Carbon Emissions in the Pune Metropolitan Region (PMR) due to Logistics Industries

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Abstract

The global supply chain is growing and becoming complex as consumer demand increases. Since 2011, the world has seen an alarming increase in vehicular carbon emissions. Today, motor vehicles are estimated to contribute nearly 24 per cent of the world's direct CO2 emissions. With the advent of E-commerce, consumers/customers prefer deliveries to be made to their doorstep. Manufacturing must keep up with the demand for more raw materials and would require more trucks to deliver goods and other production factors. These expansions and developments have put significant strain on the environment and sustainability over the years. This, in turn, highlights the importance of sustainability in logistics and green logistics. Many industries are taking various sustainable measures to balance their environmental impact.

The transportation and logistics industry is the third largest contributor to carbon emissions (as per ETenergyworld.com). According to the World Economic Outlook (2020) review report, the road freight sector is India's third most CO2-emitting sector.

In this study, we have attempted to calculate the carbon emission in the inner and outer cordons of the Pune Metropolitan Region (PMR) due to goods vehicles (logistics). The calculations are carried out for both Heavy Commercial Vehicles (HCV) and Light Commercial Vehicles (LCV). Logistic hub-wise, region-wise, and highway-wise carbon emissions are also calculated in these areas.

Keywords: Carbon Emissions, Logistics, Pune Metropolitan Region, India

JEL Classification: Q01, Q56, Q58

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1. Introduction

Pune is the second-largest city in Maharashtra State (India) after the State capital Mumbai. It is an important city in terms of economic and industrial activities. In 2021, with an estimated Gross Domestic Product (GDP) of $69 billion, Pune is the seventh-richest city in India[10]. According to the Union Housing and Urban Affairs index, Pune ranked second on the Central Government's ease of living index in 2020[11]. The Pune Metropolitan Region (PMR) is spread over 6,914.26 sq. km. The area comprises 814 villages and has a population of 73.21 lakhs as per the 2011 census. According to the PMR Draft Development Plan (DDP) 2021 – 2041, the population is projected to be 1 crore in 2021 and 1.30 crores in 2031[12].

PMR is strategically located on India's Golden Quadrilateral transport route. The region is well connected to major cities of Maharashtra like Mumbai, Kolhapur, Nashik, Nagpur, Aurangabad, Solapur, and other state capitals like Hyderabad and Bengaluru through a network of highways. The region is also well connected to the country's major cities via an extensive regional railway network. Mumbai-Pune-Solapur and Pune-Miraj are two key railway lines. Lohegaon is home to PMR's international airport. The airport enables passenger and freight operations for both internal and international aircraft. Jawaharlal Nehru Port Trust (JNPT), India's largest container port, is 140 km, and Dighi port is 165 km from PMR. PMR's strategic location and seamless connectivity with national and international geographies through road, railway, port and airport linkages make it ideal for logistics and warehousing activities.

PMR has a dense road network of 28,572 km, comprising national highways, expressways, state highways, major district roads, other district roads, village roads, and internal roads. There are five national highways, one expressway and three major state highways in the region that form a radial network providing access to goods and passengers in and out of the region. The presence of the same gives a significant boost to the logistics sector in the region.

The PMR region is the hub of the manufacturing, automobile, education, research, and Information Technology (IT) industry. It has attracted automobile manufacturers from various parts of the world. This gave Pune city the moniker "Detroit of India." Many notable IT companies like Wipro, Infosys, and Cognizant have their presence in Pune, making it the second-biggest software hub in the country[13]. Notably, Infosys, the Indian IT behemoth, was founded in Pune in 1981. Many distinguished and esteemed educational institutions were established, with increased industries focussing on this region to substantiate skill and talent requirements. This made Pune known with another title, "The Oxford of the East".

The warehousing and logistics industry in PMR is expanding, and the study area is quickly becoming one of the vital logistical centres in western India. The industrial sector, which includes automobile, engineering, electronics, logistics, high-tech, e-commerce, and consumer durables, has boosted warehousing activity in PMR.

As per the Draft Development Plan of PMR (2021-2041), 2010 Hectares of land are currently under the existing Logistics Hubs in the PMR region, which includes around 24% (474 Ha.)

