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High Accurate Automatic School Bell Controller Based On Arduino Uno DS1307 I2C Real-time Clock

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ABSTRACT

Education plays a crucial role in developing human resources with the necessary character and competence to meet the demands of the future Industrial 4.0 revolution. To ensure the effectiveness of the teaching and learning process, schools require supporting facilities and infrastructure. One such component is the school bell, which helps teachers notify students of daily schedules. As technology advances, some schools have adopted an automatic school bell as an alternative to traditional bells. These automatic school bells use Arduino microcontroller technology to ring at scheduled times, automatically improving accuracy and convenience. By utilizing sound output via an Arduino-based system, every created information can be easily delivered and reached. This study follows the System Development Life Cycle (SDLC) method, a widely used system development methodology encompassing hardware and software systems. The research successfully demonstrates an automatic school bell system capable of automatically producing notification sounds, optimizing electricity consumption, and generating precise sound frequencies during teaching and learning activities. The output voltage and current results at various parts of the automatic school bell system range from 4.17 to 5.90 volts and 488 to 602 mA, respectively. At the same time, power consumption achieved about 2.07 to 3.38 Watts. An automatic school bell system simplifies ringing the school bell as it seamlessly integrates with the scheduled timetable (software). As a result, the automatic school bell now rings automatically according to the pre-defined schedule, enhancing efficiency and ensuring timely transitions between classes and breaks.

Keywords *: Automatic school bell, Arduino Uno, System development life cycle, Real-time Clock.*

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1. INTRODUCTIONS

Education aims to produce competent people in their fields who have faith and are trustworthy when needed [1]. Human resources must be instilled through education to have the values and skills needed to meet the demands of the upcoming Industry 4.0 transformation. A school can only achieve its mission with classrooms that can teach the basics of the national curriculum. Schools are public or private educational institutions, formal or informal, whose primary goal is to train the next generation to achieve their potential as productive citizens [2]. Each school has adequate resources to ensure lessons are delivered and evaluated optimally. Many factors influence school learning, including goals, students, teachers, content, strategies, media, technology, resources, and assessment [3]. The school bell is a communication tool to inform students and staff of school lesson time line (entry, exit, and break schedules) [4]. Some schools have yet to use automatic school bells, making it difficult for students to know when class starts and ends and break times [5]. Additionally, there were problems when the occupying teachers failed to ring the bell promptly, made an announcement after it had already been made, or repeatedly made the same announcement [6].

Modern schools have installed and used electronic bells instead of traditional bells. They are used at each subject change, during class breaks, and at school when the electronic bell emits a buzzer sound or successive tones automatically. A school bell can be programmed to ring at a specific time every day using Arduino microcontroller technology. It allows teachers on picket duty to easily make statements by using bells. This technology allows for automating school bells by setting a daily ring time. All data generated can be easily understood using an Arduino-based system that outputs sound. As a result, it is critical to have a bell device that rings automatically in the classroom to aid in the learning process. An autonomous school bell machine that can emit sounds in MP3 and WAV file formats was developed in research published by [6]. It is an example of how technology can be used. This automatic school bell system employs a microcontroller to operate and regulate the ringing of the bells according to a predetermined schedule. In another study by [7], two systems were used and implemented for a browser-based bell scheduling system, where information about school bell schedules is entered and stored, and using the Arduino Uno microcontroller module circuit, RTC (Real-Time Clock), Ethernet Shield, Relay, and electric bell [8]. By entering day and hour information into a web-based system and school bell scheduling application, the system can function automatically without requiring additional input from the user until the day and time information needs to be updated.

This study uses Arduino Uno (Figure 1), Real-time Clock (RTC), an automatic bell scheduler, and web server-based technology to prototype a school bell system. Previous research on prototyping a school bell using an Arduino Uno microcontroller has been limited. Therefore, this study aims to develop a functional model that incorporates Arduino microcontroller software to create an autonomous school bell system with sound output. By implementing these technologies, the research aims to address the gap in the existing literature and provide a comprehensive solution for automating school bell systems. The study follows a systematic approach involving designing and developing the hardware and software components required for the autonomous school bell system. Through rigorous testing and analysis, the effectiveness and functionality of the system are evaluated. This research contributes to educational technology by providing a practical and innovative solution that improves the efficiency and reliability of school bell systems. It offers insights into developing and implementing Arduino-based systems in educational settings, paving the way for further advancements in the field.

