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REPUBLIC OF CAMEROON

PEACE-WORK-FATHERLAND

FACULTY OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF COMPUTER ENGINEERING

COURSE CODE: CEF440

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GROUP 11

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Requirements Gathering for the Design and Implementation of a Mobile App for Collection of Users' Experience Data from Mobile Network Subscribers.

1. **Background and Context** :

The rapid expansion of mobile networks in developing countries, such as Cameroon, has brought opportunities and challenges. While mobile connectivity has improved access to communication and digital services, subscribers tend to suffer from unreliable network performance, including:
- **Inconsistent signal strength** (e.g., sudden 4G coverage drops).
- **Service delays** (e.g., high latency during peak hours).
- **Unexpected outages** (e.g., voice call failures in rural areas).

Traditionally, Mobile Network Operators have measured service quality using network-centric Key Performance Indicators (KPIs)—bandwidth, jitter, and packet loss. These metrics do not accurately represent the user's true experience, and therefore there is a disconnect between technical performance and subscriber satisfaction.

- **The Requirement for Quality of Experience (QoE) Measurement**

Quality of Experience (QoE) builds upon traditional Quality of Service (QoS) with the addition of
- **Subjective feedback** (such as user ratings of call quality or app responsiveness).
- **Contextual factors** (such as location, time of day, and device type).
- **Behavioral insights** (such as app abandonment due to slow loading).

Without direct user input, MNOs cannot:
✓ Properly prioritize network upgrades.
✓ Reduce customer churn due to unsolved frustrations.
✓ Comply with regulatory standards for service reliability.

- **Current Limitations in Network Monitoring**

Existing measurements of mobile network performance have three critical shortcomings:

i. **Not Enough Real-Time User Feedback**

- The majority of MNOs depend on infrequent surveys or complaint histories, which are incomplete and delayed.
- Example: A frequent caller with daily call drops may never report them formally.

ii. **Too Much Emphasis on Infrastructure Measures**

- Network logs (e.g., cell tower signal levels) fail to capture usability.
- Example: A tower reports "excellent" signal quality, but customers inside experience weakened voice quality due to building material.

iii. **No Common Platform for Subjective + Objective Data**

- Subjective views (e.g., ratings) and objective data (e.g., latency) are separated so that cross-analysis is difficult.

- **Implications of These Loopholes**

- **For Users**: Tolerating poor service with no useful means to complain.
- **For MNOs**: Inefficient capital spending (e.g., upgrading the wrong towers).
- **For Regulators:** Lack of data to implement fair service standards.

- **Project Aim and Objectives**

The aim of this project is to design and implement a mobile application that enables real-time collection of users' experience data from mobile network subscribers. The app will combine active user feedback with passive network and device performance monitoring to support QoE analytics and network performance evaluation.

- **Scope of This Report**

This document will:

1. Stakeholder Identification(Users, MNOs, Developers, Regulators).
2. Requirement gathering techniques (surveys, interviews, brainstorming, reverse engineering, etc)
3. Data gathering
4. Data cleaning
5. User reluctance assessment

Part 1 : Stakeholder Identification

Stakeholder identification is crucial in ensuring that the project meets the needs of all relevant parties, including end-users, mobile network operators (MNOs), regulators, and developers. This report defines key terms, identifies stakeholders, and analyzes their interests and influence.

❖ Definition of Key Terms

- **Stakeholders** : Individuals or groups affected by or influencing the project. They include direct beneficiaries (users, MNOs) and indirect parties (regulators, app developers).
- **Mobile Network Subscribers (End-Users)**
  - Role: Provide feedback and use the app.
  - Interest: Better network performance and user experience.
  - Influence: High (adoption determines success).
  - Expectations:
  - Easy-to-use app with minimal disruption.
  - Improved network services based on their feedback.

- **Mobile Network Operators (MNOs)**
  - Role: Utilize collected data for network optimization.
  - Interest: Enhancing service quality and reducing churn.
  - Influence: High (funding, implementation support).
  - Expectations:
    - Accurate, real-time QoE data.
    - Insights for targeted infrastructure upgrades.

- **App Development Team**
  - Role: Design, develop, and maintain the app.
  - Interest: Successful deployment and functionality.
  - Influence: Medium (technical constraints affect outcomes).

- Expectations:
 - Clear requirements from MNOs and users.
- Scalable and secure data collection mechanisms.

Part 2 : Requirements Engineering

3. **Requirements Elicitation Methods**

We employed three complementary methods to elicit both user perception and technical network performance:

1. Surveys

Purpose: To gather generic, quantitative opinions of user satisfaction.
Execution:
- Conducted among mobile subscribers (age, operator, and urban/rural stratified).
- Open-ended questions.
Role in Requirements:
- Defined high-priority pain areas.
- Revealed demographic imbalances.

2. Interviews

Purpose: To find out why things fail and to explore unmet needs.
- Spoke to different users (e.g., home workers, students).
- Triggered scenario-based questions (e.g., "Describe your most recent call failure").
Role in Requirements:
- Uncovered context-dependent issues (e.g., "School campuses have dead zones").

3. QoS Measurement with Speedtest Master and Meteor 4G/5G/WiFi Tester

Goal: Independently validate network performance based on field measurements and test network coverage quality.

