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Noise Measurements in Residential Areas in North A' Sharqiyah Region -Oman

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Abstract: Noise pollution has become a serious problem nowadays due to the industrial development and urbanization. Noise level, in particular, is exceeding being an environmental issue to being a health problem for people. This study investigated the noise levels in residential areas, schools and hotels in North A' Sharqiyah region in Oman. The area covered by the study is around 20 km^2 which includes more than 200 houses, 13 schools and nine hotels. Fourteen different zones have been selected within this area to measure the noise levels. Using a sound level meter (S/N:2019023967) with a 30 to 130 dB measuring range and 1.5 dB accuracy, noise levels were measured. Around 90% of the collected data in the housing area at the city center was higher than the Omani standards (60 dB) and with an exposure time of 10 hours per day. In contrast, the housing areas outside the city center, only 5% of the measured noise was higher than the standards. In schools, it was found that the noise inside the schools is higher than the standards of indoor buildings noise. Furthermore, it was observed that the schools were built in quiet locations where the noise outside the schools met the standards. 70 % of the noise that was measured during the morning assembly in schools was higher than the standards. In hotels, it was found that the noise levels depend on the location of the hotel. The hotels located outside the city center or commercial area were found to be quiet and the noise levels within standards. In contrast, the others which locate in the city center have high noise levels.

Keywords: Sound Noise Level, Sound Level Meter, Decibel (dB)

I. Introduction

Noise pollution is one of the environmental pollutions which is increasing rapidly nowadays. Industrial noise in particular is exceeding being an environmental issue to be a health issue for workers. For example, depression, hypertension, high-stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects[1–7]. There are different sources of sound noise, such as road traffics[8–11], industrial areas[12–18], and machines [19–22]. The normal accepted level of sound noise is around 60 dB (decibel), according to the World Health Organization (WHO)[23]. Several studies have investigated noise pollution in urban areas, including in residential areas, schools, universities [24–32] and prayer places like mosques [33]. A.R. Seroji's measured sound noise in Mina during Hajj Season in 2008, where he performed at four camps distributed at different sites in the Mina area (Beginning of Mina - Middle of Mina - Streets area - Al-Jamarat area). Results show that the measured equivalent noise levels per 8 hours at these four camps were ranging between 64 - 78 dB day and night, which is exceeding the recommended noise levels by WHO [34]. Other studies have covered hotels and other rest places by noise studies[31,32,35,36] and other studies have examined the noise at hospitals and found that the main sources of noise in hospitals are road traffics and cooling machines[37–40].

To the best of our knowledge, there is no scientific studies have been done to determine the level of noise either in industrial areas or in the closest urban area in Oman. Thus, we have been motivated to investigate the noise level in some areas in Oman. Only one scientific study measured the noise level in Muscat city in 1999 done by Al-Harthy and Tamura[41]. Their results revealed that road traffics are the main source of sound noise in Muscat city, which is increasing incredibly nowadays. In addition, they found that the average level of sound noise was (70 dB), which is beyond Omani standards (65 dB)[42].

Due to the shortage of studies on noise pollution in Oman, our team focused on studying noise pollution in certain areas like residential areas, schools and hotels. As urban and industrial areas rapidly expand, noise levels need to be maintained at an acceptable level. A sound noise level that is acceptable for human health should also be determined as well as the main sources of noise. According to our expectation, some residential areas, schools, and hotels in North A' Sharqiyah region are affected by noise pollution. Testing noise levels help us identify the trends and take action to reduce noise pollution based on the data collected.

II. Methods

Within the scope of the study, the noise measurements were done using a sound level meter (S/N:2019023967) with a measuring range of (30 to 130 dB) and an accuracy of 1.5 dB. The device has a software that should be installed on a computer. The device should be connected to the computer for measurements, as shown in Figure (1).

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Figure (1): The sound noise meter that is used in this study.

At the end of the measurements, data were downloaded to the computer with the help of the utility software packed with the device, and the noise spectrum of each set of measurements was obtained, as shown in Figure (2).

