

Project Proposal L5 –Engineering and Project Management– ACDA5025

Electrical & Electronic Engineering Degree
Apprenticeship

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To develop a compact, long-lasting medical alert device that continuously monitors vitals and provides instant emergency communication.	
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1. Introduction

Medical alert devices are beneficial to a wide range of individuals, and even more so to the elderly. Those who require living aids such as transfer devices, mobility aids, and bath and shower aids are more likely to experience a fall. And after falling, the likelihood of falling again doubles [1]. Falls are the leading cause of injury for adults over the age of 65 and are considered the leading cause of injury-related deaths among adults in that age category [2]. This issue is only growing with an aging population, and more falls and fatalities are likely to occur. Many medical alert devices on the market already include communication with a call centre; however, this is generally only for when a user is at home. The project being proposed is to create a medical alert device that will provide reliable communication and continuous vital monitoring in and outside of the home.

2. Aim and Objectives

To develop a compact, long-lasting medical alert device that continuously monitors vitals and provides instant emergency communication.

3. Objectives:

Ensure Compact Form Factor

- **Rationale:** The device must be small enough to be worn discreetly on the wrist or thigh without discomfort or interference with daily activities.
- **Performance Metric:** Final prototype must fit within 80mm x 50mm x 15mm.
- **User Impact:** Ensures 24/7 wearability and user compliance.

Integrate Continuous Monitoring of Heartbeat, Pulse Oximetry, and Elevation

- **Rationale:** Real-time monitoring of vital signs enables early detection of medical anomalies such as hypoxia or cardiovascular irregularities. Continuous altitude tracking also helps detect falls or unusual movement patterns.
- **Performance Metric:** Sensors must provide reliable data with <5% error under typical use conditions.
- **User Impact:** Supports proactive healthcare and improves emergency response accuracy.

Provide Communication via Wi-Fi/Bluetooth to Direct or Relay Calls

- **Rationale:** A communication module ensures the device can function both independently and when paired with a smartphone, expanding its operational range and usability.
- **Performance Metric:** Successful transmission of emergency alerts and voice calls within 10 seconds of incident detection.
- **User Impact:** Guarantees that users can call for help regardless of location or network dependency.

Include a Microphone and Speaker for Alerts and Communication

- **Rationale:** A built-in microphone and speaker enable the device to support two-way voice communication and generate audio alerts, including battery warnings.

- **Performance Metric:** Microphone sensitivity ≥ 60 dB SPL; speaker output ≥ 70 dB at 1m.
- **User Impact:** Enables users to speak directly to emergency staff and receive audible cues without needing external devices.

Provide at Least 2-Month Battery Life with Timely Low-Battery Alerts.

- **Rationale:** To reduce user maintenance, the device must operate for a minimum of three months per battery cycle. A clear alert system must notify users when the device needs to be charged.
- **Performance Metric:** Battery capacity must support 60 days of continuous operation with proactive alert functionality triggered when the battery could affect the user in an emergency scenario.
- **User Impact:** Lowers user burden and reduces the likelihood of device failure due to power loss.

Automatically Notify Multiple User-Specified Contacts During Emergencies

- **Rationale:** In the event of a fall, sudden health deterioration, or manual activation, the device must send real-time notifications to a predefined list of emergency contacts.
- **Performance Metric:** Contact notifications must be sent within 5 seconds of the incident trigger to all stored recipients via app and SMS
- **User Impact:** Empowers users to take control of their safety network and ensures fast, distributed emergency awareness.

4. Background Research

Product Name	Form Factor	Vitals Monitoring	Fall Detection	Two Way Voice	Connectivity	Battery Life	Reference
Guardian Alert 911	Pendant	No	Yes	Yes	4G LTE	Less than 1 month	[3]
SureSafeGo	Watch	Heart Rate	Yes	Yes	4G LTE	Less than 1 week	[4]
Ageco Personal Alarm Watch	Watch	Heart Rate	Yes	Yes	4G LTE	Approximately 2 days	[5]
Life Connect24	Watch	Heart Rate, Blood Pressure	Yes	Yes	4G LTE	Unavailable	[6]

Personal medical alert devices on the market today offer a range of useful features, including two-way communication, heart rate monitoring, fall detection, and GPS tracking. For example, the SureSafeGO includes a companion app that lets users set emergency contacts and view real-time location data. However, most of these devices rely on a built-in SIM card to make calls, which requires users to pay a monthly fee. This fee typically covers the use of a call centre that responds to alerts and decides on the next steps.

