Classroom Indoor Air Quality Monitoring at Politeknik Bagan Datuk

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Abstract

The purpose of this study is to investigate the air quality of the classroom in Politeknik Bagan Datuk in relation to risk of covid 19 virus spreading. There are two (2) classrooms that are Bilik Studio and Bilik Kuliah 1, one (1) Makmal Komputer has been used during the investigation period of three (3) months from October until December 2022. A device is built using Arduino and sensors to measure and monitor the air quality data from 9.00 AM to 4.00 PM for randomly selected three (3) days. The student's occupation in the investigation area ranges from 14 students to 24 students for each class. The results show that the overall reading of the CO2 emission is in the range of 530 ppm – 723 ppm, the noise level ranged reading from 40 – 68 dB, dust particle is range from 9.2 -56.2μg/m^3, humidity ranged from 25-62 % and the temperature of classroom is between 21-27 ^{o}C. In conclusions, the findings show that the air quality in the classrooms is in acceptable range in accordance to Malaysia Code of Practice to prevent the risk of post Covid 19 virus spreading. However, the suspended dust particulate can contribute to spreading of Covid 19 virus because of the dust particles level exceeding 35 μg/m^3 for Makmal Komputer as recommended by New Malaysia Ambient Air Quality Standard (NMAAQS).

Keywords: TVET, Topic Modeling, LDA, Coherence

INTRODUCTION

Indoor air quality (IAQ) is measured with humidity meters and temperature and CO2 sensors to ensure standards for human comfort indoors. Although human comfort depends on an interaction of multiple variables, optimizing relative humidity, temperature and CO2 by measuring indoor air quality (IAQ) satisfies the comfort requirements for a wider variety of occupants than optimizing only temperature (Sadick & Issa, 2017). Classrooms can be contaminated by various indoor pollutants, such as allergens, particles, volatile organic compounds etc. Indoor air pollution can lead to long-term and short-term health problems for students and staff but also can lead to decreasing productivity (DOE, 2020; Kamaruddin et al. 2015). The main purpose is to develop a self-build, cheap and combine of few indoor air quality devices as one (1) device for user friendly use. The objective of this project is to build an Indoor Air Quality (IAQ) to monitor the air quality in the classroom and laboratory in the campus.

LITERATURE REVIEW

Afrina et al., 2023 conducted IAQ investigation on two school at northern region of Malaysia that is SK Seri Perlis and SK Putra. The study involved the selected parameters such as respirable particulates (PM10), total volatile organic compound (TVOC), formaldehyde (CH2O), carbon monoxide (CO), ozone (O3), temperature, relative humidity and velocity were measured for two months period for 8 hours basis. The results show SK Perlis air pollution is much higher than SK Putra due to location near to roadside.

Kwong et al., 2019 reported air contaminants in the laboratories and mechanical workshops causes sick building syndrome (SBS) allergies such as dry eyes, dry throat, itchy skin, tiredness and watery eyes due to higher indoor air particles (IAPs) in air-conditioned laboratories and fan assisted natural ventilation workshops. The study was conducted using questionnaires and real time monitoring with IAQ device. Chi-square test correlation study from the questionnaire further confirmed that the 86.7% of users having experienced SBS syndrome with significant ($p<0.05$) in both types of test centers. While, symptoms such as headache, dry skin, running nose and lethargy were more likely to be seen in air-conditioned building (Cheong and Chong, 2001). Hence, there is likelihood of SBS symptoms occurrence need for investigation by implementing an IAQ management plan to prevent or mitigate any potential harm in indoor air environment.

In the trend of industrial revolution (IR) 4.0 technology, Anindya et al., 2019 have reviewed 36 studies on IAQ around the world and found that most of the study focused on the pollution parameters such as temperature, humidity, and CO2. Hence, most of the studies were conducted at university campus environment by using IoT system. The outcome from the reviewed study, Anindya et al., 2018 have developed an IoT based IAQ device integrated with message query telemetry transport (MQTT). A real time system was developed to detect the parameters such as temperature, humidity, CO2, and dust at campus in a University in Malaysia for 8 hours investigation. The researcher also suggested live camera and GPS system to be added into the IoT based IAQ device for better improvement of the system for future study. Thus, from the literature review, there is a potential need to investigate the IAQ in the campus to study the air quality correlation with covid 19 virus spreading in the air-conditioned classroom during the post covid transition period.