[10] L&T Infrastructure Engineering Ltd, Comprehensive Traffic & Transportation Study (CTTS) for Pune Metropolitan Region, December 2019

[11] Manasi Saraf Joshi, 91 Percent Pollutants in Pune Air Due to Vehicles, IITM Inventory Report, May 2021

[12] 3 Pune Metropolitan Region Development Authority, Draft Development Plan of Pune Metropolitan Region 2021 – 2041 Volume -1

[13] Pune smart city development corporation https://punesmartcity.in/explore-pune/

area at Chakan as the most prominent area for logistics hubs followed by Shikarpur at 20% (404 Ha.). 43% of the area (868 Ha.) is under Chakan and Talegaon, which majorly consists of Grade A goods showing the importance of these regions in terms of trade value.

The primary warehousing at Chakan and Talegaon are Grade A goods. Items in Grade A class are significant importance, value & cost. Items in the Grade B class are of intermediate significance, and the remaining most minor value items are in Grade C. Chakan provides the most finished supply, followed by Talegaon. Other markets, such as Sanaswadi, Phulgaon, Wagholi, and Lonikand, are Grade B and C goods. Wagholi – Lonikand – Koregaon Bhima and Katraj, which serve the city's captive demand, have a loosely organised stretch of warehouse and logistical activities. Below, **figure 1** shows the location of logistic hubs in PMR.

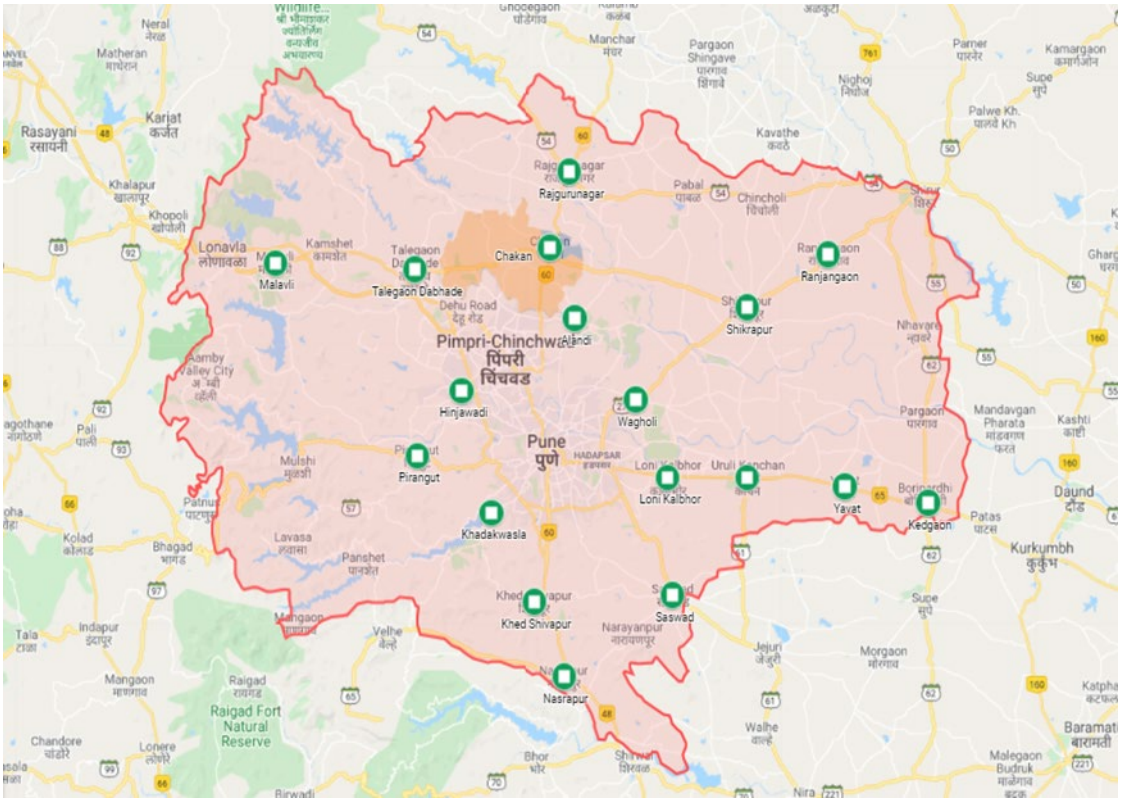

Figure 1: Location of logistic Hubs in PMR

With respect to greenhouse emissions, the highway sector is a significant source. Vehicular emission constitutes the primary source of pollution in Indian cities, including PMR, and it is estimated that they constitute around 70 % of total pollution.[14] Carbon monoxide, unburned hydrocarbons, oxides of nitrogen and Sulphur, partially burned products, particulate matter, and lead components are the major contaminants in vehicular exhaust emissions. The concentration of pollutants also varies with the fuel used in the vehicle, i.e., petrol or Diesel. As vehicular emission has reached an alarming level, both the Central and State Governments are taking various initiatives to cut down vehicular emission.