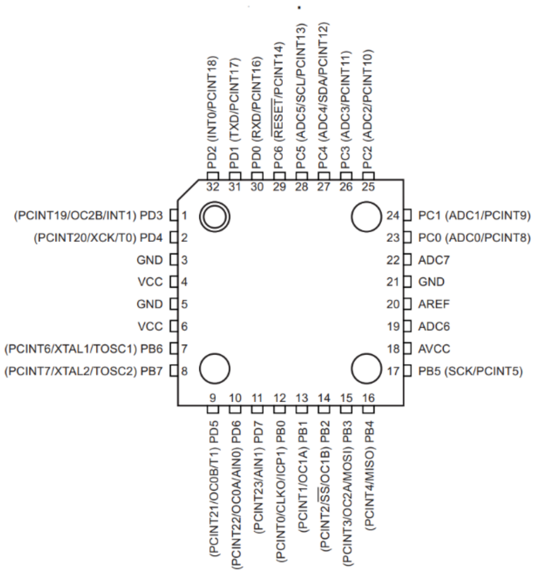


Figure 1. Pin configurations Arduino Uno [9]

2. METHODOLOGY

2.1. Development of Bell Ringing School

This investigation was conducted using qualitative methods. The Systems Development Life Cycle (SDLC) process is a tried-and-true method for developing, updating, and deploying computer systems [10].

Although the system life cycle is a process, the way it is frequently divided into hardware and software categories reflects the need to make systems faster. In system design, translating requirements into a functioning system (functioning system) is refined in collaboration with end users and analysts. Figure 2 shows the SDLC methodology to development of bell ringing school.

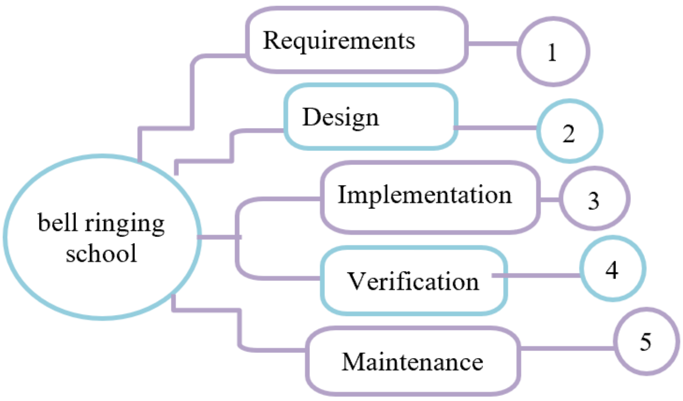
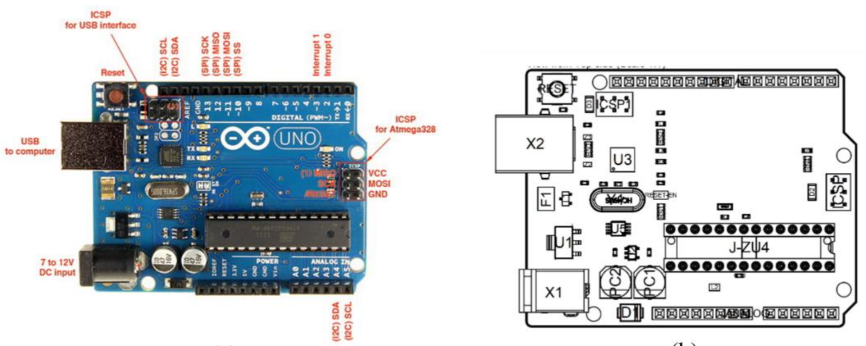


Figure 2. Development of bell ringing school using SDLC

2.2. Automatic Bell Ringing School Based nn Arduino

Arduino is a very popular hardware development platform. It is often used in various research and applications such as in kale planting applications [11], information system development [12], Fire system [13], control flowrate [14], machining system [15], light intensity [16] and collecting data based [17]. Design is a strategic step to create a detailed *automatic bell ringing school* system design following predetermined specifications. This design stage involves applying techniques, methods, and strategies to design designs used in system implementation [18].

