Department of Electronic & Telecommunication Engineering,
University of Moratuwa, Sri Lanka.

Wireless Emergency Alert System for Live Performers

Group Members:

230065H	Manitha Ayanaja
230147L	Sachinthaka Dilhara
230395T	Kaveesha Divyanga
230248X	Mishen Janodya

Submitted in partial fulfillment of the requirements for the module
EN1190 Engineering Design Project
Date: July 8, 2025

Abstract Live performance environments demand fast, discreet, and effective communication between performers and technical crew. However, conventional methods such as hand signals or physically reaching out to technicians are inefficient and disruptive. This project presents a **wireless emergency alert system** designed specifically for stage performers. Built around a custom PCB featuring the ESP32-WROOM-32 microcontroller, the wearable device enables one-touch alert transmission over a local Wi-Fi network. Alerts are displayed in real-time on a mobile-responsive web dashboard, developed using Flask and accessible via QR code. The system operates fully offline, supports multiple users, and is housed in a compact 3D-printed enclosure suitable for live stage use. With positive feedback from local musicians and event organizers, the solution offers a low-cost, scalable alternative to existing bulky or unavailable alert tools in Sri Lanka's live event industry.

Contents

1 Problem Description **3**
1.1 Problem . . . 3
1.2 Expected Goals . . . 3
1.3 Solution . . . 3
1.4 Justification of Selection . . . 3

2 Product Feasibility **3**
2.1 Technical Feasibility . . . 3
2.2 Hardware Feasibility . . . 3
2.3 Software Feasibility . . . 4

3 Applications and Extensions **4**

4 Web Application (Dashboard) **4**
4.1 Key Features: . . . 4
4.2 Technical Highlights: . . . 4
4.3 Advantages: . . . 5

5 Product Specifications **6**

6 System Architecture **6**

7 Sketches of Product Design **8**
7.1 Initial Sketch . . . 8
7.2 Final Design . . . 9

8 PCB Design **10**

9 Final Product **11**

10 Power Consumption and Battery Performance **11**

11 Market Analysis **12**
11.1 Key Advantages . . . 12
11.2 User Feedback . . . 13

12 Marketing, Sales and Beyond **13**

13 Future Improvements **13**

14 Team Task Allocation **14**

15 Final Budget and Pricing **14**

1 Problem Description

1.1 Problem

Live event environments are high-pressure and time-critical. Performers often face technical issues like audio mismatches, faulty monitors, or disconnections, but lack a fast and silent way to inform the crew. A survey conducted among 30+ local musicians and organizers revealed that over 80% experienced such issues and preferred a portable alert system over hand signals. This highlights a strong local demand for a low-cost, silent, real-time communication tool tailored for Sri Lanka's live music industry.

1.2 Expected Goals

- Real-time, silent communication
- LAN-based alert system (no internet dependency)
- Intuitive and non-intrusive device operation

1.3 Solution

We designed a compact wearable alert device that sends alerts over a local Wi-Fi network. Each device includes a single button that triggers an alert, displaying the artist's name and alert icon on a web dashboard for immediate crew response.

1.4 Justification of Selection

Selected for its simplicity, low component cost, fast deployment, and relevance to the live performance environment. It directly addresses a critical problem in a novel and efficient way.

2 Product Feasibility

2.1 Technical Feasibility

The system architecture includes two parts: a wearable transmitter and a Flask-based web server running on a laptop or Raspberry Pi. The ESP32 communicates over Wi-Fi with the server. The server includes UDP discovery, real-time alert queueing, and a local dashboard. WebSockets enable real-time updates.

All components used in this project—ESP32-WROOM-32 chip, TP4056, Li-Po batteries, and SMD parts—are readily available from local suppliers. The software is based on the lightweight Flask framework and has been tested in offline conditions. The alert mechanism has been tested using a simulated concert setup and performs reliably over a typical 3–4 hour show. LED indicators provide live status feedback, and the battery supports up to upto 5 hours of standby time on a full charge.

