

A Comprehensive Study on Road Traffic Noise of an Industrial Town of Odisha, India

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Abstract: Noise is a disturbance to the human environment and will become a major threat to the quality of human lives. In last few decades, noise in urban areas have been increasing rapidly. Noise pollution was analysed in 10 different squares (road sections) during four different specified times (7-10 a.m., 11a.m.-2 p.m., 3-6 p.m., 7-10 p.m.) to assess the level of noise pollution of the Rayagada township. The sources of noise at the studied sites were predominantly attributable to motor vehicular traffic. Noise descriptors such as L_{10} , L_{50} , L_{90} , L_{eq} , TNI (Traffic Noise Index), NPL (Noise Pollution Level) and NC (Noise climate) were analysed to reveal the extent of noise pollution of this town. L_{10} , L_{50} , L_{90} , L_{eq} , TNI, NPL, and NC values of all 10 monitored sites ranged from 85.4 to 99.3 dB, from 72.6 to 86.5 dB, from 64.6 to 76.7 dB, from 80.4 to 99 dB, from 95.2 to 128.2 dB, from 95.1 to 159.2 dB, and from 13.3 to 30.3 dB, respectively. The present noise assessment depicted that even the minimum values of L_{eq} (80.4 dB), NPL (95.1 dB), TNI (95.2 dB) during day time were more than the permissible limit (70 dB). The number of vehicles passing through a fixed point on the studied road are counted to assess the traffic volume (Q) and the percentage of heavy trucks and buses to total traffic was also calculated to work out truck traffic mix ratio (P). Moreover, individual contribution to environmental noise by the air horn of different motor vehicles has also been assessed during day time. The episodic and impulsive noise levels of different types of vehicles were more than the traffic noise-limit i.e. 70 dB (A). A survey adopting questionnaire method amongst 241 local inhabitants had also been carried out to gather information regarding the effect of noise on human health.

Key words: Rayagada, community response, noise descriptors, road traffic noise.

Introduction

Environmental noise has become a serious societal problem in different cities of India. Large segments of the population of the urban area are exposed to high levels of noise, not only at their place of work, but also in their residences. Various noise surveys conclusively reveal that the busy road traffic is the predominant source of annoyance; no other single noise has been of comparable importance. Due to rapid industrial and economic growth, the transportation sector is growing rapidly and the number of vehicles on roads is increasing

at a faster rate. In Odisha, some studies on the traffic noise monitoring have been carried out at different towns like Jharsuguda (Patel et al., 2006), Balasore (Goswami, 2009; Goswami and Swain, 2011; Goswami et al., 2011), Bhadrak (Goswami, 2011; Swain et al., 2012); Baripada (Swain and Goswami, 2013), and Bhubaneswar (Swain and Goswami, 2012) and the average noise levels in these towns have been found to be more than the recommended value. On continuation with these studies a similar attempt has been made to record the road traffic noise levels at 10 different squares (major intersection points)

to assess the extent of vehicular noise pollution in the Rayagada Town.

Rayagada District is endowed with rich natural and mineral resources. Thus, the district head quarter, Rayagada is an industrial town with paper, potash alum and ferroalloy industries. The town continues to reel under poor infrastructure. Rayagada District is created from the undivided Koraput District. Since then, Rayagada Town is made district head quarter. Thus, the population of this town has increased many folds in last two decades (Table 1). Subsequently, the vehicular density has also been increasing in last few years. Most of the noise descriptors (L_{\max} , L_{\min} , L_{mean} , L_{10} , L_{50} , L_{90} , L_{eq} , NPL, TNI, NC, traffic volume-Q, truck traffic mix ratio-P) and episodic and impulsive noise levels produced by the air horn of different motor vehicles were worked out in the present study.

