REPUBLIQUE DU CAMEROUN

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PAIX – TRAVAIL – PATRIE

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MINISTERE DE L'ENSEIGNEMENT SUPERIEURE

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UNIVERSITE DE BUEA

REPUBLIC OF CAMEROON

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REQUIREMENT ANALYSIS

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Table of Content

Abstract

This document presents the Software Requirements Specification (SRS) for a mobile application that notifies users about road conditions and explains road signs. The goal is to reduce confusion, enhance road safety, and minimize travel delays in Cameroon by providing real-time road condition updates and educational support on road signage. Based on user-centered research conducted through survey analysis, this SRS outlines functional and non-functional requirements, classifies and prioritizes them based on technical and operational feasibility, and ensures alignment with stakeholder expectations. The requirement analysis process includes identifying user needs, resolving ambiguities, evaluating dependencies, and preparing for stakeholder validation. This document serves as a foundation for the subsequent design, implementation, and validation phases of the system.

1. Introduction

1.1 Purpose of the Document

The purpose of this Software Requirements Specification (SRS) document is to define a clear, comprehensive, and validated set of requirements for a mobile-based Road Condition Notification and Road Sign Explanation System. It is intended to serve as a reference for developers, testers, designers, and stakeholders, ensuring a shared understanding of system functionalities and constraints. This document addresses key aspects of requirement analysis, including feasibility, completeness, classification, and prioritization in line with academic expectations outlined in the requirement analysis task.

1.2 Scope of the System

The system aims to enhance road safety and travel efficiency by:

- Providing real-time notifications of road conditions such as potholes, congestion, accidents, and police checkpoints.
- Offering educational support by explaining road signs users frequently misunderstand.
- Allowing users to report road issues through a user-friendly interface.
- Delivering updates via push notifications or in-app messages based on user preferences.
  The application is targeted at road users in Cameroon, including drivers, pedestrians, and delivery agents.
  The system leverages user input and live map integration, with a design tailored for Android mobile platforms.

1.3 Objectives of Requirement Analysis

The requirement analysis phase is intended to:

- Review and analyze user and stakeholder needs based on survey results.

- Identify and resolve any inconsistencies, ambiguities, or incomplete information.
- Prioritize features according to their importance and technical/operational feasibility.
- Classify requirements into functional and non-functional categories.
- Develop a detailed and traceable Software Requirements Specification (SRS).
- Prepare the groundwork for requirement validation with stakeholders.

2. Requirement Review and Analysis

2.1 Completeness

The requirement gathering process was primarily driven by user surveys administered via Google Forms, which received significant engagement from the target user base (over 90% completion across key questions). The responses revealed critical pain points in the road travel experience in Cameroon, such as:

- Frequent encounters with bad road conditions (91.1%) (see Appendix- Figure1)
- High incidence of travel delays (97.8%) (see Appendix – Figure 8)
- Frequent confusion regarding road signs (66.7%) (see Appendix – Figure 2)
- A strong willingness to receive and contribute to road condition alerts (over 85%) (see Appendix – Figure 3)

From this, a broad range of user expectations was extracted, covering both **functional** and **non-functional** area of the system. The identified requirements include:

- Real-time alerts for potholes, traffic congestion, police checkpoints, and road closures
- Educational modules to explain road signs (especially regulatory and warning signs)

- Push notifications and in-app alerts for road condition updates
- User reporting features for submitting new issues
- A map interface to visualize road hazards
- Multilingual and intuitive UI for broader accessibility

The requirements are considered **largely complete**
Based on the following criteria:

- **User-driven coverage:** All major user concerns expressed in the survey have been captured and translated into system requirements.
- **Core system features addressed:** The primary functions of notification, education, and reporting have been well defined.
- **Support for all user roles**: Requirements support drivers, pedestrians, and road users with varying degrees of road sign literacy.
- **Cross-validation with problem statement:** The functional scope directly aligns with the initial problem statement (road delays, sign confusion, poor road safety).

However, completeness will continue to be monitored as the system evolves. Future validation sessions with stakeholders may uncover edge cases or additional expectations, especially in terms of accessibility, data privacy, and regional road conditions not fully captured in the current survey.

2.2 Clarity and Unambiguity

The requirements gathered from the user survey were generally clear and well-articulated. Most participants provided consistent and comprehensible answers, which allowed for the extraction of straightforward user expectations and system functionalities.