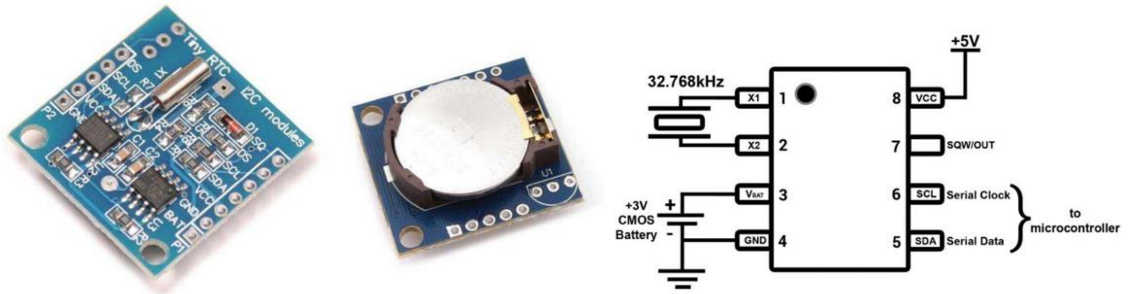
The design includes the actual system layout, which has been analyzed in the system development cycle and prepared according to the specifications set by the experts. The system design process is the visualization, planning, drawing, or arrangement of several components into a single functional unit [16]. A prototype is a miniature concrete example of a system or design used as a model for improvement or as a reference point in the development process [19]. The prototype provides an overview to the user regarding the final form of the product to be made. In addition, prototypes are also used to reduce the risk of errors and omissions in design specifications. Automatic school bells are essential devices that generate a buzzing sound and are used in school environments [7]. With the development of technology, modern school bells use electricity and can emit a single sound or a series of tones that can be adjusted as needed. Arduino Uno is a development board that uses the ATmega328 microcontroller [9]. Arduino Uno has 14 digital pins that can be configured as input/output, some of which have dual functions. The Arduino Uno also has six analog input pins, which generally have similar positions and locations on other Arduino boards (Figure 3).



(a) (b)

Figure 3. The Arduino UNO R3: (a) ATmega328 microcontroller, (b) Board topology [20]

A real-time clock (RTC) is a working electronic component storing time and date information. Time data is used to build digital clocks and integrated scheduling applications. The DS1307 RTC module can retrieve every second, minute, hour, day, month, and year. It accepts 12-hour and 24-hour time formats. The DS1307 can detect power outages and, if necessary, switch to a backup battery. Figure 4 depicts the RTC DS1307 [21].



(a) (b)

Figure 4. The track the current time and date: (a) DS1307 I2C RTC module (b) RTC DS1307 pin diagram [21]

The liquid crystal display (LCD) is LCD's primary function to regulate existing lighting (LED lights) as shown in figure Figure 5. LCD's low power consumption and growing character set have made it the preferred alternative to segment seven for many applications. LCDs are examples of none missive technologies [22] that do not generate light but control the transmission or reflection of light from another source. This study employed the LCD 16X2 1602 with I2C LCD Controller Module COM41, R11. It is intended for use with the Arduino Microcontroller, which has an I2C communication interface to display information on any Arduino-based project. It will save at least four Arduino digital/analog pins; all connectors are standard XH2.54 (Breadboard type) [23]. It has specification including display: 2 lines x 16 characters; backlight: blue with white character color; LCD controller: HD44780; pin definition: VCC/ GND/SDL and SCA; contrast adjust: potentiometer; backlight adjust: jumper; default address: 0 x27 and 0x3F; and working voltage: 5V.

Figure 5. LCD 16X2 1602 with I2C LCD Controller Module COM41, R11 [23].

