Strategic Policy on Green Transportation in Semarang

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Abstract — **Climate change has become a global issue of serious concern that need solving problem by all stakeholders. Indonesia is committed to reduce emission. It is supported by all regions. Semarang City as the capital city of Central Java Provence have this high commitment. The city itself contributes to CO_2 emission caused by the private vehicles which continues to growth 12% every year while the addition road infrastructure in only 0,9% every year. This disproportionate growth will have an impact to congestion on the roads, resulting to increase CO_2 emissions. Therefore, it is necessary to take strategic policies and comprehensive transportation development programs to become direction of policies and programs for improvement, connectivity, accessibility, mobility, safety, and environmental sustainability. This research is to find out one of the solutions to reducing transportation problems is through the integration of the public transportation system, in order to make harmony and synchronization of program, activities and budgets, all city transportation plans need to become one into a sustainable transportation management strategy. By using mixed methods that combine quantitative and qualitative research methods, to manage secondary data by combining qualitative data through the policies of stakeholders in the perspective of sustainable transportation management to reduce CO_2 emission. The strategy for reducing emissions is by carrying out green transportation with several strategy, optimizing spatial planning, improving public transport services, developing vehicle technology, developing environmentally fuels and improving traffic management.**

Keywords — **climate change, CO_2 emissions, green transportation, strategic policy**

I. INTRODUCTION

The Semarang city is the capital of Central Java Province which continues in population and economic growth and is becoming a metropolitan area that is developing into the interior areas. As the capital city of the province, it become the center of educational, health, trade, business, and final transportation facilities that support the role of the Cities around.

Based on data from the United Nation (UN) that the current global population continues to rise from 7 billion of them live in the city where the population and will continue to rise to 9.2 billion by 2050, about 40 percent of the world population live in cities and that number will increase to 47 percent in 2025 [14]. Rockstorm et al. (2009) [10], Cardinale et al. (2012) [6] explains that the growing number of global populations will encourage other global environmental problems and other water issues, biodiversity, climate change and nutrient cycle.

One of urban problems is about transportation problem. Conditions of traffic jams cause economic and social losses for the community. ITDP (2019) [9] shows that the mode share of motorized vehicles has a percentage of 80%, the meaning is private vehicles are still large percentage when compared to the community using public transportation. Based on the research results of the Inrix research institute, the average level of congestion in Semarang City reaches 37 hours a year according to the results of the INRIX research institute in Sismanto (2018) [11].

One of the causes of congestion in the city of Semarang is the disproportion between the increase in the number of private vehicles and infrastructure development. The number of private vehicles has increased rapidly due to poor public transport services, while infrastructure development has been limited due to less and more expensive land. Based on data on vehicle growth in the city of Semarang, it reaches 12% per year, while the road length growth is only 0.9% per year. Currently, there are at least 1.6 million motorcycles and 500 thousand four-wheeled vehicles in Semarang City, BPS Central Java Province (2019) [4].

Han-ru Li (2016) [8] Explain that green transportation is an important means for easing traffic congestion and solving urban pollution and environmental problems of major international cities, which actively promote green travelling and public transport, and shift from being vehicle-oriented to being human-oriented.

Therefore, a comprehensive city transportation development policy and program is needed to become the direction of policies and programs to improve connectivity, accessibility, mobility, safety, and environmental sustainability. Solecka and Zak (2014) [12] in their writing explains that one of the solutions to reduce transportation problems is through the integration of public transportation systems. To create harmony and synchronization of programs, activities and budgets, all city transportation plans need to be poured into a sustainable transportation management strategy.

II. METHODOLOGY

The research method used in this study is a mixed method research. Mixed Method is a research method that combines quantitative and qualitative research methods, namely by providing an interpretation of the results of quantitative calculations, namely by providing an interpretation of the results of quantitative calculations. In this research the steps taken include:

1.   Data Collection

Collection of Statistical Data, Collect Regulations and Policies including Semarang Middle Developing Plan (RPJMD) for year of 2021-2026, Spatial Planning (RTRW) for year of 2011-2031, Satellite Imagery and other related data.

