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Mapping of Road Network, Land Use, and Pedestrian Ways in CBD of Semarang

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Abstract. The more human activities in the city increase mobility, demand of circulation route and adequate transportation system. Semarang City Government has already provided the transportation facilities: BRT (Bus Rapid Transit) and pedestrian ways. However, the connectivity of pedestrian ways (door to door service) is still not properly used according to the safety, convenience, and the needs of urban society. As a result, the travel cost becomes expensive and mobility activities from one place to another is not efficient. The purpose of this research is about the study of integrated road networks, land use, and pedestrian ways in the center of Semarang City. The method of this research, using GIS application for mapping and planning the connectivity of land use and pedestrian ways towards public transportation or BRT (Bus Rapid Transit) route in Semarang City. The aim of the research is mapping the connectivity of pedestrian ways in order to create easy access to public transportation.

Keywords: Road networks, land use, pedestrian ways, mapping, GIS

1. Introduction

Pedestrian way is one of the public facilities which is the main needs to accommodate the urban mobility. The development of pedestrian way become important problem in the society who tends to use private transportation. The high rate of private transportation increases the road development. But, it doesn't consider environmentally friendly (eg. pedestrian way and public transportation route). The main object of pedestrian way to create comfortable and secure human area from the negative impact of motor vehicles [1,2]. The development of pedestrian way influence the improvement of traffic management, economic, environment and social aspects in the cities. But it has many challenges, because the development of main road becomes more priority than the development of integrated transportation network system.

Indonesia transportation planning system put a little attention towards pedestrian way. Many road (with public transportation) and public facilities in the cities are not connected with safe and comfort pedestrian way (including BRT/Bus Rapid Transit route). Zebra cross at the intersection often neglected to pedestrian, they prefer dangerous short-cut way to cross the road (between cars and motors). The impact, the passengers access to BRT more difficult because they need other transportation mode that more expensive and not efficient. Therefore, it is important to make pedestrian way connection to BRT bus stop.

As the capital city of Central Java Province, Semarang has developed rapidly (including infrastructure). The development from the center of the city to the sub-urban approved by high-rise building [3]. The result is the existence of small towns, which create the traffic jam at population and logistic. Semarang has built BRT facilities such as, pedestrian way and street furniture. But, those facilities are less connected as door to door service and met the society needs. The main issue of this research is "How is the connectivity of road networks, land use, and pedestrian ways in the center of Semarang City?" This question helps to find out about the integration between road networks, land use, and pedestrian ways in Semarang City.



2. Literature Review

2.1 Road Network

According to Law No. 38 of 2004, roads as part of transportation infrastructure have an important role in the economic, social, cultural, environmental, political, defense and security fields, and are used for the greatest prosperity of the people. Road network is a network that connects several segments to form a transportation node that can provide choices or alternatives for its users [4]. The road network system is divided into two, namely the primary road network and the secondary road network. The primary road network is a road network system that connects cities / regions on a national scale while secondary road networks are road network systems that connect zones or areas within cities.

According to its functions are grouped into four namely arterial roads, collector roads, local roads, and environmental roads. Determination of road class becomes arterial road, collector road, local road, and environmental road based on user needs and adjusted to the origin of the destination of the trip. The following is a picture that explains the relationship between travel needs and movement from one place to another:

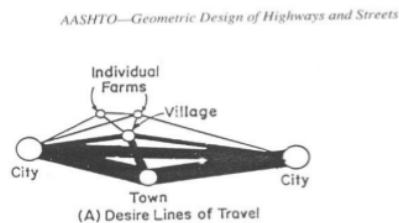


Figure 1. Road Network Hierarchy

Based on Figure 1, it can be seen that thick and thin lines describe the size of the travel needs that connect between two places. Then for the size of the circle illustrates the high and low activity or activity. The need for high travel is in the relationship between cities or districts so that the availability of adequate roads is needed. Roads provided (Figure 2) to serve movements between provinces or districts / cities have more maximal services than roads that service inter-residential centers in one city.

