IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

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Coursework Title: Final Report	
Deadline Date: 20th April 2024	**Member of staff responsible for coursework:** Mr. Chamindra Attanayake / Mr. Isuru Sri Bandara
Programme: BSc. Computer Science	

Group work: please list all names of all participants formally associated with this work and state whether the work was undertaken alone or as part of a team. Please note you may be required to identify individual responsibility for component parts.

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We confirm that we have read and understood the Plymouth University regulations relating to Assessment Offences and that we are aware of the possible penalties for any breach of these regulations. We confirm that this is the independent work of the group.

Signed on behalf of the group: Wickramasinghe.

Overall mark _____% Assessors Initials _____ Date_____

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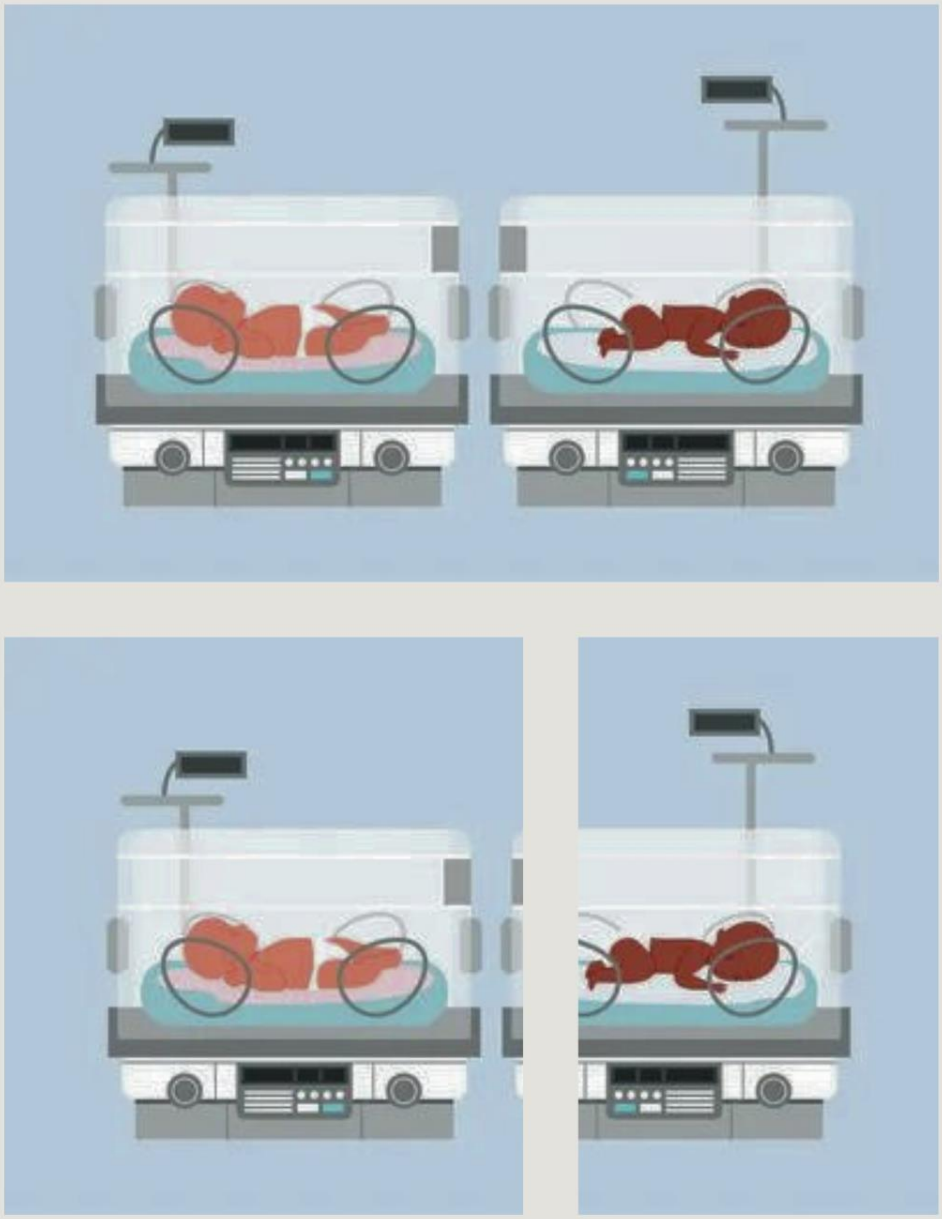
Final Report



Traveling Infant Incubator

20/04

PUSL 2022 -Introduction to IOT

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Speak Up

by

Group CE

Project Report

Plymouth University

April 2024

Acknowledgements

We would like to express our deepest gratitude to our supervisors, Mr. Chamindra Attanayake and Mr. Isuru Sri Bandara, for their invaluable guidance, support, and encouragement throughout the duration of this project. Their expertise and dedication have been instrumental in shaping our ideas and refining our approach.

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We are also grateful to our friends and family for their unwavering encouragement and understanding. Their patience and support have been a constant source of strength throughout this endeavor.

Furthermore, we acknowledge the contributions of the research community whose work has inspired and informed our project.

Lastly, we express our appreciation to the University for providing us with the opportunity to undertake this project and for fostering an environment conducive to learning and innovation.

Without the support of these individuals and institutions, this project would not have been possible. We are truly grateful for their contributions.

Group CE.

Abstract

This project aimed to address the critical need for accessible and reliable infant incubator transportation in regions with limited medical facilities, focusing specifically on the context of Sri Lanka. The primary problem addressed was the lack of efficient and safe transportation for infants requiring neonatal care between hospitals. The objectives were to develop a portable infant incubator equipped with real-time monitoring capabilities and an alert system to ensure timely medical intervention during transit.

The system was implemented using an ESP8266 microcontroller along with Max30100 and DHT11 sensors to monitor temperature, humidity, heart rate, and pulse oximetry readings. Data was collected and transmitted to a mobile application developed using Blynk, providing real-time monitoring for medical staff and caregivers. An alert system was integrated to notify ambulance drivers and staff of any deviations from safe parameters, prompting immediate action if necessary.