2.   Data Processing

The data obtained is then processed to produce information from the data.

3.   Analysis Data

The Processed data is then analyzed. The Analysis data includes sustainable transportation that is suitable for the city of Semarang and the best strategic to reduce emission in City of Semarang.
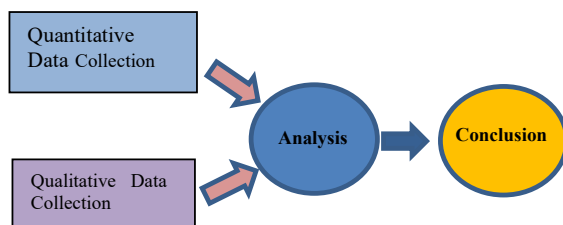

Figure 1. Mix Methodology

III. RESULT AND DISCUSSION

The Analysis in this research is take attention to the result of the data and observing the spatial planning of the Semarang City (RTRW) 2011-2031, social and economic community activities, travel need s for work activities, education and others, transportation infrastructure, accessibility and value land.

Transportation and spatial planning have a very close relationship and influence each other. In other side, the spatial structure planning determines the intensity of trips and the patterns of origin and destination of trips, and the

other condition, the transportation system determines the network structure and modes of transportation required.

In other words, the spatial structure planning is used as the basis for planning the transportation system (ship follows the trade) or vice versa, transportation system planning is used as the basis for determining the spatial structure planning (trade follows the ship). In the context of "ship follows the trade", transportation system planning is carried out based on a predetermined spatial structure planning. otherwise, in the context of "trade follow the ship", transportation system planning is the basis for determining spatial structure and land use.

One of the important issues in urban development in the 21st century is sustainable development which is often interpreted as development that is able to meet the needs of the present generation without compromising the needs of future generations. The sustainable development paradigm, especially with to urban areas, concern to various aspects that shape urban life, starting from spatial, social, economic, and environmental aspects. Indeed, the public transportation system must be one of the backbones of urban areas that is able to fulfill user mobility services effectively and efficiently.

From a spatial perspective, an effective and efficient public transportation system can prevent the uncontrolled development of urban areas (urban sprawl) so that the city structure becomes more compact. In addition, an effective and efficient public transportation system can also encourage changes in mobility behavior for Semarang residents who are currently still very dependent on the use of private vehicles. This of course can affect social and economic aspects. With a more compact city structure coupled with the support of an adequate public transportation system, the commuting time needed for city residents is shorter so that city residents can be more productive in carrying out their daily activities.

This productivity will certainly have a positive impact on local and national economic development. Furthermore, a compact city structure and changes in citizens' mobility behavior can reduce carbon emissions in the transportation sector which will certainly have an impact on improving city air quality and the health of city residents.

Low Carbon Scenario

Reducing air pollution is the expected end result of the direction of sustainable transportation development. The approach commonly used in developing a low-carbon sustainable transportation policy is Avoid, Shift, and Improve (A-S-I).
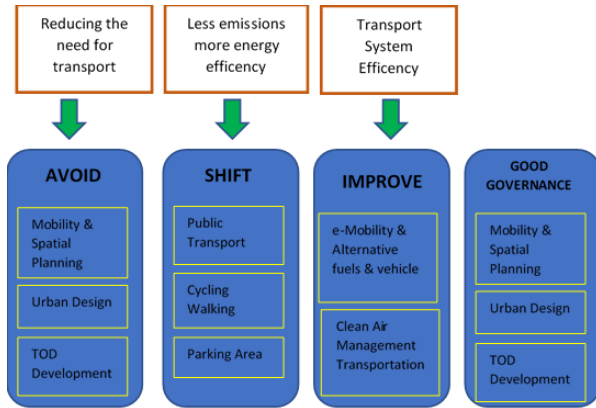
Figure 2. Urban Mobility Plan and Low Carbon Scenarios

Based on publications from the Transformative Urban Mobility Initiative (TUMI), the ASI approach was originally implemented in the 1990s in Germany to develop transport policy structures and measures to reduce environmental impact.

