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Impacts assessment of traffic noise: a case study in two Business Commercial Roads of Karachi

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Abstract
Road Traffic is a primary source of noise pollution becoming worse each day due to increase number of vehicles, inadequate infrastructure and necessity to commute during same hours. This can critically upset the quality of life in an urban city like Karachi. The purpose of present study was to examine the level of noise pollution due to transportation and its impacts on human health. For this purpose, two busiest business commercial roads of Karachi, M. A. Jinnah Road and Shahrah-e-Faisal were selected for measuring noise level at different timings of the day throughout the week during last week of April 2018. Collected data was statically analyzed by SPSS software. According to the research findings, the calculated average equivalent sound pressure levels were Leq 88.07dB at Old Radio Station Building, M. A. Jinnah Road and 86.09dB at Aisha Bhawani College, Shahrah-e-Faisal which is far above the acceptable limit of SEQS (Sindh Environmental Quality Standards). It is recommended that legislations and proper mitigation measures including noise barrier and absorbent installation to control this unseen pollution is needed to prevent noise impact on human health.

Keywords
SEQS, urban area, noise level, road traffic, legislation.

Introduction

Noise, an unwanted sound, pollutant and a hazard to human health (Chowdhury, 2010; Jatoi, 2014) is not only an environmental issue set aside in the developed countries, but also an issue for developing countries. According to World Health Organization in year 2011, only in Europe, exposure of nearly 20% of mass populace to traffic noise is ≥ 65db in day time and 30% exposed to ≥ 55db in night results in the loss of 61,000 disability-adjusted life years (DALYs). Several studies reports significant associations between urban noise and different diseases like temporal, permanent auditory or non-auditory, physiological and psychological effects on human health like annoyance, hearing loss, fatigue, anxiety, hypertension and also detrimental effect on cardiovascular system (Sorensen et al., 2012; Roosli et al., 2019). According to studies, continuous exposure of high noise can disturb autonomic

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nervous system and causes hyperproteinemia (Zubair A., Siddiqui S.N, 2011; Nazneen et.al., 2017). In Europe, the noise pollution is among the four environmental factors that have a high impact on 400 to 1500 DALYs per million populations (Hanninen et al., 2014; Tobías et al., 2015; Atif et al., 2017; Uddin et al., 2018). This noise is generated from several industrial and non-industrial sources (Kim et al., 2012). In non-industrial sources urban traffic is one of the major contributors of environmental noise than any other and has been increasing over last few years due to urbanization and population growth (Hoque et al., 2013). This urban noise depends on various factors including engine noise, friction of tires, unmaintained vehicle, horn honking, unavailability of roadside noise barriers etc. (Islam et al., 2015).

In Pakistan, there has been a rapid migration from rural centers to cities as compared to any other country in South Asia and is growing with 3% per annum. This means that in year 2030 more than half of Pakistan's 250 million citizens are expected to live in cities (Mehdi et al., 2011). Karachi being a multi-cultural city has seen nearly 35 times increase in its population and an almost 16 times increase in its spatial expansion since its independence (Qureshi and Lu, 2007). It is the 7th largest urban agglomeration and the biggest city in the Muslim world without mass public transport system till date, although several projects are under process. Being an industralized city its more rural people for work which led to urban expansión.

Lack of availability of public transport, increases private transport on urban roads, causes severe traffic congestion and issues to air and noise quality in the city. The government has responded by upgrading many urban roads but still a lot need to be done to organize traffic flow and remove issues related to road encroachment. Karachi city has not been developed through proper urban and twon planning for instance comercial, residential, recreational and silent zones are not well defined as statutory body Sindh Environmental Quality Standards (SEQS) defined noise level standards for each zone which aggravated the problems. Keeping in view the above facts and figure this study was designed to analyze and measure flow of traffic, noise level and its impact on masses exposed to traffic noise on two busiest business commercial arteries of Karachi i.e. M.A. Jinnah Road and Shahrah-e-Faisal were selected owing to the observation that most of the commuters plying those two roads, either to their work or business or back home, and the values were compared with SEQS.

