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DEVELOPMENT OF A NOISE DETECTOR ALARM DEVICE FOR NU BULACAN LEARNING RESOURCE CENTER

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ABSTRACT

This study explored the development of a noise detector alarm device designed to promote a conducive learning environment and monitor noise levels within the NU Bulacan Learning Resource Center. High noise levels in learning environments, specifically in school libraries, can negatively affect students' concentration, comprehension, and academic performance. With this, a noise detector alarm device, composed of an Arduino-based system with LED indicators, an LCD display, a sound sensor, and a buzzer, was developed using a descriptive-quantitative research design, integrating experimental testing and an acceptability survey. The research was conducted and completed in May 2026 during the Academic Year 2025–2026. The device was tested through threshold determination, accuracy testing, and spatial reliability testing at various distances (1 meter, 3 meters, and 5 meters). Descriptive statistics and a paired sample t-test were used to assess the data collected from each testing method, and survey responses were evaluated using a 4-point Likert scale. Findings showed that the device was capable of responding correctly to different sound levels with only a 0.24-second difference in buzzer duration, showed no significant difference compared to a standard sound level meter ($p = 0.919$), and performed consistently across different distances. Additionally, the survey responses showed that the device was generally acceptable in terms of overall functionality, usability, reliability, and usefulness. In conclusion, the developed noise detector alarm device is perceived as an effective, accurate, and reliable tool for real-time noise monitoring, which provides a solution to improve an effective learning environment.

Keywords: *noise detector alarm, Arduino, Arduino-based system, noise monitoring, spatial reliability, real-time noise display*

INTRODUCTION

Around the world, school libraries provide support in reading, research, and independent studying, making it an efficient learning environment. Maintaining a quiet environment is essential as excessive noise impairs students' concentration, comprehension, and academic performance. Studies have found that increased sound levels within educational spaces crucially affect acoustic perception and concentration, highlighting the significance of keeping noise low (Zhang et al., 2024). In the Philippine context, maintaining silence in school libraries remains a struggle because of limited supervision and inconsistent noise management strategies, with the internationally recommended guidelines of under 35 decibels (Kuczyński, 2025).

In the Municipality of Argao, Cebu, Philippines, students are often exposed to noise levels higher than the World Health Organization's recommended level of decibels due to traffic and other transportation noise (Camarillo et al., 2021). As the number of students continues to grow in different institutions, larger and more facilities are needed to cater to each student and provide a comfortable, sound environment that will help them with their learning conditions. In a school setup wherein overcapacity in every room is noticeable, the noise produced by the students in one room cannot be controlled easily. While having higher indoor sound levels negatively impacts students' word reception and comprehension, showing that noise challenges within indoor environments like classrooms or libraries can hinder learning processes (Bontia et al., 2025).

While existing studies highlight noise's harm to learning and document prototype basic detectors, few address scalable, automated solutions tailored for Philippine school libraries. Since the traditional noise management relies on staff intervention, such as using a bell to tone down the voices of the community/students inside the environment, it is inefficient during off-peak hours and especially during peak hours with mid to high occupancy (NEA, 2020). This study aims to develop an accessible, hands-off, real-time alarm system that enforces quiet zones independently, promoting a more focused learning environment for students. Automated detection systems with alerts provide a proactive, technology-driven solution superior to limited staff supervision, enabling real-time monitoring and warnings to maintain consistent noise control amid growing student populations and overcapacity issues (Lansangan et al., 2021; Balbuena et al., 2025). This innovation supports modern acoustic management, helping Philippine libraries adhere to WHO guidelines and foster optimal learning environments without sole reliance on manual enforcement (Sintawati, 2023).

In conclusion, this study played an essential part for students, librarians, and other members of the educational community because it addressed the persistent challenge of maintaining conducive learning environments in overcrowded Philippine school libraries, where traditional manual supervision often failed to meet international acoustic standards. By proposing the development of an automated real-time alarm system, the research sought to provide a scalable solution to the negative effects of noise pollution. This innovation connected limited school resources with the need for a quiet setting. It ensured that students had a tech-supported space that helped maintain their focus and academic potential.

Research Questions

The purpose of this study was to develop, test, and assess a functional noise detector alarm system capable of detecting, measuring sound levels, and to determine effectiveness in monitoring and reducing excessive noise within the NU Bulacan Learning Resource Center.

