International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 3, Issue 6 (June 2014), PP.30-38

Effect of Oveloading Fregiht Vehicles to Increased Carbon Dioxide Emissions (Case Study: Easst Java Province)

Wahid Wahyudi[1], Eko Ganis[2], Soemarno[3], Agus Taufik Mulyono[4]

[1]*Student of Doctoral Program in Environmental Assessment and Development, Brawijaya University*
[2]*Proffesor of Doctoral Program in Environmental Assessment and Development, Brawijaya University*
[3]*Proffesor of Doctoral Program in Environmental Assessment and Development, Brawijaya University*
[4]*Proffesor of Civil and Environmental Engineering, Technic Faculty, University of Gadjah Mada*

Abstract: Overloading of freight vehicles will increase the load on the vehicle machine, which cause the increasing of fuel consumption and air pollution. This study aims to determine the effect of overloading of freight vehicles on increasing of gas emissions, especially carbon dioxide (CO_2). The concept of this study using the quantitative method which conducts interview survey related fuel consumption and trip length in several Weigh Bridge in East Java. The results showed that the overloading of freight vehicles affect the increase in CO_2 emissions significantly. The overloading of Vehicle type .6A effect 74.3% on the CO_2 emissions and Vehicle type .6B effect 80.5% on the CO_2 emissions. The overloading of Vehicle type .7A effect 71.12% on the CO_2 emissions and Vehicle type .7B effect of 74.13% of the CO_2 emissions. Each 10% overloading will increase CO_2 emissions as large as 21.9 ton/km-year from Vehicle type .6A; 41.9 ton/km-year from Vehicle type .6B; 54.0 ton/km-year from Vehicle type .7A; and 40,7 ton/km-year from Vehicle type .7B.

Keywords: Overloading, Freight Vehicles, Road Damage, Deficit Design Life, CO_2 Emissions.

I. INTRODUCTION

The movement of freight has a strategic role in supporting economic growth in a region. Compared with passenger traffic , freight transport has special characteristics. The nature of road freight transport modes have a high flexibility and be able to realize the service from door to door and also acts as a feeder as well as a successor to the other modes. This is where the consequences for road-based modes of transport costs categorized cheaper when compared to other modes . Rreight transpors tend to have an independent nature and are not so dependent with other modes in terms of both operational and in terms of regulation that attract many people to participate in the activities of road freight transport . Moreover with infrastructure facilities are arguably reasonable cause road freight transport modes more developed .

The cost of road freight transport mode is influenced by vehicle operating costs and will affect the price of goods / commodities in a region . Vehicle operating costs consist of the cost of freight transport fuel oil (BBM) , depreciation and interest payments . The Asia Foundation survey (2008) mentions that the biggest cost of freight is the cost of fuel oil (BBM) and labor costs (driver and mechanic) . Therefore, one of the efforts made by the employers in the transportation of goods vehicle operating costs is to minimize the number of vehicles used in the transportation of goods , so on the other hand , as a consequence is many freight vehicles operating with excess load . In accordance with the Law. 22 of 2009 on traffic and road transport , the government reserves the right to monitor and crack down on freight vehicles . This is done with the weighbridge facility that serves for monitoring and enforcement of the freight traffic on the highway . Oversight function in this case is intended for monitoring weight (tonnage) load the vehicle in accordance with the rules of the allowable total weight (JBI) and in accordance with the grade of the road . While enforcement functions performed if the oversight function is found in violation of freight JBI . Thus the role of weighbridge is crucial for the improvement of road transport services in general and in particular the smooth distribution of goods .

In its current state , handling more cargo on freight transport is still not well realized . There are many things that indicate that, one of which was still in excess of the amount of freight transport capacity (overload) at the time of operation , law enforcement, and weak reporting system / evaluation and summary of the infringing goods vehicle data payload capacity . Problems overloading of freight handling this becomes very complex , due to the multiplier effects that directly affect many areas of life . Where along with the development of transportation , it turns out the excess capacity of goods transport vehicles raises new issues that also harms include congestion due to the overloading of goods vehicles not capable of running an average speed or slow down the road , and it is certainly going to make an impact derivative ie emissions produced goods vehicles will be higher given the performance of the engine is forced to adjust the load being transported . According to the research Guensler et al . in 2005 , the amount of emissions produced by a vehicle depends heavily on changes in the vehicle's engine performance.