Material and Methods

In this study, noise levels were measured by Noise Meter (Model SLM 840029) at five different locations on each arteries of Karachi city from 09:00 to 21:00 at hourly time interval. All readings were measured according to ISO 1996-1:2016 standard. Reading were taken at slow response mode at a standard height of 1.2 meter from the ground and 1 meter away from traffic flow track and the minimal recommended time for monitoring was 15 minutes (ISO 1996-1: 2016). In order to obtain the mean value of the complete measurement with ease, as many as three readings were taken at each study point. The dB (A) scale was used in all the measurement of noise. Data was collected and analyzed statistically to determine L10, L90, Lnp, Leq and TNI.

Gaussian Percentiles were used to calculate several noise pollution indices including L_{10}, L_{50} and L_{90} which were computed using collected noise data of two busiest roads of Karachi at five different points and these parameters were used to calculate Noise Climate (NC), Equivalent Continuous Noise Level (L_{eq})and Noise Pollution Level (L_{np}) (Hunashal and Patil, 2012). L_{10} is the specific dB (A) value exceeding 10% time for the complete measurement period depicts the average highest level, L_{50} is a specific dB (A) value exceeding 50% time for the complete measurement period depicts the Average level whereas, L_{90} is a specific dB (A) value exceeding 90% time for the complete measurement period depicts the Average level of background noise. The noise climate (NC) provides a wide range in which the levels of sound fluctuation in an interval of

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time and is shown in the equation [1].

$$NC = L_{10} - L_{90} \quad [1]$$

L_{eq} can be explained as a statistical value for the equivalent continuous noise level in dB (A) over a given time continuously at a particular point. Furthermore, it can also be explained as a static level of noise that generates the constant amount and intensity of energy similar to the one generated by the fluctuating level in a specific time. Moreover, it can also be called as equivalent acoustic levels of sound of a stable noise contain same energy can be calculated by using equation [2].

$$L_{eq} = L_{50} + [(L_{10} - L_{90})^2 / 60] \quad [2]$$

Noise Pollution Level (Lnp), is also used to express varying level of noise. It can be computed from the time varying noise level using following equation [3]

$$L_{np} = L_{eq} + NC \quad [3]$$

Traffic Noise Index (TNI) is yet another parameter that depicts the degree of variation in the flow of traffic. It can be expressed and computed in dB(A) by using following equation [4] (Parbat and Nagarnaik, 2007; Shalini and Kumar 2018).

$$TNI = L_{90} + 4(L_{10} - L_{90}) - 30 \quad [4]$$

For assessing the impact of noise pollution on the road side inhabitants, a public opinion survey was also conducted and the results were not very different than expected. The daily life of the local public was affected to a much greater extent and they suffered from various physiological and psychological effects due to the severity of the issue. For this purpose, a close ended questionnaire was designed based on questions related to health effects of noise pollution from road traffic. Confidentiality of data was ensured. A total of 100 people were selected randomly including shopkeeper traffic police and wardens at both study sites. The age of respondent was approximately in-between 30-55 years and they spend 8 to 9 hours daily in traffic flow area.

Study area and time

Karachi, capital of Sindh, is situated in the Southern-Eastern region of Pakistan and located

