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TASK TWO: REQUIREMENT GATHERING ON A CAR FAULT MANAGEMENT SYSTEM

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ABSTRACT

This phase of the project focused on gathering comprehensive requirements to guide the design and development of an AI-powered mobile diagnostic application for car faults. By engaging with stakeholders, reviewing existing literature, and analyzing comparable solutions, the requirements gathering process identified essential functional and non-functional needs. The findings underscore the importance of usability for non-technical users, reliable sensor integration, and effective AI model performance for both image and audio analysis. These insights will form the foundation for subsequent design, modeling, and implementation phases, ensuring the final application meets user expectations and operates effectively in real-world conditions.

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INTRODUCTION

The Car Fault Management Mobile Application aims to empower car owners with a smart diagnostic tool that uses artificial intelligence and mobile technology to identify issues and provide automated recommendations for corrective action. This report outlines the requirements gathered through live questions, surveys and general research.

The Car Fault Management mobile application aims to bridge the gap between car owners and vehicle maintenance by providing a user friendly and accurate diagnostic tool.The report provides a detailed analysis of the application's features ,functional and non-functional requirements, user needs, and technical requirements serving as foundation for the design and development of our app.

This report is intended to car owners, aspiring car owners, mechanics, engineers, marketers/entrepreneurs and developers who wish to work on a similar project.

LITERATURE REVIEW

Requirements gathering is a crucial phase in any software development process. It involves identifying user needs, functional expectations, technical constraints, and environmental factors that will shape the system.

1. Importance of Requirements Gathering in Mobile App Development
According to Sommerville (2016), poorly defined or misunderstood requirements are one of the leading causes of project failure in software development. For mobile applications, especially those involving AI and IoT features, early identification of user expectations and environmental constraints helps reduce risks and cost overruns.

2. User-Centered Design (UCD)
Norman (2013) emphasizes the importance of designing with the user in mind. In this project, the target users are car owners, many of whom lack technical expertise. Therefore, requirements gathering should focus on usability, simplicity, and accessibility.

3. Requirement Elicitation Techniques
As described by Pressman (2014), common techniques include:

- ✓ Interviews: Talking directly with car owners and mechanics to understand common problems.
- ✓ Surveys/Questionnaires: Collecting structured feedback from a broader audience.
- ✓ Observation: Watching users interact with their vehicles during fault occurrences.
- ✓ Document Analysis: Reviewing car manuals, OBD-II codes, and technical documents.

4. Similar Systems and Market Research
Studying existing mobile diagnostic apps (e.g., FIXD, Torque Pro) revealed key user frustrations: dependence on external hardware, limited fault coverage, and complex interfaces. These findings informed the decision to develop a standalone, AI-powered mobile tool using onboard sensors (camera and microphone).

5. Technical Requirements in AI-Based Diagnostics
Studies like that of Chen et al. (2020) highlight the importance of high-quality labeled datasets for training machine learning models in image and sound recognition. Requirement gathering must thus include provisions for data acquisition, data-set size, and model training feasibility on mobile platforms.

METHODOLOGY

The methodology to gather the requirements for the Car Fault Management Application involves a combination of techniques to ensure the app's requirements are accurate, comprehensive, relevant and meets the need of the intended audience. Some of the methodologies which include;

1. SURVEY/QUESTIONNAIRE

We carried out survey online using google forms and links were shared. Nine questions were asked in the questionnaire. The questions asked were:

