondary Local Roads 3	0 - 65	9 - 80	53 - 100	5 - 47	23
Footpaths	82 - 92	-	91 - 92	8 - 9	17

Source: Analysis Results, 2019

The higher the percentage of buildings without GSB and the built yard, the less green open space can function to reduce vehicle pollution, the condition of dense settlements thereby reducing thermal comfort for settlers.

Road Network Analysis

Analysis of road networks to explain the ease of access of settlers in the activities and rights of settlers as road users.

Table 2. Conditions of access and road equipment for dense settlements

Aspect	Analysis
Accessibility	An accessibility index of 25.53 > 5 (SPM) means that the road is managed by the Sambung Jawa Subdistrict to effectively serve settlers.
Road equipment	100% do not fulfil the completeness of signs, markers, and control and road safety equipment.

Source: Analysis Results, 2019

Wide conditions and types of environmental road pavement have met SNI 03-1733-2004, but road elements such as green lanes, road markings, and sidewalks are inadequate for road users and settlers in dense residential areas.

Analysis of Occupant Activities

The occupants' activities on the road are seen based on the road position which is used as a space for interaction and where the residents live. There are 5 activities which are gathering or relaxing, selling, playing, parking the vehicle, drying clothes. 5 these activities are found on the secondary local road 2 and 3 (80%) and footpaths (90%). While on secondary local roads 1, the roads are only used for vehicle parking activities.

Analysis of Vehicle Traffic to Vehicle Emissions

Analysis of vehicle traffic that occurs in dense residential areas is done to calculate vehicle emissions based on vehicle volume.

Table 3. Number of vehicles according to road classification in dense settlements

Location	Vehicle Terms/day	Vehicle/day
Secondary Local Roads 1	800-2.000	16.327
Secondary Local Roads 2	200-1.000	1.000 – 2.000
Secondary Local Roads 3	< 350	300 - 800
Footpath	< 350	50 - 100

Source: Analysis Results, 2019

In dense residential areas, traffic volume exceeds vehicle/day capacity (SNI-03-6967-2003) especially on secondary local roads 1. High vehicle volumes do not cause saturation ($DS\ 0.47 < 1$) and vehicle speed < 30 km/hour. So that the high volume of traffic at low speeds results in vehicle emissions being inhaled longer for settlers.

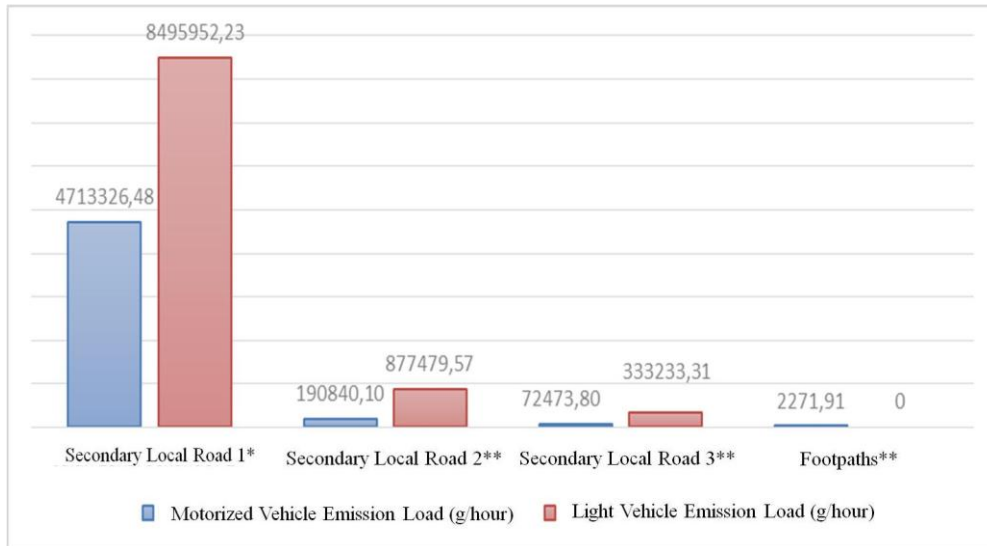


Figure 2. Vehicle emission load (CO)