The key feature requests such as real-time notifications about **road conditions** (e.g., congestion, potholes, and accidents) and a **map-based interface** displaying live

updates were frequently repeated in a manner that left little room for misinterpretation. Additionally, preferences for **pop-up notifications** and **voice alerts** were mentioned explicitly, highlighting user needs in simple, direct terms.

However, a few areas did present minor ambiguity. For example, while many respondents expressed interest in "road sign explanations," it was not always clear whether users wanted **text-based descriptions**, **audio prompts**, or **visual cues**. Similarly, when users expressed willingness to report road conditions, it was not specified what **format** or **effort level** they expected (e.g., a quick tap, form filling, or uploading a photo).

To address these, assumptions were made and will be validated with stakeholders during requirement confirmation. Overall, the clarity of user responses was high, and the analysis yielded actionable and unambiguous functional and non-functional requirements for the system.

2.3 Operational Feasibility

Operational feasibility assesses whether the proposed system can function effectively in the real-world environment of its intended users — including its compatibility with current user behaviors, willingness to adopt, and alignment with social and environmental factors.

Based on the survey responses and user engagement, the proposed **Road Signs and Road Status Notification Application** is considered **operationally feasible**, supported by the following evidence:

- **Strong User Interest and Adoption Readiness:**
  A significant portion of respondents (86.7%) – (*Appendix-Figure 6)* expressed their willingness to **receive notifications** about road conditions, while 86.7% also indicated that they are **willing to report** road issues through the app. This demonstrates a high level of user openness to both consuming and contributing to the system's operations.

- **Clear Problem-Solution Fit:**

97.8% of users reported experiencing **journey delays** due to road conditions, and 91.1% stated they encounter **bad road conditions very often**. This confirms that the app addresses a real and persistent problem, reinforcing the likelihood of continued engagement.

- **User Familiarity with Maps and Mobile Apps:** 80% of users find a live **map interface helpful**, indicating that the operational concept aligns with user expectations and current habits.

- **Education and Awareness Compatibility:** Since 66.7% of users have been confused by road signs, and over 82%(see Appendix-Figure 5) believe a **mobile app explaining road signs** would be helpful, the app has the potential to integrate seamlessly into users' ongoing learning or safety awareness behaviors.

- **Device Accessibility:** The target audience primarily uses smartphones, and the app's planned features (notifications, GPS/map, offline updates) are compatible with most entry- to mid-level Android devices common in the region.

The system's design and objectives are operationally viable. The user based is both aware of the problem and motivated to adopt a digital solution, increasing the project's chances of real-world success with proper outreach and onboarding strategies.

2.4 Technical Feasibility

Technical feasibility evaluates whether the technology, tools, and skills required to implement the system are available, affordable, and suitable for the development and deployment of the Road Signs and Road Status Notification App.

1. **Development Platform and Tools**
   The system will be developed as **a mobile application,** targeting Android devices due to their wide availability in

the region. Technologies considered feasible for implementation include:

- **Flutter** or **Java/Kotlin** for Android development
- **Firebase** or **Node.js/Express** for backend and real-time data handling
- **Google Maps SDK** for map integration and location-based services
- **Firebase Cloud Messaging (FCM)** for sending push notifications.

These tools are well-supported, have large developer communities, and are cost-effective, making them suitable for a student-led project.

2. **Resource Availability**
    - The development team has access to essential mobile development platforms, Android smartphones for testing, and stable development environments.
    - Skills in mobile programming, user interface design, and basic backend development are being developed among team members.
    - However, **poor or inconsistent internet connectivity** in some areas (especially in rural regions) is a recognized constraint. This may affect real-time features such as map updates and report submissions. To mitigate this:
        - The app will support **offline caching** of recently viewed data.
        - The app will support **offline caching** of recently viewed data.
        - A **store-and-forward** mechanism will allow users to submit reports when they regain connectivity.

3. **System Requirement and Infrastructure**
    - The system's backend and notification services can be hosted on cloud platforms like Firebase or

Render, which offer cost-effective deployment for small applications.

- The app will be designed to run on low to mid-range Android devices to ensure broader accessibility.

- Infrastructure demands are minimal at this stage, focusing on fast performance, low bandwidth use, and responsive updates.

4. **Scalability and Maintainability**
    - **A modular architecture** will be adopted to allow future enhancements such as integration with public road databases or external data sources (e.g., traffic APIs).