2.3. MP3 DFPlayer Mini on Arduino Uno

The results of the automatic school bell test will provide crucial insights into the system's reliability and effectiveness. It will demonstrate whether the prototype successfully meets the objectives and requirements set during the design phase. Any deviations or issues encountered during the test will be carefully documented for further analysis and improvement. The outcome of the test will determine the readiness of the automatic school bell system for implementation in a real educational setting. If the prototype functions according to plan and meets the desired criteria, it will signify the successful development of an efficient and reliable solution. On the other hand, if any shortcomings or areas for improvement are identified, they will be addressed in subsequent iterations of the design and development process. As a result of the system being developed, MP3 DFPlayer is required to support it.

The MP3 DFPlayer is an electronic module specifically designed to facilitate sound playback in academic applications. With the ability to play MP3 files, it offers a wide range of functionalities, including song playback, queuing machine sound generation, and customizable audio settings. This module can operate independently with basic components such as a power supply, speakers, and buttons. However, its compatibility with popular microcontrollers like Arduino opens enhanced functionality by allowing integration with other devices, such as sensors, resulting in a more convenient and versatile system. A significant advantage of the MP3 DFPlayer lies in its user-friendly interface. Utilizing serial communication, it seamlessly interfaces with microcontrollers, such as Arduino and Raspberry Pi. This enables users to effortlessly control playback functions, including play, pause, stop, and volume adjustment, through simple commands. Once the assembly and programming of the Arduino Uno are complete, the prototype of the automatic school bell will be executed on the Arduino Uno platform. The purpose of this phase is to evaluate the functionality and performance of the system. The prototype will undergo a series of tests to determine whether it can operate according to the planned specifications. The DFPlayer, Arduino circuits and an *automatic bell-ringing developed* are presented in Figure 6.

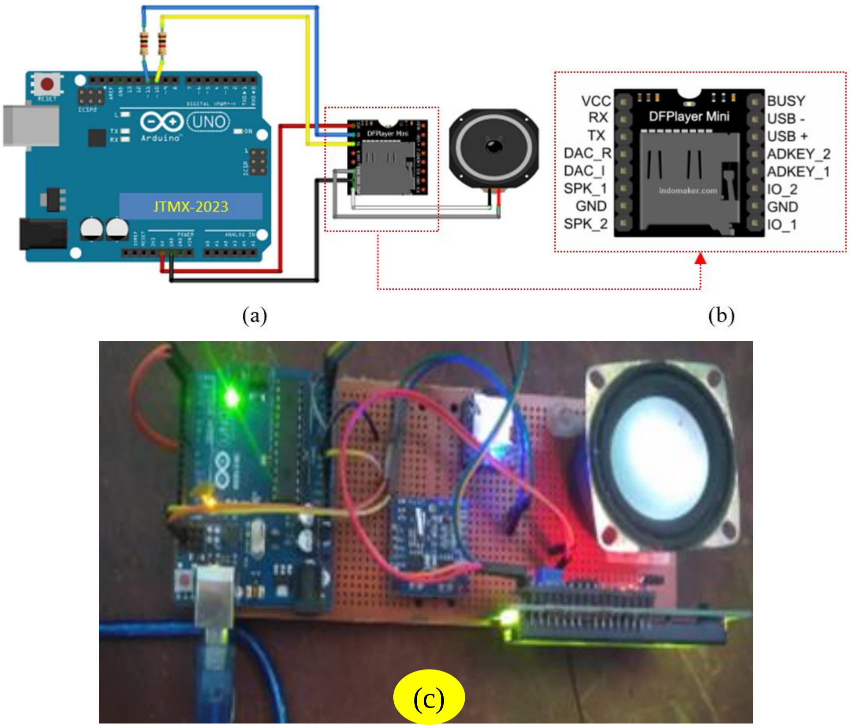


Figure 6. An automatic school bell-ringing: (a) DFPlayer and Arduino, (b) MP3 DFPlayer (c) An automatic bell-ringing developed