Under the ASI approach, transport policies to reduce greenhouse gas emissions should consist of actions aimed:
a. Avoid, or minimize the length of the trip and reduce the need for motorized travel.
b. Shift, or encouraging the efficiency of individual movement by shifting to modes of transportation (modal shift) that are more energy- efficiency, mass-producing and low-emission; and
c. Improve, or increase the efficiency modes through improving vehicle technology, encouraging renewable energy (fuel) sources, optimizing public transport operations and other.

Urban Mobility Planning (UMP)

In general, the strategic program proposals used as the basis for preparing scenarios**.** where each strategic program in the development of the transportation system refers to the main objectives of the UMP, namely efficiency to support economic growth, reducing the impact of transportation on the environment, and equality in mobility society with strategy such as:
a. Promote the use of public transport, and
b. Reducing the level of traffic congestion

The transportation system consists of two main transportation networks and one alternative transportation system such as:

a. The road network is a transportation service system with a hierarchical pattern consisting of arterial roads, collector roads and local roads
b. The public transport network is a service system with an integration pattern between road and rail-based public transport systems
c. Alternative transportation systems consist of river and canal transportation

The basis of the scenario is a multimodal transportation network system that will serve various activities in the city's economic sector includingservices to airports, stations and ports.

From the picture above, it is explained that UMP planning is carried out with policies and strategies, namely increasing connectivity, especially between transportation nodes. Improving accessibility by pushing to add transport routes, making it easy to reach each region. Sustainability by encouraging the concepts of Avoid, Shift, and Improve. Safety by improving the quality of infrastructure, protection, and quality of human resources for public transport drivers.

Semarang Transportation Node

The city of Semarang is supported by national and international scale transportation nodes for people and goods. Semarang City's transportation node is available for land, sea, air and rail transportation modes. Transportation nodes in Semarang City provide connectivity to economic activities at the international, national, provincial, and local levels.

Semarang City's international connectivity is served by Ahmad Yani International Airport and also Tanjung Emas International Port. Both also serve connectivity at the national level through domestic transportation services to and from Semarang City.
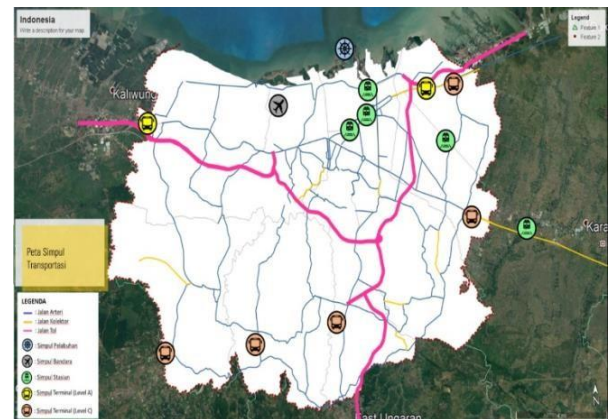
(Source: Bappeda, 2011 [1])
Figure 3. Maps of transportation nodes in semarang

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses).

Before Pandemic, Passenger Ahmad Yani Airport has increased from 800 thousand people per year and gradually increased from 4 million to 6.5 million people per year. Tanjung Emas Port has also improved the quality of its services through improving infrastructure and using environmentally friendly technology. As a part of a transportation hub for people and goods, Tanjung Emas Port also serves tourist transit via cruise ships that stop by in Indonesia. A Yani Airport 5.1 million passengers, Tanjung

Emas Port 1.5 million TEUS (twenty-foot equivalent unit) and 10 cruises per year is a potential for making increase activities in Semarang.