    - The chosen tech stack ensures that bug fixes, feature updates, and maintenance can be performed with minimal overhead.

The proposed mobile application is **technically feasible** within the scope of the academic project. The selected technologies and tools are appropriate, and potential limitations such as poor network quality have been considered in the system design to ensure a reliable user experience.

2.5 Dependency and Relationship Analysis

This section analyzes the interdependencies between different system requirements and highlights how features relate to one another. Understanding these relationships ensures coherent design, avoids conflicts, and supports smooth feature implementation.

i. Functional Dependencies

Feature	Depend On	Explanation
Real-time road status notifications	Location services, internet connectivity, user permission	Without accurate location and network access, road condition alert cannot be context-aware.
Map display of road issues	Google Maps SDK, database of reported road problems.	Requires integration of maps and a backend that stores user-generated or system collected reports
User reporting of road conditions	Authentication, form UI, internet connection	Relies on the user interface for input and backend services to submit and store reports.
Voice or pop-up alerts	Notification system, user preferences	Must link to user-configurable setting to avoid disturbing users unnecessarily.
Educational module on road signs	Multimedia support, user interface, local storage.	Requires in-app content and possibly offline access for educational materials.

ii. Relationship Between Requirements

- **User notification preferences** are closely tied to both the **alert delivery system** and **type of content** (e.g., congestion, potholes, signs). These must be customizable to respect user control and avoid alert fatigue.
- **User reporting** feeds data into the **live map,** meaning its accuracy directly impacts **map usefulness** and trust in the system.
- **Understanding road signs (educational module)**, enhances user knowledge and supports the long-term vision of safer road use. This module complements core functionality but can be implemented progressively.
- **Offline access features** are dependent on **data caching logic**, which must be designed early to ensure smooth performance in low-network areas.

iii. Risk-Linked Dependencies

- **Real-time features** like live maps and updates are high-impact but **high-risk** in areas with

unreliable internet. Therefore, they depend on solid fallback mechanisms (e.g., recent data caching, retry mechanisms for report submission).

- **User engagement** (e.g., willingness to report) is crucial for keeping the platform data-rich and up-to-date. Thus, user experience (UX), responsiveness, and incentives (like gamification or feedback messages) are indirectly linked to the system's data quality.

3. IDENTIFICATION OF ISSUES

3.1 Inconsistencies

Inconsistencies refer to contradictions or mismatches within the gathered requirements or between the requirements and the system objectives. During the analysis of the user survey data and system expectations, the following inconsistencies were observed:

i. Alert Delivery Preferences vs. Notification Expectations

- Observation: 66.7% of users prefer **pop-up notifications**, while only **15.6%** want SMS or in-app messages. However, many users also stated they want to **receive updates while traveling**, which might require **voice alerts** or **hands-free options**—which were not explicitly ranked.

- **Inconsistency**: The mode of preferred delivery (pop-ups) might **not align with driving safety** requirements, as users won't be able to look at their phones constantly while driving.

ii. Understanding of Road Signs vs. Reported Confusion

- **Observation: 44.4%** say they understand road signs "fairly well," and **35.8%** say "very well**.**" Yet, **66.7% admitted being**

confused by signs, and **37.8%** said confusion led to or contributed to an accident.

- **Inconsistency:** There is a mismatch between **self-assessed understanding** and **actual experiences,** which may indicate overconfidence or a lack of standardized sign knowledge.

iii. User Willingness to Report vs. Data Integrity

- **Observation: 86.7%** are willing to report road issues, which is promising. However, there's **no guarantee of consistent, accurate, or real-time reporting.**
- **Inconsistency:** High willingness to report does not automatically mean **reliable data,** especially if the app is misused or if reports are duplicated or falsified.

iv. Road Condition Type Prioritization

- **Observation**: Users expressed interest in **congestion (75.6%)**, **potholes (55.6%)**, and **police checkpoints (44.4%)**. Yet, some of these features (like police presence) can be **ethically or legally sensitive** depending on local regulations.
- **Inconsistency**: Some **requested features may conflict** with legal compliance or app store policies.

v. Feature Set vs. Technical Limitations

- **Observation:** Users want live maps, alerts, offline accessibility, and reporting—all of which are data-intensive.
- **Inconsistency**: These expectations **may not align** with the technical constraints of budget phones or areas with **poor network quality**.