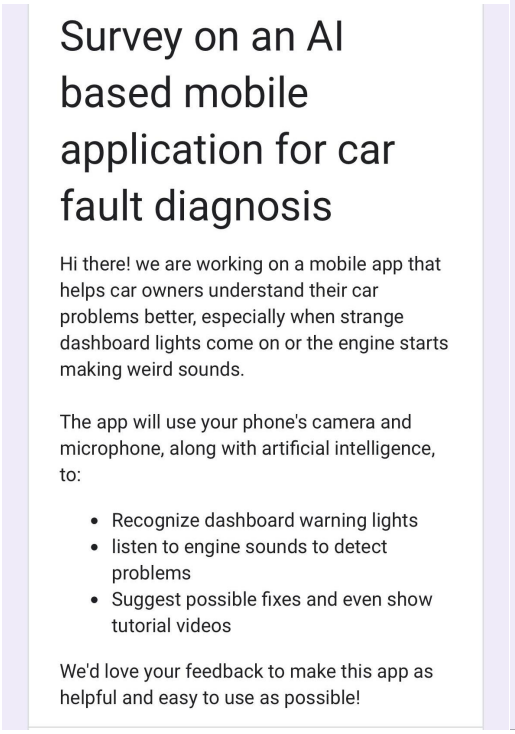


Fig 1.1: question a

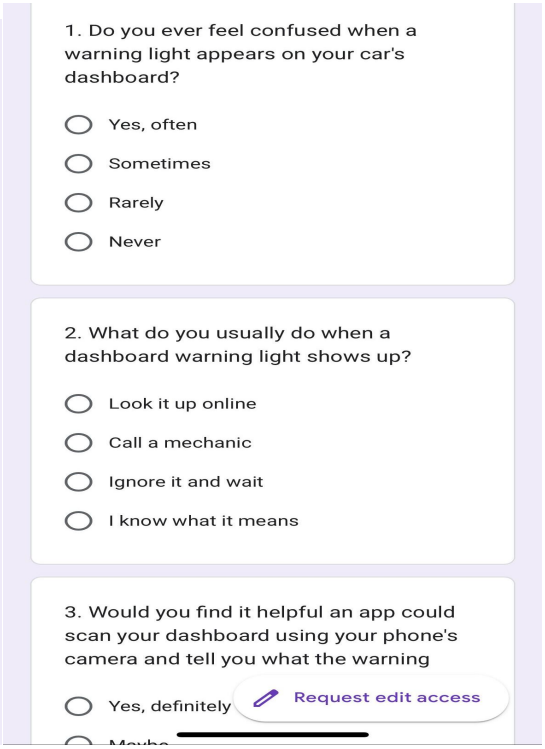


fig 1.2: *question b*

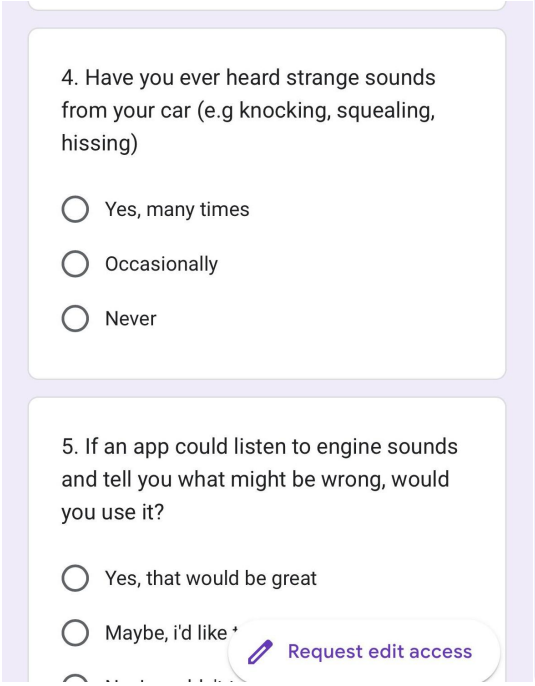


Fig1.3: question c

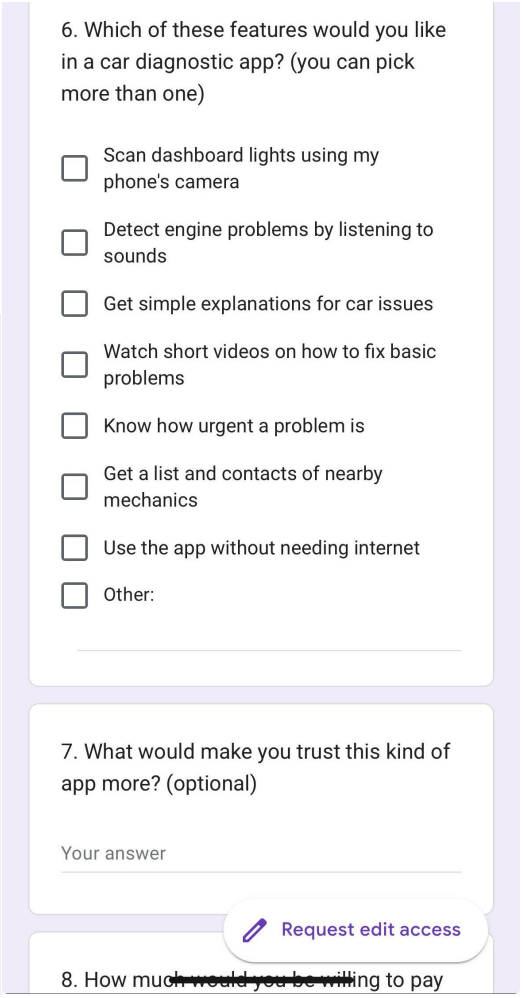


fig1.4: question d

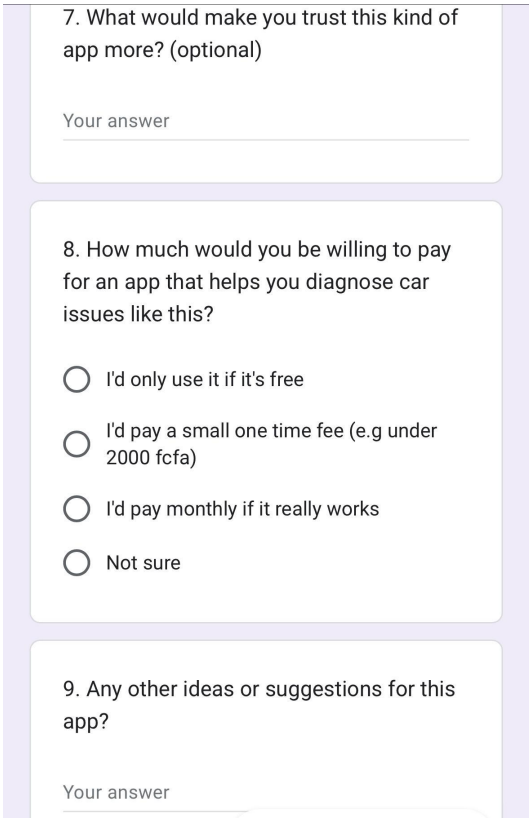


Fig1.5: question e

The data-set contains responses from 33 participants regarding their interest and preferences related to an AI-based mobile application for car fault diagnosis. Here's a summary of the insights:

Key Takeaways

1. Dashboard Warning Light Confusion:
- ✧ Most respondents reported feeling confused occasionally when a warning light appears.
- ✧ Actions taken include looking it up online, calling a mechanic, or ignoring it.

2. Interest in a Camera-Scanning App:
- ✧ A large majority of participants indicated they would definitely find it helpful if an app could scan dashboard warning lights using a phone camera and explain the meaning.

3. Recognition of Engine Sounds:
- ✧ Most users are familiar with strange engine sounds and would eagerly use an app that can analyze such sounds and offer a diagnosis.

4. Preferred Features:
- ✧ Popular features include:
- ✧ Scanning dashboard lights
- ✧ Listening to engine sounds
- ✧ Providing repair suggestions
- ✧ Offering maintenance reminders

5. Factors that Influence Trust:

- ✧ Trust factors mentioned include:
- ✧ Efficiency and accuracy
- ✧ Data security
- ✧ Confidentiality
- ✧ Proven track record or reviews

