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TECHNICAL NOTE

Construction Pre and Post Analyses of Air Quality Parameters ($PM_{2.5}$, PM_{10} and CO) and Noise Levels: A Case Study of Lal Shahbaz Qalandar Underpass, Lahore, Pakistan.

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ABSTRACT: Daily high traffic loads were reported at junctions, resulting in increased fuel consumption and air pollution at the Lal Shahbaz Qalandar underpass in Lahore. The post-EIA monitoring of Carbon Monoxide (CO), Particulate Matter ($PM_{2.5}$ / PM_{10}) and noise levels were done near Lal Shahbaz Qalandar Underpass in four different seasons. Pre-EIA (Environment Impact Assessment) monitored levels of CO, $PM_{2.5,}$ and PM_{10} of the underpass were used for the comparison. Sensor MQ7 was used for monitoring CO levels in the air, and HT608 air quality detector gas checker tester environmental meter was used to monitor particulate matter 2.5 and 10. BeneTech GM1356 digital sound level meter was used for noise level monitoring. For southwest monsoon and winter seasons, CO emissions exceeded the limit for the post-EIA phase (from 7.85 to 8.96 mg/m^3). $PM_{2.5}$ emissions exceeded the normal range both during pre/post-EIA phases. In all seasons, their emissions were constantly increasing (from 40-49 mg/m^3) to the pre-EIA phase. Similarly, PM_{10} emissions exceeded the normal range during pre/post-EIA phases. In all seasons, their emissions have constantly been increasing (from 152-160 g/m^3) during the pre-EIA phase. In the pre-EIA phase, the noise level was 81 dB(A), whereas, during the post-EIA phase, the noise level range was from 85-96 dB(A) with a maximum in spring. A significant difference existed for $PM_{2.5}$ and PM_{10} between pre-EIA data with post-EIA data. The general trend reveals that carbon monoxide, $PM_{2.5}$ and PM_{10} emissions are rising. Poor quality car fuel, unnecessary honking, increased automobile sales, new car manufacturers in Pakistan, very little use of efficient vehicles, and very few public transportation options are the causes of rising air pollution and noise levels following the completion of this underpass's megaproject. The optimal solution to ease traffic congestion and conflicts is to build another underpass/flyover at the next intersection.

Keywords: Traffic Pollution, Carbon Monoxide, Particulate Matter 2.5, Particulate Matter 10, Underpass, Post-Environmental Impact Assessment (EIA)

1. Introduction

The approach to Environmental Impact Assessment (EIA) is critical to any systematic management or environmental sciences practice. The process used to evaluate the project's social, environmental, and political ramifications is known as EIA.

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It is a method of anticipating any project's effects before it is built, whereas post-project EIA analysis helps analyze the accuracy of such estimations suggested in the pre-EIA phase (Loomis et al., 2018).

Post-Project Analysis (EIA-PPA) within the EIA process may be understood as a method of monitoring and analyzing the actual environmental effect of projects that were examined in the EIA process during planning and authorization (Zitkova et al., 2022). All development projects must undertake an EIA before they can be facilitated. The ADB (Asian Development Bank), World Bank, and UNEP (United Nations Environment Program) have mentioned regulations for EIA processes. In Pakistan, the Environmental Protection Ordinance (PEPO) rules for legal EIA significance. The benefits of the EIA procedure should be clarified by confirming stakeholder interests, carrying out a post-EIA review, giving environmental agencies resources and assuring openness (Ehtasham et al., 2022).

The environmental impact assessment is a very beneficial tool that is significantly used to diagnose the economic, environmental and social impacts of purposed projects before decision-making. The process starts with the selection of a project based on sustainable development to assure that the disadvantages of the new projects were mitigated or controlled through intelligent decision-making. For many years EIA has not been taken seriously in South Asian countries in the world. Developing countries need more development programs to enhance their economic growth (Shah et al., 2010; Babu, 2016).

All across the world, flyovers and underpasses are utilized to control traffic flow. Road traffic contributes to air and noise pollution in metropolitan areas, which has a detrimental influence on human health. Therefore, pre and post-EIA are very much important for projects involving flyovers and underpasses. Abbasi et al. (2021) assessed the environmental impacts of the Tariq Road underpass at the construction site in Karachi. It was identified that much improvement is required in terms of health, safety and environmental aspects.

The Kano State Ministry of Works, Housing, and Transport in Nigeria conducted an EIA and suggested the building of the Gadon Kaya Underpass Bridge. The project’s purpose was to eliminate the identified urban mobility issues that had hampered the region's social and environmental health. The immediate ramifications of the project involved the construction and direct usage of an underpass bridge. The most significant consequences addressed in this study were clearing, grading and roadbed construction, other land use, cultural site damage and interference with local people's movement.

The direct effects observed were those associated with increased demand for motor fuels, incidents involving and/or displacement of non-motorized transportation methods, increased air pollution, noise, roadside litter, injury or death to animals and people attempting to crossroads and environmental harm from accidents involving hazardous materials in transit and water pollution (Nabegu, 2013).