3.2 Unambiguity

Ambiguities are unclear or vague requirements that can be interpreted in multiple ways, leading to potential misunderstandings during system design and development. Based on the survey and requirement analysis, the following ambiguities were identified:

i. **Notification Preferences**
   - **Ambiguity:** While 66.7% of users prefer pop-up notifications, it's unclear under what conditions these alerts should be triggered (e.g., upon approach, real-time, based on speed?).
   - **Impact:** Without clarification, developers may implement alerts that are either too frequent (causing annoyance) or too infrequent (failing to inform users on time).

ii. **Definition of "Bad Road Conditions"**
   - **Ambiguity:** Users referenced potholes, congestion, weather hazards, and checkpoints. However, the term "bad" is subjective and context-dependent (e.g., a small pothole may not be reported by all users).
   - **Impact:** This may affect what the system considers worth alerting or recording.

iii. **User Reporting Mechanism**
   - **Ambiguity:** Though 86.7% are willing to report road conditions, **the reporting format, frequency, and verification process** were not specified.
   - **Impact:** Developers may not know whether to allow images,

GPS tagging, severity ratings, etc., potentially limiting the value of user-generated content.

iv. **Voice/Hands-Free Expectations**
- **Ambiguity:** Some users expect to get updates while driving but there's no clear indication of whether they expect **voice alerts, sound cues, or** integration with **vehicle systems.**
- **Impact:** Misunderstanding this could lead to a solution that's unusable or unsafe in practice.

v. **Map Usage and Accuracy**
- **Ambiguity:** 80% of users said a live map would be helpful, but it is unclear whether they expect **offline capability, real-time GPS-based alerts,** or integration with tools like **Google Maps or OpenStreetMap.**
- **Impact:** Misaligned assumptions may lead to poor user experience or redundant development effort.

vi. **Educational Module Expectations**
- **Ambiguity:** While 82.2% of users say a road sign education app would be helpful, it's not specified **what form** this should take (e.g., text-based tutorials, interactive quizzes, video explanations?).
- **Impact**: Ambiguity could lead to either over-simplified or overly complex implementations.

3.3 Missing Information

Despite valuable insights gathered through the survey and early requirement analysis, some crucial details required for a well-defined system specification were not provided. These missing pieces could lead to design gaps or misaligned expectations during development:

I. **User Roles and Access Levels**
   - **What's missing:** No clear distinction of whether the app will have different user roles such as administrators, road maintenance authorities, standard users, or anonymous reporters.
   - **Why it matters**: Defining roles early is essential for implementing authentication, data validation, and feature access control.

II. **Specific Geographic Coverage**
   - **What's missing:** The survey didn't specify whether the app should cover **nationwide areas, specific towns/cities,** or only **user-local environments.**
   - **Why it matters**: Determines the size of the database, the choice of map APIs, and the kind of network/data integration required.

III. **Real-Time Data Sources**
   - **What's missing:** No information on whether the system will integrate **external traffic feeds,** weather APIs, or **government data** on road works and closures.
   - **Why it matters**: External data enhances accuracy, but integration depends on availability, licensing, and technical setup.

IV. **Reporting Validation**
   - **What's missing** : The method for verifying the **authenticity or accuracy** of user-reported road incidents was not discussed.
   - **Why it matters** : Unchecked reporting could lead to **false alarms**, **spam**, or **outdated information** in the system.

V. **Update Frequency & Alert Timing**

- **What's missing:** There's no clarity on how often road status information should be refreshed or how soon notifications must be triggered before an incident is encountered.
- **Why it matters**: Impacts system responsiveness, mobile data consumption, and usability.

VI. **Accessibility Features**

- **What's missing:** There's no input about users with **disabilities**, such as hearing or visual impairments.
- **Why it matters**: May influence design decisions like adding voice narration, color contrast, or vibration alerts for inclusivity.

VII. **Device Platform and Connectivity Assumptions**

- **What's missing:** It was not specified whether the app is expected to support both **Android and iOS,** or function **offline or in low-network areas.**
- **Why it matters:** Affects technology stack, testing strategy, and budget allocation.