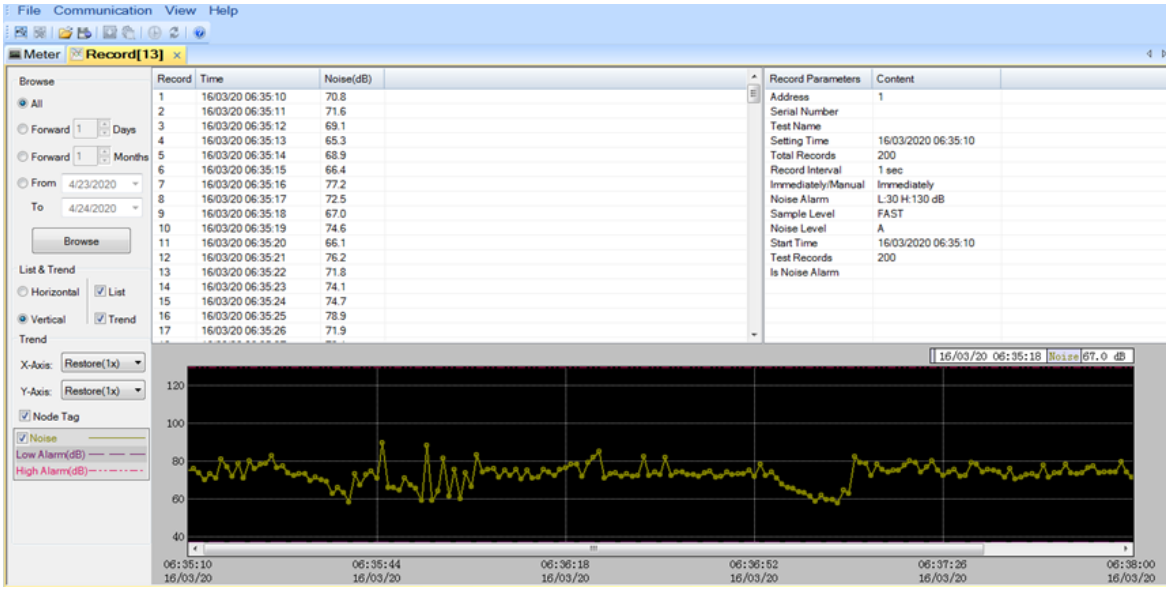

Figure (2): The noise spectrum was obtained as the output of noise measurements.

III. Results and Discussion:

The noise level measurements were carried out at different locations such as residential areas, schools and hotels. During each sampling of noise, 200 readings of noise were recorded at an interval of 1 second in a period of 3 minutes and 30 minutes. The minimum, average and maximum noise levels were recorded and analyzed. The results were compared with Omani standards, which were approved by the Omani authority.

I-Residential area:

The residential area or home zones where the people live is one crucial area to evaluate the noise level at. Therefore, this study has covered around 14 positions between people's homes. The measurements were taken for 200 s at each position at one-second intervals.

Figure (3) shows that the Google map of the area was covered by noise investigation.

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Figure (3): Google map of the covered area by noise measurements in Ibra

The maximum, minimum and average of the data were collected in housing zones at different positions in Ibra are classified in Table 1.

Table (1). Level of noise measurements for different positions(in dB).

No.of position	Minimum(dB)	Maximum(dB)	Average (200 readings)(dB)
1	47.8	80.4	58.2
2	49.6	91.2	68.9
3	56.7	95.8	66.0
4	45.2	66.6	58.8
5	44.7	70.1	56.5
6	46.7	79.6	57.9
7	48.5	70.1	55.5
8	43.9	62.7	45.6
9	43.9	83.8	48.0
10	49.1	80.9	58.5
11	46.5	80.2	56.9
12	48.8	79.2	57.8
13	47.1	73.9	52.0
14	44.2	71.3	47.6

According to the measurements listed in Table (1), the minimum measured noise levels were found to be between 40 and 56.7 dB, while the maximum was between 62.7 and 95.8 dB. It was found that the noise in the residential area depends on the location from the main traffic roads or the city center, which have higher noise sources. For example, position no. 3, is a noisy housing place, due to its location in the center of Ibra, which is a is commercial area. Figure (4) shows the Google map of position 3.

