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Estimate of the Noise Pollution and the Amount of Air Pollutants with Simulation of Road Traffic Volume

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Abstract

Noise pollution does not have a clearly specified definition but refers to a class of sounds that disrupt human activities and natural order and structure. The most obvious noise pollution problem is resulting from road traffic. Air pollution caused by transportation vehicles has adverse effects on all traffic users and city dwellers. The extent of noise pollution and the levels of the two dangerous pollutants carbon monoxide and nitrogen oxides resulting from fuel combustion in vehicles are predicted by measuring noise produced by vehicles and through simulating their movements using SIDRA Simulation. The results are compared with those specified in environmental standards and strategies are suggested to reduce noise and air pollution in the study area.

Keywords: Noise pollution, Traffic, Air, Simulation, Standard.

Introduction

Uncontrolled population growth together with industrial and technological development of metropolises cause numerous problems for the urban population one of the most important of which is environmental pollution. Noise pollution is one of the most important environmental pollutants and causes a substantial part of these problems in large cities. Noise and air pollution have a direct relationship with industrial technologies. In most industrial countries, the problem of noise and air pollution is considered as one of the most important environmental issues and is even given special attention in metropolis building management and in internal architecture of health-treatment, educational and research, residential, and business centers. Research has revealed that the hustle and bustle and worries of living like machines lead to physical and mental problems for the citizens of metropolises, with the physical, mental, and psychological damages resulting from traffic noises far greater than damages caused by other sources. European researchers studied more than 50000 residents of cities and found that a ten-decibel rise in street noises increases the chances of a stroke in all age groups by 14 percent. Research has shown a relationship between traffic noises and high blood pressure and heart attacks. Their studies show that traffic noise exposure also increases the risk of stroke. Moreover, noise acts as a stress-causing agent that disrupts sleep.

As for air pollution, pollutants within the sites of housing projects whose sources are outside of the buildings are mostly organic and inorganic gases produced by fuel combustion in vehicles and electrical installations near the buildings, or by airborne particles produced in construction activities in the area, and by other sources. In other words, air quality outside of buildings directly affects pollutants inside buildings. Studies on assessing adverse effects of road traffic, which are reviewed in this research, are one of various kinds of studies related to the sections of urban and transportation planning.

Noise generation sources

Noise is unwanted sound, allowing sound to interrupt the conversation, or cause pain, as well as the convenience of living activities impede the environment. Nowadays the noise has become a problem for many people. Noise sources can be produced by transportation, such as vehicles, airplanes, trains. Noise can cause deafness, also can affect a person's mental health, such as stress or tension. If the tension of the soul cannot be resolved then further impact is declining physical health

Noise measuring

Noise measuring was done for a week with using of sound level meter and in four points in two times of day (morning and evening). Noise is measured in units of decibels. The measuring device can be seen in Figure 1.

Figure 1: Example of noise

A sound level meter was used to measure noises. Considering the purpose of this research, this instrument was set in A-weighted sound level and Fast mode, and sound parameters included the maximum A-weighted noise level, the minimum A-weighted noise level; and the noises were measured and monitored for 15 minutes at each station.

Sources of air pollution in the external environment and estimating the quantity of the pollutants

The main sources of external pollutants in the project area were air pollutants resulting from vehicle traffic in routes around the study area. Determination of the quantities of the pollutants became possible by using some software programs and through simulating the existing conditions. To do this, the quantities of produced pollutants were estimated by determining the characteristics of the study area and by taking field samples of traffic volume for the duration of one hour. The quantities of the produced CO, NO_X pollutants were then determined by using the simulation program.

Methods

In this research, sampling was carried out using a map of the study area that was located on Didar Street and the intersection of Africa and Haqqani highways known as the Jahan-e Koodak crossroads and had a level crossing with traffic lights. At this crossroads, all incoming routes were allowed to turn right or go straight through but left turns were possible only for incoming routes of the Africa Highway intersection. Figure 2 shows the study area at this crossroads.

Figure 2: Map location

Considering what was said above, this study area was considered for investigating traffic changes and for estimating the levels of noise and air pollution. A preferred location for measuring noise pollution is observed in Figure 3.

