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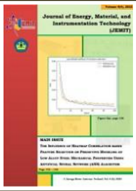

Design of a Classroom Noise Monitoring Tool Using a KY-037 Sound Sensor Based on Wemos D1R1

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Abstract

The noise level in the room is one of the factors that can influence teaching and learning activities. Research on classroom noise levels has been done using the Wemos D1 R1-based KY-037 sound sensor. This research aims to determine the noise level in the classroom and be able to monitor the noise level in the room. Data collection was carried out by sound detection in the classrooms of SMA Negeri 13 Palembang from 07.00 – 12.00 WIB for seven days. The research results show that the system is functioning well, indicated by the situation when the noise level is less than 45 dB, and the LED lights up. When the noise level is more than or equal to 45 dB, then the yellow LED, mini DFPlayer, and speaker will light up, and when the noise level is more than or equal to 55 dB, then the red USB LED, mini DFPlayer, and speaker will light up. Data on noise levels and LED conditions received can be monitored via the web server. The system used on the web server is localhost access on a computer that can be monitored within the school environment.

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Abstrak

Tingkat kebisingan dalam ruangan menjadi salah satu faktor yang dapat mempengaruhi kegiatan belajar mengajar. Penelitian mengenai tingkat kebisingan dalam ruang kelas telah direalisasikan menggunakan sensor suara KY-037 berbasis wemos D1 R1. Penelitian ini bertujuan untuk mengetahui tingkat kebisingan dalam ruang kelas dan dapat memonitoring tingkat kebisingan dalam ruangan. Pengambilan data dilakukan dengan deteksi suara dalam ruangan kelas SMA Negeri 13 Palembang dari pukul 07.00 – 12.00 WIB selama 7 hari. Hasil penelitian menunjukkan sistem berfungsi dengan baik, ditunjukkan dengan keadaan ketika tingkat kebisingan kurang dari 45 dB maka LED akan menyala, ketika tingkat kebisingan lebih dari atau sama dengan 45 dB maka LED kuning, mini DFPlayer dan speaker akan menyala, dan ketika tingkat kebisingan lebih dari atau sama dengan 55 dB maka LED USB merah, mini DFPlayer dan speaker akan menyala. Data tingkat kebisingan dan kondisi LED yang diterima dapat di monitoring melalui web server. Sistem pada yang digunakan pada web server yaitu dengan akses localhost pada komputer yang dapat dimonitoring dalam lingkungan sekolah.

1. Introduction

In Indonesia, education plays an essential role in gaining and developing knowledge. An educational institution is an institution or place where the educational process takes place. For good education, it is necessary to provide educational facilities and infrastructure to improve the quality of the teaching and learning process and facilitate the process of transforming knowledge and skills needed by society. The facilities and infrastructure that every school and university needs are buildings, rooms, laboratories, libraries, and teaching and learning equipment. A comfortable room supports the creation of a teaching and learning atmosphere that is conducive. A conducive room is a room that is far from sound and noise disturbances. Noise can cause a loss of concentration, so teaching and learning activities cannot run smoothly. Noise, according to Prasetio (1985), can be sourced from noise in the door and outdoor noise. Indoor noise sources come from humans. For example, it often occurs in classrooms. Students talk to their friends during study time, causing a commotion in the room, which is often difficult to control.

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Based on Republic of Indonesia Minister of Health Decree number No. 718 (1987) concerning noise, the noise level is divided into four zones, namely zone A (research areas, hospitals, health care settings, and the like) is 35-45 dB, zone B (housing, educational places, recreation areas, and the like) is 45-55 dB, zone C (markets, offices, shops, and the like) is 50-60 dB and z ona D (industrial environments, factories, train stations, bus terminals, and the like) is 60-70 dB. School rooms must be in zone B, set at 45 dB (maximum recommended) to 55 dB (maximum allowed). Noise from human activities can be regulated by establishing noise level standards.

The noise level standard is the maximum limit on the noise level that may be released into the environment from a business or activity so that it does not cause interference with human health and environmental comfort (State Minister for the Environment, 1996). In noise problems, the noise level can be determined automatically based on various conditions according to the frequency level displayed on the designed detection device. This tool can help in measuring noise levels for various purposes and can provide warnings when it reaches predetermined noise level standards. In this study, a noise level of 45 to 55 dB was used following the noise level standards determined by the Minister of Health of the Republic of Indonesia Decree No. 718, which states that school or education rooms are in zone B.