Another issue is battery life. Many devices only last a few days on a single charge, while some may last longer if used minimally. For individuals who need continuous monitoring, especially older adults or people living alone, short battery life and regular charging can be a major inconvenience.

This suggests a clear gap in the market: there are very few devices that offer essential features like vital monitoring, GPS tracking, and two-way communication without a subscription, and with a battery life that extends over several months. A solution that addresses this could improve accessibility and reliability for users who depend on these technologies for safety and independence.

5. Project Design

Figure 1 shows the block diagram of the project, a PSU made up of a LiPo battery and power management ICs will power the entire system. The volatile storage should allow the microcontroller to perform well and handle all peripherals. The microcontroller is connected to the peripherals handling the vital monitoring, elevation and communications.

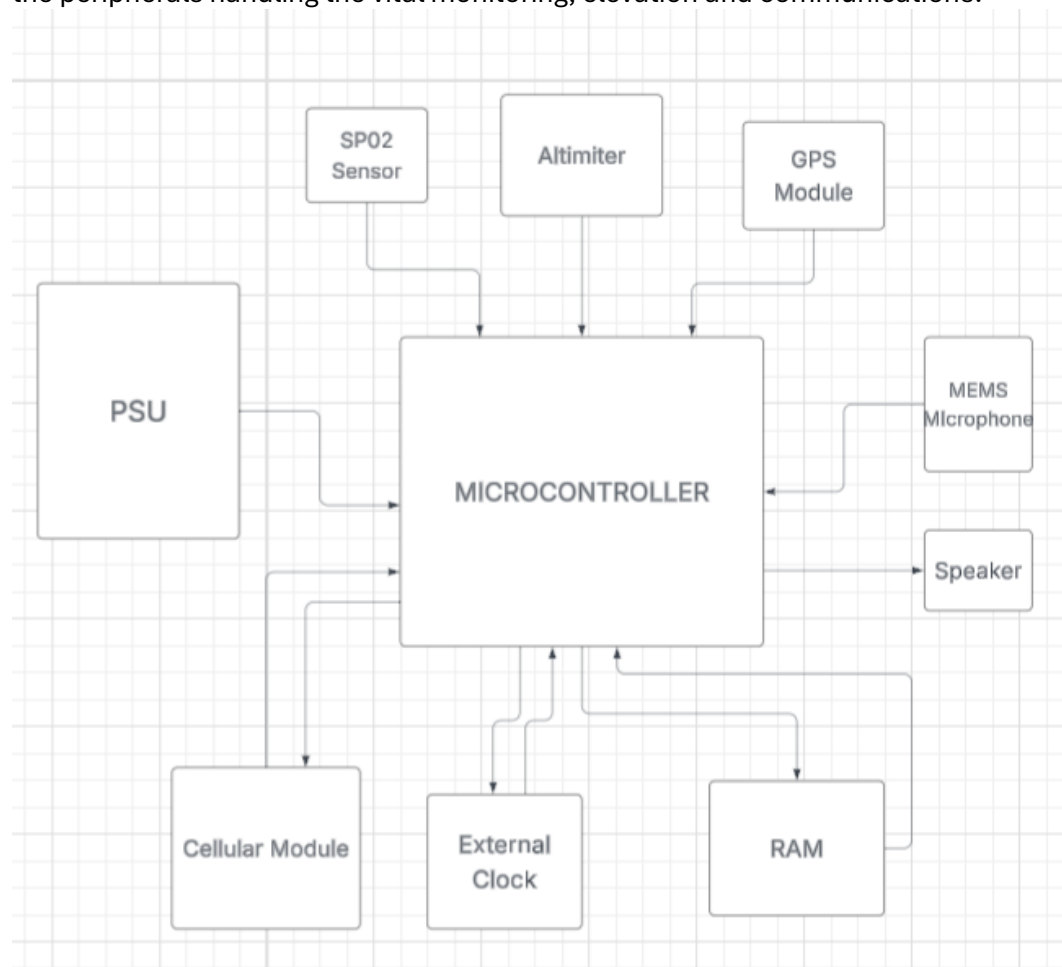


Figure 1: Block Diagram of the Device

Hardware Design:

