AccraIQ: Municipal Transit Optimization System

Africa Deep Tech Challenge 2025 - Semi-Finals Submission

Team: AccraIQ
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Summary of Updates for Semi-Finals

Since our initial submission, we have evolved AccraIQ from a powerful analytics engine into a comprehensive, dual-purpose municipal transit platform. Key improvements include:

New Public-Facing "Route & Fare Checker": We added a major new feature for citizens. This tool allows anyone to find the shortest path between any two bus stops in the city, see the estimated fare and number of transfers, and view the route on an interactive map. This transforms AccraIQ from a purely administrative tool into a public utility that enhances transit accessibility.

Streamlined User Experience (UI/UX) for Planners: The administrative dashboard has been redesigned for clarity and ease of use. It now features two distinct tabs for "Optimization (Admin)" and the public "Route & Fare Checker." Planners can run complex scenarios using clear, descriptive presets (e.g., "⚡ Fast demo," "🏛️ Municipal default") that make the underlying parameters transparent and understandable.

Enhanced Core Algorithms & Impact Modeling: The optimization pipeline has been upgraded for higher accuracy, including an improved DTW analysis and a more stable HDBSCAN clustering method. Our MunicipalImpactCalculator now provides a detailed breakdown of financial, environmental, and operational savings, giving city planners the precise data needed for budget and policy decisions.

Updated Demonstration Video: A new 2-minute video has been created to reflect the new dual-tab UI, showcasing both the powerful admin optimization features and the new, citizen-focused route checker.

Executive Summary

AccraIQ is a sophisticated AI-powered municipal transit platform that provides tools for both city planners and the public. For administrators, it transforms Accra's inefficient 651-route network into a mathematically optimized system, achieving a **38.9% route reduction** while maintaining **92% service coverage** and delivering over **₵15.8M** in verifiable annual savings. For citizens, it offers a "Route & Fare Checker" to make the transit system more transparent and easier to navigate.

Core Innovation: We provide a holistic platform that uses a core algorithmic pipeline (DTW, HDBSCAN, Set-Cover) for massive operational efficiency gains, while also leveraging that same transit data to provide a valuable public-facing service that can improve ridership and citizen satisfaction.

Technical Achievement: Real-time optimization of a city-scale transit network (<5 seconds) and a public shortest-path finder, all delivered through a simple, intuitive web-based dashboard.

Problem Context: A Tale of Two Challenges

Accra's municipal transit system suffers from two interconnected problems: massive internal inefficiency and external opacity for riders.

For the Municipality: The Crisis in Efficiency

- **Resource Misallocation:** Multiple, overlapping routes triple the operational costs (fuel, drivers, maintenance) for redundant services
- **Municipal Budget Strain:** Over ₵15.8M is wasted annually on these overlapping operations

For the Public: The Crisis in Accessibility

- **Opaque Network:** It is difficult for non-regular riders to figure out the best way to get from point A to B
- **Unpredictable Fares:** Fares and transfer rules are often unclear, creating a barrier to entry for potential riders

Solution: A Dual-Purpose Platform

AccraIQ now addresses both challenges with a two-tab interface for its distinct user groups.

For Planners: The Three-Stage Optimization Pipeline

Our system transforms raw transit data into an optimized network through a mathematically rigorous process, accessible via simple presets.

Stage 1: Dynamic Time Warping (DTW) Route Similarity Analysis
Identifies geometrically similar routes based on a composite score of path shape, bearing patterns, and spatial properties.

Stage 2: HDBSCAN Density-Based Clustering
Groups similar routes into "route families."

Stage 3: PuLP Set Cover Optimization
Selects the minimum number of routes from each family required to maintain a target service coverage (e.g., 92% of all bus stops).

For Citizens: The Route & Fare Checker

This new public-facing tool makes the transit system easy to navigate. A user can:

1. **Select a start and end stop** from a simple dropdown list
2. **Click "Find Route"** to instantly see the shortest path on a map
3. **Get key information:** The total distance, estimated fare, and number of transfers required

This feature demystifies the transit network, encouraging wider use and improving the citizen experience.

Performance and Municipal Impact

Optimization Performance (Accra Network)

Metric	Original Network	Optimized Network	Improvement
Total Routes	651	398	38.9% reduction
Network Length	6,537 km	4,338 km	33.6% reduction
Stop Coverage	100%	92.0%	Maintained service
Processing Time	-	<5 seconds	Real-time analysis

Economic and Environmental Impact

Total Annual Savings: ₵15,786,987

- **Fuel Savings:** ₵11.2M
- **Maintenance Savings:** ₵3.9M
- **Driver Savings:** ₵0.8M

CO_2 Reduction: 2,065 tonnes per year (equivalent to removing 449 cars from the road)

Development Journey & Learning

Phase 1: Problem Discovery
Interviews with municipal planners revealed the core issue of route redundancy.

Phase 2: Algorithm Development
We iterated to our current, highly accurate three-stage optimization pipeline.

Phase 3: Platform Expansion (Post-Initial Submission)
We realized that the optimized data held immense value for the public. This insight led to the development of the "Route & Fare Checker." We learned that a truly impactful municipal tool should serve both the administration and the citizens, creating a virtuous cycle of efficient planning and increased public engagement.

Next Steps & Roadmap

Immediate (Q3 2025):
Prepare for the finalist presentation with a live demo of the new dual-purpose dashboard.

Short Term (Q4 2025):
Begin pilot programs with two other West African municipalities for the optimization tool, while launching a public beta of the Route Checker in Accra.

Medium Term (2026):
Integrate real-time bus tracking data into the public-facing map and develop a standalone mobile app for citizens.

Conclusion

AccraIQ has evolved into a holistic solution that demonstrates how deep tech can create value for both governments and their citizens. Our platform moves transit planning from intuition to evidence, providing immediate budget relief while simultaneously making the transit system more transparent, accessible, and user-friendly for the public.

Key Achievements

- **₵15.8M+ Annual Municipal Savings**
- **38.9% network efficiency gain** while maintaining 92% service coverage
- **A new, public-facing Route & Fare Checker** to improve transit accessibility
- **A production-ready, planner-friendly tool** ready for deployment

With its proven performance and dual-purpose design, AccraIQ is positioned to transform transportation efficiency and accessibility in cities across Africa.