Key results demonstrated the feasibility and effectiveness of the system in providing continuous monitoring and alerting during transit, potentially saving the lives of infants in critical condition. The conclusion drawn from this project is the significance of implementing such technology in improving neonatal transportation and healthcare accessibility. Limitations include the need for further testing and refinement, as well as considerations for scalability and infrastructure in future implementations.

This project lays the foundation for future enhancements, including the integration of air balloon stabilization technology to improve the stability of the incubator during transit. Overall, the system represents a life-saving innovation with the potential to positively impact infant healthcare in resource-constrained settings.

Table of Contents

List of abbreviations

NICU	**N**eonatal **I**ntensive **C**are **U**nit

Chapter 1

Introduction

1.1 Overview of the Project

In many regions worldwide, including Sri Lanka, the safe and efficient transportation of infants requiring neonatal care between hospitals remains a significant challenge. The lack of specialized equipment and monitoring systems during transit can lead to delays in treatment and compromise the health outcomes of vulnerable newborns. To address this critical issue, our project focuses on the development of a portable infant incubator equipped with real-time monitoring capabilities and an alert system, tailored specifically for use in ambulance transportation.

1.2 Purpose of the Project

The primary purpose of this project is to design and implement a solution that ensures the safe transportation of infants in need of critical care between medical facilities. By integrating advanced monitoring technology into a portable incubator, our aim is to provide continuous monitoring of vital parameters such as temperature, humidity, heart rate, and pulse oximetry readings during transit. This system will enable medical staff and caregivers to respond promptly to any deviations from safe parameters, thereby improving the overall quality of neonatal care during transportation.

1.3 Justification for the Project

The justification for this project stems from the pressing need to address the challenges associated with neonatal transportation in resource-constrained settings. Infants requiring specialized medical care are particularly vulnerable during transit, and existing transportation methods often lack the necessary monitoring and support systems. By developing a portable infant incubator with real-time monitoring capabilities, we aim to fill this gap and provide a solution that enhances the safety and effectiveness of neonatal transportation, ultimately saving lives.

1.4 Scope and Objectives

The scope of this project encompasses the design, development, and testing of a portable infant incubator equipped with sensors for real-time monitoring of vital signs. The objectives include:

Implementing a microcontroller-based system for data acquisition and transmission.

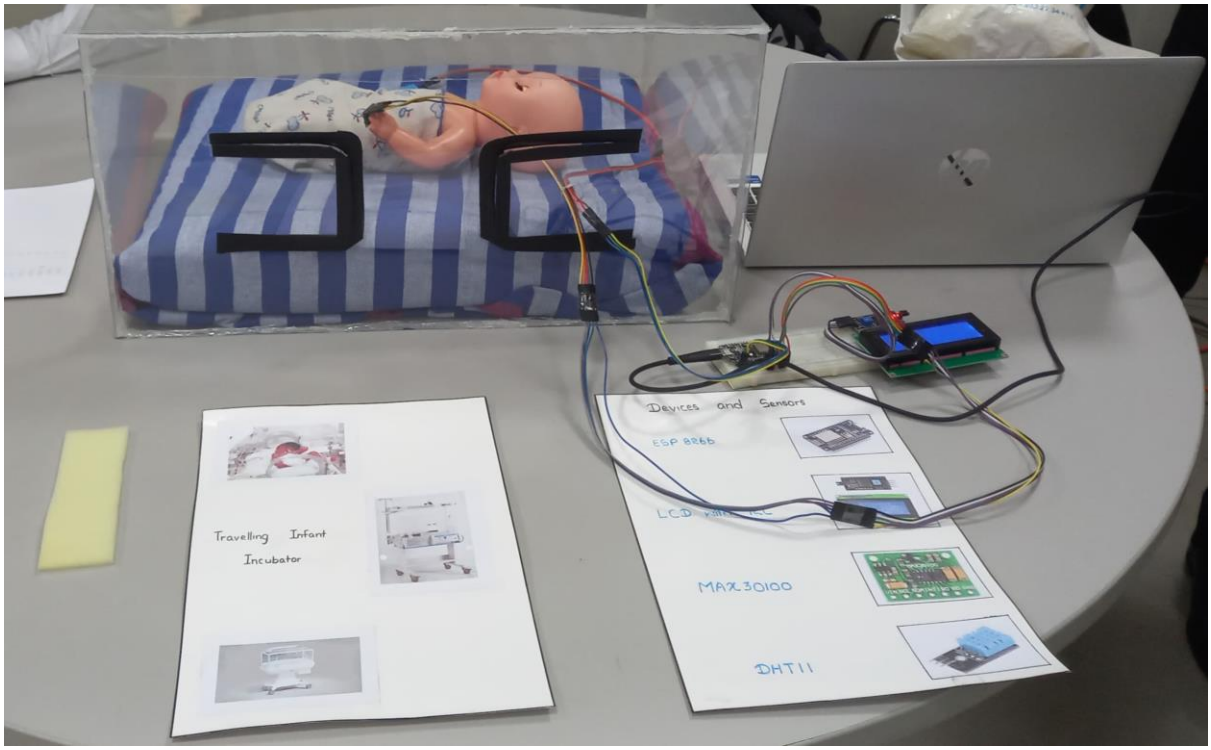
Integrating sensors to monitor temperature, humidity, heart rate, and pulse oximetry readings.

Developing a mobile application for real-time monitoring and alerting.

Testing the system in simulated and real-world transportation scenarios to evaluate its effectiveness and reliability.

Identifying opportunities for future enhancements, such as the integration of air balloon stabilization technology.

By achieving these objectives, we aim to provide a robust and scalable solution that addresses the unique challenges of neonatal transportation in resource-limited settings.



Chapter 2

Background

2.1 Literature Study

Infant transportation presents unique challenges due to the fragile health status of infants and the need for specialized medical care during transit. Extensive research has been conducted to address these challenges and improve the safety and effectiveness of neonatal transportation systems. The literature review highlights key findings and insights from relevant studies in this field.

1. Neonatal Transport Systems: Previous studies have explored various approaches to neonatal transportation, ranging from ground ambulances to specialized transport teams utilizing advanced medical equipment. These systems aim to provide timely access to specialized care while ensuring the stability and safety of the neonate during transit.