To acquire objective network performance data, we employed two mutually complementing tools:

-Speed Test Master measured:
- Download/Upload Speed (Mbps)
  - Latency (Ping in ms)
  - Jitter (ms)
  - Packet Loss (%)
  - Bandwidth Stability
  - IP Addresses (External + Internal for route tracing)
  - Transfer Time

- **Meteor 4G/5G/WiFi Tester** assessed network coverage quality, recording information on:
  - Signal strength
- Network type (4G/5G/WiFi)
- Primary connection quality metrics

Deployment Modes:
1. User-Installed App: Speed Test Master was installed by the users to capture measurements under everyday usage.
2. Researcher Hotspot Testing: Utilized specialized phones at main locations (e.g., city, suburb, countryside) to compare ISP performance.
Data Collection Method:

- Both tools ran independently with their own measurement procedure.
- Data was captured raw without meaning at this stage

Role in Requirements
- Linked subjective complaints with technical errors.
- Added baseline values for technical specifications.
- Assured survey/interview findings (e.g., bad signal = call drop).

Why This Matters
- For MNOs: Proof that "slow speeds" = 1.2 Mbps vs. promotional 4G (20 Mbps).
- For Users: Obvious proof for complaints

Key Benefits of This Method

- Triangulation: Combined what (surveys), why (interviews), and how bad (QoS data).
- Actionable Insights: Clearly relates complaints to measurable network problems.

The aggregate statistics from these solutions will be examined to:
- Establish baseline network performance profiles

- Identify potential correlation points for technical metrics against user complaints
- Guide technical specifications for network improvements