Source: Analysis Results, 2019

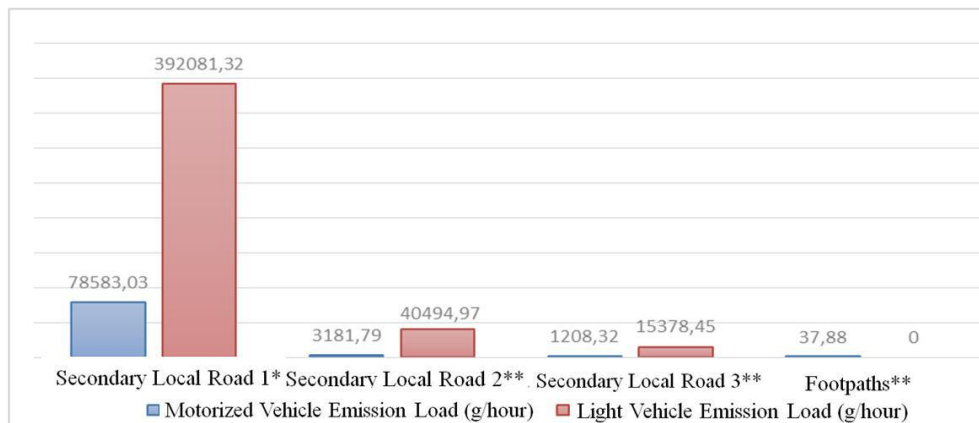


Figure 3. Vehicle emission load (NO)

Source: Analysis Results, 2019

Based on the Government Regulation of the Republic of Indonesia Number 41 of 1999 concerning air pollution control, the national standard of CO quality for 1 hour is $30,000\ \mu\text{g}/\text{Nm}^3$ (20 ppm) and NO for 1 hour is $400\ \mu\text{g}/\text{Nm}^3$ (0.05 ppm). When compared to the results of research conducted by Makhayani (2008), the number of CO and NO pollutants using the assumption of a neutral atmospheric stability class, obtained CO amount of pollutants of $76.77\ \text{mg}/\text{m}^3$ and NO of $2.74\ \text{mg}/\text{m}^3$. In accordance with Environmental Impact Management Agency (2002) CO health standards, namely $10\ \text{mg}/\text{m}^3$ and NO, namely $80\ \mu\text{g}/\text{m}^3$ means that CO and NO conditions do not meet the health standards in the densely populated Makassar City.

IV. Discussion

The Concept of Sustainable Roads in the Dense Settlements

There are occupant activities and vehicle traffic, which pose a threat to occupants' safety and health. Then efforts are needed to realize eco-friendly roads. The environmentally friendly concept is based on three aspects (Lawalata, 2013), namely environmental, social and economic aspects. The concept of sustainable roads in dense residential areas is proposed; (figure 4-7)

1. Environmental aspects, including several criteria, among others:

a. The implementation of reforestation emphasizes tree planting which can reduce emissions and vehicle

- noise, especially on roads that exceed the volume of road capacity
- b. Replacement of pavement with material that can absorb water
- 2. Social aspects, including several criteria, among others
 - a. Equality of access with priority concerns for settlers who are pedestrians, providing cover for drainage channels to function as sidewalks/pedestrians
 - b. Community participation by empowering settlers to participate in reforestation along the side of the road to make roads environmentally friendly and maintain environmental cleanliness
 - c. Maintaining interaction between settlers by providing street furniture and planning locations that can increase settler interactions.
- 3. Economic aspects, namely to facilitate the economic activities of settlers by emphasizing the priority of comfort towards public facilities by providing zebra crossing and planting productive plants to improve the economy of settlers