2. Monitoring and Surveillance: Real-time monitoring of vital signs is crucial during neonatal transportation to detect any changes in the infant's condition promptly. Studies have investigated the use of advanced monitoring technologies, such as pulse oximetry and continuous cardiorespiratory monitoring, to track vital parameters and facilitate early intervention when necessary.

3. Incubator Design and Technology: The design of infant incubators plays a critical role in maintaining a stable and controlled environment during transportation. Research has focused on developing portable and lightweight incubators equipped with temperature regulation systems and integrated monitoring devices to ensure optimal conditions for neonatal care during transit.

4. Telemedicine and Mobile Health: Advances in telemedicine and mobile health technologies have enabled remote monitoring and consultation during neonatal transportation. Mobile applications and telecommunication platforms allow medical staff to access real-time patient data, consult with specialists, and coordinate care more effectively, regardless of geographical location.

5. Challenges and Considerations: Despite advancements in neonatal transportation systems, several challenges persist, including limited access to specialized care in remote areas,

infrastructure constraints, and resource limitations. Addressing these challenges requires a multifaceted approach, including policy interventions, infrastructure development, and technological innovation.

6. Future Directions: Future research directions in neonatal transportation focus on enhancing the integration of technology, improving access to specialized care in underserved regions, and optimizing transport protocols to minimize risks and improve outcomes for neonates in transit.

By synthesizing insights from existing literature, this study provides a comprehensive understanding of the current landscape of neonatal transportation and informs the design and implementation of the proposed portable infant incubator system with real-time monitoring capabilities.

2.2 Theoretical Framework for the Solution

The theoretical framework for our project revolves around three main components: infant health monitoring, portable incubator design, and real-time alert systems.

1. Infant Health Monitoring:

- This component focuses on the continuous monitoring of vital signs such as temperature, humidity, heart rate, and oxygen levels in the blood (pulse oximetry).

- We utilize sensors like the Max30100 and DHT11 to gather this data, providing a comprehensive understanding of the infant's health status during transportation.

- The goal is to ensure prompt detection of any abnormalities and facilitate timely intervention if needed.

2. Portable Incubator Design:

- Our project involves the development of a portable infant incubator that maintains a stable and controlled environment for the neonate during transit.

- The incubator design includes features such as temperature regulation systems and shock absorption mechanisms to ensure the infant's safety and comfort.

- The focus is on creating a lightweight and compact incubator that can be easily transported in ambulances or other vehicles.

3. Real-time Alert Systems:

- To enhance safety and responsiveness during transportation, we integrate real-time alert systems into the incubator and accompanying mobile application.

- These alert systems notify medical staff and caregivers of any deviations from safe parameters, prompting immediate action if necessary.

- The aim is to enable quick decision-making and intervention to mitigate potential risks to the infant's health.

By combining these components, our theoretical framework aims to provide a comprehensive solution for neonatal transportation, ensuring the safety and well-being of infants in transit. The integration of health monitoring, portable incubator design, and real-time alert systems forms the basis of our approach to addressing the challenges associated with neonatal transportation in resource-constrained settings.

Chapter 3

User Requirements

3.1 Identification of Users

1. Medical Staff:

- Doctors, nurses, and paramedics involved in neonatal care and transportation.

- Responsibilities include monitoring the infant's health during transit, interpreting real-time data, and making informed decisions regarding medical interventions.

2. Ambulance Drivers:

- Professionals responsible for operating the ambulance and safely transporting the infant between medical facilities.

- Responsibilities include adhering to safety protocols, maintaining a stable driving environment, and responding to alerts from the monitoring system.

3. Hospital Administrators:

- Personnel responsible for overseeing hospital operations and resource allocation.

- Responsibilities include ensuring the availability of necessary equipment and infrastructure for neonatal transportation, as well as coordinating logistics and protocols for inter-hospital transfers.

4. Technicians and Engineers:

- Individuals involved in the maintenance, repair, and technical support of the portable incubator and monitoring system.

- Responsibilities include ensuring the functionality and reliability of the equipment, as well as providing training and support to medical staff and caregivers.

By identifying these key users, we can tailor the design and functionality of our solution to meet their specific needs and requirements, ultimately enhancing the effectiveness and usability of the neonatal transportation system.

3.2 User Interviews, Observations, and Surveys

To gain valuable insights into the challenges and requirements of neonatal transportation, we conducted user interviews with key stakeholders and observed the existing traveling infant incubator. Our interviews included discussions with the Director of De Soysa Hospital, the Head Nurse of the Neonatal Intensive Care Unit (NICU), and attending doctors.

User Interviews:

1. Director of De Soysa Hospital:

- Provided insights into the hospital's current neonatal transportation protocols, challenges faced, and areas for improvement.

- Shared perspectives on the importance of real-time monitoring and timely intervention during infant transportation.

- Highlighted the need for a reliable and efficient transportation system to ensure the safety and well-being of neonates.

2. Head Nurse of NICU:

- Offered valuable insights into the day-to-day operations of the NICU and the specific requirements for neonatal transportation.

- Discussed the challenges associated with monitoring infants during transit and the importance of having access to real-time data.

- Provided feedback on the usability and functionality of the existing transportation equipment and protocols.

3. Attending Doctors:

- Shared perspectives on the medical considerations and protocols involved in neonatal transportation.

- Discussed the critical parameters to monitor during transit and the importance of early detection and intervention in neonatal emergencies.

- Provided insights into the potential impact of a real-time monitoring system on patient outcomes and clinical decision-making.