[14] L&T Infrastructure Engineering Ltd, Comprehensive Traffic & Transportation Study (CTTS) for Pune Metropolitan Region, December 2019

According to the emission inventory report of Pune, 91% of pollution in Pune is due to vehicular emissions.[615] The rapid urbanisation in PMR has increased the number of motor vehicles. As the number of vehicles increases in this region, air and noise pollution has risen alarmingly. According to the Comprehensive Traffic and Transportation Study (CTTS) report of the PMR region, the core urban areas of PMR currently have around 51.88 lakh total registered vehicles as of March 2019.

2. Objectives

As per the PMR Draft Development Plan, Pune Metropolitan Region Development Authority (PMRDA) intends to adopt elements of carbon neutrality and energy efficiency in its approach to the planning and development of PMR. The concept is designed to increase the quality of life and minimise resource consumption through

- Compact Development
- Mixed-use, including habitation, offices, shops, restaurants, and social facilities
- Minimised embedded energy
- Zero Carbon operation
- Excellent mobility (Train, Bus, local streets, highway access, bike trails etc.)

In line with this approach, in this study, we have attempted to calculate the carbon emission in the PMR region from the movement of commercial goods vehicles and suggested an approach for stockholders to reduce carbon emission in PMR.

3. Data Sources

To meet the travel demand for the current and future population in the PMR and prepare a comprehensive transport plan and improvement for the next 30 years, PMRDA commissioned and completed a "Comprehensive Traffic and Transportation Study (CTTS) for PMR" in December 2019. The goods vehicles data used for calculation in this study are from daily traffic volume at inner and outer cordon locations specified in the CTTS main and Annexure Report. For calculating carbon emissions, Junai Yang and T.V. Ramachandra, in their respective research, discussed Carbon emissions performance in logistics at the city level and Emissions from India's transport sector for various categories of vehicles. Mode wise emission values are used in this report. These calculations are discussed in the next section.

4. Study Methodology

In this study, we have attempted to analyse the carbon emissions of the logistics industries at the PMR level by calculating the emission from the commercial goods vehicles that enter and exit the PMR by separating the highway data into two categories, i.e., goods vehicles at the inner cordon (Fig 2) and good vehicles at outer cordon (Fig 3)[7].

Emissions from the Logistics sector depend on fuel apart from the type of combustion engine, emission mitigation techniques, maintenance procedures and vehicle age. The primary pollutants from transportation are Carbon dioxide (CO2), Methane (CH4), Carbon monoxide (CO), Nitrous oxide (N2O), Nitrogen oxides (NOx), Sulphur dioxide (SO2), Non-methane

[15] Manasi Saraf Joshi, 91 Percent Pollutants in Pune Air Due to Vehicles, IITM Inventory Report, May 2021

volatile organic compounds (NMVOC), Particulate matter (PM) and Hydrocarbon (HC). Predominantly Diesel is used in goods vehicles and public passenger vehicles, while private two-wheelers, light motor vehicles, cars and jeeps predominantly uses petrol (gasoline) as a fuel. Below, figure 2 & 3 depicts the Inner & outer cordon of the PMR region.