Part 3 : Data gathering

i. Data collected from google survey

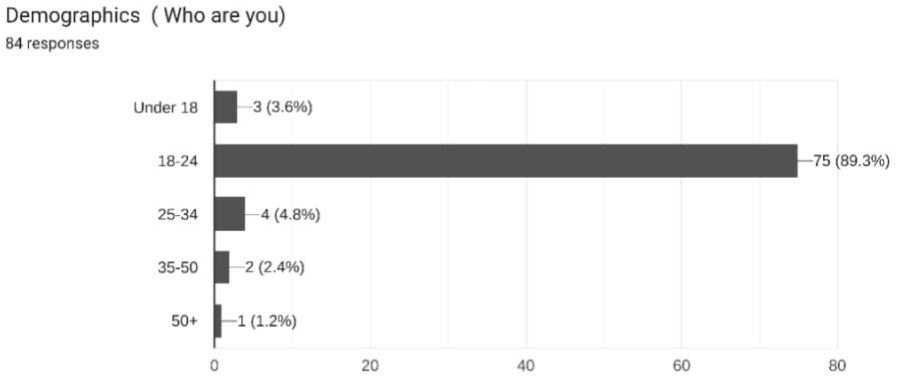


Fig 1 demographics response

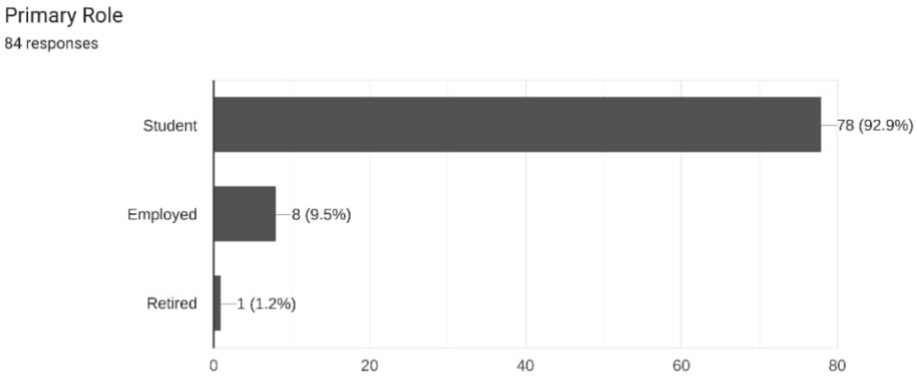


Fig 2 primary role response

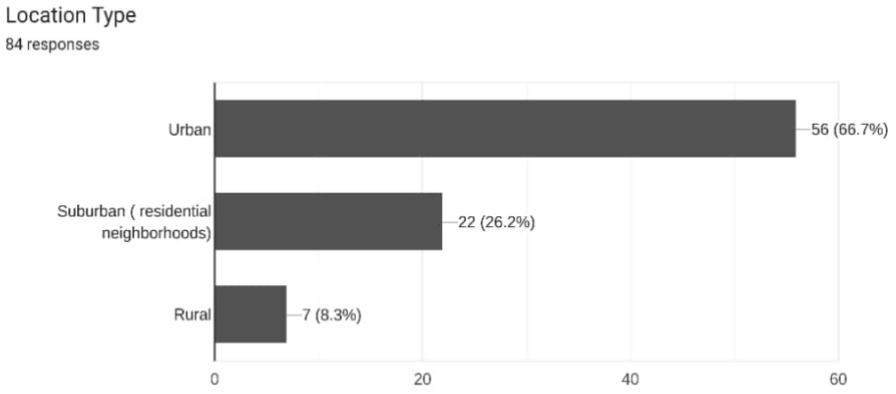


Fig 3 location response

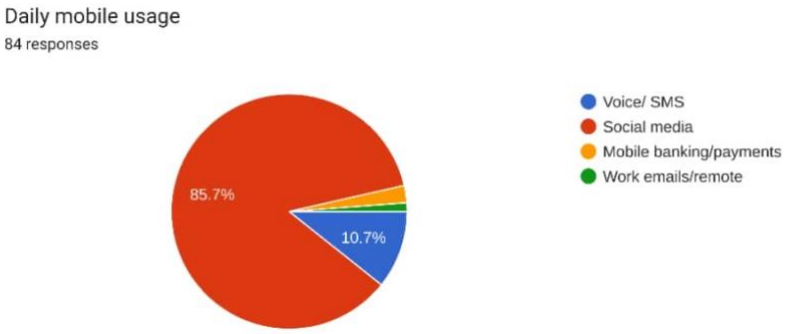


Fig 4 response on daily mobile usage

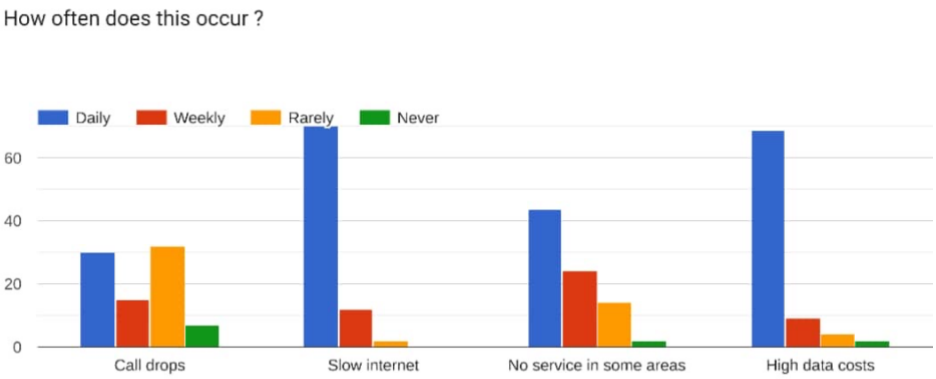


Fig 5 graphs showing how often users experience mobile network problems

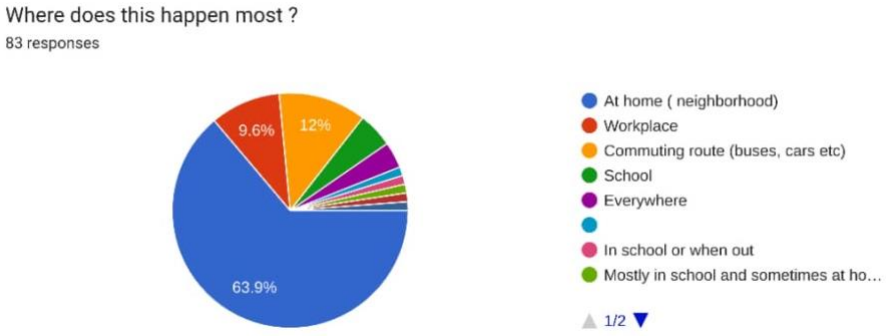


Fig 6 pie chart showing responses on where users face network problems

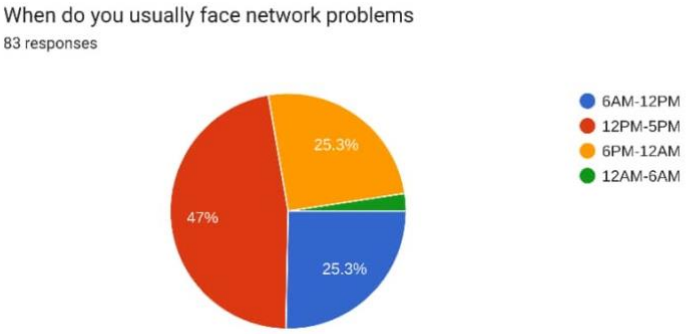


Fig 7 pie chart showing time frame when users usually face network problems

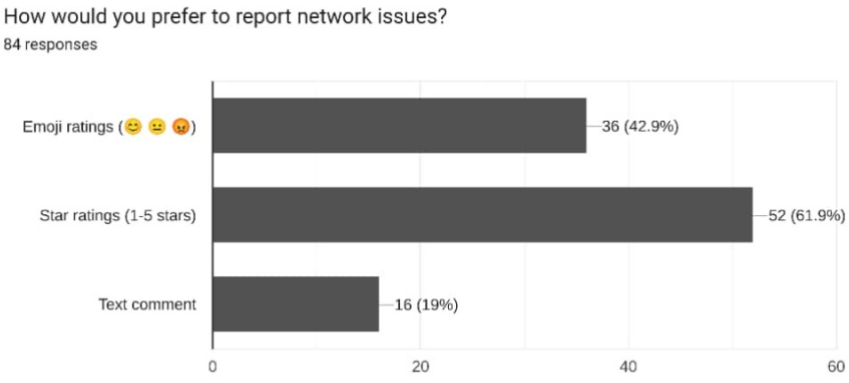


Fig 8 shows what method users would like to report network issues