Motor vehicle exhaust is classified into 2 type s , based on engine temperature , ie cold emissions produced when the engine is first turned on until the engine and emission control system reaches steady-state temperature . As well as the emission of heat produced when the engine is operating at steady-state temperature conditions have been . The smallest amount of emissions generated at the time of the motor vehicle has reached a steady state temperature of the engine , running stably , or idle , but the engine still hot and burning. Road conditions and the stability of the speed settings will affect the amount of emissions produced in small quantities. Total emissions will increase at a great pace and the addition of gear changes caused by the presence of the ramp or derivative during the course of a motor vehicle . The addition of the speed at which the vehicle will give more effort to the vehicle so that the engine will produce much greater emissions . In the case of heavy vehicles transport goods , load the vehicle will also be given to improve the business conducted by the vehicle's engine to produce large emissions.

In its current state , overloaded freight vehicles seemed to be a culture that is regarded as the best and profitable for certain parties . While on the other side of the organizers of the national road does not have the authority to control overloaded freight vehicles that operate on a primary arterial road class - 1 , and law enforcement should work hard still not to function properly . Basically regulations overloaded freight vehicles has been made such that it is expected to reduce / suppress the level of violation overloaded freight vehicles especially those operating on a primary arterial road grade - 1 . However, based on the facts on the ground that obtained from a data breach in the vehicle weighbridge offense level obtained overloaded freight vehicles each year has increased (JTC Center 2011-2012) . Based on the above facts, it appears the negative impacts caused because the repetition derivative overloaded freight vehicles , such as a decrease in air quality caused by exhaust gas freight vehicles . During this overloaded freight vehicles only connected with its effect on structural damage to roads and congestion / road services , not considering the effect of the decrease in air quality . This is because of the assumption that the factors that affect the exhaust emissions are engine maintenance and driver behavior . If this condition is left , the contamination level of exhaust emissions of freight vehicles will be higher and increase the potential for air pollution , including greenhouse gas emissions that directly affect climate change in East Java in particular and Indonesia in general . Climate change will result in significant challenges for sustainable development in Indonesia . Therefore, the Indonesian government through Presidential Decree 61 of 2011 preparing a National Action Plan for Greenhouse Gas Emission Reduction (RAN - GRK) to achieve national objectives , sectoral targets , benchmarks and action priorities to consider the issue of mitigation of climate change for economic sectors affected. One of the priority areas included in the RAN GRK is the transportation sector . The observation by the Ministry of Environment showed that the number of CO_2 emissions resulting from the transportation sector in Indonesia increased from by 58 million tons in 2000 to 73 million tons in 2007 . Compared with other sources of CO_2 emissions , the transport sector classified as the second largest emitter of CO_2 , is equal to ± 25 % below the electricity usage (MOE , 2009) . In an effort to overcome and minimize the impact of overloading of freight derivatives such , there needs to be a plan of action that is carried out in stages . The draft act aims to identify in detail the effect of overloading of heavy vehicles to transport goods exhaust emissions , especially CO_2.

II. METHODOLOGY

Study the effect of overloading freight vehicles to the emission of carbon dioxide gas is a quantitative study using field surveys and institutional data surveys. Quantitative methods are very relevant to this study because the data used are measurable technical data field. In addition, the method can kauntitatif explain the results more objective and not give biased results and or ambiguous.

III. COLECTION DATA METHOD

The data in this study is a kind of quantitative data , which characteristics are divided into two , namely primary data and secondary data . The primary data used to answer the purposes of this study were collected from the measurement results and answers of respondents (questionnaire) . Secondary data is used as supporting data supporting the analysis closer to the truth to the implementation of the primary data . Data collection method based on measuring the field and compilation of relevant agencies was very appropriate because of time and cost, so the ease and efficiency of research focus through group interaction .

Primary data collection method in this study is done by recording the events on the ground in the form of the results of the weight, payload weight and axle load of each class of heavy freight vehicles six (6) locations weighbridge is operated by the Department of Transportation and LLAJ East Java Province . Determination of six (6) locations weighbridge is already considering several important aspects related to the accelerated development of the region and an important cross- national roads as well as the results predicted pattern generation and pull movement of goods and passenger trips in 2030. Objects in this study were all classes of heavy vehicle transport goods as a source of primary data , while data relevant agencies and communities is used as a secondary data source .