4. Requirement Prioritization

4.1 Criteria for Prioritization

To ensure that the most critical and feasible requirements are implemented within the project's timeline and constraints, requirements are prioritized based on two main feasibility dimensions—Operational and Technical—alongside User Value. These criteria help balance impact, practicality, and resource constraints during development.

i. **Operational Feasibility**
This assesses whether the requirement is strongly aligned with user needs and the problem context. It includes:

- **User demand** (obtained in survey responses)
- **Relevance to app objectives** (e.g., avoiding delays, improving road sign understanding)
- **Ease of adoption** (likelihood users will use or benefit from the feature)

ii. Technical Feasibility

This evaluates how easily and realistically a requirement can be implemented with current technology, team skills, and resources.

- **Availability of data sources** (e.g., APIs for traffic or weather)
- Complexity of implementation
- Infrastructure or platform constraints

iii. **User Value and Risk**
This considers how valuable a requirement is to the user experience and whether failure to implement it would create usability risks.

- Frequency of user needs
- Potential consequences of not having it
- Support for core functionalities

iv. **Resource Availability**
Includes manpower, funding, internet/network quality, and device coverage. For example:

- If **network quality is poor**, real-time-only features may be risky.
- If **development resources are limited**, the MVP (Minimum Viable Product) should focus on high-impact, low-complexity features.

4.2 Prioritization Matrix

Based on the criteria defined in Section 4.1 (Operational Feasibility, Technical Feasibility, User Value, and Resource Availability), the following matrix presents the prioritization of core system requirements for the **Road Signs and Road Status Notification App.**

Requirement	Operational Feasibility	Technical Feasibility	User Value	Priority Level
Display live map with road issues (potholes, traffic, etc.)	High	Medium	High	High
Pop-up notifications about road conditions	High	High	High	High
Allow users to report roads problem	High	High	High	High
In-app explanations of road-signs	High	High	High	High
Enable voice alerts during driving	Medium	Medium	High	Medium
Categorized reporting (potholes, accidents…)	High	High	Medium	High
Offline access to previously downloaded road sign info	Medium	Medium	Medium	Medium
Alert user about nearby police checkpoints	Medium	Medium	Medium	Medium
Road safety tips and guidance	Medium	High	Medium	Medium
SMS-based alerts (for poor network areas)	Low	Medium	Low	Low
Feedback system for road sign explanations	Medium	Medium	Medium	Medium
Gamified quizzes to test road sign knowledge	Low	Low	Medium	Low

Notes:

- **High Priority:** These are essential to the MVP and directly reflect core user needs from survey responses.
- **Medium Priority**: Valuable additions that enhance user experience but can be postponed to second phase.

- **Low Priority**: Non-essential features with limited feasibility or impact and can be optional based on available time/resources.

5. Requirement Classification

5.1 Functional Requirements (FR)

The functional requirements describe what the system should do — the core features and behaviors of the **Road Signs and Road Status Notification App.**

ID	Functional Requirement	Description
FR1	Display live road condition updates on a map	The app should fetch and display real-time data on a map.
FR2	Enable user to report road issues.	Users should be able to select a category (e.g. potholes, traffic…) and report it
FR3	Provide pop-up notifications	The system should alert users via pop-up notifications about nearby or upcoming road issues.
FR4	Allow users to enable/disable notifications	Users can control when and how they receive alerts while driving or walking.
FR5	Explain road signs within the app.	The app should contain a database of road signs with explanations and examples
FR6	Track user location to provide nearby updates	The app uses GPS to track current location and push relevant alerts in the user's vicinity.
FR7	Categorize reported issues	Reports submitted must be stored and

		tagged by the type (e.g., accident, wheather hazard).
FR8	Enable feedback on road sign explanations	Users can rate or comment on the usefulness of road sign info to help improve content.
FR9	Display journey delay notifications	The system can notify users if there's an unusual delay ahead based on crowd-sourced reports.
FR10	Manage user preferences and settings	Users should be able to manage preferences such as notification type, sound or theme.

5.2 Non-Functional Requirement (NFR)

Non-functional requirements define the *quality attributes*, *system performance*, and *operational constraints* of the Road Signs and Road Status Notification App.

ID	Non-Functional Requirement	Description
NFR1	**Performance**	The app should respond to user actions (e.g., report submission or map loading) within 3 seconds.
NFR2	**Availability**	The system should be operational and accessible at least 95% of the time during peak hours.
NFR3	**Scalability**	The system must be capable of handling increased traffic (users and reports) during peak times.
NFR4	**Usability**	The app must have a user-friendly interface suitable for drivers and pedestrians alike.
NFR5	**Security**	User data (e.g., location) should be protected through encryption and secure communication.
NFR6	**Compatibility**	The app should be compatible with Android 8 and above; and support multiple screen sizes.
NFR7	**Maintainability**	The app should be built using modular code and clear documentation for future updates.

