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TASK 3:

REQUIREMENT ANALYSIS

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1. Problem Statement & Relevance

1.1 Customer Dwindling Support and Loyalty

Our recent survey paints a picture of widespread frustration, taking samples of users across multiple providers including MTN, Orange, and Camtel. The survey data reveals that on a 5-point satisfaction scale, the average rating is approximately 2.2, and almost half - 43% of respondents rated their network at the lowest level of satisfaction (1/5). Only 4% of respondents gave their provider the highest satisfaction rating.

Furthermore, our survey indicates that 85% of respondents use multiple SIM cards from different providers, with 74% regularly switching providers during network problems. When faced with network issues, 62% of users report toggling airplane mode as a temporary fix, while 31% completely switch to a different network provider—a clear indicator of customer frustration and lack of loyalty.

1.2 Mobile Operators Losing Money

This low customer loyalty directly impacts telecom companies' financial performance. As highlighted in research studies[3], mobile operators spend approximately seven times more to acquire a new customer than to retain an existing one. In the dynamic telecommunications environment, it is significantly more cost-effective to maintain the current customer base rather than developing strategies to acquire new users.

As Lin and Wang noted in their research [2][2], one of the most powerful ways to increase customer value is simply to keep them longer. Yet in Cameroon's mobile market, customer relationships are fleeting and fragile.

The financial implications of poor customer loyalty in Cameroon's telecom sector are substantial. With customers frequently switching between providers and maintaining multiple SIM cards, companies experience:

· Higher customer acquisition costs

· Decreased average revenue per user (ARPU)

· Reduced lifetime customer value

· Increased marketing expenses

· Lower return on infrastructure investments

1.3 One of the Solutions

From research [3] conducted, there is a clear establishment of a positive relationship between service quality and customer loyalty. Simply put, to improve customer loyalty, telecom companies must focus on enhancing service quality, particularly network reliability and technical quality.

One crucial approach to improving network reliability is implementing continuous network monitoring systems that can identify problems during their development phase and minimize their impact on service quality. By detecting issues early, operators can address them before they significantly affect customer experience.

Proactive network monitoring allows operators to:

1. Identify emerging network issues before they become widespread
2. Allocate resources efficiently for network maintenance
3. Reduce service downtime and disruptions
4. Improve overall quality of service metrics
5. Enhance customer satisfaction through reliable connectivity

As shown in the research conducted at Orange Cameroon (OCM) after interviewing them, traditional approaches to measuring customer experience quality involve applying formulas to site and customer data. Currently, administrators manually run daily queries to extract Quality of Service (QoS) values for the previous day. These values provide indicators on Voice, SMS, and DATA services by examining access success rates, but fail to incorporate actual customer feedback.

This approach makes measuring customer satisfaction with network services extremely difficult. Despite the team's ability to calculate and analyze QoS metrics, they struggle to answer the fundamental question: "Is the customer satisfied?". Our survey data confirms this disconnect, especially from the low average rating of 2.2/5 and that 72% of respondents do not believe mobile operators care about their experience as customers.

Effective network monitoring is crucial because it:

· Enables real-time detection of service degradation

· Provides objective data on network performance

· Establishes baselines for normal network operation

· Facilitates trend analysis for capacity planning

· Creates accountability for service level agreements

· Supports rapid troubleshooting during outages

1.4 Why QoS and QoE

While Orange Cameroon, takes some steps to measure the Quality of their Services(QoS), they rely on ad-hoc and word of mouth methods to gain insights into user feedback, this limits their understanding of how a large percentage of the population truly feels in real-time.While QoS metrics provide objective measurements of network performance (bandwidth, latency, packet loss), QoE captures the subjective user perception of the service.

Our survey illustrates this importance: users reported that "slow internet" (mentioned by 57% of respondents) and "poor network coverage" (noted by 43%) are their primary frustrations. These issues might appear less severe in QoS metrics but significantly impact QoE.

By combining QoS and QoE data, telecom operators can:

· Bridge the gap between technical performance and user satisfaction

· Identify which technical metrics most strongly influence customer experience

· Prioritize network improvements that will have the greatest impact on customer satisfaction

· Build predictive models to anticipate customer satisfaction issues before they occur

· Develop targeted interventions that improve both network performance and customer perception

Implementing a system that collects and analyzes both QoS metrics and customer feedback would address the fundamental disconnect highlighted in our research and provide telecom operators with the tools needed to improve service quality and build customer loyalty.

