VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY

(An Autonomous Institute Affiliated to University of Mumbai)

Department of Computer Engineering

Project Report on

SafeGuard: Enhancing Safety Assessments for vulnerable children through EQ/SQ integration using AI

In partial fulfilment of the Fourth Year, Bachelor of Engineering (B.E.)

Degree in Computer Engineering at the University of Mumbai

Academic Year 2024 - 25

By

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Project Mentor

Dr. (Mrs.) Sharmila Sengupta

A.Y. 2024 - 25

VIVEKANAND EDUCATION SOCIETY'S INSTITUTE OF TECHNOLOGY

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Certificate

This is to certify that **Tanya Lilani (D17C - 40), Vaibhavi Shetty (D17C - 59), Sakshi Valecha (D17C - 71), & Chirag Mangtani (D17C - 45)** of Fourth Year Computer Engineering studying under the University of Mumbai have satisfactorily completed the project on **"SafeGuard: Enhancing Safety Assessments for vulnerable children through EQ/SQ integration using AI"** as a part of their coursework of Major Project II for Semester VIII under the guidance of their mentor **Dr. (Mrs.) Sharmila Sengupta** in the year 2024 - 25.

This project report entitled **"SafeGuard: Enhancing Safety Assessments for vulnerable children through EQ/SQ integration using AI"** by Tanya Lilani, Vaibhavi Shetty, Sakshi Valecha, & Chirag Mangtani is approved for the degree of **Bachelor of Engineering** in **Computer Engineering.**

Programme Outcomes	Grade
PO1, PSO1	

Date: 28th April, 2025

Project Guide:

Project Report Approval
For
B. E (Computer Engineering)

This project report entitled **"SafeGuard: Enhancing Safety Assessments for vulnerable children through EQ/SQ integration using AI"** by **Tanya Lilani (D17C - 40), Vaibhavi Shetty (D17C - 59), Sakshi Valecha (D17C - 71), & Chirag Mangtani (D17C - 45)** is approved for the degree of **Bachelor of Engineering** in **Computer Engineering.**

Examiners

1. ………………………………
(Internal Examiner name & sign)

2. ………………………………
(External Examiner name & sign)

3. ………………………………
(Head of Department)

4. ………………………………
(Principal)

Date: 28th April, 2025

Place: Chembur, Mumbai

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea / data / fact / source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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(Tanya Lilani - D17C / 40)	(Vaibhavi Shetty - D17C / 59)
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Date: 28th April, 2025

Acknowledgement

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We wish to express our profound thanks to all those who helped us in gathering information about the project. Our families too have provided moral support and encouragement several times.

Computer Engineering Department

COURSE OUTCOMES FOR B.E. PROJECT

Learners will be able to,

Course Outcome	**Description of the Course Outcome**
CO1	Able to apply the relevant engineering concepts, knowledge and skills towards the project.
CO2	Able to identify, formulate and interpret the various relevant research papers and to determine the problem.
CO3	Able to apply the engineering concepts towards designing solutions for the problem.
CO4	Able to interpret the data and datasets to be utilized.
CO5	Able to create, select and apply appropriate technologies, techniques, resources and tools for the project.
CO6	Able to apply ethical, professional policies and principles towards societal, environmental, safety and cultural benefit.
CO7	Able to function effectively as an individual, and as a member of a team, allocating roles with clear lines of responsibility and accountability.
CO8	Able to write effective reports, design documents and make effective presentations.
CO9	Able to apply engineering and management principles to the project as a team member.
CO10	Able to apply the project domain knowledge to sharpen one’s competency.
CO11	Able to develop a professional, presentational, balanced and structured approach towards project development.
CO12	Able to adopt skills, languages, environment and platforms for creating innovative solutions for the project.

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Abstract

SafeGuard is an innovative, AI-powered wearable device designed to enhance child safety by integrating seamlessly into children's clothing. This compact solution continuously monitors vital environmental factors such as temperature, humidity, and oxygen levels, ensuring that children remain in a safe and healthy environment. Additionally, SafeGuard includes real-time GPS tracking capabilities, enabling parents to know their child's exact location at any moment. All data is transmitted securely to a cloud server and presented via an intuitive web interface, allowing guardians to receive immediate alerts if any readings fall outside safe parameters.

The core of SafeGuard's design revolves around three essential quotients: Safety, Social, and Emotional. The Safety Quotient ensures 24/7 monitoring, offering peace of mind for families and creating a secure environment for children. Whether at home, school, or outdoors, the device constantly collects and analyzes data, proactively identifying and responding to potential risks. Alerts for unsafe conditions—such as extreme heat, low oxygen levels, or unexpected movement—enable parents to take immediate action, reducing the chances of harm.

The Social Quotient is centered on fostering a sense of community and shared responsibility. SafeGuard promotes interaction among families and caregivers through its connected platform, enabling rapid responses in emergency situations. This collaborative approach enhances overall community safety and builds a network of support. Parents can share safety data, raise alerts, and receive updates, ensuring no child is left unattended or in danger without others being informed.

Equally important is the Emotional Quotient, which focuses on the emotional well-being of the child. Continuous monitoring helps children feel secure and supported, knowing that their safety is being actively watched over. This is especially beneficial for children with disabilities, as SafeGuard's adaptive learning capabilities tailor its functionality to their individual needs. By creating a reassuring environment, the device fosters emotional stability and encourages confidence and independence.

SafeGuard also showcases practical, real-world applications that underline its effectiveness. For example, it can alert parents if a child is accidentally left in a locked car under extreme temperatures or if sudden deviations in location patterns indicate a possible kidnapping. By combining advanced hardware like Raspberry Pi with smart sensors and predictive analytics, SafeGuard delivers a holistic, proactive approach to child safety—prioritizing prevention, timely intervention, and overall family support.

Chapter I: Introduction

1.1 Introduction

SafeGuard is an innovative AI-driven solution designed to enhance child safety through a groundbreaking wearable device that is seamlessly integrated into children's clothing. This device continuously monitors critical environmental factors, such as temperature, humidity, oxygen levels, and the child's location in real-time. By utilizing advanced technology, the device collects and transmits data to a central cloud server, allowing parents to access vital information through a user-friendly web interface. The ability to receive immediate alerts for any deviations from safe conditions empowers parents to act swiftly, ensuring their child's safety in various environments.

The project emphasizes a holistic approach to child safety, focusing on three essential quotients: Safety, Social, and Emotional. The Safety Quotient provides round-the-clock supervision, fostering a secure environment and peace of mind for families. The Social Quotient enhances community engagement, encouraging meaningful connections between families and enabling rapid emergency responses. Meanwhile, the Emotional Quotient addresses the emotional well-being of children, instilling a sense of security and support through continuous monitoring. By integrating these components, SafeGuard aims to provide comprehensive protection and support for children, particularly those with special needs, ensuring that families can navigate everyday challenges with confidence.

1.2 Motivation

The motivation behind SafeGuard stems from the urgent need to enhance child safety in an increasingly unpredictable world. With rising concerns about children's well-being, including the risks of abduction, there is a pressing demand for innovative solutions that provide real-time monitoring and support. SafeGuard aims to empower parents by offering peace of mind through continuous oversight, allowing them to respond promptly to any potential threats. Additionally, by fostering emotional well-being and encouraging community connections, SafeGuard seeks to create a supportive environment where children can thrive safely. This project is driven by a commitment to ensuring that every child feels secure, supported, and connected, enabling families to focus on nurturing their children's growth and development without constant worry.

1.3 Drawback of existing systems

Existing systems for child safety exhibit significant gaps that limit their effectiveness. Many lack personalized learning and support, failing to adapt to individual children's needs. Behavior monitoring and emotion detection capabilities are often underdeveloped, leaving caregivers without crucial insights. Real-time alerts may not be timely or accurate enough, while content filtering mechanisms frequently fall short in ensuring online safety. Additionally, predictive analytics are rarely integrated, hindering the ability to foresee potential risks. Location tracking can be inadequate, especially for unattended children, increasing vulnerability. Cultural sensitivity is often overlooked, leading to a one-size-fits-all approach. Overall, these gaps highlight the need for a more comprehensive solution that addresses the multifaceted challenges of child safety.

1.4 Problem Definition

The problem of child safety is a growing concern in today's society, as parents face numerous challenges in protecting their children from various potential threats. Traditional safety measures often fall short, lacking real-time monitoring and the ability to quickly respond to emergencies. To address these challenges, SafeGuard proposes an AI-driven solution that combines wearable technology with advanced monitoring capabilities. By seamlessly integrating a device into children's clothing, SafeGuard enables real-time tracking of location and environmental factors, allowing parents to stay informed about their child's safety at all times. This innovative approach not only enhances the immediate response to potential dangers but also supports the emotional well-being of children by fostering a sense of security.

1.5 Relevance of the project

The relevance of the SafeGuard project lies in its timely and innovative approach to addressing the critical issue of child safety in today’s complex and often unpredictable environment.SafeGuard not only enhances parental awareness through tracking of environmental factors and location but also fosters emotional well-being and social connections. By integrating advanced technology with a focus on cultural sensitivity and accessibility, the project aims to empower families and provide tailored support, particularly for children with special needs. Ultimately, SafeGuard's comprehensive framework addresses pressing safety challenges while promoting a nurturing environment, making it a vital contribution to the field of child safety and family support.

Chapter II: Literature survey

2.1 Research Papers Review

1) **L. Orriens & C. Erasmus, Social and Emotional Impact of anterior drooling in school-age children and young people with neuro-development disabilities, 15th August 2024.**

- **Abstract:** The study examines how anterior drooling in children with neurodevelopmental disabilities impacts their emotional well-being and social interactions, leading to stigma, lowered self-esteem, and reduced participation in peer activities.
- **Inference:** Physical symptoms like drooling can have deep emotional and social consequences, highlighting the need for holistic, dignity-focused care and support.
- **Relevance to our work:** SafeGuard supports emotional security and social inclusion for children with disabilities, aligning with the study's call for integrated, compassionate solutions beyond medical monitoring.

2) **K. Moussa & B.Xu, Revolutionizing Healthcare: Seamless Integration of Cloud Technology and IoT for Health Monitoring Systems, August 1 2024**

- **Abstract:** This paper explores the transformative role of integrating Internet of Things (IoT) devices with cloud computing in healthcare systems. It highlights how this synergy enables real-time patient monitoring, automated data collection, and remote diagnostics
- **Inference:** The integration of cloud and IoT empowers continuous health tracking, faster decision-making, and personalized care—reducing system strain and enhancing medical efficiency.
- **Relevance to our work:** SafeGuard adopts a similar cloud-IoT model to monitor children's safety and health conditions in real time. This study supports SafeGuard's technical foundation and its potential for scalable, intelligent, and responsive safety management—especially crucial for children with special needs or in high-risk environments.

3) **J. Anderson & C. Toolan, A novel dance intervention program for children and adolescents with development disabilities, May 14 2024**

- **Abstract:** The paper presents a dance-based intervention aimed at improving motor skills, social interaction, and emotional expression in children with developmental disabilities.
- **Inference:** Creative movement activities like dance can enhance physical coordination and emotional well-being while fostering peer connection.
- **Relevance to our work:** Aligns with SafeGuard's Emotional and Social Quotients by reinforcing the value of emotional expression and social engagement for children with special needs.

4) **F. Altinay & A. Tlili, Meta-In or Meta-Out of Students with Special Needs: A Systematic Review on the Use of Metaverse in Special Education, May 8 2024**

● **Abstract:** This systematic review analyzes how Metaverse technologies are being used in special education, focusing on their potential to enhance engagement, personalized learning, and inclusivity for students with special needs.

● **Inference:** Immersive virtual environments can support individualized learning experiences, boost motivation, and create more inclusive educational settings.

● **Relevance to our work:** Supports SafeGuard's adaptive and personalized approach by highlighting the benefits of tech-driven, immersive, and emotionally supportive tools for children with special needs.

5) **L. Arya & P. Ranade & T. Goswami, Intellectually Disabled Child Holistic Growth Management Platform; Voice Interaction and Scheduling, May 8 2024**

● **Abstract:** This paper presents a holistic growth management platform for intellectually disabled children, incorporating voice interaction and scheduling to support personalized learning and development through AI-driven systems.

● **Inference:** Voice-based interfaces and scheduled routines help manage daily tasks, enhance communication, and foster independence, leading to better developmental outcomes for children with intellectual disabilities.

● **Relevance to our work:** Aligns with SafeGuard's approach to using technology for personalized, adaptive care, emphasizing support for emotional, social, and developmental growth through user-friendly, interactive systems.

6) **Y. Wang & Y. Liu, Working memory predicts receptive vocabulary, April 29 2024**

● **Abstract:** This study explores the relationship between working memory capacity and receptive vocabulary in children, finding that stronger working memory is a key predictor of vocabulary comprehension and language development.

● **Inference:** Working memory plays a crucial role in language acquisition, particularly in understanding and retaining vocabulary, which is essential for effective communication and cognitive development.

● **Relevance to our work:** Reinforces the importance of cognitive development in children, supporting SafeGuard's approach to promoting overall well-being, including cognitive monitoring and adaptive learning, particularly for children with special needs.

7) **P. Simon & N. Grobois, How do Children with Intellectual Disabilities Empathize in Comparison to Typically Developing Children?, April 12 2024**

● **Abstract:** This study investigates how children with intellectual disabilities experience and express empathy compared to typically developing children, highlighting differences in emotional understanding and social responses.

● **Inference:** While children with intellectual disabilities may face challenges in empathizing, they still demonstrate empathy in unique ways, emphasizing the importance of tailored emotional and social support.

● **Relevance to our work:** Supports SafeGuard's Emotional Quotient by underlining the need for personalized emotional support, ensuring that children with intellectual disabilities receive the care and understanding they need to thrive socially and emotionally.

