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

Mohammed Al Bahri*, Thuraya Al-Harthy, Khalid Al Hashmi and Ibrahim Al Rishidi

Department of Basic Sciences, A'Sharqiyah University, Post Box 42, PC 400, Ibra, Oman.

**Corresponding author*

Abstract: **Noise pollution has become a serious problem nowadays due to industrial development and Urbanization. Industrial noise in particular is exceeding being an environmental issue to be a health issue for workers. In this study, we investigated the noise levels in industrial areas in Oman, specifically the largest industrial area in North A' Sharqiyah region. This study has been conducted in Ibra industrial area, in which the area covered for the study is around 3 km^2 which includes more than 200 workshops. Twenty-one different zones have been selected within this area to measure the noise levels. The noise levels were measured using the sound level meter (S/N:2019023967) with a measuring range of (30 to 130 dB) and an accuracy of 1.5 dB. The measurements have been conducted in two time intervals and on different days during the week. The primary sources of noise have been identified to be from workshops. The results have been compared to the Omani standards issued by the Ministry of Environment and Climate Affairs and it was found that the industrial area had higher levels of noise and it is beyond the Oman standard norms. The average exposure time of high noise has been calculated during working hours to be 3 hours per day.**

Keywords**: Sound Noise Level, Industrial Area, 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[12–17], and machines [18–21]. The normal accepted level of sound noise is around 60 dB (decibel), according to the World Health Organization (WHO)[22]. Several studies have investigated the noise pollution in urban areas, including in residentialareas, schools, universities [23–29] and prayer places like mosques [30]. Furthermore, A.R. Seroji's sound noise in Mina during Hajj Season in 2008 and these measurements were performed at four camps distributed at different sites in the Mina area (Beginning of Mina - Middle of Mina - Streets area - Al-Jamarat area). Results showed 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 [31]. Other studies have covered hotels and other rest places by noise studies[32–35] 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[36–39].

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[40]. Their results revealed that road traffics are the main source of sound noise in Muscat city, that 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)[41].

The shortage of studies on the sound noise pollution in Oman led our team to focus on studying the noise pollution in some areas. Due to the rapid increase of urban and industrial areas, there is an urgent need to maintain an acceptable level of noise. It's also important to determine the main sources and the level of sound noise acceptable for human's health. Based on our expectation that the industrial areas have different workshops that contribute to increase the noise pollution. So industrial areas, specifically in North A' Sharqiyah region, will be under investigation for measuring the noise level.

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 software that should be installed on a computer. The device should be connected to the computer taking measurements, as shown in Figure (1).

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

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

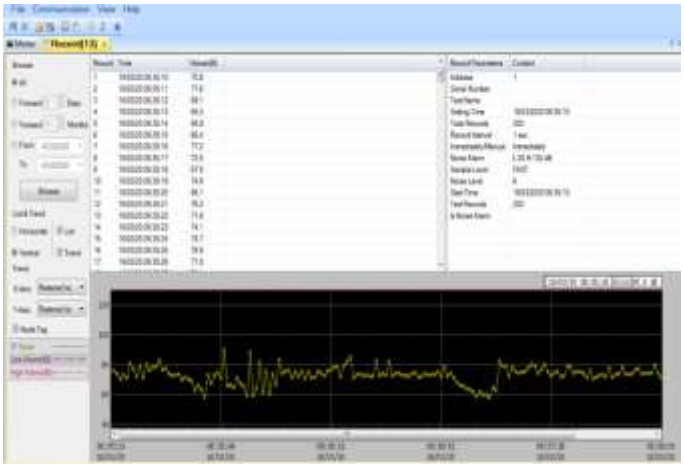

Figure (2): The noise spectrum was obtained as the output of noise measurements.

III. RESULTS AND DISCUSSION:

The measurement of sound pressure level was carried out at different times during the day with the help of a sound level meter. 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 Ministry of Environment and Climate Affairs.

The primary sources of noise in the industrial area in North A' Sharqiyah in Ibra were listed in Table 1 in which the data were collected inside the workshops or outside close to the noise source.

Table (1): The noise levels coming from different sources in the industrial area.