Research on indoor noise level devices has been carried out previously and generally has used microcontrollers such as the AVR ATMega 8535. The device's design for monitoring noise consists of sensors—input in the form of a sound sensor. AVR Atmega 8535 microcontroller as a process. The output used by Jmr and Widianti (2018) is a dot matrix display, and Kharis (2013) is a buzzer.

Apart from using the AVR ATMega 8535 microcontroller, the Arduino module has also been used for noise level detection and warning. There is an Arduino-based design where the input is a MIC sound sensor. The output provided in Nurwati's (2018) research was in the form of speakers and LCDs, and the research conducted by Angga (2018) was in the form of LEDs and buzzers.

Other research was carried out using the detection of Internet of Things - based noise level as a medium for room comfort control. Internet of Things-based research can use Arduino Mega (Hidayat et al., 2019) and Node MCU ESP8266 (Amarta et al., 2019). The resulting output can be via a buzzer (Hidayat et al., 2019) and LCD (Amarta et al., 2019).

Based on these descriptions, this research was conducted to design a tool that can detect noise in classrooms and provide warnings to room users who are less orderly and monitored with Internet of Things technology. This design process is different from previous research, namely that the output of this system is in the form of a warning sound via speakers, LEDs as a warning alarm when it reaches 55 dB (the maximum permissible noise limit), and can be monitored via a web server and has a database that can be accessed to review noise level data from the classroom.

2. Research methods

The tools and materials used in this research are Wemos D1R1, KY-037 sound sensor, mini DFPlayer, speaker, LCD, LED, USB LED, key switch, power supply, jumper, and Arduino software.

2.1 Overall Design of the Tool

Internet of Things (IoT) based classroom noise monitoring tools are arranged in a tool design block diagram, as shown in **Figure 1.**

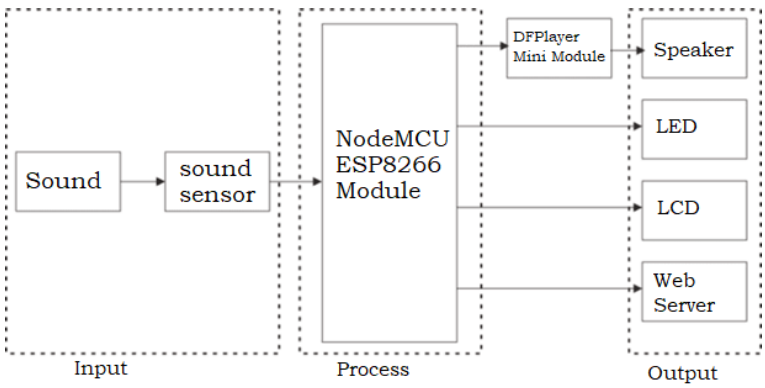

Figure 1. Block diagram of tool design

The working principle of noise monitoring tools in classrooms is based on the sound contained in the classroom being received by the sound sensor. When the sensor receives sound, it is converted into a decibel (dB) value, which Wemos D1 R1 will process and then display on the LCD screen, and the LED will light up. When the noise level is less than or equal to 45 dB, the green LED will light up as a sign that the room is still within safe limits. Then, when the noise is above the 45 dB level, the yellow LED will light up as a sign that the room is quite noisy and activate the warning alarm. It will be sent to the mini DFPlayer to activate the sound and produce output through the speakers. When the noise is above or equal to 55 dB, the red LED will light up as a sign that the room is noisy and activate the warning alarm. Noise levels and LED conditions can be monitored via the web server. The circuit of the classroom noise monitoring tool can be seen in **Figure 2.**

