

Prediction of CO, CO₂, CH₄, and N₂O Vehicle Emissions from Environmental Impact Assessment (EIA) at Toll Road of Krian-Legundi-Bunder in East Java of Indonesia

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Abstract: Environmental Impact Assessment study on Krian-Legundi-Bunder, East Java, was created in 2014 and it has the feasibility and environmental permit. From the EIA study, one of the negative impact from the operational stage is explored from the emission from vehicles, which they use this toll road. This research is aimed to study in more detail on the prediction of CO, CO₂, CH₄ and N₂O emission by using the traffic prediction data, which was performed in the feasibility process. The prediction produced the passenger carunit (PCU)/day. According to the value of PCU/day, this value can predict the total emission of CO, CO₂, CH₄ and N₂O of vehicles by multiplying the value of PCU/hour with the vehicle emission factor and the fuel consumption as well as calculating the length of the usage road. The regresion result of CO, CO₂,CH₄ and N₂O vehicle emission, which came from the toll road of Krian-Legundi-Bunder in year 2048, are: Total Emission CO = -425 + 235 Years; Total Emission CO₂ = -4254 + 2353 Years; Total Emission CH₄ = -0.693 + 0.383 Years; and Total Emission N₂O = -0.140 + 0.0777 Years respectively.

Keywords : Toll Road, Emission, CO, CO₂, CH₄, NO₂.

1. Introduction

Environmental impact analysis of Toll Road in Krian-Legundi-Bunder was created in 2014 and it has the feasibility and environmental permit. One of the negative impacts from the operational stage was the vehicle gas emission, which the vehicles use this toll road. The toll road of Krian-Legundi-Bunder, which is located in East Java, is designed as 29,2 km and intended to facilitate the access road from Tanjung Perak harbor to west side of East Java Province as well as able to reduce the load of Surabaya-Gempol Toll Road. The Surabaya-Gempol Toll Road is usually used as the access road from Tanjung Perak harbor to east side of East Java Province. This research aims to evaluate in deep regarding the prediction emission of CO, CO₂, CH₄ and N₂O by using the traffic data prediction in which was conducted in pre feasibility study. This approach produces the value of passengercar unit (PCU)/day.

2. Literature Review

Based on the pre feasibility study of Krian-Legundi-Bunder toll road in 2014, a traffic prediction data in daily average and yearly average were collected. The detail of the prediction data is shown in Table 1.

Table 1. Prediction of Yearly Traffic Average in Year 2014-2048 on Vehicle Which Will PassToll Road of Krian-Legundi-Bunder in Moderate Conditions

Year	Vehicle/year				Vehicle/year				PCU/ day
	Class. I	Class. IIA	Class. IIB	Total	Class. I	Class. IIA	Class. IIB	Total	
2014	6803235	5563330	4682220	17048785	18639	15242	12828	46709	81193
2015	7211002	5749940	4852252	17813194	19756	15753	13294	48803	84497
2016	7631002	5942148	5027384	18600534	20907	16280	13774	50960	87901
2017	8063602	6140123	5207771	19411496	22092	16822	14268	53182	91406
2018	8509180	6344036	5393569	20246785	23313	17381	14777	55471	95017
2019	8968126	6554067	5584941	21107134	24570	17956	15301	57828	98736
2020	9440839	6770399	5782054	21993292	25865	18549	15841	60256	102567
2021	9927735	6993221	5985081	22906037	27199	19160	16397	62756	106512
2022	10429237	7222728	6194198	23846163	28573	19788	16970	65332	110576
2023	10945784	7459120	6409589	24814493	29988	20436	17561	67985	114762
2024	11477827	7702603	6631442	25811872	31446	21103	18168	70717	119073
2025	12025832	7953391	6859950	26839173	32947	21790	18794	73532	123514
2026	12590277	8211703	7095313	27897293	34494	22498	19439	76431	128088
2027	13171655	8477764	7337738	28987157	36087	23227	20103	79417	132799
2028	13770475	8751807	7587435	30109717	37727	23978	20787	82492	137651
2029	14387259	9034071	7844623	31265953	39417	24751	21492	85660	142649
2030	15022547	9324804	8109527	32456878	41158	25547	22218	88923	147797
2031	15676893	9624258	8382378	33683529	42950	26368	22965	92284	153100
2032	16350870	9932695	8663414	34946979	44797	27213	23735	95745	158561
2033	17045066	10250386	8952881	36248333	46699	28083	24528	99311	164186
2034	17760088	10577608	9251033	37588729	48658	28980	25345	102983	169981
2035	18496561	10914646	9558129	38969336	50676	29903	26187	106765	175948
2036	19255128	11261796	9874438	40391362	52754	30854	27053	110661	182095
2037	20036452	11619359	10200236	41856047	54894	31834	27946	114674	188427
2038	20841215	11987650	10535808	43364673	57099	32843	28865	118807	194948
2039	21670122	12366990	10881447	44918559	59370	33882	29812	123065	201665
2040	22523895	12757709	11237455	46519059	61709	34953	30788	127449	208583
2041	23403282	13160151	11604144	48167577	64119	36055	31792	131966	215709
2042	24309051	13574665	11981833	49865549	66600	37191	32827	136618	223049
2043	25241992	14001615	12370853	51614460	69156	38361	33893	141409	230609
2044	26202922	14441374	12771544	53415840	71789	39565	34991	146345	238396
2045	27192680	14894325	13184255	55271260	74500	40806	36121	151428	246416
2046	28212130	15360865	13609348	57182343	77294	42085	37286	156664	254677
2047	29262164	15841400	14047193	59150757	80170	43401	38485	162057	263186
2048	30343699	16336352	14498174	61178225	83133	44757	39721	167612	271950

