A Preliminary Study About Noise Pollution and Related Health Impacts in Residential, Commercial, And Industrial Zones of Mandi Bahauddin

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Abstract: The purpose of this study was the assessment of noise pollution levels in different zones of Mandi Bhauddin and associated responses in terms of noise-induced impacts and health disorders in the targeted population. This study also involved the comparison of noise levels with National Environmental Quality Standards (NEQS). Moreover, the study design determinants responsible for the noise pollution in the targeted area among the respondents and analysis was performed to check the association between noise pollution and traffic density in the commercial areas of Mandi Bahauddin.

A cross-sectional study was designed using a sound level meter to evaluate the noise level at the three zones. A questionnaire was designed to determine the variables such as NLP (Noise Level Perception), EL (Exposure Level), ATD (Annoyance due to Traffic Noise), SD (Social Dysfunction), and MD (Medical Conditions). A two-stage sampling technique was used to select the 15 study locations and to collect data from 373 residents as calculated by the Raosoft calculator. An ONE-WAY ANOVA analysis were performed to analyze data. The analysis revealed that the most violated site in terms of noise pollution was a commercial site. There was a statistically significant ($p=0.05$) variation among the respondents of the three zones regarding the noise level. This study also revealed the level of perception of respondents in terms of health symptoms such as hypertension, depression, insomnia, tinnitus, annoyance, headache, and tiredness caused by noise. This study demands the compliance of NEQS especially in commercial areas by traffic diversions in the Mandi Bahauddin.

1. Introduction

Noise is an unwanted, unpleasant or disturbing sound caused by vibration. Hence, noise pollution is characterized as an environmental and health issue. Noise from industry, traffic, homes and recreation can cause annoyance, disturb sleep and affect health (Zia et al. 2021). Thus, environmental noise is a potentially serious pollutant and threat to environmental health. Rapid urbanization in the past many years has led to an increase in noise pollution (Evans et al. 2021). It has adverse effects not only on hearing but has many psychological and pathological impacts on human health. Noise is a part of daily human activity and is thus unavoidable (Piquat et al. 2019)

Noise pollution is an induced issue in commercial, industrial and residential areas. The Industrial plant laborers are in danger of noise (Yonus Kalim, et al. ,3013). The regularly determined delivery and adapting to machines, processing, forming and dust extractor establishments in the factory create noise. The sped up utilization of locally manufactured product inside the business has expanded the degree of noise and vibration.

Noise pollution can affect the people working inside as well as those home round those business structures. Depending upon the recurrence, sufficiency, and assortment of the modern noise, it can disturb your normal capability of hearing, and it can like (Keerthana et al. 2013).

Multiple studies were performed to investigate noise level and associated health impacts; Farooqi et al. 2021 designed a study about the urban noise assessment and it's no auditory effects on the residents of Chiniot and Jhang, it was concluded that increased population density and traffic density are the main reasons for increased noise level. In another study of Faisalabad, both auditory and non-auditory health impacts were investigated in industrial, commercial, residential zones mainly due to violation of standard noise limits (Farooqi et al. 2019).

A study about the assessment of traffic noise-induced annoyance among residents living around a noise-sensitive area and significant health issues as well as poor sleep quality were investigated due to increased noise levels (Towseef et al. 2021).

In the view of the noise pollution, it is seen that many people are facing hearing loss, or hear induced diseases all around the world and the country. The selected city, Mandi Bahauddin was also seen effected by it. Hence the present study was conducted to check and compare the noise pollution level of Industrial, Residential and Commercial areas, to check and compare the noise related health impacts among subjects of Mandi Bahauddin district and lastly, to investigate association of noise pollution and traffic density in commercial areas of Mandi Bahauddin district.