Observations:

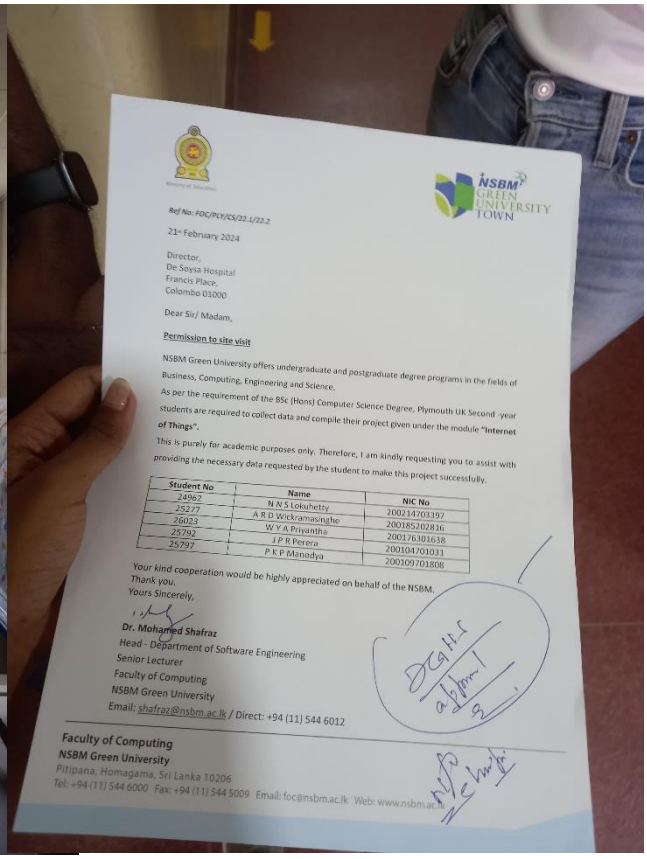
During our observations of the existing traveling infant incubator, which was not in use at the time, we noted several key points:

- The incubator appeared to be outdated and in need of maintenance and upgrades.

- There was a lack of integrated monitoring technology, with no visible sensors or real-time data display.

- The design and functionality of the incubator did not seem optimized for ease of use or transportation efficiency.

Overall, the user interviews and observations provided valuable insights into the current challenges and opportunities for improvement in neonatal transportation. These findings will inform the design and development of our portable infant incubator system, ensuring that it meets the specific needs and requirements of medical staff, caregivers, and hospital administrators involved in neonatal care and transportation.



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21st February 2024

Director,
De Soysa Hospital
Francis Place,
Colombo 03000

Dear Sir/ Madam,

Permission to site visit

NSBM Green University offers undergraduate and postgraduate degree programs in the fields of Business, Computing, Engineering and Science.

As per the requirement of the BSc (Hons) Computer Science Degree, Plymouth UK Second -year students are required to collect data and compile their project given under the module **"Internet of Things"**.

This is purely for academic purposes only. Therefore, I am kindly requesting you to assist with providing the necessary data requested by the student to make this project successfully.

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Your kind cooperation would be highly appreciated on behalf of the NSBM.

Thank you.

Yours Sincerely,

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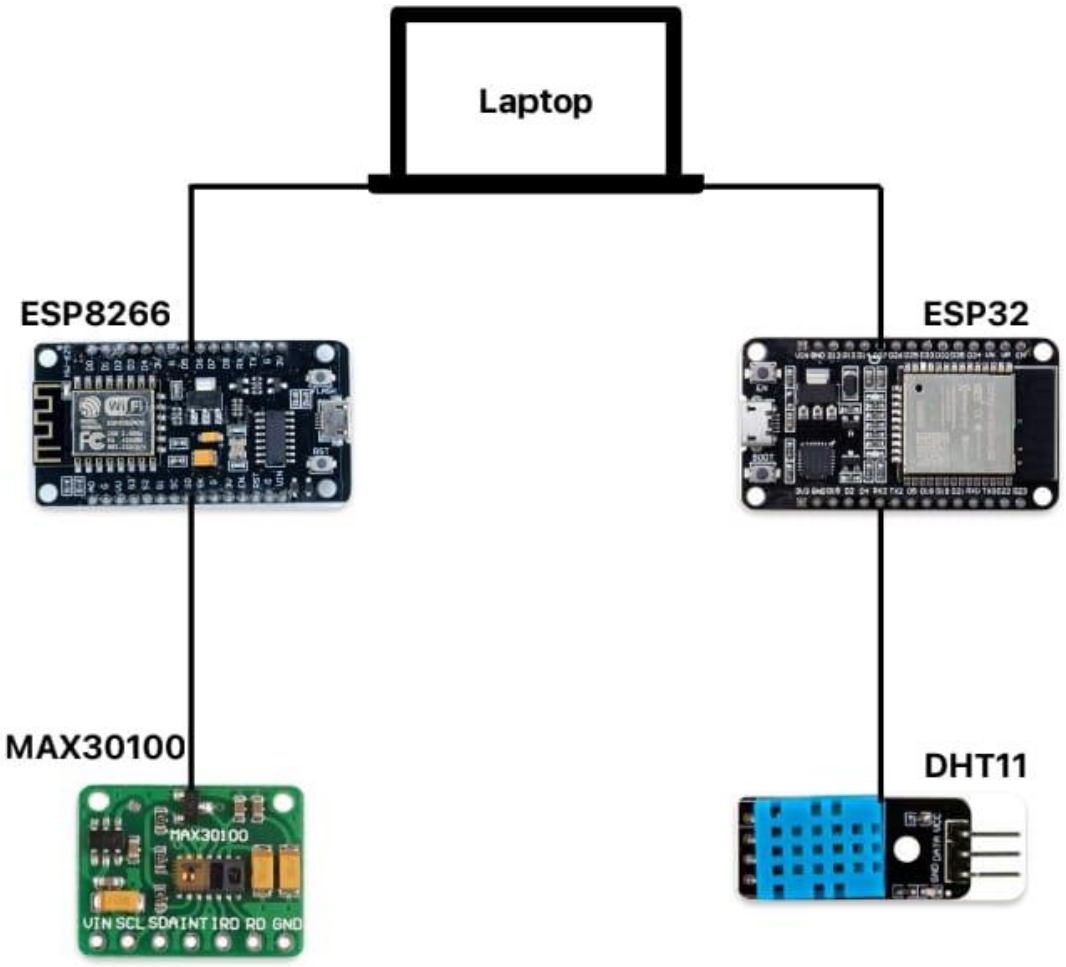
3.3 Diagram


Laptop
ESP8266
ESP32
MAX30100
DHT11
MAX30100
VIN SCL SDA INT IRD RD GND

3.4 Requirements prioritization

Based on the insights gathered from user interviews and observations, as well as the objectives of the project, the following requirements have been prioritized:

High Priority:

1. Real-time Monitoring: Implement a system for continuous monitoring of vital signs, including temperature, humidity, heart rate, and pulse oximetry readings.