The only way to guarantee that the development authorities abide by the rules set forth by the government concerning this construction project is to conduct a post-monitoring. With the use of post-EIA analysis reports, one can track environmental degradation and begin appropriate mitigating action. Dipper (1998) examined a wide range of literature to highlight the advantages of post-project analysis. He described the post-project study of eight building projects. Post-project activities reveal critical truths that obstruct optimistic constructions. An assessment of post-project analysis indicated that there is a lot of room to raise the visibility of post-auditing in EIA throughout the world. The term post-project analysis refers to research and supporting activities that are carried out after a project has been built and is ready to enter the operational phase. The primary strategy for monitoring is to evaluate important environmental implications versus baseline conditions before and after the project.

There are essential elements of EIA follow-up:

I) Monitoring: Data gathering and comparison with standards, projections, or expectations.

II) Evaluation: Assessment of the activity's compliance with standards, projections, or expectations, as well as its environmental performance.

III) Management: Decision-making and appropriate action in response to concerns raised by monitoring and evaluation activities and

IV) Communication: Informing stakeholders and the broader public on the outcomes of the EIA follow-up (Pinto et al., 2019).

There are very limited studies available on Post-EIA or EIA after construction. The Lal Shahbaz Qalandar underpass in Lahore is therefore studied to compare its environmental impacts before and after construction. Firdous market chowk is located at the crossing of Ali Zaib Road and M. M. Alam Road. At intersections, high traffic volumes are observed daily.

Significant traffic volumes occur during peak hours between vehicles moving towards the center point. Firdous market which results in massive traffic jams extended up to cavalry ground resulting in consequently more fuel consumption and high noise and air pollution. The newly constructed underpass at Firdous Market is facilitating daily traffic to access the commercial hubs, offices, schools, business places and residences with reduced travel time and vehicle operating costs.

The basic aim of the study is to determine the post-environmental impacts by assessing noise levels and emissions of carbon monoxide and particulate matter ($PM_{2.5}$ and PM_{10}) from road traffic. Congestion in traffic increases vehicle emissions and negatively impacts ambient air quality and noise levels in the area. According to recent studies, traffic congestion is the leading cause of increased sickness and death among drivers and those who live near major roadways.

Traffic on roads is significantly increased in Lahore. Before the construction of the underpass at Firdous Market Chowk, the values of PM_{10} and $PM_{2.5}$ were slightly higher than the limits prescribed imposed by Punjab Environmental Quality Standards (PEQS, 2016).

The higher values were due to high traffic flow and traffic congestion at the Ferrousz Market Underpass. The ESPAK (Environmental Services Pakistan) laboratory conducted noise measurement before the construction of the Lal Shahbaz Qalandar underpass and found that it exceeded the allowable limits (both residential and commercial) as per Punjab Environmental Quality Standard (PEQS, 2016). Vehicle emissions are the primary source of air pollutants such as Carbon Monoxide (CO), Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2), Nitrogen Oxides (NO), and Particulate Matter ($PM_{2.5}$, PM_{10}).

The current study conducted the post-project evaluation, which focused on the analysis of CO, $PM_{2.5}$, PM_{10} and noise levels before and after construction completion. To make sure the development authorities obey the regulations set forth by the Government of Pakistan for this project, a comparison of CO, $PM_{2.5}$, and PM_{10} as well as noise pre- and post-EIA data was done. Particulate matter is a combination of solids and liquids, drops and aerosols, and dry-solid fragments.

2. Materials and Methods

The main goal of this study is to investigate the post-environmental impacts in the form of noise and air pollution (carbon monoxide, $PM_{2.5}$ and PM_{10}) emissions. A simple random sampling method was used for this study.

2.1. Study Location

The area of the Firdous Market intersection consisted of hotels, plazas, a park, a graveyard, bus stands, institutes, petrol pumps and a water pumping station. The area also included an under-constructed grand mall. A receptor-based technique was used to sample noise levels and air pollution parameters. The monitoring was carried out at the Royal Star Hotel as it was the busiest area prior to the construction of the underpass (See Figure 1 for the land use near the underpass). The monitoring was done near the Hotel Royal Star located at 13A-J Gulberg III Ali Zaib Road Lahore which represents commercial and residential areas along the alignment.

2.2. CO, $PM_{2.5}$, and PM_{10} Monitoring (Pre EIA: March 2020)

In March 2020, the ambient air quality of the project site was done by monitoring the primary pollutants i.e. CO, $PM_{2.5}$ and PM_{10}. The sampling locations were selected through a receptor-based approach. The sampling was conducted for 24-hour period in March 2020. One 8-hour data slot (i.e., 8.00 am – 4.00 pm) was included.

The data of pre-EIA was collected by Environmental Services Pakistan (ESPAK), Laboratory. The results indicated that the values of PM_{10} and $PM_{2.5}$ were slightly higher than the limits and all other parameters are within the permissible limits of PEQS (2016) (Table 1). The higher values were due to high traffic flow and traffic congestion at the Firdous Market Intersection.