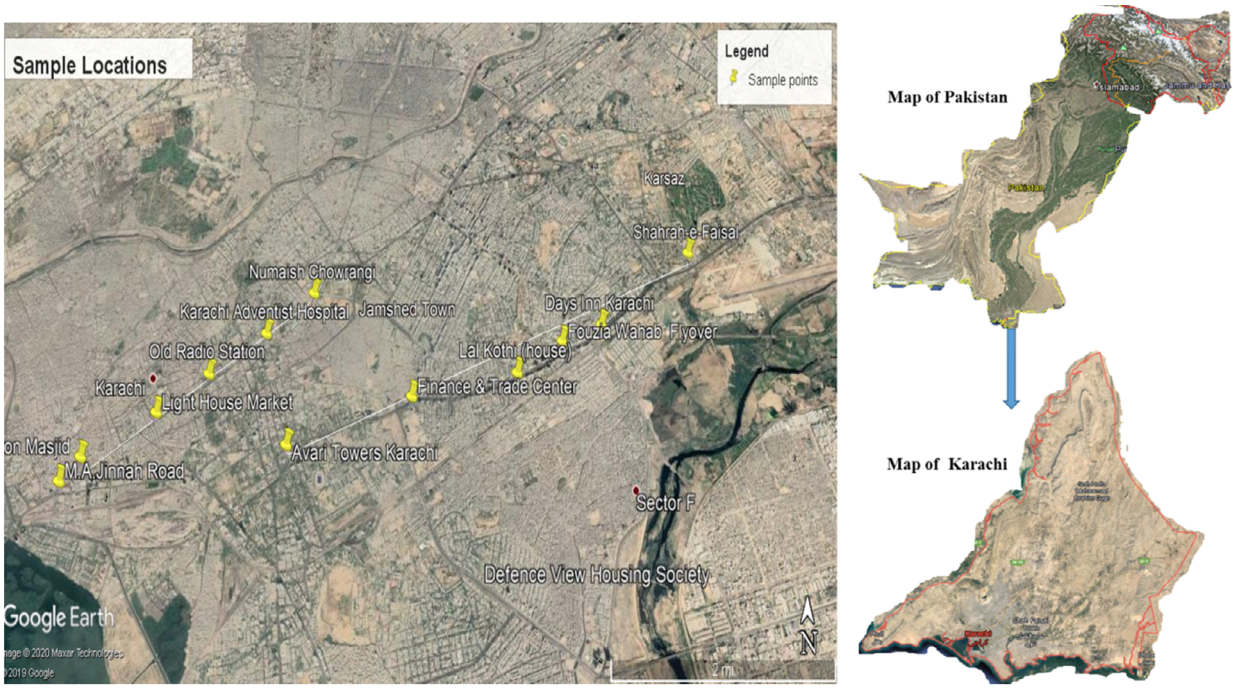

Figure 1. *Sample sites M.A. Jinnah and Shahrah-e-Faisal (Google Earth pro* software 2019).

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at 24°51′36″N 67°0′36″E. According to 2017 census, the population of this city is 14,910,352 (Statistics, 2017). This study was carried out in the last week of April, 2018 to evaluate environmental noise pollution and fatigue faced by masses. The noise levels was measured at five different points on both main arteries of the city. To assess the flow of traffic and noise various steps were followed which include estimation of load of traffic flow at each point, analyze the noise levels using Sound Level Meter and a survey was conducted to study the impact of noise on their health on local inhabitants.

Results and Discussion

Karachi city was ranked #11 as most populated city with approximately 15,741,406 population (World City Populations, 2019) therefore number of vehicles required for the people to commute has increased twofold since 2005 (Pakistan Motor Vehicle Registered, 2018).

Road traffic flow density

The selected point on the map of two main road arteries of Karachi city, where traffic load at the were evaluated at different time intervals shown in figure 1. All the selected points were on road level, away from traffic signals, crossroads and zebra crossing (pedestrian crossing) or narrow roads, where allowable limit was ~60 km/h but due to intense flow of traffic average speed of vehicle was between 25 - 35 km/h during peak hours. It was also noted on Shahrah-e-Faisal that there were number of high rise buildings on each side while on M.A. Jinnah road apart from office and commercial buildings there were mosques, schools, courts and hospitals.