Source : IAF Consultant¹

Laksono and Damayanti² have revealed a formula to calculate the total emission by taking account of total vehicles, emission factors, length of the road and the fuel consumption used by vehicles and was presented as follow: $Q = N_i \times FE_i \times L \times KI$, where: Q = emission total (g/hour), N_i = total vehicle (PCU/hour), FE_i = vehicles emission factor (g/liter), L = road length (km), KI = vehicle fuel consumption (liter/100 km). Emission factor value based on fuels and vehicles types are shown in Table 2. The specific energy consumption based on gasoline and diesel types for vehicle are shown in Table 3.

Table 2. Vehicle emission factor based on fuel type

Vehicle type / fuel	Emission Type (g/liter)			
	CH ₄	CO	N ₂ O	CO ₂
Gasoline :				
Passenger vehicle	0.71	462.63	0.04	2597.86
Small commerce vehicle	0.72	295.37	0.05	2597.87
Large commerce vehicle	0.73	281.14	0.06	2597.88
Motorcycle	3.56	427.05	0.07	2597.89
Diesel :				
Passenger vehicle	0.08	11.86	0.16	2924.90
Small commerce vehicle	0.04	15.81	0.16	2924.90
Large commerce vehicle	0.24	35.57	0.12	2924.90
Locomotive	0.24	24.11	0.08	2964.43

Source :Laksono and Damayanti²
Table 3. Specific energy consumption on vehicle

Vehicle type	Specific energy consumption (liter/100 km)	
	Gasoline	Diesel
Passanger car	11.79	11.36
Large bus	23.15	16.89
Medium bus	13.04	13.04
Small bus	11.35	11.83
Minibus	10.99	10.99
Taxi	10.88	6.25
Large truck	15.82	15.82
Medium truck	15.15	15.15
Small truck	8.11	10.64
Motorcycle	2.66	2.66

Source :Laksono and Damayanti²

3. Study methodology

The method of this study is constructed by utilizing the traffic data prediction and it produces the passengers carunit (PCU) per day. Based on this data, the calculation of CO, CO₂, CH₄, and N₂O emission prediction on toll road Krian-Legundi-Bunder can be performed by using the equation mentioned by Laksono and Damayanti².

4. Result and discussion

Based on Ministry of Energy and Resource publication³, a comparison prediction of gasoline and diesel use on transportation is about 4:3. The environmental impact assessment (EIA) study does not show the percentage detail of vehicles, whether they use the gasoline or diesel. Thus, the emission is calculated by using the similar assumption on total gasoline and diesel usage on vehicles that are 4:3. Based on Table 3 data, a conversion calculation from PCU/day to PCU/hour can be performed. The total emission calculation on Table 4 to Table 7 can be performed by summing the emission from (4/7) Q of gasoline + (3/7) Q diesel.

Table 4. Prediction calculation of CO total emission in toll road Krian-Legundi-Bunder