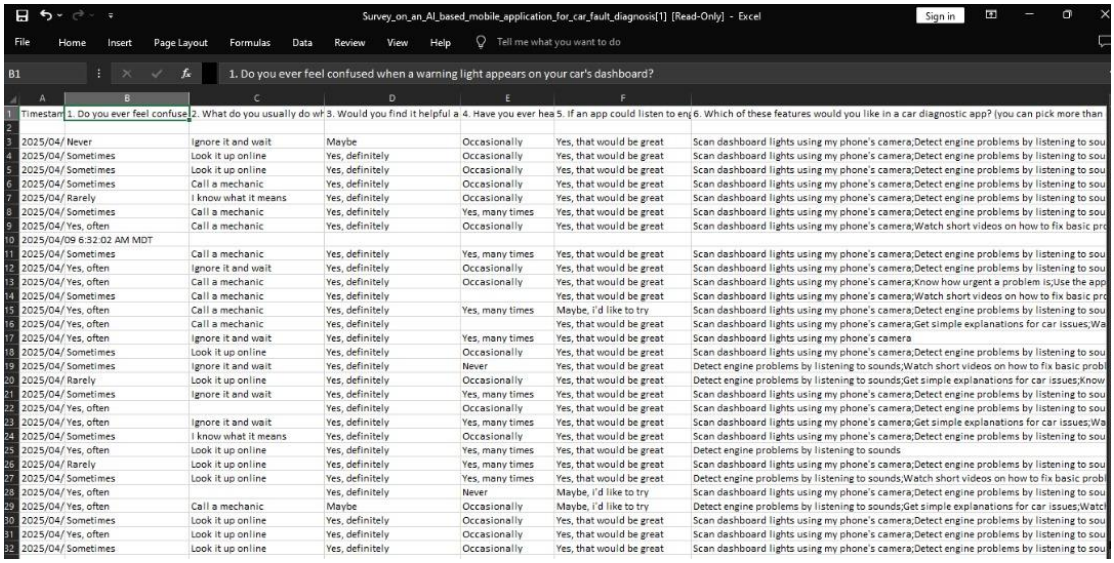
6. Willingness to Pay:

- ✧ Mixed responses:
- ✧ Some would only use it if free
- ✧ Others are open to paying a small one-time fee or monthly subscription if it works well.

7. Additional Suggestions:

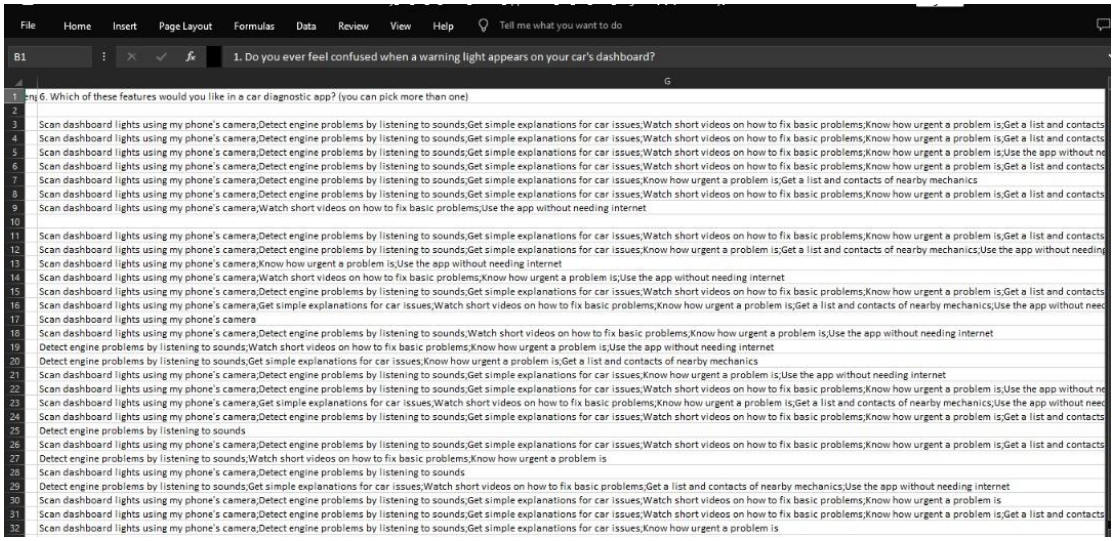
- ✧ A few users suggested adding traffic updates, weather forecasts, or real-time support.

Below are some screenshoots of the responses from the participants



	A	B	C	D	E	F
1	Timestam	1. Do you ever feel confuse	2. What do you usually do wh	3. Would you find it helpful a	4. Have you ever hea	5. If an app could listen to eng	6. Which of these features would you like in a car diagnostic app? (you can pick more than
2							
3	2025/04/	Never	Ignore it and wait	Maybe	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
4	2025/04/	Sometimes	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
5	2025/04/	Sometimes	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
6	2025/04/	Sometimes	Call a mechanic	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
7	2025/04/	Rarely	I know what it means	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
8	2025/04/	Sometimes	Call a mechanic	Yes, definitely	Yes, many times	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
9	2025/04/	Yes, often	Call a mechanic	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Watch short videos on how to fix basic pro
10	2025/04/09 6:32:02 AM MDT						
11	2025/04/	Sometimes	Call a mechanic	Yes, definitely	Yes, many times	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
12	2025/04/	Yes, often	Ignore it and wait	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
13	2025/04/	Yes, often	Call a mechanic	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Know how urgent a problem is;Use the app
14	2025/04/	Sometimes	Call a mechanic	Yes, definitely		Yes, that would be great	Scan dashboard lights using my phone's camera;Watch short videos on how to fix basic pro
15	2025/04/	Yes, often	Call a mechanic	Yes, definitely	Yes, many times	Maybe, i'd like to try	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
16	2025/04/	Yes, often	Call a mechanic	Yes, definitely		Yes, that would be great	Scan dashboard lights using my phone's camera;Get simple explanations for car issues;Wa
17	2025/04/	Yes, often	Ignore it and wait	Yes, definitely	Yes, many times	Yes, that would be great	Scan dashboard lights using my phone's camera
18	2025/04/	Sometimes	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
19	2025/04/	Sometimes	Ignore it and wait	Yes, definitely	Never	Yes, that would be great	Detect engine problems by listening to sounds;Watch short videos on how to fix basic probl
20	2025/04/	Rarely	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Detect engine problems by listening to sounds;Get simple explanations for car issues;Know
21	2025/04/	Sometimes	Ignore it and wait	Yes, definitely	Yes, many times	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
22	2025/04/	Yes, often		Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
23	2025/04/	Yes, often	Ignore it and wait	Yes, definitely	Yes, many times	Yes, that would be great	Scan dashboard lights using my phone's camera;Get simple explanations for car issues;Wa
24	2025/04/	Sometimes	I know what it means	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
25	2025/04/	Yes, often	Look it up online	Yes, definitely	Yes, many times	Yes, that would be great	Detect engine problems by listening to sounds
26	2025/04/	Rarely	Look it up online	Yes, definitely	Yes, many times	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
27	2025/04/	Sometimes	Look it up online	Yes, definitely	Yes, many times	Yes, that would be great	Detect engine problems by listening to sounds;Watch short videos on how to fix basic probl
28	2025/04/	Yes, often		Yes, definitely	Never	Maybe, i'd like to try	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
29	2025/04/	Yes, often	Call a mechanic	Maybe	Occasionally	Maybe, i'd like to try	Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch
30	2025/04/	Sometimes	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
31	2025/04/	Yes, often	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou
32	2025/04/	Sometimes	Look it up online	Yes, definitely	Occasionally	Yes, that would be great	Scan dashboard lights using my phone's camera;Detect engine problems by listening to sou