8) **K. Boyd & V. Baril, Aging with intellectual and development disabilities, March 30 2024**

● **Abstract:** This paper examines the challenges and unique needs faced by individuals with intellectual and developmental disabilities (IDD) as they age, focusing on healthcare, social inclusion, and adaptive support systems to enhance quality of life.

● **Inference:** Aging individuals with IDD require specialized care that addresses both their physical and emotional needs, with an emphasis on accessible healthcare and fostering independence in later life.

● **Relevance to our work:** Reinforces the importance of continuous, adaptive support systems, such as SafeGuard, to monitor and ensure the well-being of children and adults with IDD as they grow older, promoting health, safety, and emotional security.

2.2 **Inference Drawn**

Based on the literature survey, several key inferences can be drawn regarding the field of meeting summarization and its application to our work:

● A common thread across the studies is the importance of personalized and adaptive support systems for children and individuals with intellectual and developmental disabilities. From dance interventions to holistic platforms, the research underscores that no one-size-fits-all solution exists—technological tools must be flexible and capable of adjusting to individual needs to effectively support physical, cognitive, and emotional development.

● Emotional and social development emerged as crucial factors, with multiple studies—such as those by Orriens & Erasmus and Simon & Grosbois—highlighting the impact of emotional well-being and empathy on the lives of children with disabilities. Emotional challenges like stigma or limited social understanding require solutions that go beyond monitoring and actively foster emotional resilience and positive social interaction.

- Technology plays a vital enabling role. The integration of cloud technology and IoT, as explored by Moussa & Xu, validates the technical backbone of platforms like SafeGuard. Real-time data transmission, predictive alerts, and remote monitoring empower caregivers with continuous oversight, making interventions more timely and effective.
- Several studies emphasized communication and routine management, especially for intellectually disabled children. Arya, Ranade, & Goswami showed how voice-interactive platforms and scheduling tools can improve autonomy and daily functioning. This highlights how SafeGuard can evolve to include not just passive monitoring, but active engagement and interaction.
- Creative, movement-based therapies, such as dance (Anderson & Toolan), revealed their value in improving not only motor coordination but also emotional expression and peer bonding. This underlines the need for SafeGuard to recognize and potentially integrate support for non-clinical, expressive outlets as indicators of emotional health.
- The use of immersive and emerging technologies like the Metaverse (Altinay & Tlili) shows promise in engaging students with special needs in inclusive, virtual learning environments. SafeGuard can draw from this by considering future integrations with immersive platforms to extend its reach into educational and emotional development spaces.
- Cognitive abilities, especially working memory, play a major role in a child's learning and vocabulary acquisition (Wang & Liu). This points to the potential of SafeGuard to not only track environmental and physical metrics but also include cognitive insights, providing a fuller picture of a child's developmental status.
- The need for long-term, lifespan-oriented care is highlighted in the study by Boyd & Baril, which focused on aging individuals with developmental disabilities. This underscores the value of designing SafeGuard not as a child-only system, but as a scalable platform that can support users through different life stages.
- A consistent theme across these studies is the importance of community and caregiver involvement. Whether through platforms that connect parents or interventions that encourage peer interaction, there's a growing understanding that support systems must include and empower families, educators, and communities for truly sustainable care.
- Ultimately, the literature supports a multi-dimensional approach to care—one that merges technology with empathy, education with engagement, and monitoring with emotional insight.

SafeGuard stands at the intersection of these needs, offering a foundation that can evolve into a holistic tool for child safety, cognitive development, and emotional well-being across a variety of real-world settings.

2.3 Comparison with the Existing System

Feature	Existing Meeting Summarization Systems (General)	Our Proposed System (Career Counseling Focused)	Potential Advantages o Our System
Domain Specificity	Generic; not tailored to any specific field	Specifically designed for career counseling session	More relevant summarie with career-specific insights
User Personalization	Limited or no personalization	Tailors outputs to individual students' backgrounds and aspirations	Enhances guidance by aligning with personal goals
Emotional/Sentimen Analysis	Often ignored or basic	Includes emotional tone analysis during counseling	Helps counselors better understand student mindset
Goal-Oriented Tracking	Focuses on conversation structure or key points	Tracks progress toward career goals and advice follow-up	Improves accountability and clarity for students
Integration with Academic Records	Rare or not available	Supports more holistic, data-informed counseling	Supports more holistic, data-informed counselin
Recommendation System	Not typically included	Suggests career paths, resources, and next steps based on session content	Adds actionable value beyond summarization
Session History	Basic or session-isolated		Enables continuity and

Feature	Existing Meeting Summarization Systems (General)	Our Proposed System (Career Counseling Focused)	Potential Advantages of Our System
Management		Maintains cumulative counseling history for each student	better long-term planning
Feedback Mechanism	Often missing	Includes feedback from both student and counselor	Enhances system refinement and session quality

Table 2.1: Comparison of proposed system with existing systems

Chapter III: Requirement Gathering for the Proposed System

3.1 Introduction to requirement gathering

To develop a domain-specific meeting summarization system tailored for career counseling, we began by identifying key stakeholders, including students, career counselors, academic advisors, and administrative staff. Initial interviews and surveys helped us understand the real-world counseling workflow, communication patterns, and common challenges faced during sessions. The core requirement identified was the need for intelligent summarization of counseling sessions, focusing on goal tracking, career recommendations, and emotional insights. Users expressed a strong interest in having summaries that highlight advice given, action items, and emotional cues from students. Counselors also emphasized the importance of accessing previous session histories and tracking student progress over time. From the technical perspective, the system needs to support natural language processing, sentiment analysis, and keyword extraction, with optional voice-to-text integration for live transcription. Integration with academic databases was also considered essential for delivering context-aware recommendations.

3.2 Functional Requirements

Functional requirements outline the specific features and capabilities that SafeGuard must possess to effectively ensure child safety. These may include:

- Real-time location tracking
- Continuous environmental monitoring
- User-friendly web interface for parents
- Instant alert system for deviations from safety parameters
- Emergency response features, including a panic button
- Geofencing capabilities for safe area monitoring
- Secure data storage and remote access via cloud server
- Customizable alert settings for caregivers
- Integration of multiple sensors with Raspberry Pi
- Accessibility features for users with disabilities
- Behavior monitoring and analysis
- Content filtering for enhanced safety

3.3 Non-Functional Requirements

Non-functional requirements specify the quality attributes, system performance, and constraints that SafeGuard must adhere to. These may include:

- Performance: The system must provide real-time updates with a latency of less than 2 seconds for location and environmental data.
- Scalability: The architecture must support a growing number of users and devices without degradation in performance.
- Reliability: The system should have an uptime of 99.9%, ensuring continuous monitoring and alert capabilities.
- Security: Data transmission and storage must be encrypted to protect sensitive information from unauthorized access.
- Usability: The web interface should be intuitive, requiring minimal training for parents and caregivers to navigate effectively.
- Compatibility: The system must be compatible with various devices and operating systems, including desktops and mobile platforms.
- Maintainability: The software should be designed for easy updates and maintenance, allowing for the integration of new features and improvements.
- Accessibility: The interface must meet accessibility standards to accommodate users with disabilities, ensuring all features are usable by everyone.
- Interoperability: The system should be able to integrate seamlessly with third-party applications and services for enhanced functionality.
- Response Time: The alert system must notify users within 5 seconds of detecting any unsafe conditions or events.
- Data Retention: The system must adhere to legal and regulatory requirements for data retention, ensuring compliance with privacy laws.
- User Support: Provide comprehensive documentation and support resources to assist users with troubleshooting and usage inquiries.

3.4 Hardware & Software Requirements

Category	Requirement
Hardware Requirements	
CPU	Intel Core i7 or higher
RAM	16 GB or more

GPU	NVIDIA T4 / NVIDIA P100 – 16 GB or more VRAM
Webcam / Camera	Required for video-based interactions
Microphone	Required for audio-based meetings or recordings
Software Requirements	
Operating Environment	Jupyter Notebook
Code Editor	VS Code or any Python-supported IDE
Visualization Tools	Matplotlib, Seaborn, Plotly (for charts/graphs)
Browser	Any modern browser (e.g., Chrome, Firefox, Edge)
Containerization Tool	Docker 28.0.4 (for scalable deployment and meet bot creation)
Language Model	LLaMA 3.1 (8B), loaded using Unsloth in 4-bi quantized format

Table 3.1: Hardware & Software Requirements

3.5 Constraints

- Device Compatibility
- Environmental Conditions
- Battery Life
- Internet Connectivity
- Sensor Calibration
- User Proximity
- Mobile Device Support
- Privacy Regulations
- Alert Limitations
- Accessibility Standards

3.6 Tools & Techniques utilized till date

- Sensor Integration: Utilizing various sensors (BME680, MIX8410, GPS HAT) for real-time monitoring of environmental conditions and location tracking.
- Data Processing: Implementing Raspberry Pi as a central processing unit to collect and analyze data from the sensors.
- Cloud Computing: Leveraging cloud storage for secure data management and remote access to monitoring information.
- Web Development: Creating a user-friendly web interface to provide parents with real-time updates and alerts.
- Raspberry Pi: A compact computer serving as the central processing unit for data collection and analysis.
- BME680 Sensor: Used for monitoring temperature, humidity, pressure, and air quality.
- MIX8410 Sensor: Employed for detecting oxygen levels to assess air quality.
- GPS HAT: Facilitates real-time location tracking of the child.
- Wi-Fi Module 802.11: Enables wireless communication between the device and the cloud server.
- Cloud Storage Services: Utilized for secure data storage and remote access (e.g., AWS, Google Cloud).

3.7 Development Stack

- **Frontend:** React.js with Tailwind CSS for building a responsive, intuitive user interface tailored for both students and counselors.
- **Backend:** Node.js with Express.js to handle APIs, session management, and business logic.
- **NLP & AI Integration:** Python (using libraries like spaCy, NLTK, or Transformers from Hugging Face) for summarization, sentiment analysis, and recommendation engine.
- **Database:** MongoDB or PostgreSQL for storing session data, user profiles, and historical summaries securely.
- **Speech-to-Text & Integration:** Google Cloud Speech-to-Text or Whisper by OpenAI for transcribing live or recorded sessions, integrated with cloud storage (AWS/GCP).

Chapter IV: Proposed Design

4.1 Block diagram of system

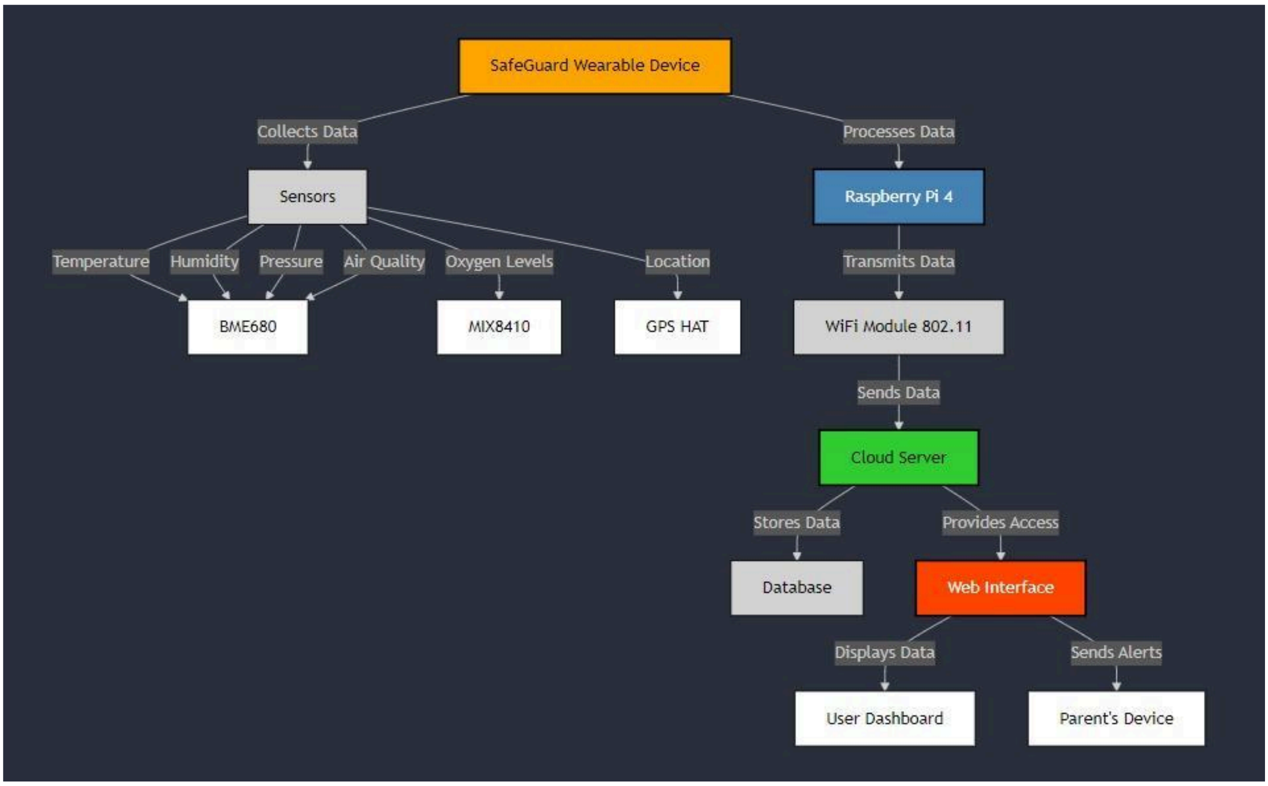


Figure 4.1: Block diagram of the system

This block diagram represents the structure and data flow of the SafeGuard wearable device system, designed for continuous child safety monitoring. Here's a breakdown of each component and its role in the system:

1. **SafeGuard Wearable Device:** This is the central unit, containing various sensors and processing components that collect and transmit data related to the child's environment and location.