Specifically, this study sought to answer the following objectives:

1. To determine appropriate noise level thresholds that will trigger visual and sound alerts when noise levels exceed the set thresholds.
2. To compare the decibel readings detected by the noise detector system with those measured by a standard digital sound level meter across varying noise levels to assess the system's measurement accuracy.
3. To determine the reliability and consistency of the sound sensor's detection response at varying fixed distances (1 meter, 3 meters, 5 meters) from a controlled noise source.

METHODOLOGY

This study applied the quantitative method. According to Stanat (2026), quantitative research is a systematic data collection and analysis approach that emphasizes quantifiable and numerical data. This study focused on measuring and analyzing numerical data to determine the effectiveness of the noise detector alarm system. The study involved collecting decibel readings, survey scores, and frequency counts, which could be quantified, compared, and statistically analyzed.

Additionally, the researchers utilized a descriptive quantitative research design because the study aimed to systematically measure and present the device's performance based on observed data rather than establish cause-and-effect relationships. Specifically, the researchers described the device's ability to detect sound levels, respond to predefined thresholds, and maintain consistency across different distances. According to Unimrkt Research (2023), descriptive design focuses on the objective measurement and statistical analysis of data to provide a clear and concise summary of the research topic.

Furthermore, the study utilized structured testing procedures and an acceptability survey using a Likert scale to quantify the respondents' evaluations in terms of functionality, usability, reliability, and usefulness. Likert scales are widely used in research because they allow the measurement of attitudes and perceptions and convert subjective responses into quantifiable data suitable for statistical analysis, according to Jebb et al. (2021). The collected data were analyzed using descriptive statistical tools such as mean, frequency, range, and standard deviation to provide a clear and objective summary of the results.

The descriptive quantitative design was used for the study because it allowed the researchers to objectively evaluate and describe the effectiveness and overall performance of the noise detector alarm system based on measurable data, without requiring experimental manipulation or control groups.

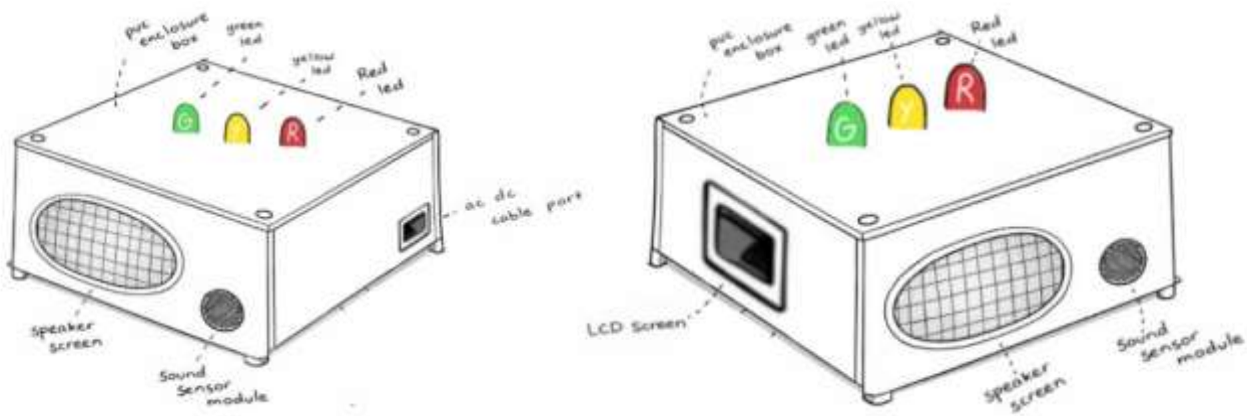

Figure 1. Project Design and Specifications

This part presented the development of a Noise Detection Alarm Device, an Arduino-based monitoring device designed to promote a healthier acoustic environment. By utilizing a high-sensitivity sound sensor, the system actively tracked ambient noise levels and provided immediate visual and auditory feedback to users. Encased in a durable PVC enclosure, this portable solution was ideal for classrooms, libraries, or offices where maintaining a specific sound threshold was essential for productivity and well-being.

Real-Time Noise Display. The system utilizes a sound sensor module to continuously detect ambient decibel levels and provides instant feedback through both an integrated LED traffic light system and an LCD screen that displays the real-time noise level in decibels within the room.

Audible Warning Alerts. An internal speaker system triggers an alarm when noise exceeds a preset threshold to immediately notify occupants to lower their volume.

Portable Protective Design. The entire circuit is housed in a compact PVC enclosure with a dedicated DC port, making it a durable and mobile solution for various indoor settings.