The product should weigh no more than 100 grams and be no larger than 3 by 2 inches. The user will wear it with a strap, housed in a 3D printed body, will be the internal rechargeable battery, a high-density 6-layer PCB,

- Compact PCB layout within 3x2 inches
- Internal chargeable battery
- 3D printed housing

Electronic Design:

The product should contain low-power modules such as:

- L76-L GPS
- STM32L4 MCU
- BMP390 Altimeter
- MEMS Microphone
- Piezoelectric speaker
- BG95-M3 Cellular module
- MAX30102 Pulse oximeter
- 754060 LiPo – 4500 mAh
- FA-238 External Clock
- ESP-PSRAM64 PSRAM

Low-power modules such as these will allow the engineers to develop a system that will last for at least 60 days, given a 2-hour emergency call in that time.

Software Design:

Embedded firmware engineers will be needed to manage sensors and the power usage by the microcontroller; this will be separate from any phone applications that may be implemented. The firmware engineer will need to implement a battery monitoring system and connect that through to the speaker for low-battery alerts. To configure emergency contacts, an application will be necessary, connecting to the users' phone, and from there, the device, when in range, will be able to send messages to said contacts. Communications will also need to be established with the emergency services; however, this should be able to be accessed separately from a phone.

6. Resources

The project will require a team of electronic, software, and hardware engineers, as well as product testers and a project management chain. The project manager will be in charge of costing and collating necessary resources to allow the engineers to achieve their goals. Each engineering team will be headed by a member of each discipline and will meet with the project manager to discuss where the team is in relation to each objective. The team leads will be briefed on the project's specification and will task the project manager with the tools needed for the project.

Resource List

- Hardware:
 - Accelerometers
 - Microcontrollers
 - Speaker
 - MEMS microphones
 - Resistors
 - Capacitors
 - LEDs
 - Diodes
 - RAM modules
 - Batteries
 - Casing materials
- Software Tools:
 - Arduino

- Mobile app Development tools,
- VoIP integration APIs
- Facilities:
 - Lab equipment for testing
 - Oscilloscopes
 - Multimeters
 - soldering irons
 - signal generators
 - 3D printer