METHODOLOGY

Three (3) standards have been used as reference to analyze the measured data namely The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE, 2007), Malaysia Code of Practice (DOSH, 2010) and New Malaysia Ambient Air Quality Standard (NMAAQS) (DOE, 2020). ASHRAE, 2007 and DOSH, 2010 recommend that healthy air quality level in a classroom should have carbon dioxide below 1000 ppm, temperature range 23oC – 26oC and humidity range 30% - 70%. The air-conditioned room gave some advantages as it reduces outside hot ambient air humidity and kept the room at comfort level. However, the suspended dust particulate in indoor classroom recommendation from Malaysia Department of Environment (DOE, 2020) should not exceed 35 µg/m3 for particulate matter saiz 2.5µg/m (PM2.5) measured.

IAQ device connected to power bank it switched ON to measure classroom five (5) data reading parameters that are Dust Particles ($\mu g/m^3$), Temperature (^oC), Humidity (%), Noise

(dB) and Carbon dioxide (CO2) (ppm). Data are measured for three (3) times over 5 minutes period for each parameter and then average the value (Marzuki et al., 2010). The procedures are repeated hourly for three (3) consecutive days at three (3) different places that are Bilik Studio, Bilik Kuliah 1, and Makmal Komputer. The students in the occupied the space range from 14 students to 24 students for each class.

Figure 1-3 show the room condition at Bilik Studio, Bilik Kuliah 1, and Makmal Komputer at Politeknik Bagan Datuk

Figure 1: Bilik Studio with area of 1500 cm x 1100 cm occupied by 24 students

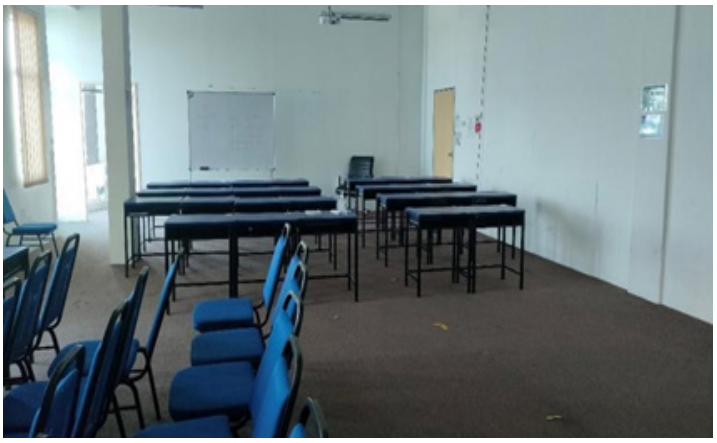

Figure 2: Bilik Kuliah 1 with area of 650 cm x 400 cm

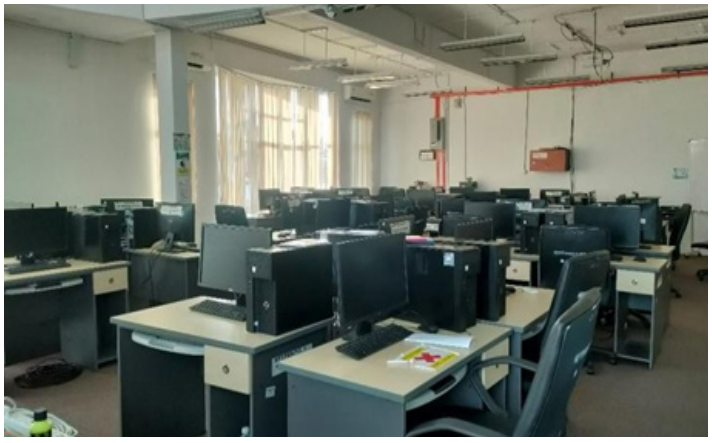

Figure 3: Makmal Komputer with area of 800 cm x 500 cm

PROTOTYPE DEVELOPMENT

Figure 4 shows the IAQ device built for this project with the budgeted cost of RM200.