2. Product Perspective

The QoE mobile application is envisioned as a data-centric platform that empowers end users to passively and actively report on their mobile network experience. It fits within a broader ecosystem aimed at improving network quality and accountability among telecom providers in Cameroon. The app functions as an independent tool but has potential for integration with external systems such as ISP analytics dashboards, regulatory monitoring tools, and third-party data services.

This system is designed to operate primarily on Android devices, utilizing background services for passive data collection (e.g., network type, signal strength, latency) and foreground interfaces for user-submitted feedback. To support data integrity and usability, it incorporates mechanisms for offline data storage and later synchronization with cloud-based systems like Firebase.

2.1 Key components of the product include:

A. **Client-Side Mobile App:** Gathers both passive and active feedback from users with minimal disruption to device performance. It supports background operation, adaptive prompts, and privacy-sensitive data tracking.

B. **Backend Infrastructure:** Receives, stores, and processes incoming data. This may involve cloud-hosted databases, authentication services, and scalable storage.

C. **Administrative & Analytics Interface(future scope):** Intended for use by telecom administrators and possibly regulatory bodies, this interface would enable visualization of aggregated data trends to inform policy or infrastructure changes.

The product is dependent on several internal and external systems to function effectively.

Internally, it relies on:

- Coordinated background services.
- Local caching, and authentication.

Externally, it faces constraints from:

- Mobile OS policies (especially around battery use and background operation)
- The need for user permissions, and cooperation from mobile network operators.

2.1 Monetization Strategies

Despite its public-good orientation, the application introduces several monetization mechanisms aligned with its mission:

1. **Aggregated Insights for ISPs & Telecom Operators**

   Model: Subscription-based access or report licensing.

   Value: Helps network providers identify performance issues and reduce customer churn.

2. **Regulatory & Government Contracts**

   Model: Public-sector contracts or data-as-a-service agreements.

   Value: Supports policy development and regulatory compliance with real-world data.

3. **Freemium Analytics Tools**

   Model: Basic tools free for users; advanced tools or historical data under a paid tier.

   Value: Democratizes access while generating revenue from professional or high-frequency users.

4. **Sponsorships or Public-Private Partnerships**

   Model: Co-branded initiatives, NGO funding, or corporate CSR sponsorship.

   Value: Expands reach and credibility while securing financial support.

5. **Academic and Research Access**

   Model: Paid data licensing or collaborative research grants.

Value: Enables research on urban digital infrastructure and network planning.

6. **Consumer-Oriented Add-ons (Long-Term)**

Model: In-app purchases or premium subscriptions for tools like ISP comparison or signal optimization tips.

Value: Enhances user experience while unlocking new revenue streams.

7. **API Access for Developers**

Model: Tiered API pricing based on usage volume.

Value: Encourages third-party innovation and ecosystem growth.

This product's perspective positions it not merely as a standalone app, but as a critical **interface between users, operators, regulators, and researchers** in the digital infrastructure space. The monetization approach is designed to be **ethically aligned** with its mission—creating public value first, while enabling revenue generation through strategic partnerships and data services.

3. Product Scope – MVP V1.0

The primary goal of this MVP is to develop a lightweight mobile application for users in Cameroon to easily report their perceived internet Quality of Experience (QoE) at specific locations. The application will capture user feedback (ratings, common issues, optional comments) and associate it with precise GPS coordinates and basic network context (signal strength, network type, operator). This anonymized, location-tagged QoE data will be securely transmitted to participating Mobile Network Operators (MNOs) to provide them with real-world insights into customer experience across their network coverage areas.

3.1 Key Focus Areas for MVP

1. **Simple User Feedback**
   Effortless way for users to rate their current internet experience and select common issues.

2. **Accurate Location Tagging**
   Precise GPS data linked to every feedback submission and background metric reading.

3. **Basic Network Context**
   Collection of essential background metrics like signal strength and network type to contextualize user feedback.

4. **Anonymity and Security**
   Ensuring user privacy and secure data handling.

5. **Data Transmission**
   Reliable delivery of anonymized data to MNOs.