Fig 2.1: Reponse a



6. Which of these features would you like in a car diagnostic app? (you can pick more than one)
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Use the app without ne
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Know how urgent a problem is;Get a list and contacts of nearby mechanics
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Watch short videos on how to fix basic problems;Use the app without needing internet
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Know how urgent a problem is;Get a list and contacts of nearby mechanics;Use the app without needing
Scan dashboard lights using my phone's camera;Know how urgent a problem is;Use the app without needing internet
Scan dashboard lights using my phone's camera;Watch short videos on how to fix basic problems;Know how urgent a problem is;Use the app without needing internet
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts of nearby mechanics;Use the app without need
Scan dashboard lights using my phone's camera
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Watch short videos on how to fix basic problems;Know how urgent a problem is;Use the app without needing internet
Detect engine problems by listening to sounds;Watch short videos on how to fix basic problems;Know how urgent a problem is;Use the app without needing internet
Detect engine problems by listening to sounds;Get simple explanations for car issues;Know how urgent a problem is;Get a list and contacts of nearby mechanics
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Know how urgent a problem is;Use the app without needing internet
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Detect engine problems by listening to sounds;Watch short videos on how to fix basic problems;Know how urgent a problem is
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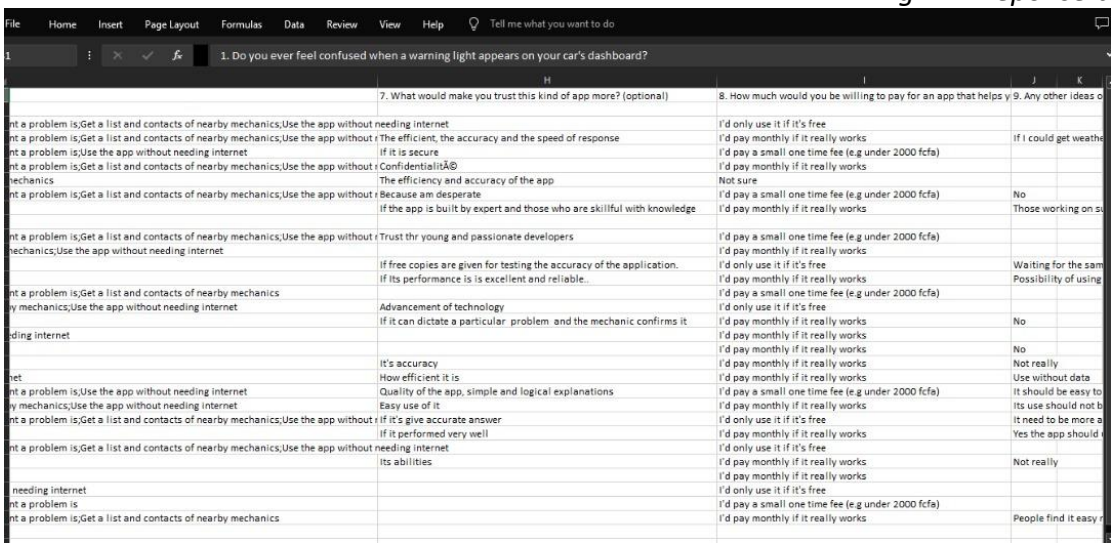
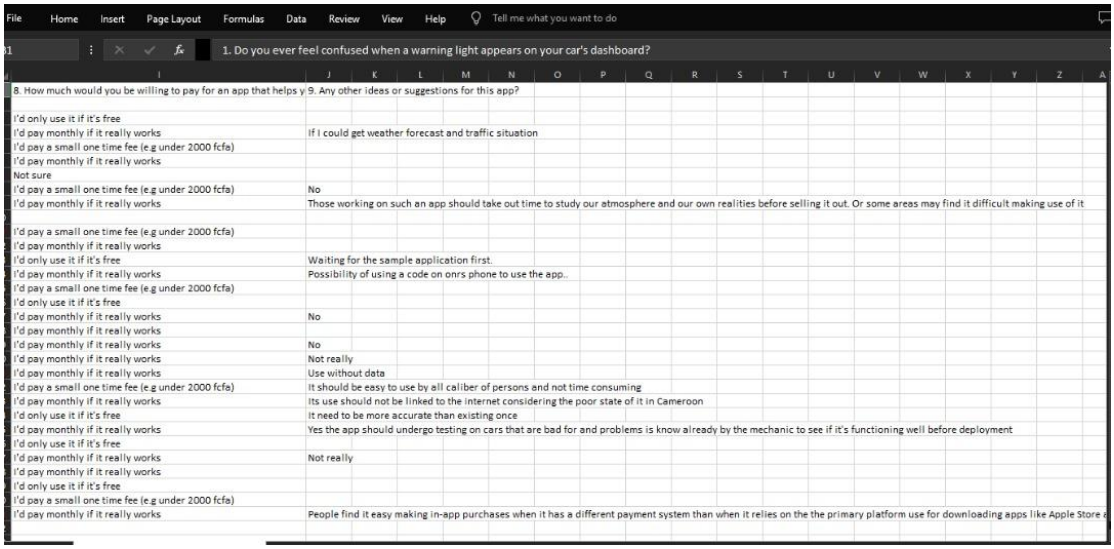
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Watch short videos on how to fix basic problems;Know how urgent a problem is;Get a list and contacts
Scan dashboard lights using my phone's camera;Detect engine problems by listening to sounds;Get simple explanations for car issues;Know how urgent a problem is