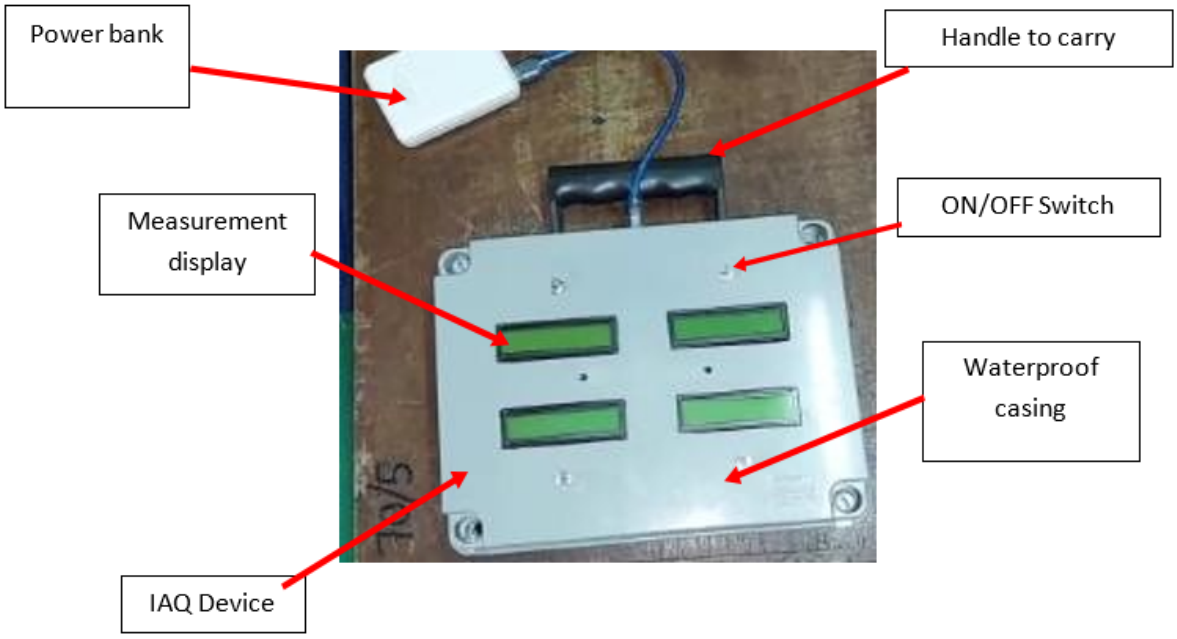

Figure 4: Indoor Air Quality (IAQ) device

Figure 5 shows the circuit connection of the IAQ device, ON/OFF switch and the four (4) data measurement LCD displays. The device is waterproof with handle, hence it is portable and light weight to carry. There are four (4) ON/OFF switch where use can choose to ON/OFF each of the LCD display. This device is built using Arduino and user own programming.