3.2 QoE Collection Application Requirements – MVP V1.0

3.2.1 Functional Requirements (FR)

FR1: Background Metrics Collection

- Collect mobile network signal strength data (e.g., dBm, ASU) periodically in the background.
- Record network type (e.g., 3G, 4G/LTE, 5G, Wi-Fi) and operator information periodically or upon change.
- Associate collected metrics with timestamps and GPS coordinates.

FR2: Location Services

- Capture precise GPS coordinates (latitude, longitude, accuracy) during user feedback submission and periodic background metric collection.
- Associate GPS coordinates reliably with all collected data points (feedback and background metrics).
- *(Backend/MNO Portal Functionality)*: Enable mapping of collected QoE feedback and signal strength to specific geographic areas.
- *(Backend/MNO Portal Functionality)*: Allow identification of potential coverage gaps or areas with consistently poor reported QoE based on aggregated data.

FR3: User Feedback System

- Provide a simple 1–5 star (or similar intuitive scale like happy/sad faces) rating option for the user's *current* perceived internet experience.
- Include quick-select buttons/options for common internet-related issues (e.g., "Slow Internet," "Cannot Connect," "Video Buffering," "Website Not Loading").
- Allow users to add optional short text comments for more detailed feedback.

- Implement an easily accessible "quick feedback" mechanism (prominent in-app button).

FR4: Multi-Provider Support

- Detect the current network operator via SIM/network information and associate it with collected data. *(If device supports dual SIM actively): Attempt to differentiate metrics/feedback based on the active data SIM where possible (may require specific permissions/APIs).*

- Record instances where the user might manually switch SIMs (if detectable via network registration events).

FR5: Data Management & Transmission

- Log all collected data (feedback, background metrics) with timestamp, location, accuracy, network operator, network type, device model (anonymized), and OS version.

- Store collected data locally on the device temporarily.

- Securely transmit queued, anonymized data to a central server periodically when an internet connection is available (using HTTPS).

FR6: User Interface & Basic Display

- Display current network operator, type, and signal strength reading.

- Provide a clear and simple interface for submitting feedback (ratings, issues, comments).

- Allow users to view a simple history of their *own* submitted feedback entries (timestamp, rating, issue reported, location on a map).

FR7: Settings & Permissions Management

- Clearly request and allow users to manage necessary permissions (Location - precise, Phone State/Network Info).

- Provide a clear option for users to enable/disable passive background metric collection.
- Allow users to specify data upload conditions (e.g., Wi-Fi only, Any Network).
- Provide a clear opt-in during onboarding and an easy opt-out option within settings to stop all data collection and contribution.

FR8: Offline Functionality

- Store background metric readings and user feedback submissions locally when the device is offline.
- Automatically queue and transmit stored data when an internet connection becomes available.

FR9: Basic User Identification

- Generate a unique, anonymous user ID upon installation to associate longitudinal data from the same device without collecting personal information.

3.2.2 Non-Functional Requirements (NFR)

NFR1: Performance

- Maintain minimal battery consumption for background monitoring (e.g., target <5–7% increase over baseline).
- Ensure the app UI is responsive and feedback submission is instantaneous.
- Optimize background processes to have negligible impact on device performance.

NFR2: Reliability

- Ensure high success rate (>99%) for capturing and locally storing feedback and background metrics, even in poor network conditions.
- Maintain data integrity during storage and transmission.

- The application should be stable and minimize crashes.

NFR3: Usability

- Design an extremely intuitive and simple interface, especially for feedback submission (target 1–2 taps for rating + issue).
- Ensure displayed information (current network status, feedback history) is clear and easily understandable.
- Use accessible design principles (e.g., sufficient contrast, clear fonts).

NFR4: Scalability

- **App**: Function correctly on a wide range of Android (and potentially iOS) devices prevalent in Cameroon, including lower-end models.
- **Backend**: The server infrastructure must handle data ingestion from a large user base (e.g., target 50,000–100,000+ users) and efficiently process/store location-tagged data.

NFR5: Security & Privacy

- Encrypt all data transmissions (HTTPS). Consider encryption for locally stored data.
- Ensure robust anonymization of any potentially identifying information before transmission to MNOs.
- Strictly adhere to user permissions. Data collection stops if permissions are revoked.
- Comply with Cameroon data protection regulations and provide a clear privacy policy.