Table 1. Materials and Costing

Materials	Quantity	Unit Price
Breadboard	1 pc	₱59.00
Arduino Uno	1 pc	₱349.00
Arduino Case	1 pc	₱120.00
5 mm LED	3 pcs	₱75.00
Passive Buzzer	1 pc	₱49.00
MAX4466 Sound Sensor	1 pc	₱690.00
Resistors	6 pcs	₱94.00
Wires	9 pcs	₱84.00
Jumper Wires	11 pcs	₱50.00
Speaker Grill	1 pc	₱48.00
PVC Enclosure Box	1 pc	₱305.00
DC (5V) Adapter	1 pc	₱145.00
16x2 LCD Display	1 pc	₱95.00
Electrical Tape	1 pc	₱35.00
Illustration Board	1/8	₱16.00
Black Spray Paint	1 can	₱73.00
TOTAL:		**₱2,287.00**

Breadboard. Used to assemble and test the electronic components without bonding.
Arduino Uno. Serves as the system's main controller. It processes input from the sound sensor and controls the output devices, such as the LED and buzzer.
Arduino Case. Used to protect the Arduino Uno from external factors.
5 mm LED. Used as a visual indicator. It lights up to signal when the noise level exceeds the set limit.
Passive Buzzer. The piezo buzzer provides an audible alert when excessive noise is detected. It helps warn users to reduce noise levels.
MAX4466 Sound Sensor. Used to detect noise levels in the surroundings.
Resistors. Used to control the flow of current in the circuit. They protect components such as LEDs from damage.

Wires. Used to connect the electronic components on the breadboard. They allow power to be transferred within the circuit.
Jumper Wires. Used to establish temporary, solderless connections between components on a breadboard and the pins of an Arduino board, allowing for quick circuit prototyping and testing.
Speaker Grill. Used to cover and protect the speaker's opening. It allows sound to pass through while preventing dust or damage to the internal components.
PVC Enclosure Box. Used to protect the circuit and components. It is where the Breadboard and Arduino are placed. It helps keep the device safe and organized during installation and use.
DC (5V) Adapter. Used to supply power to the system. It converts power into a 5-volt output needed for the device to operate properly.
16x2 LCD Display. Used to display the real-time monitoring of the decibel levels produced by the noise source within the room.
Illustration Board. Serves as a platform for the internal parts of the device within the PVC Enclosure Box.
Black Spray Paint. Used to coat the PVC enclosure box, providing a clean finish and enhancing the visibility of the LED lights.

Table 2. Equipment needed

Materials	Quantity
Laptop	1 pc
USB Cable	1 pc
Screwdriver	1 pc
Soldering Iron	1 pc
Sandpaper	2 sheets
Glue Gun and Glue Stick	1 pc

Laptop. The Laptop is used to write, upload, and modify the program for the Arduino Uno. It is also used to monitor the system during testing.
USB Cable. The USB Cable is used to connect the Arduino Uno to the laptop.
Screwdriver. The screwdriver is used to tighten or loosen screws when assembling the enclosure and mounting the components securely.
Soldering Iron. The soldering iron is used to make a hole in the PVC Enclosure box.
Sandpaper. Used to smooth the surface of the PVC enclosure box before painting, ensuring that the spray paint adheres properly and produces a clean and even finish.

Glue Gun and Glue Sticks. Used as an adhesive to secure various components, such as attaching the illustration board inside the enclosure and fixing internal parts in their designated positions.

This project aimed to design and develop a noise detector alarm device for the NU Bulacan Learning Resource Center. This step-by-step approach ensured that the final device was accurate, reliable, and capable of maintaining an optimal learning environment.

1. Planning and Project Proposal
2. Approval of the Project Proposal
3. Further investigation into noise issues in the Learning Resource Center
4. Planning the operation of the Noise Detector Device
5. Selection of Required Electronic Components
6. Preparation of Materials and Tools
7. Circuit Layout and Wiring Connections
8. Assembly of the Noise Detector Device
9. Initial Testing of the Noise Detector Device
10. Adjustment and Troubleshooting
11. Consultation with an expert regarding the Noise Detector Device for evaluation and feedback
12. Providing an evaluation certificate to the expert for validation and signature
13. Preparation of the Acceptability Survey Questionnaires
14. Face Validity Test by the Research Adviser
15. Distribution of the Acceptability Survey Questionnaires as Reliability Testing to fellow students
16. Undergoing Reliability Testing of Acceptability Survey Responses
17. Demonstration of the Noise Detector Alarm Device to the Librarians
18. Collection of Librarians' Feedback and Evaluation through the Acceptability Survey
19. Collection and Analysis of Acceptability Survey Responses

The study employed a descriptive quantitative design with a structured testing setup to evaluate the performance of the developed noise detector alarm device. The device was tested under varying noise levels to determine whether it accurately detected sound and activated the appropriate visual and audible alerts based on predefined thresholds.