Table 1: Changing structure of population in Rayagada Town

Year	Population	Male	Female	Feminine sex ratio
1951	9386	4847	4539	936
1961	14537	7485	7052	942
1971	25064	-----	----	
1981	35838	-----	-----	
1991	48247	24837	23410	943
2001	57759	29519	28240	957

Materials and Methods

The studied Rayagada Town is located at 19° 09' North latitude and 83° 27' East longitude (Figure 1). The geographical area of the Rayagada block is around 531 sq. km, while that of Rayagada Town is only 18.65 sq. km. Noise levels were measured following standard procedure using calibrated sound level (dB) meter (Model LUTREN, SL-4010) in the month of April and May, 2012 at ten crowded squares (road sections) of Rayagada (Goswami and Swain, 2012; Mohapatra and Goswami, 2012a, b; Swain et al., 2011). Sixty measurements were made within one hour duration (i.e. at one minute interval) during four specified times i.e. from 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., and 7-10 p.m. The noise monitoring was done in a good climatic condition, (where there was no sign for cloud) on all working days excluding Sunday and local holidays in order to get better result.

Equivalent Noise Levels (L_{eq})

L_{eq} represents the equivalent energy sound level of a steady state and invariable sound. It includes both intensity and length of all sounds occurring during a given period. The noise levels of different squares in different time intervals were predicted along with their equivalent noise levels (L_{eq}). The value of L_{eq} in dB(A) unit is calculated by using the formula of Robinson (1971), i.e.,

$$L_{\text{eq}} = L_{50} + (L_{10} - L_{90})^2 / 56$$

For the present study the different percentile noise levels used are:

L_{10} : The level that were exceeded during 10% of the measuring time in dB(A).

L_{50} : The level that were exceeded during 50% of the measuring time in dB(A).

L_{90} : The level that were exceeded during 90% of the measuring time in dB(A).

Noise Pollution Level (NPL)

As L_{eq} is an insufficient descriptor of the annoyance caused by fluctuating noise (Robinson, 1971), Noise Pollution Level (NPL) expressed in dB is calculated by using the formula:

$$\text{NPL} = L_{\text{eq}} + a (L_{10} - L_{90})$$

where $a = 1.0$ (constant in the equation).

NPL takes into account the variations in the sound signal and hence serves as better indicator of the pollution in the environment for physiological and psychological disturbance of the human system.

Traffic Noise Index (TNI)

Traffic Noise Index (TNI) is another parameter, which indicates the degree of variation in a traffic flow. This is also expressed in dB(A) and can be computed using the following relation:

$$\text{TNI} = 4 (L_{10} - L_{90}) + L_{90} - 30 \text{ dB(A)}$$

Noise Climate (NC)

Noise Climate (NC) is the range over which the sound levels are fluctuating in an interval of time and is assessed using the following formula:

$$\text{NC} = (L_{10} - L_{90})$$

where L_{90} , the level exceeded for 90% of the time of record, is very near to the background noise level.



Figure 1: Map of India showing location of Rayagada Town.

Traffic Volume (Q)

The noise level near the highway depends on the number of vehicles. The noise level increases with an increase in traffic volume. Traffic volume is defined as the total number of vehicles flowing per hour. The number of vehicles passing through a fixed point on the road was counted.

Truck-Traffic Mix Ratio (P)

Trucks and buses are contributing more noise to the environment, than compared to non-commercial automobiles. It is evident that, besides the total noise level, the number of heavy vehicles will be an important parameter in the annoyance function. This is especially the case in the transition range between continuous noise and “just annoying noise events”. The ratio of heavy trucks and buses to total traffic is called truck traffic

mix ratio. This was computed in terms of percentage. An increase in this ratio will increase the noise level.

Questionnaire Survey

A sample of public (241) was interviewed using a questionnaire in the month of April, 2012 to delineate the perception about the noise and its significance on health of community. A random criterion was employed for the selection of the interviewed people. The first section of questionnaire comprised identifying data of the interviewee and the second involved aspects of his perception of the road traffic noise of Rayagada Town. It is imperative to note that none of these questions involved the word ‘noise’ in order to avoid inducing responses about this issue. The word ‘noise’ (negative connotation) was replaced by ‘sound’ (neutral connotation) (Szeremeta and Zannin, 2009; Mohapatra and Goswami, 2010; Patil et al., 2011; Krishna Murty et al., 2007).