Year	Ni (PCU/hour)	Fei (g/liter) Gasoline	Fei (g/liter) Diesel	L (km)	KI (liter/100km) Gasoline	KI (liter/100km) Diesel	Q Gasoline (g/hour)	Q Diesel (g/hour)	Total Emission CO (Ton/hour)
2014	3383.04	462.63	11.86	29.2	11.79	11.36	5388127	133092	3456.81
2015	3520.71	462.63	11.86	29.2	11.79	11.36	5607387	138508	3597.48
2016	3662.54	462.63	11.86	29.2	11.79	11.36	5833283	144088	3742.40
2017	3808.58	462.63	11.86	29.2	11.79	11.36	6065881	149834	3891.63
2018	3959.04	462.63	11.86	29.2	11.79	11.36	6305514	155753	4045.37
2019	4114.00	462.63	11.86	29.2	11.79	11.36	6552315	161849	4203.71
2020	4273.63	462.63	11.86	29.2	11.79	11.36	6806547	168129	4366.81
2021	4438.00	462.63	11.86	29.2	11.79	11.36	7068345	174596	4534.77
2022	4607.33	462.63	11.86	29.2	11.79	11.36	7338040	181257	4707.80
2023	4781.75	462.63	11.86	29.2	11.79	11.36	7615831	188119	4886.02
2024	4961.38	462.63	11.86	29.2	11.79	11.36	7901918	195186	5069.56
2025	5146.42	462.63	11.86	29.2	11.79	11.36	8196631	202465	5258.64
2026	5337.00	462.63	11.86	29.2	11.79	11.36	8500171	209963	5453.38
2027	5533.29	462.63	11.86	29.2	11.79	11.36	8812802	217685	5653.95
2028	5735.46	462.63	11.86	29.2	11.79	11.36	9134790	225639	5860.52
2029	5943.71	462.63	11.86	29.2	11.79	11.36	9466467	233832	6073.31
2030	6158.21	462.63	11.86	29.2	11.79	11.36	9808099	242270	6292.49
2031	6379.17	462.63	11.86	29.2	11.79	11.36	10160016	250963	6518.27
2032	6606.71	462.63	11.86	29.2	11.79	11.36	10522419	259915	6750.77
2033	6841.08	462.63	11.86	29.2	11.79	11.36	10895705	269135	6990.26
2034	7082.54	462.63	11.86	29.2	11.79	11.36	11280272	278635	7236.98
2035	7331.17	462.63	11.86	29.2	11.79	11.36	11676254	288416	7491.03
2036	7587.29	462.63	11.86	29.2	11.79	11.36	12084181	298492	7752.74
2037	7851.13	462.63	11.86	29.2	11.79	11.36	12504385	308871	8022.32
2038	8122.83	462.63	11.86	29.2	11.79	11.36	12937131	319561	8299.95
2039	8402.71	462.63	11.86	29.2	11.79	11.36	13382885	330571	8585.93
2040	8690.96	462.63	11.86	29.2	11.79	11.36	13841977	341911	8880.47
2041	8987.88	462.63	11.86	29.2	11.79	11.36	14314872	353592	9183.86
2042	9293.71	462.63	11.86	29.2	11.79	11.36	14801969	365624	9496.36
2043	9608.71	462.63	11.86	29.2	11.79	11.36	15303665	378017	9818.23
2044	9933.17	462.63	11.86	29.2	11.79	11.36	15820426	390781	10149.76
2045	10267.33	462.63	11.86	29.2	11.79	11.36	16352649	403928	10491.22
2046	10611.54	462.63	11.86	29.2	11.79	11.36	16900865	417469	10842.93
2047	10966.08	462.63	11.86	29.2	11.79	11.36	17465539	431417	11205.20
2048	11331.25	462.63	11.86	29.2	11.79	11.36	18047135	445783	11578.33

Table 5. Prediction calculation of CO₂ total emission in toll road Krian-Legundi-Bunder