Nazir (2004) in Mulyono (2007) states that the sample design is a procedure against the majority of the population are taken and used to determine the desired trait or characteristic of the population . The sample is part of a population that is taken from the portion of data that is considered to be representative of the entire population of characters . The opinion is in line with the thinking Sugiyono (2007) which states that the sample is part of the number and characteristics possessed by the population . The number of samples is strongly influenced how much of the total population . Akdon and Hadi (2005) suggested that the sample is part of a population (or a representative portion of the population studied) . The samples were part of the population is taken as a source of data and can represent the entire population . Sampling was done in this study with probability sampling technique that takes into account the existence of equal opportunity for the elements (members) to be elected as members of the population sample . Probability sampling technique chosen is proportional random sampling , that sampling is done in proportion to the number of population in a simple availability . Sugiyono (2006) argues that not only calculates the sample based on the error (error) 5 % , but it varies up to 15 %

IV. RESULT AND DISCUSSION

Calculation of Overloading Effect on Gas Emissions of Freight Vehicle

Implementation of traffic and road transport (LLAJ) is part of the national transportation system must be developed to realize the potential and role of security , safety , order , and fluency in road traffic and road transport operations , as mandated by Law No. 22 Year 2009 on traffic and Transportation . In line with this aim , the Government asserts that every motor vehicle operated on the roads must meet the technical requirements and road worthy . It is intended for vehicular use can create safety aspects , safety , and comfort for the user and the environment . Ground transportation has an important and strategic position as a means to accelerate the economy , strengthen national unity , in order to strengthen the archipelago embodiment insight and improve national security . The importance is reflected in the implementation of transport which affects all aspects of life of the nation and the state as well as the increasing need for transportation services for the mobility of people and goods in the country . Ground transportation a big impact for improved and equitable development and results . Community needs for goods and services , in a place not everything can be fulfilled itself , so as to meet the needs in the form of goods and services from one place to another is necessary transportation .

If the emission factors and activity levels are known then the multiplication between the two will result in issuance costs . Emission factors are generally determined from measurement data on one or multiple facilities within an industry category , so that the emission factor represents a value similar to the industry but by no means representative of what really happens on a particular source . Published emission factors are available. Emission factors allow issuance cost estimates from several source categories . Currently Indonesia has no documents / publications that contain emission factors that apply nationally . Some foreign publications containing reference emission factors for a variety of facilities and industry categories based on the level of activity in countries such as EMEP / CORINAIR , U.S. EPA AP - 42 , and the IPCC . Calculation and estimation of the amount of emissions can be used several already published emission factors . Mobile sources of emissions calculation methods generally use emission factors . Specifically , the emissions from motor vehicles generated from the combustion process in the engine exhaust gases issuing (nitrogen , CO_2 , water , and air pollutants) ; evaporation of fuel in the engine , and when refueling .

The type and amount of pollutants emitted from various categories of vehicles are affected by the level of use of the vehicle in tons or kg - km . Berbaga emission factor is influenced by parameters such as: the characteristics of the engine , vehicle technology , fuel characteristics , age and vehicle maintenance , and use of the vehicle . The accuracy is determined by a calculation of emission factors that represent the intended vehicle operating conditions . However , the current national and local emission factors are not available , so in the guidelines has been agreed to use the European emission factor (CORINAIR) . Reference CORINAIR emission factors available in : http://www.eea.europa.eu/publications/emepeea-emission-inventory-guidebook-2009 . The guide contains emission factors for various categories and sub - categories of sources . If a facility is not found in the CORINAIR emission factors , it can use the reference U.S. EPA emission factors AP - 42 http://www.epa.gov/ttnchie1/ap42/ .

Analysis of overload (overload) transport heavy goods vehicles on primary arterial roads around the weighbridge can be calculated as a moving source emission factors commonly used method . Specifically , the emissions from motor vehicles generated from the combustion process in the engine exhaust gases issuing (nitrogen , CO_2 , water vapor , and air pollutants) ; evaporation of fuel in the engine when refueling , and others . The type and amount of pollutants emitted from various categories of vehicles are affected by the level of use of the vehicle in ton - miles - or kg . Emission factors are influenced by various parameters , such as: the characteristics of the engine , vehicle technology , fuel characteristics , age and vehicle maintenance , and use of the vehicle .

