Noise Pollution Assessment and Control in Selected Schools in Baghdad City

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Abstract:-

Healthy school environment is one of the main determinants of students' health in order to strengthen the benefit from the educational programs. In this study, assessment of noise pollution level in six schools in Baghdad was conducted. The schools were selected to cover different ages and grades (girls, boys, mixed, primary, secondary and intermediate schools). Measurements were taken inside and outside the school; in classrooms, schoolyards; during classes and break time, and in the first and second floor of each school. The measurements were conducted using a digital sound level meter connected to the personal computer to obtain measurement data of sound pressure level (SPL), and the data were analyzed to obtain A-weighted Equivalent Sound Pressure Level L_{Aeq} for each location with the background. The results showed that the noise level at all the six schools do not comply with international standards. Noise pollution sources are either external (streetcars, industrial areas, shops, electric generators) or internal due to the large noise arises from the interaction of the students with their teachers and the noise during break time. Theoretical adjustment of the school fence was adopted to reduce the noise levels inside the schools. Calculations showed that barriers could be used to reduce noise level by more than 50% in two of the six schools by increasing their fence with only one meter, while other schools did not show improvement. The main reason behind that is the noise level arises from inside the schools was higher than that transferring to the schools from external sources. This call for changes in the design of the schools and in the education methodologies.

Key Word: Noise pollution, Sound pressure level, A-Weighted SPL, schools

1. Introduction

Noise defines as "undesired or disagreeable sound" or other disturbance. From the acoustics view, noise and sound consist of the similar phenomenon of atmospheric pressure fluctuation about the mean atmospheric pressure. What is considered a sound by somebody can be considered a noise by another person **[5**]. Noise is with no doubt a normal phenomenon of life and is derived to be one of the most efficient alarm systems in human's physical environment. However, it is continuously disturbing human peace and tranquility **[9].** Noise pollution can cause annoyance, hypertension, aggression and high stress levels. High noise level causes cardiovascular effects and exposure to moderately high level during a period of eight hours causes rise in blood pressure and increase in stress and vasoconstriction **[4].**

Noise pollution can be seen as an endemic part of the modern urban and industrial world. Noise, is an important physical environmental factor plays a critical role in student health and academic performance **[11].** The American Academy of Pediatrics defines a "healthful school environment" as "one that protects students and staff against immediate injury or disease and promotes prevention activities and attitudes against known risk factors that might lead to future disease or disability" **[1].** Therefore, the school environment encompasses the social, physical and biological factors. Moreover, as learning in classrooms is mainly facilitated through verbal and auditory communication between teachers and students, good quality school buildings are required. Students' perception of the school environment, either indoors or outdoors, is directly related to their satisfaction with those environments, and student satisfaction promotes more active behavior **[2].** It has been found that noise has harmful effect on student's attention **[8]**.

Noise control in school environment is a vital inquiry in public health. There has been a great deal of research in the past 30 years in the effects of noise on student's learning and performance at school **[10].**

The main objectives of this study are:

1. Evaluating the noise levels in six schools in Baghdad for different student's ages and stages.
2. Analyzing the data measured in these schools.
3. Suggesting simple solution for the schools that exposed to noise pollution.

2.Methodology and Experimental Procedure

2.1 Site Location and Description

Six schools were selected at different locations in Baghdad in Al-Karkh Aluolaa District: Al-Hariri Primary

school (mixed), Al-Yarmook Secondary school for girls, Al-Nidhal Secondary school for girls , Al-Maamon Intermediate school for boys, Bab Al-seif Primary school for girls and Al-Karar Intermediate school for boys. The selection of these schools was determined because they are exposed to different kinds of noise levels as illustrated below:

1- Al-Hariri school is located in residential area and there is an electrical generator beside the school.
2- Al-Yarmook school is located between a residential area and a main street and there is a mosque beside the school.
3- Al-Nidhal and Al-Maamon Schools are located on a main street and exposed to traffic noise.
4- Bab Al-Seif School is located in a commercial area in Al-Alawy region, where there are shops, restaurants, and metal workshops in front of the school and there is a big generator nearby the school.
5- Al-Karar School is located in an industrial area near carpenter's workshops in Al-Salihia region.

Fig. (1) shows the location of these six schools and Table (1) summarizes their information. As a preliminary conclusion, it is clear that all the schools contain large number of students in each class, and the area of these classes are considerably small.