The density of traffic was calculated manually at each sampling point. All variety of vehicle were included in the measurement including HTV (Heavy Transport Vehicle) like buses, trucks, trawlers which includes vehicle used in constructional activities and LTV (Light Transport Vehicles) includes van, small-truck, coaster and other similar mini-automobiles, motorcars, motorcycles, auto rickshaws and others. Ambulances and solid waste collection vehicles/ dumpers were included as others in the study. This increased number of vehicle is one of the major source of noise pollution in the city. Figure 2 shows the graph depicts flow of

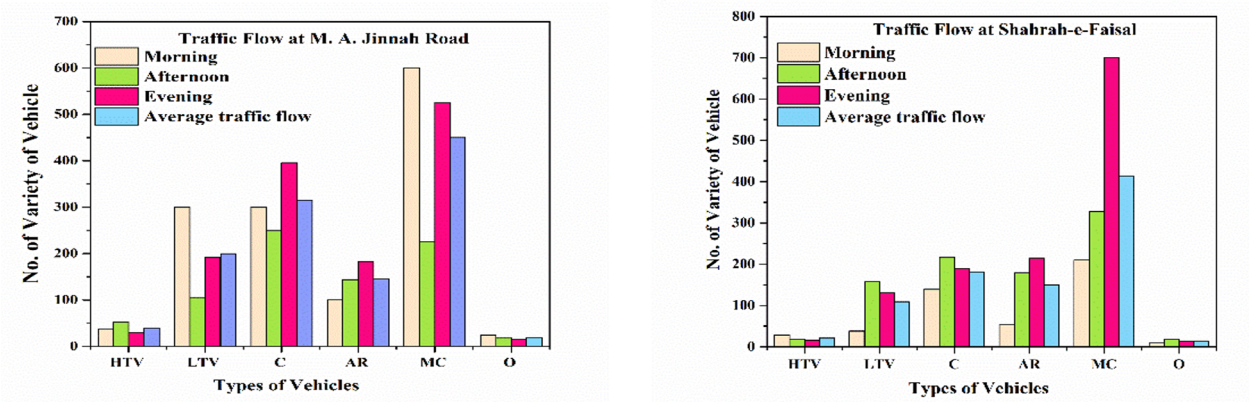

Figure 2. *Illustration of Traffic Flow at M. A. Jinnah Road and Shahrah-e-Faisal.*

traffic on these two traffic arteries of Karachi city. Figure 3 and 4 showed the average noise level parameters at different points of two main traffic arteries (M. A. Jinnah and Shahrah-e-Faisal) of mega city Karachi viz L_{10}, L_{50}, L_{90} TNI, NC, L_{np} and L_{eq} at various time intervals (i.e. 09:00 am to 09:00 pm).

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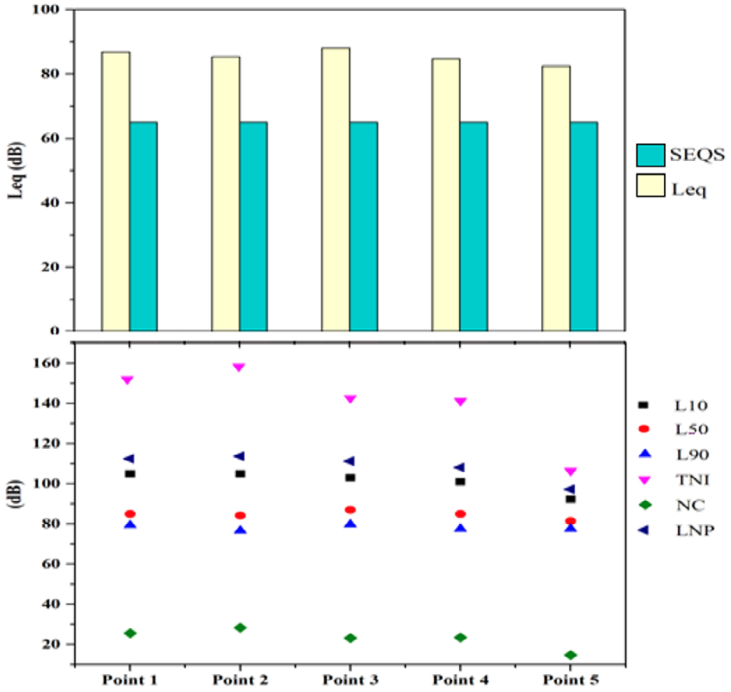