To further assess performance, testing was conducted at fixed distances of 1 meter, 3 meters, and 5 meters to evaluate the spatial reliability and consistency of the readings. The researchers performed self-testing, while field experts also conducted independent evaluations using the established procedures.

1. **Threshold Determination Test** – Determined whether the system correctly activated visual and sound alerts when predefined noise thresholds were exceeded. The test used the noise detector system, sound level meter, speaker, audio source, and data recording materials, and was conducted with a testing fee of ₱0.00.
2. **Accuracy Testing** – Evaluated the accuracy of the system by comparing its decibel

readings with those obtained from a standard digital sound level meter across varying noise levels. The test used the noise detector system, sound level meter, speaker, audio source, and recording sheet, and was conducted with a testing fee of ₱0.00.

3. **Spatial Reliability Test** – Assessed the consistency of the system's detection capability at fixed distances (1 meter, 3 meters, and 5 meters) from a controlled sound source. The test used the noise detector system, sound level meter, speaker, measuring tape, and markers, and was conducted with a testing fee of ₱0.00.

The data collected in the study were gathered primarily through a structured acceptability survey. Before conducting the survey, the instrument first underwent face validation by the research adviser to ensure that the statements were clear and relevant for evaluating the device. After validation, a reliability test was conducted among selected fellow students to check its consistency and identify any items that needed revision before its final use.

Once the instrument underwent validation and reliability testing, a product demonstration of the noise detector alarm device was conducted for the LRC staff. During the demonstration, the device's features, components, and functionality, including how the sound sensor detected noise and how the visual and audible alerts operated when the preset threshold was exceeded, were presented.

In addition, the researchers conducted self-testing, while field experts also conducted independent testing of the device using the established operating and testing procedures, such as the threshold determination test, accuracy test, and spatial reliability test, to systematically gather raw and reliable data. These procedures ensured that the device's performance, consistency, and measurement accuracy were properly assessed.

Afterward, the acceptability survey was distributed to the library staff, students, and field experts. The survey used a 4-point Likert scale (Unacceptable, Partially Unacceptable, Partially Acceptable, and Acceptable) to evaluate the device in terms of functionality, usability, and usefulness in maintaining a quiet environment. All collected data were securely compiled, stored, and used solely for academic purposes.

A thorough evaluation of the noise detector alarm device was conducted to ensure the reliability of its performance. The device was first finalized before undergoing evaluation by qualified field experts, who conducted product testing using the established operating and testing procedures to ensure that the device met the research objectives and performance standards. Following this, the researchers provided an evaluation certificate, which was formally validated by the experts, confirming that the device had been reviewed and verified.

Once validated, a structured acceptability survey was also administered to the field experts to gather their professional assessment of the device. Afterward, a product demonstration was presented to the LRC staff and students, followed by the distribution of the same survey to gather feedback on the device's effectiveness and usability. All data collected from the researchers' self-testing, expert evaluation, and survey responses were then analyzed using descriptive and inferential statistical methods to determine the overall performance, reliability, and acceptability of the device.

Table 3. Likert Scale

Weight/Scale	Mean Score Range	Mean Rating/Interpretation
4	3.25 - 4.00	Acceptable
3	2.50 - 3.24	Partially Acceptable
2	1.75 - 2.49	Partially Unacceptable
1	1.00 - 1.74	Unacceptable

This study used descriptive and inferential statistics to analyze the data collected from the noise detector alarm system. Measures such as the mean, range, and standard deviation were used to summarize the decibel (dB) readings from both the developed device and a standard sound level meter. Additionally, these measures helped determine appropriate threshold levels and assess variability in noise levels. Sensor readings at different distances (1 meter, 3 meters, and 5 meters) were also analyzed to identify patterns and evaluate measurement consistency across spatial conditions. These methods provided a clear overview of the system's performance under different conditions.

Furthermore, a Paired Sample T-test was applied to compare the device's decibel readings with those of a standard sound level meter to determine accuracy. This statistical method helped identify whether there was a significant difference between the two sets of readings, as both measurements were taken under the same conditions. All statistical tests were conducted at a 0.05 level of significance to ensure the validity and reliability of the findings, allowing for an objective evaluation of the device's performance.