Fig 2.2: Reponse b



	7. What would make you trust this kind of app more? (optional)	8. How much would you be willing to pay for an app that helps y	9. Any other ideas o
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	needing internet	I'd only use it if it's free	
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	The efficient, the accuracy and the speed of response	I'd pay monthly if it really works	If I could get weathe
nt a problem is;Use the app without needing internet	If it is secure	I'd pay a small one time fee (e.g under 2000 fcfa)	
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	ConfidentialitÃ©	I'd pay monthly if it really works	
echanics	The efficiency and accuracy of the app	Not sure	
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	Because am desperate	I'd pay a small one time fee (e.g under 2000 fcfa)	No
	If the app is built by expert and those who are skillful with knowledge	I'd pay monthly if it really works	Those working on su
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	Trust thr young and passionate developers	I'd pay a small one time fee (e.g under 2000 fcfa)	
echanics;Use the app without needing internet		I'd pay monthly if it really works	
	If free copies are given for testing the accuracy of the application.	I'd only use it if it's free	Waiting for the sam
	If its performance is is excellent and reliable..	I'd pay monthly if it really works	Possibility of using
nt a problem is;Get a list and contacts of nearby mechanics		I'd pay a small one time fee (e.g under 2000 fcfa)	
y mechanics;Use the app without needing internet	Advancement of technology	I'd only use it if it's free	
	If it can dictate a particular problem and the mechanic confirms it	I'd pay monthly if it really works	No
ding internet		I'd pay monthly if it really works	
		I'd pay monthly if it really works	No
	It's accuracy	I'd pay monthly if it really works	Not really
net	How efficient it is	I'd pay monthly if it really works	Use without data
nt a problem is;Use the app without needing internet	Quality of the app, simple and logical explanations	I'd pay a small one time fee (e.g under 2000 fcfa)	It should be easy to
y mechanics;Use the app without needing internet	Easy use of it	I'd pay monthly if it really works	Its use should not b
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	If it's give accurate answer	I'd only use it if it's free	It need to be more a
	If it performed very well	I'd pay monthly if it really works	Yes the app should
nt a problem is;Get a list and contacts of nearby mechanics;Use the app without	needing internet	I'd only use it if it's free	
	Its abilities	I'd pay monthly if it really works	Not really
		I'd pay monthly if it really works	
needing internet		I'd only use it if it's free	
nt a problem is		I'd pay a small one time fee (e.g under 2000 fcfa)	
nt a problem is;Get a list and contacts of nearby mechanics		I'd pay monthly if it really works	People find it easy

Fig 2.3: Reponse c



8. How much would you be willing to pay for an app that helps y	9. Any other ideas or suggestions for this app?
I'd only use it if it's free	
I'd pay monthly if it really works	If I could get weather forecast and traffic situation
I'd pay a small one time fee (e.g under 2000 fcfa)	
I'd pay monthly if it really works	
Not sure	
I'd pay a small one time fee (e.g under 2000 fcfa)	No
I'd pay monthly if it really works	Those working on such an app should take out time to study our atmosphere and our own realities before selling it out. Or some areas may find it difficult making use of it
I'd pay a small one time fee (e.g under 2000 fcfa)	
I'd pay monthly if it really works	
I'd only use it if it's free	Waiting for the sample application first.
I'd pay monthly if it really works	Possibility of using a code on onrs phone to use the app..
I'd pay a small one time fee (e.g under 2000 fcfa)	
I'd only use it if it's free	
I'd pay monthly if it really works	No
I'd pay monthly if it really works	
I'd pay monthly if it really works	No
I'd pay monthly if it really works	Not really
I'd pay monthly if it really works	Use without data
I'd pay a small one time fee (e.g under 2000 fcfa)	It should be easy to use by all caliber of persons and not time consuming
I'd pay monthly if it really works	Its use should not be linked to the internet considering the poor state of it in Cameroon
I'd only use it if it's free	It need to be more accurate than existing once
I'd pay monthly if it really works	Yes the app should undergo testing on cars that are bad for and problems is know already by the mechanic to see if it's functioning well before deployment
I'd only use it if it's free	
I'd pay monthly if it really works	Not really
I'd pay monthly if it really works	
I'd only use it if it's free	
I'd pay a small one time fee (e.g under 2000 fcfa)	
I'd pay monthly if it really works	People find it easy making in-app purchases when it has a different payment system than when it relies on the the primary platform use for downloading apps like Apple Store