2.3. Noise Levels Monitoring (Pre EIA March 2020)

Noise level monitoring was carried out at different locations.

Fig. 1. Land use map of Lal Shahbaz Qalandar underpass

Table 1. CO, $PM_{2.5}$ and PM_{10} monitoring near hotel royal star (Courtesy: Nespak laboratory Lahore) (lda, 2020)

Parameters	Unit	Allowable values (PEQS 2016 standards)	Mean concentration
CO	mg/m^3	5 mg/m^3 (8 hours)	0.94±0.35
$PM_{2.5}$	$\mu g/m^3$	35 $\mu g/m^3$ (8 hours)	36.9±7.02
PM_{10}	$\mu g/m^3$	150 $\mu g/m^3$ (8 hours)	150.2±13.1

Key: Exceeding allowable limits (red); within allowable limits (green)

Noise levels were monitored with the help of a potable digital sound meter at the project site for 24 hours and compared with PEQS for noise. As the area is surrounded by under-construction commercial shops so the noise levels measured during the monitoring are compared with Category B i.e., 'noise levels for commercial area' as specified under PEQS.

Therefore, 65 dB during the daytime and 55 dB during the nighttime was used as a reference standard. The average values of noise levels are given in Table 2. Noise monitoring results showed that the noise levels at day and night time exceed the permissible limits (both residential and commercial) of PEQS (2016), which may be due to noise generated by the usage of horns by vehicles, commercial activities, and traffic congestions in the project area. The pre-EIA was done by ESPAK, Lahore.

2.4. Ambient Air Quality Monitoring (Post EIA)

The monitoring point was selected at Firdous Market commercial area near Hotel Royal Star. This location represents a dense commercial activity and serves as an intersection for commuters from all directions using the project alignment. The selection of monitoring locations was based on environmental factors including the direction of the wind on a particular day and the amount of turbulence in the air etc. The noise and air quality monitoring (CO, $PM_{2.5}$, PM_{10}) for post-EIA of the project was done in four seasons on weekdays to compare the readings and give authentic results. Ambient air quality and noise levels monitoring was done for a time duration of eight hours continuously from morning 8 am to 4 pm. Monitoring activity was started on June 2021 and completed on February 2022 (Table 3). The testing of ambient air quality and noise levels was done in June 2021, September 2021, December 2021, and February 2022.

Table 2. Average values of noise levels (Nespak laboratory Lahore) (lda, 2020)

Sampling locations	Equivalent hourly mean-dba	PEQS (2016) (commercial)-dba		Peqs (2016) (residential)-dba	
Hotel Royal Star	Day time (8 hours)	Day time (0600-2200 hours)	Night time (2200-0600 hours)	Day time (0600-2200 hours)	Night time (2200-0600 hours)
	81	65	55	55	45

Table 3. Timetable for data collection for CO, $PM_{2.5}$, PM_{10} and noise levels

Season	Month	Year	Start time	End time
Summer	June	2021	8:00:00 am (87.8 °F)	4:00:00 pm (105.4 °F)
Southwest monsoon	September	2021	8:00:00 am (83.2 °F)	4:00:00 pm (95.1 °F)
Winter	December	2021	8:00:00 am (44.6 °F)	4:00:00 pm (66.2 °F)
Spring	February	2022	8:00:00 am (46.9 °F)	4:00:00 pm (68.0 °F)

Note: Temperature values are averages

2.5. Sensor Used for Measuring CO (Post EIA)

The concentration of Carbon Monoxide (CO) was monitored by placing the sensor on the trunk of the Honda Civic Turbo 2017 model. The sensor used for the estimation of the concentration of carbon monoxide is MQ-7. This sensor has a fast response and high sensitivity. It requires a +5 voltage and 150 mA power for smooth operations. The structure of the MQ-7 gas sensor consists of a micro Al_2O_3 ceramic tube, Tin Dioxide (SnO_2) sensitive layer, a calculating electrode and a heater. All of these components are attached into a crust made of plastic and a stainless-steel net.

The heater provides necessary work conditions for the working of sensitive components of the sensor. The MQ-7 has 6 pins, 4 of which were used to fetch signals, and the other 2 are used for giving heating current. It can detect the concentration from 10-10,000 ppm of CO in the environment. Its main components are tin dioxide (SnO_2), which is a very sensitive material with low conductivity in clean air. Because of this very interesting property when ammonia is present in the air, the conductivity of this sensor gets increased too. This immense rise in conductivity because of the presence of ammonia in the environment is different in output signals representing the concentration of ammonia through a connected computer board.

The detection range is from 5 to 500 ppm and requires 5V for its smooth operation. To record the traffic emissions accurately, the sensor device was placed on the trunk of the car in front of Hotel Royal Star. The spot was selected based on safety and accuracy. The sensing device measured carbon monoxide. The readings were represented in ppm. The ppm values were then converted to mg/m^3 to compare the values of pre-EIA. The sensing device measured vehicular pollution emission data for 8 hours. The data was collected from 8.00 am to 4.00 pm (week days). This time includes the peak hours. The data was collected for the following seasons: Summer, Southwest Monsoon, Winter and Spring. The sampling point for CO measurement was done at Firdous Market (near Hotel Royal Star).