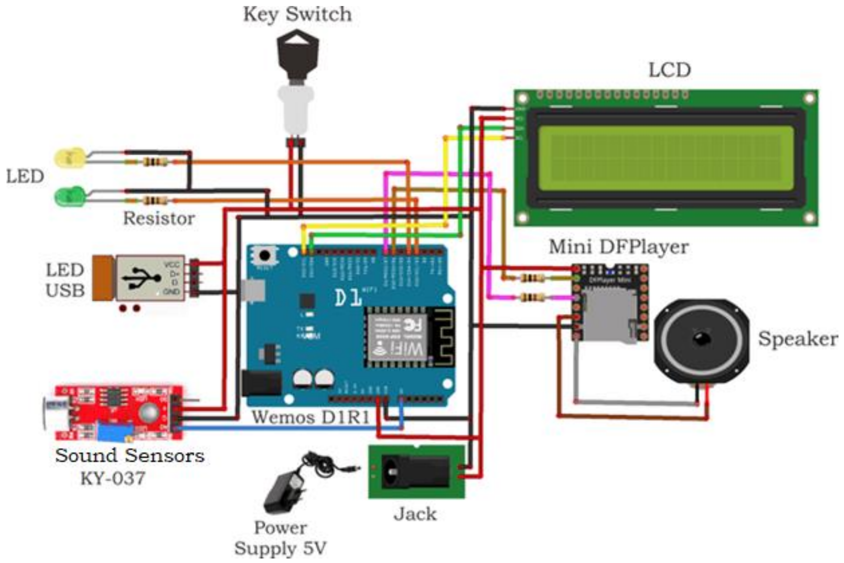

Figure 2. Classroom Noise Monitoring Tool Set

Based on the circuit in **Figure 2,** there is Wemos D1 R1, which will carry out data measurements and calculations. After the device is connected to a voltage source, the sound sensor will immediately detect sounds in the room. After that, the sound sensor will send its data to the Wemos D1 R1 microcontroller. Data will be calculated and converted to decibels (dB), and the noise level status will be displayed on the LCD screen connected to the circuit. Apart from that, Wemos D1 R1 will detect WiFi connections that have been previously programmed. If the WiFi connection is connected, the data will be displayed on the web server. If the internet connection is not connected, the tool will continue to calculate data and detect sound signals. The 3-dimensional design of the noise monitoring tool can be seen in **Figure 3.**

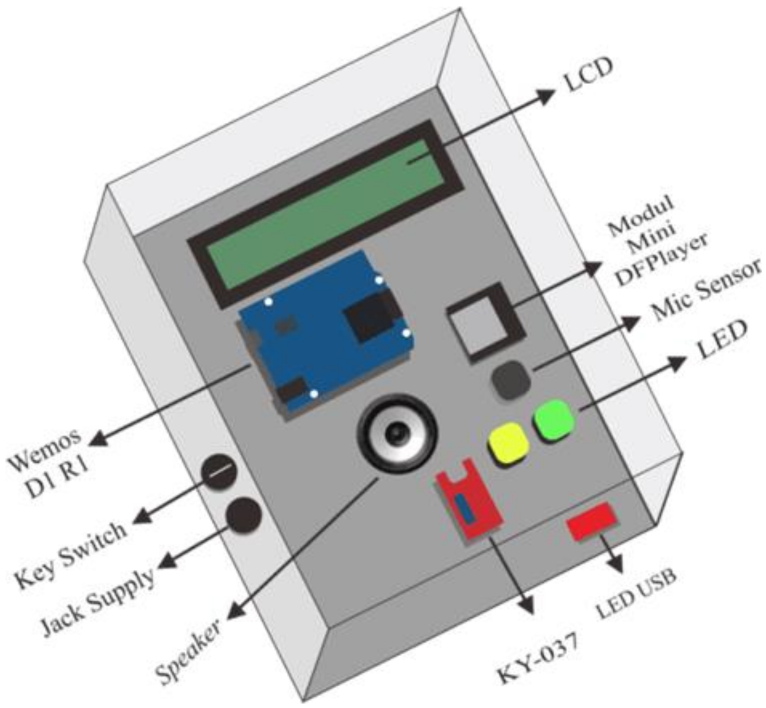

Figure 3. Side View Toolkit

The noise monitoring toolbox in **Figure 3** has dimensions of 21 x 14.8 x 3 cm. On the front of the box, there is an LCD to display the results of noise detection. There are 2 LEDs with colors, namely yellow and green, a speaker as a warning, and a mic from the KY-037 sound sensor as a sound detector. On the left, there is a 5v power supply as a voltage source and a key switch. At the bottom, there is a red USB LED. The noise monitoring device is placed in one classroom at the front, next to the blackboard. Because this location can be seen and heard easily by students or teachers when the device issues a warning and the location is far enough from other noise sources such as fans, it does not affect the collection of noise level data.