Fig. 1. Map for study area (Baghdad) with locations for the six selected schools (from Google earth)

Table 1. Schools geographical location and information

	School Name	Location		Number of classrooms	Number of students
		Latitude	Longitude		
1	Al-Hariri Primary School	33°17'47.16" N	44°20'57.73"E	17	650
2	Al-Yarmook Secondary School	33°17'59.56" N	44°20'43.26"E	14	293
3	Al-Nidhal Secondary School	33°18'1.79"N	44°21'21.07"E	11	368
4	Al-Maamon Intermediate School	33°18'13.61" N	44°20'25.74"E	15	650
5	Bab Al-Seif Primary School	33°19'51.25" N	44°23'15.45"E	10	450
6	Al-Karar Intermediate School	33°19'45.58" N	44°23'19.31"E	6	285

2.2 Data Collection

Data collection took place in a period extending from December 2013 to April 2014 (5 months). It was carried out in classrooms, schoolyards, and outside the selected schools during the morning study hours between 8 a.m. and 1 p.m.

The sound pressure level (SPL) measurements were taken every 20 seconds for 10 minutes for indoor measurements and 15 minutes for outdoor measurements **[6].**

The measurements were conducted by using a Sound Pressure Level meter model: SL-4112 from Lutron Electronic Enterprise Co. (Taiwan) with an accuracy of 0.1dB. SPL meter was connected to a computer using a program called Lutron801 as shown in Fig. 2, where all the data saved in the meter can be exported as an Excel workbooks. Fig. 3 shows the SPL meter setup used in this work.

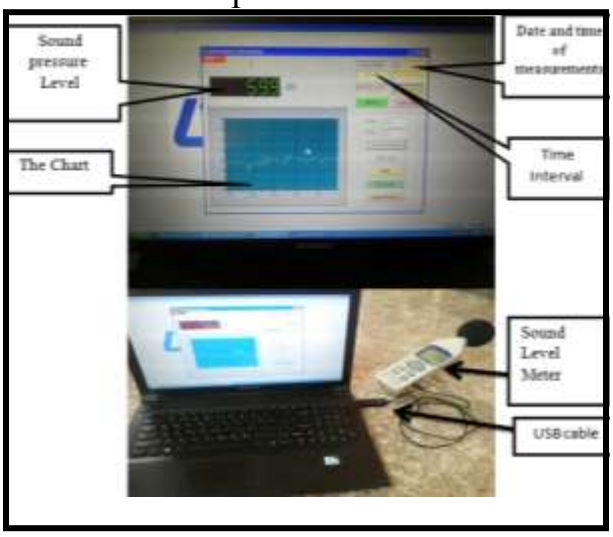

Fig 2. Sound Level Meter connected to Laptop by Lutron program

Fig 3. Sound Level Meter in the work field

2.3 Noise attenuation

The noise level inside the schools were measure and calculated using international procedure **[3]**. Equivalent A weighted sound pressure level, in relation to a fluctuating sound pressure level, was calculated as follows**: [12]**.

$$L_{Aeq} = 10 \log_{10} \left[\frac{t_1 \, 10^{\frac{L_1}{10}}}{T} + \frac{t_2 \, 10^{\frac{L_2}{10}}}{T} + \cdots + \frac{t_n \, 10^{\frac{L_n}{10}}}{T} \right]$$

Where:
L_{Aeq} = A weighted equivalent sound pressure level. (dB.A)
L =sound pressure level dB.
t= time interval for L_1, L_2,…, L_n.
T= total time interval for L_{Aeq}.

A weighted sound pressure level was then compared with World Health Organization WHO **[11]** for further adjustment and control.
Noise attenuation model described in the ISO6913-2 **[7]** was then considered to calculate the effect of increasing the height of the fence of the school (as a barrier) on the noise level inside the school. The following effects were taken into consideration in the calculations:

1- Sound propagation in the atmosphere
2- Geometrical divergence
3- Atmospheric absorption
4- Ground interaction and reflection, and
5- Obstructions and barriers effects.

An algorithm was built using Excel that took into consideration the above mentioned effect using their mathematical model description from the ISO6913-2, and the results were projected on the schools area using contour lines.

3. RESULTS AND DISCUSSION

3.1 Noise Pollution Assessment inside the six schools

The measured total equivalent A-weighted sound pressure level ($L_{Aeq.total}$) for the six schools, indoor and outdoor, with the measured background levels are shown in Table-2.