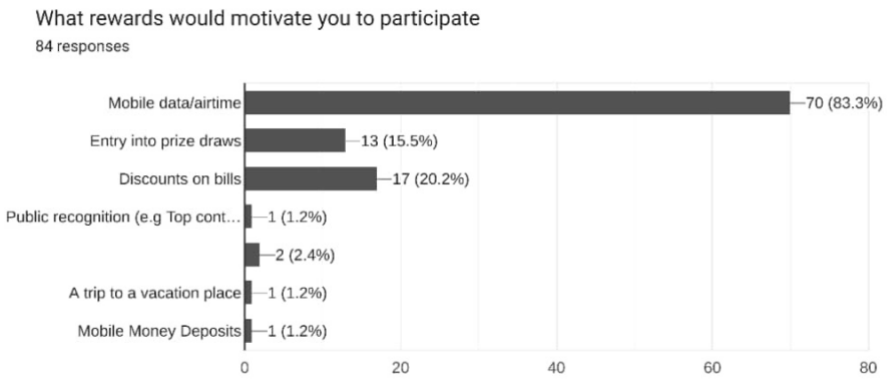


Fig 9 shows incentives which will push participants to participate

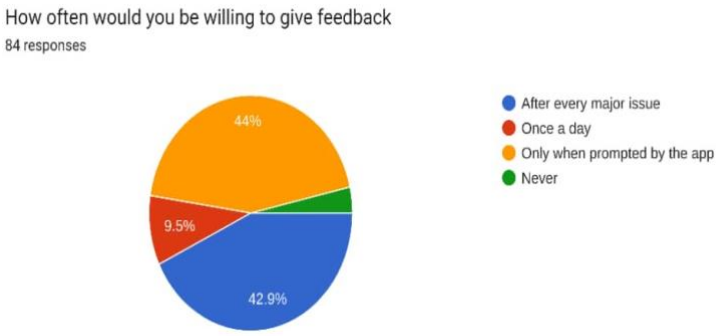


Fig 10 shows how willing users are to give feedback

Fig 11 shows what percentage of users are willing to share their location

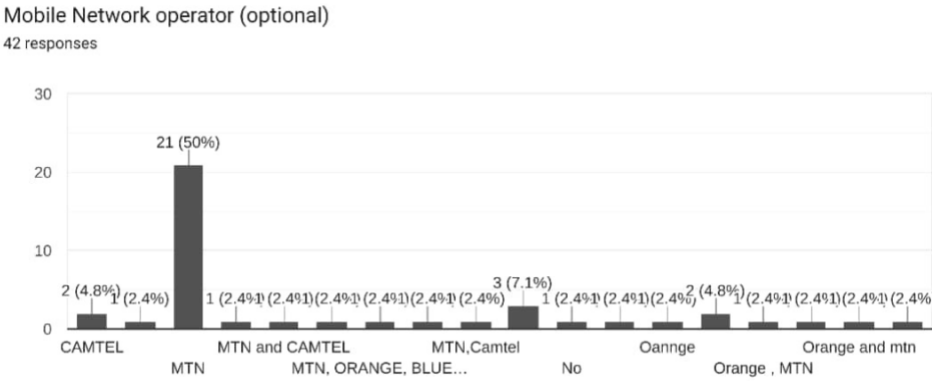


Fig 12 shows what percentage of users are subscribed to a particular network operator

Fig 13.1 shows several responses from users to an open ended question

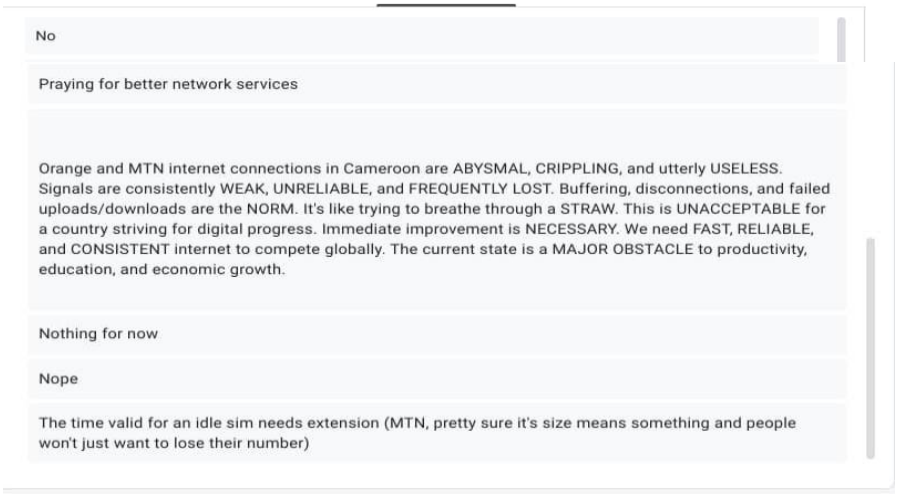


Fig 13.2 a continuation of responses

II. Data collected from interviews

#	Location	MNO(s)	Worst Problem (Direct Quote)	Impact	Will Use App	Dealbreaker	App Feature Suggestion
1	Urban (Molyko)	MTN	Slow video download and upload	Missed group interactions	Yes	If it doesn't drain battery.	Peak-hour alerts with speed logs