2. Materials and Methods

Field surveys in district Mandi Bahauddin for different industrial, residential and the commercial site was done to examine the noise pollution in those area. A questionnaire was designed on google doc in English language to assess the noise perception among the residents to determine the variables such as NLP (Noise Level Perception), EL (Exposure Level), ATD (Annoyance due to Traffic Noise), SD (Social Dysfunction), and MD (Medical Conditions).
A two-stage sampling technique was used to select the 15 study. And according to the census sources total population is 127,956 And the margin of error was kept 5% so total sampling participants was 373. The sampling size was determined by using Roman Sampling Calculator (Raosoft web 2023).
The measurements methods for noise was carried out using Sound Level Meter. The measurements were performed on different working days and the sampling time for each measurement was 10 min. At each sampling point, for each sampling strategy, at least three measurements were taken randomly selected in the following time-intervals:

- Morning (9:00 am)
- Afternoon (2:00 pm)
- Evening (7:00 pm)

3. Descriptive Analysis of Demographic Information

A questtionare was designed to evaluate the perception of noise amomg the targeted population. An online survey was created and face too face interview was done between industrial, commercial and residential people. The demographic information shows that how various respondent of each hub differ from each other. The response can vary differently depending on the type of area, working shift, job type of the respondent. The results of survey depicts following facts:

Table 3.1 Demographic Characteristics of Studies Samples			
Characteristics	**Categories**	**n**	**Percentage%**
Gender	Male	219	58.71%
	Female	154	41.29%
Age	15-20	38	10.19%
	21 to 25	161	43.16%
	26 to 30	85	19.84%
	31 to 40	74	22.79%
	41 or above	15	4.02%
Education	Illiterate	27	7.24%
	Matriculation	90	24.13%
	Intermediation	109	29.22%
	Graduation	147	39.41%,
Marital Status	Unmarried	190	50.9%
	Married	141	38.0%
	Divorced or widowed	26	6.9%
	No Comment	15	4%
Outdoor Time	4 to 5	88	24.1%
	6 to 7	108	28.6%
	8 to 9	121	32.4%
	10 hours or above	55	14.7%
Type of Noise	Traffic vehicles	175	47.9%
	Machinery	113	30.2 %
	Vendors	81	21.7%

4. Results and Discussion

4.1 Zone with Studied Variables (one-way ANOVA)

Table 4.1 Multiple Comparisons Between Type of Zone and Studied Variables

Dependent Variable	(I) Zone	(J) Zone	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Noise Level Perception	Industrial	Commercial	.24307*	.05049	.000	.1438	.3423
Exposure Level	Industrial	Commercial	.19841*	.06356	.002	.0734	.3234
Annoyance Due to Traffic Noise	Industrial	Commercial	.20427*	.05142	.000	.1032	.3054
		Residential	.21966*	.05576	.000	.1100	.3293

*. The mean difference is significant at the 0.05 level.

A least square difference of Post HOC Test revealed that the perception of noise in the industrial zone is significantly different than the Commercial (p=0.00). Similarly, the LSD test indicates that the exposure level of industrial and commercial zone(p=0.02) is significantly different from each other. Lastly, the perception of responded in terms of annoyance due to traffic of industrial area is

significantly different than the commercial and residential area (p=0.000, 0.000 respectively). As they are mainly exposed to machinery throughout the day.

An association between noise level and different zone of the studied area was found. This stay consistent to all the areas producing noise, and it also aligned with the previous studies (Aziz et al. Adnan et al. 2020). It was seen that high traffic density in the commercial area was responsible for high noise level (Khan et al. 2020). Similarly, unmaintained machinery in the industrial zone is responsible for high noise density in the respected area (Farhan Ahmed 2021). The indigenous noise level in the residential area is caused by some off road traffic, vendors and residents. It was also found in the study of (Adnan Lodhi, 2021).

4.2 Gender (one way) with Studied Variables

Table 4.2 **ANOVA**

		Sum of Squares	df	Mean Square	F	Sig.
Noise Level Perception	Between Groups	3.087	1	3.087	17.884	.000
	Within Groups	64.050	371	.173		
	Total	67.138	372			
Annoyance Due to Traffic Noise	Between Groups	4.076	1	4.076	23.200	.000
	Within Groups	65.177	371	.176		
	Total	69.252	372			

There was a statistically significant difference between responses of gender i.e. Male and Female in terms of NLP (17.8) and ATN(F=23.2) as shown in table with a significant value of (p=0.00). It was seen that male was more exposed to noise level in Mandi Bahauddin due to their daily activities requirement such as going out for work, doing house chores etc (Chang et al. 2019, Little 2018). The consistency between gender continues from industrial to commercial area due to site specific jobs in which they were engaged from day to day.

