Advances in Economics, Business and Management Research, volume 179
Proceedings of the Sixth Padang International Conference On Economics Education, Economics, Business and Management, Accounting and Entrepreneurship (PICEEBA 2020)

Towards the Green Economy:
Calculating the Degradation of Transportation Sector in Batu City

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ABSTRACT
Population growth in urban areas has a major effect on developments in various sectors, both formal and informal. As a result of these developments, population mobility is getting higher so that it affects traffic density. As a result, there are traffic jams that cause considerable losses to road users. The losses that occur will have an impact on the waste of fuel which results in an increase in vehicle operating costs. This study aims to calculate the value of the loss due to urban traffic congestion in Batu City. This study also calculates the value of the greenhouse gas effect caused by activities in transportation sector in Batu City. The data used in this study are primary and secondary data. Primary data were obtained from interviews and distributing questionnaires to 30 samples of motorists in Batu City while secondary data were obtained from the Central Bureau of Statistics (BPS) of Batu City. Economic value calculations are carried out to calculate the values of activities that cannot be monetized, such as time losses due to congestion and greenhouse gas effects. To calculate them, we use the travel cost method and the replacement cost method. The calculation results show that the environmental degradation caused by transportation sector activities in Batu City from 2015 to 2019 is in the range of IDR 1 - 1.5 trillion. As a tourist destination, it is advisable for the Batu City government to rearrange the transportation system so that congestion can be reduced.

Keywords: *Economic development, Traffic congestion, Degradation, Economic value.*

1. INTRODUCTION

In today's era, more and more countries in the world are faced with various environmental problems. Environmental problems include degradation of natural resources, the environment, energy, and food resources [1, 2, 3, 4]. Human nature who never feels satisfied makes the environment worse, the exploitation of non-renewable resources is getting worse and often takes lives, especially those around the mining area. In addition, the unpredictable climate change and global warming are further reducing the ability of nature to meet the needs of humanity in this world.

In realizing sustainable economic development, an indicator is needed to measure the extent of economic development in a region. One measure of the success of sustainable development is the efficient use of natural resources. This means that every single unit of use of natural resources should produce greater benefits. In addition, the use of natural resources must also consider the sustainability of these resources for future generations. One measure of sustainable economic development is the environmentally friendly Gross Domestic Product (GDP) or Green GDP [5, 6, 7]. Green GDP takes into account all aspects of resource use including depletion and degradation of natural resources as a deduction from GDP. In conventional GDP calculations, these two things add value to GDP.

Transportation is an important part of the growth and movement of the economy in an area, especially in urban areas [8, 9]. Transportation has a very big role in planning and regional growth where the mode of transportation supports the activities of all levels of society. Public transportation is the main choice for all middle and lower class people in meeting their mobile needs. In the context of urban transportation, public transportation is a vital component that affects the urban transportation system. A good, planned and well-coordinated public transport system will increase the effectiveness and efficiency of the urban

transportation system [10, 11, 12]. The success of the transportation system can be seen from 4 things, including time efficiency, energy and fuel efficiency, impact on the environment and the level of traffic safety [13, 14, 15, 16].

Batu City is a city with a high level of population mobility, this condition is caused by the large number of tourists who come from various cities in the province of East Java in particular and from various provinces throughout Indonesia in general. With the high population mobility in Batu, there is an increase in the volume of vehicles in Batu city, because most tourists bring vehicles from their places of origin. The high mobility of vehicles in and out of Batu City which is not matched by the construction of transportation infrastructure will cause general problems in the transportation sector, namely congestion at peak hours of activity.

This congestion will have major implications for the activities of road users. Starting from boredom and an increase in fuel consumption that can be measured directly. However, there are several things that are calculated from the value of the loss due to this congestion which is examined from various aspects, both from the aspects of the driver, the road and the vehicle. So it is necessary to take into account the losses due to congestion on the road in Batu city which is assessed from the aspect of the driver and of course from the environmental aspect.

This study aims to calculate the number of losses due to congestion and environmental impacts due to community activities in Batu City in the transportation sector in 2015 – 2019. Losses due to congestion calculated are losses due to additional operational costs due to congestion, and time losses due to congestion. The environmental aspect is the loss caused by the emission of greenhouse gases (CO2).