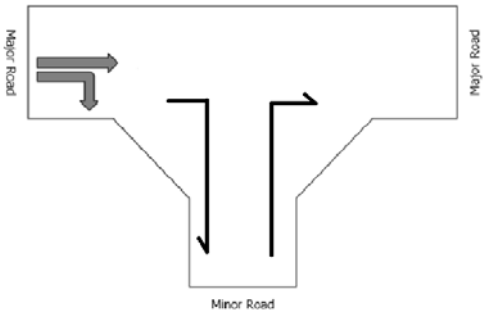

Figure 3: Simulation of the study area for estimating the level of environmental pollution

Characteristics of the study route

First, the study route had four lanes but since vehicles (light vehicles, motorcycles, buses, trucks, and tow cars) were parked on the rightmost lane, normally only three lanes could be used.

Second, the studied forked road had flickering traffic lights and so vehicles would not make complete stops. In the project, air pollution caused by an ordinary vehicle driving at 60 kilometers per hour was estimated.

Determination of the volume of traffic passing the study area and demand for changes in the current status

It is necessary to determine the current traffic volumes in order to study the level of pollution. Therefore, taking field samples of the volumes of traffic of all kinds of vehicles passing the study area was put on the agenda.

Field sampling plan

Measuring traffic volume, and collecting information regarding it, is a simple matter in any place: counting the number of vehicles passing a specific cross section of the study area during a specific period. This information may be classified based on the type of vehicles, the traffic lanes, turning movements, etc. Therefore, in recording the information, sufficient care must be exercised and the following steps must be taken into account:

Determining the suitable place and time of making the measurements

Organizing field operations

Designing and selecting the suitable method for recording information

Selecting suitable methods of analysis and of preparation of information to be used in extracting results

Presentation of the data in a specific and suitable way for analysis

Two methods are available for conducting traffic volume counts: (1) manual and (2) automatic. Manual counts are typically used to gather data for determination of vehicle classification, turning movements, direction of travel, pedestrian movements, or vehicle occupancy. Automatic counts are typically used to gather data for determination of vehicle hourly patterns, daily or seasonal variations and growth trends, or annual traffic estimates. In this study, manual method is used. Using the sample worksheet can be seen in Figure 4 that the traffic volume information obtained.

Count the Volume of Vehicles

Time Data Recording: Sampling Location:

From: Until:

Bicycle & Motorcycle		Car	Taxi & Van		Pickup		Bus & Minibus		Heavy vehicles	Other

Figure 4: Worksheet for the measuring traffic volume

Results of field sampling with regard to the volume of each Arc/Link

After carrying out field sampling, the first extractable information was the determination of the peak morning and evening hours in the study area and the determination of the volume of vehicles in each arc/link of the study area. In this section of the report, the way the peak hours were determined and the traffic volume in each street were presented.

Determination of peak hours

The peak hour volume is the volume of traffic that uses the approach, lane, or lane group in question during the hour of the day that observes the highest traffic volumes for that intersection. For example, rush hour might be the peak hour for certain interstate acceleration ramps. The peak hour volume would be the volume of passenger car units that used the ramps during rush hour. Notice the conversion to passenger car units. The peak hour volume is normally given in terms of passenger car units, since changing turning all vehicles into passenger car units makes these volume calculations more representative of what is actually going on. The volumes of counted vehicles in the arcs/links of the network had to be first converted into passenger car equivalents. The coefficients of passenger car equivalents for all types of vehicles are presented in Table 1. According to this table, each bus passing the study area was equivalent to 5 passenger cars and each two-wheeled vehicle equivalent to 0.3 passenger car with respect to their effects on the traffic characteristics of the streets.

Table 1: Coefficients for each of the types of passenger vehicles

Coefficients	vehicle	
0.3	Motorbikes	1
1	Car	2
1.5	Taxi	3
1	Pickup	4
5	Bus	5
3	Heavy vehicles	6

Using the mentioned coefficients of passenger car equivalents, and employing the volumes of different kinds of counted vehicles in every 15 minutes, we could calculate the traffic rates in all of the routes for every 15 minutes. As was mentioned in the previous section, the peak intervals were 8-9 in the morning and 4:30-5:30 in the evening. In these intervals, traffic rates in the field samples taken in the set of arcs/links were higher compared to other intervals.