Table 2. Total Equivalent A weighted Sound Pressure Level ($L_{Aeq.total}$) for indoor, outdoor, and background of the six schools

School Name	In-door $L_{Aeq.total}$ (dB.A)	Out-door $L_{Aeq.total}$ (dB.A)	Indoor back-ground $L_{Aeq.total}$ (dB.A)	Outdoor back-ground $L_{Aeq.total}$ (dB.A)
Al-Hariri School	79	79	57	68
Al-Yarmook School	75	67	51	56
Al–Nidhal School	73	70	58	67
Al-Maamon School	80	81	56	69
Bab-Al-Seif School	81	81	54	73
Al-Karar School	78	81	56	68

The comparison between $L_{Aeq.\ total}$ for indoor, outdoor and background with the WHO Standards are shown in Fig.s 4 and 5, were the guideline sound pressure level inside schools are (35-40) dB.A for indoor and (45-50) dB.A for outdoor. These Fig.s show clearly that all the six schools are not in compliance with the International Standards, and hence the environment of these schools is considered noisy.

The analysis of the noise levels for each school showed that noise level in schools for boys is greater than those for girls. In addition, noise level in primary schools is greater than the noise level in intermediate and secondary schools.

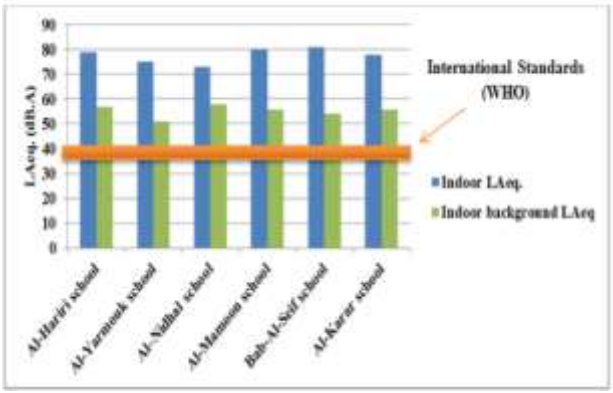

Fig 4. Indoor L_{Aeq} for six schools with their background and international standard

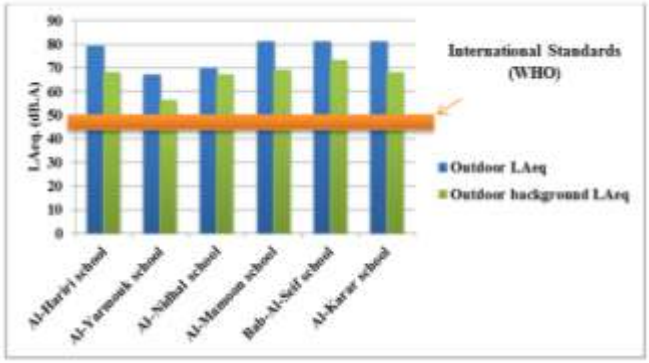

Fig 5. Outdoor L_{Aeq} for six schools with their background and international standard

3.2 Noise Reduction inside schools

This section describes the noise reduction from external sources by theoretically changing the height of the school fence (a barrier that reflects the sound wave from the school). Reasonable fence height will affect mainly schoolyards and classrooms in the first floor only.

Through calculations were employed for each of the six schools. A point at the schoolyard was selected as

recipient point. The noise level at this point due to the effect of the external point source was calculated, and the effect of other sound sources from inside the schools was calculated by subtracting the calculated value from the measured average value.

The same calculation was repeated to calculate the noise level at the same point after changing the school fence height (adding 1 meter to the height), and adding the effect of inside sources.

Results showed that the attenuation of noise pressure level using barriers could be useful to two out of the six schools (Al-Yarmook and Al-Maamon).

The results are shown in Fig.s 6 and 7 for Al-Yarmook school before and after changing the fence height respectively. Comparing these Fig.s showed that there was a significant noise level reduction (54%). This reduction was enough to make the noise level inside the school in comply with the international standard.