Mobile source emission control equipment is a catalyst that can reduce CO emissions , HC , NOx by more than 90 % . The equipment generally has been installed on new vehicles that meet Euro II standards upwards , so the emission factor has been the efficiency of control equipment . Emission factor refers to the EURO standards for a new type of vehicle that is adjusted by factors including the age of the vehicle fleet composition , vehicle technology , traffic conditions , driving behavior , the type and quality of fuel. This study uses emission factors are still referring to the national emission factors that represent conditions over the Indonesian archipelago , as shown in Table 2 .

Tabel 2. Emission Factor of Vehicles in Indonesia

Kategori	CO (gr/km)	HC (gr/km)	NOx (gr/km)	PM_{10} (gr/km)	CO_2 (gr/km)	SO_2 (gr/km)
Motorcycle	**14**	**5,9**	**0,29**	**0,24**	**3.180**	**0,008**
Passenger Car Unit (Premium) Mobil	**40**	**4**	**2**	**0,01**	**3.180**	**0,026**
Passenger Car Unit (Premium)	**2,8**	**0,2**	**3,5**	**0,53**	**3.172**	**0,44**
Bus	**11**	**1,3**	**11,9**	**1,4**	**3.172**	**0,93**
Truck	**8,4**	**1,8**	**17,7**	**1,4**	**3.172**	**0,82**

Sumber : Kementerian Lingkungan Hidup (2010)

Especially for the parameters CO2, emission factors can also refer to the IPCC http://www.ipcc-nggip.iges.or.jp/public/2006gl/ which gives more accurate analysis results than national emission factors. IPCC emission factors are influenced by fuel consumption, the equations used to calculate the CO2 emissions with the IPCC emission factor method presented in Equation (1) and Table 3.

$E_{cji} = VKT_{ji} \,.\, EF_{IPCC} \,.\, K \,.\, (100\text{-}C)/100$ (1)

Note :

E_{cji} = c pollutant emissions for the vehicle category j on the road section i

EF_{IPCC} = emission factor for each pollutant which refers to the IPCC emission factor K = Fuel consumption of freight vehicles (kg/km)

$$K = \sum_{j=1}^{n} K_j / L_j \;\; x \; 0{,}832$$

K_j = Fuel consumption each vehicles (liter)

L_j = The length of each vehicle trip (km)

C = efficiency of emission control equipment (%)

C = 0, if there is no control equipment

Tabel 3. IPCC Emission factors of Diesel vehiclerefer to IPCC method

Emission Parameter	Emission Factor IPCC
NOx	**33,37**
Sox	**0,214**
NMVOC (HC)	**1,92**
PM_{10}	**0,94**
CO	**7,58**
CO_2	**17400**

Source: http://www.ipcc-nggip.iges.or.jp/public/2006gl/ (diakses 01/02/2014; 11:32)

Study sites were selected as examples of analysis, Weigh Bridge (JT) Singosari in Malang , while for the five (5) other locations such as Sedarum JT , JT Rejoso , Trowulan JT , JT and JT Lamongan Mojoagung analyzed with the help of microsoft excel software is then direct analysis of the results obtained . Weigh (JT) Singosari in Malang airport cargo weighing motor vehicles that transport goods across national roads with primary arterial function : (1) section 094 (Gempol - Pandaan) ; (2) section 095 (Pandaan Ring Road Bypass) ; (3) section 096 (Pandaan - Purwosari) ; (4) section 097 (Purwosari - Purwodadi) ; (5) section 098 (Purwodadi-Bts. District. Malang) ; (6) section 099 (Bts. District. Pasuruan - Karanglo) ; and section 102 (Bts. Malang - Kepanjen) . The road sections form a network of cross- connecting traffic between the north and south traffic that has a major role in supporting the development master plan and the accelerated development of economic corridors - Gempol - Pasuruan - Malang, Sidoarjo . Analysis of the effect of overweight cargo transport heavy goods vehicles crossing the national road sections are listed in JT Singosari on levels of exhaust emissions can be calculated as follows :