2.6. Noise Levels Monitoring (Post EIA)

Noise levels monitoring was done at Hotel Royal Star for 8 hours continuously through BeneTech GM1356 digital sound level meter. BeneTech GM1356 digital sound level meter measures the noise level of air / environment for 8 hours. It gives the result in the form of a text file that has noise levels in units of decibels weighted average ‘A’ (dba). To simulate how the human ear hears, dba levels are "A" weighted using the weighting curves. This meter has accuracy up to +/- 1.5 db. It has a measurement range of 30-130 dBA. Alternating Current (AC) and Pulse Width Modulation (PWM) both signal outputs are available in this digital sound meter. To get recorded data to connect with a PC through an USB cable, then it gives real-time data analysis. The Benetech GM1356 digital sound meter measured the mean, minimum and maximum ambient sound levels in decibels.

This low-cost sound meter is designed for simple noise surveys and sound levels checked. This sound meter only needed to be turned on to begin measuring using the most common settings. Monitoring was done in four different seasons that is Summer, Southwest Monsoon, Winter and Spring, from 8:00 am to 4:00 pm (week days) near Hotel Royal Star.

2.7. Monitoring of $PM_{2.5}$ and PM_{10} (Post EIA)

Monitoring of particulate matter was done by the HT608 indoor/outdoor air quality detector gas checker tester environmental meter. It monitors $PM_{2.5}$ and PM_{10} in µg/m3. The sensor was placed on the trunk of the Honda Civic Turbo 2017 model.

This multi-function air quality detector gives real-time and highly stable particulate matter $PM_{2.5}$ and PM_{10} concentration data. It has completely customizable settings for convenience during its use (US Department of Labor, 2022). See Table 4, to record concentration data of $PM_{2.5}$ and PM_{10} held it firmly in the air and then turned it on with the power button.

Table 4. Specifications of air quality detector

Specification	Measuring range	Resolving	Accuracy
$PM_{2.5}$	0-999 µg/m^3	1.0 µg/m^3	+/- 10%
PM_{10}	0-999 µg/m^3	1.0 µg/m^3	+/- 10%

Once the power button is turned on it started giving concentrations of air quality. All the readings were then collected in the form of a pdf file by connecting the meter to the computer with the help of an USB cable. Monitoring was carried out near Hotel Royal Star on week days from 8:00 am to 4:00 pm during the four distinct seasons of summer, southwest monsoon, winter and spring.

3. Results

3.1. Mean Emissions in Summer June 2021 (Post EIA)

Table 5 shows the mean emissions of CO, $PM_{2.5}$ and PM_{10} on week days in the summer season of June 2021. It can be seen that the values of carbon mono oxide were under the limit i.e. 3.58 mg/m^3, but the values of $PM_{2.5}$ and PM_{10} were 39.5 (mg/m^3) and 152.2 (mg/m^3), respectively that were exceeding the limits.

The higher values were due to high traffic flows. A significant difference (p value < 0.0001) existed for CO, between pre-EIA (March 2020) data with post-EIA (June 2021) data.

3.2. Mean Emissions in Southwest Monsoon September 2021 (Post EIA)

Table 6 shows the mean emissions of CO, $PM_{2.5}$ and PM_{10} on week days in the Southwest Monsoon season of September 2021. It can be seen that carbon mono oxide (mean emission: 7.85 mg/m^3) has exceeded the limit. $PM_{2.5}$ and PM_{10} also gradually increased in the environment near Hotel Royal Star Lahore. The concentration of particulate matter $PM_{2.5}$ was 40.1 μg/m^3 and the concentration of particulate matter PM_{10} was 154.2 μg/m^3. A significant difference (p value < 0.0001) existed for CO, between pre-EIA (March 2020) data with post EIA (September 2021) data.

3.3. Mean Emissions in Winter December 2021(Post EIA)

Table 7 shows the mean emission of CO, $PM_{2.5}$ and PM_{10} on week days in the winter season of December 2021. It can be seen that the trend among the three gases is increasing at its extreme due to smog season in Pakistan. The value of CO was increased from 7.85 mg/m^3 to 8.96 mg/m^3.