This study focused on building and testing a noise detector alarm device for the NU Bulacan Learning Resource Center. The system measures sound levels in real time with sound sensors. It classifies noise according to specific thresholds, such as light noise (around 35 to 55 dB) and high or alert-level noise (above 85 dB).

The study described the design, assembly, calibration, and testing of the noise detector alarm device. We evaluated the device's ability to detect sound levels and activate an alarm when those levels reached the noise threshold. We also created surveys to assess how effective, easy to use, and acceptable the device was for librarians and students.

Following the expert's suggestion, future studies could improve the system design by using multiple sensor nodes instead of just one. This recommendation addressed the limits of sound travel and sensor range in larger classroom environments. Standard sound sensors like the MAX4466 worked best at short distances, and they sometimes struggled to pick up scattered noise in bigger areas. However, during the study's development, the researchers found the MAX4466 to be the most suitable and accessible sound sensor available at the time. Despite its drawbacks, the sensor performed effectively based on the study's goals and testing results.

The expert also suggested using ESP32-C3 microcontrollers with wireless options like Wi-Fi and Bluetooth Low Energy (BLE). This recommendation reduced wiring difficulties and allowed more flexible sensor placement. Additionally, future enhancements could involve portable power sources like lithium-ion batteries with TP4056 charging modules, as well as power-saving methods such as intermittent data transmission or activation based on thresholds. However, the current prototype was deliberately designed as a DC-powered device, following the advice of the initial group of panelists. Since the device was intended for a fixed classroom setting, a steady power supply was prioritized to ensure stable and uninterrupted operation.

This study only developed and demonstrated a prototype. It does not cover the actual installation in the Learning Resource Center. Our evaluation relies on survey responses, which may limit how broadly we can apply the findings. The device detects noise and alerts users. It does not offer noise reduction or soundproofing features. Also, hardware limitations might impact accuracy because of changes in background noise and sensor placement.

RESULTS

Table 4. Threshold Determination Test

THRESHOLD DETERMINATION TEST				REACTION DELAY	
dB Range	LED	Buzzer	LCD Status	Expected Results	Actual Results
30-40	Green	OFF	Quiet	10-200 ms refresh	10-200 ms refresh
41-60	Yellow	OFF	Medium	10-200 ms refresh	10-200 ms refresh
61+	Red	OFF (unless confirmed)	LOUD	10-200 ms refresh	10-200 ms refresh
61+ confirmed	Red	ON (3s)	ALERT	3s active. 2s cooldown	3.24s active, 0.74 cooldown

Table 5. Accuracy Test

Trials	Standard Meter Reading (dB)	Device Reading (dB)	p value
1st Trial	31.8	32	
2nd Trial	42.7	43	
Final Trial	45.3	43	
Average	**39.93**	**39.33**	**0.919**

Legend: *p<0.05, **p<0.01, ***p<0.001

Table 6. Spatial Reliability Test

Trials	Device Reading (dB)		
	1 Meter	**3 Meter**	**5 Meter**
1st Trial	32	40	43
2nd Trial	43	48	43
Final Trial	43	45	58
Average	**39.33**	**44.33**	**48**

Table 7. Overall Functionality of the Device

No.	Statement	Weighted Mean	Verbal Interpretation
1	The device is capable in accurately detecting noise levels in the school library environment.	3.80	A
2	The device is capable of responding quickly when noise exceeds the set threshold.	3.70	A
3	The device is capable of activating alerts	3.70	A

	at the appropriate noise level.		
4	The device is capable of distinguishing between low and high noise levels effectively.	3.30	A
5	The device is capable of maintaining consistent performance during operation.	3.30	A
OVERALL:		**3.56**	**A**

Legend: Unacceptable (U) 1.00-1.74, Partially Unacceptable (PU) 1.75-2.49, Partially Acceptable (PA) 2.50-3.25, Acceptable (A) 3.25-4.00

Table 8. Overall Usability of the Device

No.	Statement	Weighted Mean	Verbal Interpretation
6	The device is capable of being easily understood by students and staff.	3.40	A
7	The device is capable of being easy to operate without assistance and user-friendly in its overall design and function.	3.20	PA
8	The device is capable of providing clear and understandable alerts to users.	3.50	A
9	The device is capable of being conveniently placed within the library environment.	3.30	A
OVERALL:		**3.35**	**A**

Legend: Unacceptable (U) 1.00-1.74, Partially Unacceptable (PU) 1.75-2.49, Partially Acceptable (PA) 2.50-3.25, Acceptable (A) 3.25-4.00