Source	Aluminum workshop	Steel workshop	Wood workshop	Block making factory	Vehicles	Drilling workshop
Average giving noise level (dB)	100-120	85-112	90-94	100-105	82-90	76-106

From the results, it is clear that all the workshops in the industrial area contribute to high levels of noise, which exceeded the normal level (70 dB)[41].

To investigate the levels of noise in industrial area environment, an enclosed area inside the industrial area in Ibra was chosen, which is expected to have higher levels of noise in this area. Twenty-one different positions were selected for the measurements, which were taken for 200 seconds and a 1-second interval at each position. Figure (3) shows the enclosed area where measurements were collected.

Figure (3): The enclosed area for measurements inside the industrial area in Ibra with the twenty positions.

The measurements were taken three times in the morning and another three times in the afternoon for one week. The bar graph in Figure (5) shows the 21 positions of measurements with the minimum, average and maximum values of noise levels in the morning time. For all positions, it was found that the minimum is between 44.7 and 54.4 dB, the average values were between 50.7 and 70 dB, and the maximum values were between 75 dB and 100 dB. Moreover, noise levels greater than 70 dB were collected at each position.

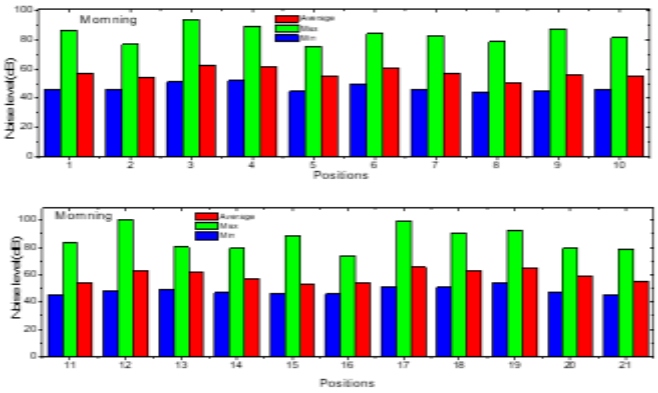

Figure (4): Bar graph for 21 different positions of noise measurements in the morning period.

On the other hand, the same measurements were repeated at the same positions in the afternoon, and the results were analyzed to find the minimum, average and maximum values. Figure (5) shows the values of minimum, average and maximum at the same positions in the afternoon. The maximum values range between 76.6 and 102.7 dB, slightly higher than the levels of the morning period; this might be the result of the increase in the number of operating workshops. The average value was found between 57.7 and 77.8, while the minimum value was between 45.7 and 54.7.

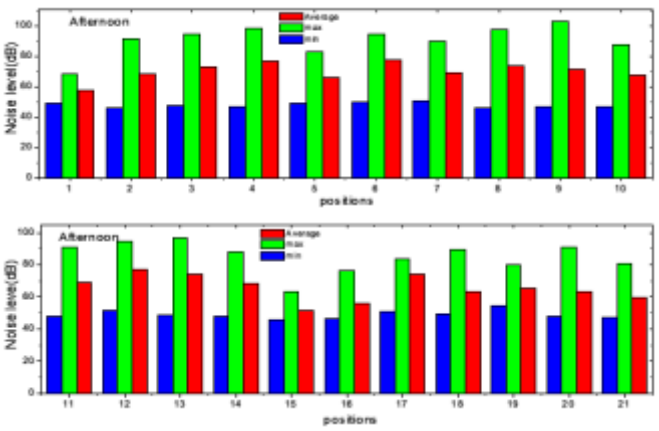

Figure (5): Bar graph for 21 different positions in the afternoon period.

The trend of noise level over time as collected by sound noise level is shown in Figure (6) for two positions as an example. Figure (6) (a) shows the two line graphs of position number 8 in the morning and afternoon, and Figure (6) (b) shows the graphs of point 17. In both graphs, the noise in the afternoon period is higher than the noise measured in the morning. This supports our results that the maximum and average values for the afternoon are higher than in the morning.