2.2 Hardware Feasibility

- ESP32-WROOM-32 chip
- TP4056 Charging Module for Li-Po battery
- Slide switch for power control
- Compact 3D-printed enclosure with button access
- Status LED for feedback

2.3 Software Feasibility

- ESP32 Firmware (Arduino C++): Wi-Fi config, alert button logic, server discovery via UDP
- Web Server (Python Flask): Web app, alert queue, dashboard
- HTML/CSS/JavaScript: Frontend for display

3 Applications and Extensions

Applications:

- Live concerts and music festivals
- School or university performances
- Theater productions
- Emergency signaling for disabled performers

Future Extensions:

- Multi-role access (organizer/crew dashboard view)
- Alert classification (instrument, monitor, lighting)
- Mobile dashboard app

4 Web Application (Dashboard)

The web application is a key component of the Wireless Emergency Alert System, acting as the central interface for the technical crew to monitor live alerts from performers. Designed using Flask (Python) for the backend and HTML/CSS/JavaScript for the frontend, it runs locally on a PC.

4.1 Key Features:

- **Real-Time Alert Display:** When a performer presses the button on their wearable device, the alert is instantly displayed on the dashboard with the device name and timestamp.
- **Audio Notification:** A built-in alert sound helps grab attention during live scenarios, ensuring no alert goes unnoticed.
- **Responsive Design:** The dashboard is optimized for both desktops and mobile devices, enabling use on tablets or phones without requiring any additional apps.
- **QR Code Sharing:** The app generates a QR code containing the server URL, allowing other users on the same network to join the dashboard instantly.
- **Network Device Discovery:** The system supports detection of server IP addresses dynamically, making the setup process easier in multi-device networks.
- **Tab-based Sidebar:** The user interface includes tabs for "Sound Settings" and "Dashboard Sharing," improving user control and configuration.

4.2 Technical Highlights:

- Built using Flask's Jinja2 templating to dynamically render alerts.
- WebSockets and JavaScript ensure live updates without page refresh.
- Compatible with all modern browsers with zero installation required.

4.3 Advantages:

- **No Internet Required:** Runs entirely on a local network, ensuring full functionality even in offline venues.
- **Multi-User Support:** Multiple crew members can view the dashboard from their own devices simultaneously.
- **Low Hardware Requirements:** Can be hosted on a low-cost device like Raspberry Pi or any basic laptop.