Table 9. Overall Reliability of the Device

No.	Statement	Weighted Mean	Verbal Interpretation
10	The device is capable of consistently monitoring noise levels throughout the day.	3.50	A
11	The device is capable of functioning	3.40	A

	properly without frequent errors or interruptions.		
12	The device is capable of producing accurate readings at different distances from the noise source.	3.60	A
13	The device is capable of providing stable and dependable performance over time.	3.20	PA
OVERALL:		**3.43**	**A**

Legend: Unacceptable (U) 1.00-1.74, Partially Unacceptable (PU) 1.75-2.49, Partially Acceptable (PA) 2.50-3.25, Acceptable (A) 3.25-4.00

Table 10. Overall Usefulness of the Device

No.	Statement	Weighted Mean	Verbal Interpretation
14	The device is capable of helping maintain a quiet and conducive learning environment.	3.60	A
15	The device is capable of supporting library staff in managing noise effectively.	3.60	A
16	The device is capable of being a valuable addition to the Learning Resource Center.	3.60	A
OVERALL:		**3.60**	**A**

Legend: Unacceptable (U) 1.00-1.74, Partially Unacceptable (PU) 1.75-2.49, Partially Acceptable (PA) 2.50-3.25, Acceptable (A) 3.25-4.00

DISCUSSION

Table 4 showed the data of the threshold determination test. Based on the results gathered, the noise detector device was able to respond correctly to different noise levels. When the noise level was within 30–40 dB, the LED stayed green, the buzzer did not activate, and the LCD displayed “Quiet.” For 41–60 dB, the LED changed to yellow with a “Medium” status, and still no buzzer was triggered. When the noise level reached 61 dB and above, the LED turned red and displayed “Loud,” and the buzzer activated for a few seconds once confirmed. In terms of comparison, the expected response of the system (such as LED color, buzzer activation, and LCD output) was followed by the actual results. The response time was close to what was expected. The buzzer was expected to remain active for 3 seconds, while the observed duration was approximately 3.24 seconds, resulting in a difference of 0.24 seconds, indicating minimal deviation. The cooldown time also slightly differed, but remained within an acceptable range. This showed that the device performed consistently with only minor differences.

This meant that the device was reliable in following the set noise thresholds and giving the correct alerts. The slight difference between expected results and actual results did not significantly impact the system's overall performance. Similar to the study of Lansangan et al. (2021), noise detector systems were effective in identifying sound levels and providing real-time alerts. In addition, Sintawati (2023) explained that combining visual and sound alerts helped improve awareness, especially in quiet environments like libraries.

Table 5 showed the findings on the noise detector alarm device performance in terms of detecting decibel levels accurately when compared to a standard digital sound level meter. Across the three trials, the device readings (32 dB, 43 dB, and 43 dB) closely matched the standard meter readings (31.8 dB, 42.7 dB, and 45.3 dB). Additionally, the computed average values of 39.93 dB for the standard meter and 39.33 dB for the device showed minimal differences, further confirming the closeness of the measurements. Moreover, the p-value of 0.919, which was well above the 0.05 level of significance, indicated that there was no significant difference between the two sets of readings, validating that the device was capable of producing measurements that were statistically comparable to a standard instrument.

These findings supported existing literature, which emphasized that properly calibrated sensor-based systems could achieve reliable and accurate noise measurements comparable to standard devices. Rayon et al. (2023) highlighted that Arduino-based noise detection systems could produce consistent and dependable readings when tested under controlled conditions. Similarly, research on environmental noise monitoring (Zhang et al., 2024) confirmed that minimal variation between sensor readings and standard instruments indicated strong measurement validity. Therefore, the results validated the accuracy of the developed device and supported its use as a reliable tool for real-time noise monitoring.

Table 6 was organized into two sections. The "Trials" column showed the testing runs: 1st Trial, 2nd Trial, and Final Trial, while the "Device Reading" column presented the recorded values at a distance of 1 meter, 3 meters, and 5 meters, along with the computed average for each trial. The results showed readings of 32 dB for the 1st Trial, and 43 dB for both the 2nd and Final Trials, giving an average of 39.33 dB. At 3 meters, values increased slightly, ranging from 40 dB to 48 dB, with an average of 44.33 dB. At 5 meters, the readings varied more widely, from 43 dB to 58 dB, resulting in a higher average of 48 dB.