Results and Discussion

It is clearly observed that the main contributor of noise in this town is road transportation. The noise data collected from different monitoring sites displayed wide ranges of noise level varying in four different times (day time: 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m. and 7-10 p.m.). The noise levels of such ten road sections ranged from 60.1 to 106.7; 60.5 to 101.3, 64.7 to 101.1, 59.8 to 98.7, 57.4 to 97.8, 60.9 to 104.8, 67.1 to 108.7, 60 to 108, 60.1 to 101, 59.3 to 101.7, 66.1 to 95.8, and 62.5 to 100.1 dB, respectively (Table 2).

L_{10} values of all 10 monitored sites ranged from 90.1 to 99.5, 85.4 to 98.3, 88.5 to 95.3, 83.6 to 98.3 dB during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m., respectively (Table 2). Similarly, L_{50} and L_{90} values of all 10 monitored sites varied from 80.6 to 87.4 and 70.1 to 77.5 dB, 75.6 to 84.7 and 68 to 75.6 dB, 80.1 to 86.5 and 68 to 76.7 dB, 72.6 to 81.1 and 64.6 to 69.9 dB during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m., respectively (Table 2). Accordingly, the calculated Leq (equivalent noise levels) values ranged from 86 to 99, 80.9 to 94, 83.1 to 93 and 80.4 to 94 dB, during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m., respectively (Table 2). NPL values of all 10 monitored sites ranged from 100.7 to 156.9, 100.9 to 159.2, 95.1 to 139.9 and 101.9 to 138.4 dB during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m., respectively (Table 3). TNI values ranged from 97.7 to 128.2, 98.2 to 124.3, 95.2 to 117, 96.5 to 119.1 dB during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m., respectively, while NC values ranged from 13.3 to 29.2, 14.3 to 30.3, 12.1 to 25.2 and 15.8 to 25.6 dB during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m., respectively (Table 3). All these values clearly revealed high noise levels in Rayagada town mostly throughout the evening time starting from 7 to 10 p.m.

The present noise assessment depicted that even the minimum values of Leq (80.4 dB), NPL (95.1 dB), TNI (95.2 dB) during day time were more than the permissible limit (70 dB). It was also observed that at some locations the characteristics of noise caused by fast moving traffic was different from those caused by congested or slow moving traffic. Noise from congested traffic was found to contain occasional peaks and vary more in levels. A systematic comparison between TNI and Leq noise levels for all selected locations revealed that the TNI values were much more than respective Leq levels. This simply demonstrated that although the noise levels during any period of the day were generally constant but the presence of single-event noise was sufficient to affect the values of different noise percentile levels and consequently the

TNI. This is due to over-populated roadways with bad conditions, broken roads, minimal traffic management and hooting behaviour of drivers (Agarwal and Swami, 2009).