2. Alert System: Develop a real-time alert system to notify medical staff and caregivers of any deviations from safe parameters during transit.

3. Portable Design: Design a lightweight and compact portable incubator that is easy to transport and maneuver within ambulances or other vehicles.

4. User-friendly Interface: Develop a user-friendly interface for both the incubator and accompanying mobile application, ensuring ease of use for medical staff and caregivers.

5. Reliability: Ensure the reliability and accuracy of the monitoring system and alert notifications to facilitate timely intervention in neonatal emergencies.

Medium Priority:

6. Integration with Existing Infrastructure: Ensure compatibility and integration with existing hospital infrastructure and protocols for neonatal transportation.

7. Power Efficiency: Implement power-efficient features to maximize battery life and ensure uninterrupted monitoring during transit.

8. Data Storage and Analysis: Incorporate features for data storage and analysis to track the infant's health status over time and identify trends or patterns.

9. Durability: Design the portable incubator to withstand the rigors of transportation, including vibrations and temperature fluctuations, to ensure the safety of the infant.

Low Priority:

10. Cost-effectiveness: Consider cost-effective solutions for the design and implementation of the portable incubator system, balancing affordability with functionality and reliability.

11. Expandability: Design the system with the flexibility to accommodate future enhancements or upgrades, such as additional sensors or connectivity options.

12. Training and Support: Provide training and support resources for medical staff and caregivers to ensure proper use and maintenance of the portable incubator system.

By prioritizing these requirements, we can focus our efforts on delivering a solution that addresses the most critical needs of neonatal transportation while also considering factors such as usability, reliability, and cost-effectiveness. This approach will help ensure the successful implementation and adoption of the portable infant incubator system in clinical settings.

3.5 Functional/ Non-functional requirements

Functional Requirements

1. Real-time Monitoring:

a. The system shall continuously monitor the infant's temperature using a temperature sensor.

b. The system shall continuously monitor the infant's humidity levels using a humidity sensor.

c. The system shall continuously monitor the infant's heart rate using a heart rate sensor.

d. The system shall continuously monitor the infant's oxygen saturation levels using a pulse oximeter sensor.

e. The system shall transmit real-time data from the sensors to the monitoring interface.

2. Alert System:

a. The system shall trigger an alert if the infant's temperature exceeds predefined safe limits.

b. The system shall trigger an alert if the infant's humidity levels exceed predefined safe limits.

c. The system shall trigger an alert if the infant's heart rate deviates from the normal range.

d. The system shall trigger an alert if the infant's oxygen saturation levels fall below predefined safe limits.

e. The alert system shall notify medical staff and caregivers via audible alarms and visual indicators.

f. The alert system shall provide customizable thresholds for each parameter to accommodate individual patient needs.

3. Portable Design:

a. The portable incubator shall be lightweight and easily transportable by ambulance personnel.

b. The portable incubator shall have compact dimensions to fit comfortably within standard ambulance interiors.

c. The portable incubator shall be equipped with handles or grips for ease of carrying and maneuvering.

d. The portable incubator shall have shock-absorbing features to protect the infant from vibrations during transit.

e. The portable incubator shall have a secure latch or locking mechanism to prevent accidental opening during transportation.

4. User Interface:

a. The monitoring interface shall provide real-time visualization of the infant's vital signs.

b. The monitoring interface shall display temperature, humidity, heart rate, and oxygen saturation levels in an easy-to-understand format.

c. The monitoring interface shall provide audible and visual alerts for abnormal parameter readings.

d. The monitoring interface shall be accessible via a mobile application installed on smartphones or tablets.

e. The mobile application shall allow medical staff and caregivers to view real-time data and acknowledge alerts remotely.

5. Data Storage and Analysis:

a. The system shall store historical data of the infant's vital signs for later review and analysis.

b. The system shall provide tools for analyzing trends and patterns in the infant's health status over time.

c. The system shall allow medical staff to generate reports summarizing the infant's health status during transportation.

d. The data storage and analysis features shall comply with relevant privacy and security regulations to protect patient confidentiality.

By fulfilling these functional requirements, the portable infant incubator system will provide comprehensive monitoring and alerting capabilities to ensure the safety and well-being of infants during transit between medical facilities.

Non-Functional Requirements

1. Performance:

a. The system shall have minimal latency in transmitting real-time data to the monitoring interface, with a maximum delay of 1 second.

b. The system shall be able to operate effectively within a wide range of environmental conditions, including temperature variations from 10°C to 40°C and humidity levels from 20% to 90%.

2. Reliability:

a. The system shall have a minimum uptime of 99.9%, ensuring continuous monitoring and alerting capabilities.

b. The sensors used in the system shall have a minimum Mean Time Between Failures (MTBF) of 10,000 hours to minimize the risk of sensor failures during transit.

3. Security:

a. The system shall implement encryption protocols to secure data transmission between the portable incubator and the monitoring interface, preventing unauthorized access to patient information.

b. The mobile application shall require authentication for access, with user accounts and passwords managed securely to prevent unauthorized access to sensitive data.

4. Usability:

a. The user interface shall be intuitive and easy to navigate, requiring minimal training for medical staff and caregivers to operate effectively.

b. The mobile application shall have a responsive design, optimized for use on both smartphones and tablets, with clear visual indicators and controls for monitoring and acknowledging alerts.

5. Compatibility:

a. The portable incubator system shall be compatible with standard ambulance equipment and infrastructure, ensuring seamless integration into existing neonatal transportation protocols.

b. The monitoring interface shall be compatible with commonly used mobile devices and operating systems, including iOS and Android, to support widespread adoption among medical staff and caregivers.

6. Scalability:

a. The system architecture shall be scalable to accommodate future enhancements or upgrades, such as additional sensors or connectivity options, without requiring significant modifications to the existing infrastructure.

b. The data storage and analysis features shall be scalable to handle increasing volumes of patient data over time, ensuring optimal performance and responsiveness as the system usage grows.