(1) The length of the average trip freight vehicles per year or VKT (vehicle kilometers Traveled), is obtained:

$$VKT_{j,line} = \sum_{i=1}^{n} Q_{ji}\, l_i$$

= 134.412 x 43.82
= 5.889.933,84 kend.-km

(2) The VKT value can be used to calculate the levels of exhaust emissions from heavy vehicle freight transport activity with national emission factors, obtained:

(a) Gas Emission NOx

$$E_{cji} = VKTji.EFcj\ (100 - C)/100$$

= 5.889.933,84 x 17,7 x (100-0)/100
= 104.251.829 kg/km-year
= 104.251,8 ton/km-year

(b) Gas emission SO_2

$$E_{cji} = VKTji.EFcj\ (100 - C)/100$$

= 5.889.933,84 x 0,82 x (100-0)/100
= 4.829.746 kg/km-year
= 4.829,74 ton/km-year

(c) Gas emission NMVOC (HC)

$$E_{cji} = VKTji.EFcj\ (100 - C)/100$$

= 5.889.933,84 x 1,8 x (100-0)/100
= 10.601.881 kg/km-year
= 10.601,8 ton/km-year

(d) Particulate emission PM_{10}

$$E_{cji} = VKTji.EFcj\ (100 - C)/100$$

= 5.889.933,84 x 1,4 x (100-0)/100
= 8.245.907 kg/km-year
= 8.245,9 ton/km-year

(e) Gas emission CO

$$E_{cji} = VKTji.EFcj\ (100 - C)/100$$

= 5.889.933,84 x 8,4 x (100-0)/100
= 49.475.444 kg/km-year
= 49.475,4 ton/km-year

(f) Gas emission CO_2

$$E_{cji} = VKTji.EFcj\ (100 - C)/100$$

= 5.889.933,84 x 3.172 x (100-0)/100
= 18.682.870.140 kg/km-year
= 18.628.870,1 ton/km-year

The calculation of CO_2 emissions of freight vehicles using IPCC emission factor is more appropriately used in this study because it is imposible to fuel consumption survey data that occur in the field. The results of the calculation of CO_2 emissions with the IPCC emission factor using fuel consumption data can be obtained by:

(1) Average fuel consumption of freight vehicles

$K = \sum_{j=1}^{n} K_j / L_j \;\; x\ 0{,}832$;K=Konsumsi bahan bakar (liter); L=Jarak Tempuh (km)

K = (10,4+10,5+20,5+...+ n) / (70+70+140+...+ n) x 0,832 = 0,24 kg/km

(2) Gas emission CO_2

E_{cji} = VKT_{ji} . EF $_{IPCC}$. K. (100-C)/100
= 5.889.933,84 x 17.100 x 0,24 (100-0)/100
= 24.172.288.479 kg/km-year
= 24.172.288,4 ton/km-year

Furthermore, from the calculation of the levels of each pollutant exhaust emissions due to transport heavy goods vehicles that cross sections of the national road to Malang Gempol can be seen in Table 4.

Table 4. Results of the analysis of vehicle exhaust emission levels of heavy goods transport in JT Singosari Malang

Type kendaraan berat	Jumlah Kendaraan overload th.2013	Panjang jalan (km)	VKT (kend.-km)	Konsumsi BBM (kg/km)	Estimasi Emisi gas buang (ton/km-year)					
					CO	NMVOC	NOx	PM_{10}	CO_2 *)	SOx
6A	52.728	43,82	2.443.273,00	0,17	20.523	4.398	43.246	3.420,58	7.227.202	2.003
6B	45.426	43,82	2.104.918,06	0,22	17.681	3.789	37.257	2.946,89	8.057.626	1.726
7A	16.860	43,82	781.246,83	0,27	6.562	1.406	13.828	1.093,75	3.670.298	641
7B	12.096	43,82	560.495,95	0,31	4.708	1.009	9.921	784,69	3.023.315	460