Spatial Planning policies and developments

Based on Semarang population density data in 2020 and 2030, there is a tendency for changes in the pattern of population density in the City of Semarang to occur in the city center and suburban areas. It is estimated in 2030, urban villages located in the downtown area will experience a decrease in population density. Sub-districts located in the area around Simpang Lima and Tugu Muda areas, such as Pekunden Sub-District and Pendrikan Lor Sub-District, have experienced a significant decline in population density due increasing in land values and the conversion of residential areas into commercial areas, that causing residents to have to look place to live in another location, more remote area. affordable (gentrification).

Inversely proportional condition in the downtown area, suburban areas are expected to experience an increase in population density in 2030. The increase in population density occurs in the southern and southeastern areas of Semarang. Districts such as Tembalang and Banyumanik which have developed as residential areas will significantly increase in density levels in 2030. Land prices are still relatively cheaper, the proximity of access to Solo and Jogja, and access to the Trans Java toll gate are cause of this.
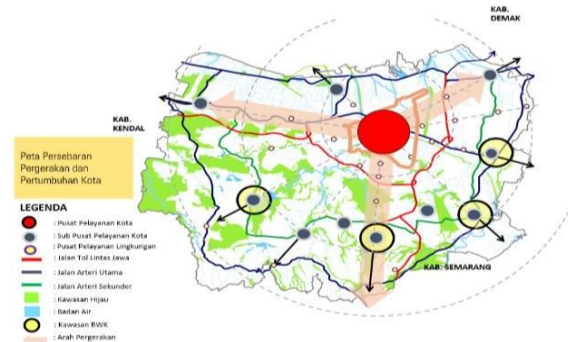
(Source: Bappeda, 2020) [3]
Figure 4. Map of Transportation Nodes in Semarang

Seeing these conditions there are several things related to spatial planning and transportation as follows:
a) With travel patterns that tend to be radial, mass transportation networks need to accommodate travel needs. Therefore, it is proposed that a mass public transport system which is also radially oriented and concentrated in commercial center areas as an ideal mass public transport system network must have radial orientation and concentrated in commercial center areas;
b) The development of activity in centers of the city has been largely connected with the mass public transportation system, especially the east-west corridor BRT. With the current developments, it is necessary to strengthen the interaction between the northern and southern regions which are relatively unserved by the mass public transportation system;

c) Primary activity centers are advised to be more oriented towards mass public transport systems (mass transit oriented) considering that the capacity of the road network system is relatively unable to accommodate all movements/travels of people with quite a large volume, especially during peak hours and anticipate an increase in the number of passengers along with population growth;
d) Mass public transport system corridors are planned to be more oriented towards increasing regional accessibility and will connect primary and secondary activity centers, especially those that have the potentialto develop TOD as an economic generator and avoid development based on Ribbon Development.

Spatial planning development policies and strategies focus on structures spatial planning, spatial patterns, and strategic areas. Development policies and strategies for structures spatial planning are closely related to the future development of transportation to support the priority activities such as traditional trade, education, tourism and service activities.

The transportation policy targeted by the Semarang Municipality is how to increase accessibility and linkages between activity centers through increasing road network capacity, developing mass transit systems, developing inner ring roads-outer ring roads-radial roads, developing people and goods terminals, and intermodal integration.


(Source: Bappeda, 2020 [3])
Figure 5. Projection of Distribution of Population Movement

in Semarang Motorized movements are dominated by private vehicles (motorcycles: 68%; cars: 25%; public transport 7%). The level of motorization is seen from the development of the number of motorized vehicles and their use. In terms of the number of motorizations it can be seen from the ratio of vehicles per 1000 residents. The level of motorization in Semarang City for passenger cars is 22/1000 residents, for motorcycles it has reached 937.9/1000 residents.