4.3 Age (one way) with Studied Variables

Table 4.3 **Multiple Comparisons Between Age and Studied Variables**

Dependent Variable	(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Noise Level Perception	26-30	15-20	.38563*	.07834	.000	.2316	.5397
		21-25	.19801*	.05382	.000	.0922	.3038
	31-40	15-20	.45712*	.08012	.000	.2996	.6147
		21-25	.26950*	.05638	.000	.1586	.3804
	41 or above	15-20	.40075*	.12241	.001	.1600	.6415
Exposure Level	41 or above	21-25	.21476*	.07217	.003	.0729	.3567
		15-20	.48772*	.15668	.002	.1796	.7958
		21-25	.41656*	.13871	.003	.1438	.6893
	21-25	15-20	.25979*	.07516	.001	.1120	.4076

Annoyance Due to Traffic Noise	26-30	15-20	.37443*	.08132	.000	.2145	.5343
	31-40	15-20	.41223*	.08316	.000	.2487	.5758
	41 or above	15-20	.43404*	.12707	.001	.1842	.6839
		26-30	-.23092*	.07632	.003	-.3810	-.0808
Medical Condition	26-30	15-20	.23092*	.07632	.003	.0808	.3810
*. The mean difference is significant at the 0.05 level.							

The HOC Test reveals that the perception of noise between age group of 15-20 and 21-25 was significantly different than the age group of 26-30(p=0.00). Similarly, the age the exposure level of age group of 15-20, 21-25 was significantly different than the age group of 41 or above (p=0.01, 0.002 respectively). And also, the perception of responded regarding annoyance due to traffic noise of the age group of 15-20 was significantly different from the age group of 21-25, 26-30, 31-40(p=0.00, 0.00,0.01 respectively). Also, the age group of 15-20 and 26-30(p=0.03) was significantly different from the age group of 41 or above. Lastly, the perception of age group 15-20 in terms of medical condition was significantly different from the 26-30(p=0.03).

The age factor compliance with noise exposure. The outcome remains consistent in all the categorize of the variables studied on the targeted population of Mandi Bahauddin. The age group of 26 to 30 were more exposed to noise in the all area of zones. The reason could be that they were youngsters and were more active than the other age categorizes and they were more fit and ready to do the job to earn money and it is also in line with previous studies (Aslam 2008, Salim 2018).

4.4 Education (One Way) with Studied Variables

Table 4.4 Multiple Comparisons of Education and Studied Variables

Dependent Variable	(I) Education	(J) Education	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Noise Level Perception	Matriculation	Graduate or Above	.23414*	.05566	.000	.1247	.3436
Annoyance Due to Traffic Noise	Matriculation	Illiterate	.29321*	.08898	.001	.1182	.4682
	Graduate or Above	Illiterate	.31683*	.08491	.000	.1499	.4838
Medical Condition	Matriculation	Illiterate	.27037*	.08561	.002	.1020	.4387
*. The mean difference is significant at the 0.05 level.							

The least square difference of Post HOC Test reveals that the responded from matriculation group have significantly different perception of noise than the group of graduate or above(p=0.00). Similarly, the perception of matriculation and graduate or above in terms of annoyance due to traffic density was significantly different than the illiterate group (p=0.001, 0.000 respectively). And lastly, the group of matriculation has significantly different perception of medical condition than the illiterate group (p=0.002).

Study reveals that the most of the people of targeted population that were most exposed to noise were from the matriculation sector. As they were mostly vendors on commercial site and the workers of the industrial sector that were not highly educated and the study aligns with previous studies (Quila,2018, Furlog, 2018). Another reason could be that the graduated or intermediate

were mostly working in the close ventures and doing their businesses. Where the level of noise was lower than the areas where noise level was high due to high traffic density, high population density and noises of machinery (Zhi-ling 2010).