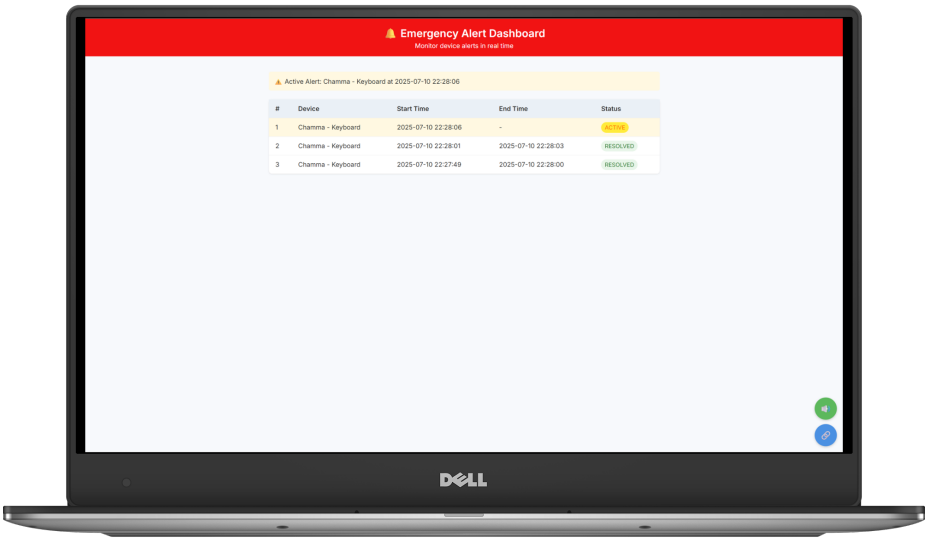

Figure 1: Web App View 1

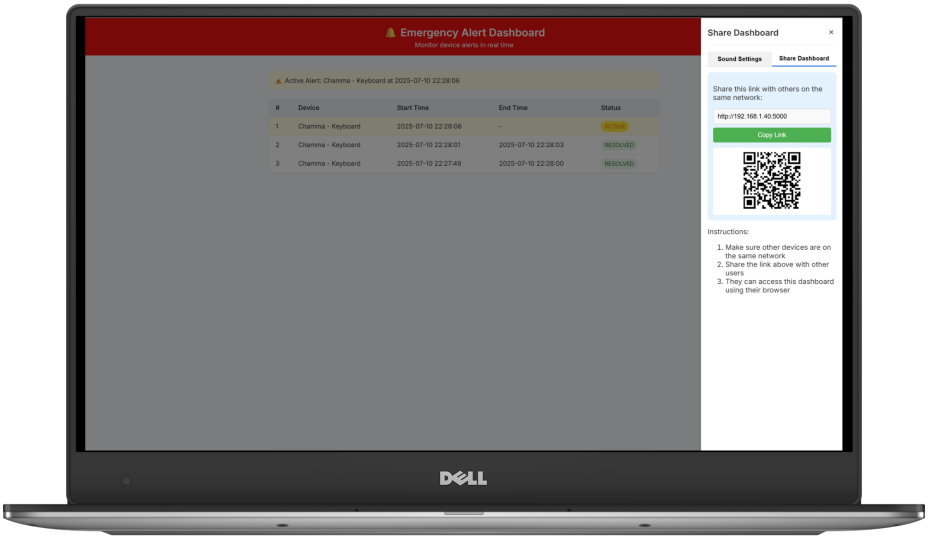

Figure 2: Web App View 2

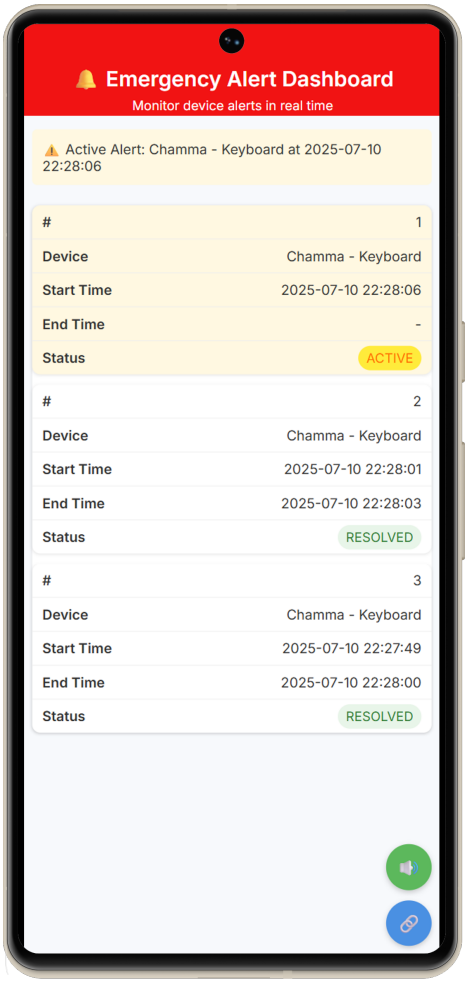

Figure 3: Mobile View

5 Product Specifications

- **Microcontroller:** ESP32-WROOM-32 Chip
- **Connectivity:** 2.4GHz Wi-Fi, local-only
- **Power:** 3.7V 500mAh Li-Po rechargeable
- **Charging:** Micro-USB via TP4056
- **Alert Interface:** Tactile push button, LED feedback
- **Enclosure:** Custom 3D print, clip-on or belt-mount

6 System Architecture

The product is designed as a modular system consisting of hardware and software components that together facilitate seamless emergency communication during live performances. The architecture is divided into the following key blocks:

- **ESP32 Control Unit:** Acts as the brain of the system. It reads input from the alert button, handles Wi-Fi connectivity, and sends alert data to the server.

- **User Interface:** Includes a tactile alert push button, two side buttons (for Wi-Fi reconnect and artist info reset), and a status LED that blinks upon alert transmission.
- **Power Supply:** A rechargeable 3.7V 500mAh Li-Po battery powers the device. It is managed via a TP4056 charging module with a slide switch for manual ON/OFF control.
- **Web Server (Flask):** Hosted on a local PC or Raspberry Pi. It receives alerts from ESP32 and updates the dashboard in real-time using WebSockets.
- **Web Dashboard:** A browser-accessible UI that displays live alerts with timestamps. It also provides QR sharing, sound settings, and is mobile-optimized.