The total vehicle population in 2018 was 1,564,904 motorcycles, 36,751 cars, and 8,552 public transportation vehicles. With the increasing number of motorized vehicles, the number of motorized vehicles has also increased.

Meanwhile, the existing conditions in 2020 show that mode use is still dominated by private vehicles as much as 93% . The dominance of private vehicles will last until 2040 by 90%. If the distribution of traffic is not support by a new road network and supported by adequate modal shifts, vehicle congestion is inevitable.

The government needs to pay attention to an increase in the number of trips by 17.3% from 2022-2040. To meet this increase, a road-based transportation system needs to be developed. The reason for using private vehicles to be the preferred mode of choice is that the average length of reach of private vehicles is farther than public transport or non-motorized vehicles. Improving public transport services that are excellent and reach many areas will extend the average trip length in Semarang City. In addition, the government needs to regulate area development and spatial planning so that the distribution of movement does not fill the already congested road network. This effort aims to regulate traffic volume. The government can regulate the points of attraction and other generation so that the movement is more distributed.
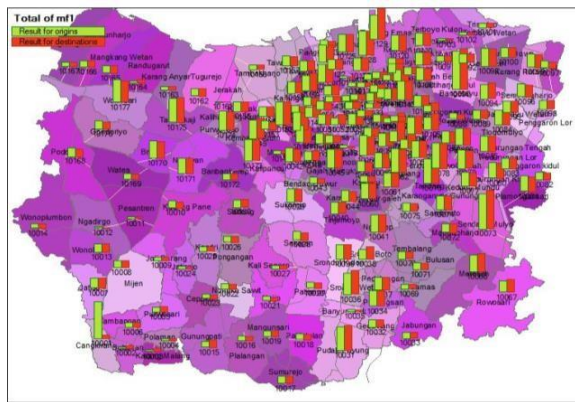
(Source: Sofaniadi, 2019 [13])
Figure 6. Origin Destination (O-D) Movement Pattern

Movement Pattern

The number and distance of movement of the people of Semarang City continues to increase to 2.817 million motorized trips per day in 2020. The results of the analysis show that this number will continue to increase to 105% in 2030 one of them caused Settlements are spread to the outskirts of the city even though work locations are concentrated in the city center.

From the picture below of the movement pattern it is explained that the movement pattern which is still high and significant is in the center of Semarang City. This pattern of movement is directly proportional to the population density, including in the Pedurungan District where the Origin and Destination (OD) value is quite high. Apart from that, suburban areas that are increasingly developing are also a trigger for increased movement patterns of attraction and generation.

Figure 5 shows an increase in traffic flow and volume throughout the Semarang City road network. This increase is marked by the enlargement of the trip flow diagram which is distributed from east-west-south to the city center

The four figures show that the distribution of existing movements and the movements of the people of Semarang City in the next 10-20 years have the same characteristics. The same characteristics can be seen from the projected generation of Semarang City that leads from the center of the city to the west of Semarang City.

From the picture above it is explained that significant CO_2 emission are in Pedurungan District, West Semarang and Tembalang District

CO_2 emission in Transportation Sector

The following Table 1 are some of the factors that affect environmental quality: The number of motorized movements continues to increase. Motorized movements rise 2% annually. The number of motor cycle increased by 12% per year. The VKT value per day is 42 km for cars, 40 km for motorbikes, 99 km for public transportation, 119 km for buses and 127 km for taxis.

Table 1. Vehicle Kilometres Travelled (VKT)

Type	Unit	Average VKT (Km/year)	VKT Total (km/year)
Bus	786	43.435	34.139.910
Truck	2.633	10.115	26.632.795
Taxsi	2.966	46.355	137.488.930
Mikrolet	2.112	36.135	76.317.120
Private Car	56.453	15.330	865.424.490
Private Motorcycle	247.936	14.600	3.619.865.600