4.5 Marital Status (One Way ANOVA) with Studied Variables

Table 4.5 Multiple Comparisons Between Marital Status and Dependent Variables

Dependent Variable	(I) Marital status	(J) Marital status	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Noise Level Perception	Married	Unmarried	.19874*	.04556	.000	.1091	.2883
	Divorced/Widowed	Unmarried	.34910*	.08588	.000	.1802	.5180
Exposure Level	Married	Unmarried	.22938*	.05732	.000	.1167	.3421
Annoyance Due to Traffic Noise	Married	Unmarried	.14076*	.04711	.003	.0481	.2334
	Divorced/Widowed	Unmarried	.27142*	.08881	.002	.0968	.4461

*. The mean difference is significant at the 0.05 level.

A least square difference of Post HOC Test reveals that the perception of noise of unmarried was significantly different from the married and widowed/divorced (p=0.00, 0.000 respectively). Also, the exposure level perception of unmarried was significantly different than the married (p=0.00). Similarly, the annoyance due to traffic noise perception of unmarried was significantly different married and widowed/divorced (p=0.003, 0.002 respectively).

5. Descriptive Analysis of Symptoms with Studied Sample

Table 5.1 Symptoms

Sr. No.	Characteristics	Response Type	n	%
MC9	Dizziness	○ Yes	147	39.4
		○ No	226	60.6
MC10	Insomnia	○ Yes	301	80.7
		○ No	72	19.3
MC11	Tiredness	○ Yes	282	75.6
		○ No	91	24.4
MC12	Headache	○ Yes	165	44.2
		○ No	208	55.8
MC13	Psychological Stress	○ Yes	122	32.7
		○ No	251	67.3
MC14	Ringing or buzz	○ Yes	119	31.9
		○ No	254	68.1
MC15	Annoyance	○ Yes	204	54.7
		○ No	169	45.3
MC16	Depression	○ Yes	166	44.5
		○ No	207	55.5

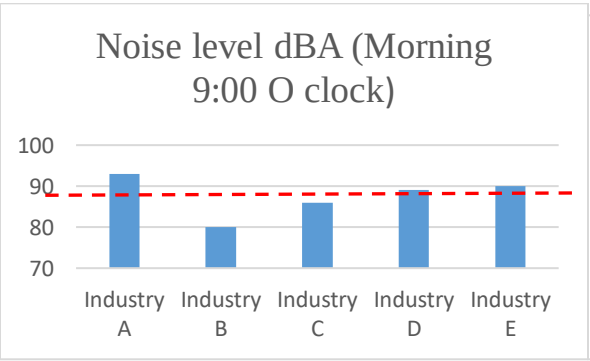
MC17	Hypertension	○ Yes	168	45.0
		○ No	205	55.0
MC18	Induced hearing loss	○ Yes	122	32.7
		○ No	251	67.3

Table 4.6 indicated that the respondents show higher level of symptoms of insomnia with value of 301 and almost 81%. While the same response shows deviation of lowest n value i.e. 72 and % of 19.3% i.e. they don't have good sleep or don't have issues if insomnia. This was due to the factor of the time they spend outside in the environment, where their mind was constantly exposed to the noise. And their nerves and brain was irritated due to those noises and could not be put on calm. Also, the answers obtained indicates that MC11, MC12, MC13, MC14, MC15, MC16, MC17, MC18 were less shown symptoms in the targeted population. As they are present in some respondent but their values are lower as compared to not having these symptoms at all. The % shows that only 32% have induced hearing loss, 45% had Hypertension, 44% had Depression, 54% were annoyed by noise, 31% of people hear ringing or buzzing in the ear, 32% respondents had psychological stress, 44% had headache. But 75% of respondent agreed to the fact that they were tired after doing their work.