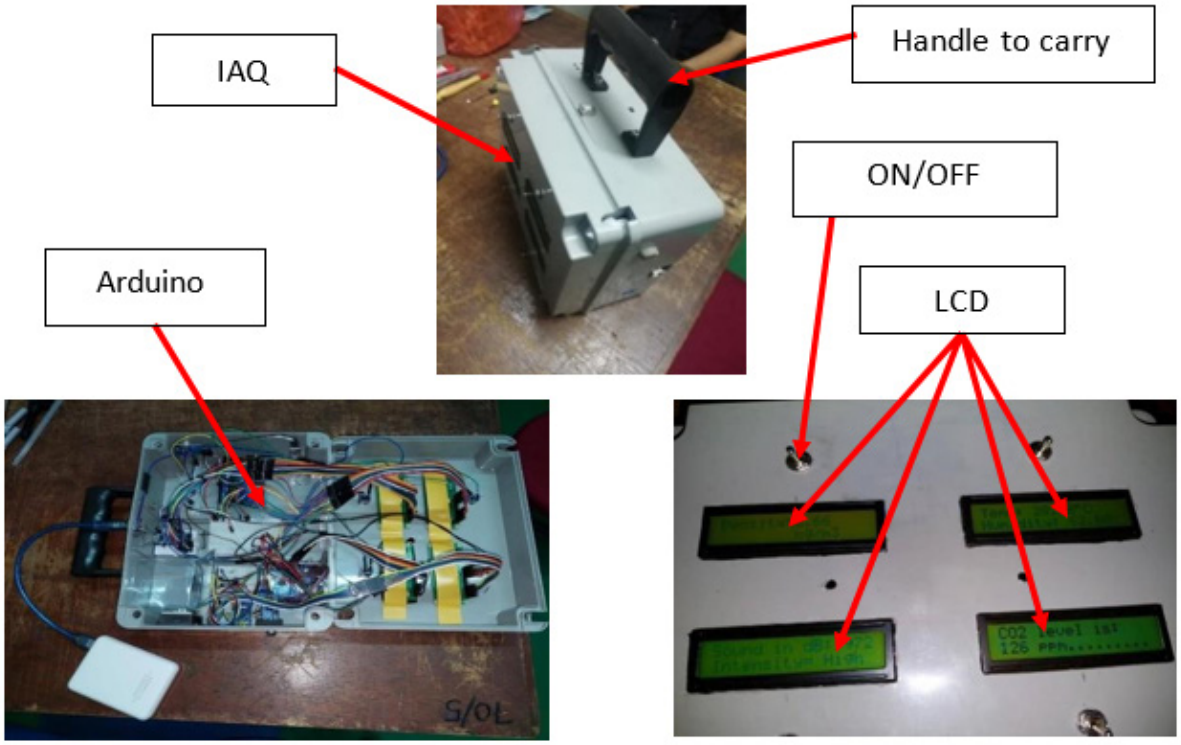

Figure 5: Circuit connection of Arduino and LCD display

RESULTS AND DISCUSSION

Table 1 shows the average experimental data measured Bilik Studio at Politeknik Bagan Datuk, Hutan Melintang, Perak on 6th October 2022, 12th October 2022 and 6th November 2022. The average measured data for Bilik Studio shows that Noise level reached range between 43 – 68 dB whereas carbon dioxide (CO2) emission range between 533 – 656 ppm at the same period. Room temperature is almost constant at 23oC, while an average the concentration of dust particles is maintained below 9.2 $\mu g/m^3$ throughout the 8 hours of lecture day. The concentration of dust particles is still in the acceptable range by according to the NMAAQS standard DOE, 2020.

Figure 6 shows the four (4) electronic sensors consisting of dust particles sensor, temperature & humidity sensor, noise sensor and Carbon dioxide (CO2) sensor. A total of five (5) measurements reading can be shown at the LCD display that are **Dust Particles ($\mu g/m^3$), Temperature (^oC), Humidity (%), Noise (dB) and Carbon dioxide (CO2) (ppm).**

Table 1: Average data measured at Bilik Studio

Measurements Data	Dust Particles ($\mu g/m^3$)	Temperature (^oC)	Humidity (%)	Noise (dB)	Carbon Dioxide (ppm)
9.00 AM	8.6	23	54	64	602
10.00 AM	7.2	22	54	68	656
11.00 AM	8.5	23	58	60	638
12.00 PM	12.3	23	64	43	615
1.00 PM	7.7	23	55	45	631
2.00 PM	11.3	23	54	45	631
3.00 PM	8.1	23	57	43	620
4.00 PM	9.8	24	59	43	611

Table 2 shows the average experimental data measured Bilik Kuliah 1 at Politeknik Bagan Datuk, Hutan Melintang, Perak on 16th October 2022, 12th November 2022 and 03rd December 2022. The average measured data for Bilik Kuliah 1 shows that Noise level reached range between 40 – 55 dB whereas carbon dioxide (CO2) emission range between 530 – 674 ppm at the same period. Room temperature with range 23^oC to 28^oC, while an average the concentration of dust particles is 56.2 $\mu g/m^3$ throughout the 8 hours of lecture day. The concentration of dust particles is exceeding the acceptable level by according to the NMAAQS standard DOE, 2020 that to show Bilik Kuliah 1 is containing high mass of suspended particulates that can contribute to the risk of covid-19 virus spreading. Room temperature is slightly above the recommended level that is 23^oC - 26^oC by (DSM, 2014 and DOSH 2010) may due to hot weather outside classroom or faulty air conditioner that unable to cope with classroom cooling capacity.