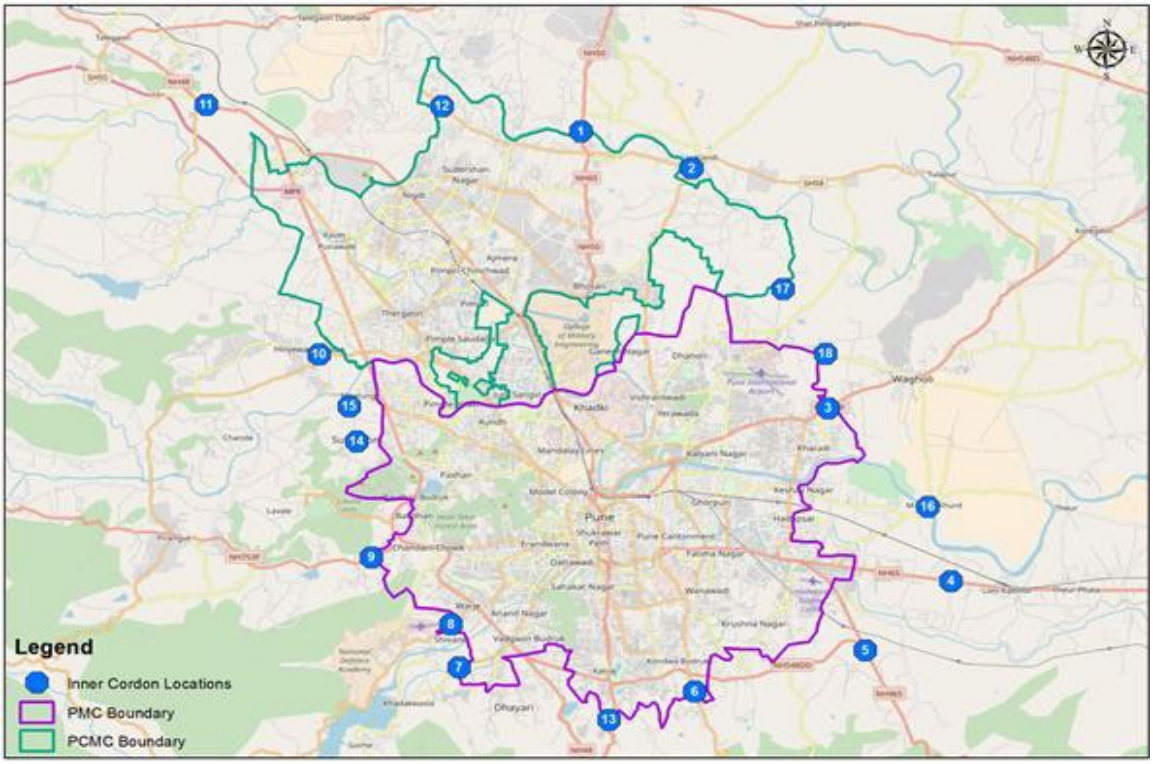

Figure 2: Figure shows the Inner Cordon Vehicle Data Point

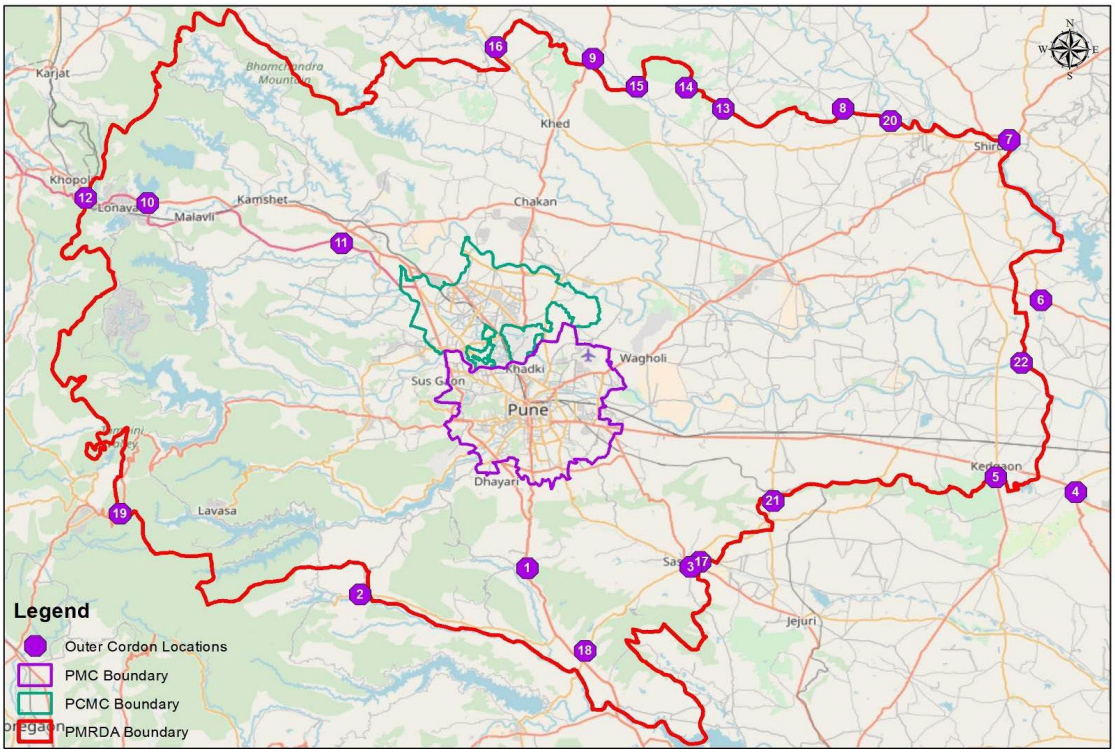

Figure 3: Figure Shows Outer Cordon Vehicle Data Points

For calculating daily carbon emission per vehicle in Kg, we have added emission values[16,17] from each significant pollutant emitted from goods vehicles (Heavy Commercial Vehicle (HCV) and Light Commercial Vehicle (LCV)), i.e., Greenhouse gases. Further, it was assumed that the day-to-day running of goods vehicles (both HCV's and LCV's) is 50 km within PMR. The formula and Details of calculations are provided in below **Table 1**.

Daily Carbon Emission per Vehicle (Kg) = Running Distance (Km) X Emission factor (Kg/Km)

Table 1: Emission Values to Calculate Carbon Emission for HCV and LCV

Heavy Commercial Vehicles			**Light Commercial Vehicles**		
CO2	515.2	g/km	CO2	515.2	g/km
CO	3.6	g/km	CO	5.1	g/km
NOx	6.3	g/km	NOx	1.28	g/km
CH4	0.09	g/km	CH4	0.09	g/km
SO2	1.42	g/km	SO2	1.42	g/km
PM	0.28	g/km	PM	0.2	g/km
HC	0.87	g/km	HC	0.14	g/km
Emission Factor	0.52776	Kg/km	Emission Factor	0.52343	Kg/km
Approx. Running within the city (KM)		50	Approx. Running within the city (KM)		50
Daily Carbon Emission (KG)		**26.39**	**Daily Carbon Emission (KG)**		**26.17**

Daily carbon emission from goods vehicles calculated as per the above calculations is multiplied by total goods vehicles at the inner and outer cordon of PMR to calculate total emissions from goods vehicles. Out of total goods vehicles, based on the CTTS report, we have assumed that HCV's are around 63.95% for the outer cordon, while LCV's are about 36.05%. Similarly, the inner cordon HCV's are 41.41%, and LCV's are 58.59%.

5. Results & Discussion

Master carbon emission calculations due to LCVs and HCVs in the inner and outer cordons are presented and discussed in (Table 2). We have presented carbon emissions in three separate ways, i.e., logistics hub-wise carbon emission, region-wise carbon emission and highway-wise carbon emissions. This distinctive calculation will help us to analyse regions-wise, zone-wise and highway-wise emissions. Subsequent sub-sections talk about emissions and potential reasons behind those emission numbers.