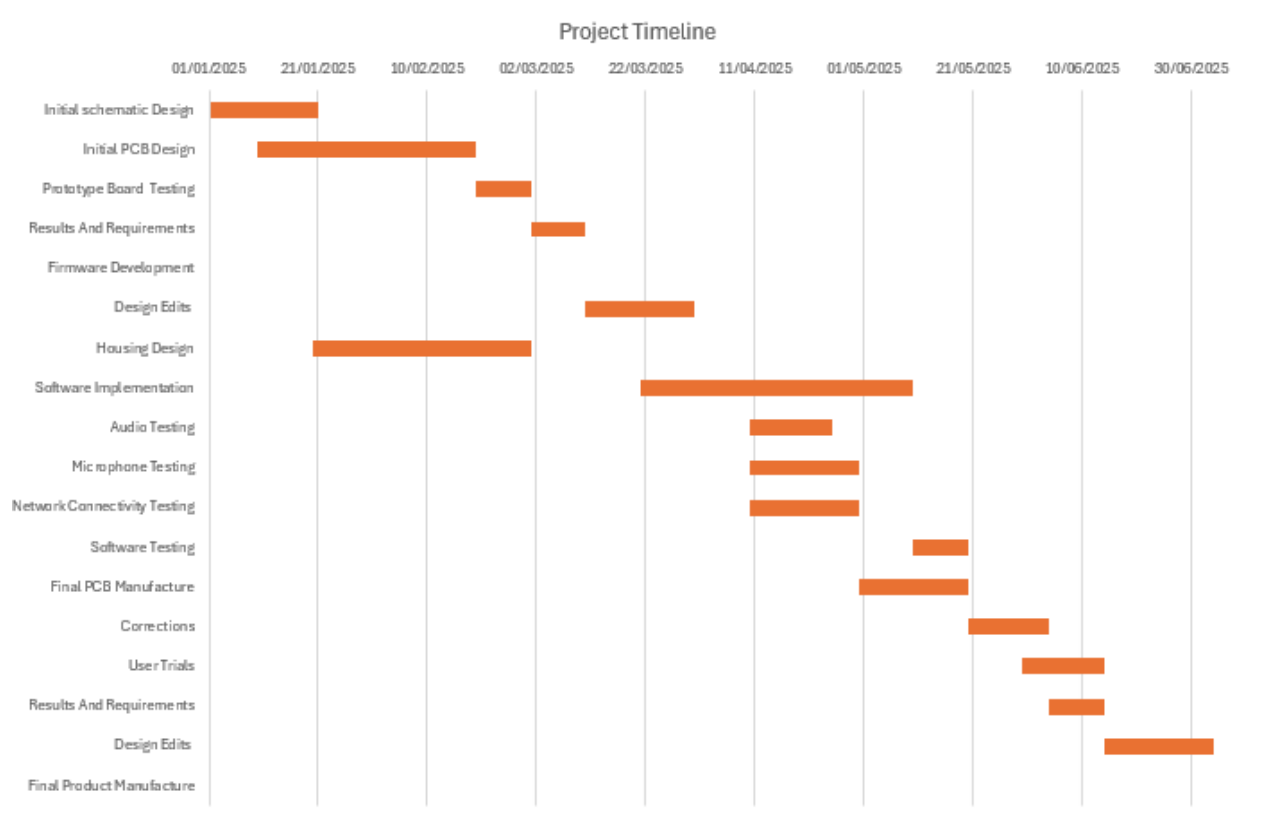
These resources are only a guide as to what the team may need; the team leads will discuss with the project manager on specifics, and the real resource list will need to be costed into the final budget. The electronic and software teams will be made up of three engineers, whilst the product testers and hardware teams will be made up of two respective engineers. Below is a costed spreadsheet detailing each task's cost and planned completion time. The time scale set out by this table shows a production schedule from start to finish over the course of 7 months. Whilst the time blocks given to each task have overhead in case of staff illness or delays, the final total cost has been multiplied by 20% to ensure the project is properly budgeted for. Each staff member has been given a wage of £200 a day and it is assumed each team member will be working for all of the days budgeted. Adding to the facilities and resources needed, this total cost is likely to expand to a maximum of £250,000 over a maximum of 8 months.

Start	TASK	TIME	COST	WHO	End	PEOPLE	RATE
01/01/2025	Initial schematic Design	20	12000	Electronic Engineer	21/01/2025	Electronic Engineer	600
10/01/2025	Initial PCB Design	40	24000	Electronic Engineer	19/02/2025	Software Engineer	600
19/02/2025	Prototype Board Testing	10	4000	Product Tester	01/03/2025	Product Tester	400
01/03/2025	Results And Requirement	10	2000	Project Manager	11/03/2025	Hardware Engineer	600
01/03/2024	Firmware Development	20	12000	Software Engineer	21/03/2024		
11/03/2025	Design Edits	20	12000	Electronic Engineer	31/03/2025	Project Manager	200
20/01/2025	Housing Design	40	24000	Hardware Engineer	01/03/2025		
21/03/2025	Software Implementation	50	30000	Software Engineer	10/05/2025		
10/04/2025	Audio Testing	15	6000	Product Tester	25/04/2025	Total Cost	
10/04/2025	Microphone Testing	20	8000	Product Tester	30/04/2025	188000	
10/04/2025	Network Connectivity Tes	20	8000	Product Tester	30/04/2025		
10/05/2025	Software Testing	10	6000	Software Engineer	20/05/2025		
30/04/2025	Final PCB Manufacture	20	8000	Product Tester	20/05/2025		
20/05/2025	Corrections	15	9000	Electronic Engineer	04/06/2025		
30/05/2025	User Trials	15	3000	Project Manager	14/06/2025		
04/06/2025	Results And Requirement	10	2000	Project Manager	14/06/2025		
14/06/2025	Design Edits	20	12000	Electronic Engineer	04/07/2025		
04/07/2025	Final Product Manufactur	10	6000	Hardware Engineer	14/07/2025		

Figure 1: Costed time plan of the entire project.

7. Planning

Figure 2: Gantt Chart visualising the project timeline



Project Timeline

01/01/2025: Layout of connections of all core components any additional components such as resistors and capacitors are added as and when they are needed.