Note : *) = Emission factor refer to IPCC method

In addition to the calculation of the overall exhaust emissions also performed calculations exhaust emissions by overloaded cluster grouped every 10 % overload . The analysis has an important role to determine the influence of heavy vehicle overloading of freight charges to the amount of pollution generated by exhaust emissions , especially on the national road sections of Gempol to Malang JT Singosari especially in locations that passed all classes of heavy vehicles transport goods . Conditions payload transport heavy goods vehicles crossing Singosari JT has a load variation reaches more than 100 % or up to 2 (two) times greater than the maximum allowed load . These conditions force the vehicle's engine to work harder with an average travel distance of nearly 50 miles , so it can be presumed impact of air pollution is much greater than normal load conditions the charge . The results of the calculation of CO_2 emissions produced as a result of overloaded cargo transport heavy goods vehicles crossing Singosari - Malang JT locations based clusters overloaded as presented in **Table 5**. Calculation of CO_2 emissions by 10 % each cluster is overloaded then performed at all locations research which then becomes the input in the correlation and regression analysis between percent overloaded heavy vehicles and freight transport CO_2 emissions released.

Table 5. Results of calculation of CO2 emissions by freight vehicle in Singosari Malang

Overloading (%)	Gas emission CO_2 (ton/km-year)							
	6A	tiap10%	6B	tiap10%	7A	tiap10%	7B	tiap10%
0-10%	421,3		452,1		866,9		935,5	
11%-20%	422,4	1,1	455,8	3,7	881,5	14,6	953,0	17,5
20%-30%	477,7	55,3	462,9	7,1	899,8	18,3	948,0	(5,0)
30-40%	507,9	30,2	481,4	18,4	919,3	19,5	966,3	18,2
40-50%	531,9	24,1	501,3	19,9	935,1	15,8	1.080,0	113,8
50-60%	538,5	6,6	591,9	90,6	952,5	17,3	1.164,0	84,0
60-70%	583,3	44,8	512,5	(79,4)	974,6	22,1	1.132,0	(32,0)
70-80%	561,3	(22,0)	531,1	18,6	1.011,1	36,5	1.264,5	132,5
80-90%	650,0	88,6	549,2	18,2	967,6	(43,5)	1.156,9	(107,6)
90-100%	642,4	(7,6)	659,6	110,4	1.038,6	71,0	1.274,4	117,5
101%-110%	632,8	(9,6)	631,1	(28,5)	1.503,9	465,3	1.462,7	188,3
111%-120%	634,9	2,1	540,0	(91,1)	1.649,5	145,6		
121%-130%	606,8	(28,1)	936,3	396,3	1.644,4	(5,1)		
131%-140%	597,6	(9,2)	973,9	37,6	1.771,7	127,3		
141%-150%	671,5	73,9	1.014,6	40,7	1.920,4	148,7		
151%-160%	677,2	5,8						
Rerata tiap10%		17,1		40,2		75,2		52,7

Effect of overloading freight vehilces on gas emissions at the sites 6 (six) research location

Based on the calculation of CO_2 emissions at various percentages of overloading freight vehicles are summarized from 6 (six) research location then can be analyzed mathematically model the regression equation between the percentage of overloaded cargo and CO_2 emission levels. The analysis showed there was a strong enough correlation between heavy vehicle overloading of freight vehilces charges and increased levels of CO_2 emissions that occur in the main traffic of freight transport in East Java, as shown in Figure 1.