The calculations are done by multiplying the number of goods vehicles (categorised into LCVs and HCVs) by the daily carbon emission (Table 1) for respective LCVs and HCVs. For the calculation of daily carbon emissions, it is assumed that the respective vehicles would travel an average of 50 km within the city.

[16] Junai Yang, Carbon emissions performance in logistics at the city level, Journal of Cleaner Production 231 (2019) 1258-1266

[17] T.V. Ramachandra, Emissions from India's transport sector: Statewise synthesis, Atmospheric Environment 43 (2009) 5510–5517

Table 2: Master Carbon Emission Calculation Results

Carbon Emission by Goods vehicles in PMR per day												
				Outer Cordon	**HCV**	**63.95%**	**LCV**	**36.05%**				
				Inner Cordon	**HCV**	**41.41%**	**LCV**	**58.59%**				
S. N	**Region**	**Logistics Hub**	**Highways**	**Type of Cordon**	**Good Vehicles**	**Heavy Commercial Vehicles (HCV)**	**Light Commercial Vehicles (LCV)**	**Carbon Emission HCV (Ton)**	**Carbon Emission LCV (Ton)**	**Total Carbon Emission (Ton)**	**Total Carbon Emission (Ton) in Hubs**	**Total Carbon Emission (Ton) in Region**
1	East	Kedgaon	Solapur Highway - Pastas toll Plaza	Outer	9,485	6,065	3,420	160	90	250	335 (7.50%)	1,084 (24.30%)
2			Khedgaon - Supa Road	Outer	2,996	1,916	1,080	51	28	79		
3			Alegaon-Kashi Road	Outer	220	141	79	4	2	6		
4		Loni-Kalbhor	Kawadipeth Toll Plaza, Solapur Road	Inner	12,851	5,322	7,529	140	197	337	409 (9.20%)	
5			Manjari Village	Inner	2,742	1,135	1,607	30	42	72		
6		Wagholi	Lohegaon - Nilgudi Road	Inner	215	89	126	2	3	6	340 (7.60%)	
7			Lohegaon - Wagholi Road	Inner	1,836	760	1,076	20	28	48		
8			Nagar Road	Inner	10,905	4,516	6,389	119	167	286		
9	North	Alandi	Near Sambhaji Chowk,Alandi Road	Inner	5,365	2,222	3,143	59	82	141	141 (3.20%)	991 (22.30%)