Table 5. Mean emissions of CO, $PM_{2.5}$ and PM_{10} on week days in the summer season (June 2021)

Parameters	Units	Limit values (PEQS)	Pre-EIA (march 2020) 24 readings	Post EIA mean concentration (2021) 9 readings	T-test comparisons between pre and post-EIA measurements
CO	mg/m^3	5 mg/m^3	0.94±0.35	3.58±0.6	P value < 0.0001* t = 15.75; df = 31 CI (95%): -2.98 to -2.29
$PM_{2.5}$	μg/m^3	35 μg/m^3	36.9±7.02	39.5±1.5	P value = 0.28 t = 1.09; df = 31 CI (95%) = -7.45 to 2.25
PM_{10}	μg/m^3	150 μg/m^3	150.2±13.1	152.2±3.75	P value = 0.65 t = 0.44; df = 31 CI (95%) = -11.12 to 7.12

Key: Exceeding allowable limits (red); within allowable limits (green), *Significant difference

The values of $PM_{2.5}$ and PM_{10} were 49.2 μg/m^3 and 160.2 μg/m^3, respectively. The effect of winter inversion is so visible in December as air pollution increase due to trapped air pollutants in the air. The values of CO were exceeding the limits and particulate matter was also high due to smog from brick kilns and automobile exhausts pollution and excessive traffic on the underpass. A significant difference existed for CO (p value < 0.0001), $PM_{2.5}$ (p value < 0.0001), and PM_{10} (p value = 0.03) between pre-EIA (March 2020) data with post-EIA (December 2021) data.

3.4. Mean Emissions in Spring February 2022 (Post EIA)

Table 8 shows the mean emission of CO, $PM_{2.5}$ and PM_{10} on week days in the spring season of February 2022. The monitored emission of CO was 7.97 mg/m^3. The monitored emissions of $PM_{2.5}$ and PM_{10}

were 48.2 μg/m^3 and 158.2 μg/m^3, respectively. The emissions of gasses were lower than in December 2021 but still higher than the limits (PEQS, 2016).

A significant difference (p value < 0.0001) existed for CO, between pre-EIA (March 2020) data with post-EIA (February 2022) data. The overall trend shows that the emissions of carbon mono oxide, $PM_{2.5}$, and PM_{10} have been increasing. The graphical comparison is given in Figure 2.

3.5. Noise Levels Results

The results are straightly showing an obvious increase in noise levels at Lalshahbaz Qalandar Underpass Lahore. The observed reason for the increase in noise levels is the high use of traffic horns and heavy traffic flow. Figure 3 shows a 2D column graph between seasons /month on the x-axis and noise levels in dBA on the y-axis.

Table 6. Mean emissions of CO, $PM_{2.5}$ and PM_{10} on week days in the southwest monsoon season (September 2021).

Parameters	Units	Limit values (PEQS)	Pre-EIA (march 2020) 24 readings	Post EIA mean Concentration (2021) 9 reading	T-test comparisons between pre and post-EIA measurements
CO	mg/m^3	5 mg/m^3	0.94±0.35	7.85±0.8	P value < 0.0001* t = 34.93; df = 31 CI (95%): -7.31 to -6.50
$PM_{2.5}$	μg/m^3	35 μg/m^3	36.9±7.02	40.1±1.6	P value = 0.189 t = 1.34; df = 31 CI (95%): -8.06 to 1.66
PM_{10}	μg/m^3	150 μg/m^3	150.2±13.1	154.2±3.82	P value = 0.378 t = 0.89; df = 31 CI (95%): -13.12 to 5.12

Table 7. Mean emissions of CO, $PM_{2.5}$ and PM_{10} on week days in the winter season (December 2021)

Parameters	Units	Limit values (PEQS)	Pre-EIA (March 2020) 24 readings	Post EIA Mean Concentration (2021) 9 readings	T-test comparisons between pre and post-EIA measurements
CO	mg/m^3	5mg/m^3	0.94±0.35	8.96±0.9	P value < 0.0001* t = 37.46; df = 31 CI (95%): -8.45 to -7.58
$PM_{2.5}$	μg/m^3	35μg/m^3	36.9±7.02	49.2±1.9	P value < 0.0001* t = 5.13; df = 31 CI (95%): -17.18 to -7.41
PM_{10}	μg/m^3	150μg/m^3	150.2±13.1	160.2±3.96	P value = 0.03* t = 2.23; df = 31 CI (95%): -19.13 to -0.86

Key: Exceeding allowable limits (red); within allowable limits (green), *Significant difference

Table 8. Mean emissions of CO, $PM_{2.5}$ and PM_{10} on week days in the spring season (February 2022)

Parameters	Units	Limit values (PEQS)	Pre-EIA (march 2020) 24 readings	Post EIA Mean concentration (2021) 9 readings	T-test comparisons between pre and post-EIA measurements
CO	mg/m^3	5mg/m^3	0.94±0.35	7.97±0.9	P value < 0.0001* t = 32.84; df = 31 CI (95%): -7.46 to -6.59
$PM_{2.5}$	μg/m^3	35μg/m^3	36.9±7.02	48.2±1.7	P value = 0.26 t = 1.14; df = 31 CI (95%): -31.4 to 8.80
PM_{10}	μg/m^3	150μg/m^3	150.2±13.1	158.2±3.91	P value = 0.107 t = 1.65; df = 31 CI (95%): -17.84 to 1.84

Key: Exceeding allowable limits (red); within allowable limits (green), *Significant difference