3. Results and Discussion

3.1 Tool Implementation

The design of a classroom noise monitoring tool using an IoT based system has been realized with the results shown in **Figure 4.**

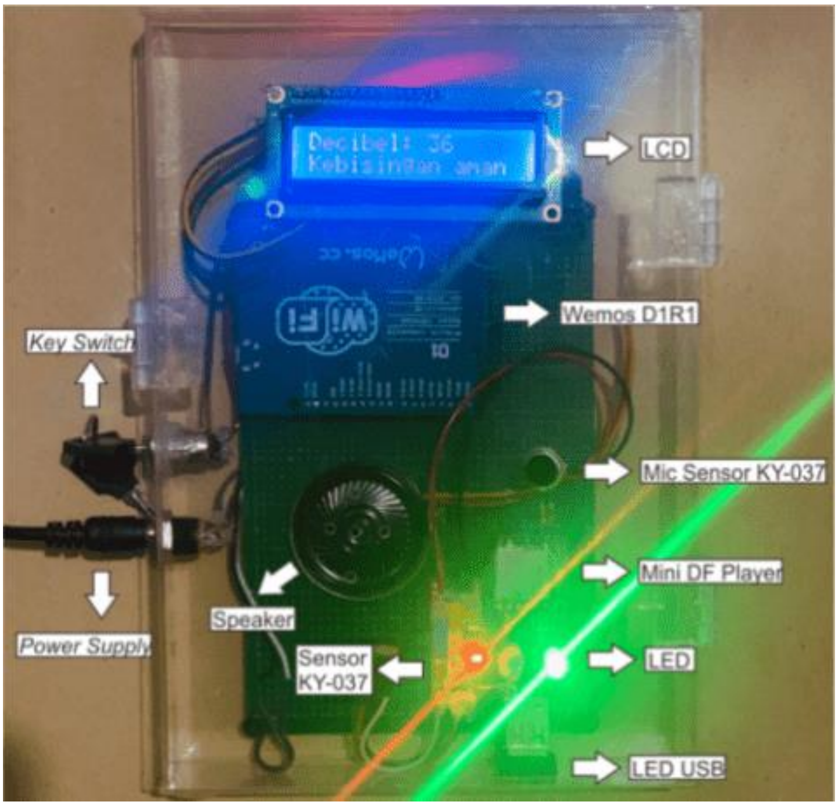

Figure 4. Noise Monitoring Tool Using the KY-037 Sound Sensor

Figure **4.1** is the result of the design of a classroom noise monitoring tool with an IoT based system. There is a component in the form of a KY-037 sound sensor, which receives input from Wemos D1 R1 sound to process data from the KY-037 sound sensor. LCD to display decibels and description of noise detected by the sound sensor. Mini DFPlayer to play audio files as sound alerts at a predetermined noise level through the speaker. Speaker for sound warning alarm. LED and USB LED for warning lights. Sounds detected on noise devices can be monitored via a web server accessed via a laptop. The web server will display graphs of real-time noise levels and LED status. The system used on the web server is localhost access on a computer that can be monitored within the school environment.

3.2 KY-037 Sound Sensor Testing

The KY-037 sound sensor is used to detect the noise level (dB) in the room. This sensor is equipped with a microphone as a sound detector, which is then converted into an analog-digital to-converter (ADC) value. Testing of the microphone sensor was carried out to determine whether the sensor could respond well when there was sound. The sensor is connected to Wemos D1 R1, LED, and buzzer with a distance between the sensor and the sound source of 10 – 50 cm and a noise level of 30 – 55 dB, as in **Figure 5.**