NFR8	**Localization**	It should support both English and French (main languages in Cameroon).
NFR9	**Reliability**	Notifications should be delivered with 99% accuracy based on user location and verified reports.
NFR10	**Battery Efficiency**	The app must optimize GPS and background services to minimize battery consumption.

6. Software Requirement Specification (SRS)

6.1 System Overview

The *Road Sign and Road State Mobile Notification Application* is a location-aware, Android-based system designed to enhance road safety and traffic efficiency for users in Cameroon and similar developing contexts. The system addresses key challenges such as poor signage visibility, inadequate awareness of road signs, and a lack of timely information about road conditions.

The proposed mobile application will serve as a digital companion for drivers and road users, delivering timely notifications and updates about road signs and road states (e.g., accidents, traffic congestion, poor road quality). It will leverage mobile GPS, user-contributed reports, and possibly third-party data to offer customized alerts and guidance based on user location and preferences.

The system aims to :

- Improve **driver awareness and education** on road signage.
- Deliver **real-time road condition updates**, aiding in route decisions.
- Promote **community-based reporting**, allowing users to share road condition alerts.
- Ensure **safety, usability, and accessibility** through a simple and intuitive interface.
- Function effectively in **low-resource environments**, considering limited internet access and device capabilities.

The system is intended for deployment in urban and semi-urban road networks where road safety challenges persist. It focuses on scalability,

security, low battery consumption, and multi-lingual, support, primarily in English and French.

6.2 Functional Requirement Detailed (FR)

The functional requirements describe the core features and functionalities that the Road Sign and Road State Mobile Notification Application must perform to meet user expectations and fulfill the project objectives.

ID	Requirement Description	Requirement Specification	Priority
FR-01	Real-time road condition notifications.	The app shall push live alerts when new road issues are reported near the user's location.	High
FR-02	Road condition reporting by users.	The app shall include a "Report Issue" form with predefined categories (pothole, traffic, etc.) and location tagging.	High
FR-03	Live map displaying road issues.	The app shall integrate a map with pins showing the latest reported road conditions.	High
FR-04	User preferences for notification type.	Users shall be able to choose between pop-ups, SMS, or in-app messages for alerts.	Medium
FR-05	Voice alerts for road issues.	The app shall offer optional voice alerts for hands-free notification while driving.	Medium
FR-06	Educational module on road signs.	The app shall provide a module explaining various road signs with examples and quiz features.	High
FR-07	Offline functionality with cached data.	The app shall store the latest map and reports locally for offline access.	Medium
FR-08	User account creation and login.	Users shall be able to register and log in with basic details (email, phone number).	Medium
FR-09	Syncing of data post-offline usage.	The system shall auto-sync user reports and data once the device regains internet access.	Medium
FR-10	Tracking report status.	The app shall allow users to view the status (pending, verified, resolved) of their submitted reports.	Low

FR-11	Rating update accuracy.	Users shall be able to rate the usefulness and correctness of received road updates.	Low
FR-12	Location-based alerts.	The app shall trigger alerts when a user approaches a reported road hazard location.	High
FR-13	Feedback on road sign understanding.	The app shall allow users to submit feedback on difficult-to-understand road signs.	Medium

6.3 Non-Functional Requirement (NFR)

These requirements define the quality attributes, system performance criteria, and constraints that the Road Sign and Road State Mobile Notification Application must satisfy to ensure usability, reliability, and maintainability.

ID	Requirement Description	Requirement Specification	Priority
NFR-01	Performance	The system shall deliver road condition alerts within 5 seconds of issue detection or submission.	High
NFR-02	Usability	The interface shall be intuitive and usable by individuals with limited digital literacy.	High
NFR-03	Availability	The app shall be available and operational at least 95% of the time, excluding maintenance periods.	High
NFR-04	Scalability	The system shall support a growing number of users without performance degradation.	Medium
NFR-05	Security	User data shall be securely stored using encryption and secure authentication methods.	High
NFR-06	Maintainability	The codebase shall follow modular design to allow for easy updates and bug fixes.	Medium
NFR-07	Compatibility	The system shall be compatible with Android 8.0+ and IOS 12+.	Medium
NFR-08	Offline Support	The app shall allow viewing of last-updated road reports when offline, and sync updates once reconnected.	Medium