#	Location	MNO(s)	Worst Problem (Direct Quote)	Impact	Will Use App	Dealbreaker	App Feature Suggestion
			speeds, I can't even enjoy social media to my satisfaction				
2	Rural (Muea)	Orange	No signal in my living room	Can't call my loved ones without the network breaking frequently	No	Orange won't fix this anyway.	Offline mode to log dead zones
3	Suburban (G. Soppo)	MTN+CAMTEL	MTN voice calls echo.	Embarrassed during international client calls	Maybe	Must work for both SIMs.	Dual-SIM diagnostics
4	Urban (Bonduma)	Orange	4G icon lies – can't upload CVs, can't even download materials for school that keeps me unmotivated and behind…	Frequent late submissions and piled-up schoolwork	Yes	Show proof to demand refunds.	Real-time speed vs. promised graph
5	Rural (Bokwaongo)	CAMTEL	Camtel internet is too slow.	Offline most of the day unless hotspot is available	No	CAMTEL doesn't care.	Indicate to users which areas are suitable for their network
6	Urban (Long Street)	MTN	Data finishes suddenly – suspect theft.	Wasted 10K on extra bundles	Yes	Must track data balance secretly.	Background data monitor
7	Suburban (Sandpit)	Orange	WhatsApp calls take too long to connect and	Broken communication	Yes	Pinpoint exact drop locations.	Increase signal strength

#	Location	MNO(s)	Worst Problem (Direct Quote)	Impact	Will Use App	Dealbreaker	App Feature Suggestion
			they are usually not smooth always breaking.				
8	Rural (Mile 16)	CAMTEL	Network goes ‘off’ every rainy season.	Can’t access the internet at all	Never	Need satellite internet instead.	Weather-impact alerts
9	Urban (Federal Quarters)	MTN	Bundle expires unused – no signal!	Wasted 15K this month, MTN boxes don’t work	Yes	Auto-refund for unused data.	Bundle usage tracker
10	Suburban (Checkpoint)	Orange	Network busy’ errors during emergencies.	Delayed response	Only if	Must alert Orange HQ immediately.	Priority emergency reporting

III. Data collected from the applications

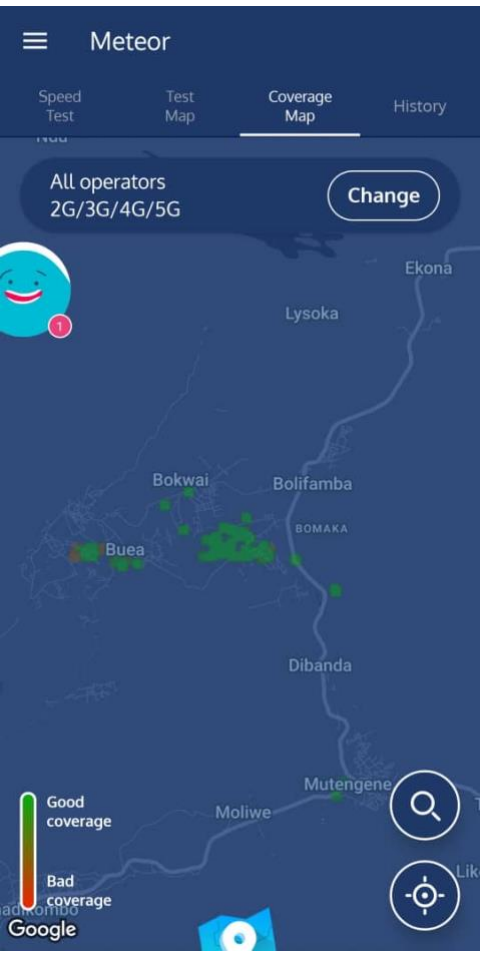
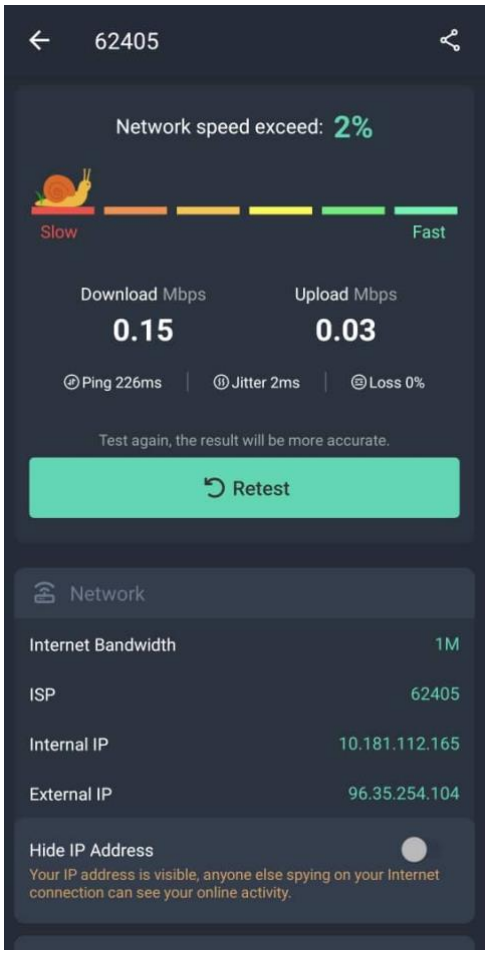