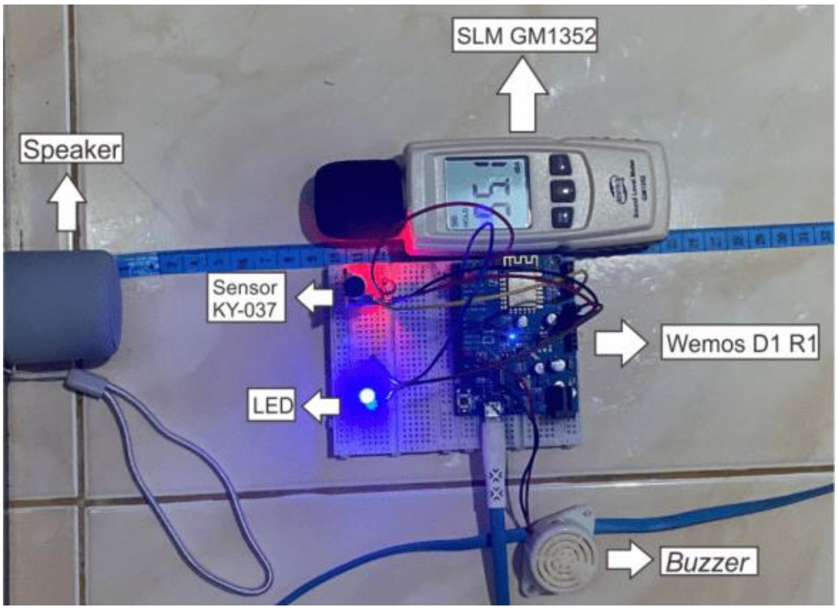

Figure 5. Testing the KY-037 Sound Sensor *Microphone*

The testing process for the KY-037 sound sensor microphone was carried out five times with four noise levels, and the output results were that the LED and buzzer lit simultaneously when the sensor microphone received sound. Data from testing the microphone sensor can be seen in **Table 4.1.**

Table 1. KY-037 Microphone Sensor Test Results Data

No	Distance (cm)	dB					LEDs					Buzzers				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	10	30	30	30	30	30	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	20						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	30						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	40						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	50						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1	10	40	40	40	40	40	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	20						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	30						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	40						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	50						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1	10	50	50	50	50	50	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	20						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	30						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	40						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	50						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1	10	55	55	55	55	55	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	20						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	30						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	40						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	50						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Next, the sensor is tested so that the sensor readings match the calibrated tool readings. The output from the sensor is an analog value connected to the analog pin (A0) of Wemos D1 R1. The results of the measurements are displayed on the Arduino IDE serial monitor with repeated measurements at 2000 ms intervals. Sensor testing was conducted using a Sound Level Meter (SLM) GM1352 as a comparison tool with analog values before being implemented indoors. The mechanism in this research is that the KY-037 sound sensor is placed side by side with the SLM GM1352 at a distance of 20 cm from the sound source, as in **Figure 6.**

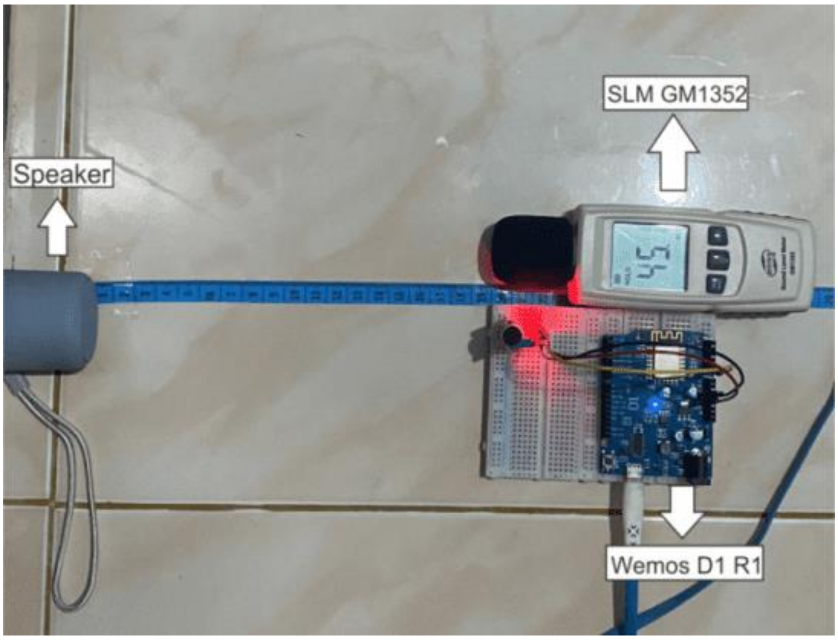

Figure 6. KY-037 Sound Sensor Noise Level Testing

The testing process was done by turning on the sound source at 20 cm from the KY-037 and SLM GM1352 sound sensors with a measurement range of 32-78 dB. Analog test results data from the KY-037 sound sensor output can be seen in **Table 2.**