NFR-09	Localization	The system shall support multiple languages, starting with English and French.	Low
NFR-10	Responsiveness	The mobile interface shall respond to user interactions within 1 second.	High
NFR-11	Accuracy	Location data and alerts shall have a margin of error no greater than 15 meters.	Medium
NFR-12	Legal Compliance	The app shall comply with local data protection and digital communication laws in Cameroon.	High

6.4 Constraints and Assumptions

This section outlines the known constraints and assumptions that may influence the design, development, and deployment of the Road Sign and Road State Mobile Notification Application.

Contraints

Constraint No.	Description
C-01	The application must be developed using **Flutter** to support both Android and iOS platforms.
C-02	The system must work effectively under **low-bandwidth or poor mobile network conditions**.
C-03	Only devices running **Android 8.0+ and iOS 12+** will be officially supported.
C-04	The backend services will be hosted on **limited cloud resources**, potentially affecting scalability.
C-05	Development must be completed within **academic project timelines and limited team size**.
C-06	**Real-time data** is dependent on third-party sources (government or crowd-sourced updates).
C-07	The application must comply with **university project submission guidelines and evaluation rubrics**.

Assumptions

Assumption No.	Description
A-01	End users have **basic smartphone literacy** and can install and use mobile apps.

A-02	Stakeholders (e.g., road safety agencies) will be **willing to support data sourcing**.
A-03	Users will **enable location services and internet access** for real-time features.
A-04	The mobile application will be used **primarily in urban and peri-urban areas**.
A-05	There will be **feedback from test users** during prototype testing and evaluation.
A-06	The app will undergo **future updates** for scalability and extended feature sets post-project phase.
A-07	The project team will have **access to development tools and emulators/simulators** during testing.

7. Validation with Stakeholders

7.1 Validation Methods

To ensure that the requirements gathered are aligned with user needs and expectations, a structured validation approach was followed.

The following **validation methods** were used during the requirement analysis phase for the *Road Sign and Road State Mobile Notification Application*:

i. Stakeholder Interviews and Discussions

- **Participants**: Target users (drivers), transport officials, and tech-literate citizens.
- **Purpose**: To clarify ambiguous requirements and verify the relevance of proposed features.
- **Outcome**: Helped refine the core use cases and prioritize needs such as real-time updates, road sign directory, and low-data mode.

ii. Survey Feedback Validation

- **Approach:** Patterns from survey results were compared against initial assumptions.

- **Purpose**: To validate "must-have" vs "nice-to-have" features.
- **Outcome**: Confirmed the necessity of features like push notifications, offline map access, and language localization.

iii. Traceability Matrix (Planned)

- **Purpose:** Map requirements to stakeholder needs and validate that all expectations are addressed.
- **Outcome:** To be completed during final system review for full alignment between goals, features, and delivery.

7.2 Validation Outcomes

Based on the validation methods used, the following key outcomes were derived:

i. Alignment with User Needs

- The majority of user requirements identified from surveys (e.g., real-time road updates, push notifications, and road sign explanations) were **validated** as essential features.
- Visual walkthroughs and interviews helped clarify that **simplicity and clarity** are preferred in both design and alerts.

ii. Requirement Refinement

- Some features were refined after validation. For example:
  - Instead of a complex reporting form, a **one-click "Report Issue" button** was proposed.
  - Notifications will support both **text and icons**, based on stakeholder feedback.

iii. Resolved Ambiguities

- Clarified misunderstood survey questions such as types of road signs users struggle with.
- Feedback also helped disambiguate system behavior in areas with poor internet connection — leading to the inclusion of **offline support**.

iv. Prioritization Confirmation

- Stakeholders helped validate the prioritization matrix, confirming that features like:
  - Live road problem maps
  - Notifications while driving
  - Notifications while driving

  should be addressed in the first development cycle.

8. Conclusion

This report presented a comprehensive requirement analysis and specification for the mobile application titled **"Design and Implementation of a Road Signs and Road Status Notification App."** The process followed a structured approach involving survey data collection, stakeholder interaction, feasibility analysis, and formal documentation of user needs.