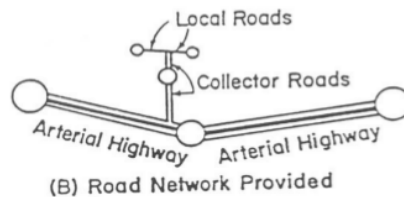


Figure 1-2. Channelization of trips.

Figure 2. Road Network Hierarchy

2.2 Land Use

[5] provide understanding of land on two different scales, namely land on a broad scale and in the context of urban scale. In a wide area, land is the resource (source) of obtaining raw materials needed to support the survival of human life and its activities. In the context of resources, land is classified into several categories, namely mining, agriculture, grazing and forestry. Some definitions that distinguish the meaning of use and use of land, but some literature says that the notion of land use and land use are the same, namely about human activities on earth to meet their needs [6]. Use / use of land is a complex mixture of various characteristics of ownership, physical environment, structure and use of space [7]. Land / land use patterns are arrangements for various activities. Social activities and activities to support sustainability that require number, type and location .

2.3 Pedestrian

A pedestrian is someone that walking in the spesific distance. Whereas, pedestrian way is a safe and comfort path for pedestrians. Walking activity is the way to connect one area to another (the tool of city movement) and to fulfill the needs of interaction in commercial and culture urban [8].

Peraturan Pemerintah No. 43 Tahun 1993 (The Government Regulation No. 43 Year 1993) about Utilities and Traffic Road, mentions about pedestrian facility as follow:

1. A walking path facility (not include pedestrian way)
2. Crossing facilities are needed to overcome the problems with another facilities.
3. The terminal for pedestrians (benches, bus stop, etc).

Walking is a part of city activities with its various purposes. Walking is one of the solving problem for big cities nowadays in transportation. [9] said, walking activity is the way to connect one area to another (the tool of city movement) and to fulfill the needs of interaction in commercial and culture urban. Walking is transportation mode that having unique characteristics [8]. The main factors of pedestrian facilities are:

1. Pedestrian way is one of the important city transportation.
2. Pedestrian way is an important factor in urban planning, pedestrian way development, and main road (city harmonization).
3. The ideal of facility development strategy could support the city centre circulation.

Walking mode is suitable for short mobile due to it's character. It helps a lot to get the public transportation easily. Thus, it's better to walk in short distance with a lot of people. Because it doesn't need speed and time for walking (comparing with taking vehicles).

Pedestrian models have some categories:

1. Statistical physics models, including particle dynamic, kinematic gas, and fluid flow approach.
2. Microsimulation models, including agent based, artificial intelligence, and cellular automata approach.
3. Configurational models, including space syntax and visibility graph analysis approach.
4. Sketch plan models, including service level approach, aggregate estimation approach, and similar planning approach.
5. Origin – Destination / route choice models, including discrete choices model, activity scheduling models, relative utility models, and stochastic models. This model resemble traditional transportation trip demand model in some aspects [10–13].

The above models prove that pedestrians based on heuristic utility maximization, they decided when they walked, which route they took and when they going. [14] found out that pedestrians would choose the shortest route and easiest access [15].

3. Research Methodology

The city of Semarang is a metropolitan city if viewed from its population, approximately 1.6 million people. Metropolitan cities have high movements and are centrally located in the city. The city center or CBD of Semarang City is in Central Semarang District. Central Semarang in this study was used as a research location or rather took locations along Pemuda Street, Gajah Mada Street, and Pandanaran Street. The three main roads are called the golden triangle area. This area is mostly trade and services along the location of research sites and settlements on the inside of the research location.