In last two decades 34,909 number of vehicles have been registered only in the Rayagada Regional Transport Office (Table 4). Table 5 depicts year-wise registrations of vehicles during 1990 to 2010 in Regional Transport Office, Rayagada. The data reveal that more than three thousand vehicles are being registered each year since 2006 (in 2010, it is around four thousand). This demonstrates that every day, thousands of autorickshaws, two wheelers and cars, hundreds of buses, cargo carrying trucks and dumpers run along these roads. A comparative data on the number of different types of vehicles passing through the studied traffic squares in a day is presented in Table 6. The number of total vehicles passing in unit time was also observed. The maximum number of vehicles in four specified times i.e. in 12 hours (7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m., 7-10 p.m.) is 7117 at Station square followed by Kapilash square (6330), Ramkrushna Nagar square (6235) and Paika street (6161). Similarly, minimum number of total vehicles passing along the studied roads during aforesaid four specified times was observed at Brahmin street (4869), Saheed Laxamana Nayak street (4873), and Chaudhury street (5417) (Table 6). The number of vehicles passing through a fixed point on the studied road was counted to assess the traffic volume (Q) (Table 7). The traffic volume is maximum (620.3) at Daily market square during 7-10 p.m., followed by 610.7 at Ramkrushna Nagar square during 7-10 p.m. and 595.7 at Paika street during 7-10 p.m. It was observed that noise levels were increasing with increased traffic volume. The percentage of heavy trucks and buses to total traffic is calculated to work out truck traffic mix ratio (P) (Table 7). Similarly, truck traffic mix ratio (P) was maximum (12.1) at New bus stand square during 11 a.m.-2 p.m., followed by 12 at Station square during 3-6 p.m. and 8.8 at Kapilash square during 7-10 a.m. These data revealed that an increase in this ratio has increased the noise level.

The objective of measuring the noise levels of different types of vehicles was to have an estimate of its individual contribution to the environmental noise and to reflect the maintenance levels of the vehicles prevalent in the area. The vehicular noise levels of Rayagada are depicted in Table 8. It was observed that the trucks (125.2 dB) were producing more noise followed by bus (124.7 dB). Noise produced from motor cycles/scooters, mini trucks, town

Table 3: Noise descriptors (TNI, NPL, NC) variations at different squares of Rayagada Town at different time intervals

Monitoring Sites	7-10 a.m.			11 a.m.-2 p.m.			3-6 p.m.			7-10 p.m.		
	TNI	NPL	NC	TNI	NPL	NC	TNI	NPL	NC	TNI	NPL	NC
Saheed Laxamana Nayak street	128.2	156.9	29.2	107.4	119.6	19.7	113.4	128.8	22.5	110	124.3	21.6
Ramkrushna nagar square	122.3	143.8	25.8	124.3	159.2	30.3	117	139.9	25.2	117.2	138.4	25.6
Bramhin street	106.2	114.3	17.2	106.7	116.6	19	108.2	120.7	19.1	108.7	125.9	21.8
Paika street	105.3	115.8	18	102.7	116.1	19.2	106.1	117.2	18.6	96.5	101.9	15.8
Vaishya street	97.7	116.8	18.2	98.2	107.3	17.3	108.1	120	20.5	100	110.6	19
Dhobi street	121.5	141.2	23.9	109.9	118.2	18.9	112.2	122.9	19.2	119.1	131.6	21.5
Chaudhary street	102	100.7	13.3	100.2	102.8	14.3	105.9	117.1	18.4	103.6	117.9	19.7
Laxminarayan street	103.5	114.8	17.5	109.7	121.5	20.4	95.2	95.1	12.1	102.6	112.9	18.5
Station square	109.3	118.9	19.6	109.7	119.5	19.4	111.7	124.3	21	110	120.7	19.7
Kapilash square	108.4	123.2	19.3	99	100.9	15.1	113.1	124.1	21.2	103.1	107.5	16.9
New bus stand square	128.2	156.9	29.2	107.4	119.6	19.7	113.4	128.8	22.5	110	124.3	21.6
Daily market square	122.3	143.8	25.8	124.3	159.2	30.3	117	139.9	25.2	117.2	138.4	25.6

bus, tempos, trucks, cars, buses, tractor, boleros/tata sumos, rickshaws and cycle ranged between 91.6 and 116, 100.6 and 118.4, 101.7 and 121.6, 95.6 and 113.4, 110.2 and 125.2, 98.9 and 115.4, 105.5 and 124.7, 100.1 and 119.8, 102.5 and 118, 61.2 and 96.3 and 45.6 and 76.3 dB, respectively (Table 8).