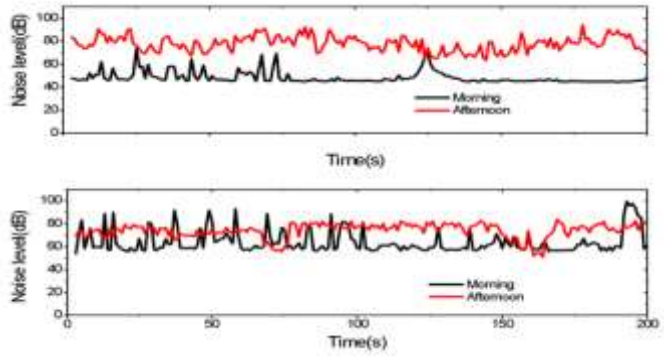

Figure (6): line graph of noise levels versus time at two positions (a) number 8 and (b) number 17.

Based on the aforementioned results, it is clear that high noise levels were collected at all the twenty-one positions, whether in the morning or afternoon. From that, we can conclude that the noise levels are high. It was observed that the noise levels exceeded the prescribed levels as given by the Ministry of Environment and Climate Affairs. Therefore, it seemed important to investigate the noise exposure time in this area. Herein, during each sampling of noise, 2000 readings of noise were recorded at an interval of 1 second for 30 minutes (2000 seconds). These measurements were taken at 8 different positions within the industrial area in Ibra. These positions are listed as (A,B,C,D,E,G and H). As an example, Figure (7) shows the noise level versus time for 2000 s at the A and B and C positions.

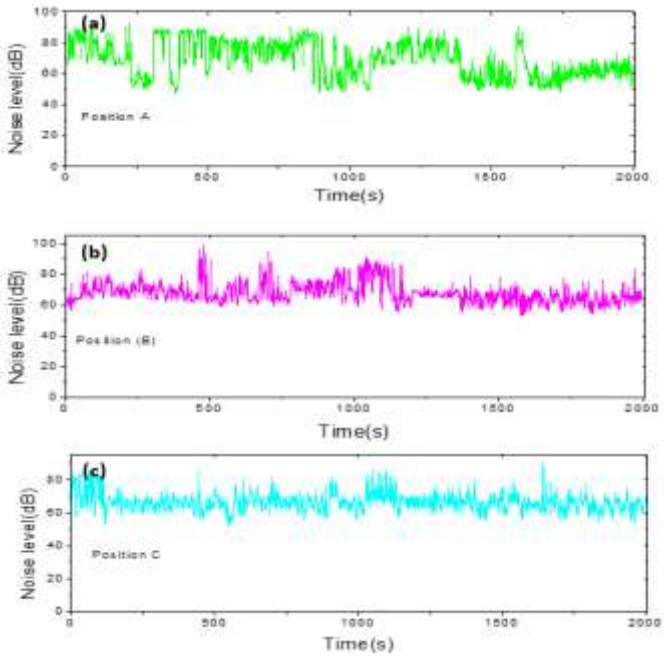

Figure (7): line graphs of noise levels versus time at three positions.

It is noted from the line graphs in Figure (8), that all the positions are noisy. Furthermore, some of these positions have fluctuating noise when the noise suddenly goes up like a pulse. Also, from these line graphs, it was observed that the noise was high and exceeded the normal noise level. Thus, the number of readings higher than 70 dB were counted at each position. For example, at position F, more than 1072 readings out of 2000 readings with sound levels higher than the standards as set by the Ministry of Environment and Claimant Affairs. Figure (8) shows the number of reading out of 2000 readings that are greater than 70 dB at the eight positions.

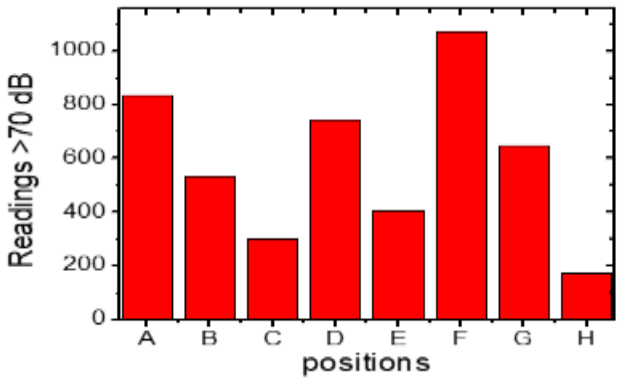

Figure (8): Number of readings greater than 70 dB at different positions.