2.4. Measurement of Power Consumptions

Measurement of power consumption in an automatic bell-ringing system based on Arduino involves monitoring and measuring the electrical energy consumed by the system. The automatic bell ringing system, which utilizes Arduino as a microcontroller, controls the timing and activation of the bells in a school. Digital multimeters (DMMs) are selected for accurately measuring electrical parameters in these applications. Among these parameters, voltage and electrical current play crucial roles in electrical circuit analysis, troubleshooting, and system optimization. Measurement power consumption aims to measure voltage and electrical current effectively. Measurement power consumption should promote safe working practices by following the outlined steps and safety precautions. Select the appropriate voltage range on the DMM's dial to measure voltage and ensure that it exceeds the expected value. Connect the red test to the positive terminal and the black test to the negative terminal of the measured automatic bell-ringing system. The DMM will display the voltage reading of the electrical potential difference. The following step is measuring the electrical current; it is essential first to disconnect the circuit or component under consideration. Select the appropriate range and set the DMM to the current measurement mode. Break the circuit at the desired point and connect the DMM in series, with the red test lead connected to the positive and the black test lead connected to the negative. The DMM will display the current flowing through the automatic bell-ringing circuit. Power consumed by the automatic bell-ringing system using the formula in equation 1 [24].

$$P = V.I \tag{1}$$

Where *P* donated power (watt), *V* donated for voltage (volt), and *I* donated for an electrical current (ampere).

3. RESULT AND DISCUSSION

3.1. Power Consumption Analysis

The output voltage and current are measured at 4 locations using a digital multimeter. The first measurement was carried out on the DFPlayer component (DFP), then continued on the RTC, LCD, and Arduino components. Measurements were taken five times at eight predetermined 20-minute intervals in the range of 07.40-08.20, 8.20-09.00, 09.00-09.40; 09.40-10.20; 10.20-10-40; 10.40-11.00; 11.00-11.20; 11.20-12.00 and 12.00-12.00. The results were averaged and recorded with the unique code T1-T8. The output voltage at various parts of the automatic school bell system ranges from 4.17 to 5.90 volt, as shown in Figure 7. The mean voltage recorded during the testing was 4.73 volts. This voltage ranging from 4.17 to 5.90 volts, is close to the acceptable value. It guarantees that no power increases harm system parts while ensuring the entire system can function and operate safely. Furthermore, this data offers an overview of the supply of electrical power essential by the automatic school bell system. The system's required electrical power can be preserved securely and effectively with a steady output voltage that meets created requirements. Its automatic school bell system may provide the expected dependability and functionality while maintaining the output voltage throughout the allowed limits. It guarantees that the system operates appropriately inside the school surroundings and that the expected advantages of keeping precise and on-time bell timetables are realized.

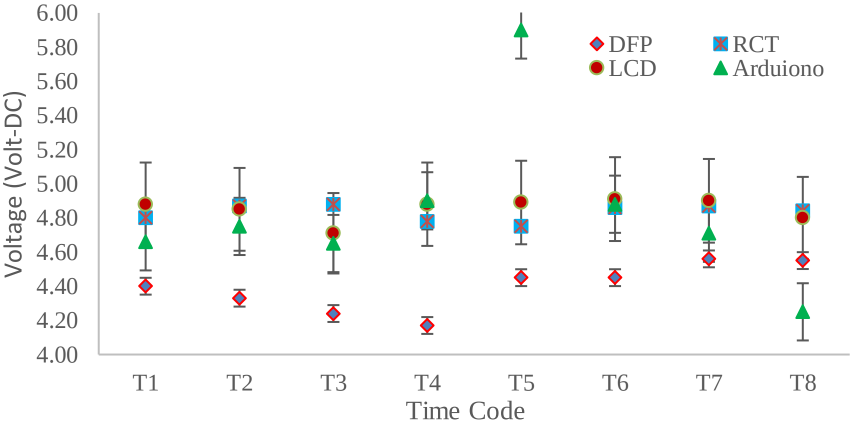


Figure 7. The result of voltage measurement on an automatic bell-ringing system

Measurements were taken five times at eight predetermined 20-minute intervals in the range of 07.40-08.20, 8.20-09.00, 09.00-09.40; 09.40-10.20; 10.20-10-40; 10.40-11.00; 11.00-11.20; 11.20-12.00 and 12.00-12.20. The results were averaged and recorded with the unique code T1-T8. Figure 8 shows that the automatic school bell component uses a current ranging from 488 to 602 mA. The average electrical current during the measurement is 0.535 mA. As a result, 5.31 watts of average power are required and provided to run the automatic school bell from 7.40 a.m. to 12.40 p.m.