Figure 3. *Graphical presentation of L10, L50, L90 TNI, NC, LNP and Leq at M. A. Jinnah Road. Point 1. Numaish Chaurangi, Point 2. Karachi Adventist Hospital, Point 3. Old Radio Station Building, Point 4. Light House Point. 5. New Memon Masjid.*

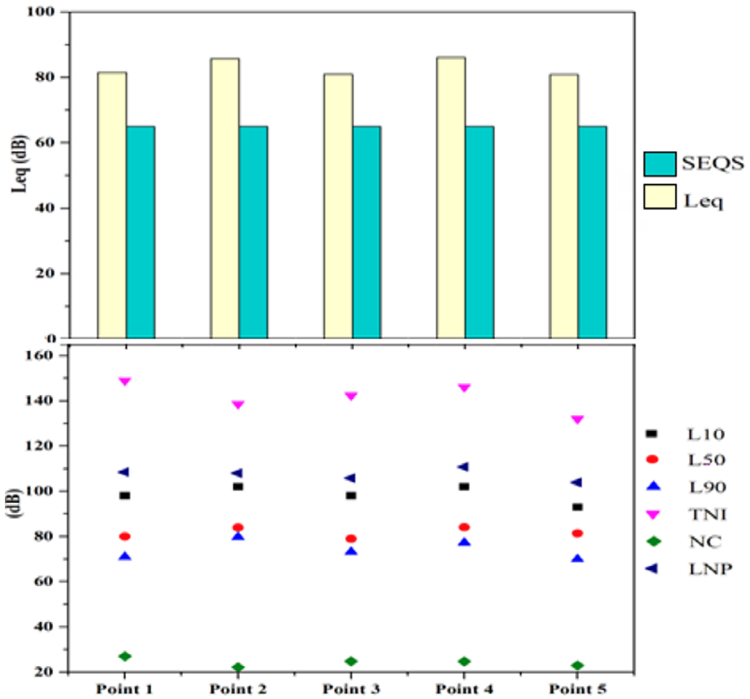

Figure 4. *Graphical Presentation of L10, L50, L90 TNI, NC, Lnp and Leq at Shahrah-e- Faisal. Point 1. Lal Kohti, Point 2. Fozia Wahab Flyover, Point 3. Baloch colony bridge, Point 4. Aisha Bhawani College, Point 5. Avari Hotel Tower.*

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Table 1 clearly shows that the L_{10} values on all point of M.A. Jinnah road was beyond 100 dB(A) except near New Memon Masjid bus stop, but still it was 92.5 dB(A). Similarly, TNI value were very high i.e. 151.8, 159.9, 142.6, 141.2 and 106.4 dB(A) for Numaish Chaurangi, Karachi Adventist Hospital, Old Radio Station Building, Light House and New Memon Masjid respectively as this track leads to the busiest business commercial center / port of the city. During day time high number of LTV, cars, rikshaws and bikes uses this track. Also movement of heavy trucks during these hours could also be a major reason for high noise level on this artery.

Table 1. *Values of L10, L50, L90 TNI, NC, Lnp and Leq at M. A. Jinnah Road*

Locations	SEQS	Leq	L10	L50	L90	TNI	NC	LNP
Point 1[a]	65	86.84	105	85	79.4	151.8	25.6	112.441
Point 2[b]	65	85.41	105	84.2	76.7	159.9	28.3	113.716
Point 3[c]	65	88.07	103	87	79.8	142.6	23.2	111.275
Point 4[d]	65	84.72	101	85	77.6	141.2	23.4	108.125
Point 5[e]	65	82.53	92.3	81.4	77.6	106.4	14.7	97.233

a = Numaish Chaurangi, b = Karachi Adventist Hospital, c = Old Radio Station Building, d= Light House, e = New Memon Masjid.

In day time Leq observed on this artery was much higher than the prescribed SEQS limits, which is 65 dB(A). Lnp takes into account both NC and Leq indices and gives an idea of high noise pollution in the area. It is considered as the best indicator physiological / psychological impact of noise on humans.

Similar results were obtained on other key artery of the city Shahrah-e-Faisal as shown in table 2.