(Source: Kajian Inventarisasi Emisi Kota Semarang Dinas Lingkungan Hidup Kota Semarang, 2017 [14])
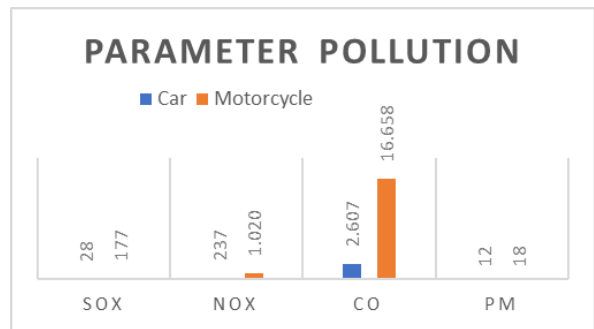
(Source: Buanawati, 2017 [5])
Figure 7. Paramater Polluiton for Each Type of Vehicle

Seen in Table 1 The average VKT value of various types of vehicles in 2017.
a. Technological condition and age of the vehicle. Vehicle technology is dominated by injection engines of the Multi-Pt Fib type with Euro 2 emission standards for motorcycles and Euro 2 and Euro 3 for cars. The average age of the car is 3 years and the motorbike is 1 year. In the graph of Figure 7 it can be seen that the age distribution of vehicles over six years is starting to decrease.
b. Transportation fuel. Ron 88 gasoline dominatesSemarang city fuel. The new CNG is used for 72 retrofit BRT buses.
c. The level of exhaust emissions issued by each motorized vehicle. Pollution from motorcycle use is higher than car based on VKT, city topography, pattern and amount of

use. In the graph of Figure 7 it can be seen that CO_2 pollution from motorcycles is 8 times greater than cars.

d. Driving culture. The driving style of motorcyclists and cars is still wasteful of fuel. The application of eco-driving is not yet entrenched. Fuel prices are still cheap.

Reducing Emission Strategy

The launch of the air pollution reduction program in Semarang City can be seen from the size of the emissions produced by each vehicle. From Table 1 and Figure 7 it is explainedthat CO_2 emissions are produced by Motor Cycle (MC) and Personal Car (PC) or in terms of private motorbikes and cars.

Several strategic to reduce emissions with several as follows:

a. Spatial Improvement;
b. Improvement of Public Transport Services;
c. Vehicle Technology Development;
d. Development of environmentally friendly fuels;
e. Traffic Engineering Management;
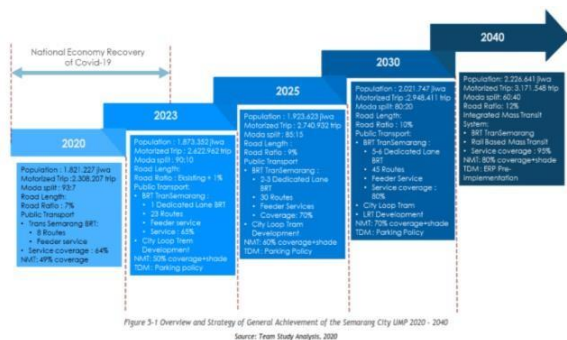
(Sources: Bappeda, 2020 [3])

Figure 8. Sustainable transportation strategy in Semarang

With the various sustainable transportation strategies above, it is hoped that transportation emission will decrease. The strategy for reducing emissions is by carrying out green transportation with several strategy, optimizing spatial planning, improving public transport services, developing vehicle technology, developing environmentally fuels and improving traffic management.

III. CONCLUSION

1. The approach commonly used in developing a low-carbon sustainable transportation policy is Avoid, Shift, and Improve (A-S-I);

2. Reducing the impact of transportation on the environment, and equality in mobility society with strategy such as:Promote the use of public transport, and Reducing the level of traffic congestion.
3. Green transportation becomes an important part in the development of sustainable transportation.
4. The strategy for reducing emissions is by carrying out green transportation with optimizing spatial planning, improving public transport services, developing vehicle technology, developing environmentally fuels and improving traffic management.

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