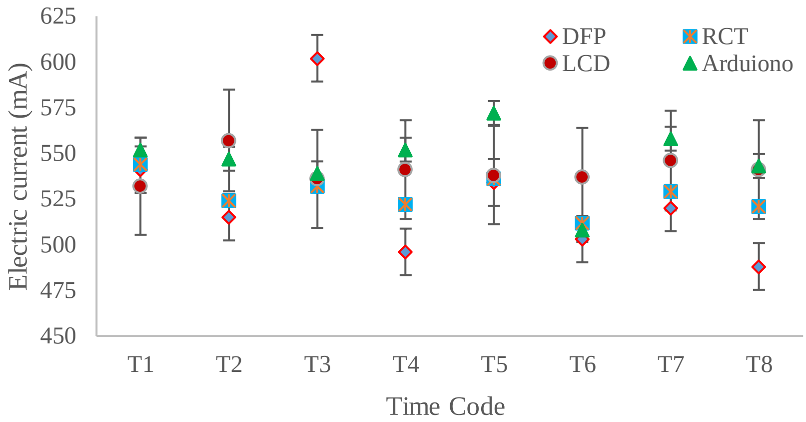


Figure 8. The result of electrical current measurement on an automatic bell-ringing system

In the programming process, the Arduino IDE software is used. This software is used to enter the program code into the Arduino, RTC, DS1307, and DFPlayer components. The programming process is done through input on the Arduino and in the form of looping. If the programming process is successful, the hardware outputs on the RTC, DFPlayer, and DS1307 components will turn on according to the program set. Thus, the automatic school bell requires a power consumption of about 2.07 to 3.38 Watts. Equation 1 calculates the power consumed by the automatic school bell-ringing system. The result of power consumption was taken five times at eight predetermined hourly intervals between Power consumption results were taken five times at eight predetermined 20-minute intervals in the range 07.40-08.20, 8.20-09.00, 09.00-09.40; 9:40-10:20; 10:20-10-40; 10.40-11.00; 11.00-11.20; 11.20-12.00 and 12.00-12.20 are presented in Figure 9.

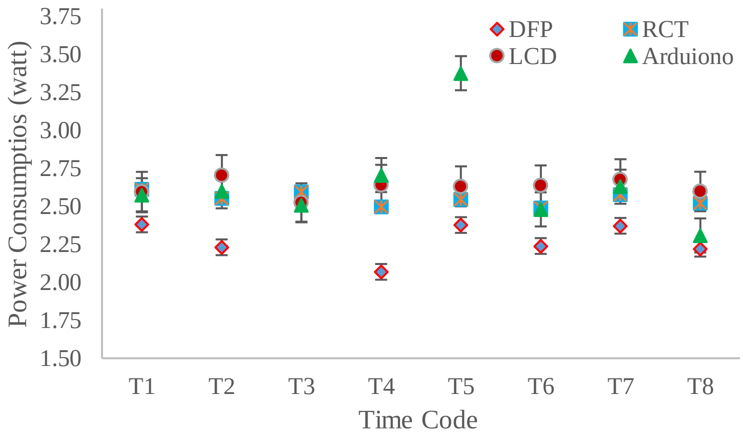


Figure 9. The results of the calculation of electric power in the automatic bell sound system