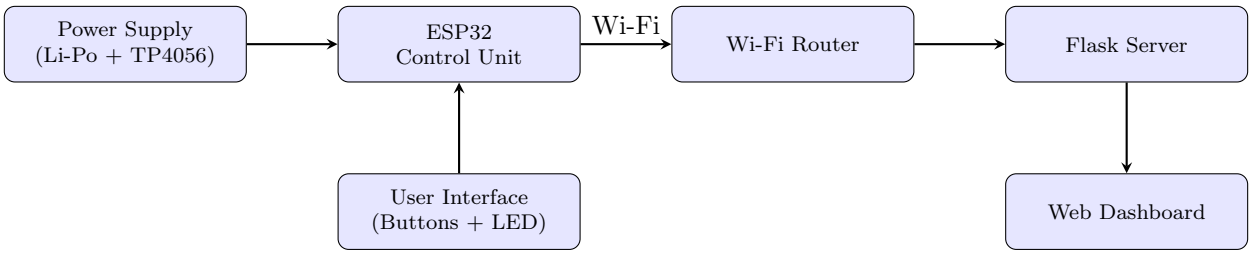

Figure 4: Compact Block Diagram

Design Notes

- The ESP32 firmware is written in Arduino C++, using HTTP POST and UDP for server discovery.
- The web server uses Flask with WebSocket integration for real-time updates.
- All components are placed on a compact custom PCB with SMD components.
- The enclosure design ensures quick access to buttons while protecting internal components during live events.
- Two auxiliary buttons on the side allow easy Wi-Fi reconnection and artist ID reset without external tools.

Note on Deviations: The design followed the original plan with no major deviations. However, two extra buttons were added as enhancements to provide on-device resetting and Wi-Fi reconnect features.