NFR6: Resource Efficiency

- Minimize application storage footprint.

- Optimize background data collection frequency and data upload batching to minimize mobile data usage.
- Implement adaptive monitoring if possible (less frequent checks when stationary or on Wi-Fi).

NFR7: Compatibility

- Support a defined range of OS versions (e.g., Android 8.0+, iOS 11 +).
- Adapt UI gracefully to different screen sizes and resolutions.

NFR8: Maintainability

- Implement a modular architecture.
- Ensure code is well-structured, documented, and potentially includes unit/integration tests.

NFR9: Availability

- Core feedback logging and background metric collection must function reliably offline.
- Ensure high availability (>99.5%) of the backend server for data reception.

NFR10: Localization

- Support English and French languages in the UI.
- Consider adding major local languages in future iterations.

3.3 Future Work (Post-MVP)

This section outlines features and capabilities considered valuable but deferred from the initial MVP release due to scope constraints.

1. Advanced Network Performance Testing

- Re-introduce Speed Tests (Download, Upload, Latency, Jitter).
- Implement Video Streaming QoE tests (buffering, resolution, stall time).
- Add basic Web Browsing tests (page load time).
- *Explore*: Voice Call Quality monitoring (requires significant permissions and complexity).
- *Explore*: SMS Delivery tracking.

2. Enhanced Background Monitoring

- Monitor and log network connectivity interruptions (time and duration of no service/data).
- Track estimated cellular data usage by the app itself and potentially overall device usage.
- Detect and log Wi-Fi network details (SSID, BSSID, signal strength) when connected.

3. Advanced Location & Network Information

- Display nearby cell tower information (Cell ID, LAC/TAC) and potentially signal direction.
- Integrate and display crowd-sourced coverage maps within the user application.

4. Richer Data Visualization & User Features

- Provide users with more detailed historical performance trends and visualizations within the app.
- Display personal coverage maps based on the user's collected data.
- Offer performance scorecards comparing providers based on crowd-sourced data.

- Visualize peak vs. off-peak performance differences from aggregated data.
- Allow users to view personal contribution statistics.

5. Enhanced Reporting & Sharing

- Allow users to generate simple performance summaries or reports from their own data.
- Implement functionality for users to easily share specific issue reports on social media.
- Develop real-time issue alerting mechanisms for MNOs based on aggregated anomaly detection.
- Create aggregated community performance reports.

6. Advanced User Preferences & Account Management

- More granular controls over testing frequency and background monitoring parameters.
- Advanced data management options (e.g., exporting personal data, detailed deletion controls).
- Full account system with options for profile management beyond basic anonymous tracking.

7. Deeper Multi-Provider Analysis

- Implement in-app comparisons of provider performance based on aggregated community data.
- Analyze and potentially visualize user SIM switching patterns in relation to reported QoE.

8. Expanded Localization

- Add support for major local languages identified as important in Cameroon.

3.4 Requirements Prioritization

Classification Framework

- **Must-Have**: Essential for core functionality; MVP cannot launch without these
- **Should-Have**: Important features that add significant value but aren't blocking launch
- **Could-Have**: Desirable features that can be deferred if time/resources are limited
- D**on't-Have (this time)**: Features identified for future releases

The table on the next page summarizes the requirements based on these criteria:

Figure 1.0: Requirements Prioritization

Must-Have	Should-Have	Could-Have	Won't have
Background Metrics Collection: Signal strength, network type data (FR1)	**Extended User Feedback:** Quick-select buttons for common issues (FR3)	**Advanced Location Mapping**: Coverage gap identification (FR2)	Advanced Network Performance Testing
Basic Location Services: GPS coordinates for data points (FR2)	**Enhanced UI:** History of user's own submissions (FR6)	**Optional Comments**: Text input for detailed feedback (FR3)	Enhanced Background Monitoring
Simple User Feedback: 1-5 star rating system (FR3)	**Advanced Settings:** Network upload conditions (Wi-Fi only, etc.) (FR7)	**Dual SIM Handling**: Differentiate metrics by active data SIM (FR4)	Richer Data Visualization