2. Sensors: The device uses several sensors to monitor environmental parameters:

- **BME680:** Measures Temperature, Humidity., Pressure, and Air Quality. These readings help determine the child's immediate surroundings and detect potentially unsafe environmental conditions.
- **MIX8410:** Measures Oxygen Levels to ensure the air quality is safe and adequate for the child.
- **GPS HAT:** Tracks the Location of the child in real-time, enabling caregivers to monitor the child's whereabouts.

3. **Raspberry Pi 4:** This serves as the processing unit within the wearable device. It collects data from the sensors, processes it, and prepares it for transmission. The Raspberry Pi interprets the readings and determines if any parameters are outside the safe range, which would trigger alerts.

4. **WiFi Module 802.11:** This module handles data transmission. It sends the processed data from the Raspberry Pi to the Cloud Server via an internet connection, ensuring real-time updates are available.

5. **Cloud Server:** The Cloud Server acts as a centralized data storage and access point. It receives data from the wearable device, stores it, and makes it accessible to connected devices for monitoring and alerting.

6. **Database:** The Cloud Server uses a database to store the sensor data. This allows historical data tracking, enabling caregivers to review past environmental and location data if needed.

7. **Web Interface:** The web interface is the user-facing component that allows caregivers (parents) to access the data collected by the device. It provides two main functions:

4.2 Modular design of the system

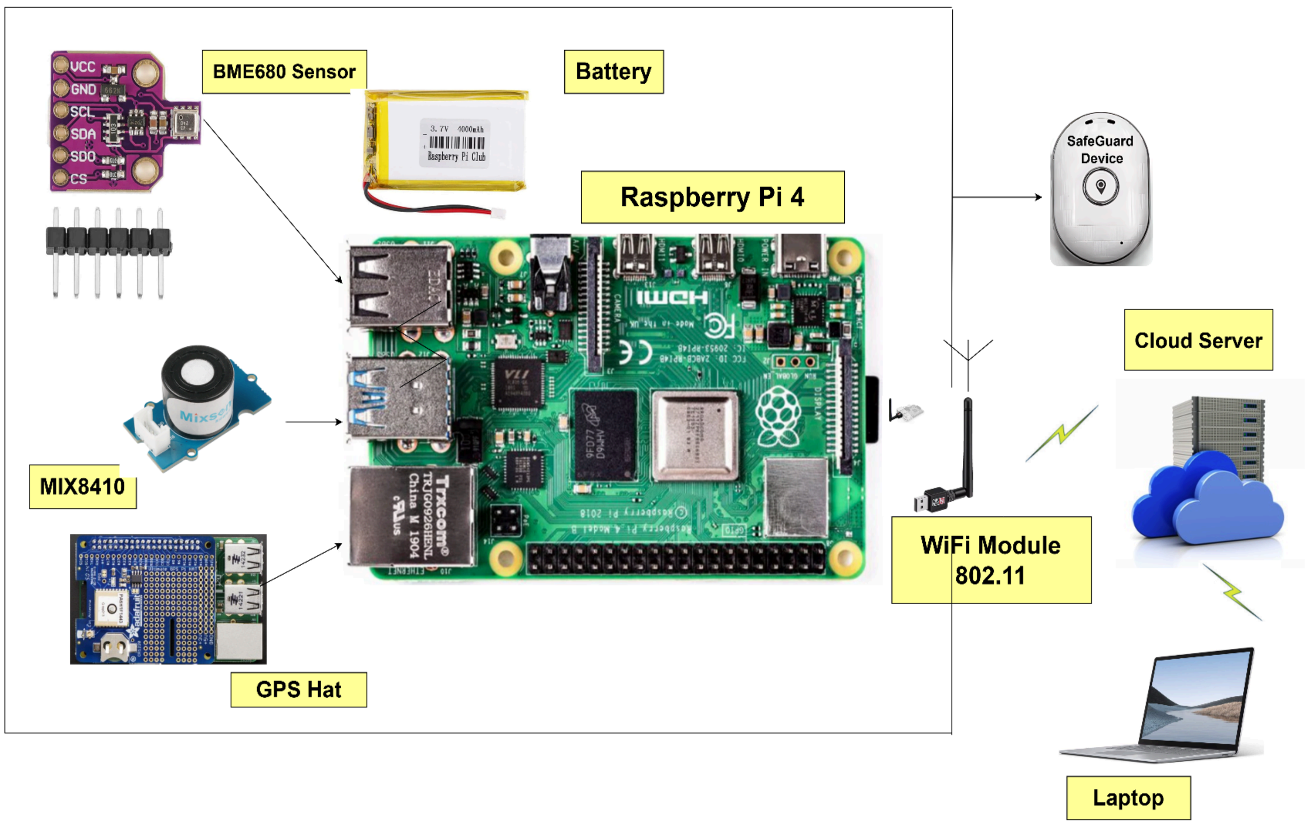
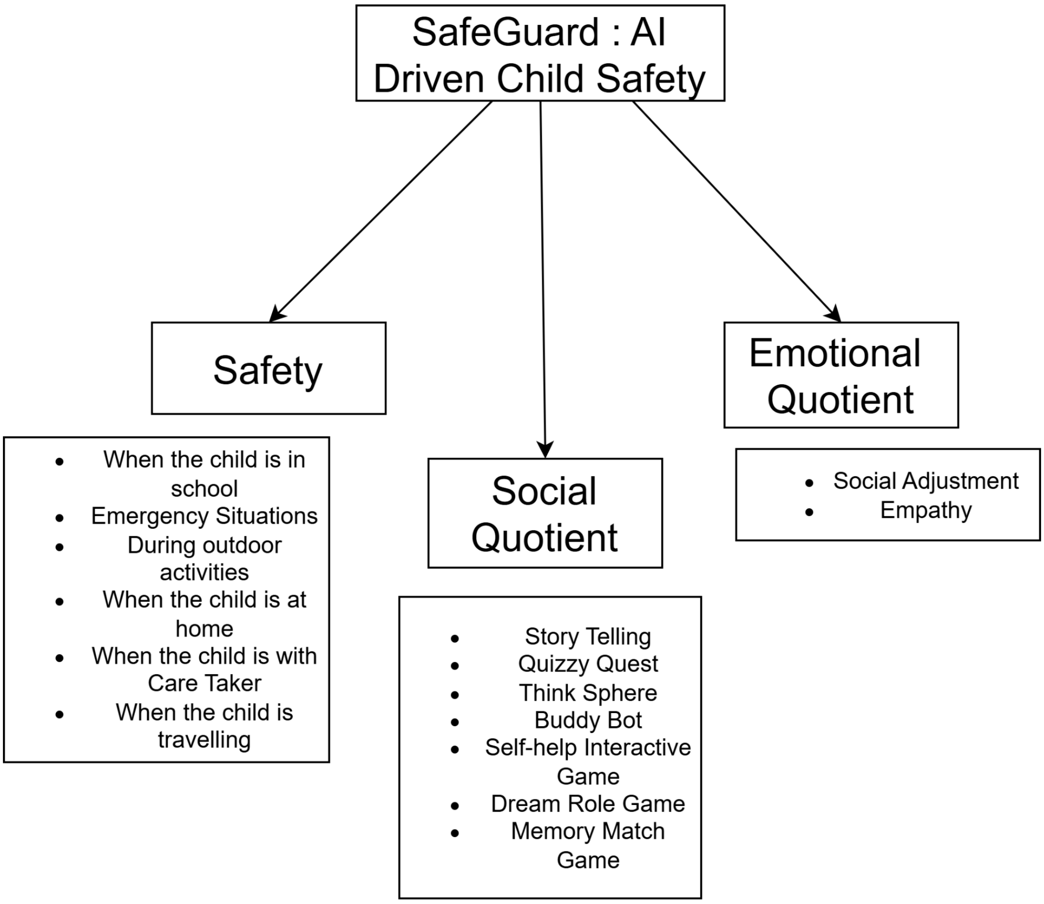


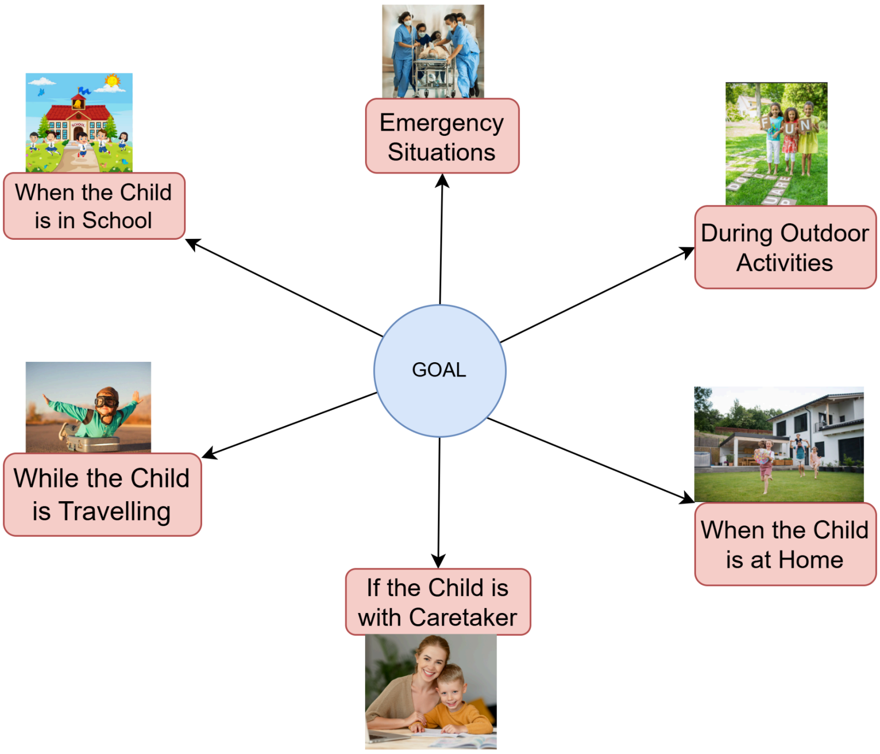
Figure 4.2: Modular diagram of the system

This diagram shows the SafeGuard wearable device's data flow for continuous child safety monitoring. The device includes sensors (BME680, MIX8410, and GPS HAT) that collect data on environmental factors (temperature, humidity, pressure, air quality, oxygen levels) and location. This data is processed by a Raspberry Pi 4, which then transmits it via a WiFi Module 802.11 to a Cloud Server. The server stores data in a Database for record-keeping and provides access through a Web Interface. The web interface features a User Dashboard for live data visualization and sends alerts to the Parent's Device when unsafe conditions are detected, ensuring real-time safety monitoring and response.

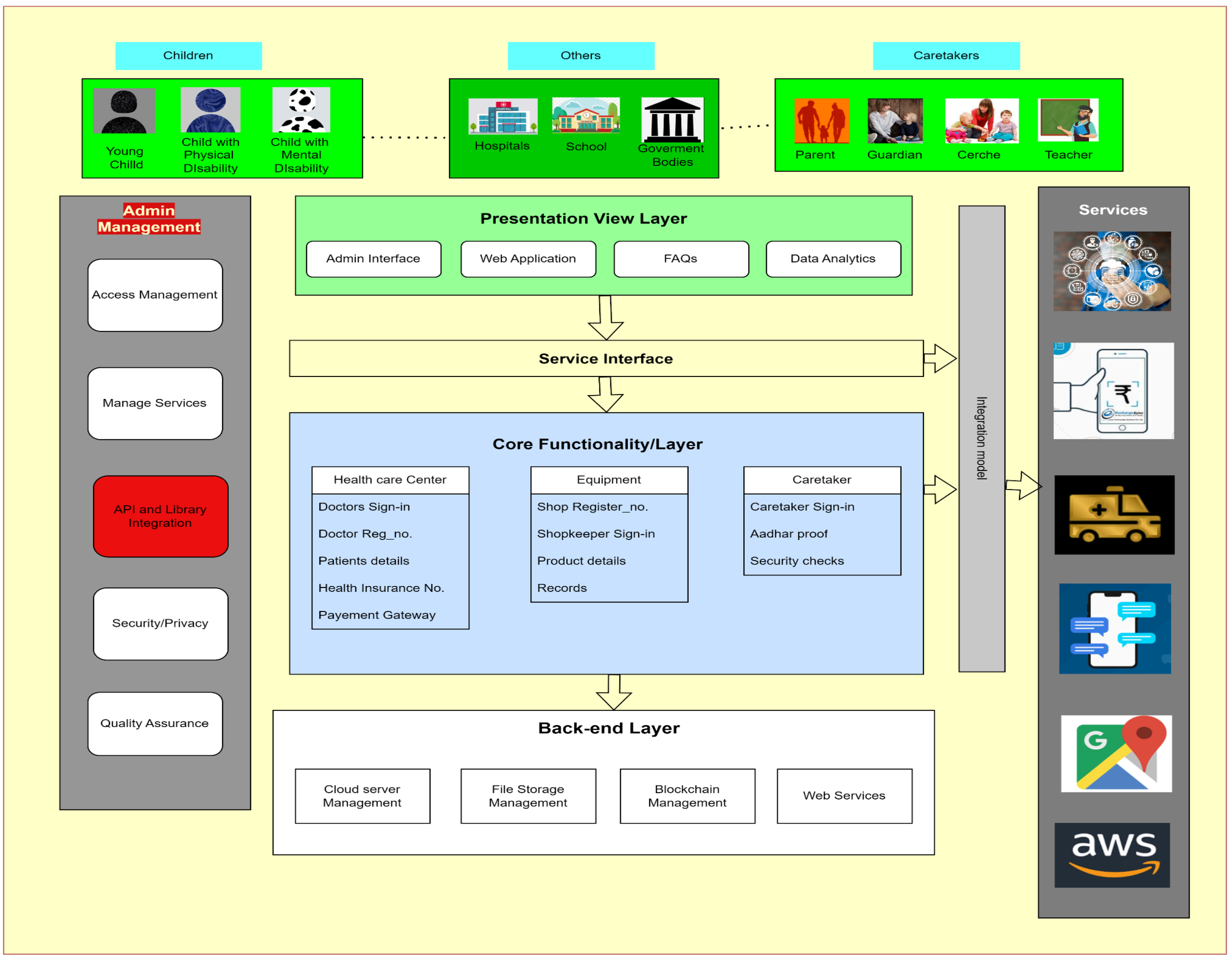
4.3 Design of the proposed system

a. Data Flow Diagrams





b. Flowchart for the proposed system



c.