7 Sketches of Product Design

7.1 Initial Sketch

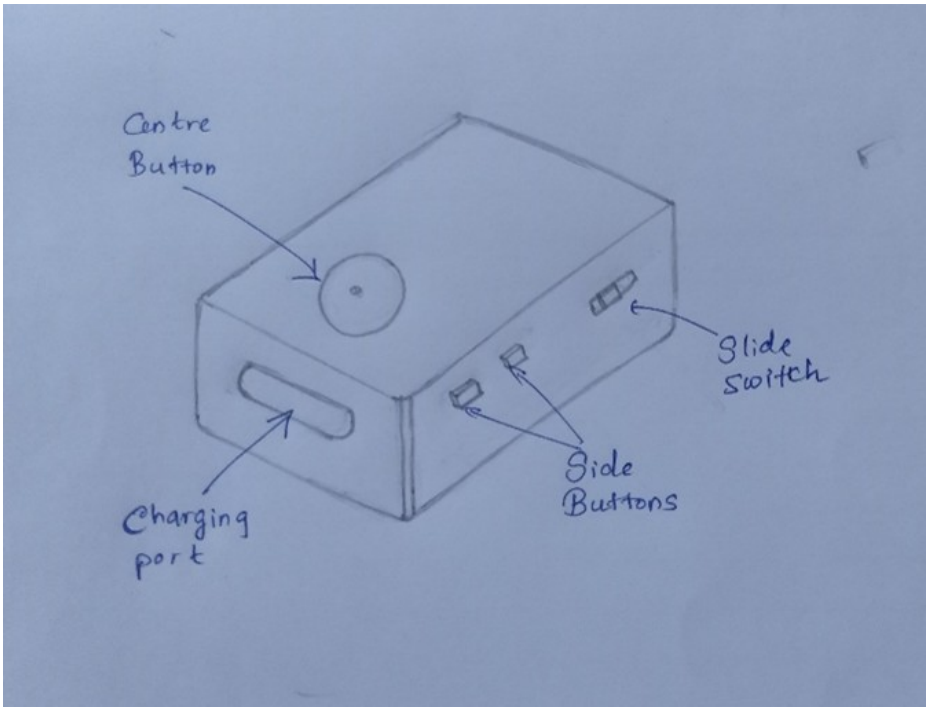

Figure 5: Initial Sketch

7.2 Final Design

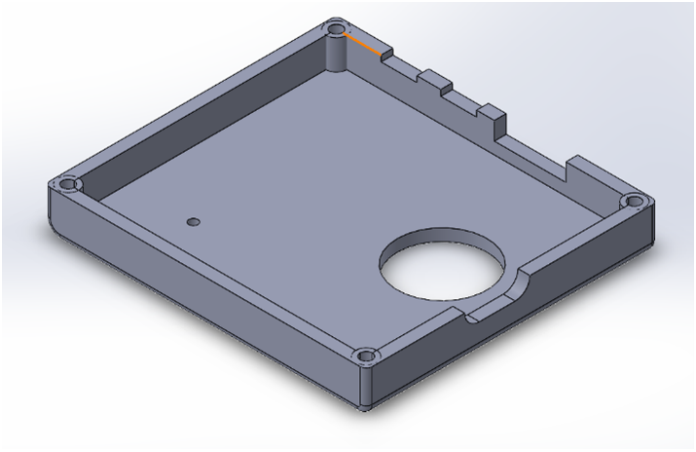

Figure 6: Upper Lid

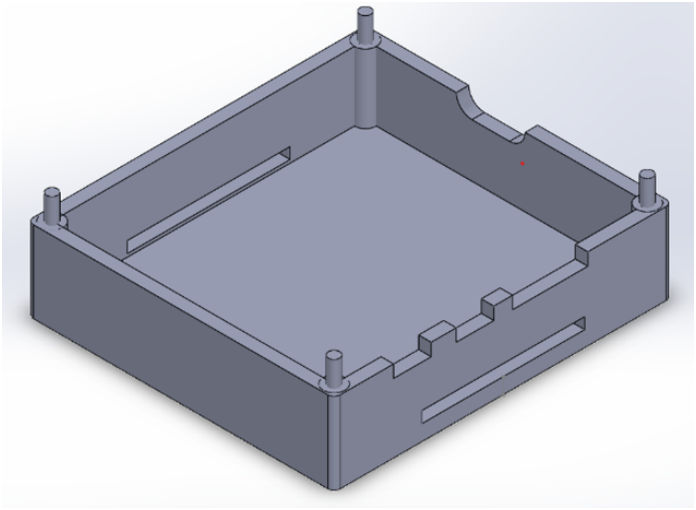

Figure 7: Lower Lid

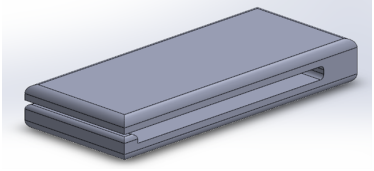

Figure 8: Handle

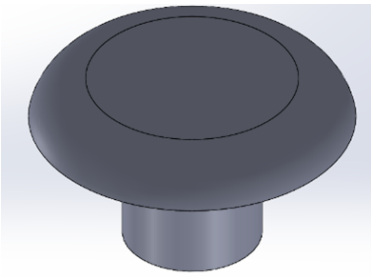

Figure 9: Center Button

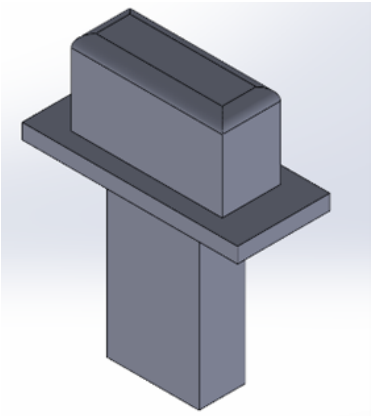

Figure 10: Side Button

8 PCB Design

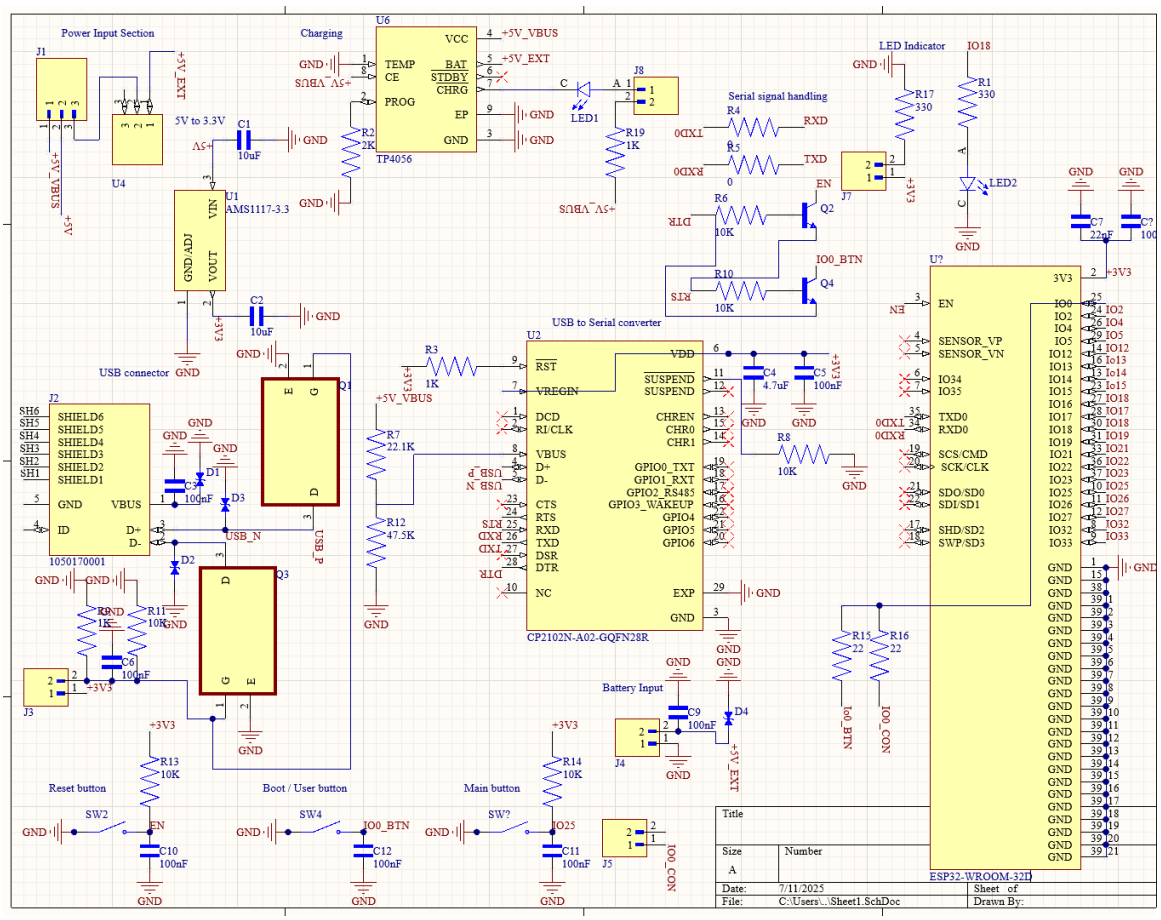

Figure 11: Schematic Diagram

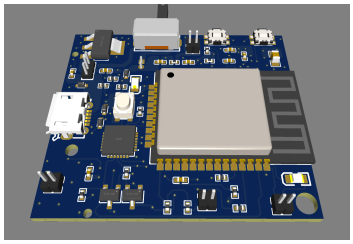

Figure 12: PCB 3D

9 Final Product

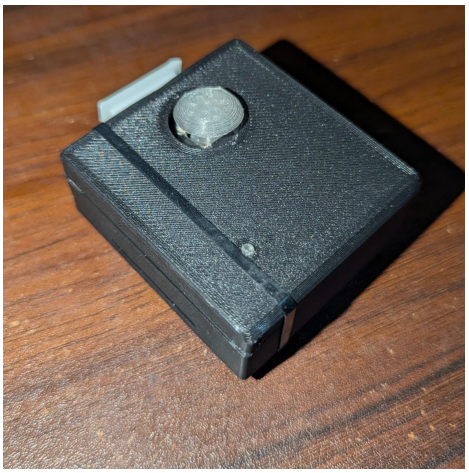

Figure 13: Front View

Figure 14: Internal View

Figure 15: Rear View

10 Power Consumption and Battery Performance

The device is designed to operate efficiently during typical concert durations, while ensuring reliable wireless connectivity and alert functionality.

Power Source

- **Battery Type:** 3.7V 500mAh Li-Po rechargeable battery
- **Charging Module:** TP4056 with micro-USB (5V input)

Measured Current Draw

- **Idle Mode (Wi-Fi connected):** ∼80–100 mA
- **During Alert Transmission:** Peaks at ∼150–160 mA (for a few seconds)

Battery Life Estimate

The estimated battery life is calculated using average consumption:

$$\text{Average consumption} \approx 90\,\text{mA} \quad \Rightarrow \quad \frac{500\,\text{mAh}}{90\,\text{mA}} \approx 5.5\,\text{hours}$$

- **Expected Usage Time per Charge:** 4–5 hours of continuous Wi-Fi connection (realistic usage in live events)
- **Charging Time:** ∼1.5–2 hours (via standard 5V USB power supply)

Conclusion

The battery is sufficient for most concerts and rehearsals, which typically last 2–4 hours. The device is designed for daily charging, similar to other stage equipment.