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Figure (4): Google map of housing position no.3.

Wherase, position no.8 is a quiet housing location. It is around 3 Km away from the main road and the center. Figure(5) shows position no.8,

Figure (5): Google map of housing position no.8.

Furthermore, 85% of the maximum noise values measured in residential areas have exceeded 60 dB. According to Omani Environmental Regulations, the expected noise level in Urban residential is between 55 and 60 dB. Therefore, the calculated noise measurements were analyzed at each position for values greater than 60 dB. The results were plotted as a bar graph in Figure (6). It is clear from the graph that some positions with 90% of collected data are greater than 60 dB, like positions 2 and 3, located in the city center of Ibra.

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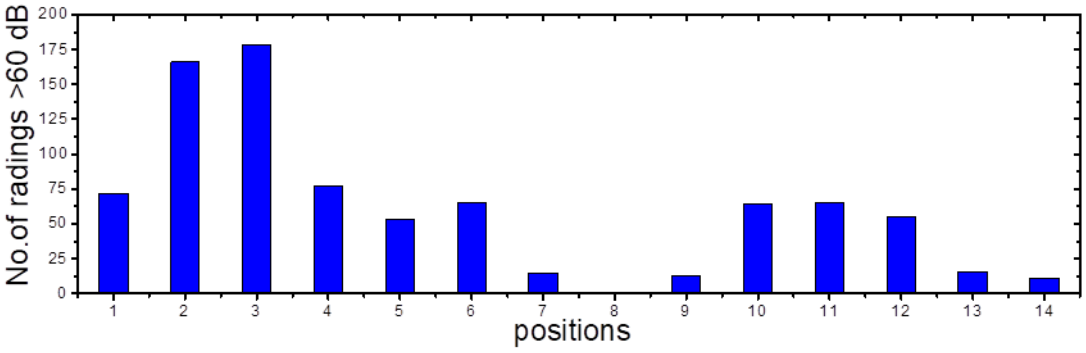

Figure (6): The histogram of the noise level readings higher than the standard value at different positions.

On the other hand, the positions no.8, 13 and 14 have only 5% of the readings greater than 60 dB. Collecting high noise levels led us to calculate the exposure time during the daytime (12 hours). It was found that people living, for example, in positions 2 and 3, receive high levels of noise for around 10 hours out of 12 hours, which is sigfincantlty harmful to their health. However, in a quiet position like position no.8, people only receive high levels of noise for around 3 minutes. Table (2) includes the exposure time during the day at different positions.

Table (2). The exposure time of high noise levels at different residential positions.

Position	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
exposure time per day (hours)	4	9	10	5	3	4	0.9	0.06	0.78	3.8	3.9	3	0.96	0.66

ii-Schools:

The residential area noise levels measurements led us to measure the noise levels at schools. Many studies around the world have focused on the noise effects on student's school learning. Thus, we conducted this study at schools from inside and outside. The sampled schools (13 schools) in Ibra, the measurements were conducted at the center of each school to collect 200 readings every 1 second. It was found that the minimum value was between 48.8 dB and 60.8 dB. In comparison, the averages are between 56.8 dB and 75.4 dB. In contrast, the maximum values reached between 74 dB and 97 dB. All this data shows that the noise inside the schools is high, exceeding the standard value (55 dB), and mainly comimg from teachers and students shouting. Figure (8) Shows the bar graph of sound level at each school (minimum, average and maximum).

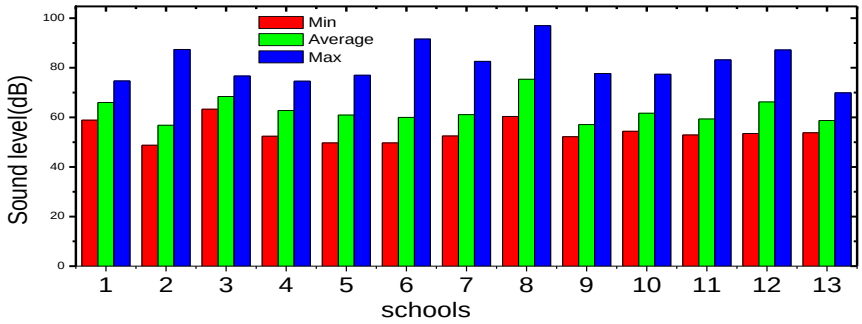

Figure (8): Noise levels inside the schools (minimum, average and maximum).