The movement in the research location is classified as high and has been supported by the presence of public transport such as the Semarang City BRT. BRT has stops or stops along the research location. However, because along the way the research location has a function of land use for trade and services, most pedestrians are used for street vendor trading activities. Pedestrians feel uncomfortable when walking, pedestrians go down the road and endanger pedestrians. The reason for choosing the intersection of five, connects the city of Semarang to the west to the east and north to south

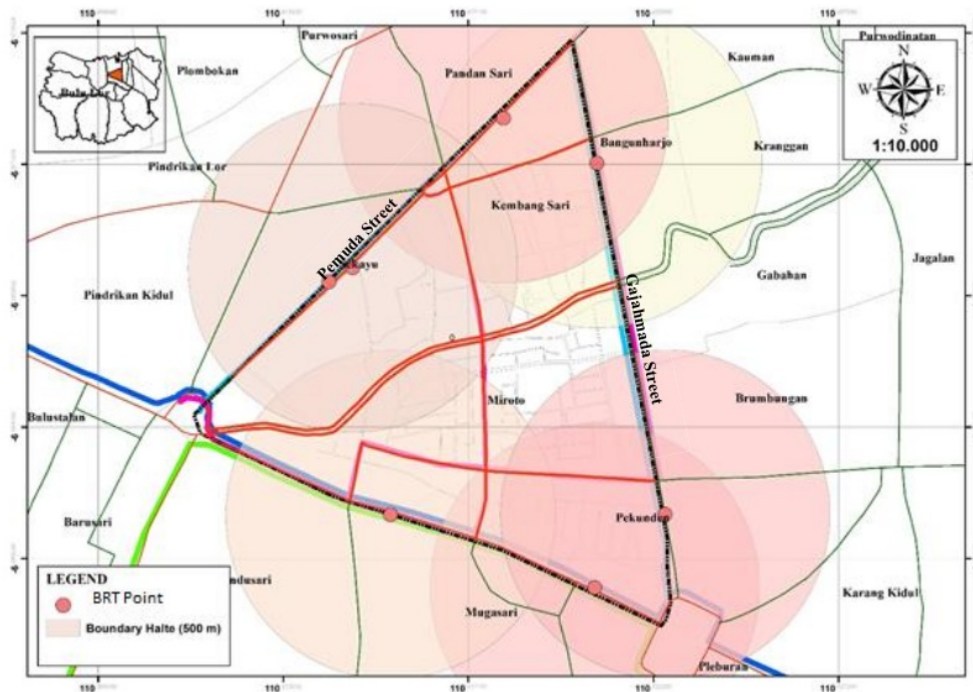


Figure 3. Site Research

The research location (Figure 3) has two types of roads, namely major street and minor street. Each type of road has different characteristics. Land use in the major street is dominated by trade and services, while in minor street is dominated by land use in the form of settlements both plan and unplanned. In addition to land use, it can also be seen from the availability of pedestrians, pedestrians are only on major street.

The analytical method used in this study is quantitative analysis based on observations and GIS. Using this method is expected to provide an explanation related to the relationship between road networks, pedestrian and land use in the CBD of Semarang City.

4. Analysis Results

4.1 Road Network

The golden triangle area consists of five urban villages namely Sekayu, Pekunden, Miroto, Kembang Sari, and Pekunden Villages. The golden triangle area is served by three main roads in Semarang, namely Jalan Pemuda, Jalan Gajah Mada, and Jalan Pandanaran. According to its function, the road in the golden triangle area is divided into three, namely secondary arterial roads, secondary collector roads and local roads. The secondary arterial road in the golden triangle area has a width of eight meters wide road body. Then for secondary collector roads, the width of the road is six to seven meters wide. Local or environmental roads have a width of approximately two to four meters.

Based on the road network map in the golden triangle area, residents in the area are served by three types of roads, namely secondary collector roads, secondary arterial roads, and local / environmental roads. The golden triangle area has been served by public transport such as the Bus Rapid Transit (BRT) of Semarang City. The corridor that passes through the golden triangle is Corridor 1 (Mangkang-Penggaron), Corridor 3A (Port-Diponegoro Taman), Corridor 4 (Tawang-Cangkiran Station), and Corridor 5 (Anjasmoro PRPP-Meteseh Dinas Mas). BRT routes connect the east, west, south, and north parts of Semarang that transit in Central Semarang (research area).

4.2 The pedestrian assessment results are related to land use

From the research findings about integration of road network, land use, and pedestrian way in the center of Semarang, look at the pedestrian way route map as follow Figure 4.