The accounting of the readings greater than 70 dB, leads us to calculate the high noise exposure time at each position. We estimate that during working hours (around 8 hours per day), workers in this area will be exposed to high-level noise for around 5 hours during the day. Simple calculations have been done to estimate the exposure time of high level noise.

$$\text{High noise percentage at this position} = \frac{\text{number of readings} > 70dB}{\text{Total collected data}} = \frac{1702}{2000} = 54\%$$

At this position, 54% of 8 working hours is around 4 hours. Therefore, the people at this position are estimated to be exposed to high noise for 4 hours. The same calculations were done for the rest.

Table 2 shows the exposure time of high-level noise at different positions during eight working hours.

Table (2). The exposure time at the eight positions per day in hours

Position	A	B	C	D	E	F	G	H
exposure time per day(hours)	4	2.5	1.5	3.5	2	5	3	1

The average exposure time the person might get is around 3 hours per day in the industrial area, which might cause harmful effects on people's health[42].

While collecting data in the industrial area, it was observed that rest places like coffee shops and restaurants are located wall to wall with workshops. Therefore, around 15 measurements were done inside different coffee shops. Figure (9) shows the noise levels at the coffee shops in the industrial area. It is noted that the maximum value of the noise level is between 73.7 and 95.5 dB, which is greater than typical values, so the locations of the coffee shops are not allocated at optimal locations.

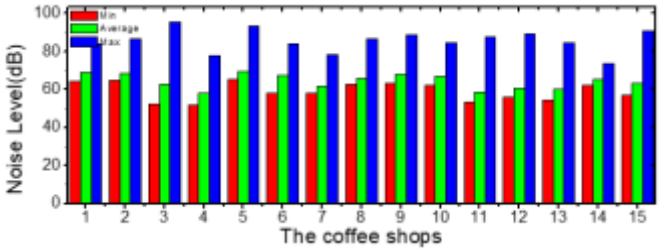

Figure (9): Bar graph of noise level (minimum, average and maximum) at 15 coffee shops in the Ibra industrial area.

Moreover, from the line graph, we observed that the sound levels rising suddenly as pluses, which is more annoying to people at these rest positions. Figure (10) shows the line graph of noise level versus time at two coffee shops

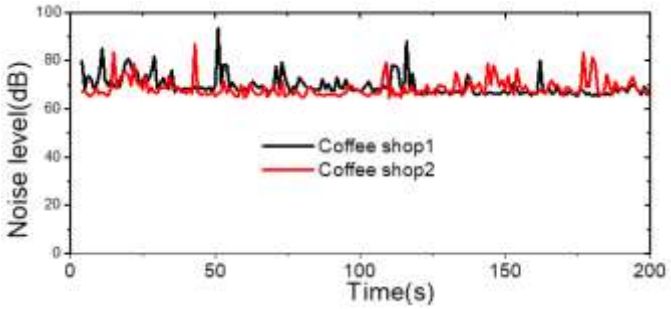

Figure (10): The line graph of noise level at two coffee shops.

IV. CONCLUSION

In summary, the noise level in North A' Sharqiyah region in industrial areas was measured and investigated. The main source of the noise was the machines' sound that found to be in workshops. These machines contribute to raising the noise in industrial areas to be high and beyond the accepted level base on Omani standards. The sound levels were high during both the morning or afternoon time. Furthermore, the exposure time rate of high noise was high and harmful to workers in some position areas. The workers at different workshops and factories in the industrial areas misconduct the proper precautions, for example by not wearing ear protection while working. In addition, the rest places inside industrial areas are located close to the workshops. Thus, in a nutshell, in order to reduce the noise pollution in the industrial areas, it is recommended to build workshops with soundproof insulation walls so the sound does not snike out to the surrounding environment. On the other hand, the rest places like coffee shops and restaurants should be built away from workshops.

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