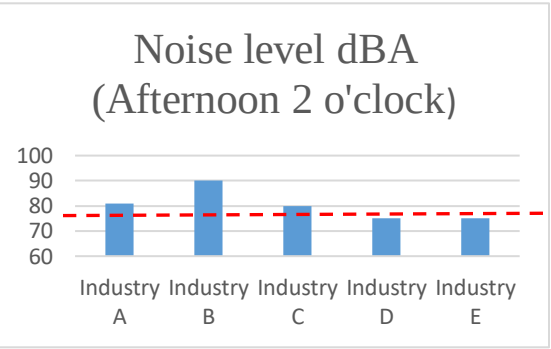
6. Noise Level Data

The noise level meter was used to measure the noise level of the city of Mandi Bahauddin of the three zones. The measurement took place by placing the sound level meter at a distance of 10 m from the source and at height of 3.5 ft.

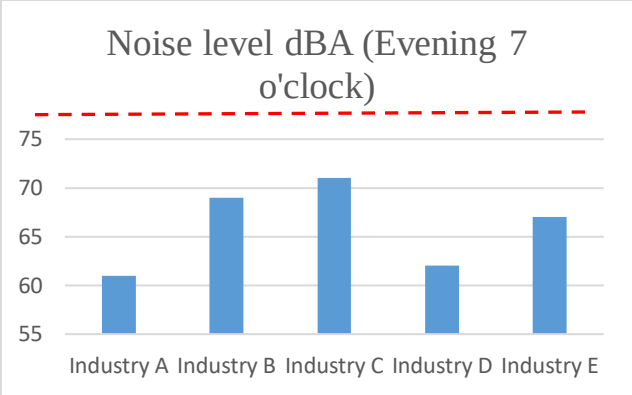
6.1 Industrial Zone



Graph 6.1.1



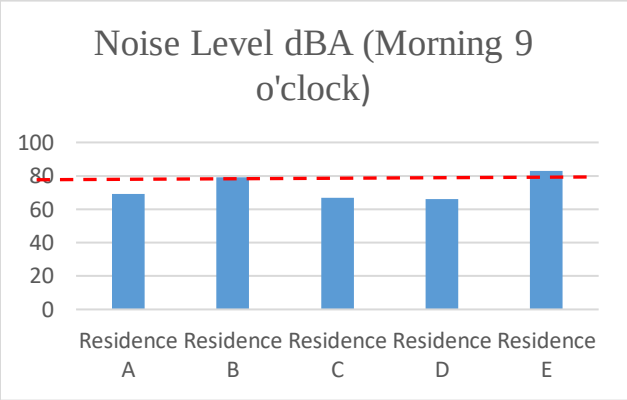
Graph 6.1.2



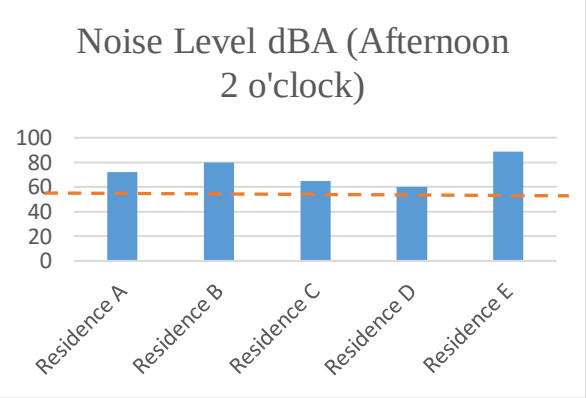
Graph 6.1.3

The graphs indicate that the permissible level of noise in the industrial sector is 85 dB (PEPA, 2023). And as seen the industries were violating the law.