1.1. The Green Economy

The United Nations Environment Programme (UNEP) sparked the idea of a "Green Economy" in order to support efforts to reduce greenhouse gas emissions [17]. This idea aims to provide great opportunities in order to support the implementation of development that is oriented towards environmental and ecosystem aspects. In recent years, the concept of a green economy has received increasing worldwide attention because it is considered in line with the efforts of the world community in finding solutions to various global problems currently occurring.

In addition to many who support the green economy concept, there are also those who doubt this concept and have not yet reached an understandable understanding. This makes many people, even from the originators of the green economy concept itself, continue to question what the real meaning of the green economy concept is [18].

The modern concept in this perspective of a green economy does not only emphasize various standard policies, such as how to assess the environment economically and sanction activities that are harmful and potentially damaging to the environment. But what is more important is how the green economy concept is able to encourage economic actors to produce goods, trade and consume environmentally friendly things or products and services that are more environmentally friendly [19, 20, 21].

1.1.1. Economic Value of Resouces

Every decision made by an individual or a community is always based on economic considerations [22, 23]. An individual or a community (society) will make a decision (action) if he feels that the action will benefit him. When it is related to nature conservation, economic reasoning concludes that the government or society will conserve a natural resource and the environment, only if the conservation provides benefits that are at least equal to the cost of preservation or even higher than the cost of preservation.

Excessive exploitation of natural resources as a result of giving too low value / undervalued to natural resources causes externalities to arise. This is a failure to give the resource an appropriate value, resulting in inefficient use. The provision of economic value (economic valuation) of natural resources in total, is a response to externalities that arise, rooted in the human error in assessing resources and their ecosystems as a whole and as a whole, as well as human failure to interpret natural resources as economic and social assets for the current generation and future generation. Assigning value to resources (resource valuation) by giving monetary value (monetization) to all natural resources and the environment and their functions, gives people the opportunity to understand all the impacts of their activities in utilizing natural resources and the environment [24, 25, 26, 27]. This also allows decision making to determine policies for the use of natural resources that do not conflict with the use of other natural resources, efficient allocation, and determine the level of utilization of a resource with the aim of making these resources sustainable.

2. METHOD

2.1. Data Collection

The data used in the study are primary data and secondary data. Primary data obtained from the results of observations, surveys, interviews, and

questionnaires with road users in Batu City. The samples used in primary data collection were 30 car drivers who were residents of Batu City with the purposive sampling technique. The primary data used is data on fuel usage, travel time, and everything related to losses experienced by the community due to congestion. While the secondary data used is data on the number of vehicles in Batu City which is obtained from the publication of Batu City's Central Bureau of Statistics (BPS).

2.2. Data Analysis

2.2.1. Greenhouse-Gas Emission

One of the components of development that has an effect on decreasing environmental quality is greenhouse gas emissions. The greater the value of greenhouse gas emissions released, the greater the reduction in air quality. To improve air quality, in relation to greenhouse gas emissions, there are three steps that need to be taken, namely: 1) Calculating total greenhouse gas emissions. The total carbon dioxide / greenhouse gas emissions in this study were calculated from the emissions resulting from the consumption of fuel from vehicles and human respiration. The assumptions used are the assumptions of DEFRA [28] which state that for every liter of gasoline burned produces 2.3 grams of CO2; 2) Calculating carbon absorption. The need for land to absorb carbon is calculated by dividing the amount of emissions produced by the number 64 which is the IPCC (Intergovernmental Panel on Climate Change) stipulation that the carbon stock of urban forests is 64 tons of carbon per hectare. For example, if the amount of carbon produced is 1,663,210.00 tonnes and the value of carbon stocks for urban forest is 64, then the amount of land required is 25,987.66 hectares; 3) Calculating the difference between carbon absorption capacity and the number of emissions produced. Calculating the costs required is done by multiplying the costs required to carry out planting and maintenance by the area of land that must be planted. The cost of planting and cultivating urban forest is 60 million rupiah per hectare and the area of land to be planted is 25,987.66 hectares, so the cost required to plant and maintain an urban forest is Rp. 1,559,259,375,000.00 (one trillion five hundred fifty-nine billion, two hundred and fifty-nine million, three hundred and seventy-five thousand rupiah).