Summary of Accomplishments:

- **User Needs Identified:** Based on extensive surveys, users showed strong interest in real-time road condition alerts, map visualizations, and road sign education.
- **Requirements Reviewed and Analyzed:** The requirements were found to be largely complete, unambiguous, and aligned with real-world usage contexts. Operational and technical feasibility confirmed the project's viability.
- **Prioritization Applied:** Through a structured matrix and stakeholder input, core features like push notifications, live road maps, and voice alerts were ranked as must-haves.
- **Classification and Documentation:** Functional and non-functional requirements were clearly defined, supporting system design and future development stages.

- **Stakeholder Validation:** Interactive sessions ensured requirements reflected actual user expectations, refining and confirming key features and assumptions.

Challenges Addressed:

- Resolved inconsistencies from survey feedback.
- Considered network constraints as a technical limitation.
- Incorporated feedback from both end-users and academic reviewers.

9. Appendix

9.1 Glossary

Term	Definition
SRS	Software Requirements Specification – a document that describes the system's functionality, constraints, and interactions.
NFR	Non-Functional Requirement – criteria that judge the operation of a system, rather than specific behaviors.
Road Status Notification	Real-time alerts or updates about current road conditions such as potholes or congestion.
Stakeholders	Individuals or groups with an interest in the system, including users, developers, and road authorities.
Functional Requirement	Specific behavior or function of the system (e.g., report a pothole).
Feasibility Study	An analysis to determine whether the proposed system is technically and operationally viable.
Prioritization Matrix	A tool used to rank requirements based on criteria like feasibility and impact.
Pop-up Notification	A mobile alert that appears on the screen to inform users of important updates.
GPS	Global Positioning System – used to track or report user and road conditions' locations.
Localization	Adapting the system to support multiple languages and regional settings.

9.2 References

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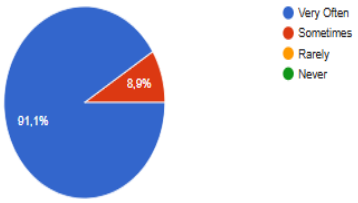

Figure1: Road Condition Experience Survey Result

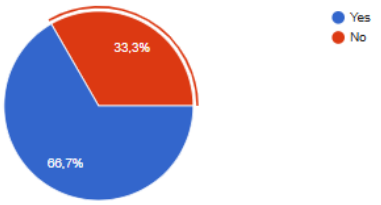

Figure 2: Road Sign confusion Survey Result

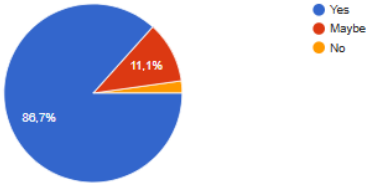

Figure 3: Real time contribution Survey Result

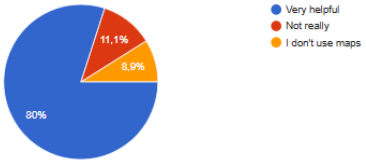

Figure 4: Map Integration Survey Result

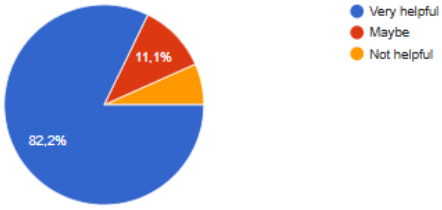

Figure 5: Mobile Road Sign tutorial Survey Result

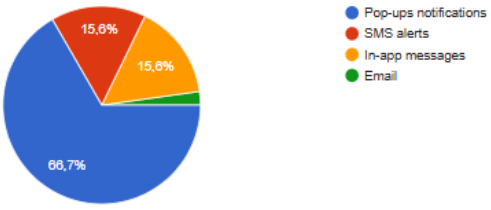

Figure 6: Notification Approach Survey Result

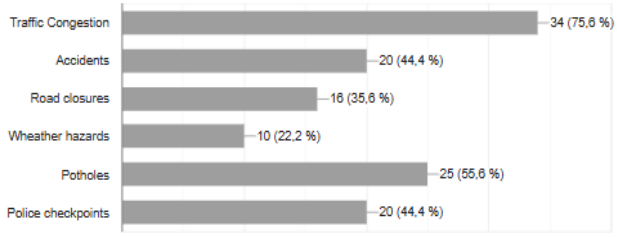

Figure 7: Real-Time Alert Survey Result

Figure 8: Travel Delay Survey Result