Fig 15.1 Taken with meteor master



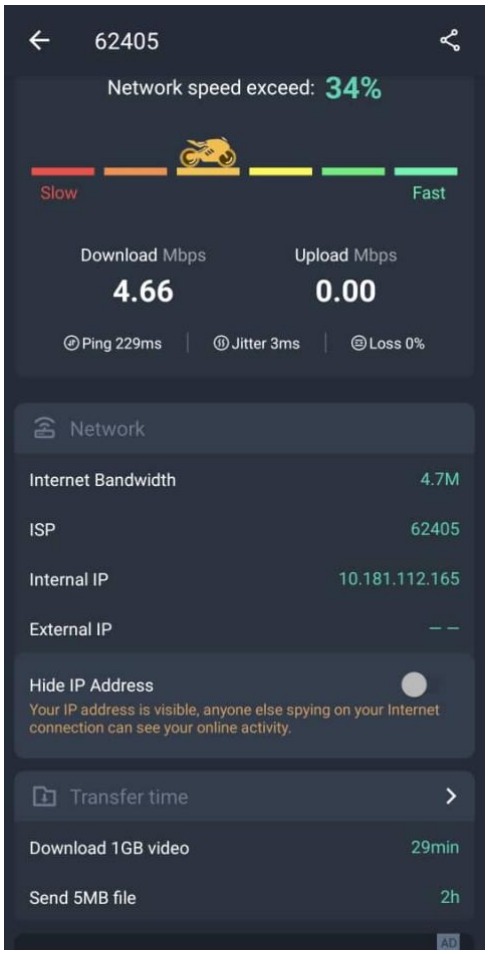


Fig15.2 a & b Speed test taking with Speed test

Above is a representation of some screenshots taken with speed Test Master and meteor speed test application.

Part 4 : Data Cleaning

A. Surveys

1. Demographics

Raw Data:
- Age Groups:
  - 89.3% between the ages of 18-34 (75 respondents)
  - 4.8% between the ages of 35-50 (4 respondents)
  - 3.6% under 18 years old (3 respondents)
  - 1.2% 50 and above (1 respondent)
- Primary Role:
  - 92.9% students (78 respondents)
  - 9.5% working (8 respondents)
  - 1.2% retired (1 respondent)

Interpretation:
The data shows that the majority (89.3%) of users are 18–34 years old, and 92.9% are students. This highlights that the app is being used by young, presumably tech-savvy people who may be more open to mobile-first and reward-based interaction. Speed, simplicity, and relevance will be essential to keeping their attention.

2. Location & Network Issues

Raw Data:
- User Location:
  - Urban: 66.7% (56 respondents)
  - Suburban: 26.2% (22 respondents)
  - Rural: 8.3% (7 respondents)
- Network Problems Reported:

  - Slow internet: 47%
  - Call drops: 25.3%
  - No service: 12%
  - High data costs: 15.7%
- When Issues Occur:
  - 47% between 12PM-5PM
  - 25.3% between 6PM-12AM

Interpretation:
They are predominantly located in urban regions (66.7%) and report half of them (47%) facing network problems during peak daytime (12PM–5PM) hours, which is probably caused by congestion. Even though rural users are fewer in number (8.3%), they have more severe issues such as "no service," implying that there are gaps in coverage. This calls for peak-hour alerts for urban users and offline reporting capabilities for rural region users.

3. **Feedback Preferences**

Raw Data:
- Feedback Frequency:
  - 44% after major issues
  - 42.9% only when prompted
  - 9.5% once daily
  - 3.6% never
- Reporting Format:
  - 61.9% prefer star ratings (1-5 stars)
  - 42.9% prefer emoji ratings
  - 19% prefer text comments

Interpretation:
Customers prefer simple, low-effort ways of giving feedback—61.9% prefer star ratings, and 42.9% prefer emoji feedback. Few want to type. Most customers (44%) prefer to give feedback only after issues that are critical or after prompting. This shows a preference for smart, event-based prompting over frequent reminders.

4. **Reward Expectations**

Raw Data:
- Top Incentives:
  - 83.3% mobile data/airtime
  - 20.2% bill discounts
  - 15.5% prize draws
  - 1.2% public recognition

Interpretation :
Airtime or mobile data is the strongest motivator, sought by 83.3% of the subscribers—hinting at quick, tangible rewards as being core to interest. While 20.2% also have interest in bill discount, these are considered secondary and not core motivators.

5. Operator Preferences

Raw Data:
- Operator Distribution:
  - MTN: 50%
  - Orange: 7.1%
  - CAMTEL: 4.8%
  - Multi-SIM (e.g., MTN + Orange): 4.8%

- Other: 33.3%

Interpretation:
MTN is the clear market leader with respondents, 50% usage, and thus must be the top priority for feature testing, optimization, and network-specific integration.

6. Recommendations

The app should prioritize:
- 1-tap feedback
- Context-aware prompting at peak hours
- Immediate reward through data
- Network-specific orientation (starting with MTN)

These recommendations are data-driven and based on the most common user habits and needs.