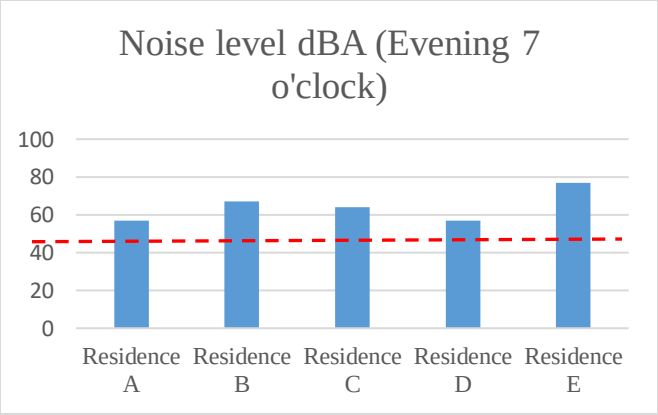
6.2 Residential Site



Graph 6.2.1



Graph 6.2.2

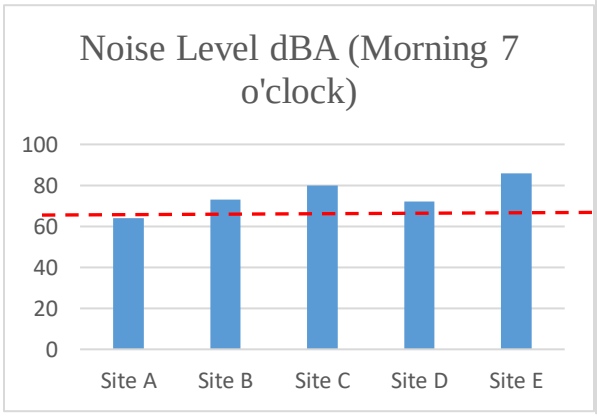


Graph 6.2.3

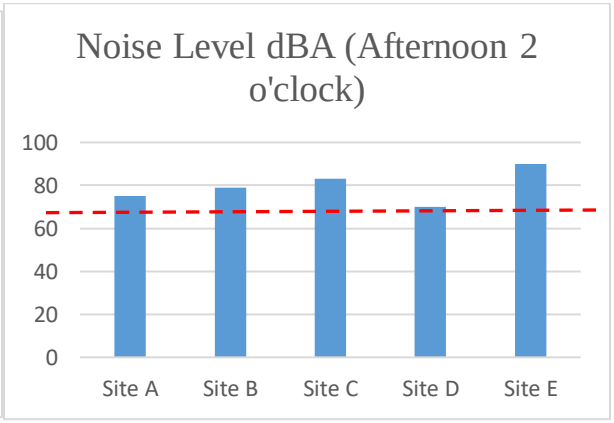
Graph 6.2.1 indicates that the permissible level of noise at residential site in morning is 55 decibels. The graph 6.2.2 indicates that the permissible level of noise in the studied area during afternoon is also 55 decibels which was also not followed by any residential site either they are highly

sophisticated town or simple mohalla. The accepted noise level set by WHO is 45 decibels which was far low than any other residential site showing.