10		Chakan, Khed Rajgurunagar	Moshi Toll Plaza, Nashik Road	Inner	13,810	5,719	8,091	151	212	363	850 (19.10%)	
11			Talwade Dehu Alandi Road	Inner	12,279	5,085	7,194	134	188	322		
12			Nashik Highway - Peth	Outer	5,355	3,424	1,931	90	51	141		
13			Pabal-Loni Road	Outer	448	286	162	8	4	12		
14			Rajgurunagar - Dhamai Road	Outer	85	54	31	1	1	2		
15			Pabal-Pargaon Road	Outer	86	55	31	1	1	2		
16			Rajgurunagar - Chas Road	Outer	287	184	103	5	3	8		
17	North East	Ranjangaon, Shikrapur	Nirvi - Nharva Road	Outer	311	199	112	5	3	8	264 (5.90%)	264 (5.90%)
18			Nagar Road - Shirur	Outer	9,088	5,811	3,277	153	86	239		
19			Maltan - Awasari Bhudruk	Outer	397	254	143	7	4	10		
20			Ranjangaon - Takai Haji Road	Outer	228	146	82	4	2	6		
21	South	Khed-Shivapur	Katraj-Satara Road	Inner	5,211	2,158	3,053	57	80	137	460 (10.30%)	460 (10.30%)

22			Satara road-khed Sivpur Toll Plaza	Outer	10,854	6,941	3,913	183	102	286		
23			Saswad-Bhor Road	Outer	1,447	925	522	24	14	38		
24	South East	Saswad	Saswad Road	Inner	7,007	2,902	4,105	77	107	184	362 (8.10%)	389 (8.70%)
25			Saswad-Bopdev Road	Inner	2,836	1,174	1,662	31	43	74		
26			Saswad - Jejuri Road and Indraprastha Road	Outer	3,482	2,227	1,255	59	33	92		
27			Saswad-Supa Road	Outer	434	278	156	7	4	11		
28		Urali Kanchan, Saswad	Urullikanchan - Jejuri Road	Outer	1,009	645	364	17	10	27	27 (0.60%)	
29	South West	Khadakwasla	Sinhgad Road	Inner	3,615	1,497	2,118	40	55	95	175 (3.90%)	175 (3.90%)
30			NDA Academy Road	Inner	2,904	1,203	1,701	32	45	76		
31			Velhe Bhudruk Village Road	Outer	140	90	50	2	1	4		
32	West	Hinjewadi	Sus Road	Inner	1,758	728	1,030	19	27	46	202 (4.50%)	1,089 (24.50%)
33			Nande - Balewadi Road	Inner	1,068	442	626	12	16	28		

34			Shivaji Chowk,Hinjawadi	Inner	4,880	2,021	2,859	53	75	128		
35		Pirangut	Near Bhugaon ,Mulshi Road	Inner	3,277	1,357	1,920	36	50	86	100 (2.20%)	
36			Vile- Bhagud MIDC ,Mulshi Rd.	Outer	518	331	187	9	5	14		
37		Talegaon	Dehu Road Toll Plaza, Mumbai-Pune Highway	Inner	9,781	4,050	5,731	107	150	257	787 (17.70%)	
38			Mumbai-Pune Expressway	Outer	9,066	5,797	3,269	153	86	239		
39			Mumbai-Pune Highway (Lonavala)	Outer	4,083	2,611	1,472	69	39	107		
40			Mumbai-Pune expressway - Lonavala entry	Outer	7,014	4,485	2,529	118	66	185		
				TOTAL	**1,69,373**	**85,244**	**84,129**	**2,249**	**2,202**	**4,451**	**4,452**	**4,452**

5.1. Logistic Hub Wise Carbon Emission

PMR has several Logistics Hubs due to higher industrialisation and significant manufacturing units located in and around the logistics hubs. From Table 2 above, high carbon emission is visible in the Chakan-Khed-Rajgurunagar hub, Talegaon and Khed – Shivapur hub, which accounts for carbon emission of 850 Tons (19%), 787 Tons (18%), and 460 Tons (10%) respectively. These three Hubs together account for 47% logistics market share. A few upcoming logistic hubs, such as Loni – Kalbhor, Saswad, Wagholi and Ranjangaon – Shikrapur, are emerging as good options for the industrial and commercial sectors.