Year	Ni (PCU/ hour)	Fei (g/liter) Gasoline	Fei (g/liter) Diesel	L (km)	KI (liter/100k m) Gasoline	KI (liter/100km) Diesel	Q Gasoline (g/hour)	Q Diesel (g/hour)	Total Emission CO ₂ (Ton/hour)
2014	3383.04	2597.86	2924.90	29.2	11.79	11.360	30256574	32823097	34564.60
2015	3520.71	2597.86	2924.90	29.2	11.79	11.36	31487809	34158772	35971.14
2016	3662.54	2597.86	2924.90	29.2	11.79	11.36	32756310	35534874	37420.25
2017	3808.58	2597.86	2924.90	29.2	11.79	11.36	34062448	36951806	38912.36
2018	3959.04	2597.86	2924.90	29.2	11.79	11.36	35408088	38411589	40449.60
2019	4114.00	2597.86	2924.90	29.2	11.79	11.36	36793973	39915033	42032.81
2020	4273.63	2597.86	2924.90	29.2	11.79	11.36	38221595	41463754	43663.70
2021	4438.00	2597.86	2924.90	29.2	11.79	11.36	39691700	43058560	45343.13
2022	4607.33	2597.86	2924.90	29.2	11.79	11.36	41206149	44701474	47073.21
2023	4781.75	2597.86	2924.90	29.2	11.79	11.36	42766062	46393707	48855.22
2024	4961.38	2597.86	2924.90	29.2	11.79	11.36	44372557	48136472	50690.46
2025	5146.42	2597.86	2924.90	29.2	11.79	11.36	46027496	49931792	52581.03
2026	5337.00	2597.86	2924.90	29.2	11.79	11.36	47731997	51780878	54528.22
2027	5533.29	2597.86	2924.90	29.2	11.79	11.36	49487551	53685347	56533.74
2028	5735.46	2597.86	2924.90	29.2	11.79	11.36	51295649	55646818	58599.28
2029	5943.71	2597.86	2924.90	29.2	11.79	11.36	53158154	57667310	60726.97
2030	6158.21	2597.86	2924.90	29.2	11.79	11.36	55076556	59748442	62918.52
2031	6379.17	2597.86	2924.90	29.2	11.79	11.36	57052719	61892233	65176.06
2032	6606.71	2597.86	2924.90	29.2	11.79	11.36	59087761	64099898	67500.86
2033	6841.08	2597.86	2924.90	29.2	11.79	11.36	61183917	66373862	69895.47
2034	7082.54	2597.86	2924.90	29.2	11.79	11.36	63343424	68716549	72362.45
2035	7331.17	2597.86	2924.90	29.2	11.79	11.36	65567027	71128770	74902.66
2036	7587.29	2597.86	2924.90	29.2	11.79	11.36	67857707	73613757	77519.49
2037	7851.13	2597.86	2924.90	29.2	11.79	11.36	70217327	76173533	80215.08
2038	8122.83	2597.86	2924.90	29.2	11.79	11.36	72647378	78809713	82991.13
2038	8402.71	2597.86	2924.90	29.2	11.79	11.36	75150468	81525129	85850.62
2040	8690.96	2597.86	2924.90	29.2	11.79	11.36	77728461	84321801	88795.68
2041	8987.88	2597.86	2924.90	29.2	11.79	11.36	80383965	87202559	91829.28
2042	9293.71	2597.86	2924.90	29.2	11.79	11.36	83119216	90169829	94953.98
2043	9608.71	2597.86	2924.90	29.2	11.79	11.36	85936450	93226036	98172.34
2044	9933.17	2597.86	2924.90	29.2	11.79	11.36	88838276	96374010	101487.34
2045	10267.33	2597.86	2924.90	29.2	11.79	11.36	91826929	99616176	104901.53
2046	10611.54	2597.86	2924.90	29.2	11.79	11.36	94905391	102955770	108418.31
2047	10966.08	2597.86	2924.90	29.2	11.79	11.36	98076270	106395619	112040.67
2048	11331.25	2597.86	2924.90	29.2	11.79	11.36	101342175	109938556	115771.58

Table 6. Prediction calculation of CH₄ total emission in toll road Krian-Legundi-Bunder

Year	Ni (PCU/ hour)	Fei (g/liter) Gasoline	Fei (g/liter) Diesel	L (km)	KI (liter/100km) Gasoline	KI (liter/ 100km) Diesel	Q Gaso line (g/hour)	Q Diesel (g/hour)	Total Emission CH ₄ (Ton/hour)
2014	3383.04	0.71	0.08	29.2	11.79	11.36	8269	898	5.63
2015	3520.71	0.71	0.08	29.2	11.79	11.36	8606	934	5.86
2016	3662.54	0.71	0.08	29.2	11.79	11.36	8952	972	6.10
2017	3808.58	0.71	0.08	29.2	11.79	11.36	9309	1011	6.34
2018	3959.04	0.71	0.08	29.2	11.79	11.36	9677	1051	6.59
2019	4114.00	0.71	0.08	29.2	11.79	11.36	10056	1092	6.85
2020	4273.63	0.71	0.08	29.2	11.79	11.36	10446	1134	7.12
2021	4438.00	0.71	0.08	29.2	11.79	11.36	10848	1178	7.39
2022	4607.33	0.71	0.08	29.2	11.79	11.36	11262	1223	7.67
2023	4781.75	0.71	0.08	29.2	11.79	11.36	11688	1269	7.96
2024	4961.38	0.71	0.08	29.2	11.79	11.36	12127	1317	8.26
2025	5146.42	0.71	0.08	29.2	11.79	11.36	12579	1366	8.57
2026	5337.00	0.71	0.08	29.2	11.79	11.36	13045	1416	8.89
2027	5533.29	0.71	0.08	29.2	11.79	11.36	13525	1468	9.21
2028	5735.46	0.71	0.08	29.2	11.79	11.36	14019	1522	9.55
2029	5943.71	0.71	0.08	29.2	11.79	11.36	14528	1577	9.90
2030	6158.21	0.71	0.08	29.2	11.79	11.36	15053	1634	10.25
2031	6379.17	0.71	0.08	29.2	11.79	11.36	15593	1693	10.62
2032	6606.71	0.71	0.08	29.2	11.79	11.36	16149	1753	11.00
2033	6841.08	0.71	0.08	29.2	11.79	11.36	16722	1815	11.39
2034	7082.54	0.71	0.08	29.2	11.79	11.36	17312	1879	11.79
2035	7331.17	0.71	0.08	29.2	11.79	11.36	17920	1945	12.21
2036	7587.29	0.71	0.08	29.2	11.79	11.36	18546	2013	12.63
2037	7851.13	0.71	0.08	29.2	11.79	11.36	19191	2083	13.07
2038	8122.83	0.71	0.08	29.2	11.79	11.36	19855	2156	13.52
2039	8402.71	0.71	0.08	29.2	11.79	11.36	20539	2230	13.99
2040	8690.96	0.71	0.08	29.2	11.79	11.36	21243	2306	14.47
2041	8987.88	0.71	0.08	29.2	11.79	11.36	21969	2385	14.96
2042	9293.71	0.71	0.08	29.2	11.79	11.36	22717	2466	15.47
2043	9608.71	0.71	0.08	29.2	11.79	11.36	23487	2550	16.00
2044	9933.17	0.71	0.08	29.2	11.79	11.36	24280	2636	16.54
2045	10267.33	0.71	0.08	29.2	11.79	11.36	25096	2725	17.10
2046	10611.54	0.71	0.08	29.2	11.79	11.36	25938	2816	17.67
2047	10966.08	0.71	0.08	29.2	11.79	11.36	26804	2910	18.26
2048	11331.25	0.71	0.08	29.2	11.79	11.36	27697	3007	18.87