c. Gantt Chart

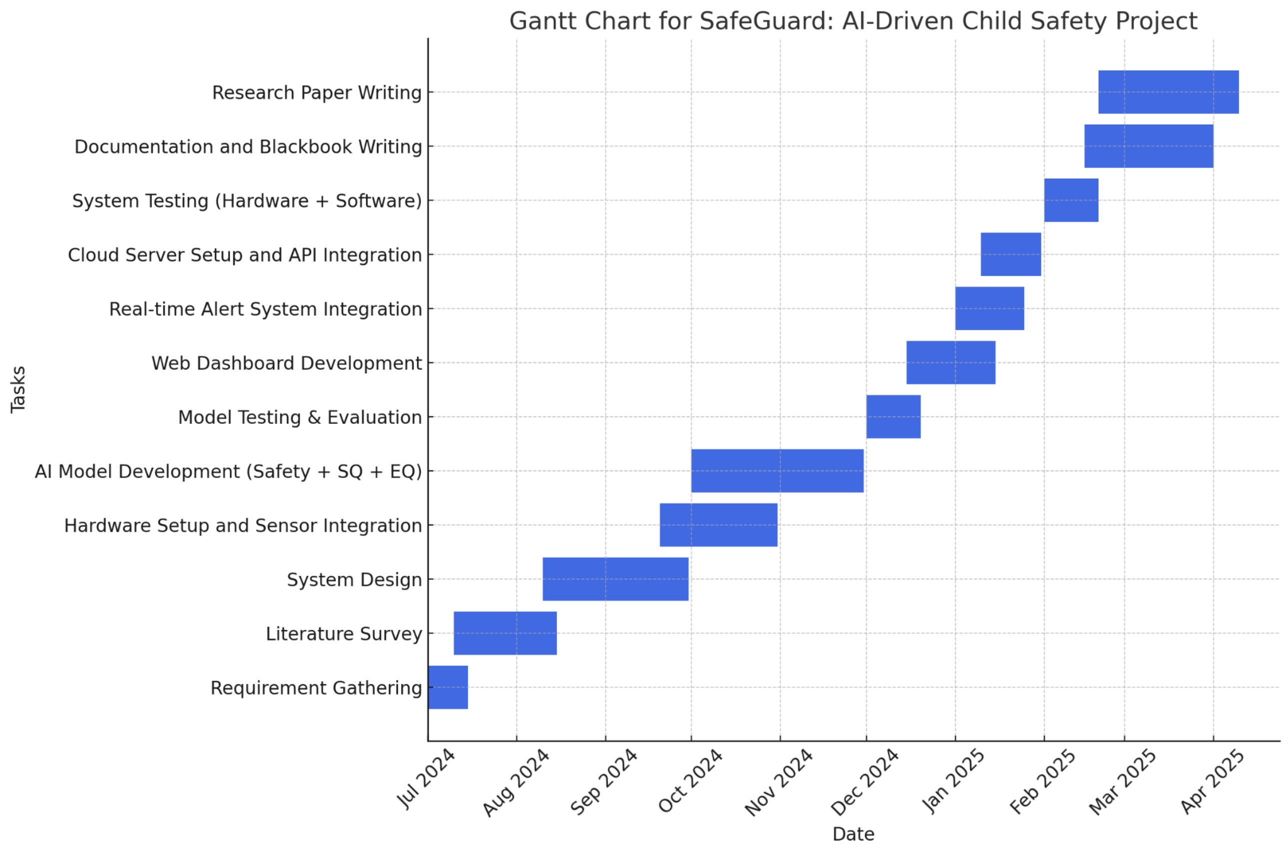


Figure 4.4: Gantt chart - project timeline

Chapter V: Implementation of Proposed System

5.1 Methodology employed for development

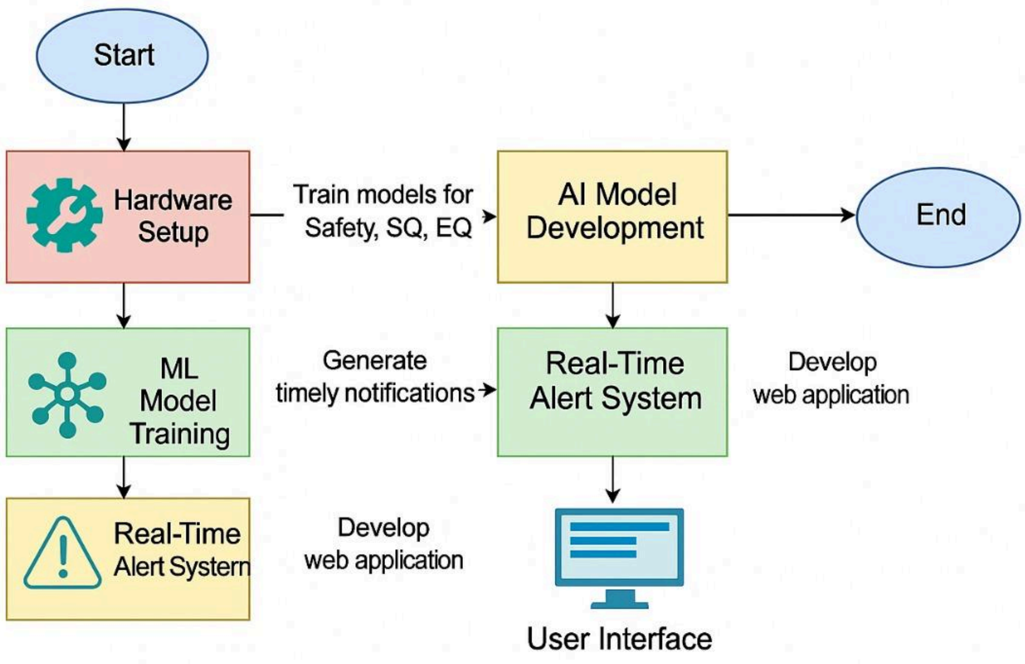


Figure 5.1: Methodology Employed

The development of the SafeGuard: AI driven child safety followed a structured and sequential methodology to ensure the integration of all components for a smooth user experience. The process involved the following steps:

1. Model Development and Fine-Tuning

The project focused on building a robust child safety and well-being monitoring system tailored to physically and emotionally vulnerable children. To achieve this, three core models were developed targeting different aspects: Safety Detection, Social Quotient (SQ) Assessment, and Emotional Quotient (EQ) Evaluation.

The development pipeline began with preprocessing multi-modal datasets collected from wearable sensors (for safety conditions), interactive activities (for SQ analysis), and emotional simulation sessions (for EQ analysis).

These structured datasets were organized into labeled formats — such as sensor readings with event labels, behavioral parameters with SQ scores, and audio-video data with emotional states.

Training leveraged TensorFlow and PyTorch frameworks, with edge-optimized models intended for lightweight deployment on Raspberry Pi 4 hardware.
For efficient training, models were fine-tuned using Transfer Learning approaches, starting with pre-trained CNNs for vision-based tasks and RNNs with attention mechanisms for sequence-based emotion recognition.

Key hyperparameters included:

- Learning Rate: 1e-4
- Batch Size: 16
- Max Sequence Length: 512 tokens (for emotion NLP analysis)
- Optimizer: Adam optimizer with weight decay regularization
- Scheduler: Step Learning Rate Decay
- Quantization: TensorFlow Lite post-training quantization for Raspberry Pi deployment

Performance monitoring and experiment tracking were conducted via TensorBoard and Weights & Biases (W&B), ensuring transparent model performance evaluation and reproducibility.Multiple experiments were run iteratively, with models being evaluated and versioned based on real-time performance metrics such as detection accuracy, inference time, and false alarm rate.

2. Evaluation and Multilingual Testing

For systematic evaluation, the SafeGuard models were tested across multiple real-world scenarios and simulated environments to validate their performance on safety detection, social behavior analysis, and emotional well-being monitoring.

Testing environments included diverse settings such as homes, schools, playgrounds, and travel paths to ensure robustness across varied conditions. Special focus was placed on assessing the model’s ability to generalize across children with different physical and cognitive abilities.

The evaluation process involved continuous monitoring over live sessions and structured test cases, allowing the models to handle both known (seen) and unknown (unseen) events effectively.

Evaluation metrics included both conventional and task-specific measures:

- Accuracy: Percentage of correctly detected safe/unsafe events, emotional states, and social behaviors.

- Precision and Recall: Especially critical for distress and emergency detection to minimize false positives and false negatives.

- F1-Score: Harmonic mean of precision and recall for balanced performance measurement.

- Detection Latency: Time taken from an unsafe event occurring to alert generation—targeted under 2 seconds.

- False Alarm Rate: The proportion of alerts triggered falsely without an actual threat—lower values desired.

- Social Quotient (SQ) Deviation: Difference between system-predicted SQ scores and expert evaluations—measured using Mean Absolute Error (MAE).

- Emotional Quotient (EQ) Analysis: Cross-validation with human observations to verify emotional state detection accuracy.

- Environmental Sensor Accuracy: Compared sensor outputs (temperature, oxygen, humidity) against calibrated standard devices to measure deviation.

Additionally, multilingual testing was performed across English and Hindi emotional datasets to ensure emotional detection models were inclusive and culturally sensitive.
These metrics ensured that the SafeGuard system was not only accurate and reliable but also responsive, inclusive, and suitable for real-time deployment in sensitive child safety applications, as detailed in Table 7.3 of the report.

3. Dashboard Development

The first step in the development was to create the React Dashboard, which acts as the user interface for interacting with the platform. The dashboard provides users with three primary options: Create a Meeting, Join an Existing Meeting, and Upload a Transcript. This dashboard is designed to be user-friendly and provides easy navigation for users to engage with the platform's various features.

4. Working with SafeGuard Device

A major feature of the platform was the Attendee Bot, which automates the process of joining Google Meet sessions and capturing meeting data.

The bot was built using Docker and integrated with the Attendee API to allow seamless joining of Google Meet sessions. Once in the meeting, the bot transcribes and processes the conversation in real-time.

SafeGuard Device, designed to automate the collection, processing, and cloud transmission of real-time child safety data.

The workflow begins with the initialization of the device environment, where all sensors and modules are calibrated and activated.
The device continuously collects:

- Environmental data (temperature, humidity, air quality, oxygen levels),
- Location coordinates via GPS,
- Behavioral interaction logs (for SQ scoring),
- Emotional indicators (facial expression and voice analysis for EQ scoring).

The raw sensor and AI-processed data are then streamed to a local processing pipeline, which handles:

- Cleaning and filtering of noise,
- Segmentation into meaningful time windows,
- Timestamping and anomaly flagging.

Once refined, the data is securely transmitted to the cloud server over Wi-Fi using encrypted channels.
The cloud system further processes and stores the information, making it accessible via the SafeGuard Dashboard for parents, caregivers, and authorized users to monitor in real time.
The device thus ensures continuous, autonomous, and intelligent supervision of the child's physical, social, and emotional well-being, significantly enhancing proactive safety measures.

5. Integrating SafeGuard to Frontend

Once the SafeGuard Device was fully functional and capable of capturing real-time sensor readings and behavioral data, the next step was to integrate it with the frontend dashboard.

This integration ensured a seamless workflow, allowing users to:

- View live location tracking of the child on an interactive map,
- Monitor real-time environmental conditions (temperature, oxygen, humidity, air quality),

- Access updated Social Quotient (SQ) and Emotional Quotient (EQ) scores,
- Receive instant alerts triggered by anomalies or unsafe conditions.

The SafeGuard Device continuously streamed processed data to the cloud server, where it was securely stored and made accessible through the dashboard's real-time data pipelines.
This integration ensured that parents and caregivers could monitor the child's safety, social engagement, and emotional health remotely with minimal latency, enhancing proactive intervention and quick response capabilities.

6. Model Deployment and API Implementation

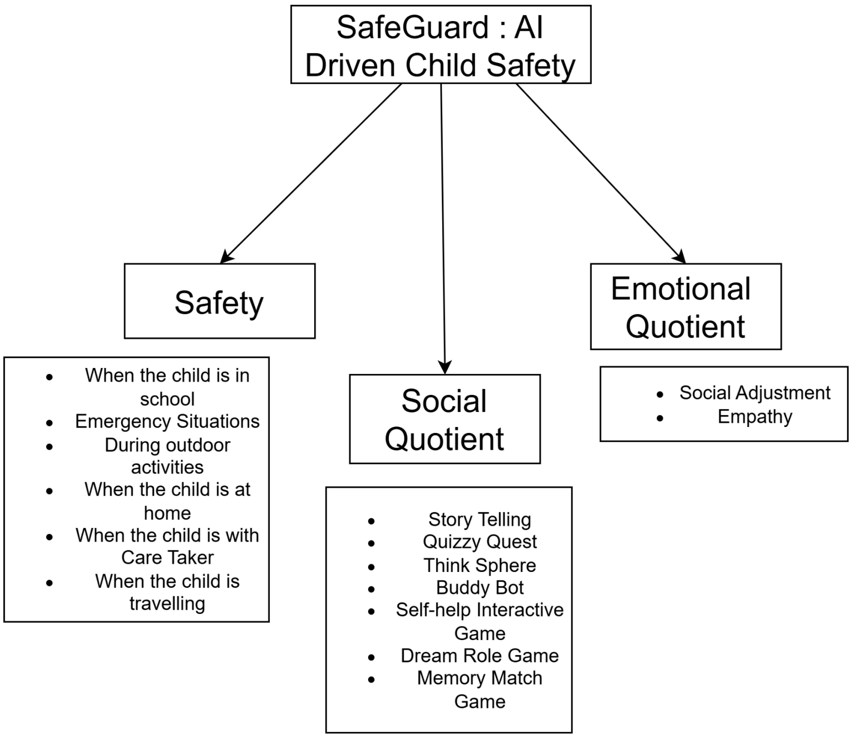
After the SafeGuard Device and AI models were deployed, the next step was to integrate them with the frontend dashboard. This integration allowed the real-time transmission of location, environmental readings, SQ scores, and EQ scores directly to the user interface. Users could now view live tracking updates, receive emergency alerts, and monitor emotional and behavioral insights seamlessly. The frontend ensured that all data was displayed clearly and updated instantly, providing parents and caregivers with continuous visibility into the child's safety and well-being.