Table 2: Average data measured at Bilik Kuliah 1

Measurements Data	Dust Particles ($\mu g/m^3$)	Temperature (^oC)	Humidity (%)	Noise (dB)	Carbon Dioxide (ppm)
9.00 AM	56.3	25	62	45	530
10.00 AM	56.1	23	45	43	566
11.00 AM	56.2	27	60	49	579
12.00 PM	58.2	27	58	55	588
1.00 PM	55.5	28	56	43	609
2.00 PM	55.8	27	53	47	616
3.00 PM	54.7	24	51	42	638
4.00 PM	56.6	24	44	40	674

Table 3 shows the average experimental data measured Makmal Komputer at Politeknik Bagan Datuk, Hutan Melintang, Perak on 3th October 2022, 11th November 2022 and 01st December 2022. The average measured data for Makmal Komputer shows that Noise level reached range between 50 – 63 dB whereas carbon dioxide (CO2) emission range between 558 – 723 ppm at the same period. Room temperature is range from 21^oC to 23^oC, while the average concentration of dust particles is 21.3 $\mu g/m^3$ throughout the 8 hours of lecture day. The high carbon dioxide level is due to student are having 4 hours class continuously and there is no exchange of new student into the Makmal Komputer to improve the air ventilation. However, the concentration of dust particles is still in the higher acceptable level by according to the NMAAQS standard DOE, 2020.

Table 3: Average data measured at Makmal Komputer

Measurements Data	Dust Particles ($\mu g/m^3$)	Temperature (^oC)	Humidity (%)	Noise (dB)	Carbon Dioxide (ppm)
9.00 AM	56.3	25	62	45	530
10.00 AM	56.1	23	45	43	566
11.00 AM	56.2	27	60	49	579
12.00 PM	58.2	27	58	55	588
1.00 PM	55.5	28	56	43	609
2.00 PM	55.8	27	53	47	616
3.00 PM	54.7	24	51	42	638
4.00 PM	56.6	24	44	40	674

Figure 7 – Figure 10 show the trend profile of Carbon dioxide (CO2), dust particulate, temperature and humidity of air in the room. Indoor room humidity comfortable percentage range is between 30% - 70% humidity according to Malaysia Code of Practice (DOSH, 2010), while Figure 9 shows the humidity ranged from 25 – 62% is still in the comfortable humidity level. Meanwhile, Figure 11 is to show the noise that can disturb teaching and learning lesson for other rooms as noise detected can reach 68 dB at Bilik Studio.