5.2. Region Wise Carbon Emission

Similarly, based on the carbon Emission calculation (Table 2), it is observed that the west region and east region of PMR contribute 48.82%, i.e., 2173 Tons of carbon emission with 1089 Tons (24.47%) in the west region and 1084 Tons (24.35%) at east region.

The West Region, which includes Talegaon, Hinjewadi and Pirangut logistics hubs, has better transport connectivity due to proximity to Mumbai, JNPT and Mumbai Pune Expressways.

The East region, which includes Kedgaon, Loni Kalbhor and Wagholi logistics hubs, has connectivity to Solapur and Nagar. It also has emerging MIDC markets where industries are growing faster.

After West and East, North Region, with 991 Ton (22.26%), is the major contributor because of the logistics Hub at Chakan-Khed-Rajgurunagar and Alandi, because of its manufacturing and tourism importance.

It is also observed that the Khed–Shivapur logistic hub in the South region and Ranjangaon–Shikrapur logistic hub in the North East region, account for 460 Tons (10%) and 264 Tons (6%) of total carbon emission, respectively. Ranjangaon–Shikarpur is well connected to Nagar Highway, whereas Khed – Shivapur is well connected to Pune Satara National Highway.

5.3. Highways Wise Carbon Emission

Out of all the highways in and around PMR, highways as identified in CTTS report, namely Moshi Toll Plaza - Nashik Road, Kawadipeth Toll Plaza - Solapur Road, Talwade Dehu Alandi Road, Nagar Road, Satara road- khed Sivpur Toll Plaza, Dehu Road Toll Plaza - Mumbai-Pune Highway, Solapur Highway - Pastas toll Plaza, Nagar Road – Shirur, Mumbai-Pune Expressway, Mumbai-Pune expressway -Lonavala entry, together with accounts 62% of the total carbon emission in the PMR (Table 3). These highways are the primary connectivity for the PMR to nearby cities like Mumbai, Nashik, Nagar, Solapur, and Satara.

Table 3: Carbon Emission on Highways in PMR

Carbon Emission by Goods vehicles in PMR per day								
S. N	**Highways**	**Type of Cordon**	**Good Vehicles**	**Heavy Commercial Vehicles (HCV)**	**Light Commercial Vehicles (LCV)**	**Carbon Emission HCV (Ton)**	**Carbon Emission LCV (Ton)**	**Total Carbon Emission (Ton)**
1	Moshi Toll Plaza, Nashik Road	Inner	13,810	5,719	8,091	151	212	363
2	Kawadipeth Toll Plaza, Solapur Road	Inner	12,851	5,322	7,529	140	197	337
3	Talwade Dehu Alandi Road	Inner	12,279	5,085	7,194	134	188	322
4	Nagar Road	Inner	10,905	4,516	6,389	119	167	286
5	Satara road- khed Sivpur Toll Plaza	Outer	10,854	6,941	3,913	183	102	286
6	Dehu Road Toll Plaza, Mumbai-PuneHighway	Inner	9,781	4,050	5,731	107	150	257
7	Solapur Highway - Pastas Toll Plaza	Outer	9,485	6,065	3,420	160	89	250
8	Nagar Road - Shirur	Outer	9,088	5,811	3,277	153	86	239
9	Mumbai-Pune Expressway	Outer	9,066	5,797	3,269	153	86	239
10	Mumbai-Pune expressway - Lonavala	Outer	7,014	4,485	2,529	118	66	185
11	Saswad Road	Inner	7,007	2,902	4,105	77	107	184
12	Near Sambhaji Chowk,Alandi Road	Inner	5,365	2,222	3,143	59	82	141
13	Nashik Highway - Peth	Outer	5,355	3,424	1,931	90	51	141
14	Katraj-Satara Road	Inner	5,211	2,158	3,053	57	80	137
15	Shivaji Chowk,Hinjawadi	Inner	4,880	2,021	2,859	53	75	128
16	Mumbai-Pune Highway (Lonavala)	Outer	4,083	2,611	1,472	69	39	107
17	Sinhgad Road	Inner	3,615	1,497	2,118	40	55	95
18	Saswad - Jejuri Road and Indraprastha Road	Outer	3,482	2,227	1,255	59	33	92
19	Near Bhugaon, Mulshi Road	Inner	3,277	1,357	1,920	36	50	86
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36	Alegaon- Kashi Road	Outer	220	141	79	4	2	6
37	Lohegaon - Nilgudi	Inner	215	89	126	2	3	6
38	Velhe Bhudruk Village	Outer	140	90	50	2	1	4
39	Pabal-Pargaon Road	Outer	86	55	31	1	1	2
40	Rajgurunagar - Dhamai	Outer	85	54	31	1	1	2
		Total	**1,69,373**	**85,244**	**84,129**	**2,249**	**2,202**	**4,452**