7. Frontend Integration for Summary and Insight Display

Finally, after the models were deployed and the APIs were fully functional, the live monitoring results were integrated into the SafeGuard Dashboard. This allowed users to view real-time location tracking, environmental conditions, and behavioral and emotional scores in a clear and organized manner.

The dashboard was designed to be responsive and intuitive, ensuring that parents and caregivers could easily monitor safety updates, receive alerts, and make informed decisions based on the live data provided by the system.

5.2 Algorithms and flowcharts for the respective modules developed



1. Safety Module Algorithm (Real-time Tracking and Alerts)

1. Start.
2. Initialize wearable device sensors (GPS, Temperature, Oxygen, etc.).
3. Continuously capture:
    - Current latitude and longitude.
    - Environmental parameters (temperature, oxygen levels).
4. Compare current location with predefined safe zone coordinates.
5. If deviation from the safe zone exceeds threshold **OR** environmental parameters are unsafe:
    - Trigger emergency alert (notify parents/guardians).
    - Log the event.
6. Else:
    - Continue monitoring.
7. End.

2. Social Quotient (SQ) Module Algorithm

1. Start.
2. Register the child into the SafeGuard platform.
3. Allow the child to perform a series of interactive tasks:
   - Memory Match
   - Dream Role
   - Quizzy Quest (Questionnaire)
   - Think Sphere
   - Self-Help Interactive Game
   - Create Your Story
   - Buddy Bot
4. Capture responses, scores, and time taken.
5. Process responses using Machine Learning (ML) and NLP:
   - Behavioral pattern analysis.
   - Sentiment and keyword extraction.
6. Calculate **Social Age (SA)**.
7. Compute **Social Quotient (SQ)** using the formula:

   SQ =$\left(\frac{Social\ Age(SA)}{Chronological\ Age(CA)}\right) \times 100$
8. Classify SQ:
   - If SQ < 100: Low SQ
   - If SQ = 100: Average SQ
   - If SQ > 100: High SQ
9. Store the SQ score and category.
10. End.

3. Emotional Quotient (EQ) Module Algorithm

1. Start.
2. Engage child with:
   - Role-playing emotional scenarios.
   - Reflection exercises.
   - Problem-solving tasks.
   - Buddy Bot conversation.

3. Capture text and behavioral responses.
4. Analyze responses using NLP sentiment analysis:
   - Detect positive, neutral, or negative emotional tones.
5. Calculate **Emotional Age (EA)** (through models/score mappings).
6. Compute **Emotional Quotient (EQ)** using the formula:

   Emotional quotient = $\left(\frac{Emotional\ Age(EA)}{Chronological\ Age(CA)}\right) \times 100$
7. Classify EQ:
   - If EQ < 100: Low EQ
   - If EQ = 100: Average EQ
   - If EQ > 100: High EQ
8. Store the EQ score and category.
9. End.

5.3 Dataset Source and Utilization

For the SafeGuard project, a SQ & EQ dataset was created due to the lack of publicly available datasets addressing real-time child safety, social behavior, and emotional well-being monitoring.
Data was collected from wearable device sensor readings, classroom observations, behavioral interaction activities, and emotional response sessions.
The dataset included multiple types of information such as:

- Environmental sensor readings
- Real-time GPS coordinates
- Behavioral scores for Social Quotient (SQ)
- Emotional markers for Emotional Quotient (EQ)

All data was cleaned, annotated, and organized in CSV and JSON formats to support easy parsing and model training.
The datasets were used to fine-tune AI models by providing structured input-output pairs:

- Input: Real-time sensor and behavioral data

- Output: Safety alerts, SQ scores, and EQ assessments

The dataset also served as an evaluation benchmark using metrics like detection accuracy, F1-Score, and real-time response latency, ensuring the system could reliably perform in real-world environments.

EQ Dataset:

SQ_TEST		EMS					EQ-i:YV					VABS			ECI				SDQ						
Name	Age	Stability	Progression	Social Adjustment	Independence	Personality Integration	Interpersonal Skills	Intrapersonal Skills	Stress Management	Self-Adaptability	General mood	Motor skills	Communication	Socialisation	Motivation	Empathy	Social Skills	Self-regulation	Emotional symptoms	Conduct Problems	Hyperactivity	Peer Problems	Prosocial behaviour	Emotional Age	score
Lekha	11	0.9	0.2	0.8	0.1	0.5	0.3	0.3	1.0	0.9	1.0	0.3	0.3	0.1	0.3	0.9	0.2	0.8	0.5	0.1	1.0	0.9	1.0	12.5	113.5454
Osha	10	0.3	0.2	0.2	0.6	0.9	0.8	0.9	0.1	0.8	0.9	0.8	0.9	0.9	0.5	0.4	0.7	0.3	0.7	0.5	0.1	0.8	0.9	13.1	131.2
Banjeet	8	0.8	0.9	0.1	0.7	0.3	0.1	0.0	0.8	1.0	0.1	0.1	0.0	0.1	0.6	0.5	0.4	0.5	1.0	0.8	0.8	1.0	0.1	10.6	132.75
Aashi	8	0.3	0.9	1.0	0.7	0.5	0.4	0.2	1.0	0.8	0.3	0.4	0.2	0.6	0.0	0.4	0.1	0.9	0.1	0.4	1.0	0.8	0.3	11.4	142.5
Yasti	9	0.7	0.7	0.8	0.6	0.1	0.5	0.9	0.2	0.5	0.0	0.5	0.9	0.5	0.1	0.6	0.4	0.6	0.9	0.8	0.2	0.5	0.0	11.1	123.6666
Vedika	6	0.8	0.7	0.4	0.6	0.1	0.5	0.5	0.8	0.4	0.7	0.5	0.5	0.7	0.7	0.1	0.8	0.0	0.2	0.8	0.8	0.4	0.7	11.9	198.8333
Nidhi	7	0.2	0.9	0.5	0.0	0.3	0.7	0.5	0.2	0.4	1.0	0.7	0.5	1.0	0.9	0.2	0.4	0.3	0.5	0.6	0.2	0.4	1.0	11.2	159.8571
Chavvi	9	0.7	0.4	0.7	0.2	0.1	0.8	0.5	0.1	0.7	0.5	0.8	0.5	0.6	0.7	0.6	0.9	0.9	0.7	0.5	0.1	0.7	0.5	11.9	132.6666
Vansha	8	0.7	0.2	0.2	0.5	0.6	0.8	0.7	0.9	0.0	0.9	0.8	0.7	0.2	0.1	0.7	0.5	0.9	0.7	0.7	0.9	0.0	0.9	12.2	153
Ishita	12	0.1	0.8	1.0	0.4	0.0	1.0	0.4	1.0	0.8	0.1	1.0	0.4	0.0	0.0	0.8	1.0	0.7	0.6	1.0	1.0	0.8	0.1	12.8	107
Tejas	7	0.1	0.9	0.4	0.1	0.5	0.7	0.4	0.8	0.9	0.1	0.7	0.4	0.9	0.3	0.0	0.0	0.7	0.3	0.5	0.8	0.9	0.1	10.1	144.5714
Yamini	12	0.7	0.9	0.6	0.4	0.3	0.8	0.7	0.6	0.0	0.2	0.8	0.7	0.3	0.6	0.0	0.2	1.0	0.5	0.2	0.6	0.0	0.2	10.4	86.33333
Liam	8	0.9	0.3	0.9	0.7	0.5	0.3	0.8	0.3	0.1	0.6	0.3	0.8	0.8	0.1	0.1	0.5	0.0	0.3	0.8	0.3	0.1	0.6	10.3	128.25
Baghyawa	6	0.1	0.1	0.8	0.1	0.6	0.7	0.4	0.5	0.5	0.5	0.7	0.4	0.4	1.0	0.3	0.8	0.4	0.0	0.4	0.5	0.5	0.5	9.9	164.8333
Logan	12	0.8	0.2	0.5	0.3	0.5	0.4	0.8	0.8	0.6	0.1	0.4	0.8	0.1	0.6	0.5	0.6	0.6	0.6	1.0	0.8	0.6	0.1	11.6	96.83333
Girish	12	0.6	0.9	0.5	0.9	0.5	0.9	0.6	0.8	0.3	0.3	0.9	0.6	0.2	0.4	0.3	0.7	0.5	0.0	0.7	0.8	0.3	0.3	12.0	99.66666
Zashil	9	0.0	0.8	0.3	0.2	0.5	0.6	0.7	1.0	0.5	0.9	0.6	0.7	0.8	0.8	1.0	0.8	0.9	0.2	0.7	1.0	0.5	0.9	14.1	156.8888
Manan	11	0.6	0.2	0.9	0.0	0.5	0.3	0.8	0.3	0.6	0.3	0.3	0.8	0.8	0.4	0.4	0.2	0.9	0.9	0.7	0.3	0.6	0.3	11.1	100.4545
Dayita	7	0.5	0.9	0.7	0.7	0.1	0.5	0.2	0.4	0.6	0.4	0.5	0.2	0.0	0.6	0.6	0.1	0.6	0.2	1.0	0.4	0.6	0.4	9.9	141.8571
Hardik	12	0.6	0.9	0.7	1.0	0.3	0.8	1.0	0.9	1.0	0.4	0.8	1.0	1.0	0.1	0.9	1.0	0.0	0.7	0.3	0.9	1.0	0.4	15.3	127.3333
Ethan	5	0.9	0.0	0.3	0.0	0.9	0.6	0.5	0.9	0.2	0.8	0.6	0.5	0.5	0.5	1.0	0.2	0.9	0.5	0.6	0.9	0.2	0.8	12.3	245.2
Ganga	7	0.7	0.0	0.5	0.7	0.1	0.4	0.0	1.0	0.7	0.1	0.4	0.0	0.4	0.0	1.0	0.8	0.1	0.0	0.9	1.0	0.7	0.1	9.4	134.8571
Urmi	6	0.8	0.3	0.7	0.9	0.3	0.0	0.2	0.5	0.5	0.7	0.0	0.2	0.3	1.0	0.3	0.9	0.6	0.2	0.1	0.5	0.5	0.7	10.1	168
Harrison	11	0.8	0.6	0.1	1.0	0.7	0.1	0.2	0.6	0.7	0.8	0.1	0.2	0.8	0.2	1.0	1.0	0.9	0.2	0.5	0.6	0.7	0.7	12.3	111.7272
Irya	5	0.9	0.2	0.3	0.6	0.7	0.1	0.9	0.8	0.6	0.5	0.1	0.9	0.5	0.7	0.6	0.6	0.7	0.3	0.1	0.8	0.6	0.5	12.2	243.4
Radha	6	0.5	0.2	0.0	0.7	0.6	0.2	0.7	0.3	0.8	0.6	0.2	0.7	0.5	0.7	0.8	0.2	0.8	0.6	0.0	0.3	0.8	0.6	10.6	176.6666
Diya	9	0.4	0.9	0.7	0.4	0.1	0.1	0.3	0.9	0.7	0.2	0.1	0.3	0.5	0.1	0.9	0.9	0.8	0.8	0.4	0.9	0.7	0.2	10.9	121.4444
Samarth	8	0.5	0.4	0.6	0.4	0.2	0.7	0.4	0.3	0.4	0.6	0.7	0.4	0.6	0.1	0.7	0.4	0.5	0.8	0.8	0.3	0.4	0.6	10.7	133.25
Vansha	5	0.4	0.1	0.5	0.9	1.0	0.7	0.1	0.4	1.0	0.9	0.7	0.1	1.0	0.9	0.4	0.4	0.1	0.2	0.4	0.4	1.0	0.9	12.3	245.6
Saanvi	7	0.8	0.3	0.1	0.5	0.5	0.7	0.5	0.4	0.9	0.4	0.7	0.5	0.1	0.9	0.4	0.8	0.4	0.3	0.2	0.4	0.9	0.4	11.2	160
Abha	5	0.9	0.0	0.6	0.9	0.1	0.9	0.8	0.7	0.2	0.3	0.9	0.8	0.8	0.9	0.4	0.1	0.7	0.4	0.7	0.7	0.2	0.3	12.1	242
David	12	0.5	0.7	0.2	0.3	0.8	0.7	1.0	0.0	0.7	0.1	0.7	1.0	0.4	0.9	0.5	0.3	0.1	0.0	0.2	0.0	0.7	0.1	9.8	81.33333
Akshay	5	0.5	0.2	0.1	0.9	0.5	0.4	0.5	0.3	0.7	0.3	0.4	0.5	0.9	0.2	0.3	0.6	0.0	0.4	0.8	0.3	0.7	0.3	9.6	192.6
Girik	12	0.1	0.1	0.1	0.8	0.8	0.8	0.0	0.4	0.1	0.4	0.8	0.0	0.2	0.5	0.1	0.9	0.9	0.4	0.9	0.4	0.1	0.4	9.4	78.25
Mohini	8	0.7	0.8	0.5	0.5	0.2	0.4	0.2	0.0	0.6	0.7	0.4	0.2	0.9	1.0	0.0	0.5	0.4	0.6	0.3	0.0	0.6	0.7	10.3	129.125
Aarav	8	0.7	0.7	0.7	0.2	0.6	0.3	0.2	0.5	0.7	0.2	0.3	0.2	0.8	0.6	0.3	0.6	0.0	0.8	0.2	0.5	0.7	0.2	10.0	125.25