Table 2. Test Results of KY-037 Sound Sensor with SLM GM1352

No	KY-037 Sound Sensor Voltage (mV)	SLM GM1352 (dB)
1	327	32
2	351	35
3	440	44
4	483	49
5	544	53
6	550	56
7	611	61
8	662	65
9	764	71
10	770	78

The graph of the KY-037 sound sensor output test results compared to the SLM GM1352 results is shown in **Figure 7.**

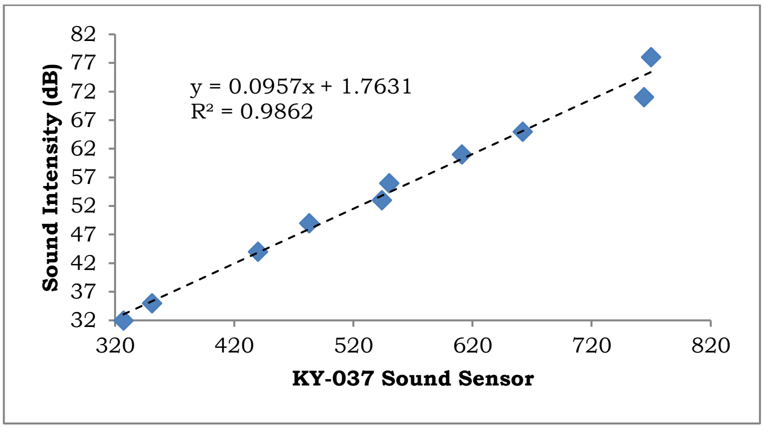

Figure 7. Graph of KY-037 Sound Sensor Output Test on Sound Intensity (dB)

Based on the graph in **Figure 7.** testing the output of the KY-037 sound sensor against the sound intensity (dB) of the SLM GM1352 with a measurement range of 32-78 dB**, The obtained** value $R^2$is 0.986 with the linear regression equation, namely $y = 0{,}0957x + 1{,}7631$. So, we get the equation shown in **Equation 1.**

$$dB = 0{,}0957 * x + 1{,}7631 \quad (1)$$

The linearity equation in **Equation 1** is entered into the instrumentation system program so that the readings from the KY-037 sound sensor match the calibrator tool. Then, testing was carried out again on the KY-037 sound sensor, which had been assembled into the noise monitoring system and included in the linearities program to ensure the accuracy and error levels were by standard calibrated tools. The test results of the KY-037 sound sensor, which has been included in the linearity program, are shown in **Table 3.**

Table 3 Noise Monitoring System Test Results

No	SLM GM1352 (dB)	Noise Monitoring system (dB)					Average	Errors (%)	Accuracy (%)
		1	2	3	4	5			
1	35	35	36	36	35	35	35.40	1.14	98.86
2	40	40	40	41	41	41	40.60	1.50	98.50
3	45	44	45	45	45	45	44.80	0.44	99.56
4	50	50	51	49	50	51	50.20	0.40	99.60
5	55	55	55	56	56	55	55.40	0.73	99.27
6	60	59	60	60	59	60	59.60	0.67	99.33
7	65	65	66	65	65	65	65.20	0.31	99.69
8	70	70	70	69	70	70	69.80	0.29	99.71
9	75	75	76	75	75	75	75.20	0.27	99.73
10	80	81	80	80	80	81	80.40	0.50	99.50
Average								0.62	99.38

The average value of the KY-037 sound sensor test results in **Table 3** will be compared with the dB Meter on SLM. The noise level (dB) test results from the KY-037 sound sensor against the SLM GM1352 were obtained R^2at 0.9995. Based on the calculation results in **Table 3,** an average error value of 0.6-2 % was obtained, resulting in an average accuracy value for the KY-037 sound sensor of 99.38 %. It shows that the KY-037 sound sensor that will be used has good accuracy so that it can be applied to detect noise levels (dB) in classrooms.