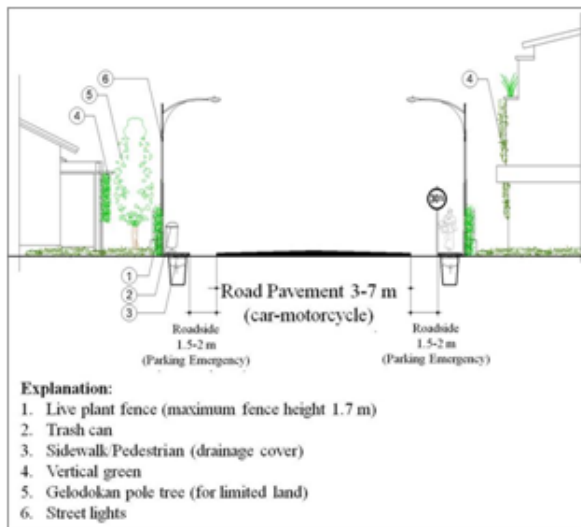


Figure 4. Secondary local road 1

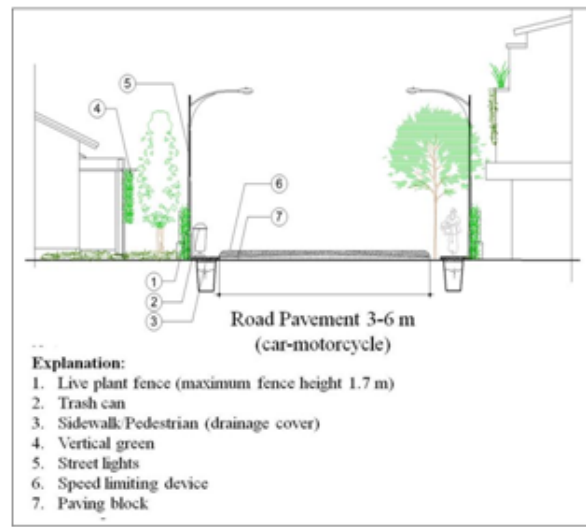


Figure 5. Secondary local road 2

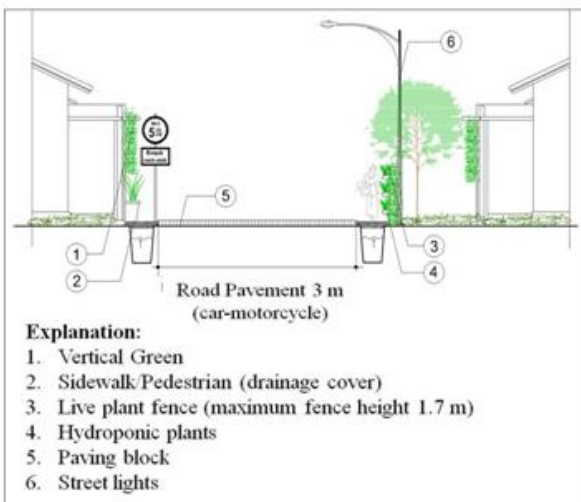


Figure 6. Secondary local road 3

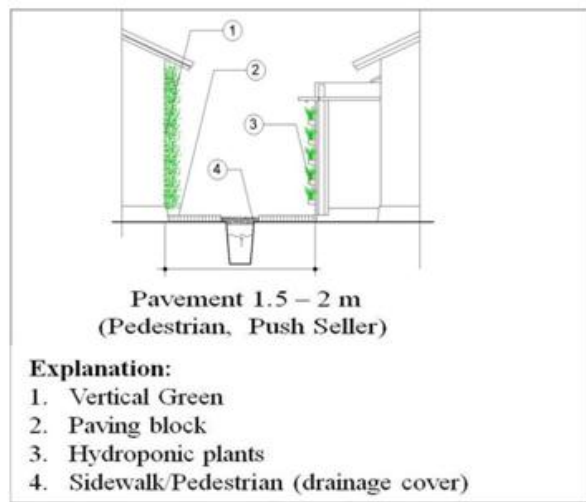


Figure 7. Footpaths

V. Conclusion And Recommendation

The condition of the building site in dense residential areas is considered prone to safety for residents because it does not have a building border vulnerable to vehicle emission pollution. The yard is built so that the noise level caused by vehicle traffic can be even higher. The height of the fence that exceeds the requirements makes the visibility of the occupants when they want to get out of the house is limited. Adequate accessibility in serving large, dense residential areas, but not yet equipped with road equipment.

Settler activities tend to use the shoulder and body of the road. The amount of traffic contained in the dense residential road network has exceeded the standard (SNI-03-6967-2003) resulting in emissions of CO and NO vehicles that have exceeded health standards.

The concept of sustainable roads in dense settlements can be done by implementing environmentally friendly roads, which are to multiply plants on the side of the road to reduce emissions from vehicle volumes which tend to increase every year and as shade.

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