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The results inside the schools show a high level of noise, encouraging us to take measurements outside in the front of the sampled schools, to compare the outdoor with the indoor. The results outside were found to be that the minimum ranged between 44.3 dB and 48.7 dB. While the average is between 46.1dB and 57.9 dB, and the maximum is between 59.7dB and 79.8 dB. Figure(9) Illustrates the bar graph of noise levels outside schools.

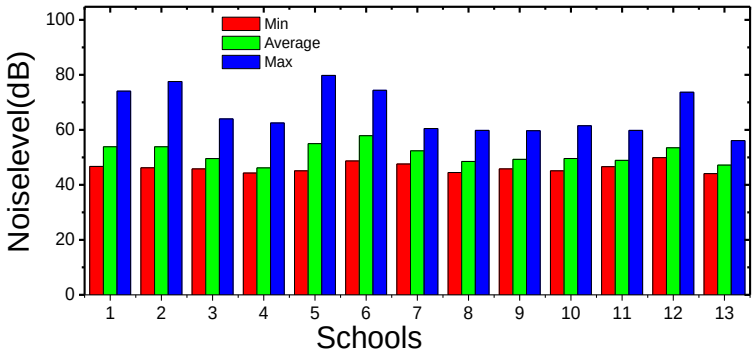

Figure (9): Noise levels outside the schools (minimum, average and maximum).

Comparing the inside average noise results with the outside shows that the noise level inside the schools is higher than outside, as shown in Figure (10). This means the noise inside the school comes from the school itself. Noting that the school's locations are relatively quiet places.

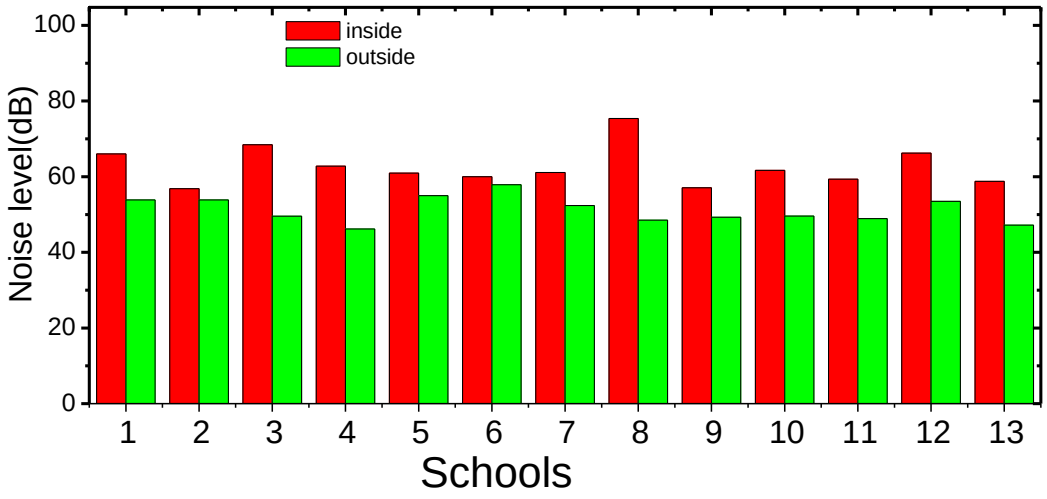

Figure (10): The average noise levels inside and outside the schools.

Furthermore, the noise during student morning assembly has been measured for four schools in a period of 800s. The noise level was analyzed to compare it with the expected level (55dB). It was found that 65% of 800 readings collected during morning assembly are higher than the normal level, as shown in Figure (11). This means the students have received a high level of noise during the morning assembly for an average of 15 minutes as exposure time per day. Therefore, students have received high levels of noise for around 6 hours per month, which might affect their health.