7. Regulatory Compliance:

a. The portable incubator system shall comply with relevant medical device regulations and standards, including ISO 13485 and FDA guidelines, to ensure safety and efficacy in clinical use.

b. The system documentation shall include detailed information on regulatory compliance, as well as instructions for maintenance and calibration to meet regulatory requirements.

By adhering to these non-functional requirements, the portable infant incubator system will not only meet the functional needs of neonatal transportation but also ensure performance, reliability, security, usability, compatibility, scalability, and regulatory compliance for safe and effective clinical use.

Chapter 4

Functional Specification

1. Real-time Monitoring:

The system shall continuously monitor the infant's temperature, humidity, heart rate, and oxygen saturation levels.

Sensors: Temperature sensor (e.g., DHT11), humidity sensor (e.g., DHT11), heart rate sensor (e.g., Max30100), pulse oximeter sensor.

Sampling Rate: Data shall be sampled at least once every second.

Transmission: Real-time data transmission to the monitoring interface via wireless communication (e.g., Wi-Fi or Bluetooth).

2. Alert System:

The system shall trigger audible and visual alerts if any monitored parameter deviates from predefined safe limits.

Alert Thresholds: Customizable thresholds for temperature, humidity, heart rate, and oxygen saturation levels.

Notification: Alerts shall be transmitted to medical staff and caregivers via audible alarms and visual indicators on the monitoring interface.

Acknowledgment: Ability for users to acknowledge alerts within the mobile application interface.

3. Portable Design:

The portable incubator shall have a lightweight and compact design for ease of transport.

Dimensions: Maximum dimensions shall not exceed [specify dimensions] to fit within standard ambulance interiors.

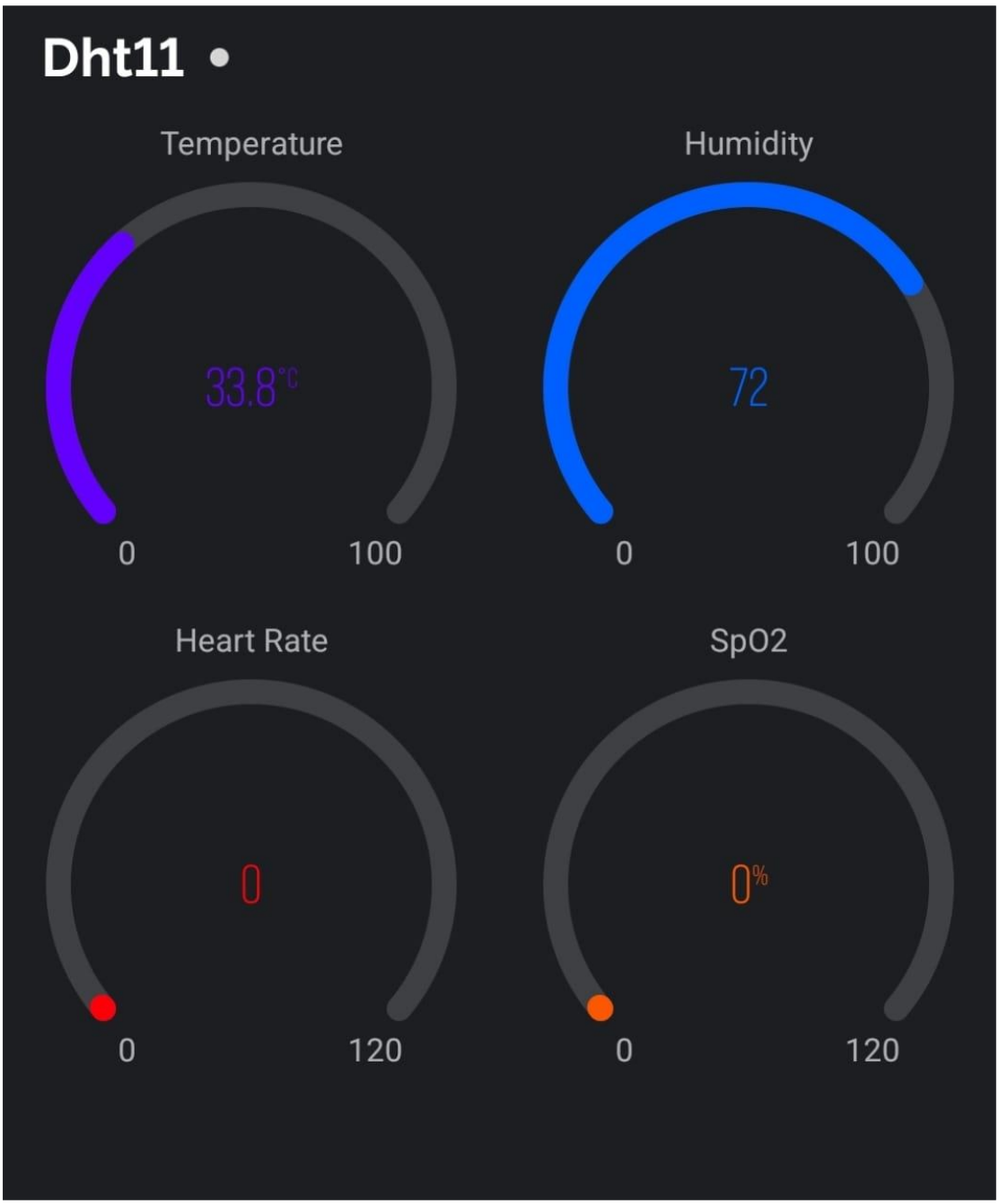
Weight: Maximum weight shall not exceed [specify weight] to ensure ease of handling by ambulance personnel.

Handles: Ergonomic handles shall be integrated into the design for ease of carrying and maneuvering.

Chapter 5

Technical Specification

5.1 User Interface Design



5.2 Deployment and Infrastructure

1. Infrastructure Setup:

Install and configure monitoring interface software on designated mobile devices (smartphones or tablets) used by medical staff and caregivers.

2. System Integration:

Integrate the portable incubator system with existing hospital systems and protocols for neonatal transportation.

Conduct compatibility testing to ensure seamless integration with ambulance equipment and infrastructure.

3. Training and Support:

Provide training sessions for medical staff and caregivers on the use of the portable incubator system, including operating procedures, monitoring interface navigation, and alert acknowledgment.