10/01/2025: Translation of PCB layout out is initiated, initially only a large, tested board is created, once completed the layout designer will focus on minimising the size of the board

20/01/25: Enclosure design begins in parallel to accommodate all electronics and possible changes

19/02/25 Initial test of PCB functionality, power regulation and component integration. Any issues with the boards are identified

1/03/2025: Feedback from the prototype board testing is used to update technical requirements, adjustments are made to the specifications if needed and timelines are updated

1/03/2025: Firmware development begins, creating software to use and test the prototype board further as well as to allow the software developers to integrate features to the device

11/03/2025: Overhead is dedicated for any problems the teams may have run into in the development cycle as well as a for any changes to be made

20/03/2025: Once firmware engineers have finished with the prototype board software engineers can develop using the board to test and build onto the prototype. Development of the application and functionality of the board is done in this time

10/04/2025: By this time a revised board will have been created, this will then be taken for experimental testing in a lab environment to find the benchmarks of the board

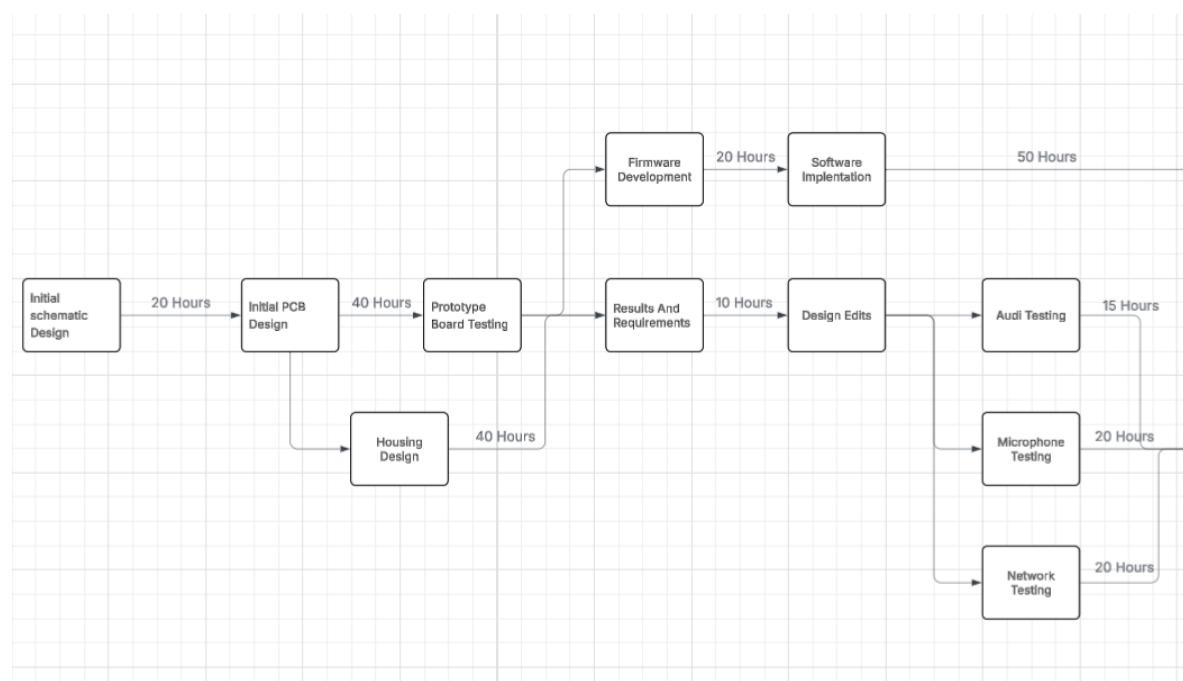
30/04/2025: Any minor corrections made post-manufactured including bug fixes will be made as well as providing overhead for any testing