2.2.2. Losses Due to Congestion

Losses due to congestion are calculated only from four-wheeled vehicles because the authors assume that for two-wheeled vehicles, traffic jams are relatively more manageable for two-wheeled drivers. The method used is to use the travel cost approach. Travel costs are all costs incurred by a person from the departure location to the destination until returning home (note: the person only visits one destination) [29]. The calculation formula is as follows:

$$NED = \sum_{n=1}^{i} K\ Tc \qquad (1)$$

Whereby,
NED = Economic Value of Impact
K = Quantity of Impact
Tc = Total of Travel Cost

For example, Traffic congestion increases the cost of commuting to the office every day. If the additional cost of motorized vehicle materials is an average of IDR 7,500 per round trip per day, the number of vehicles is 1,500 cars per day, and if due to traffic jams the community also spends an average of IDR 10,000 per round trip per day. Then the total loss of congestion is as follows:

$$NED = -[(IDR\ 7{,}500\ /\ round\ trip\ /\ day + IDR\ 10{,}000\ /\ round\ trip\ /\ day) * 1{,}500\ car * 24\ workdays * 12\ months]$$

$$NED = -IDR\ 7{,}560{,}000{,}000\ /\ year$$

Then the loss due to road congestion has an impact on the increase in costs by minus IDR 7,560,000,000 / year.

3. RESULT AND DISCUSSION

3.1. Wasted Time and The Inefficient Cost

Congestion is a problem that has arisen in cities including the city of Bogor. The problem of congestion will have an impact on various things. The impact is a decrease in productivity. In this case, the value of fuel consumption inefficiency and wasted time is calculated. Loss due to road congestion in Batu City was taken through a field survey of 30 car drivers whose owners are residents of Batu City. In addition, secondary data on the number of vehicles is also taken from Batu City's BPS.

From a survey of 30 motorists in Batu City, it is known that the inefficiency of the cost or the additional costs that must be incurred by car owners is, on average, IDR 27,000 per day. From a survey of 30 motorists in Batu City, it was found that the inefficiency of costs or the additional costs that car

owners had to pay was, on average, IDR 27,000 per unit per day while the value of time loss due to congestion reached IDR 63,906,250 per unit per year on average. By assuming the workhour is 8 hour/day and the workday is 25 day in a month (so that, 300 day in a year), time loss due to congestion is obtained by the following formula:

$$TLc = \left(\frac{Y}{8}\right) 300 t_w \quad (2)$$

where,
TLc = Value of time losses due to congestion
Y = Income per month
t_w = Wasted time

The results of calculations regarding congestion degradation are obtained from wasted fuel costs and wasted time costs. The results of the calculations are as follows:

Table 1. Number of Vehicles, Time Loss, Traffic-Jam Loss of Batu

Year	*Passenger Car*	*Freight Car*	*Total*	*Loss due to Traffic Jam (million IDR)*	*Loss due to Wasted Time (million IDR)*	*Total Loss*
2015	14,354	6,760	21,114	211,931.78	1,349,316.56	1,561,248.34
2016	12,431	3,746	16,177	162,376.64	1,033,811.41	1,196,188.04
2017	17,461	4,050	21,511	215,916.66	1,374,687.34	1,590,604.01
2018	14,446	5,369	19,815	198,893.06	1,266,302.34	1,465,195.41
2019	15,062	5,288	20,350	204,263.13	1,300,492.19	1,504,755.31

Table 1 shows that the losses due to congestion which consist of time losses and additional costs due to traffic jams experience less extreme fluctuation. This, of course, is caused by the rise and fall of the number of cars in Batu City and recorded by Batu city's BPS. However, the amount in the range of IDR 1.1 - 1.5 trillion is still a large amount. The value of loss due to traffic hours is calculated by multiplying IDR 27,000, as the average value of additional costs or fuel inefficiency per unit per day, with the total number of cars in Batu City then multiplied by 365 (number of days in one year) while the value of time wasted is obtained by multiplying IDR 63,906,205, as the average value of time wasted per unit per year, with the number of cars in Batu City.