Fig 2.4: Response d

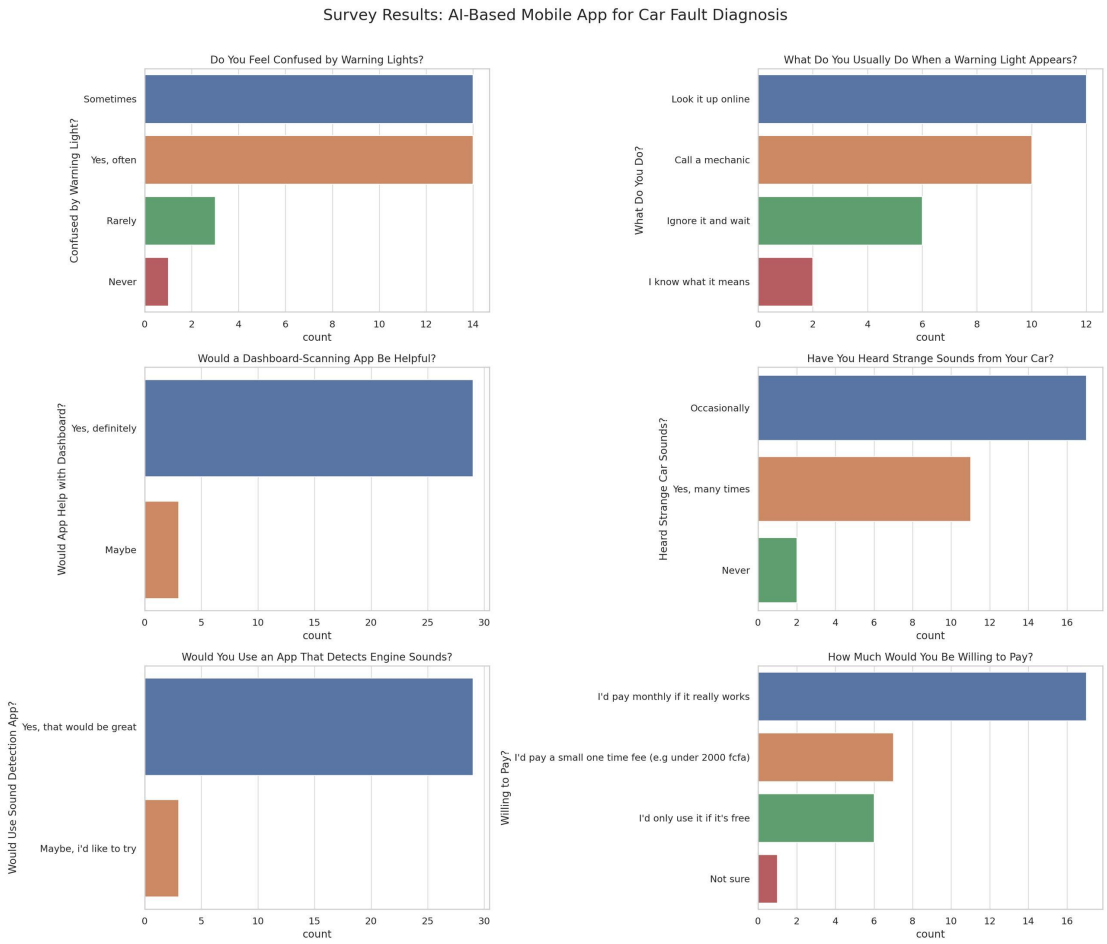


Fig 3: bar chat of all survey responses

2. INTERVIEWS

We went to garage at **JOVI'S GARAGE Mile 18** and we had the opportunities to ask a few questions and seven of them also answered the survey questions with the following responses:

1. Do you ever feel confused when a warning light appears on your car's dashboard?
   - Yes, often
   - Sometimes
   - Rarely
   - Never

Responses: 4 never, 1 rarely, 2 sometimes

2. What do you usually do when a dashboard warning light shows up?
   - Look it up online
   - Call a mechanic
   - Ignore it and wait
   - I know what it means

Responses: 5 I know what it means, 2 ignore it and wait

3. Would you find it helpful an app could scan your dashboard using your phone's camera and tell you what the warning means

- Yes, definitely
- Maybe
- Not really

Responses: 2 Yes, definitely, 5 Maybe, 1 Not really

4. Have you ever heard strange sounds from your car (e.g knocking, squealing, hissing)

- Yes, many times
- Occasionally
- Never

Responses: 1 Yes, many times, 3 occasionally, 3 never

5. If an app could listen to engine sounds and tell you what might be wrong, would you use it?

- Yes, that would be great
- Maybe, i'd like to try
- No, I wouldn't trust it

Responses: 4 No, I wouldn't trust it, 2 Maybe, i'd like to try, 1 Yes, that would be great

6. Which of these features would you like in a car diagnostic app? (you can pick more than one)

- Scan dashboard lights using my phone's camera
- Detect engine problems by listening to sounds
- Get simple explanations for car issues
- Watch short videos on how to fix basic problems
- Know how urgent a problem is
- Get a list and contacts of nearby mechanics
- Use the app without needing internet
- Other

Responses:
5 Use the app without needing internet
1 Get a list and contacts of nearby mechanics
7 Know how urgent a problem is
2 Detect engine problems by listening to sounds
2 Scan dashboard lights using my phone's camera

7. What would make you trust this kind of app more? (optional)

Responses:
Some asked for it to be approved by highly experienced mechanics

8. How much would you be willing to pay
for an app that helps you diagnose car
issues like this?

- I'd only use it if it's free
- I'd pay a small one time fee (e.g under 2000 fcfa)
- I'd pay monthly if it really works
- Not sure

- Responses: 4 I'd only use it if it's free, 2 I'd pay monthly if it really works, 1 Not sure

9. Any other ideas or suggestions for the app
No responses

3. MARKET RESEARCH

We made some research online and we found some common car faults in Cameroon which will go a long way for the designing of our application. Some of these common car faults in Cameroon include

1. Suspension System Damage
- Causes: Rough, unpaved roads and potholes.
- Signs: Noises when going over bumps, uneven tire wear, poor handling.

2. Engine Overheating
- Causes: Low coolant levels, radiator issues, poor maintenance.
- Signs: High-temperature gauge, steam from engine, loss of power.

3. Brake Problems
- Causes: Worn-out brake pads, fluid leaks, low-quality replacements.
- Signs: Squealing noise, reduced stopping power, soft brake pedal.

4. Battery Failure
- Causes: Old batteries, extreme weather, poor alternator function.
- Signs: Slow start, dim lights, complete electrical failure.

5. Clutch Wear (Manual Cars)
- Causes: Heavy traffic, frequent gear changes, poor driving habits.

- Signs: Slipping clutch, difficulty changing gears, burning smell.

6. Faulty Fuel System
- Causes: Contaminated or low-quality fuel, dirty fuel filters.
- Signs: Engine misfires, hard starts, poor acceleration.

7. Transmission Issues
- Causes: Lack of servicing, low transmission fluid, worn components.
- Signs: Gear slipping, delayed shifts, fluid leaks.

8. Exhaust System Failures
- Causes: Age, rust, or bad fuel.
- Signs: Loud engine noise, decreased fuel efficiency, foul smell.