The present study explicitly demonstrated that in most of the cases, the average assessed sound pressure levels were more than the permissible limit (70 dB for road traffic noise) (WHO, 1999). The whole population of Rayagada including thousands of floating population coming to this town for different purposes from nearby semi-urban and rural areas are exposed to this urban noise levels of more than 70.0 dB(A). This is a very high level, corresponding to the day time limit recommended by the WHO for urban centres (55 dB).

The noise perception survey was carried out by a questionnaire, which was administered to 241 individuals in Rayagada during April, 2012. In total 48% respondents were not satisfied about the noise level in and around Rayagada. They considered traffic noise as most unpleasant sound. The reasons for noise pollution were evaluated as horn (51%) followed by traffic jam (19%), silencer (10%) and engine (07%). Majority of the respondents (41%) were irritated with the air-horn noise from motor cycle and auto-rickshaw. 28% respondents identified headache as the main health effect of noise pollution. 19% interviewees were feeling mental stress, 9% were suffering from insomnia and 0.41% respondent was suffering from hearing loss. 19% of people shared their sleep disturbance due to traffic noise during night-time.

Conclusion

The present study clearly revealed that the transportation sector is one of the major contributors to noise in this town. Such noise measurements and questionnaire survey could be helpful in understanding the problem of noise pollution and contribute to improve town administration in abatement of noise pollution. The emission of road noise in residential areas can be lowered by reducing the noise propagation from the road to the residential areas. The first approach should be on reduction of noise at source. Design and fabrication of silencing devices and their use in trucks, cars and motorcycles, would be an effective measure. Ban on honking of air horns and planning main traffic arteries, industrial establishments, residential colonies, creation of silent zones near schools and hospitals are the need of the hour. General public are ignorant of the severe effects of the noise pollution. Television, radio, internet, and newspapers have a greater role for spreading awareness regarding prevention and abatement of noise pollution.

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Table 4: Vehicle class-wise registrations during 01-01-1990 to 30-09-2011 in Regional Transport Office, Rayagada

Sl. No.	Vehicle class	Number of vehicles registered
1	Ambulance	41
2	Bus (cc)	21
3	Bus (sc)	125
4	Camper Van (cc)	1
5	Car taxi	147
6	Crane	11
7	Delivery van	8
8	Dumper	1
9	Haulage vehicle	6
10	Heavy goods vehicle	1497
11	Invalid carriage-p	2
12	Jeep taxi	269
13	L.M.V. (car) (cc)	85
14	L.M.V. (car-p)	822
15	L.M.V. (imp—p)	1
16	L.M.V. (jeep/Gypsy-cc)	182
17	L.M.V. (jeep/Gypsy-p)	242
18	L.M.V. (van-cc)	5
19	L.M.V. (van-p)	25
20	Light commercial vehicle	36
21	Light goods vehicle	679
22	Light motor vehicle	83
23	Maxi cab	367
24	Medium goods vehicle	256
25	Mini bus (cc)	7
26	Mini bus (sc)	69
27	Moped	1464
28	Motor cycle	20988
29	Omni bus (pass) (cc)	4
30	Omni bus (pass) (sc)	11
31	Omni bus (Private) (cc)	6
32	Pickup van	105
33	Private service vehicle	20
34	School bus	82
35	Scooter with side car	2
36	Scooter/moped	2881
37	Tanker	10
38	Three wheeler (goods)	107
39	Three wheeler (passenger)	775
40	Tourist taxi	11
41	Tractor (agriculture)	216
42	Tractor (commercial)	1602
43	Tractor (private)	9
44	Tractor trailer	5
45	Trailer (agriculture)	12
46	Trailer (commercial)	1588
47	Trailer with private vehicle	3
48	Trekker (cc)	12
49	Trolley	7
50	Utility van	1
	Total	34909

N.B. sc: stage carriage; cc: contract carriage; p: private/personal

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Table 5: Vehicles class-wise and year-wise registrations during 2006 to 2010 in Regional Transport Office, Rayagada