3.2. The Intensity of Sound (dB)

The intensity of a sound (in dB, or W.m^{-2}) is used to confirm the design of the Arduino-based automatic bell sound system. A sound's intensity is measured using a digital sound level meter (DSLM), which has an accuracy of 0.1 dB, as shown in Figure 10. The DSLM used has a measurement range between 30 – 130 dB. In a quiet environment free from noise, the sound frequency of the automatic school bell is tested. Notification sounds are played at set intervals, and the intensity is measured. The sound intensity can vary depending on power of automatic school bell is generated. It relevant with fundamental theory that sound intensity is the amount of sound energy radiated per second through a unit area [25]. Measurements were made five times at 12.00-12.20 (T8). This period was chosen because the temperature is assumed to be at the optimum condition [26] [27]. Employers have a legal obligation to ensure the safety and health of their workers, especially when it comes to protecting them from excessive noise exposure. The regulations require employers to take specific measures to protect employees and provide an appropriate work setting. The level at which employers must provide hearing assistance and establish getting safety zones represents one of the critical levels. The limit is 85 dB(A) for exposure daily average in eight hours continuously. When noise levels in the workplace exceed this level, employers must provide workers with appropriate protection for their ear equipment. To reduce the risk of hearing harm, they also must create assigned areas or zones where noise protection is mandatory.

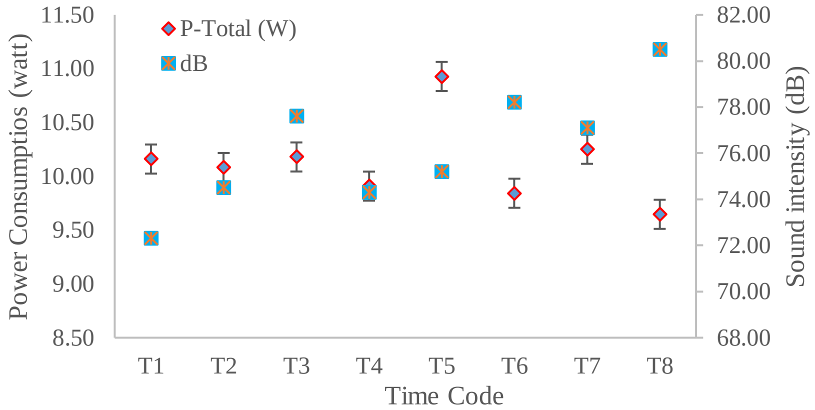


Figure 10. The results of the sound intensity of the automatic bell sound system

The evaluation involves assessing the potential effect of exposure to noise on worker well-being and implementing risk-mitigation precautions. Furthermore, there is a being exposed limit of 87 dB (A) that considers any exposure decrease provided by ear protection. Workers should not be subjected to noise levels exceeding this threshold, even if they wear hearing aids. Employers must guarantee that noise levels are monitored and maintained below this level to protect personnel getting health.

4. CONCLUSION

The automatic school bell devices are designed to include every necessary electronic part, such as an Arduino Uno, RTC, DFPlayer, i2C LCD, and speakers. The instrument's examination validated its ability to function and demonstrated its assembling possibility. The automatic school bell tool proves efficient and effective, aligning with the school bell schedule and simplifying the ringing or activating of the bell without requiring manual adjustments. Furthermore, the tool successfully fulfills its intended purpose. With the automatic scheduling feature, manual settings are eliminated, streamlining the bell activation process. The tool's performance and usability make it a viable candidate for commercial production. The test results highlight the automatic school bell's commercial potential. Its exceptional performance and user-friendly design make it suitable for implementation in various educational institutions, ensuring punctuality and accuracy in school bell schedules. The design of the automatic school bell achieves its goals. The automatic school bell significantly contributes to efficient time management in the school surroundings by providing automatic notifications and ease of use..

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation, and discussion of results. The authors read and approved the final manuscript.

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contributions in data collection, analysis, and manuscript preparation are greatly appreciated.

Availability of data and materials
All data are available from the authors.

Competing interests

The authors declare that they have no competing interests. They conducted this study solely to investigate the impact of various parameters on the welding process. The selection of materials and the formation of proper weld joints were deemed critical in ensuring the accuracy and reliability of the experimental results.

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