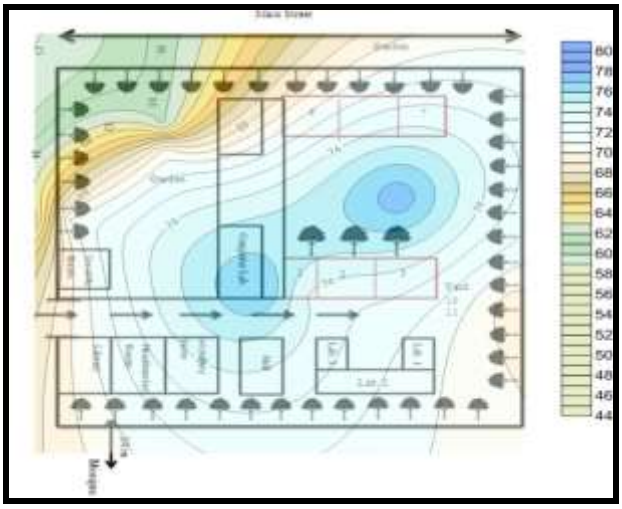

Fig 6. Average L_{Aeq} of five months for Al-Yarmook School

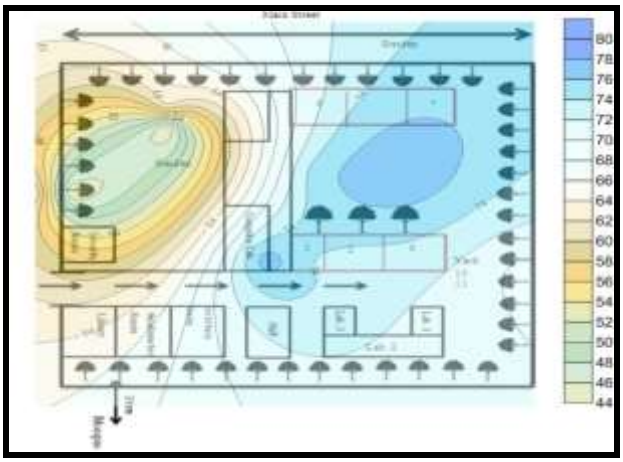

Fig. 7. Average L_{Aeq} of five month for Al-Yarmook School after changing school fence elevation.

Similarly Fig.s 8 and 9 shows the same information for Al-Maamon School, and by comparing these Fig.s, it can be shown that there is a significant reduction in the noise level (51%). Nevertheless, the outdoor noise level inside the school after increasing the fence height is still higher than the international standard

level because of the elevated noise level arises from inside the school.

Other schools were not affected by the reduction level of the noise obtained after changing the fence height. This result calls for changes inside the schools in two main field; the first is the infrastructure and architecture of the schools design and the second is the methodologies adopted in teaching lessons to the students.

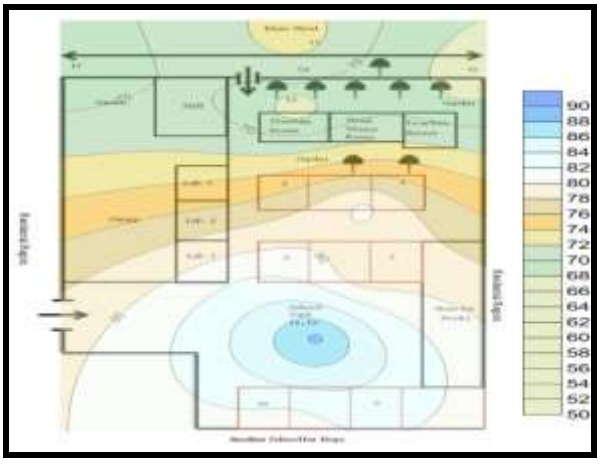

Fig. 8. Average L_{Aeq} of five months for Al-Mamoon School

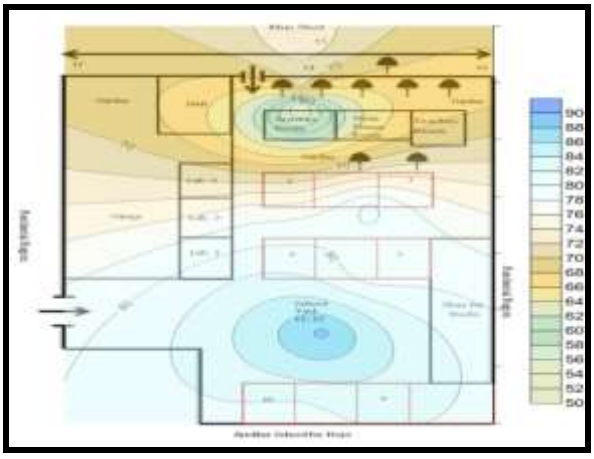

Fig. 9. Average L_{Aeq} of five month for Al-Mamoon School after changing school fence elevation

4. CONCLUSION

From the previous analysis, the following conclusions can be highlighted:

1. All the schools have higher noise level than that recommended by the national standards.
2. Noise level in schools for boys is greater than those in schools for girls.
3. Noise level in primary schools is greater than the noise level in intermediate and secondary schools.
4. Teaching methodology and the interaction of students with their teachers often contribute in raising the noise levels inside the classrooms.
4. Industrial areas, generators and markets near the schools have a significant contribution in

increasing the noise level inside them.