3.3 Data Retrieval and System Analysis

Data was collected using class XII.3 of SMA Negeri 13 Palembang with 18 students from 07.00 – 12.00 WIB. The results of testing the noise monitoring tool in the XII.3 classroom at SMA Negeri 13 Palembang when the classroom was at a noise level of less than 45 dB are shown in **Figure 8.**

Figure 8. LCD and LED display when Noise Is Less Than or Equal To 45 dB

The noise level can be detected using the KY-037 sound sensor, and the detection results are visible on the LCD and web server. When the classroom is at a noise level of less than or equal to 45 dB, the green LED will light up, and the LCD will display the detected decibels and the statement "Noise is safe." **Figure 9** shows the appearance of the web server when it was at a noise level of 42 dB at 09:08:04 WIB with the green LED status. So when the noise level is less than or equal to 45 dB, the green LED will light up.

Figure 9. Web Server Display when Less Than or Equal to 45 dB

The results of testing the noise monitoring tool in the XII.3 classroom at SMA Negeri 13 Palembang when the classroom was at a noise level of more than 45 dB are shown in **Figure 10.**

Figure 10. LCD and LED display when Noise is More Than 45 dB

When the classroom has a noise level of more than 45 dB, the yellow LED will light up, and the blue LED on the mini DFPlayer will light up. The speaker will emit a warning sound. The LCD will display the detected decibels of more than 45 dB and the statement "Warning 1". **Figure 11** shows the appearance of the web server when it is at a noise level of 50 dB at 09:09:14 WIB with the yellow LED status being green. So when the noise level is more than 45 dB, the yellow LED will light up.

Figure 11. *Web Server* Display when More Than 45 dB

The test results of noise detection devices and warning alarms in class XII.3 SMA Negeri 13 Palembang when the classroom had a noise level of more than 55 dB is shown in **Figure 12.**

Figure 12. LCD and LED display when Noise Is More Than or Equal To 55 dB

When the classroom has a noise level of more than or equal to 55 dB, the red USB LED will light up, and the blue LED on the mini DFPlayer will light up. The speaker will emit a warning sound, and the LCD will display the detected decibels of more than or equal to 55 dB with the description "Warning 2". **Figure 12** shows the appearance of the web server when it was at a noise level of 57 dB at 09:11:08 WIB with the red LED status green. So when the noise level is more than or equal to 55 dB, the red LED will light up.

Figure 12. Web Server Display When More Than or Equal To 55 dB

The results of testing the noise monitoring device and warning alarm in class XII.3 SMA Negeri 13 Palembang as a whole for seven days from 07.00 to 12.00 WIB are shown in Figure **13.**