These data could evaluate the spatial reliability of the device being tested. A complete spatial reliability test was conducted to ensure the correctness and consistency of the device's measurements at different distances and in different environments. This aligned with the findings of Nguyen et al. (2023), which emphasized the importance of rigorous spatial reliability assessments to ensure the reliability of devices.

Table 7 illustrated the overall functionality of the Arduino-based noise detector alarm device. Statement 1, “The device is capable of accurately detecting noise levels in the school library environment,” received the highest weighted mean of 3.80, interpreted as Acceptable. The statements 2 and 3, “The device is capable of responding quickly when noise exceeds the set threshold,” and “The device is capable of activating alerts at the appropriate noise level,” similarly scored a weighted mean of 3.70. On the other hand, statements 4 and 5, “The device is capable of distinguishing between low and high noise levels effectively,” and “The device is capable of maintaining consistent performance during operation,” received the lowest weighted mean of 3.30 but still fell under the Acceptable interpretation. The overall grand weighted mean of 3.56, which corresponds to Acceptable.

These findings showed that respondents found the device’s ability to detect noise levels in the area to be acceptable. However, its performance may not have been consistent during operation. Similar results were seen in a classroom noise monitoring system that used an Arduino-based KY-037 sound sensor. This system showed effective noise detection and alert activation, but it needed proper calibration to ensure stable and reliable performance (Rifqah et al., 2023). This showed that while Arduino-based noise detection systems were usually effective at recognizing sound levels and triggering responses, their reliability could change depending on calibration and environmental conditions.

Table 8 presented the overall usability of the device based on the respondents’ evaluation. Statement 6, which stated “The device is capable of being easily understood by students and staff,” obtained a weighted mean of 3.40 and was verbally interpreted as Acceptable (A). Statement 7, "The device is capable of being easy to operate without assistance and user-friendly in its overall design and function,” received the lowest weighted mean of 3.20, meeting the verbal interpretation of Partially Acceptable (PA). Statement 8, "The device is capable of providing clear and understandable alerts to users,” earned the highest weighted mean of 3.50 and was interpreted as Acceptable (A). Lastly, Statement 9, which states that "The device is capable of being conveniently placed within the library environment,” obtained a weighted mean of 3.30 and was also interpreted as Acceptable (A). Overall, the device achieved a weighted mean of 3.35 with the verbal interpretation as Acceptable (A), indicating that respondents generally find the device usable.

Among the given indicators, Statement 8 garnered the highest weighted mean of 3.50, suggesting that the device could effectively provide clear and understandable alerts to its users. This supported existing studies, which emphasized that clear system feedback improved user interaction by keeping users informed (Žerovnik, 2024). In contrast, Statement 7 received the lowest weighted mean of 3.20, indicating that the capability of the device to operate without assistance still needed improvement. A recent study by Munandar & Santoso (2025) showed that improving a system’s interface to make it more intuitive significantly increased user satisfaction and usability scores. These results suggested that the device could provide clear and understandable alerts to users.

However, it still needed to improve its ability to operate independently and become more user-friendly. Doing so could increase its effectiveness and usability.

The data in Table 9 presented the respondents' assessment of the overall reliability of the device. Statement 12, which indicated that "The device is capable of producing accurate readings at different distances from the noise source," obtained the highest weighted mean of 3.60 and was verbally interpreted as Acceptable (A). This was followed by Statement 10, stating "The device is capable of consistently monitoring noise levels throughout the day," with a weighted mean of 3.50 (Acceptable). Statement 11, "The device is capable of functioning properly without frequent errors or interruptions," concerning performance without frequent errors, garnered a weighted mean of 3.40 (Acceptable). On the other hand, Statement 13, stating "The device is capable of providing stable and dependable performance over time," received the lowest weighted mean of 3.20, resulting in a verbal interpretation of Partially Acceptable (PA). Overall, the table showed a grand weighted mean of 3.43, which fell under the Acceptable (A) category, indicating that while there was room for improvement in long-term stability, the respondents generally perceived the device as a reliable tool for noise monitoring.

The acceptable reliability ratings suggested that the device effectively maintained high-quality data collection through its multi-sensor detection methods, which was critical for ensuring signal accuracy in educational contexts (Ping & Tao, 2025). The high rating for accuracy across distances, Statement 12, was particularly notable because recent research indicated that measurement error in portable monitoring tools could vary significantly depending on the hardware used, with some mobile-based sensors maintaining accuracy within 38 to 78 dB in real-world settings (Huyan et al., 2023). These results showed that there were continuing technical challenges in the field. Modern sensor design often faced difficulties in achieving high precision and reliability while working in complex environmental conditions. It was crucial to address these stability issues to ensure the device could effectively reduce the moderate negative impact that environmental noise had on students' cognitive and academic performance.