Table 7. Prediction calculation of N₂O total emission in toll road Krian-Legundi-Bunder

Year	Ni (PCU/ hour)	Fei (g/liter) Gasoline	Fei (g/liter) Diesel	L (km)	KI (liter/ 100km) Gasoline	KI (liter/100km) Diesel	Q Gasoline (g/hour)	Q Diesel (g/hour)	Total Emission N ₂ O (Ton/hour)
2014	3383.04	0.04	0.16	29.2	11.79	11.36	466	1796	1.14
2015	3520.71	0.04	0.16	29.2	11.79	11.36	485	1869	1.19
2016	3662.54	0.04	0.16	29.2	11.79	11.36	504	1944	1.24
2017	3808.58	0.04	0.16	29.2	11.79	11.36	524	2021	1.29
2018	3959.04	0.04	0.16	29.2	11.79	11.36	545	2101	1.34
2019	4114.00	0.04	0.16	29.2	11.79	11.36	567	2183	1.39
2020	4273.63	0.04	0.16	29.2	11.79	11.36	589	2268	1.44
2021	4438.00	0.04	0.16	29.2	11.79	11.36	611	2355	1.50
2022	4607.33	0.04	0.16	29.2	11.79	11.36	634	2445	1.56
2023	4781.75	0.04	0.16	29.2	11.79	11.36	658	2538	1.61
2024	4961.38	0.04	0.16	29.2	11.79	11.36	683	2633	1.67
2025	5146.42	0.04	0.16	29.2	11.79	11.36	709	2731	1.74
2026	5337.00	0.04	0.16	29.2	11.79	11.36	735	2833	1.80
2027	5533.29	0.04	0.16	29.2	11.79	11.36	762	2937	1.87
2028	5735.46	0.04	0.16	29.2	11.79	11.36	790	3044	1.94
2029	5943.71	0.04	0.16	29.2	11.79	11.36	818	3155	2.01
2030	6158.21	0.04	0.16	29.2	11.79	11.36	848	3268	2.08
2031	6379.17	0.04	0.16	29.2	11.79	11.36	878	3386	2.15
2032	6606.71	0.04	0.16	29.2	11.79	11.36	910	3506	2.23
2033	6841.08	0.04	0.16	29.2	11.79	11.36	942	3631	2.31
2034	7082.54	0.04	0.16	29.2	11.79	11.36	975	3759	2.39
2035	7331.17	0.04	0.16	29.2	11.79	11.36	1010	3891	2.47
2036	7587.29	0.04	0.16	29.2	11.79	11.36	1045	4027	2.56
2037	7851.13	0.04	0.16	29.2	11.79	11.36	1081	4167	2.65
2038	8122.83	0.04	0.16	29.2	11.79	11.36	1119	4311	2.74
2039	8402.71	0.04	0.16	29.2	11.79	11.36	1157	4460	2.84
2040	8690.96	0.04	0.16	29.2	11.79	11.36	1197	4613	2.93
2041	8987.88	0.04	0.16	29.2	11.79	11.36	1238	4770	3.03
2042	9293.71	0.04	0.16	29.2	11.79	11.36	1280	4933	3.14
2043	9608.71	0.04	0.16	29.2	11.79	11.36	1323	5100	3.24
2044	9933.17	0.04	0.16	29.2	11.79	11.36	1368	5272	3.35
2045	10267.33	0.04	0.16	29.2	11.79	11.36	1414	5449	3.46
2046	10611.54	0.04	0.16	29.2	11.79	11.36	1461	5632	3.58
2047	10966.08	0.04	0.16	29.2	11.79	11.36	1510	5820	3.70
2048	11331.25	0.04	0.16	29.2	11.79	11.36	1560	6014	3.82