11 Market Analysis

The **Wireless Emergency Alert System** is specifically designed for **musicians, stage performers, and technical crew members** in live entertainment settings. Its primary target audience includes **music bands, audio technicians, university concerts, school events, theater productions**, and other stage-based performances where quick, non-verbal communication is critical.

Based on a detailed survey conducted among over 30 individuals in the industry — including guitarists, drummers, singers, and event organizers — a clear need for such a system was identified. Commonly reported issues include:

- In-ear monitor failures
- Audio level mismatches
- Instrument disconnections
- Delay in reaching technicians during live performances

Traditional communication methods such as hand signals or physically approaching technicians were found to be disruptive and inefficient. Respondents expressed a preference for portable alert systems that are silent, reliable, and easy to use during performances.

11.1 Key Advantages

Our system offers several competitive benefits:

- **Affordable:** Estimated cost of LKR 7,500 per device falls well within the expected user budget (LKR 2,000–15,000).
- **Offline Operation:** No internet required. Operates entirely on a local Wi-Fi network.
- **Custom PCB Design:** Built using a custom PCB with SMD components and the ESP32-WROOM-32 chip, ensuring compact size and reliability.
- **Scalable:** Supports multiple performers simultaneously. A typical band setup can have each member using their own device.
- **Customizable:** Software and dashboard can be adapted for different stage roles or alert categories upon request.
- **Dashboard Access:** Alerts are displayed in real-time on a mobile-friendly web dashboard, accessible via QR code or local IP.

11.2 User Feedback

Although the system has not yet been tested in a live concert, direct feedback from musicians and event organizers has been highly positive. Many expressed interest in:

- Vibration and LED feedback (for quiet environments)
- Visual dashboards for audio engineers
- Multi-device accessibility

These responses validate both the **demand** and **practicality** of the product, especially in the Sri Lankan performance sector where such tools are largely unavailable or cost-prohibitive. Our system fills this gap with a **market-ready, locally-built, and cost-effective solution**.

12 Marketing, Sales and Beyond

Marketing Strategy:

- Direct outreach to pofessional bands, gig players, technicians, and live event organizers.
- Leverage demo sessions and word-of-mouth from music professionals.
- Use social media to showcase the device and market.

Sales Model:

- Sell units in packs (e.g., 5-unit starter packs) for typical band setups.
- Provide QR-code based dashboard access, plug-and-play experience.
- Offer software customization for specific stage roles or device naming.

Scalability:

- The system supports multiple wearable devices connected to a single server.
- Server software allows dynamic addition/removal of users.

Support Plans:

- Include user manual with each pack.
- Provide optional updates, remote setup help, and warranty for up to 6 months.

13 Future Improvements

The system currently fulfills its intended use; however, we plan the following enhancements:

- **Vibration Alert Module:** For silent environments like acoustic concerts or theaters.
- **OLED Display Integration:** To show alert confirmation, battery status, or role name.
- **Mobile App Companion:** To enable organizers to send alerts back to performers.
- **Battery Indicator LEDs:** To show real-time battery level and charging status.
- **Wi-Fi Mesh Support:** To improve coverage in larger venues or outdoor stages.

14 Team Task Allocation

Name	**Task Description**
Manitha Ayanaja (230065H)	Firmware programming, web application development, dashboard UI, soldering, PCB designing
Sachinthaka Dilhara (230147L)	PCB designing, soldering
Kaveesha Divyanga (230395T)	Enclosure designing, soldering
Mishen Janodya (230248X)	PCB designing, soldering

Table 1: Task Allocation

15 Final Budget and Pricing

Component	**Price (Rs.)**
ESP32-WROOM-32 Chip	800
Custom PCB	540
PCB Components	3500
Li-Po Battery	730
3D Printed Enclosure	1200
Miscellaneous Expenses	1000
Total Cost Per Device	**Rs. 7,770**

Table 2: Final Prototype Bill of Quantities

Selling Price Justification

To ensure long-term sustainability and profitability, we propose a selling model based on batch sales:

- **Target Market:** Music bands with 5–7 performers typically order in sets.
- **Profit Margin:** A margin of 20% is added to the production cost.
- **Final Price:** Rs. 7,770 $\times$ 1.2 = **Rs. 9,324** (rounded to Rs. 9,350)

Thus, a 5-unit band pack would be offered at Rs. 46,750, competitive and practical for the local market.