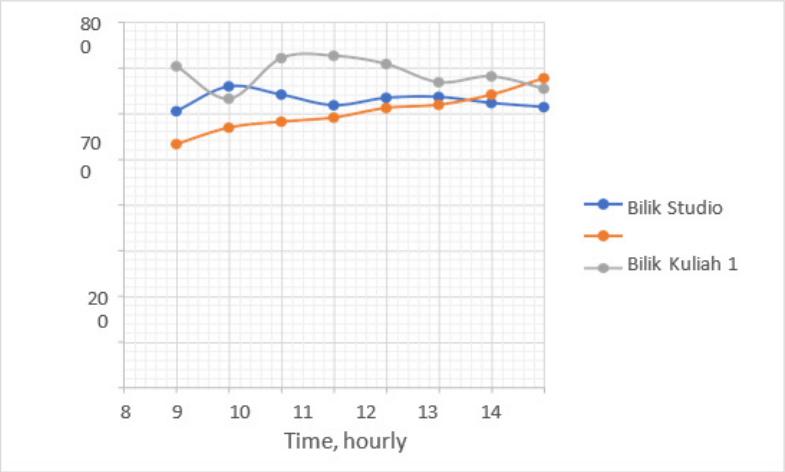

Figure 7: Carbon Dioxide level

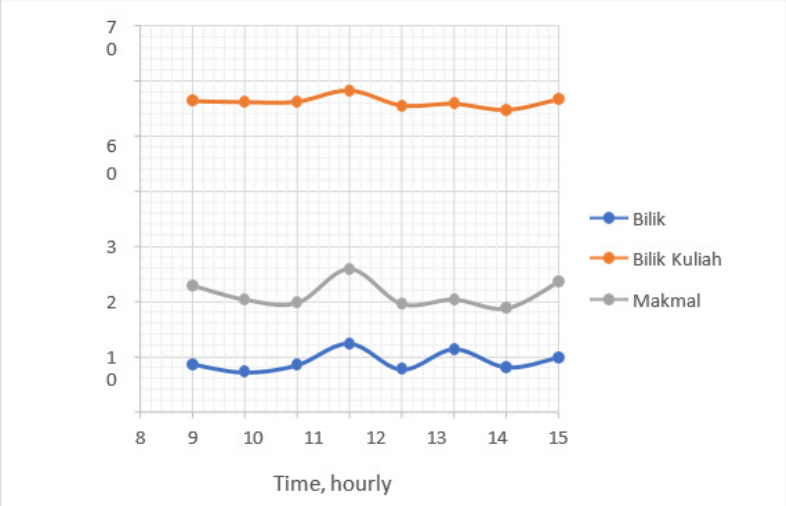

Figure 8: Dust Particles level

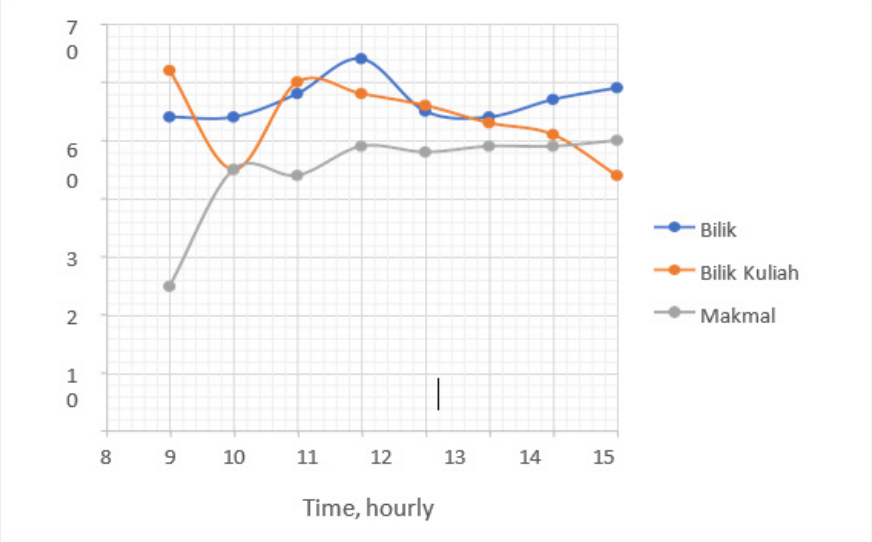

Figure 9: Humidity level

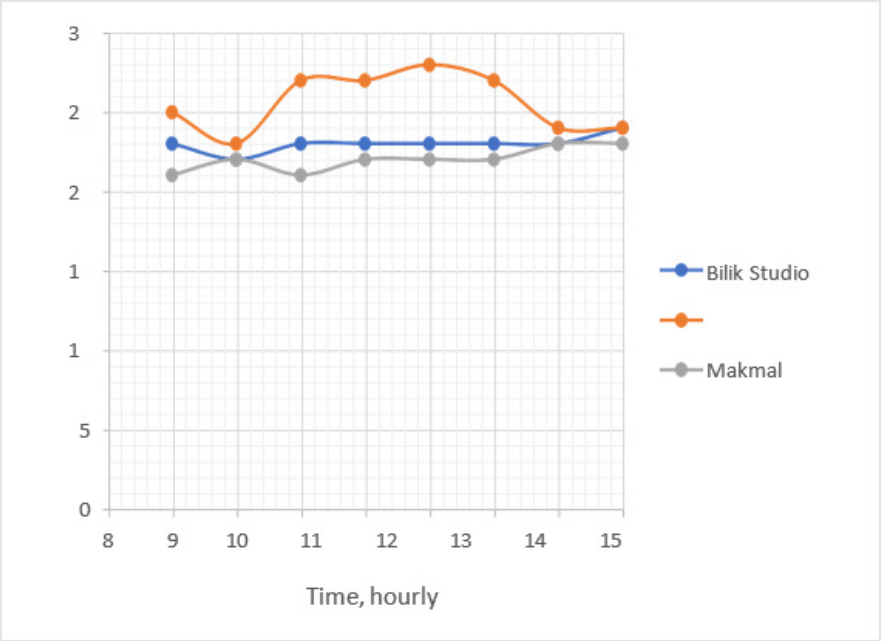

Figure 10: Temperature level

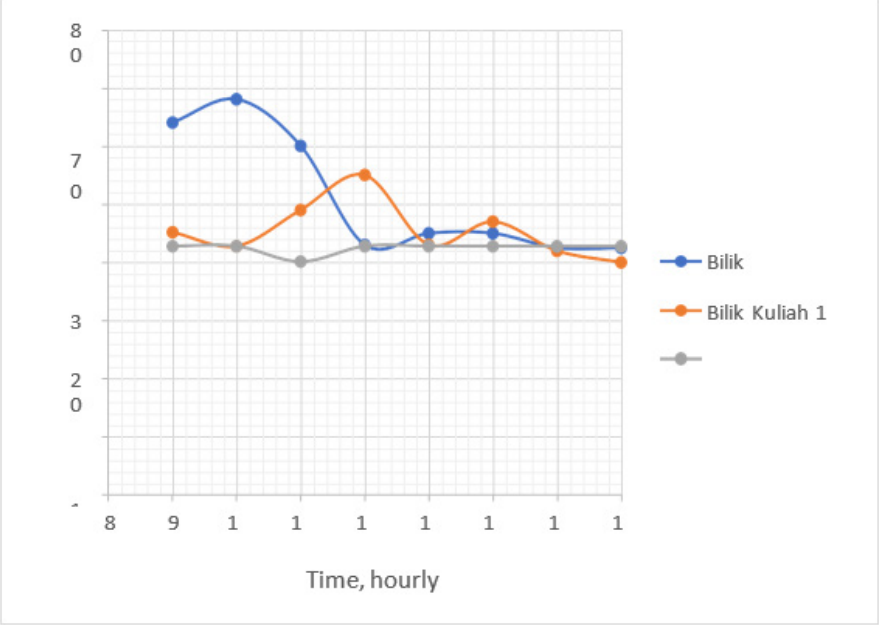

Figure 11: Noise level

CONCLUSIONS AND FUTURE RESEARCH

The investigation conclude that the CO2 emission is in the acceptable range of 530 ppm – 723 ppm that is below 1000 ppm and the noise level ranged from 40 – 68 dB is that is still well below the threshold level, 90 dB. In the meantime, study shows that air-conditioned classroom shows that student is comfortable for learning process in the class. The humidity parameter 25-62% shows acceptable comfortable humidity for indoor room with air conditioner. Next, the suspended dust particle is relatively high for Bilik Kuliah 1 that is 56.2 $\mu g/m^3$ as the Bilik Kuliah 1 is closed door with air conditioned and carpet flooring. Overall, at the post covid-19 stage, there are 53-73% chances of covid-19 virus spreading in the classroom by referring the CO2 concentration measurement and carpet flooring that accumulate dust from shoe. However, no cases of Covid-19 spreading have been reported in the institution. The future research can be conducted at classroom in polytechnics, school near the quarry site and industries to study the indoor air quality and human comfort.

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