9. Tyre Problems
- Causes: Poor road conditions, underinflation, worn-out tires.
- Signs: Frequent punctures, vibrations, uneven wear

10. Electrical Problems
- Causes: Faulty wiring, poor battery health, humidity.
- Signs: Non-functional lights, failing power windows or locks.

4. STAKEHOLDER ANALYSIS

Stakeholders are individuals or groups who are affected by the system or have a role in its development and use.

STAKEHOLDER	ROLE	INTERESTS	INFLUENCE	CONCERNS
Driver	End-user	Easy way to report faults, updates on repairs	Medium	UX/UI of the app
Mechanics	Technicians	Access to fault details, status tracking	high	Missing or inaccurate fault information
System admin	Maintain system	Manages user roles, ensures uptime	high	Security and technical issues
Developer	Builder of the app	Clear, actionable requirement	medium	That the system meets the needs of the users

RESULTS

Based on the survey responses, we identified a set of core requirements that form the foundation for the proposed AI-based mobile application for car fault diagnosis. These requirements, directly derived from user feedback, are summarized as follows:

Functional Requirements

- Dashboard Light Recognition

The application should enable users to scan car dashboard warning lights using their phone's camera and receive clear interpretations of the alerts.

- Engine Sound Analysis

Users indicated high interest in an app that listens to engine sounds (e.g., knocking or hissing) and provides a corresponding diagnosis based on the detected sound patterns.

- Repair Guidance and Maintenance Reminders

The app should not only identify issues but also offer practical repair suggestions and timely maintenance reminders, thereby enhancing its practical value.

- Integrated Multi-Feature Dashboard

The survey suggests that a unified interface—consolidating diagnostic features, repair suggestions, and maintenance alerts—would be most beneficial.

- Optional Mechanic Locator

While not a primary feature, some respondents recommended the integration of a tool to locate nearby mechanics, potentially increasing user trust and app utility.

Non-Functional Requirements

- Accuracy and Reliability

High diagnostic accuracy is crucial to meet user expectations and build trust. The system must minimize false positives in both visual and audio analyses.

- Security and Privacy

Respondents emphasized the importance of data security. The app must protect personal data and any recordings or scans in compliance with relevant privacy standards.

- User-Friendly Interface

An intuitive and clear user interface is necessary to accommodate users with varying levels of technical expertise, ensuring ease of navigation and understanding.

- Performance and Cross-Platform Support

The application should operate efficiently across both Android and iOS devices, delivering quick responses (within seconds) during scanning and analysis, with robust offline functionality where possible.

This synthesis of user needs lays the groundwork for further system design and development. For a detailed breakdown of these requirements, please refer to **Appendix B.**

Tools and technologies

From the questions provided we came up with some tools and technologies. Some of the best tools and technologies for the mobile app include:

1. Mobile App Development
Framework: Flutter
Why: Single codebase for both Android and iOS, fast UI rendering, excellent performance.
Language: Dart
Alternative: React Native

2. AI/ML Model Deployment (Image & Audio Recognition)
- ✓ **Library:** TensorFlow Lite
- ✓ **Why**: Lightweight, runs ML models efficiently on mobile (ideal for dashboard light recognition and sound diagnosis).
- ✓ **Alternative**: Core ML (for iOS only) or PyTorch Mobile (if your models are trained in PyTorch)
- ✓ **Model Optimization**: Use TensorFlow Model Optimization Toolkit for quantization and pruning to improve speed and reduce size.

3. Image & Sound Processing
- ✓ **Image Processing**: OpenCV (integrates well with Flutter via native plugins)
- ✓ **Use**: For pre-processing dashboard warning light images
- ✓ **Audio Analysis (Training Phase):** Librosa (Python)
- ✓ **Use**: Extract sound features like MFCCs to train models for detecting engine faults

4. Backend Services & APIs
- ✓ **Framework**: FastAPI (Python)

- ✓ **Why**: Fast, modern, and perfect for serving ML models or managing user data via APIs
- ✓ **Cloud Platform**: Google Cloud Platform (GCP)
- ✓ **Why**: Offers TensorFlow support, easy model deployment, serverless functions, scalable databases
- ✓ **Alternative**s: AWS or Azure
- ✓ **Database:** Firebase Firestore or PostgreSQL (if you need more structured relational data)

5. Authentication & User Management

Tool: Firebase Authentication

Why: Easy integration with mobile apps, secure, supports multiple login methods (email, Google, Apple, etc.)

6. Performance Monitoring & Analytics

- ✓ Firebase Performance Monitoring
- ✓ Tracks app speed, crash rates, and network latency
- ✓ Firebase Crashlytics
- ✓ Real-time crash reporting with user context
- ✓ Firebase Analytics
- ✓ Tracks user behavior and app usage metrics

7. Testing and CI/CD

Testing Tools:

- ✓ Flutter Test (unit and widget testing)
- ✓ Appium (cross-platform UI testing)

CI/CD Tools:

- ✓ GitHub Actions or Codemagic (great Flutter integration)
- ✓ Automate build, test, and deployment pipelines

8. Security

- ✓ **Data Encryption**: AES for sensitive data (can be handled through plugins or native code)
- ✓ HTTPS for all API communications
- ✓ Authentication with Firebase + role-based access control on the backend

Bonus Tools

- ✓ Postman: For API testing
- ✓ Figma: For UI/UX design prototypes
- ✓ Git: For version control

ASSUMPTIONS AND CONTRAINTS

I. Assumptions

These are conditions assumed to be true during the requirements gathering and development process:

1. Users have basic digital literacy : Drivers and mechanics can use mobile or web applications.
2. All users have access to smartphones or computers with internet connectivity.
3. Vehicles are already equipped with basic sensors or GPS .
4. Users will report faults honestly and in a timely manner.
5. Mechanics will be available to respond to fault notifications within a reasonable time.
6. There is a centralized database for storing all fault-related information.
7. All users (drivers, mechanics, etc.) are registered and authenticated in the system.
8. The organization has existing infrastructure to support application hosting (e.g., servers or cloud services).
9. System will not support predictive fault diagnosis in the initial phase (manual entry only).