From Table 3, it can be observed that the highest contributor to emission came from the Moshi Toll Plaza, Nashik Road, which accounts for 8.15% of Total carbon Emission because of the connectivity with the Chakan and Rajgurunagar Logistic hubs, which is followed by Kawadipeth Toll Plaza, Solapur Road with 7.58% due to the presence of MIDC along the Solapur Highway.

6. Other Observations

This study analysed carbon emissions in PMR due logistics industry from the highway, Logistics hubs and region perspective by examining goods vehicular movements in and out of the PMR region. According to the calculation, total carbon emissions are 4452 Tons per day. The industrial and manufacturing performance of the city is positively and significantly related to the carbon emissions performance of the city.

7. Conclusion & Recommendations

Transportation is an integral part of logistics service. Goods vehicles are commonly used in the transportation of goods, and they significantly contribute to carbon emissions in any region in general and in PMR in particular. PMRDA envisions adopting the elements of carbon neutrality and energy efficiency to reduce emission levels in PMR. In line with this objective, we have calculated the carbon emission in this region from logistics services. Chakan – Khed Rajgurunagar and Talegaon are the primary logistics hub contributors for carbon emissions, with 850 tons/day and 787 tons/day, respectively, as they are the hubs with a higher presence of industries. Other hubs like Khed Shivapur, Loni-Kalbhor, Wagholi, and Saswad also contribute significantly to carbon emissions. Switching to EVs (Electric Vehicles), Green alternative fuels like CNG, LNG, and biodiesel are some recommendations to mitigate the carbon emissions in this region. Below are a few suggestions that the stockholders can implement immediately to reduce carbon emissions.

Stakeholder	Recommendations
Transportation and Communication	• The ring road proposal in PMR should be implemented as soon as possible, and PMRDA can create multi-modal logistics facilities around the ring road. • Metro must be planned to connect all the logistics hubs in the PMR region so that all the employees working at logistic hubs can use energy efficient transportation for daily commutes. • Strict by-laws for shifting towards electric goods vehicles within a prescribed time frame.
Central Government	• The Government should endorse Renewable Transport Fuel Obligation to promote the production of biofuels to reduce environmental damage. This obligation requires that transport suppliers must be able to show that a percentage of fuel that they supply comes from renewable sources. • PLI schemes should be there for players working to promote EV component manufacturing plants to reduce the initial investment for logistics players moving towards EVs.
State Government	• Tax Breaks to logistics businesses or warehouse owners on the money spent on carbon emissions reduction programs by industries. • Companies should be encouraged to participate in carbon trading by receiving a tax rebate. • Promote the use of technology such as GIS for better route management by end delivery personnel resulting in fuel savings and reduced carbon emission.
Urban Local Bodies	• An incentive scheme for logistics businesses or warehouse owners to reduce carbon emissions. • ISO 14001 (Environmental Management System (EMS)) Certification should be mandatory for warehouse or logistics companies. • Rewards/ Rebates for Alternate Fuel/ technology Logistics vehicles (LCV- Electric/CNG, HCV- CNG) • ULBs should optimize vehicle sizing to reduce vehicle overloading problems. • ULBs should conduct a driver training program to encourage them to drive with optimal acceleration and speed and discourage them from driving overloaded vehicles.

Logistic Companies	• Adapt green and sustainable logistics by optimizing supply chain networks, using flexible, lightweight custom packaging, recyclable plastic pallets, and returnable transport containers. Various low carbon technologies have come up in recent years that can be adapted. • Develop a multi-modal logistics hub and choose greener means of transportation. Rail transportation emissions are comparatively less than road transportation. • The emergence of alternative fuels provides logistics companies with many opportunities to tap. Some effective alternative fuels are Liquified Natural Gas (LNG), Compressed Natural Gas (CNG), Hydrogen – CNG, etc.

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