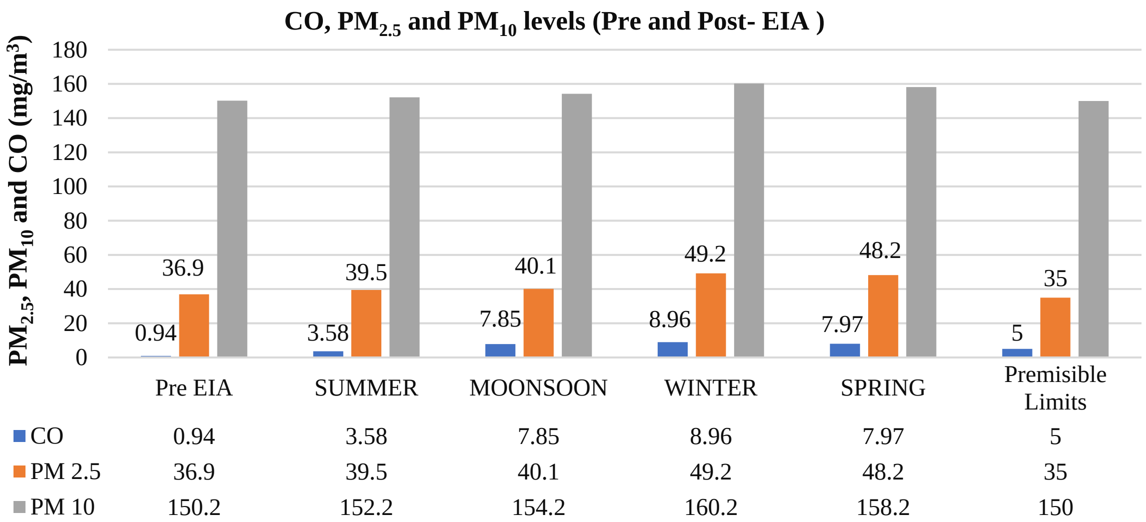

Fig 2. Chart showing CO, $PM_{2.5}$ and PM_{10} levels collectively of four seasons (Post-EIA)

Note: Air pollution in winter is the highest of all seasons that is due to pollutants remaining for a longer period in the air and breathed out at a higher rate than during the summer season. Cold air is dense and moves slower than warm air. As seen in the spring season as the temperature rises air pollution also decreases.

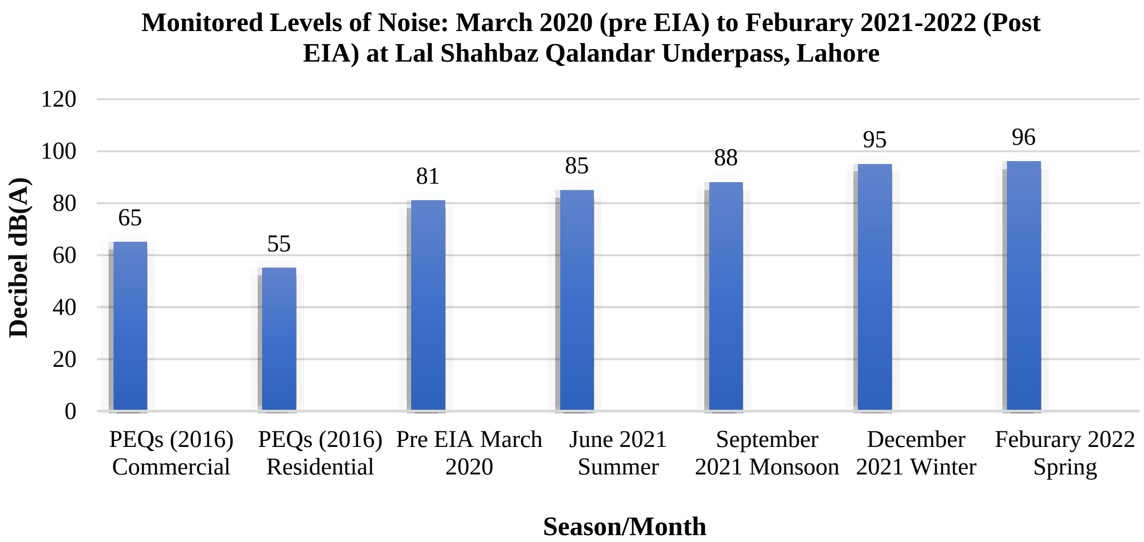

Fig 3. Monitored noise levels in four different seasons at Lal Shahbaz Qalandar Underpass, Lahore

4. Discussion

Road construction projects are particularly important since they provide social, economic, and political advantages to the country. Post-EIA is, therefore, a critical component in assessing the consequences of any developed project related to roads. A post-environmental impact assessment was conducted by measuring emissions of PM and CO and noise levels for the Lal Shahbaz Qalandar Underpass in Lahore, from by road traffic.