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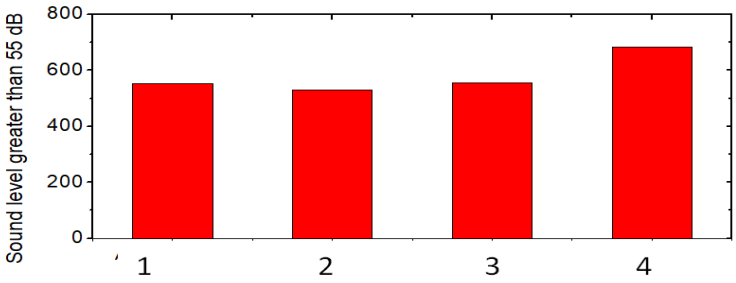

Figure (11): The histogram of the noise readings higher than the standard level during the morning assembly in four schools.

For more specification, the number of noise readings was classified as in the Table

Table (3). The noise readings were collected during the morning assembly, classified every 10 dB.

School	>90 dB	80-90 dB	70-80 dB	60-70 dB	50-60 dB	<50 dB
1	56	195	174	128	188	69
2	56	195	174	128	188	69
3	57	194	174	128	188	69
4	57	194	174	127	187	70
persentage	6.8%	24%	21.7%	16%	23.5%	8.6%

Table (3) notes that in the four schools, the highest percentage of noise in morning assembly is between 80 and 90 dB and between 70 and 80 dB. This noise might affect student health negatively.

iii. Hotels:

Noise is acknowledged to be the top reason for guest complaints in Hotels. Therefore, in this study,nine hotels were included to evaluate the noise inside and outside them in the North A' Sharqiyah region.

The noise measurements were taken for 200 seconds with an interval of one second inside the hotel and another 200 seconds outside the hotel. Figure(12) shows the bar graph of noise level for minimum, Average and maximum noise values inside the hotels. The measurements were taken at the reception area of the hotel. It was found that the average noise values were between 47.2 dB and 53.9 dB, which is higher than the expected values, where it was expected to be between (40-45 dB). In addition, the maximum noise values were observed to be varies between 60.8 and 78.5 dB, while the minimum was between 44.7 and 54 dB. It was found that the main noise sources inside the hotel came from the people's conversation, cleaning machines and the outside noise like traffic.

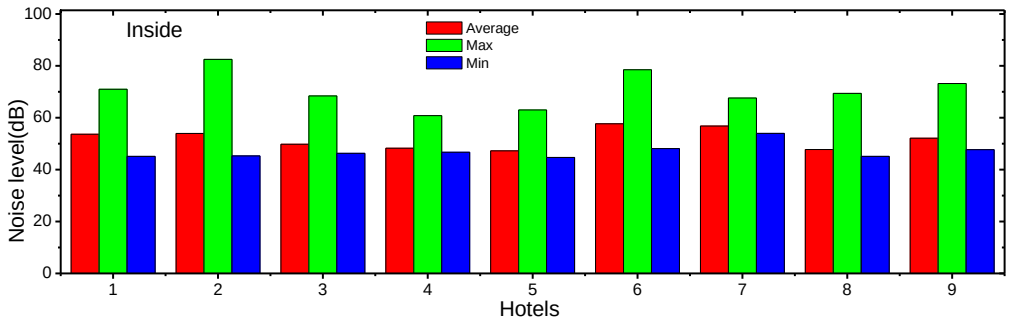

Figure (12): Noise levels inside hotels.

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To compare the noise level inside the hotels with outside noise, measurements of noise were done near the main hotel gate. The outside noise was analyzed to maximum, average and minimum values. The results were plotted as a bar graph in Figure (13).