7. Data Limitations

This section identifies where data cleaning wasn't able to bridge all the gaps. For instance, the rural sample is extremely small (only 7 respondents), so results aren't quite as transferable. Additionally, open-ended/free-text responses require techniques like sentiment analysis to systematically capture tone and urgency. The small rural sample suggests the need for ground truthing, perhaps through field work or follow-up surveys.

B. Application Measurement

C.

	App/Tool	Time Stamp	Network Type	Download Speed (Mbps)	Upload Speed (Mbps)	Latency/Ping (ms)	Jitter (ms)	Packet Loss (%)	Geo Location	Network Quality
1	Meteor	Morning	Blue 4G	3.3	1.23	186	45	0	Mutengene	Moderate
2	Speed Test	Morning	MTN 4G	5.5	6.42	58	152	0	Yaoundé	Good
3	Speed Test	Mid-day	Orange 4G	6.92	10.81	150.73	146.35	0	Buea	Good
4	Meteor	Mid-day	Blue 4G	2.8	0.477	158	132	2	Buea	Poor
5	Meteor	Morning	Orange 4G	8.6	9.6	142.7	132	0	Buea	Good
6	Speed Test	Morning	MTN 4G	3.9	2.31	156	145	0	Mutengene	Moderate
7	Meteor	Mid-day	Blue 4G	0.15	15	50	122	0	Mutengene	Good
8	Speed Test	Morning	MTN 4G	4.62	7.43	10	140	0	Tiko	Good
9	Meteor	Mid-day	Orange 4G	5.90	0.0	34	1	0	Yaoundé	Awesome
10	Speed Test	Morning	MTN 4G	4.2	3.1	213	2	1	Mutengene	Moderate
11	Meteor	Morning	Blue 4G	0.39	0.41	261	3	2	Mutengene	Poor
12	Speed Test	Mid-day	Orange 4G	13.21	7.96	65	39.19	0	Buea	Good

Definition of key terms :

1. **Download Speed (Mbps)**

Definition: How fast data (e.g., videos, web pages) transfers from the internet to your device.

Why It Matters:

- > 10 Mbps: Smooth HD streaming.

- <5 Mbps: Buffering, slow loading.

Example: Orange's 13.21 Mbps in Buea = Fast Netflix.

2. **Upload Speed (Mbps)**

Definition: How fast data (e.g., photos, videos) transfers from your device to the internet.

Why It Matters:

- > 5 Mbps: Good for video calls/uploads.

- <1 Mbps: Delayed WhatsApp media sends.

Example: Blue 4G's 0.41 Mbps = Struggles to upload CVs.

3. **Latency/Ping (ms)**

Definition: Delay between your action (e.g., clicking a link) and the response.

Why It Matters:

- <50 ms: Ideal for gaming/voice calls.

- > 150 ms: Laggy Zoom meetings.

Example: MTN's 10 ms in Tiko = Instant webpage loads.

4. **Jitter (ms)**

Definition: Inconsistency in latency over time.

Why It Matters:

- <30 ms: Stable calls.

- > 100 ms: Choppy audio ("Hello? Can you hear me?").

Example: Orange's 146 ms jitter = Callers talk over each other.

5. **Packet Loss (%)**

Definition: Percentage of data packets lost in transit.

Why It Matters:

- 0%: Perfect.

- > 1%: Dropped calls, frozen videos.

Example: Blue 4G’s 2% loss = VoIP calls cut out.

6. **Signal Strength (dBm)**

Definition: Power level of the cellular signal.

Why It Matters:

- > -80 dBm: Strong (full bars).

- <-100 dBm: Weak (dead zones).

Example: Rural "no signal" = -110 dBm indoors.

7. **Network Type (4G/5G/WiFi)**

Definition: Technology generation of the connection.

Why It Matters:

- 5G: Faster speeds, lower latency.

- 3G: Slower, outdated.

Example: MTN 4G vs. Orange 5G = Speed gap.

- **Network Performance by Operator**

  MTN 4G:
  • Shows up 5 times in the dataset, with download speeds ranging from 3.9 to 5.5 Mbps and upload speeds ranging from 2.31 to 7.43 Mbps.
  tLatency is highly disparate (10ms to 213ms), and jitter is typically high (up to 152ms).
  tNetwork quality is regularly graded as Moderate to Good, with one single "Awesome" rating in Yaoundé (implying urban advantage).
  tInterpretation: MTN is fairly reliable but performance
  is inconsistent, particularly in semi-
  urban areas such as Mutengene. Optimizing latency and jitter leaves

room for a smoother ride.

Orange 4G:
Available in 4 entries, with download rates between 5.90 and 13.21 Mbps, the strongest all around performance .
Uploading speeds are good too(up to 10.81 Mbps).
Less jitter and latency than MTN in some areas.
Rated consistently Good or Awesome.
Interpretation: Orange's connections are faster and more consistent, particularly in Buea and Yaoundé. From a performancerecommendation standpoint, Orange is currently at the top.