Before the construction of the underpass at Firdous market chowk, the values of PM_{10} and $PM_{2.5}$ were slightly higher than the limits of PEQS (2016). The higher values were due to high traffic flow and traffic congestion at the Firdous Market underpass. It was observed that during the summer season, CO emission was within the limits in both Pre/Post-EIA assessments. For southwest monsoon and winter seasons, CO emissions exceeded the limit during the Post-EIA phase (from 7.85 to 8.96 mg/m^3). However, CO emissions reduced a bit during the spring season during the Post-EIA phase. $PM_{2.5}$ emissions exceeded the normal range both during Pre/Post-EIA phases. In all seasons, their emissions were constantly been increasing (from 40-49 g/m^3) during the Pre-EIA phase. Similarly, PM_{10} emissions were also found to exceed from normal range both during Pre/Post-EIA phases. In all seasons, their emissions were constantly been increasing (from 152-160 g/m^3) Pre-EIA phase.

All noise levels exceeded the standards of PEQS (2016). In the Pre-EIA phase (2020), the noise level was 81 dB(A), whereas, during the Post-EIA phase, the noise level range was from 85-96 dB(A) with a maximum in spring (February 2022). A significant difference existed for CO measurements, between Pre-EIA (March 2020) and Post-EIA (June-September 2021 and February 2022) data. A significant difference existed for $PM_{2.5}$ and PM_{10} between Pre-EIA (March 2020) data with only December (2021) Post-EIA data. It is also observed that as winter approaches, the reported levels of air pollutants rise, which is the consequence of inversion in winter. Because pollutants are trapped in warmer, drier air throughout the summer and monsoon seasons and because air pollution drops abruptly in spring as the temperature rises, it is obvious to see how temperature affects air quality.

Yasin et al. (2017) presented the findings of a massive project of the Faisalabad flyover, which was under construction to reduce high traffic in the city, but unfortunately, the project had a negative environmental impact. A public poll was conducted at the site, and 49.1% of respondents believed that the level of dust rose after the flyover was built. 32.72% of respondents were concerned about the rise in noise pollution levels. According to the experts, the main cause of these issues is that EIA parameters were not fully evaluated and followed effectively. Following the Pre-EIA report, a brief period should be set apart to examine if the project's objectives have been accomplished, and if the findings are unacceptable, certain preventive measures should be adopted before the project starts.

Aurangzaib et al., (2020) studied the Kashmir underpass project in Faisalabad. The study examined how the project's components influence the environment. During the investigation, a questionnaire survey was conducted. Almost 93% of respondents were unfamiliar with the term EIA and its importance. Workers on the project were unsure whether or not the EIA for this underpass had been completed. The building of the underpass did not cause significant environmental deterioration, but it did increase dust particles, noise, and traffic loads, according to the project activities.

Marshall (2005) mentioned that the follow-up for environmental impact assessment is very necessary. Environmental impact assessment is not an option for developing countries. It is a precaution and protective measure to use against the system. It is very important to perform a survey, to ask stakeholders and to check the contribution of the construction and its impacts on the ecosystem. Follow-ups for EIA also represent the life cycle of highly budgeted projects. It also ensures development and encourages the integration of environmental purposes. Environmental impact assessment is a method for predicting the effects of any project before it is built and post-project analysis helps assess the accuracy of such predictions.

Del Furia and Wallace-Jones (2004) examined the public legislation and EIA processes that contribute the most to the improvement of EIA, as well as their actual execution. Ashraf et al., (2013) measured preliminary air quality at 19 distinct Lahore city locations near major traffic junctions for three months. The results were then compared to National Environmental Quality Standards (NEQS) for air quality and the US-EPA's National Ambient Air Quality Standards. For 24 hours, the concentration of $PM_{2.5}$ was greater than the limits recommended by NEQS and USEPA.

Rehman et al., (2007) completed an environmental impact assessment study on the Faisalabad-Pindi Bhattian Motorway M3. The study identified several practical methodologies utilized in the EIA of highway and road projects, from planning to construction and administration. According to EIA estimates, CO levels will surpass in 2027, SOX levels will exceed specified limits in 2012 and Suspended Particulate Matter (SPM) levels will exceed in 2017. Other emissions, such as NOx and HC (hydrocarbon), will continue to rise until the finalization of the project's design lifetime. Noise levels are not predicted to violate Pakistan's NEQS regulations, although they will most certainly exceed 75 dB(A) in 2010. The influence of traffic car emissions on plants and agriculture is regarded to be negligible.

Road traffic contributes to air and noise pollution in metropolitan areas, which has a detrimental influence on human health. Thus, quantifying exposure to road traffic air and noise pollution (hereinafter, air and noise pollution) is critical in epidemiological investigations to better knowledge of human health effects (Khan et al., 2018). The residents of Lahore are constantly and severely exposed to noise pollution from road traffic. According to (LDA, 2020) a report of Lahore Development Authority (LDA) and National Engineering Services Pakistan, it averages around 95dB +/- 5dB on a particular day. A significant portion of this noise has been generated by auto-rickshaws, which emit noise levels of roughly 100-110 dB. Traffic is one of the biggest sources of noise pollution in Lahore.