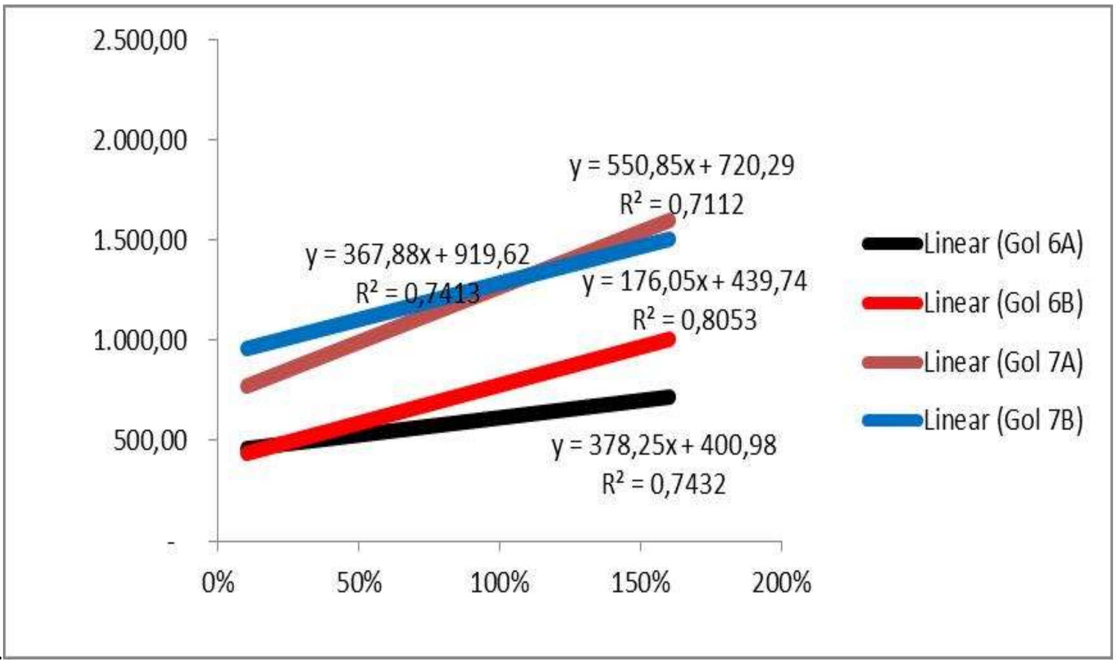

Figure 1. The influence of the percentage of each class of cargo overloaded heavy vehicles to transport goods increased levels of CO_2 emissions in East Java

The results of analysis of the mathematical model can be described as follows:

(1) Effect of the percentage of overloading freight vehicles type 6A to increased levels of CO_2 emissions in East Java is modeled as Y = 378.25 . X + 400.98 ; with determination coefficient R^2 = 0.7432 ; means the percentage of overloading freight vehicles type 6A accounted for 74.32 % of the increased levels of CO2 emissions . The remaining 25.69 % increase in CO_2 emissions is influenced by other variables not included in the equation.

(2) The effect of the percentage of overloading freight vehicles Type 6B to increased levels of CO_2 emissions in East Java is modeled as Y = 176.05 . X + 439.74 ; with determination coefficient R^2 = 0.8053 ; means the percentage of overloading freight vehicles type 6B accounted for 80.53 % of the increased levels of CO_2 emissions. The remaining 19.47 % increase in CO_2 emissions is influenced by other variables not included in the equation.

(3) The effect of the percentage of overlaoding freight vehicles type 7A to increased levels of CO_2 emissions in East Java is modeled as Y = 550.85 . X + 720.29 ; with determination coefficient R^2 = 0.7112 ; means the percentage of overloaded heavy vehicle charges Type 7A accounted for 71.12 % of the increased levels of CO_2 emissions . The remaining 28.88 % increase in CO_2 emissions is influenced by other variables not included in the equation .

(4) The effect of the percentage of overloaded cargo transport heavy goods vehicles Type 7B to increased levels of CO_2 emissions in East Java is modeled as Y = 367.88 . X + 919.62 ; with determination coefficient R^2 = 0.7413 ; means the percentage of overloaded heavy vehicle charges Type 7B accounted for 74.13 % of the increased levels of CO_2 emissions . The remaining 25.87 % increase in CO_2 emissions is influenced by other variables not included in the equation .

The mathematical model can provide a quantitative indicator of the general impact of each increase of 10% excess weight of freight vehicles to JBI (maximum load), as shown in **Table 6**. Terms of practical effect indicates that increase of 10% by weight of a freight vehicles type 6A, Type 6B, Type 7A, and Type .7B across the weighbridge locations in East Java will provide the impact of increased levels of CO_2 emissions amounted to 21.9 tons / km-year; 41.9 tons / km-year; 54.0 tons / km-year; and 40.7 tons / km-year.