Blue 4G
• Performs worst in 4 tests: download speeds of just 0.15 Mbps, upload speeds of less than 1 Mbps in some cases, and over 150ms latency.
• Priced Poor in 2 tests, Moderate or Good in others, suggesting variable quality.
• **Interpretation**: Blue is underperforming, especially in Mutengene. It will likely be less consistent in rural or lower-coverage areas and therefore a top candidate for optimization or user warning.

2. **Time of Day Performance**
• Morning tests are the most prevalent in the sample, with variable performance between networks.
• Mid-day tests have higher speeds, especially for Orange and MTN.
• Interpretation: Mid-day could suggest less congestion or better signal quality. This is in line with user-reported peak issues between 12PM–5PM, and this indicates a need for real-time reminders or auto-logging during these windows.

3. **Geo-location Trends**
• Mutengene: Most tested location, mostly with MTN and Blue.

Performance is highly variable, with results ranging from Good to Poor.
• Buea: All Orange and Blue tests. Orange is consistently strong, andBlue is weak.
• Yaoundé: MTN and Orange are Good to Awesome quality, underpinning urban network stability.
• Tiko: Single entry (MTN), but Good rating with low latency (10ms).
• Interpretation:
• Urban locations (Yaoundé, Buea) offer better, more stable experiences—especially with Orange.
• Mutengene appears to have patchy service and may be a focus for support or offline capabilities.
• Geographic variation is a sign of the need for location-aware diagnostics and diverse MP support in the app.

4. **Key Technical Insights**
• Packet Loss: Rare (1-2%) in some Blue and MTN records, which could make call or stream quality suffer.
• Latency: Orange has been persistently low (under 150ms) relative to others.
• Jitter: Extremely high on MTN and Blue in some cases, which could impact real-time services like VoIP or video call.

Interpretation:
These performance measurements confirm the importance of auto-loggedQoS metrics in the app (as previously suggested). Jitter and packet loss metrics should trigger real-time reminders or background reporting.

General Observations:
• Orange is great at performance and consistency.
• MTN is strong but volatile, especially outside major urban areas.
• Blue performs poorly, especially in Mutengene.
• Data inform introducing features such as:
• Network-driven reminders for performance.

• Self-capture of technical measures(ping, jitter, speed) to avoid user burden.

Part 5 : User Reluctance assessment

Factor	Survey Data (84 Users)	Interview Insights (10 Users)	App Feature Solution	Priority
Reward Demand	83.3% mobile data/airtime	I'd report if MTN gives 50MB proof (Urban)	Instant 30-100MB rewards per valid report	Tier 1
Reporting Effort	61.9% prefer star ratings	No time to type essays (Suburban)	One-tap 5-star rating + auto-capture QoS	Tier 1
Engagement Frequency	42.9% only when prompted	Don't spam me daily (Rural)	AI-triggered prompts (e.g., after 3 drops)	Tier 2
Operator Trust Gap	20.2% want bill discounts	MTN lies about 4G coverage (Urban)	Public proof: Your report upgraded this tower	Tier 2
Rural Pessimism	1.2% public recognition	CAMTEL won't fix dead zones (Rural)	Shame map: Bokwaongo: 0 bars (12 reports)	Tier 3

The data presented in the table offers an unambiguous measure of user resistance by highlighting a set of barriers to user participation as well as the potential for overcoming them.

Reward Demand

A high percentage of users (83.3% from the survey) expect tangible rewards—specifically mobile data or airtime—demonstrating that without an immediate and meaningful benefit, users are reluctant to report issues. This is reinforced by interview insights, such as "I'd report if MTN gives 50MB proof," which highlights the need for rewards.

Reporting Effort

61.9% of survey respondents prefer easy star ratings, and interview comments highlight the aversion to lengthy reporting ("No time to type essays"). This suggests that the perceived effort of reporting acts as a major deterrent. Effort should be made to make reporting easy through one-tap interactions and automation.

Frequency of Engagement

A fairly low proportion (42.9%) of users engage on demand, suggesting that spontaneous, frequent engagement is not the norm. Research comments like "Don't spam me daily" reflect an understanding of over-communication. A thoughtful balance in user-engagement methods is necessary, such as AI-driven prompts after specific events.

Operator Trust Gap

A lower proportion of users (20.2%) expressed that they would desire bill discounts, and qualitative responses reflect distrust of operator assertions ("MTN lies about 4G coverage"). This reflects a trust concern that will discourage users from availing the service until they notice obvious, public evidence that their complaints will lead to real changes.

Rural Pessimism

An even smaller percentage (1.2%) aspire to public recognition, and rural user interview results ("CAMTEL won't fix dead zones") indicate a deep skepticism regarding the operator's responsiveness. This suggests that incentives like a "shame map" could work, but must be well-crafted to overcome deeply ingrained pessimism in certain communities.

Conclusion

Overall, the table quantifies critical areas of user reluctance and points to accompany app feature solutions that can lessen these barriers. By measuring the system in this way, we can appreciate the intertwined drivers of user reluctance and enable interventions that target these issues, creating enhanced user satisfaction and engagement.

Appendix

Link to google forms excel sheet : https://docs.google.com/spreadsheets/d/1uF-wQ-2sD8G2E3sIO89jnBl2Y4Y_2_xS9LmpAFrUSNQ/edit?usp=sharing