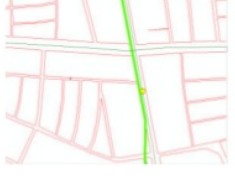

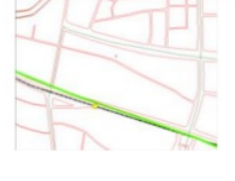





Figure 4. Map of Pedestrian Ways

The population livelihood that working in that area is suitable with the biggest land use. It creates the assumption that the daily high mobility is centered in the area. The application of Semarang Government regulation about private transportation and parking area, is expected to affect the population by using public transportation and pedestrian way as the transit mode (see Table 4).







Table 4. The Map of Pedestrian Ways Condition on Main Roads

Street	Node	Road	Pedestrian Ways	Remark
Pemuda street	Node 1st Balaikota Semarang			Pedestrian ways around Balaikota Semarang have wide space with floors for special difable lanes. Pedestrian ways also have good access to the BRT stop which is generally used by students and employees.

Pemuda street	Node 2nd Bank Mandiri Pemuda			Pedestrian ways on Jl Pemuda that arrow to Johar Tradisional Market have good conditions although width of pedestrian ways is not as wide as the pedestrian ways on Jl Pemuda (Near Balaikota Semarang).
Gajahmada street	Node 3th Gumaya Tower Hotel			Pedestrian ways on Jl. Gajahmada (Near Gumaya Tower Hotel) has a good condition. There are seating facilities, and a public trash.
Gajahmada street	Node 4th Ibis Hotel			Pedestrian ways have condition is the same as node 1st, because it is still in the same roads on Jl. Gajah Mada. The different is the BRT stops is not as big as that contained in Balaikota Semarang because it is a transit stop.
Pandanaran street	Node 5th Med Pandanaran			Pedestrian ways on Jl Pandanaran have width space the same as Jl. Gajahmada, where there are some PKL (illegal to sell) on pedestrian
Pandanaran street	Node 6th @Hom Hotel			Pedestrian ways at node 6th is not too different from node 5th on Jl. Pandanaran. The different is not seen PKL on the pedestrian ways.

The pedestrian ways in arterial street has integrated with BRT (Bus Rapid Transit) route in Semarang. These pedestrian ways connect one area with another that include offices, commerce, services, and religious facilities area. But these pedestrian ways not yet integrated with other facilities function or human settlement. In fact, the pedestrian ways has already connected The Golden Triangle Area in Semarang along Pemuda St., Gajahmada St., and Pandanaran St. The condition of pedestrian ways at Pemuda St. is good with the main land use for offices. On Gajahmada St. the pedestrian ways is good that people can use it freely. But on Pandanaran St. the pedestrian ways main occupied by street vendors, so create inconvenience for people to cross through it (see Table 5).

Table 5. The Map of Pedestrian Ways Condition (Minor Street)

Node	Road	Pedestrian Ways	Remark
Node 7th Jl. Inpeksi			This node is a residential area where there is no pedestrian for pedestrians.
Node 8th Kampung Kali Area			This area is along the highway, but there is no pedestrian for pedestrians and the curb is generally used for car parking.
Node 9th Jl. Seteran Barat			Node 9th is not much different from the node 7th with dominant settlement function and there is no pedestrian ways.

It is different in research area, especially on settlement function, there is no pedestrian path. In addition, not all main roads have BRT route. Some locations have not been connected to the pedestrian ways so that local residents use the edge of the road to walk and also go to BRT stops.

5. Conclusion

The high trip attraction that from the high intensity of activities in the Central Business District (CBD) causing high movement in the research area. To meet the needs of population movement has been by BRT. BRT is also followed by the provision of pedestrian ways and BRT stops for passengers. While the pedestrian ways for door to door service for comfortable to destination. However in the research area, there are land use settlements located on the inside of the golden triangle between Pemuda Street, Gajahmada street and Pandanaran street. This settlement grew out of the development of kampungs within the city that had the provision of minimal pedestrian ways. So the door to door service cannot be fulfilled on trip production from the settlement.

6. Acknowledgment

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