SL. No.	Vehicle class	No. of vehicles registered during						Total as on 30-09-2011
		2006	2007	2008	2009	2010	1990-2005 & 2011	
1	Ambulance	5	3	1	6	7	19	41
2	Bus (cc)	1	1	1	1	3	14	21
3	Bus (sc)	8	3	3	1	3	107	125
4	Camper Van (cc)	-	-	-	-	-	1	1
5	Car taxi	5	7	13	8	17	97	147
6	Crane	3	2	1	2	-	3	11
7	Delivery van	-	1	-	-	-	7	8
8	Dumper	-	-	-	-	-	1	1
9	Haulage vehicle	-	-	-	-	-	6	6
10	Heavy goods vehicle	139	102	108	99	86	963	1497
11	Invalid carriage-p	-	1	-	-	-	1	2
12	Jeep taxi	1	4	5	15	31	213	269
13	L.M.V. (car) (cc)	6	11	6	15	1	46	85
14	L.M.V. (car-p)	52	54	56	76	106	478	822
15	L.M.V. (imp—p)	-	-	-	-	-	1	1
16	L.M.V. (jeep/Gypsy-cc)	32	14	6	27	1	102	182
17	L.M.V. (jeep/Gypsy-p)	23	11	20	21	7	160	242
18	L.M.V. (van-cc)	-	-	-	1	-	4	5
19	L.M.V. (van-p)	1	-	-	3	-	21	25
20	Light commercial vehicle	4	2	-	-	-	30	36
21	Light goods vehicle	74	41	58	51	105	350	679
22	Light motor vehicle	18	6	-	-	-	59	83
23	Maxi cab	14	13	18	31	64	227	367
24	Medium goods vehicle	11	24	39	38	52	92	256
25	Mini bus(cc)	-	-	1	-	1	5	7
26	Mini bus(sc)	7	4	-	2	-	56	69
27	Moped	74	98	183	242	310	557	1464
28	Motor cycle	2142	2160	1890	2231	2410	10155	20988
29	Omni bus (pass) (cc)	1	-	1	-	-	2	4
30	Omni bus (pass) (sc)	-	-	-	-	-	11	11
31	Omni bus (Private) (cc)	-	-	3	-	2	1	6
32	Pickup van	-	1	8	14	6	76	105
33	Private service vehicle	-	-	1	1	1	17	20
34	School bus	2	4	10	5	8	53	82
35	Scooter with side car	-	-	-	-	-	2	2
36	Scooter/moped	32	55	129	238	326	2101	2881
37	Tanker	1	-	1	1	1	6	10
38	Three wheeler (goods)	7	9	15	3	9	64	107
39	Three wheeler (passenger)	68	48	49	52	77	481	775
40	Tourist taxi	-	-	2	2	1	6	11
41	Tractor (agriculture)	27	11	28	37	5	108	216
42	Tractor (commercial)	160	175	109	110	156	892	1602
43	Tractor (private)	2	2	-	-	-	5	9
44	Tractor trailer	4	-	-	-	-	1	5
45	Trailer (agriculture)	-	1	-	-	-	11	12
46	Trailer (commercial)	152	172	97	101	182	884	1588
47	Trailer with private vehicle	-	-	-	-	-	3	3
48	Trekker (cc)	-	-	-	-	-	12	12
49	Trolley	1	-	-	-	-	6	7
50	Utility van	-	-	-	-	-	1	1
		3077	3040	2862	3434	3978	18518	34909

Table 6: Total number of vehicles passing the road at different times of a day in and around Rayagada Town