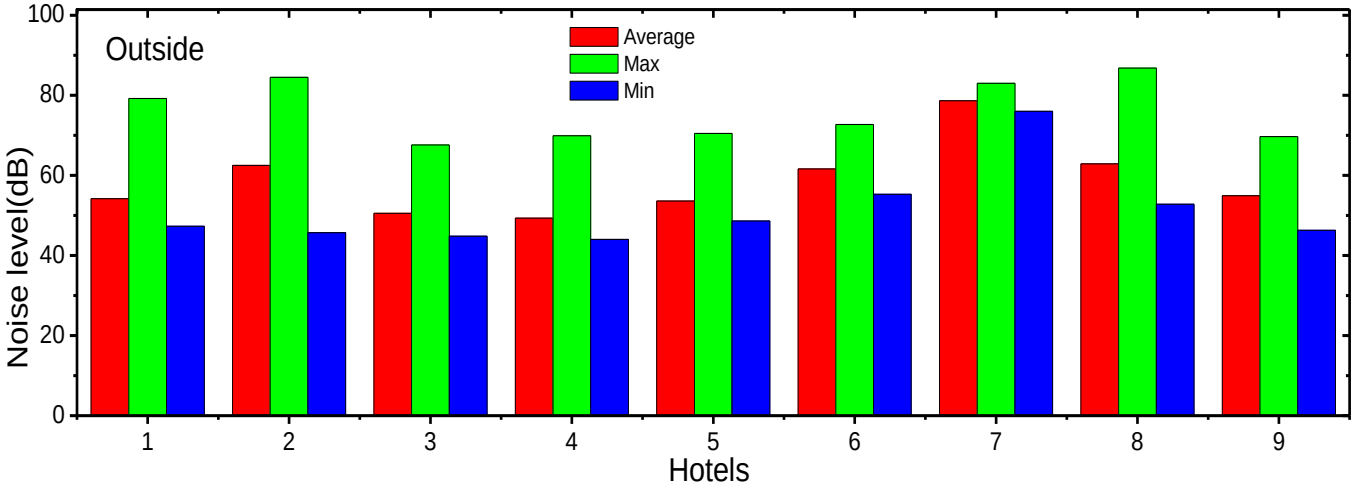

Figure (13): Noise levels outside hotels.

It was observed that in some hotel locations, the noise average up to 78.7 dB, like hotel number 7, located in the Ibra industrial area. The same high noise was found at hotel locations in commercial places. For example, hotel number 6 and hotel number 8 have an average noise level of 61.6 and 62.9 dB, respectively.

In contrast, in some hotels located in quiet positions outside the city center, such as hotel number 3 and hotel number 4, located outside the Ibra center, the noise in their locations was found to be 50.5 and 49.3 dB, respectively.

Figure (14) shows the comparison between the average noise outside and inside the hotel. The graph shows clearly that the outside noise is higher than the inside. Besides that, the outside noise contributes to raise the inside noise.

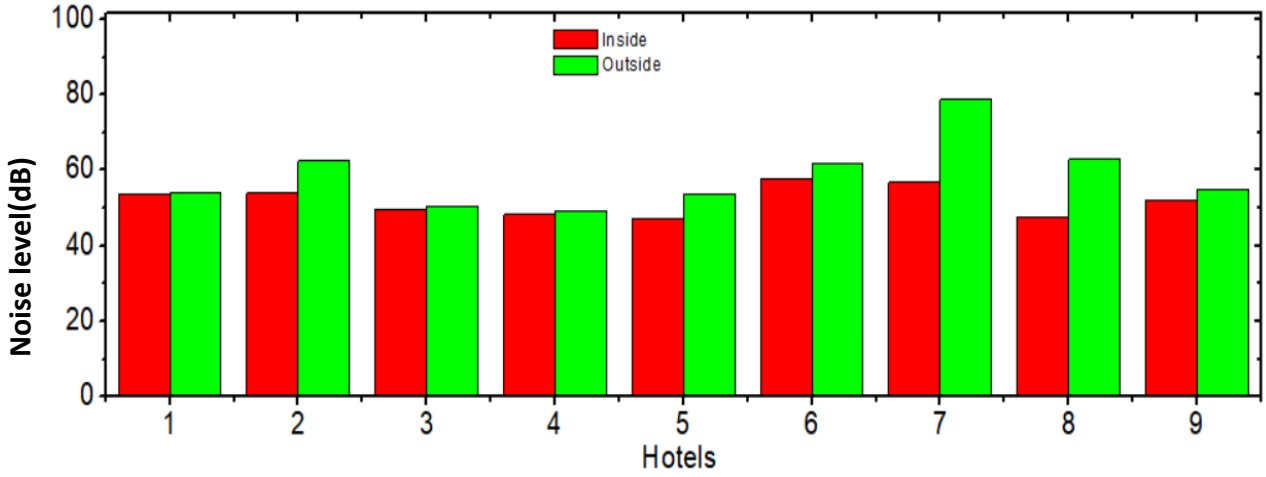

Figure (14): The average noise levels inside and outside the hotels.