Current Network Detection: Identify active operator (FR4)	**Full Reliability:** >99% capture success rate (NFR2**)**	**Advanced Data Management**: Adaptive monitoring (NFR6)	Advanced User Preferences
Basic Data Storage & Transmission: Secure local storage and upload (FR5)	**Enhanced Usability: 1**-2 tap feedback submission (NFR3)	**Enhanced Compatibility**: Support for wider range of devices (NFR7)	Deeper Multi-Provider Analysis
Minimal User Interface: Clear feedback submission mechanism (FR6)	**Resource** Optimization: Minimize data usage (NFR6)		
Core Permissions Management: Required permissions handling (FR7)	**Basic Localization:** English and French support (NFR10)		
Basic Offline Support: Store data when offline (FR8)			
Anonymous User ID: Basic user tracking (FR9)			
Basic Security: Data encryption,			

anonymization (NFR5)			

4. Review And Analysis Of Requirements Gathered

Review and Analysis of Requirements Gathered is a crucial phase in the software development process where all the collected requirements are carefully examined to ensure clarity, feasibility, completeness, and alignment with the project goals.

1. Purpose of the Review

- **Validate Understanding:** Make sure everyone (stakeholders, developers, designers) interprets the requirements the same way.
- **Prioritize Needs:** Determine which features are *must-have*, *nice-to-have*, or can be postponed.
- **Assess Feasibility:** Check if each requirement can realistically be implemented given the time, budget, and technical constraints.
- **Identify Gaps or Conflicts:** Spot missing requirements or ones that contradict each other.

2. Key Questions Asked

- Are all user needs clearly defined?
- Can each feature be built with the available resources?
- Are there legal, technical, or operational limitations?
- Do any features overlap or repeat the same function?

3. Output of the Analysis

- A refined and prioritized list of requirements.
- Technical notes on what needs further research or design

Figure 1: Functional Requirements (FR) Analysis

	Feature	Clarity	Feasibility	Completeness	Alignment
1	**Background Metrics Collection**	Clear	High (uses standard Android APIs)	Complete for MVP	Strong (Core to app function)
2	**Location Services**	Clear	High (standard GPS and geolocation libraries)	Complete	Strong (essential for mapping metrics)
3	**User Feedback System**	Clear and intuitive	Highly feasible	Covers core use cases	Strong (balances user input with data)
4	**Multi-Provider Support**	Moderately clear (dual SIM handling needs more detailing)	Medium to High (depends on device APIs and permissions)	Good start; may need more detailing for edge cases	Strong
5	**Data Management & Transmission**	Clear	High (storage and sync are common)	Covers all major data points	Strong
6	**User Interface & Display**	Clear	High (simple UI)	MVP	Strong (user-facing core element)

7	**Settings & Permissions**	Clear	High	Well covered	Strong (ensures privacy and control)
8	**Offline Functionality**	Clear	High	Core needs met	Strong (essential in target regions)
9	**Basic User Identification**	Clear	High	Simple and complete	Strong (respects anonymity and consistency)

Figure 2: Non-Functional Requirements (NFR) Analysis

	Feature	Clarity	Feasibility	Completeness	Alignment
1	**Performance**	Clear	High	Clearly defined targets	Strong
2	**Reliability**	Clear	High	Strong coverage of reliability metrics	Strong
3	**Usability**	Clear	High	Thoughtfully defined for local users	Strong
4	**Scalability**	Clear	Medium–High (backend needs thoughtful	Good projections	Strong

			architecture)		
5	**Security & Privacy**	Clear and detailed	High	Aligns with regulations	Strong
6	**Resource Efficiency**	Clear	Medium–High (some optimizations needed)	Well thought out	Strong
7	**Compatibility**	Clear	High	Realistic OS support	Strong
8	**Maintainability**	Clear	High if best practices followed	Modular focus helps future growth	Strong
9	**Availability**	Clear	Medium–High (backend uptime important)	Clear expectations	Strong
10	**Localization**	Clear	Feasible for MVP; future expansion defined	Meets minimum for MVP	Strong for Cameroon context