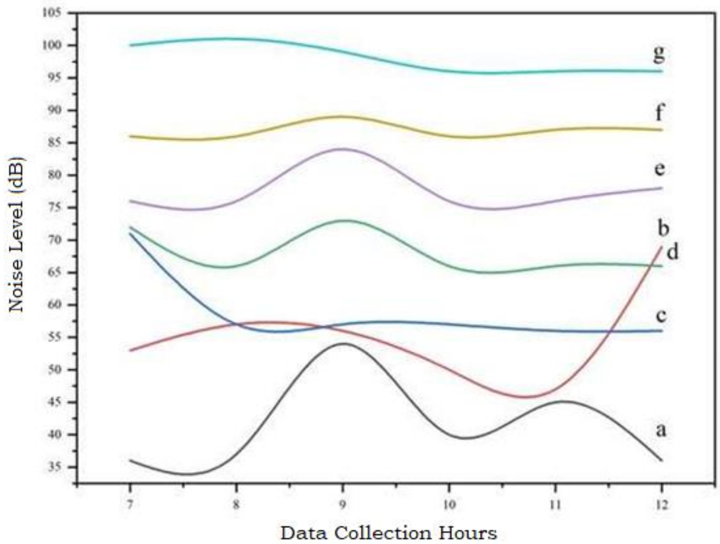

Figure 13. Graph Data from Monitoring Noise Levels in Classrooms for 7 Days

The graph in **Figure 13** shows the overall noise results in class XII.3. Testing was carried out for seven days from 07.00 – 12.00 WIB. Data collection on days (a) one, (b) two, (c) three, (d) four, (e) five, (f) six, and (g) seven, at 07.00 – 08.59 WIB as a whole from the data The test results show that the noise level does not exceed the recommended maximum of 45 dB and does not exceed the quality standard of 55 dB because it is a teaching and learning activity, except on day (b) two at 08.00 WIB and day (c) three at 07.00 WIB. On days (b) two at 08.00 WIB and (c) three at 07.00 WIB, the noise was at warning level 1, namely quite noisy because the teacher who was teaching was not coming in. 09.00 - 09.20 WIB is break time, so at that time the noise in the room is quite loud, exceeding 45 dB but still meets the quality standard of 55 dB. 09.20 – 11.40 WIB is teaching and learning hours so that classroom conditions do not exceed the recommended maximum of 45 dB or exceed the quality standard of 55 dB. At 12.00 WIB is the time for school to go home, so the classroom conditions are not noisy, except on day (b) two. On the second day at 12.00 WIB, the noise level was at warning two because, on that day, the class was used for extracurricular meetings.

They were based on data obtained from classroom noise monitoring tools successfully made, indicated by the noise readings being at quality standards that meet the standards that noise does not affect teaching and learning activities (KBM) and the teaching and learning process can occur well. The noise will increase when the teacher who is teaching does not come in during break time, namely 09.00 WIB and during extracurricular meetings.

4. Conclusion

A classroom noise monitoring tool can be made using the KY-037 sound sensor. The KY-037 sound sensor can measure classroom noise levels and display them via LCD and can be monitored via a web server. This tool produces output in the form of a green LED that lights up at noise less than equal to 45 dB, a yellow LED and speaker lights up at noise more than 45 dB as warning 1, a red USB LED and speaker lights up at noise more than or equal to 55 dB as warning 2 The classroom noise monitoring system can be based on the internet of things (IoT). This system can monitor classroom noise levels in real-time using a web server via a laptop.

5. Bibliography

Amarta, S., Putrada, A. G., & Suwastika, N. A. (2019). *Asesmen Kebisingan di Open Library Telkom University Menggunakan Sistem Monitoring Suara Berbasis IoT*. *6*(1), 2057–2064.

Hidayat, A. D., Sudibya, B., & Waluyo, C. B. (2019). *Pendeteksi Tingkat Kebisingan berbasis Internet of Things sebagai Media Kontrol Kenyamanan Ruangan Perpustakaan*. *1*(1), 99–109.

Jmr, S., & Widianti, S. Y. (2018). Rancang Bangun Pengontrolan dan Monitoring Kebisingan Ruangan Berbasis Mikrokontroler AVR ATMega 8535. *Electrical Technology*, *3*(1), 1–5.

Keputusan Menteri Kesehatan Republik Indonesia (pp. 1–39). (1987).

Kharis. (2013). *Rancang Bangun Sistem Deteksi Kebisingan Sebagai Media Kontrol Kenyamanan Ruangan Perpustakaan*. Universitas Islam Negeri Sunan Kalijaga.

Menteri Negara Lingkungan Hidup. (1996). *Keputusan Menteri Lingkungan Hidup No. 48 Tahun 1996 Tentang Baku Mutu Kebisingan* (Issue 48). https://toolsfortransformation.net/wp-content/uploads/2017/05/48-Tahun-1996-Kepmen-LH-Baku-Tingkat-Kebisingan.pdf

Nurwati. (2018). Pendeteksi Tingkat Kebisingan Dan Pemberi Peringatan Pada Perpustakaan Berbasis Arduino. *Seminar Nasional Royal (SENAR)*.

Prasetio. (1985). *Akustik Lingkungan 1*. Erlangga.

Siregar, A. W. P. (2018). Indikator Tingkat Kebisingan di Dalam Ruangan Bengkel Berbasis Arduino. *Undergraduate thesis*. Universitas 17 Agustus 1945 Surabaya.