SQ Dataset:-

Name	Age	Communication	Cooperation	Responsibility	Empathy	Self-Control	Locomotion	Socialisation	Self-direction	Self-help Dressing	Occupation	Conceptual Skills	Social Skills	Practical Skills	Sharing	Complementing others	Aggression	Withdrawal	Emotional Problems	Conduct Problems	Hyperactivity	Prosocial behaviour	Social Age	score
Lekha	11	0.8	0.4	0.3	0.5	0.4	0.8	0.3	0.5	0.6	0.9	0.5		0.8	0.6	0.3	0.9	1.0	0.8	0.9	0.3	0.9	0	0
Osha	10	0.5	0.1	0.4	0.6	0.9	1.0	0.5	0.9	0.3	0.8	0.6	0.0	0.7	0.4	0.8	0.7	0.0	0.5	0.9	0.2	0.9	12.3	123.4
Banjeet	8	0.9	0.2	0.8	0.1	0.5	0.1	1.0	0.9	1.0	0.5	0.3	0.3	0.1	0.3	0.9	0.2	0.8	0.6	0.3	0.1	0.3	11.6	144.375
Aashi	8	0.3	0.2	0.2	0.6	0.7	0.5	0.1	0.8	0.9	0.9	0.8	0.9	0.9	0.5	0.4	0.7	0.3	0.8	0.9	0.9	1.0	10.3	128.5
Yasti	9	0.5	0.7	1.0	0.9	0.8	0.1	0.6	0.5	0.6	0.9	0.2	0.7	0.1	0.2	0.8	0.3	0.8	0.1	0.2	0.7	0.6	13.2	146.2222
Vedika	6	0.0	0.6	0.6	0.6	0.4	0.4	1.0	0.0	0.0	1.0	0.2	0.1	0.2	0.8	0.9	0.0	0.4	0.1	0.3	0.2	0.4	11.3	187.5
Nidhi	7	0.1	0.5	0.6	0.7	0.4	0.3	0.9	0.5	0.9	0.6	0.7	0.2	0.8	0.8	0.2	0.2	0.5	0.1	0.9	0.7	0.7	8.2	117.7142
Chavvi	9	0.7	0.4	0.7	0.2	0.7	0.5	0.1	0.7	0.5	0.1	0.8	0.5	0.6	0.7	0.6	0.9	0.9	0.1	0.3	0.8	0.1	11.0	122.4444
Vansha	8	0.7	0.2	0.2	0.5	0.7	0.7	0.9	0.0	0.9	0.6	0.8	0.7	0.2	0.1	0.7	0.5	0.9	0.9	0.6	0.0	0.3	10.6	132.625
Ishita	12	0.1	0.8	1.0	0.4	0.6	1.0	1.0	0.8	0.1	0.0	1.0	0.4	0.0	0.0	0.8	1.0	0.7	0.6	0.2	0.6	0.3	10.8	90.25
Tejas	7	0.1	0.9	0.4	0.1	0.3	0.5	0.8	0.9	0.1	0.5	0.7	0.4	0.9	0.3	0.0	0.0	0.7	0.6	1.0	0.9	0.0	11.2	160.4285
Yamini	12	0.7	0.9	0.6	0.4	0.5	0.2	0.6	0.0	0.2	0.3	0.8	0.7	0.3	0.6	0.0	0.2	1.0	0.3	0.4	0.6	0.5	9.8	81.91666
Liam	8	0.9	0.3	0.9	0.7	0.3	0.8	0.3	0.1	0.6	0.5	0.3	0.8	0.8	0.1	0.1	0.5	0.0	0.3	0.7	0.2	0.6	9.8	122.625
Baghyawa	6	0.1	0.1	0.8	0.1	0.0	0.4	0.5	0.5	0.5	0.6	0.7	0.4	0.4	1.0	0.3	0.8	0.4	0.4	0.1	0.9	0.9	9.9	165
Logan	12	0.8	0.2	0.5	0.3	0.6	1.0	0.8	0.6	0.1	0.5	0.4	0.8	0.1	0.6	0.5	0.6	0.6	0.4	0.5	0.7	0.8	9.5	79.25
Girish	12	0.6	0.9	0.5	0.9	0.0	0.7	0.8	0.3	0.3	0.5	0.9	0.6	0.2	0.4	0.3	0.7	0.5	0.8	0.5	0.9	0.1	11.4	94.66666
Zashil	9	0.0	0.8	0.3	0.2	0.2	0.7	1.0	0.5	0.9	0.5	0.6	0.7	0.8	0.8	1.0	0.8	0.9	0.2	0.5	0.6	0.5	11.5	127.4444
Manan	11	0.6	0.2	0.9	0.0	0.9	0.7	0.3	0.6	0.3	0.5	0.3	0.8	0.8	0.4	0.4	0.2	0.9	0.2	0.7	0.3	0.5	12.3	112.0909
Dayita	7	0.5	0.9	0.7	0.7	0.2	1.0	0.4	0.6	0.4	0.1	0.5	0.2	0.0	0.6	0.6	0.1	0.6	0.4	0.4	0.8	0.9	10.5	150.5714
Hardik	12	0.6	0.9	0.7	1.0	0.7	0.3	0.9	1.0	0.4	0.3	0.8	1.0	1.0	0.1	0.9	1.0	0.0	0.4	0.4	0.2	0.6	10.3	85.75
Ethan	5	0.9	0.0	0.3	0.0	0.5	0.6	0.9	0.2	0.8	0.9	0.6	0.5	0.5	0.5	1.0	0.2	0.9	0.4	0.1	0.1	0.4	13.0	259
Ganga	7	0.7	0.0	0.5	0.7	0.0	0.9	1.0	0.7	0.1	0.1	0.4	0.0	0.4	0.0	1.0	0.8	0.1	0.9	0.2	0.2	0.9	10.3	146.5714
Urmi	6	0.8	0.3	0.7	0.9	0.2	0.1	0.5	0.5	0.7	0.3	0.0	0.2	0.3	1.0	0.3	0.9	0.6	0.3	0.6	0.1	0.3	9.5	158.8333
Harrison	11	0.9	1.0	0.8	0.3	0.2	0.8	0.3	0.4	0.1	0.1	0.0	0.1	0.1	0.4	0.6	0.7	0.1	0.4	0.6	0.1	0.4	9.5	86.45454
Irya	5	0.4	0.0	1.0	0.9	0.4	0.4	1.0	0.1	0.2	0.1	0.1	0.6	0.2	0.7	0.9	0.2	0.4	0.2	1.0	0.3	0.4	8.4	167.6
Radha	6	0.5	0.2	0.0	0.7	0.6	0.0	0.3	0.8	0.6	0.6	0.2	0.7	0.5	0.7	0.8	0.2	0.8	0.3	1.0	0.1	0.0	9.3	155.6666
Diya	9	0.4	0.9	0.7	0.4	0.8	0.4	0.9	0.7	0.2	0.1	0.1	0.3	0.5	0.1	0.9	0.9	0.8	0.1	0.9	0.3	0.5	9.5	105
Samarth	8	0.5	0.4	0.6	0.4	0.8	0.8	0.3	0.4	0.6	0.2	0.7	0.4	0.6	0.1	0.7	0.4	0.5	0.4	0.5	0.7	0.7	10.6	132.375
Vansha	5	0.4	0.1	0.5	0.9	0.2	0.4	0.4	1.0	0.9	1.0	0.7	0.1	1.0	0.9	0.4	0.4	0.1	0.0	0.3	0.6	0.9	10.5	210.6
Saanvi	7	0.8	0.3	0.1	0.5	0.3	0.2	0.4	0.9	0.4	0.5	0.7	0.5	0.1	0.9	0.4	0.8	0.4	0.8	0.4	0.2	0.9	11.1	158.4285
Abha	5	0.9	0.0	0.6	0.9	0.4	0.7	0.7	0.2	0.3	0.1	0.9	0.8	0.8	0.9	0.4	0.1	0.7	0.7	0.7	0.6	0.4	10.6	211.4
David	12	0.5	0.7	0.2	0.3	0.0	0.2	0.0	0.7	0.1	0.8	0.7	1.0	0.4	0.9	0.5	0.3	0.1	0.9	0.8	0.3	0.3	11.6	96.41666
Akshay	5	0.5	0.2	0.1	0.9	0.4	0.8	0.3	0.7	0.3	0.5	0.4	0.5	0.9	0.2	0.3	0.6	0.0	0.5	0.4	0.9	0.5	9.6	192.8
Girik	12	0.1	0.1	0.1	0.8	0.4	0.9	0.4	0.1	0.4	0.8	0.8	0.0	0.2	0.5	0.1	0.9	0.9	0.3	0.4	0.6	0.5	9.8	82
Mohini	8	0.7	0.8	0.5	0.5	0.6	0.3	0.0	0.6	0.7	0.2	0.4	0.2	0.9	1.0	0.0	0.5	0.4	0.1	0.4	0.3	0.6	9.4	117.75
Aarav	8	0.7	0.7	0.7	0.2	0.8	0.2	0.5	0.7	0.2	0.6	0.3	0.2	0.8	0.6	0.3	0.6	0.0	0.1	0.4	1.0	0.1	9.6	120.25
Wakeeta	8	0.8	0.8	0.6	0.7	0.2	0.7	0.8	0.8	0.4	0.6	0.6	0.9	0.1	0.8	0.5	0.4	0.5	0.0	0.2	0.7	0.5	9.7	121.625
Gauri	12	0.6	0.7	0.1	0.1	0.4	0.2	0.3	0.3	0.9	0.2	0.3	0.8	0.3	0.9	0.7	0.7	0.2	0.3	0.2	0.0	0.1	11.5	95.58333
Yagnesh	7	0.4	0.5	0.1	0.2	0.0	1.0	0.3	0.8	0.3	0.7	0.1	0.9	0.5	0.1	0.3	0.7	0.7	0.8	0.4	0.0	0.5	8.1	116.2857
Eshana	12	0.8	0.6	0.1	1.0	0.2	0.5	0.6	0.7	0.8	0.7	0.1	0.2	0.8	0.2	1.0	1.0	0.9	0.7	0.8	0.6	0.4	9.3	77.75
Dev	6	0.6	0.5	0.2	0.6	0.3	0.8	0.7	0.0	0.9	0.0	0.1	0.3	0.2	0.2	0.4	0.7	0.4	0.3	0.5	0.4	0.9	12.6	209.8333
Rayaan	12	1.0	0.8	0.6	0.3	0.7	0.5	0.7	0.4	0.5	0.0	0.7	0.0	0.7	0.6	0.8	0.3	0.7	0.2	0.5	0.3	1.0	8.9	74.5
Tristan	8	0.1	1.0	0.8	0.9	0.2	0.7	0.5	0.9	0.2	0.9	0.2	0.9	0.8	0.6	0.1	0.2	0.3	0.3	0.3	0.5	0.4	11.2	140.125
William	7	0.0	0.1	0.0	0.1	0.9	1.0	0.5	1.0	0.8	0.8	0.8	0.2	0.6	0.4	1.0	0.2	0.2	0.7	0.2	0.1	0.8	10.6	152
Lucky	11	0.8	0.3	0.3	0.4	1.0	0.7	1.0	0.5	0.6	1.0	0.2	0.8	0.8	0.8	0.8	0.2	0.7	0.9	0.6	0.4	0.6	10.2	92.27272
Sara	11	0.6	0.8	0.8	0.9	0.4	1.0	0.2	0.2	0.4	0.7	0.0	0.7	0.6	0.2	0.2	0.8	0.4	0.6	0.2	0.7	0.9	13.0	118.5454
Gavin	6	1.0	0.2	0.9	0.9	0.6	0.9	0.3	0.9	0.8	0.6	0.1	0.0	0.0	0.3	0.8	0.4	0.8	0.6	0.4	0.9	0.5	11.2	186.5

Chapter VI: Results & Discussion

6.1 Screenshots of User Interface (UI) for the respective module

The SafeGuard dashboard shown in fig. 3 offers intuitive options for live tracking from source to destination and navigation to various predefined safe locations. In cases where a different destination needs to be selected, users can simply choose the 'Other' option to input a new location for travel. Once the destination is set, the GPS system begins tracking the child's real-time location along a predefined path marked with optimal waypoints. These optimal markers represent safe intervals that a child can travel without supervision, ensuring continuous safety and effective monitoring throughout the journey.The route assigned for tracking is accompanied by directional prompts, functioning like a virtual signboard to guide the child while moving along the path, ensuring they follow the correct and safe route at every step. The figure also illustrates the live movement of the child, represented by a black dot, accurately following the designated route towards the destination, confirming that the child is on the correct and safe path.