5. The large number of students and the small area of the classrooms contributed in increasing the noise level in schools.

5. REFERENCES

[1] American Academy of Pediatrics, 1993, "Committee on School Health", School Health Policy and Practice, Fifth Edition.

[2] Fjörtoft, I., Sageie, J., 2000, "The natural environment as a playground for children: Landscape description and analyses of a natural landscape", Landscape and Urban Planning, 48(1): 83–97.

[3] International Standard (ISO6913-2), 1996, "Acoustics _ attenuation of sound during propagation outdoors", part2, ISO6913-2:1996(E).

[4] Ising, H., and Kruppa B., 2004, "Health Effects caused by Noise: Evidence in the Literature from the

Past 25 Years", Noise Health, 22: 5-13.

[5] Lawrence, K., Wang, and Norman, C., Pereira, and Yung-Tse, Hung , 2005, "Advanced Air and Noise pollution Control", Humana Press ,New Jersey USA, volume 2.

[6] Noise measurement procedures manual, 2008, 2nd Edition, Environment Division, Department of Environment, Parks, Heritage and the Arts, Australia.

[7] Piercy, J.E., Embleton, T., and Sutherland L., 1977,"Review of noise propagation in the atmosphere", JASA 61(6), June, Pp. 1403-1418.

[8] Romero, J., Lliso, D.,1995, "Perception and acoustic conditions in secondary Spanish schools", Proceedings of the 15th Int., Congress on Acoustics, Trondheim, Norway, Pp. 271-274.

[9] Spence, D ., 2003, "Pollution, noise pollution and toxic torts", Environmental Law Lecture 7 delivered at the Law Society, Earlsfort Centre, Dublin.

[10] Shield, B., Dockrell, J.,2003, "The effect of the noise on children at school: a review ", J. Building Acoustics, 10(2): 97-106.

[11] WHO ,1990, "Indoor environment - health aspects of air quality, thermal environment, light and noise, Geneva, World Health Organization. http://libdoc.who.int/hq/1990/WHO_EHE_RUD_90.2.pdf

[12] WSH,Workplace Safety and Health Act, 2011,chapter 354A, Workplace Safety and Health, noise regulations.

تقييم التلوث الضوضائي ومحاولة السيطرة عليه في مدارس مختارة في مدينة بغداد

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الخلاصة :-

تعتبر البيئة الصحية للمدارس واحدة من متطلبات صحة التلاميذ من اجل الاستفادة من البرامج التعليمية. اشتملت هذه الدراسة على تقييم مستوى تلوث الضوضاء في ستة مدارس في بغداد. اختيرت المدارس لتغطية مختلف المراحل الدراسية والعمرية (أولاد وبنات ومختلط، ابتدائية ومتوسطة وإعدادية). أخذت القياسات في عدة أماكن داخل وخارج المدرسة، وداخل القاعات الدراسية، وفي ساحة المدرسة (وقت الاستراحة ووقت الدراسة)، في الطابق الأول والطابق الثاني لكل مدرسة. أخذت القياسات بواسطة جهاز رقمي يدعى مقياس مستوى الصوت مربوط بواسطة جهاز حاسوب للحصول على معدل مستوى ضغط الصوت (SPL). حللت البيانات المقاسة للحصول على مستوى ضغط الصوت المكافئ L_{Aeq} لكل موقع مع الخلفية. أظهرت النتائج بأن جميع المدارس المختارة لا تمتثل للمحددات المحلية أو العالمية. مصادر الضوضاء كانت إما خارجية مثل (السيارات والمناطق الصناعية والسواق ومولدات الكهرباء) أو مصادر داخلية ترجع إلى الارتفاع الكبير في مستوى الضوضاء بسبب طريقة التعليم وتفاعل الطلاب مع أساتذتهم. في محاولة لتقليل مصادر الضوضاء الخارجية لغرض تقليل تأثيرها داخل المدرسة تم احتساب استخدام حواجز (زيادة ارتفاع جدار المدرسة). أظهرت الحسابات إمكانية استخدام الحواجز لتقليل مستوى الضوضاء لإثنين من المدارس الستة بواسطة رفع جدار المدارس متر واحد ليقل مستوى الضوضاء بأكثر من 50٪. المدارس الأخرى لم تتأثر بارتفاع الجدار، والسبب الرئيسي وراء ذلك أن مستوى الضوضاء الصادر من داخل المدارس اعلى من مستوى الضوضاء المنتقل إليها من الخارج مما يتطلب إجراءات تصميمة وإجرائية فيما يخص طريقة التعليم.