Several studies on the traffic noise level in Lahore have been conducted. Aftab et al., (2007) conducted road traffic noise research in Lahore in 2008 in 18 major sites with significant traffic flow during peak hours. The results revealed that the daytime average noise level in Lahore exceeded the statutory limit of 85 dB(A) at 90% of the busiest spots. The highest average decibel noise levels measured in Lahore were 104 dB(A). The high noise level was caused by vehicular activity, including autos/rickshaws with inadequate silencers and the frequent use of pressure horns by buses, wagons and trucks.

The fundamental cause of the significant increase in air pollution is the extensive sale of automobiles in Pakistan from March 2020 to February 2022 as reported by Pakistan Automotive Manufacturers Association (PAMA). This growth has the potential to gravely affect Lahore's built and natural environments. The pollution hazards are continually increasing due to a variety of environmental factors, one of which is the fast growth in automobiles and increased usage of low-quality gasoline. Emissions from automobiles contribute to excessive levels of air pollution in cities. According to a news source, air pollution is responsible for 153 million premature deaths worldwide, with Pakistan accounting for 11 million of them. At sustained CO concentrations of 150 to 200 ppm, disorientation, coma, and death are all possible (Crossley et al., 2021).

The second main cause of increased air pollution in the environment is the lack of ecologically efficient automobiles. Governments should introduce ecologically friendly automobiles. Environmentally friendly vehicles will have lower CO_2 emissions and noise pollution. The engine is the primary generator of noise in a road vehicle. Constant noise exposure causes a variety of health problems, such as high blood pressure, hearing loss/impairment, sleep disruption, insomnia and learning difficulties in children (Sørensen et al., 2020). Traffic congestion at the following junction, which is located in the cantonment district and follows the Lal Shahbaz Qalandar underpass, is one of the sources of high levels of traffic and noise. The best solution is to build another underpass/flyover at the next intersection to relieve traffic congestion and conflicts.

Unnecessary honking is extremely dangerous on the road because it clearly causes noise pollution and is also a major cause of anxiety in children and adults. Honking is also one of the leading causes of car accidents. The increase in the number of vehicles on the road is proportional to the increase in CO and other toxic levels of air pollution in the environmental system. This rise in automobile emissions contributes to global warming and ozone depletion.

According to Nailya et al., (2019), there is a lack of integration into the global logistic system, stages of post-project assessment, and mechanisms for optimizing transport and environmental risks of international corridors have yet to be developed, considering their impact on the development of the transit regions. There is a need for an overview of the phases of post-project evaluation and monitoring of international transport corridors, their environmental impact, what is required to confirm, assessment of the environmental impact of construction and effective mitigation. The sensitivity of climate change impacts caused by air pollution from automobile emissions should also be addressed in the post-EIA.

Studies concentrating on urban development in the sense of post-EIA principles allow enhancing projections within the EIA process and learning more about how to achieve more sustainable development. The findings of Zítkova et al. (2022) revealed that the predictions and findings about chosen EIA assessment criteria were correct during the building phase and the first year of use of the residential complex. Agah et al., (2021) investigated the environmental parameters in pre and post monsoons at the Chabahar Bay, Gulf of Oman. As a result, environmental impact evaluations and monitoring can alert to potential climate change implications as well.

5. Conclusions

The current case study highlighted the need of doing Post-EIA analysis to identify constructed underpasses as an environmental concern and raise awareness about controlling noxious gases and particle matter to mitigate air pollution. At the Lal Shahbaz Qalandar underpass, during the Post-EIA era, CO emissions surpassed the limit during the southwest monsoon and winter seasons. $PM^{2.5}$ emissions surpassed the normal level both before and after the EIA. In all seasons, their emissions increased steadily as compared to the Pre-EIA period. PM_{10} emissions were likewise determined to be above the usual level during both the Pre-and Post-EIA stages. In all seasons, their emissions increased steadily as compared to the pre-EIA period. All noise levels surpassed PEQS regulations during the post-EIA phase, with a peak in spring.

The following are the primary sources of rising air pollution and noise levels even after the completion of a megaproject of this underpass: poor quality car fuel, unnecessary honking, increased automobile sales, new car manufacturers in Pakistan, very little use of greenest vehicles, very few public transportation options near the Lal Shahbaz Qalandar underpass, no ban on vehicles without catalytic converters and no vehicle rules and regulations.

To alleviate traffic congestion and conflicts, the ideal answer is to construct another underpass/flyover at the next intersection. To lessen the hazards of the urban environment, studies on the post-environmental effect of road, underpass, flyover and bridge construction are urgently needed. More environmental factors should be measured to provide more thorough reporting. The key shortcomings should also be addressed in EIA processes. To protect the environment and comply with existing environmental regulations, mitigation activities should focus on physical data analysis. In addition, an environmental protection plan should be created, which included environmental training, emergency response, environmental reporting, inspection, analysis and environmental monitoring, to ensure successful environmental management throughout the project's lifespan.

6. References

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