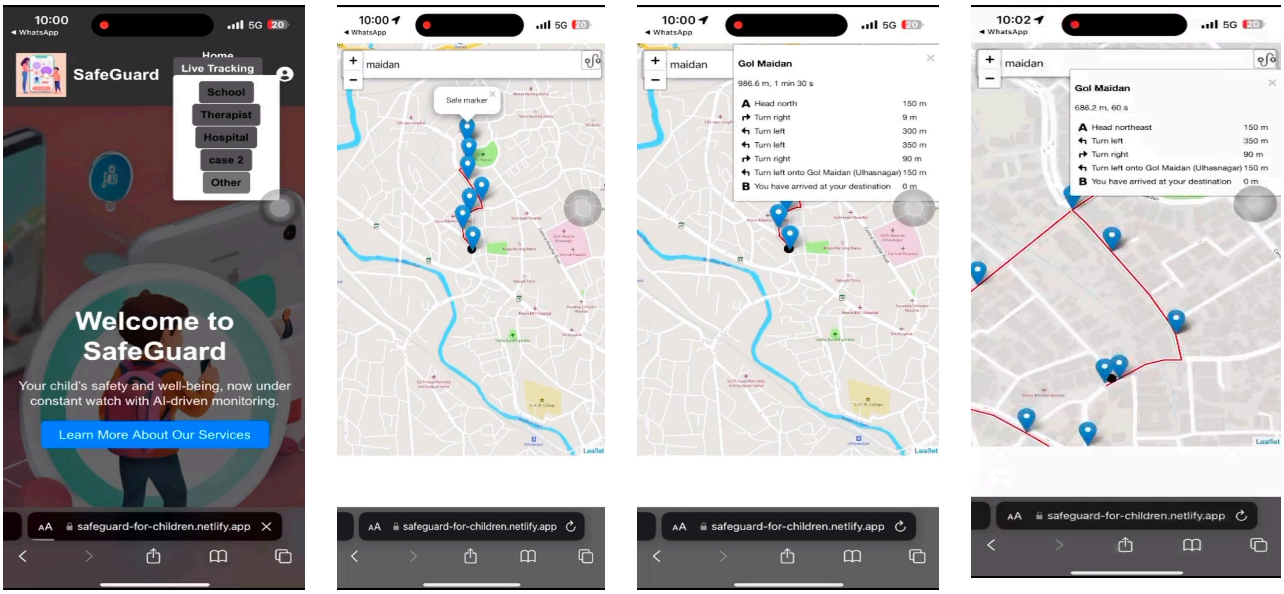


Fig. 3 Screenshot of SafeGuard dashboard, Optimal marker distance, directional prompts and real-time tracking When any marker on the route is clicked, it displays the corresponding latitude and longitude of that specific position, providing precise location details for better tracking and verification. shows user deviation from the actual predefined path, and hence the system alert with "off-route" message. When the child's ambient temperature is detected to be outside a safe and sustainable range, the system once again triggers an alarm and sends an instant notification to the parent, ensuring timely awareness. The last figure shows the follow-up page after extreme unsustainable conditions are detected and gives options to make an SOS call.

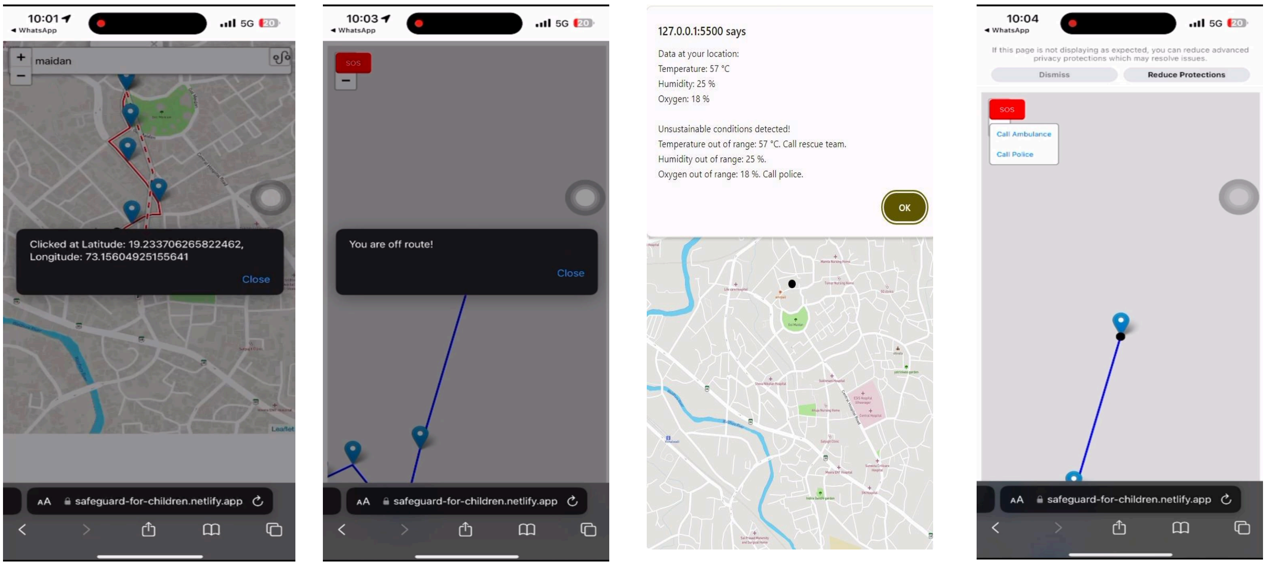
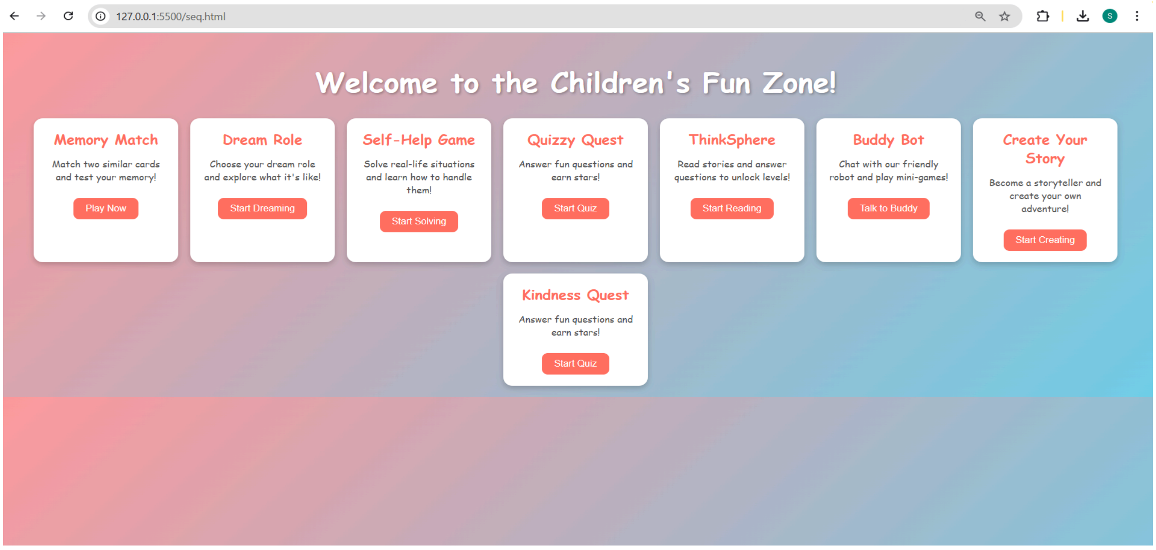


Fig.4 Screenshot of SafeGuard showing Positional latitude and longitude coordinates, Off-route detection alert, Unsustainable environmental conditions alert, SOS (ambulance/police) call option. When any marker on the route is clicked, it displays the corresponding latitude and longitude of that specific position, providing precise location details for better tracking and verification When the child's ambient temperature is detected to be outside a safe and sustainable range, the system once again triggers an alarm and sends an instant notification to the parent, ensuring timely awareness.



Screenshot of SafeGuard showing Positional latitude and longitude coordinates, Off-route detection alert, Unsustainable environmental conditions alert, SOS (ambulance/police) call option.When any marker on the route is clicked, it displays the corresponding latitude and longitude of that specific position, providing precise location details for better tracking and verification. When the child's ambient temperature is detected to be outside a safe and sustainable range, the system once again triggers an alarm and sends an instant notification to the parent, ensuring timely awareness.

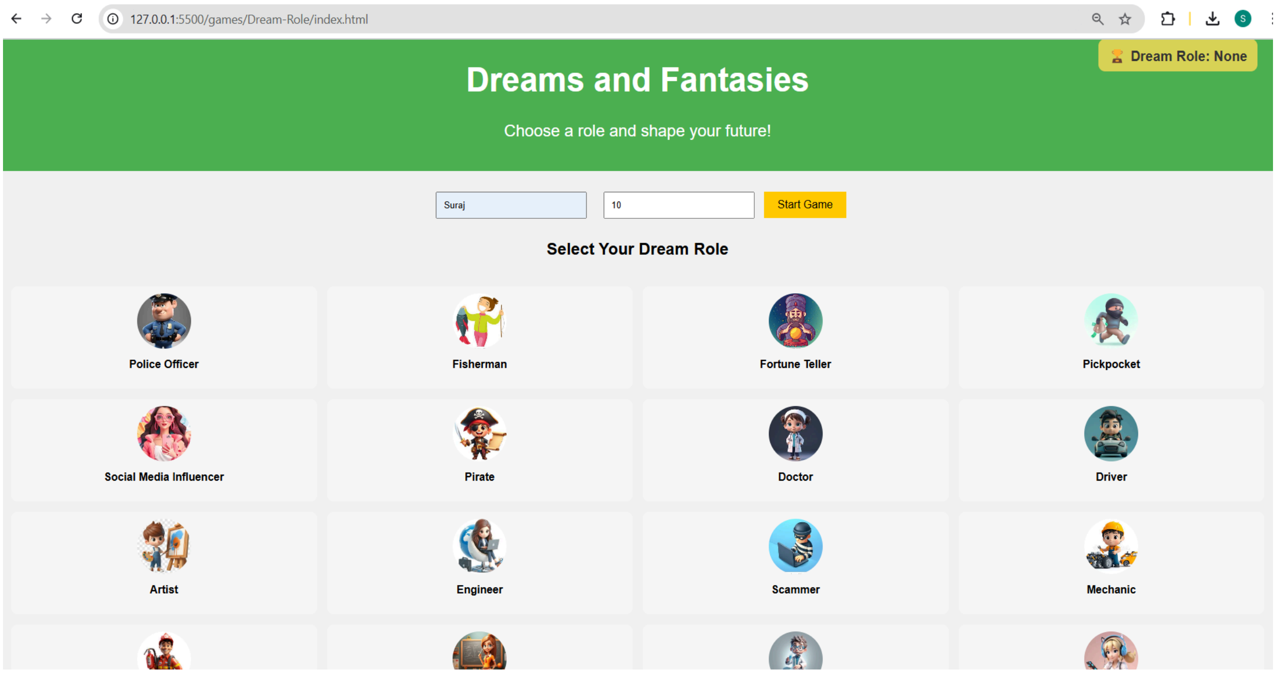


Fig. 5 Features of SQ and the example scenario of "Dream Role"

The colorful, interactive dashboard presents multiple gamified learning and behavior-assessing modules designed for children. Each module targets specific areas like memory, imagination, kindness, and communication, creating an engaging environment while collecting valuable psychological data. In the Dream Role Game, children pick a dream profession (like doctor, pilot, or artist), which reflects their interests and aspirational thinking. This insight contributes to analyzing a child's social orientation, creativity, and self-perception.

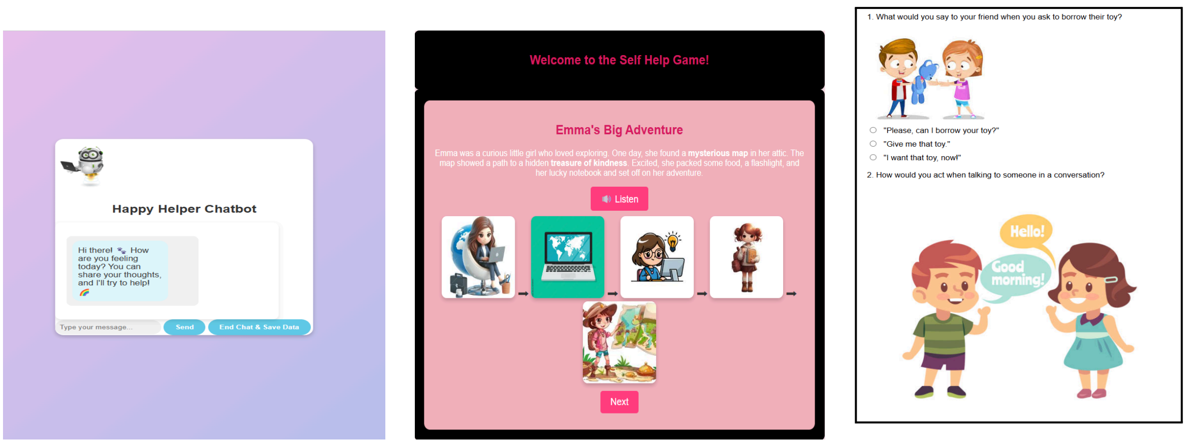
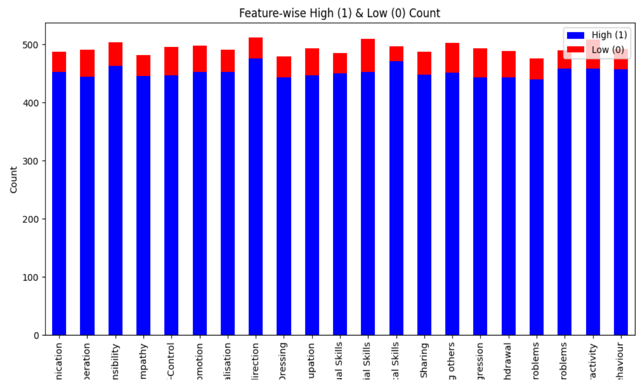


Fig. 6 Example scenarios of Buddy Bot, Self-Help interactive game, Kindness Quest

The Happy Helper Chatbot, or Buddy Bot, encourages children to converse freely. It records their responses to analyze tone, keywords, and sentiment, which are crucial in understanding social behavior, emotional awareness, and conversational confidence. Emma's Big Adventure" is a story-based, decision-making game that teaches children about self-help and making the right choices. It builds emotional intelligence by presenting scenarios that encourage empathy, courage, and problem-solving. This interactive quiz asks situational questions to gauge how empathetic, considerate, and socially aware the child is. Their responses are analyzed to understand their moral reasoning, compassion, and readiness to help others.