Data Analysis and Results

Considering the amount of traffic, measuring noise in the desired location and Sidra traffic simulation program for air pollution, results can be calculated as it is evident table 1.

Noise evaluation using valid standards

Taking various types of applications into consideration, Iran's Environmental Protection Organization has defined two outdoor noise standards, one for the day and the other for the night. Standards for noise in open area is shown in table 3.

Table 2: Results of the measuring for noise pollution and air pollutants

(mg/m^3) NOX	(mg/m^3) CO	Maximum noise level dB-	Minimum noise level - dB	Traffic volume pcu		Location
				Peak in evening	Peak in morning	
0.76	0.74	79.8	62.4	1689	1446	Didar Street South to North of Haghani Expressway
0.57	0.7	84.6	62.7	1170	1295	Didar Street South of Haghani Expressway
0.78	0.67	87.4	64.8	1659	1559	Didar Street North of Haghani Expressway
0.64	0.68	87.6	64.5	1295	1457	Didar Street North to South of Haghani Expressway

Table 3: Standard for noise values

Night (10pm-7am) Unit in decibels	Day (7am-10pm) Unit in decibels	Type of region
45	55	Residential
50	60	Residential - commercial
55	65	commercial
60	70	Residential-industry
65	75	industry

Comparison of results obtained from the traffic simulation program for air pollution with the standards

Using the Sidra program and collected traffic information from the study area, the quantities of air pollutants were estimated. After uniformization of units and taking into account that the fuel used in Iran for vehicles was Euro 3 (or Euro 4 at best), output results of the software were listed in Table 4 and compared with European Union standards. It was found that the quantities of air pollutants in the study area exceeded the European Union standards. Therefore, since it is almost impossible to control pollution resulting from vehicle traffic, necessary steps must be taken when designing and constructing buildings in order to protect people and buildings against external pollutants.

Table 4: Emission standard in Europe for passenger vehicles

Particulate	NO_x	CO	Effective date	Emission levels
0.05	0.5	0.64	2000/1	EURO 3
0.025	0.25	0.5	2005/1	EURO 4

Permitted noise levels

Noise pollution has destructive effects on human health. The most recognized one of these effects is the physical damage inflicted on the hearing system, and one of the most important ones is reduced lifetime. Therefore, sound insulation and use of sound insulators and suitable isolators in buildings are necessary for having a desirable sound level, for reducing noise pollution, and for preventing bothersome noises exceeding 55 decibels from entering buildings. Sound insulators are very efficient in absorbing and decreasing noise and, if suitably designed and installed, can reduce sound to a desired level. The reduction in sound energy passing through insulators depends on

various parameters. Various insulator materials will tangibly enhance this reduction (especially at low frequencies) if they are thicker or if suitable air gap is allowed behind them. Substances such as rock wool, polystyrene sponge, etc. reduce sound passing through constituents of structures, or absorb sound on their surfaces, and thus decrease sound transfer (that is, reduce sound energy when it passes through walls, floors, roofs, etc.), and are thus very good sound insulators for buildings. It is possible to prevent noise levels from increasing in buildings by using these materials.

Conclusion

Comparison of the obtained results indicates that noise level in the study area is higher than the standard. More attention must be paid to the following points to prevent or reduce noise pollution caused by vehicles:

Use of suitable insulators on those sides of buildings that are close to Haqqani Highway and to traffic flow

Correct traffic signal timing at the intersection and at the forked road

Use of plant cover and suitable green spaces in building construction to reduce noise pollution.

Use of transportation and traffic studies as an important factor in vehicle traffic in the study area (In this relation, it is possible to develop a project for improving traffic flow and to regulate movements of vehicles in the study area).

Using the estimated noise pollution by using examples of places and people that are in the scope is appropriate for planning.

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