The data in Table 10 presented the respondents' assessment of the overall usefulness of the device. Statement 14, which stated that "The device is capable of helping maintain a quiet and conducive learning environment," obtained a weighted mean of 3.60 and was verbally interpreted as Acceptable (A). Similarly, Statement 15, stating that "The device is capable of supporting library staff in managing noise effectively," also garnered a weighted mean of 3.60 with a verbal interpretation of Acceptable (A). In addition, Statement 16, which indicated that "The device is capable of being a valuable addition to the Learning Resource Center," received the same weighted mean of 3.60 and was likewise interpreted as Acceptable (A). Overall, the table showed a grand weighted mean of 3.60, which fell under the Acceptable (A) category, indicating that respondents generally perceived the device as useful.

All statements obtained the same weighted mean of 3.60, indicating consistent responses among the respondents. This suggested that respondents consistently agreed on the usefulness of the device across all given aspects. Since there was no highest or lowest among the statements, it could be inferred that each feature of the device was equally valued by the respondents. This finding aligned with Renaud et al. (2024), who emphasized that excessive noise in learning environments could negatively affect students' psychological and physical well-being, highlighting the importance of maintaining a quiet and conducive academic setting. In addition, the study on the development of a portable noise detector device with vibration mechanism and light warning signal (Rayon et al., 2023) found that such devices effectively alerted users to excessive noise levels and were perceived as helpful and acceptable by respondents. Their findings further supported the effectiveness and usefulness of noise-detecting devices in promoting awareness and reducing unnecessary noise in library environments.

Conclusions

This study examined the development of a noise detector alarm system to monitor noise levels and create a better learning environment at the NU Bulacan Learning Resource Center.

The results showed that the noise detector alarm device could detect sound levels effectively and consistently. It proved reliable during testing. Survey results also indicated that the device was efficient, easy to use, and helpful in creating a more inviting learning environment for students and library staff.

Based on expert input, the study found that the current prototype used one MAX4466 sensor and an Arduino board. Its performance was limited by single-point detection and sound propagation issues. This limitation showed a clear opportunity for improvement through multi-node sensing systems that used ESP32-C3 microcontrollers.

The study concluded that adding wireless communication, distributed sensors, and improved power management could greatly enhance the device's scalability and real-world application. The project successfully demonstrated that accessible embedded systems technology could help monitor classroom noise. It served as a simple prototype for more advanced and scalable solutions in the future.

Recommendations

Based on the study results and expert suggestions, the researchers recommend these improvements for the noise detector alarm device:

First, the device's usability can be improved by simplifying its interface and operation. Clearer labels, better instructions, and a more user-friendly setup can help reduce confusion for first-time users.

Second, the device's stability and long-term performance should improve. Future versions may use better power management with lithium-ion batteries and TP4056 charging modules. Better power strategies, such as intermittent data transmission or threshold-based activation, can also help.

Third, it is recommended to upgrade the system from a single-sensor setup to a multi-node sensor system that uses ESP32-C3 microcontrollers. This change will fix problems with sound coverage and improve detection accuracy in larger or more complex environments.

Fourth, future researchers should test the device in a real library or classroom to evaluate its performance under different noise conditions and crowd sizes.

Fifth, upgrading hardware components such as the sound sensor—improving the sensitivity and calibration of MAX4466 or other sensors—can further enhance accuracy and reliability.

Lastly, future studies could look into adding features like noise level logging, data visualization, or pattern tracking. These additions could help find noise trends and support better decisions for maintaining quiet learning environments.

Compliance with Ethical Standards

This study was conducted while respecting the rights, safety, and privacy of all participants in accordance with the Data Privacy Act of 2012 to ensure that all information gathered was protected and used properly. Before conducting the testing and demonstration of the noise detector alarm device, permission was first requested from the school administration and the Learning Resource Center staff.

Participation in the acceptability survey was voluntary. The respondents were informed about the purpose of the study and how the data would be used. No personal or identifying information was collected. In addition, the noise detector alarm device only measured sound levels in decibels and did not record voices or conversations. This ensured that the privacy of students and staff inside the Learning Resource Center was protected. The testing of the device was also conducted in a way that did not disturb regular library activities.

All collected data were safely stored and were only accessed by the researchers. The information gathered was used solely for the completion of the study. These steps ensured that the research was conducted responsibly and that the participants' rights and privacy were properly protected

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