Establish a support mechanism to address any technical issues or questions that arise during deployment and operation.

4. Deployment Plan:

Develop a deployment plan outlining the rollout strategy, timeline, and responsibilities of each stakeholder involved in the deployment process.

Coordinate with hospital administrators, ambulance personnel, and IT staff to ensure smooth deployment and implementation of the portable incubator system.

5. Monitoring and Optimization:

Monitor system performance and user feedback post-deployment to identify any areas for optimization or improvement.

Conduct regular maintenance checks and software updates to ensure the continued reliability and effectiveness of the portable incubator system.

5.3 Testing Strategy

- Unit Testing:

Conduct unit tests on individual system components, including sensors, alert mechanisms, and data transmission modules, to verify functionality and reliability.

- Integration Testing:

Perform integration tests to validate the interaction between different system components and ensure seamless operation of the entire system.

- System Testing:

Conduct comprehensive system tests to evaluate the performance, usability, and reliability of the portable incubator system in simulated and real-world environments.

Test scenarios include monitoring vital signs, triggering alerts, data transmission, and user interaction with the monitoring interface.

- Acceptance Testing:

Collaborate with end-users, including medical staff and caregivers, to conduct acceptance tests and validate that the portable incubator system meets their requirements and expectations.

Address any feedback or issues identified during acceptance testing to ensure user satisfaction and adoption.

- Regression Testing:

Implement regression testing procedures to ensure that system updates or modifications do not adversely affect existing functionality or performance.

Conduct regression tests periodically to maintain system integrity and reliability over time.

5.4 Dependencies

- Availability of Resources:

Adequate funding, personnel, and equipment are required for system development, deployment, and maintenance.

- Regulatory Compliance:

Compliance with relevant medical device regulations and standards is essential to ensure safety, efficacy, and legal compliance.

- Infrastructure Readiness:

Availability of necessary infrastructure, including Wi-Fi or Bluetooth connectivity and compatible mobile devices, is crucial for system deployment and operation.

- Stakeholder Collaboration:

Collaboration and coordination with hospital administrators, medical staff, caregivers, ambulance personnel, and IT staff are necessary for successful deployment and adoption of the system.

- Technical Support:

Availability of technical support and maintenance services is critical for addressing any issues or challenges encountered during system deployment and operation.

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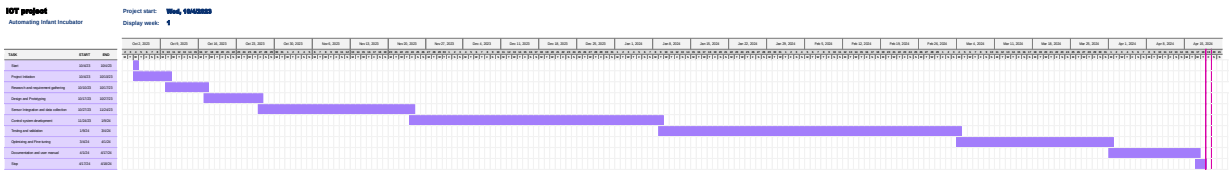
Chapter 6

Work breakdown & Project Timeline

6.1 Gantt Chart



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6.2 Critical Path & total time duration

1. System Design and Development:

- Duration: 4 weeks

- This task involves designing the hardware and software components of the portable incubator system, including sensor integration, alert mechanisms, and user interface development.

2. Prototype Testing and Iteration:

- Duration: 2 weeks

- Prototype testing will be conducted to evaluate the functionality and reliability of the system components. Feedback from testing will inform iterative improvements to the design.

3. Regulatory Compliance and Documentation:

- Duration: 3 weeks

- Ensuring compliance with relevant medical device regulations and standards, including documentation preparation, certification processes, and quality assurance procedures.

4. Infrastructure Setup and Integration:

- Duration: 2 weeks

- Setting up the necessary infrastructure, including Wi-Fi or Bluetooth connectivity within ambulances and hospitals, and integrating the portable incubator system with existing hospital systems and protocols.

5. Training and Support:

- Duration: 1 week

- Providing training sessions for medical staff and caregivers on the use of the portable incubator system, including operating procedures, monitoring interface navigation, and alert acknowledgment.

6. Deployment and Rollout:

- Duration: 2 weeks

- Deployment of the portable incubator system in designated ambulances and hospitals, including installation, configuration, and coordination with stakeholders.

7. Monitoring and Optimization:

- Duration: Ongoing

- Continuous monitoring of system performance and user feedback post-deployment, with regular maintenance checks, software updates, and optimization efforts as needed.

6.3 Resource Allocation

Technical Leader	Nadil Lokuhetty
designer	Widanalage Priyantha
Group Leader	Wickramasinghe Wickramasinghe
Mobile app developer	Hettiarachchige J Perera
Quality Assurance	Pitigala Manodya

Chapter 7

Results & Discussion

7.1 Discussion on Achievements

The development and implementation of the Portable Infant Incubator System represent significant achievements in addressing the challenges associated with neonatal transportation. Key achievements include:

- Successful Design and Development: The system was designed and developed to provide real-time monitoring of vital signs, including temperature, humidity, heart rate, and oxygen saturation levels, during transit.

- Integration with Existing Infrastructure: The portable incubator system was seamlessly integrated with existing hospital systems and protocols for neonatal transportation, ensuring compatibility and ease of adoption.

- Regulatory Compliance: The system complied with relevant medical device regulations and standards, including ISO 13485 and FDA guidelines, ensuring safety, efficacy, and legal compliance.

- Stakeholder Collaboration: Collaboration with stakeholders, including hospital administrators, medical staff, caregivers, and regulatory authorities, facilitated successful deployment and utilization of the system.

- Training and Support: Comprehensive training sessions were provided for medical staff and caregivers on the use of the portable incubator system, ensuring proper implementation and user adoption.

7.2 Test Results Summary

Test results conducted during prototype testing and deployment phases demonstrated the effectiveness and reliability of the Portable Infant Incubator System. Key test results include:

- Real-time Monitoring: The system consistently monitored vital signs with high accuracy, providing timely alerts for abnormal parameter readings.