Figure (38) shows the line graph of collected data (noise level versus time) (a) illustrates the flat line of collected data in a quiet hotel (number 4), and it overlaps with outside noise. However, Figure (b) shows noise versus places of the hotels and clearly shows a large difference between inside and outside noise (hotel number 7).

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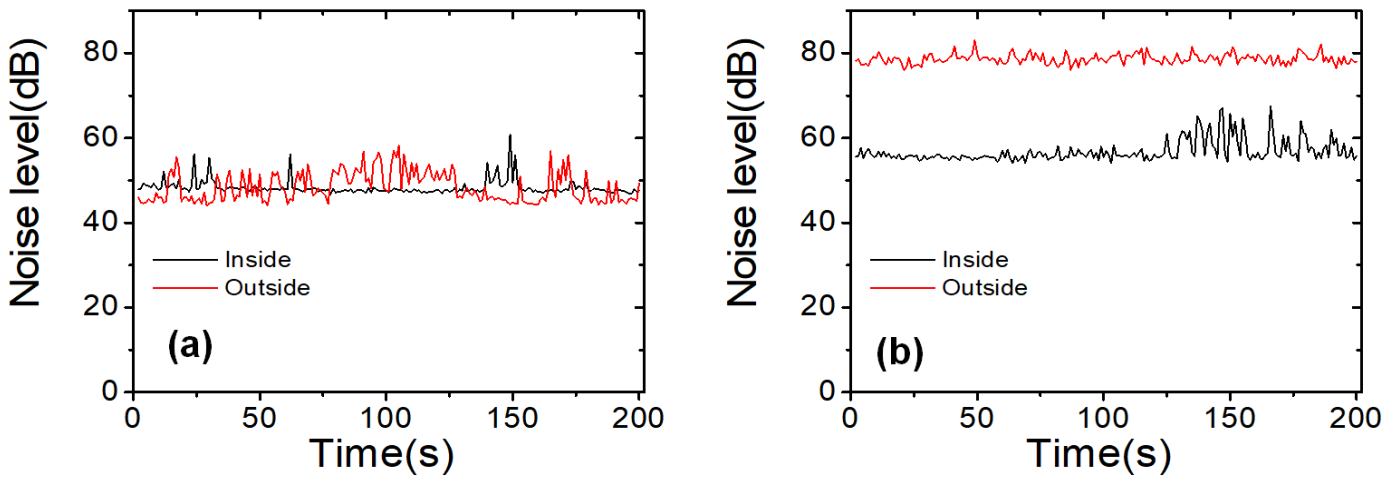

Figure (15): (a) The line graph of noise level inside and outside of (a) a quite hotel and (b) noisy hotel

IV. Conclusion

In summary, the noise level in North A' Sharqiyah region in residential areas, schools and hotels was measured and investigated. The results show that the housing at city center is noisy and noise levels exceeds the Omani standards. The main sources of the noise at residential areas are the main roads and people activities. In contrast, the residential areas outside the center y are more quiet places. It was observed that the noise levels inside the schools range between 56.8 and 75.4 dB exceeding the standard levels of 55 dB. However, the noise levels outside the schools were between 46.1dB and 57.9 dB, which meet with Omani standards, the schools were built in quiet places. Furthermore, 70% of the data of noise levels were collected during the morning assembly are greater than the standards.

The noise levels investigation in hotels found that the noise levels inside the hotels depend on their locations. Some of them are in quiet areas with a noise level that is agreed with the standards, while those hotels in the city center have a higher noise level than the standards.

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