Monitoring sites	Number of vehicles that passed in a day															Grand total					
	7-10 a.m.					11 a.m.-2 p.m.					3 p.m.-6 p.m.						7 p.m.-10 p.m.				
	2 & 3 W	LMV	HMV	Total		2 & 3 W	LMV	HMV	Total		2 & 3 W	LMV	HMV	Total			2 & 3 W	LMV	HMV	Total	
Saheed Laxamana Nayak street	1030	102	04	1136		1123	145	12	1280		1205	101	15	1321		980	145	11	1136	4873	
Ramkrushna nagar square	1123	56	50	1229		1402	142	57	1601		1396	103	74	1573		1602	146	84	1832	6235	
Bramhin street	1025	120	00	1125		1221	145	00	1366		785	102	00	887		1402	89	00	1491	4869	
Paika street	1225	114	00	1339		1423	142	00	1565		1325	145	00	1470		1640	147	00	1787	6161	
Vaishya street	1448	104	00	1552		1002	125	00	1127		1231	128	00	1359		1254	120	00	1374	5412	
Dhobi street	1234	175	00	1409		1354	135	00	1489		1258	104	00	1362		1478	142	00	1620	5880	
Chaudhary street	1225	102	11	1338		1322	59	21	1402		1070	124	24	1218		1294	146	19	1459	5417	
Laxminarayan street	1325	175	24	1524		1420	86	21	1527		1236	142	25	1403		989	87	24	1100	5554	
Station square	1465	185	123	1773		1545	154	113	1812		1201	213	192	1606		1585	245	96	1926	7117	
Kapilash square	1025	254	123	1402		1130	213	103	1446		1456	145	98	1699		1542	156	85	1783	6330	
New bus stand square	1003	98	52	1153		956	99	145	1200		1236	123	56	1415		1427	132	97	1666	5434	
Daily market square	968	23	25	1016		1277	115	32	1424		1245	156	64	1465		1567	245	49	1861	5766	
2 and 3 W: Two and Three Wheelers;						LMV: Light Motor Vehicles;					HMV: Heavy Motor Vehicles										

Table 7: Traffic volume (Q) and Truck-traffic mix ratio (P) in unit time at different times of a day at Rayagada Town

Monitoring sites	7-10 a.m.		11 a.m.-2 p.m.		3-6 p.m.		7-10 p.m.	
	Q	P (%)	Q	P (%)	Q	P (%)	Q	P (%)
Saheed Laxamana Nayak street	378.7	0.35	426.7	0.93	440.3	1.1	378.7	0.93
Ramkrushna nagar square	409.7	4.07	533.7	3.6	524.3	4.7	610.7	4.6
Bramhin street	375	0	455.3	0	295.7	0	497	0
Paika street	446.3	0	521.7	0	490	0	595.7	0
Vaishya street	517.3	0	375.7	0	453	0	458	0
Dhobi street	469.7	0	496.3	0	454	0	540	0
Chaudhary street	446	0.82	467.3	1.5	406	2.0	486.3	1.3
Laxminarayan street	508	1.6	509	1.4	467.7	1.8	366.7	2.2
Station square	591	6.9	604	6.2	535.3	12.0	642	5.0
Kapilash square	1405	8.8	482	7.1	566.3	5.8	594.3	4.8
New bus stand square	384.3	4.5	400	12.1	471.7	3.4	555.3	5.8
Daily market square	338.7	2.5	474.7	2.2	488.3	4.6	620.3	2.6

Table 8: Average episodic and impulsive noise levels by the air-horn of motor vehicles in Rayagada Town

No.	Type of vehicle	Number of experiments	Sound pressure level in dB (A)	
			Min	Max
1.	Motor cycle/Scooter	25	91.6	116
2.	Mini-truck/Pick-up van	25	100.6	118.4
3.	Town bus	25	101.7	121.6
4.	Tempo	25	95.6	113.4
5.	Truck	25	110.2	125.2
6.	Car	25	98.9	115.4
7.	Bus	25	105.5	124.7
8.	Bolero/Tata-sumo	25	102.5	118
9.	Tractor	25	100.1	119.8
10.	Rickshaw	25	61.2	96.3
11.	Cycle	25	45.6	76.3

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