Table 2. *Values of L10, L50, L90 TNI, NC, LNP and Leq at Shahrah-e- Faisal*

Locations	SEQS	Leq	L_{10}	L_{50}	L_{90}	TNI	NC	LNP
Point 1[a]	65	81.47	98	80	71	149	27	108.475
Point 2[b]	65	85.77	102	84	79.8	138.6	22.2	107.975
Point 3[c]	65	81.00	98	79	73.2	142.4	24.8	105.808
Point 4[d]	65	86.09	102	84.1	77.3	146.1	24.7	110.791
Point 5[e]	65	80.89	93	81.4	70	132	23	103.891

a = Lal Kohti, b = Fozia Wahab Flyover, c = Baloch colony bridge, d = Aisha Bhawani College, e = Avari Hotel Tower.

Noise level was exceeding the SEQS limit (Leq = 65 dB(A)) but comparatively much lesser then M.A. Jinnah Road. It was observed that maximum Leq level went upto 86.09 at baloch colony bridge and minimum near Avari tower bus stop, which was 80.89 dB(A). L_{90} was 71, 79.8, 73.2, 77.3, and 70 at Lal Kohti, Fozia Wahab Flyover, Baloch colony bridge, Aisha Bhawani College and Avari Hotel Tower stop respectively, whereas, L_{10} values were 98, 102, 98, 102 and 93 on the same points. It was also noted that traffic flow rate was 148 vehicles/hour at Shahr-e Faisal. The permissible values of TNI and L_{np} was 74 and 88 dB(A) respectively. The obtained data of the study observed exceeding values of all selected parameters with their permissible limits at most of the sample points on both roads.

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High noise level was observed on these two main arteries of the city at the public service facilities such as school, hotels and government/ private offices, court house, hospitals and parks. Sindh Environmental protection Agency has marked them in a silent zone and recommended Day Time (from 6.00 a.m. to 10.00 p.m.) Leq level should be less than 50 dB(A).

Survey results of this study showed that almost all participants believed noise pollution badly affects human health. Results showed that 69%, 50% and 76% are suffering from stress, hearing loss and headache respectively at M. A. Jinnah Road whereas 66%, 45% and 70% at Shahrah-e- Faisal. During survey, shopkeepers complained about the problem in communication with customers while traffic police man and wardens complained about difficulties in paying concentration during task and work performance. They lost temper during public dealing. Another interesting thing observed during survey was that 44 % and 34% of respondent do not perceive noise as pollution as highlighted by our research.

Conclusions

Noise levels in M.A. Jinnah and Shahrah-e-Faisal roads were higher than the permissible limit of SEQS. The traders and dwellers are exposed to the bad effects of noise pollution at both the roads. Above results have effect of noise traffic movement on both sides of the roads and traffic jams are the vital sources of this unseen environmental pollution levels which affect human activity, creativity, intellectual capacity and work performance. Avoiding this issue requires effective environmental control strategies and promoting environmental awareness for all traders and dwellers. As of the study conducted by Rehman (Rehman ZU., et.al, 2017) suggested that noise level higher than limits in organized and well developed areas having residential and other activities is a major concern and a big barrier towards work efficiency.

Therefore, following strategies are recommended to control the noise pollution in metropolitan city Karachi including public consciousness, growing green belts along the road side because plants are natural absorbents to diminish the noise level, identifying sensitive locations by Non-Horn or Silence Zone, broadening of congested roads, construction of flat, signal and speed breaker free roads, control of commercial activities on already constructed roads, banning of unmaintained and earsplitting silencers in automobiles along with noisy and troubling pressure horns, creating awareness among students and youth to recognize noise as a serious pollutant, and prohibiting parking on roads. By adopting theses strategies, the level of noise pollution in the urban center could be effectively controlled and United Nations Sustainable Development Goals 3 “Good health & well-being” & 11 “sustainable cities and communities” (United Nations SDGs, 2015) could be achieved.

Conflict of Interest

The authors declare no conflict of interest.

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