Similarly, "Quizzy Quest" is a form to be filled by stakeholders which captures essential behavioral data like self-control, sociability, and hyperactivity from parents or guardians. The grading of SQ as high and low is done by applying SVM to the dataset presented in figure 2. The classification and feature-wise performance of the ML model is shown in figure 7 with an accuracy around 73% and can be improved gradually with more training examples.

6.2 Performance Evaluation Measures



	precision	recall	f1-score	support
avg	0.00	0.00	0.00	3
high	0.74	0.98	0.84	128
low	0.67	0.12	0.21	48
accuracy			0.73	179
macro avg	0.47	0.37	0.35	179
weighted avg	0.70	0.73	0.66	179

Accuracy Score: 0.7318435754189944

Feature-wise high and low SQ, overall performance measure. Every child is asked questions based on a set of predefined graded questionnaires on empathy, sentiments, helpfulness, social adjustment measuring EQ. The system analyzes videos of the child answering these questions by extracting frames and audio, performing OCR and speech transcription using openCV. The sentiment analysis is performed using NLP on the text extracted from the audio. Further the significant frames extracted from the video are manually labelled based on normal conditions of any child by marking as neutral, negative and positive body language shown while answering the questions. The applied sentiment, empathy, and social analysis aids to generate comprehensive insights from both visual and audio content as shown in figure 8 and 9. The audio transcription reveals a negative sentiment with low empathy and social adjustment scores, indicating feelings of nervousness, loneliness, and limited social response or engagement.

Fig. 8 Frame conversion, OCR, Audio extraction, Speech to text conversion, sentiment analysis for EQ calculation

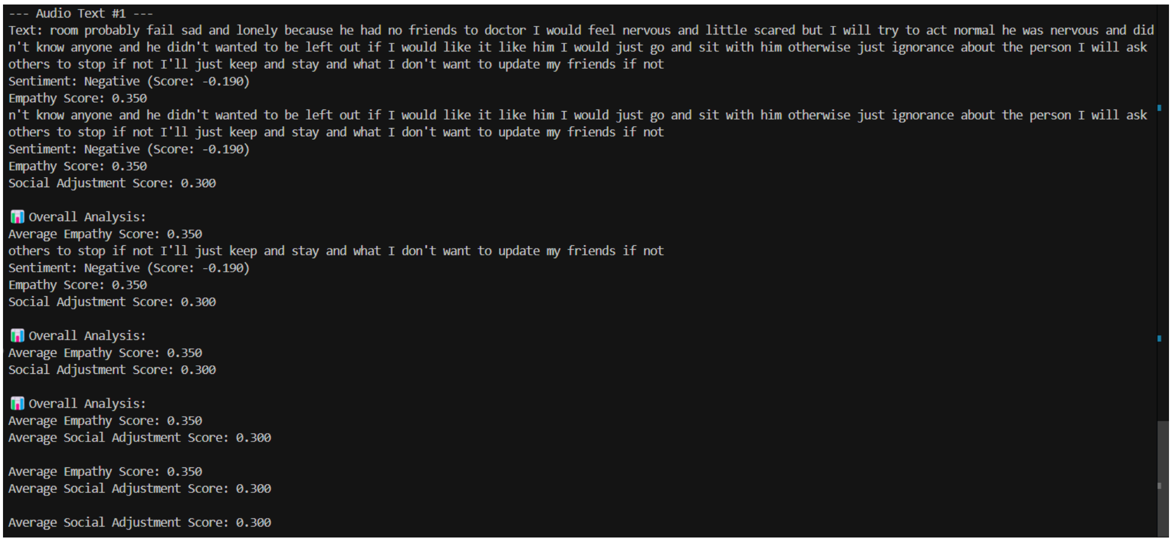


Fig. 9 Overall analysis of EQ

6..3 Input Parameters / Features considered

In the SafeGuard system, multiple parameters and features were considered to accurately evaluate the Safety, Social Quotient (SQ), and Emotional Quotient (EQ) of children. These features were carefully selected based on behavioral science principles, emotional development studies, and real-time monitoring requirements.

1. Safety Module Features:

- Latitude and Longitude:

Real-time GPS coordinates used to track the child's location and identify deviation from the assigned safe path.

- Temperature Levels:

Environmental temperature readings to detect unsafe climatic conditions affecting child health.

- Oxygen Levels (O_2):

Oxygen concentration levels in the environment to monitor air quality and detect respiratory threats.

- Movement/Locomotion Data:

Analyzing walking patterns, sudden inactivity, or abnormal movement indicating distress or emergency.

- Deviation Distance from Safe Zone:

If the child moves beyond a predefined radius from the safe area, an alert is triggered.

- Environmental Humidity and Pressure:

Additional weather parameters to support decision-making for outdoor safety.

2. Social Quotient (SQ) Module Features:

- Memory Performance (Memory Match Game):

Number of correct matches, time taken, and recall ability scores.

- Dream Role Selection:

Preferred roles selected by the child indicating imagination, social aspiration, and personality inclination.

- Questionnaire Responses (Quizzy Quest & Kindness Quest):

Responses measuring traits like cooperation, empathy, aggression, responsibility, and self-control.

- Storytelling Creativity (Create Your Story):

Creativity, logical thinking, and social value embedded in stories created by the child.

- Self-Help Game Performance:

Ability to handle real-life simulated tasks indicating responsibility and independence.

- Chatbot Interaction (Buddy Bot):

Analysis of conversation style, prosocial behavior, hyperactivity detection, and interaction skills using NLP (sentiment analysis and keyword detection).

- Locomotion Data:

Integrated in questionnaires to understand the child's physical activity and social engagement levels.

3. Emotional Quotient (EQ) Module Features:

- Role-Playing Scenario Responses:

Child's decision-making and emotional reactions in simulated emotional scenarios.

- Reflection Exercises and Problem-Solving Outcomes:

Ability to reflect on situations, show empathy, manage emotions, and propose solutions.

- Emotional Tone in Chatbot Conversations:

Sentiment analysis using NLP to identify emotional states (positive, neutral, negative).

- Stress Handling Indicators:

How children manage stress and uncertainty in quiz and game activities.

- Social Interaction Scores:

Ability to initiate, maintain, and positively conclude social interactions during games and chatbot engagement.

Each parameter contributes either quantitative (e.g., scores, counts, timings) or qualitative (e.g., sentiment, creativity, emotional expression) data points, which are processed using machine learning models to calculate the final SQ and EQ. Children are classified into three categories based on their computed scores:

- Low (SQ/EQ < 100)
- Average (SQ/EQ = 100)
- High (SQ/EQ > 100)

The combination of real-time sensor data and AI-based behavioral evaluation ensures a comprehensive, 360-degree assessment of a child's physical, social, and emotional safety.

6.4 Comparison of Results with Existing System

1. Prevalence of Intellectual Disabilities:

- SafeGuard addresses the lack of early intervention and health/education challenges discussed in the research by integrating real-time monitoring and AI-driven analysis for physically disabled children.

- Builds upon the need for inclusive support systems highlighted in existing literature.

2. **Surveillance Technologies in Education:**

- While existing surveillance focuses on location tracking and speech recognition, SafeGuard enhances it with AI anomaly detection and emotional state monitoring, making child safety more proactive instead of reactive.

- Addresses the gap in applying surveillance specifically for special-needs children and emotional well-being.

3. **IoT for Smart Education:**

- Unlike general IoT-based learning environments, SafeGuard adapts IoT for real-time environmental safety monitoring, emphasizing not just learning but life protection and emergency detection.

- Integrates continuous environmental assessment (air quality, oxygen levels) into education settings.

4. **AI/ML and Well-Being Research:**

- While most studies are techno-positive, SafeGuard critically addresses potential negative aspects by emphasizing privacy, ethical data collection, and the emotional-social impact of monitoring.

- Involves stakeholders like parents, teachers, and therapists directly, bridging the gap in inclusive representation for disabled children.

7.5 Inference Drawn

The SafeGuard system successfully demonstrates that **artificial intelligence**, **real-time monitoring**, and **interactive learning activities** can be effectively integrated to assess and enhance the **safety**, **social development**, and **emotional well-being** of children, especially those in need.

Through the **Safety Module**, we infer that continuous **tracking of location and environmental conditions** enables early detection of threats such as deviations from safe zones, dangerous temperature levels, and poor oxygen quality. The system's proactive alert mechanisms ensure that children are never left unattended without immediate action being triggered, thus providing a critical layer of protection.

From the **Social Quotient (SQ) Module**, it was observed that **interactive games and questionnaires** can reliably capture a child's social skills, cooperation, empathy, problem-solving, and communication abilities. Children were classified into **Low, Average, or High SQ categories** based on machine learning analysis of their performance and responses. The results highlight that playful, engaging environments encourage genuine behavior, enabling better evaluation compared to traditional static tests.

Similarly, the **Emotional Quotient (EQ) Module** confirms that **role-playing, reflection exercises, and chatbot conversations** are effective tools to assess emotional awareness, empathy, self-regulation, and stress management. Sentiment analysis and behavioral scoring provided rich insights into a child's emotional health, helping identify children who may require early emotional support.

Overall, the system successfully **prepares an accurate dataset** by collecting, processing, and analyzing multimodal data (sensor data, text conversations, game responses). This dataset enables stakeholders such as **parents, teachers, counselors, psychiatrists, and doctors** to collaboratively intervene, design personalized care plans, and provide timely emotional and social support to children.

Thus, SafeGuard not only acts as a **monitoring solution** but also emerges as a **preventive, diagnostic, and therapeutic support system**, promoting the holistic safety and development of children with special needs.

Chapter VII: Conclusion

7.1 Conclusion

SafeGuard redefines and elevates the traditional notions of child safety by introducing a holistic, AI-powered framework that transcends conventional GPS tracking systems. By integrating real-time environmental monitoring, Social Quotient (SQ) and Emotional Quotient (EQ) assessments, and advanced behavioral intelligence, SafeGuard offers a multidimensional and deeply responsive protective solution for children, particularly those who are specially abled. At the heart of this system lies an innovative IoT-enabled wearable device, discreetly woven into the child's clothing, capable of monitoring critical environmental parameters such as temperature, oxygen levels, and precise geolocation. The data collected is transmitted securely to a cloud-based platform for continuous analysis, enabling real-time tracking and early detection of any anomalies or potential risks. This empowers caregivers, teachers, and healthcare providers to intervene proactively, thus making child safety both preventive and highly personalized.

Beyond its immediate safety benefits, SafeGuard also acts as a valuable research tool by generating a curated dataset that can be accessed by medical practitioners, therapists, and researchers. This data will aid in the deeper analysis of behavioral patterns, emotional responses, and environmental interactions, contributing significantly to the study of child psychology and the specific needs of children with different syndromes or abilities. Over time, this could lead to more effective therapeutic strategies, personalized education plans, and enriched emotional support systems. In essence, SafeGuard is not merely a safety device; it is a comprehensive ecosystem that bridges technology, healthcare, and education to foster a more inclusive, secure, and understanding environment for all children. Through continuous innovation and research-driven development, SafeGuard sets a new benchmark in child protection, making the future safer, smarter, and more empathetic.

Chapter VIII: References

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Chapter IX: Appendix

9.1 Project Review Sheet

Inhouse/ Industry _Innovation/Research:

Class: D17 A/B/C

Group No.: 14

Sustainable Goal: 4: Quality Education

Project Evaluation Sheet 2024 - 25

Title of Project: Safeguard: AI driven Child Safety

Group Members: Sakshi Valecha D17C-71, Tanya Lilani D17C-40, Vaibhavi Shetty - D17C-59

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (2)	Applied Engg&M gmt principles (3)	Life - long learning (3)	Profess ional Skills (3)	Innov ative Appr oach (3)	Resear-ch Paper (5)	Total Marks (50)
04	04	05	03	04	01	02	02	01	01	03	03	03	03	04	43

Comments:

Name & Signature Reviewer1

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (2)	Applied Engg&M gmt principles (3)	Life - long learning (3)	Profess ional Skills (3)	Innov ative Appr oach (3)	Resear -ch Paper (5)	Total Marks (50)
04	04	05	03	04	01	02	02	02	01	03	03	03	03	04	44

Comments:

Date: 1st March, 2025

44

Name & Signature Reviewer 2

Figure 9.1: Project Review I marks sheet

9.2 Project Review Sheet

Inhouse/ Industry _Innovation/Research:

Class: D17 A/B/C

Group No.: 14

Sustainable Goal: 4. Quality Education

Project Evaluation Sheet 2024 - 25

Title of Project: Safeguard: AI driven Child Safety

Group Members: Sakshi Valecha (D17C-71), Tanya Lilani (D17C-40), Vaibhavi Shetty (D17C-59), Chirag Mangtani (D17C-45)

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (2)	Applied Engg&M gmt principles (3)	Life - long learning (3)	Profess ional Skills (3)	Innov ative Appr oach (3)	Resear ch Paper (5)	Total Marks (50)
05	05	05	03	04	02	02	02	02	02	02	02	03	03	03	47

Comments:

Name & Signature Reviewer1

Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environ ment Friendly (2)	Ethics (2)	Team work (2)	Presentati on Skills (2)	Applied Engg&M gmt principles (3)	Life - long learning (3)	Profess ional Skills (3)	Innov ative Appr oach (3)	Resear ch Paper (5)	Total Marks (50)
05	05	05	03	04	02	02	02	02	02	02	02	03	03	02	47

Comments:

Date: 1st April,2025

Name & Signature Reviewer 2

Figure 9.2: Project Review II marks sheet