From Table 4 to Table 7, the regressions lines are made and the regressions equations can be gathered by using Minitab 16 as shown in Figure 1 to Figure 4.

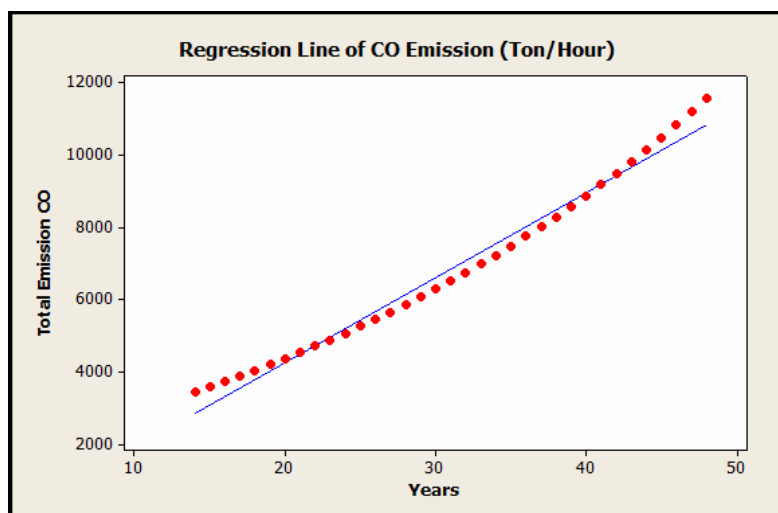


Figure 1. Regression Line of CO emission

From the result of Figure 1, the regression equation is Total Emission CO = -425 + 235Years. The detail of Minitab result is shown in Figure 2.

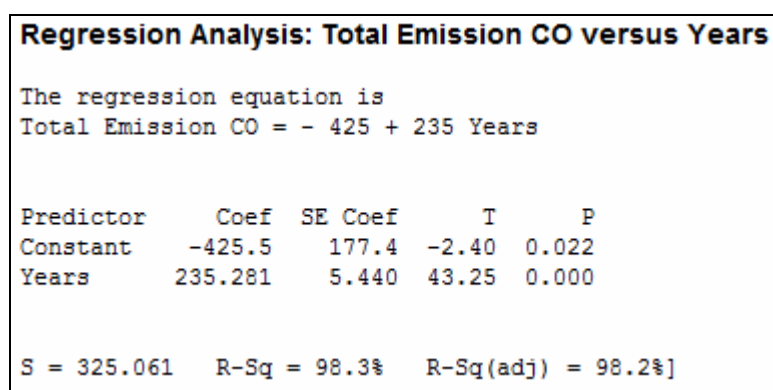


Figure 2. Regression equation of CO emission

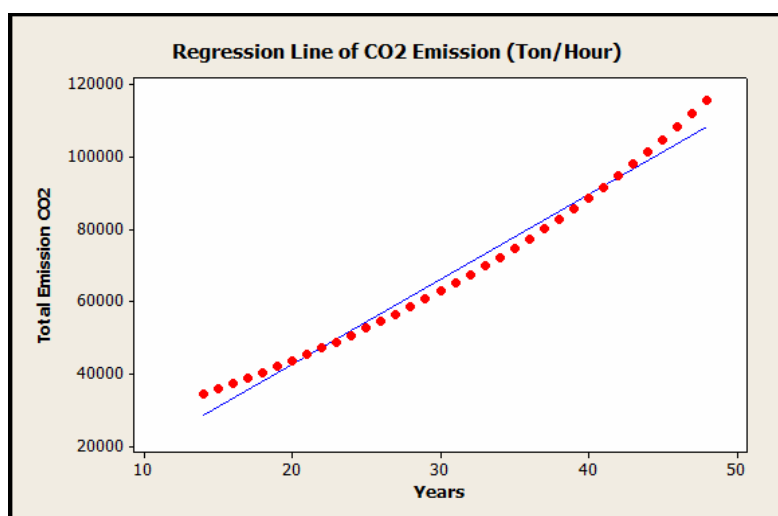


Figure 3. Regression Line of CO₂ emission

From the result of Figure 3, the regression equation is Total Emission CO₂ = -4254 + 2353 Years. The detail of Minitab result is shown in Figure 4.