Tabel 6. The mean increase in CO_2 emissions for each 10% overweight freight vehicles in East Java

Research Location	Average of increasing CO_2 emission (ton/km-year) each 10% overloading			
	Vehicle type 6A	Vehicle type 6B	Vehicle type 7A	Vehicle type 7B
JT Singosari (Kab. Malang)	17,1	40,2	75,2	52,7
JT Sedarum (Kab. Pasuruan)	21,1	44,3	41,4	34,6
JT Rejoso (Kab. Pasuruan)	20,0	45,1	54,7	32,2
JT Lamongan (Kab. Lamongan)	16,5	33,8	59,0	62,1
JT Trowulan (Kab. Mojokerto)	17,1	43,7	50,5	31,5
JT Mojoagung (Kab. Jombang)	39,3	44,5	43,4	31,0
Total in East Java	131,1	251,6	324,2	244,1
Mean each location in East Java	21,9	41,9	54,0	40,7

The results of this analysis provide a quantitative result that freight vehicles type 7A (truck 1,2,2) load distribution of Sb - 1 (5T) , Sb - 2 (9T) , Sb - 3 (9T) and Type 6B (1.2 Trucks H) single -axis double wheel (STRG) load distribution of Sb - 1 (5T) , Sb - 2 (10T) had a significant impact contribution increased levels of CO_2 emissions per freight vehicle load of 10 % of excess weight than other types of vehicles in East Java . Conditions of freight is dominated by Type 6B, 7 Type A and Type 7B closely related to the role of national roads in East Java in support of manufacturing goods traveling from the city of Sidoarjo and Surabaya to Jakarta through midle and north route of freight vehilces in East Java. In addition, freight vehicles Type 6B and 7A supporting agricultural commodity goods traveling from Pasuruan and Jember to Bali .

Based on the data and analysis results show that freight vehilces Type 6A overloaded almost double that allowed up to an average of 85 % and a sizable amount on all weigh station locations, so that its effect on ambient air quality in the surrounding streets its path is quite large . Similarly freight vehilces Type 6B load limit of 21 tons , the fact that the load is transported on average reached 24.6 tonnes , equivalent to 2 (two) times the allowable load , so the influence on the increase in CO_2 emitted air to reach 80 %. The charge excess weight problem also occurs in heavy vehicle transport goods Type 7A with a load limit of 21 tons, but the amount of load that occurs on average 31 tons and Type 7B with a load limit of 35 tons, but the magnitude of which occurred an average of 47 tons . Overloading of freight vehicles requires more power, so it can affect fuel consumption and resulting higher emissions of CO_2.

V. CONCLUSION

The conclusion of this study indicate that overloading of freight vehicles significantly affect the increase in CO_2 emissions is equal to 74.3% for the vehicle Type 6A; 80.5% for the Vehicle type 6B; 71.12% for vehicles Type 7A; and amounted to 74.13% for vehicles Type 7B. The mean increase in CO_2 emissions for each 10% overload is equal to 21.9 tons / km-year for the Vehicle type 6A; amounted to 41.9 tons / km-year for the Vehicle type 6B; amounted to 54.0 tons / km-year for vehicles Type 7A; and amounted to 40.7 tons / km-year for vehicles type 7B.

REFERENCES

[1]. IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning,Z. Chen, M.Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge Universitype ess, Cambridge, United Kingdomand New York, NY, USA.

[2]. IPCC, 2007: Summary for Policymakers. In:Climate Change 2007: Impacts, Adaptation and Vulnerabil ity. Contributionof Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,M.L.Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson,Eds., Cambridge University Press, Cambridge, UK, 7-22.

[3]. IPCC, 2007: Summary for Policymakers. In: Climate Change 2007 : Mitigation. Contribution of Working Group III to the Fourth Assessment Report of theIntergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R.

[4]. Mulyono, A.T., 2007, Model Monitoring dan Evaluasi Pemberlakuan Standar Mutu Perkerasan Jalan Berbasis Pendekatan Sistemik, Disertasi Doktor Teknik Sipil, Program Pascasarjana Universitas Diponegoro, Semarang.

[5]. Sekretariat Negara, 2009, Undang-Undang Nomor 22 Year 2009 tentang Lalu Lintas dan Angkutan Jalan, Jakarta.

[6]. Sekretariat Negara, 2009, Undang-Undang Nomor 32 year 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup, Jakarta.

[7]. Sugiyono. 2004. Statistika Untuk Penelitian, Alfabeta, CV Bandung

[8]. Sugiyono.2002.Metode Penelitian Admnistrasi, Bandung : Alfabeta.

[9]. United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol 1997, Kyoto, Jepang

[10]. United State Environmental Protection Agency (US-EPA).2002. Waste Wise Update. United States Environmental Protection Agency. Washington.