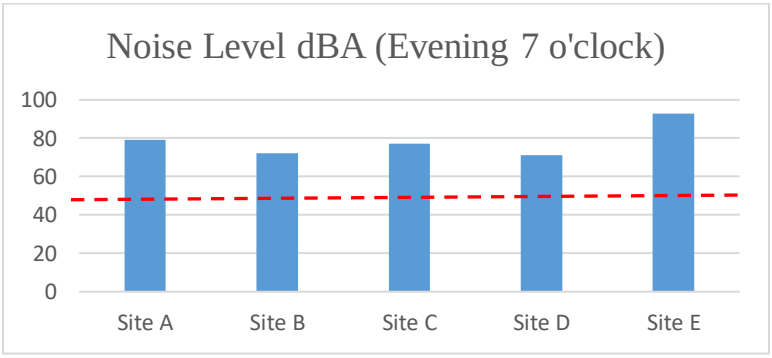
6.3 Commercial Site



Graph 6.3.1



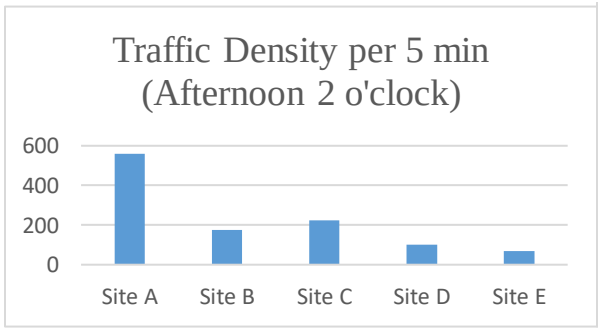
Graph 6.3.2



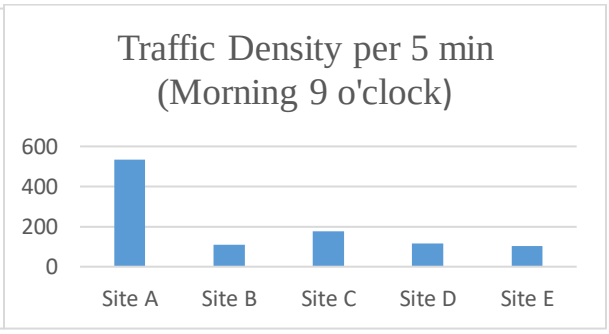
Graph 6.3.3

The graphs indicate that the permissible noise level at the commercial site is 65 decibels during morning. But all the sites were violating the law and was showing high noise level density. Similarly, the graph 6.3.2 indicates that the sites were also showing high level of permissible level that is high than the sais values i.e. 65 decibels. And lastly, the graph 6.3.3 indicates that the threshold values of noise in the commercial site during night is 55 decibels.

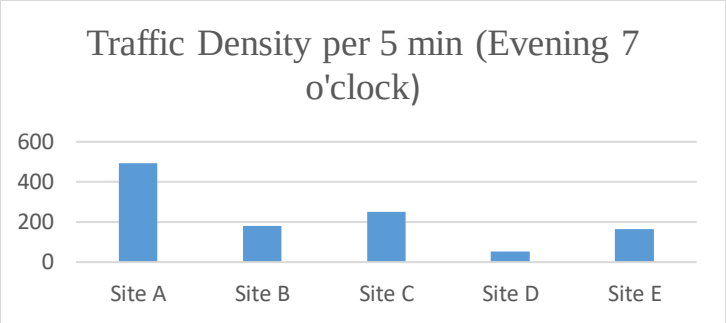
6.4 Traffic Density in Commercial Site



Graph 6.4.1



Graph 6.4.2



Graph 6.4.3

Traffic density measurement

Traffic density was measured as the number of vehicles/h that occupied a segment of a road (Farooqi et al. 2020). The traffic density was calculated as number of vehicles/h by simple calculation as described by Paunovic et al. (2013) in which the number of vehicles was counted for 5 min at each location simultaneously with noise level recordings. It was observed that in graph 7.4.1, 7.4.2, 7.4.3 the density was high in site A among all the commercial sites. The other commercial sites traffic density ranges from 100-150.

7. Conclusion

This study concludes that the three zones of Mandi Bahauddin are facing issues regarding the noise pollution. And that has effected the population of the targeted city. The analysis revealed that the most violated site was commercial in terms of noise pollution. The other zones were also showing high level of noise than the set standards The study also concludes that the people are facing issues such as hypertension, depression, insomnia, tinnitus, annoyance, headache, tiredness after being exposed to continuous high level of noise. It also reveals that the respondent from the commercial area are most effected by noise level of Mandi Bahauddin. The study found that there was not any law regarding the noise pollution enforced in the city and the industrial, commercial and residential were not even following the permissible limit set by PEPA, 2010 said NEQs.

8. Recommendations

- Rotation of workers schedule in order to reduce the noise pollution impact
- Compliance in terms of PPEs availability and usability by the workers
- For Engineering control measures install noise barrier to isolate the workers and the source.
- To lessen the noise level government should cycle the vehicle system by controlling the hours of vehicle type to route of the area such as morning for Rickshaws, bikes and cars, noon for cart sellers, rickshaws, and evening for big vehicles.
- Roads should be installed with noise-reducing road surfaces to lessen the noise level. It has seen that such roads reduce noise level by 6-10 dB
- Plantation of trees at the sides of the road as vegetation cover should be absorb noise to lessen its impact.
- For Engineering control measures use soundproofing walls or acoustic sound-absorbing material during the construction of homes to lessen the noise pollution outside and inside

Keywords: Noise pollution, Noise related health impacts, Mandi Bahauddin, Environmental Pollution, Pakistan

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