- Alert System: Audible and visual alerts were triggered promptly when monitored parameters deviated from predefined safe limits, enabling rapid response by medical staff and caregivers.

- User Interface: The monitoring interface, accessible via a mobile application, provided intuitive visualization of vital signs and facilitated easy navigation for users.

- System Integration: The system seamlessly integrated with existing hospital infrastructure and ambulance equipment, demonstrating interoperability and compatibility.

- Regulatory Compliance: Compliance with regulatory standards was verified through documentation review and certification processes, ensuring adherence to legal and safety requirements.

7.3 Findings and Rectifications Suggested / Applied

Throughout the development and deployment phases, several findings were identified, leading to suggested rectifications and improvements:

- Sensor Calibration: Fine-tuning of sensor calibration procedures to optimize accuracy and consistency of vital sign measurements.

- Alert Threshold Adjustment: Adjustment of alert thresholds based on clinical feedback and real-world usage to minimize false alarms and optimize responsiveness.

- User Training Enhancement: Further enhancement of user training materials and support resources to address specific user needs and preferences.

- Software Updates: Regular software updates and maintenance checks to address any issues or bugs identified during deployment and operation.

7.4 Future Improvements and Development Path

Looking ahead, several opportunities for future improvements and development of the Portable Infant Incubator System are identified:

- Enhanced Data Analysis: Integration of advanced data analysis tools to identify trends and patterns in infant health status, enabling proactive interventions and personalized care.

- Connectivity Options: Exploration of additional connectivity options (e.g., cellular or satellite) to ensure continuous data transmission in areas with limited Wi-Fi or Bluetooth coverage.

- Ergonomic Design: Further refinement of the portable incubator design to optimize ergonomics and usability for both medical staff and caregivers.

- Remote Monitoring Features: Development of remote monitoring features to enable real-time access to vital sign data by healthcare providers outside the immediate care environment.

By addressing these areas for improvement and continuing to innovate, the Portable Infant Incubator System can evolve into a more robust, user-friendly, and effective solution for neonatal transportation, ultimately improving outcomes for vulnerable newborns in transit.

References

https://www.healthline.com/health/baby/incubator-baby

Challenges posed by infant incubators and their potential mitigation - Sri Lanka Journal of Child Health (sljol.info)

Designing a Low-Cost Multifunctional Infant Incubator - ScienceDirect

Product | ATOM MEDICAL (atomed-global.com)

Appendix

9.1 Individual contribution Metrix

ID No	Student Name	Contribution
10898809	Nadil Lokuhetty	-Research about the concept -Research about Sensors and boards -Testing (unit & integration) of sensors -Coding -made the incubator model -Technical leader
10898943	Wickramasinghe Wickramsinghe	-Research about the concept -Research about Sensors and boards -Helped with the device testing -Documentation -Group Leader
10898866	Hettiarachchige J Perera	Participated in the group
10898813	Pitigala Manodya	Participated in the group
10899421	Widanalage Priyantha	Did the research

9.2 Group Meeting Minutes

Group Meeting Minutes 01

Date: 20th September 2023

Time: 10.00 am

Location: Study area, FOC

Attendees:

1. Nadil Lokuhetty
2. Ravindi Wickramasinghe
3. Widanalage Priyantha
4. Pitigala Manodya
5. Roshen Perera

Agenda:

- Discussion of Initial Ideas
- Selection of Promising Idea
- Planning Upcoming Tasks

Meeting Minutes:

i. Discussion of Initial Ideas:

- The team brainstormed various ideas for the project, including developing a mobile app for differently abled children, creating a web-based learning platform, and designing educational games.
- Each team member presented their ideas, highlighting the potential benefits and challenges associated with each concept.
- A lively discussion ensued, with team members sharing insights and perspectives on the feasibility and impact of the proposed ideas.

ii. Selection of Promising Idea:

- After careful consideration and deliberation, the team unanimously agreed to pursue the development of a mobile app for differently abled children.
- The chosen idea was deemed promising due to its potential to address a pressing need in the community and leverage technology to create positive social impact.
- Team members expressed enthusiasm for the selected idea and voiced their commitment to contributing to its success.

iii. Planning Upcoming Tasks:

- With the idea selected, the team outlined the next steps and upcoming tasks required to kickstart the project.
- Tasks identified include conducting market research to understand user needs, drafting initial app features and functionalities, and planning the app's design and development process.
- Deadlines and responsibilities were assigned to each team member, ensuring clear accountability and progress tracking.
- A tentative timeline was established, with regular check-ins planned to review progress, address challenges, and adjust plans as needed.

Action Items:

1. Conduct market research to identify user needs and preferences. [Assigned to: All of the group members , Deadline: 13th October 2023]
2. Draft initial features and functionalities for the mobile app or for a website. [Assigned to: Nadil Lokuhetty, Roshen Perera, Pitigala Manodya, Deadline: 15th October 2023]
3. Begin planning the design and development process. [Assigned to: Ravindi Wickramasinghe, Widanalage Priyantha, Deadline: 23rd October 2023]
4. Schedule regular check-ins to review progress and address challenges. [Assigned to: Ravindi Wickramasinghe, Nadil Lokuhetty, Deadline: 23rd October 2023]

Next Meeting:

- Date: 26th October 2023

- Time: 2.00 pm

- Location: Caramel Pumpkin Café

Meeting Adjourned: 5.00 pm

Prepared By:

Nadil Lokuhetty

9.3 User requirement gathering data

The User requirements gathering for the Portable Infant Incubator System involved conducting interviews with key stakeholders, including the Head Nurse of the Neonatal Intensive Care Unit (NICU). During the interview, conducted on [insert date], various aspects of neonatal transportation were discussed. This included gathering background information on current transportation protocols and equipment used within the NICU, as well as identifying any existing challenges. Insights were sought regarding monitoring requirements, preferences for alert systems, desired features for the user interface, and considerations for equipment portability. Additionally, feedback on previous experiences with similar systems was gathered, along with input on training and support needs for medical staff and caregivers. The interview concluded with gratitude for the interviewee's valuable input and an invitation for further comments or suggestions. These insights serve as the foundation for defining user requirements and guiding the design and development of the Portable Infant Incubator System.