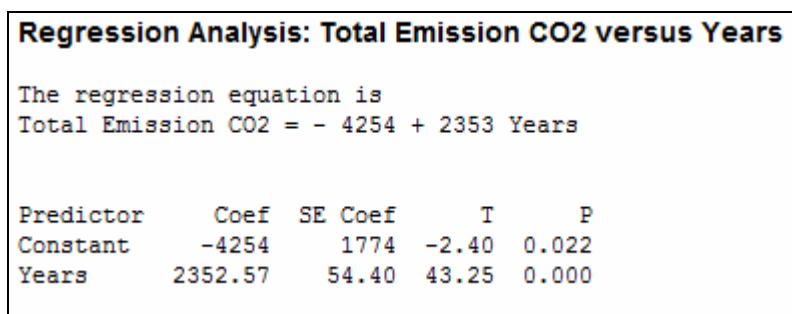


Figure 4. Regression equation of CO₂ emission

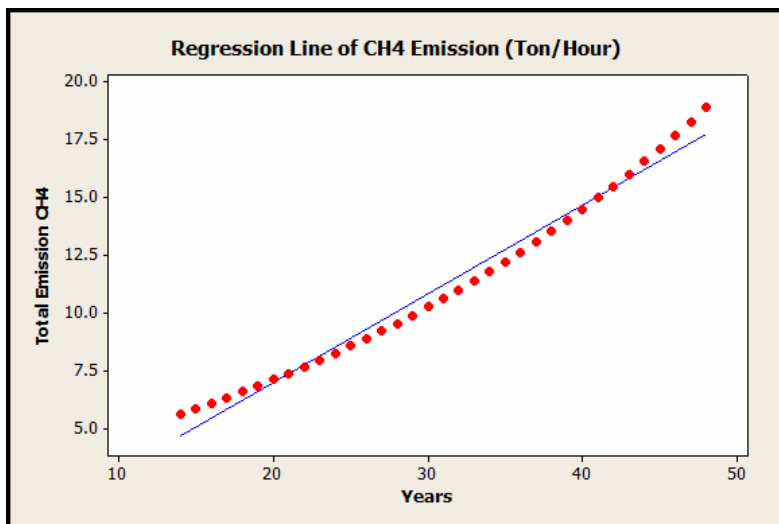


Figure 5. Regression Line of CH₄ emission

From the result of Figure 5, the regression equation is Total Emission CH₄ = -0.693 + 0.383Years. The detail of Minitab result is shown in Figure 6.