Figure 3: Future Work (Post-MVP Features) Review

	Feature Category	Clarity	Feasibility	Value	MVP Impact
1	**Advanced Testing**	Clear	Medium (some features like voice monitoring	High (enhances depth of analysis)	Can be safely deferred

			need more access)		
2	**Enhanced Monitoring**	Clear	Medium–High	Valuable for stability & context	Can be deferred
3	**Advanced Location Info**	Clear	Medium	Valuable, especially for visualization	Not MVP-critical
4	**Richer Visualization**	Clear	High value for users and stakeholders	Long-term engagement benefit	Secondary to core functions
5	**Advanced Reporting**	Clear	Medium–High	Aligns well with transparency goals	Can follow MVP success
6	**Preferences & Account Management**	Clear	Medium	Optional for MVP	Deferred
7	**Deeper Provider Comparison**	Clear	Medium (requires more data aggregation)	High stakeholder interest	Can evolve with user base
8	**Expanded Localization**	Clear	High	Important culturally	Iterative implementation is ideal

Figure 4: Overall Summary

Aspect	Evaluation
Clarity	The requirements are mostly well-written, with minor need for elaboration (e.g., dual SIM logic).
Feasibility	MVP features are practical using standard tools/APIs. Some advanced features will require technical exploration and backend resources.
Completeness	The core requirements comprehensively address the MVP goal. Deferred features are clearly scoped for future iterations.
Alignment with Project Goal	Strong alignment. The MVP directly targets measurable mobile internet quality, user feedback, and geolocation-based insights—crucial for improving telecom experiences in Cameroon.

5. Tools & Techniques

After careful consideration of the requirements for the QoE Collection Application, we have selected the following tools and technologies to support efficient development and ensure the application meets all functional and non-functional requirements:

5.1 Development Framework

React Native

We've chosen React Native as our primary development framework for the following reasons:

- **Native Capabilities Access:** React Native provides direct access to native device features critical for our QoE metrics collection, including signal strength monitoring, network type detection, and precise GPS location services.
- **Cross-Platform Efficiency**: While focusing initially on Android (prevalent in Cameroon), the codebase can be adapted for iOS with minimal changes, supporting future expansion.
- **Performance Optimization:** The framework offers near-native performance, essential for background monitoring with minimal battery impact.
- **Component-Based Architecture:** Facilitates modular development aligned with our maintainability requirements (NFR8).
- **Rich Ecosystem:** Access to libraries specifically designed for network monitoring and data visualization.

5.2 Backend Infrastructure

Firebase

We'll utilize Firebase as our backend solution because:

- **Offline Data Persistence:** Firebase Realtime Database and Firestore support offline caching and synchronization when connectivity is restored, addressing our offline functionality requirement (FR8).
- **Authentication:** Provides simple anonymous authentication to generate and maintain unique user IDs (FR9).
- **Scalability:** Can easily scale to handle data from tens of thousands of users as outlined in NFR4.
- **Real-time Data:** Supports instant transmission of QoE metrics when connectivity is available.
- **Security Rules:** Enables implementation of robust data access controls and encryption in line with our security requirements (NFR5).
- **Analytics Integration:** Simplifies tracking app usage patterns and user engagement.

5.3 Development Tools

- **Expo:** For rapid prototyping and simplified access to native APIs
- **Redux:** For state management across the application
- Jest & Detox: For unit and integration testing
- ESLint & Prettier: For code quality and consistency
- GitHub Actions: For CI/CD pipeline implementation

5.4 Data Collection & Processing

- Background Services API: For passive metric collection with minimal battery impact.
- React Native NetInfo: For detailed network type and connection monitoring
- Geolocation API: For precise location tagging of network metrics
- Firebase Cloud Functions: For server-side processing of aggregated data

5.5 Design & User Experience

- Material Design Components: For intuitive, accessible interface following established patterns
- Figma: For UI prototyping and design system development
- React Native Animations: For smooth, responsive user interactions

This technical stack supports our MVP requirements while establishing a foundation for future feature implementation. Our choices specifically address the challenging connectivity environment in Cameroon, prioritizing offline functionality, minimal resource usage, and robust data collection mechanisms.

Conclusion

This requirement analysis report lays the groundwork for developing a mobile Quality of Experience (QoE) application that addresses declining customer satisfaction and revenue losses among mobile operators. It begins by framing the problem and highlighting the relevance of QoS and QoE in today's telecom landscape. The product perspective defines how the app fits into the broader ecosystem, including partnerships, monetization opportunities, and user empowerment goals. A clear MVP scope, along with prioritized requirements, ensures a focused and achievable first version, while future work outlines the path for growth. The tools and techniques selected support scalability, usability, and reliable data collection, making this report a solid starting point for the next development phase.

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