These findings suggest that the economic impact of congestion is enormous. Starting from wasted fuel to other additional costs that arise due to an individual being stuck in traffic, such as buying drinks or snacks. This confirms the findings of Sweet [30] who examined the impact of congestion in metropolitan cities in the US, which states that congestion has a large economic impact. Therefore, the Batu City government needs to pay attention to existing transportation facilities and infrastructure.

3.2. Greenhouse-Gas Emission

As explained in the previous sub-chapter, the assumption used to calculate emissions arising from fuel combustion is the result of a DEFRA study which states that for every liter of gasoline burned it produces 2.3 grams of CO2. Then the need for land to absorb carbon is calculated by adding the resulting emissions divided by the number 64, according to the IPCC (Intergovernmental Panel on Climate Change) stipulation that for urban forests, the carbon stock is 64 tons of carbon per hectare. Next step is to calculate the amount of urban forest needs for emission reduction. The calculation method is to multiply the previously calculated urban forest requirement by IDR 60,000,000 as the cost per hectare for planting and maintaining urban forest.

Table 2 shows that the financing needs of urban forest in Batu fluctuate every year. The use of gasoline is obtained by multiplying the number of vehicles with the average purchase of fuel in one year, which is 2,255.91 per unit per year, which is obtained from the survey results of 30 respondents that have been discussed in the previous sub-chapter. The highest funding value was in 2017 where in that year the number of vehicles was the largest. This funding value is the value of emission degradation that must be borne by Batu City due to transportation activities in the City.

Table 2. Value of Emission Degradation Due to Use of Fuel

Year	*Total of Vehicles*	*Gasoline Used/year (liter)*	*Emission (gram)*	*Emission (ton)*	*Urban Forest Needs (Hectare)*	*Funding Needs (IDR/Hectare)*
2015	21,114	47,631,420	109,552,265	109.55	1.71	102,705,248.85
2016	16,177	36,493,960	83,936,109	83.94	1.31	78,690,101.86
2017	21,511	48,527,019	111,612,143	111.61	1.74	104,636,383.82
2018	19,815	44,700,984	102,812,264	102.81	1.61	96,386,497.40
2019	20,350	45,907,900	105,588,169	105.59	1.65	98,988,908.50

3.3. Degradation of Transportation Sector

The total value of degradation caused by activities in the Batu City transportation sector is calculated by adding up the two aspects we discussed earlier, the value of losses due to congestion and the value of emission degradation.

Table 3. Degradation of Transportation Sector

Year	*Total Loss (Million IDR)*	*Funding Needs (Million IDR/Hectare)*	*Total (Million IDR)*
2015	1,561,248.34	102.71	1,561,351.05
2016	1,196,188.04	78.69	1,196,266.73
2017	1,590,604.01	104.64	1,590,708.65
2018	1,465,195.41	96.39	1,465,291.80
2019	1,504,755.31	98.99	1,504,854.30

The transportation sector is an important sector for Batu City. This is because one of the pillars of the tourism sector is the transportation sector. However, if the transportation sector is not the main focus in development planning it will cause enormous losses as shown in table 3. The large number of private car users contributes to a very large degradation value. Road traffic regulation and optimization of public transportation should be Batu City's top priorities in order to create sustainable economic development so that it can support tourism sector effectively and efficiently [31].

4. CONCLUSION

Based on the calculation of the value of environmental degradation in Batu City caused by activities in the transportation sector, it can be concluded that the Batu City Government still has a lot of homework to do with the congestion that occurs. Indeed, it is inevitable for Batu City as one of the national and international tourist destinations to experience traffic jams almost every day. The biggest loss experienced by the residents of Batu City is the loss due to time wasted when stuck in traffic. In connection with congestion and the number of vehicles coming and going to Batu City, it is recommended that the Batu City government establish cooperation in the transportation sector with the surrounding region and the central government in regulating inter-regional connectivity that allows tourists to reach Batu City without having to bring private vehicles. Thus, traffic congestion in Batu City, which is mostly caused by the high number of visits to Batu City, can be reduced. To support this, Batu City must also rearrange public transport routes and make regulations related to the requirement for public transportation to provide a more comfortable fleet and can become a source of regional income, such as Trans-Jakarta in Jakarta City.

ACKNOWLEDGMENT

Thanks are conveyed to the Universitas Negeri Malang through the Research and Community Service Agency (LP2M) who has funded this research.

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