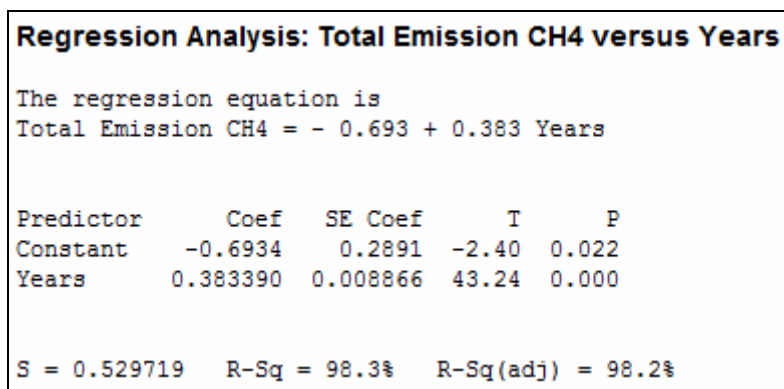


Figure 6. Regression equation of CH₄ emission

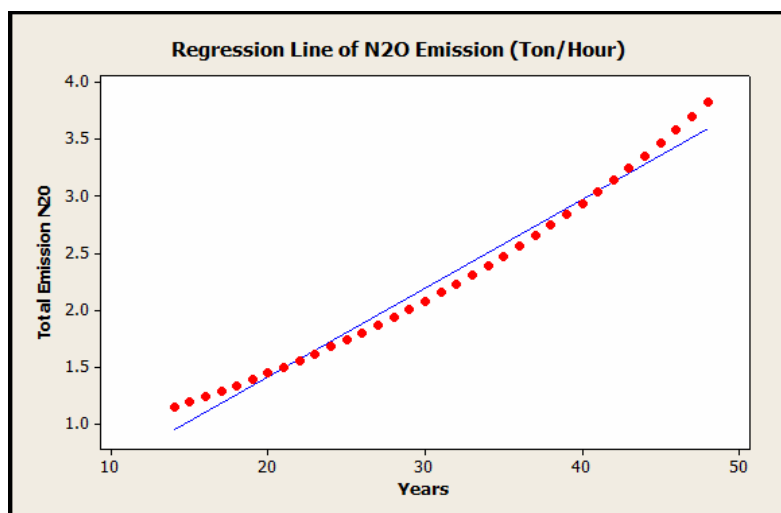


Figure 7. Regression Line of N₂O emission

From the result of Figure 7, the regression equation is Total Emission N₂O = -0.140 + 0.0777Years. The detail of Minitab result is shown in Figure 8.

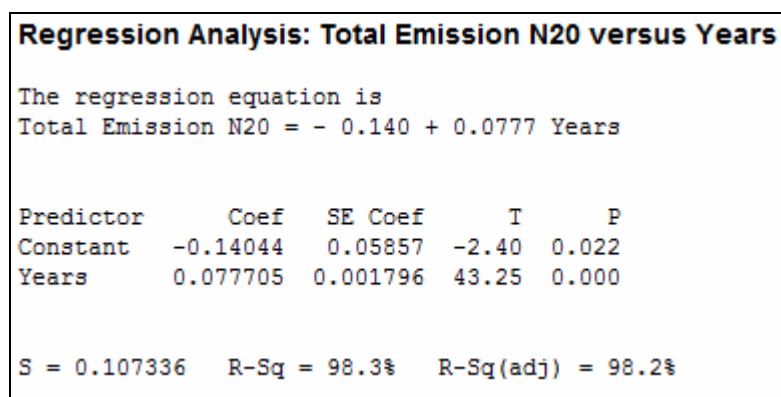


Figure 8. Regression equation of N₂O emission

The result of this observation is in Tons and it is relatively large. However, this result is comparable to other research. Ratanavaraha & Jomnonkwao⁴ said with the CO₂ emission forecast, the maximum predicted value was 225.33 million tons by 2030 using curve estimation (cubic), and the minimum predicted value was 91.68 million tons using log-linear regression. Rodríguez *et al*⁵ suggest that fragmented and highly constructed cities experience higher concentrations of NO₂ and PM₁₀ and that densely populated cities suffer from higher SO₂ concentration. Çaprazet *al*⁶ said among the three air pollutants, SO₂ was associated with the largest RR for deaths from cardiovascular disease, respiratory disease and total mortality and the study showed that short-term exposure to air pollution was associated with increased cardiovascular, respiratory and total non-accidental mortality in the city during 2007–2012. Su *et al*⁷ said for all seven cities, the portion of population potentially exposed was positively correlated with roadway density and, to a lesser extent, with population density. Mustapa & Bekhet⁸ results demonstrate that removal of fuel price subsidies can result in reductions of up to 652 Ktonnes of fuel consumption and CO₂ emissions can be decreased by 6.55%, which would enable Malaysia to hit its target by 2020. Su *et al*⁹ said that final regression models explained 81%, 86% and 85% of the variance in measured NO, NO₂ and NO_x concentrations, respectively, and cross-validation analyses suggested a prediction accuracy of 87–91%. Yazdian *al*¹⁰ said that average CO emission factors were estimated to be in a range of 4 to 12 g/km, and those of PM₁₀ were 0.1 to 0.2 g/km, depending on traffic conditions and variations of these emission factors under real working condition with speeds were determined.

5. Conclusion

Based on the study result, several conclusions are made:

1. The predicted result of total CO emissions from vehicles, which use toll road Krian-Legundi-Bunder in year 2048, is 11578.35ton/hour by using the equation of regression line that is Total Emission CO = $-425 + 235\text{Years}$.
2. The predicted result of total CO₂ emissions from vehicles, which use toll road Krian-Legundi-Bunder in year 2048, is 115771.72ton/hour by using the equation of regression line that is Total Emission CO₂ = $-4254 + 2353\text{Years}$.
3. The predicted result of total CH₄ emissions from vehicles, which use toll road Krian-Legundi-Bunder in year 2048, is 18.87ton/hour by using the equation of regression line that is Total Emission CH₄ = $-0.693 + 0.383\text{Years}$.
4. The predicted result of total N₂O emissions from vehicles, which use toll road Krian-Legundi-Bunder in year 2048, is 3.82ton/hour by using the equation of regression line that is Total Emission N₂O = $-0.140 + 0.0777\text{Years}$.

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