II. Constraints

These are limitations that could affect system design, development, or performance:

1. Budget Constraint : Development must stay within a fixed budget.
2. Time Constraint : The system has to be delivered within a set timeline.
3. Platform Constraint :System must work on moblie
4. Regulatory Compliance :Must have with data protection/privacy laws
5. Security Constraint : Only authenticated users can report, view, or modify fault reports.
6. Network Dependency – Real-time features (like notifications or status updates) depend on active internet connectivity.
7. Language Constraint :System will initially support only one language which is english
8. Data Storage : Storage limits for multimedia fault reports (e.g., photo uploads capped at 5MB).
9. User Load – System must support up to 500 concurrent users in its first phase.

CHALLENGES

We faced a couple of challenges gathering these requirements;

- Getting answer from car mechanics was a little tough as they felt like the app will reduce their customer-base hence they were not really open with their responses.
- Some car mechanics who were willing to answer our questionnaires in the google form didn't have smart phones.
- Most people around us have little or no idea about cars and its common faults

CONCLUSION

The requirements gathering phase provided valuable insights into the expectations of target users and the functional demands of the mobile diagnostic application. Through interviews, surveys, and comparative analysis of existing solutions, we identified core needs such as the ability to recognize dashboard icons, detect engine anomalies, and provide user-friendly guidance. This phase also highlighted technical constraints and shaped the initial design strategy, setting a clear foundation for system modeling, data acquisition, and implementation in subsequent phases. Successful execution of these requirements will ensure the application meets its goal of making car diagnostics more accessible, especially in regions like Cameroon where professional diagnostic tools may be scarce or costly.

APPENDIX

Appendix A: Survey Data Summary

Title of Survey: Survey on an AI-Based Mobile Application for Car Fault Diagnosis
Number of Respondents: 33
Date Conducted: April 2025
Objective: To assess user interest, needs, and expectations for a mobile application capable of diagnosing car faults using dashboard light scanning and engine sound analysis.

A1. Survey Questions and Response Summaries

1. Do you ever feel confused when a warning light appears on your car's dashboard?
- Yes, sometimes – 17 respondents
- Rarely – 7 respondents
- Never – 4 respondents
- Often – 4 respondents

2. What do you usually do when a dashboard warning light shows up?
- Look it up online – 12 respondents
- Call a mechanic – 6 respondents
- Ignore it and wait – 5 respondents
- I know what it means – 5 respondents
- Ask a friend – 2 respondents

3. Would you find it helpful if an app could scan your dashboard using your phone's camera and tell you what the warning means?
- Yes, definitely – 26 respondents
- Maybe – 6 respondents

4. Have you ever heard strange sounds from your car (e.g., knocking, squealing, hissing)?
- Occasionally – 22 respondents
- Never – 5 respondents

- Frequently – 3 respondents

5. If an app could listen to engine sounds and tell you what might be wrong, would you use it?
- Yes, that would be great – 27 respondents
- Maybe – 4 respondents
- No – 1 respondent

6. Which of these features would you like in a car diagnostic app? (Multiple selections allowed)
- Scan dashboard lights using phone camera
- Analyze engine sounds for issues
- Provide repair advice
- Remind for routine maintenance
- Link to nearby mechanics

7. What would make you trust this kind of app more? (Optional)
Common themes:
- Accuracy and efficiency
- Secure and private usage
- Professional/official endorsement
- Clear user interface

8. How much would you be willing to pay for an app that helps you diagnose car issues like this?
- I'd only use it if it's free – 10 respondents
- I'd pay a small one-time fee (e.g., under 2000 FCFA) – 7 respondents
- I'd pay monthly if it really works – 6 respondents
- Not sure – 6 respondents

9. Any other ideas or suggestions for this app? (Optional)
Examples:
- Add weather and traffic info
- Include voice feedback for ease of use
- Real-time chat with a mechanic
- Offline mode for remote areas

A2. Visual Representations of Data

✓ Graphs in *fig 3* include bar charts on user confusion, reaction to warning lights, interest in app features, and willingness to pay.

Appendix B: Functional and Non-Functional Requirements

B1. Functional Requirements

These are the core features the application should provide based on user feedback:

1. Dashboard Light Recognition
- The app shall use the phone camera to scan and identify car dashboard warning lights.
- The app shall provide a clear explanation of what each warning light means.

2. Engine Sound Analysis
- The app shall use the phone microphone to listen to engine sounds (e.g., knocking, squealing).
- The app shall analyze and diagnose possible issues based on sound patterns.

3. Repair Guidance
- The app shall provide recommended solutions or steps to take after identifying a problem.
- The app shall suggest when it's necessary to visit a mechanic.

4. Maintenance Reminders
- The app shall remind users of scheduled maintenance tasks (e.g., oil change, tire rotation).

5. Multi-feature Dashboard
- The app shall allow users to access all features (scanning, sound analysis, reminders) in one central dashboard.

6. Mechanic Locator (Optional)
- The app may offer a feature to locate nearby trusted mechanics or garages.

7. Multilingual and Audio Support (Optional)
- The app may provide audio feedback and language options for accessibility.

B2. Non-Functional Requirements

These describe how the system should behave and meet user expectations:
1. Accuracy and Reliability

- The app must provide highly accurate diagnoses based on image and sound recognition.
- The system should have a low false-positive rate to gain user trust.

2. Security and Privacy
- User data, including recordings and scans, must be securely stored and processed.
- The app must comply with relevant data protection regulations.

3. User Interface (UI) and Usability
- The interface must be intuitive, simple, and user-friendly for both tech-savvy and non-technical users.
- The app should support clear navigation with minimal learning curve.

4. Performance
- The app should provide quick responses (within seconds) after scanning or analyzing.
- It should function smoothly on most mid-range Android and iOS smartphones.

5. Offline Capability
- The app should retain basic functionality (e.g., accessing stored warnings or sound examples) without internet access.

6. Cross-Platform Compatibility
- The app must be compatible with both Android and iOS operating systems.

7. Scalability
- The system should be built to handle future feature additions such as live chat with mechanics or integration with car systems.

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