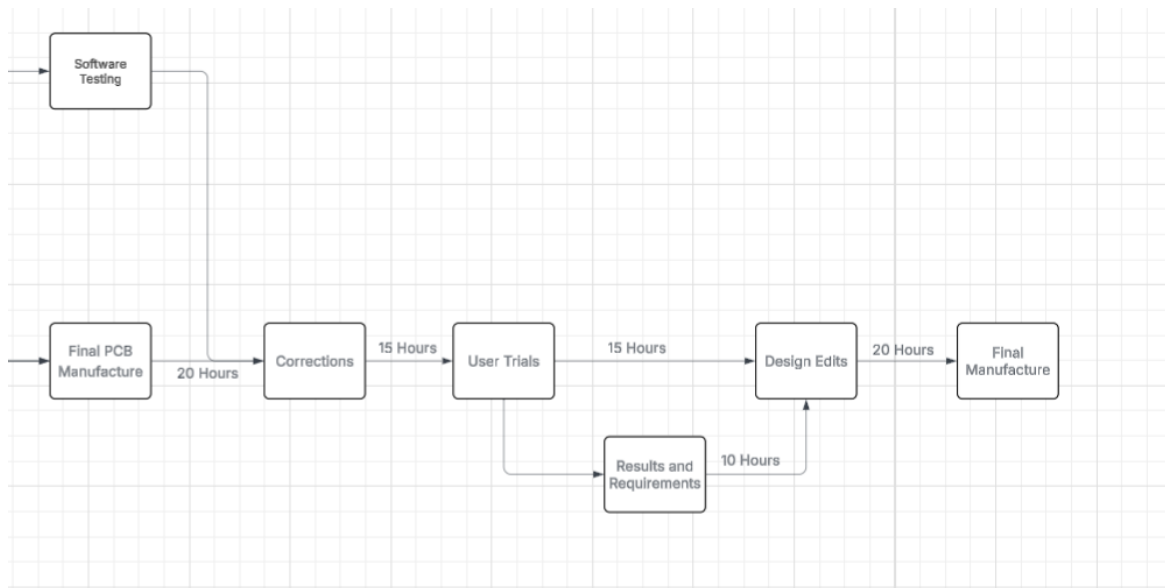
15/05/2025: Beta testing begins will users in care facilities and volunteers, Evaluation includes comfort, usability, accuracy of vital monitoring and general reliability.

25/05/2025: As results come in user feedback will be reviewed any requirement to software changes can be acted upon

Critical Path Analysis

The critical path network shows how tasks within the project will be able to be completed concurrently whilst also highlighting the dependencies and possible pitfalls to the project if there are delays. Wherever possible tasks will be completed concurrently. Whilst software implementation relies upon the development of the firmware it is completely separate from any other task allowing and development will not be curtailed by any issues within the development of the hardware.





Milestones:

Milestones will represent the critical phases of development necessary to complete the concept to fully fledged device.

PCB prototype assembly

Target Date: 19/02/2025

Requirement: The initial prototype should be created by the target date, the PCB should take the form of a test board, being whilst being significantly larger than the final product it should allow for testing to occur which will be necessary if the project is to go forwards, this stage will allow for engineers to find any issues with the board and implement fixes.

Housing Design

Target Date: 15/05/2025

Requirement: The housing design should be completed by the 1/03/25 however the final deadline will be the user trials, due to the fluid nature of agile development the final size of the board and of the housing may change. The initial deadline is set before the final product testing, at which point the prototypes size should change in a major way

Feature Testing

Target Date: 30/04/2025

Requirement: The final testing should be completed by the target date, the initial board testing should have found any issues with the boards design, this milestone will be the prototype working in real world conditions, in the housing. The data from the testing will be compared against the objectives outlined above, depending on how quickly the development has progressed will inform whether concessions will need to make or whether the project deadlines need to be moved back.

Beta Prototype creation

Target Date: 30/05/2025

Requirement: The device should now be realised such that a prototype can be sent out to volunteers and user feedback can be sent out, this will be a test of how the device functions in real world situations and will allow engineers to make any changes before the development and creation of the final product

8. Risk and Ethical Considerations

The device comes with a number of risks and ethical considerations that need to be addressed to ensure compliance with health and safety laws as well as data protection laws. The device must be robust so as not to fail during an emergency; this risk could take the form of the electronic components failing, the device's software malfunctioning, unexpected power draw, or false positives in alerts. This problem will be handled using high-quality components, overheads in power usage, robust testing for software, and accurate battery monitoring, handled through the application for the device. This is a high-risk problem, so it should be at the forefront of design. The device needs to conform to the UK government's standards of GDPR, as it will be handling personal medical data. This includes information relating to the user's health, location, and emergency contacts, all of which are classified as sensitive information. To comply, data must be stored securely, only accessed when necessary, and processed with the user's informed consent. Measures such as encryption and privacy policies must be in place, and the user should be able to delete their data at any time to conform to the standard [7].

9. References

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