AMARAVATHI QUANTUM VALLY HACKATHON 2025

AQVH 2025

IBM | TCS TATA CONSULTANCY SERVICES | Qiskit

VOID LOOP

HYBRID QUANTUM APPROXIMATE OPTIMIZATION FOR EFFICIENT PARCEL TRUCK ROUTING

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PREFACE

- India's logistics systems from postal services to healthcare deliveries suffer from delays, fuel wastage, and high costs.
- Parcels often arrive late, ambulances lose critical minutes in traffic, and students miss fresh meals.
- These inefficiencies not only increase operational expenses but also affect lives, trust, and sustainability.

PROBLEM STAEMENT

- India's large-scale logistics networks suffer from inefficient routing, fuel wastage, and delivery delays, affecting cost and reliability.
- Conventional algorithms fail to handle dynamic, multi-depot constraints and real-time data in complex systems like India Post.
- There is a critical need for a scalable, intelligent optimization framework that improves efficiency, speed, and sustainability across logistics operations.

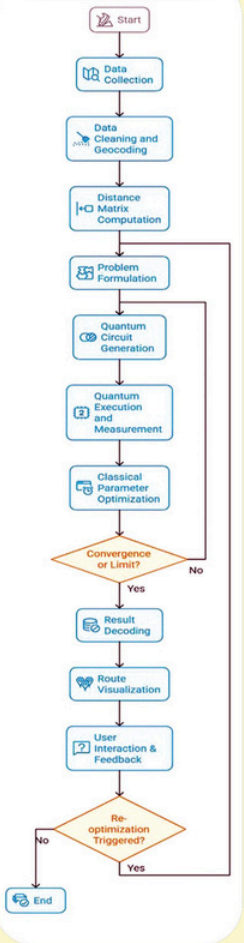
STATE OF ART

Existing routing systems rely on classical heuristics like Genetic and Ant Colony algorithms, which are efficient but limited in scalability and adaptability. Emerging quantum optimization methods such as QAOA offer improved performance but remain underutilized in real-world logistics. QFLEET uniquely integrates quantum algorithms with real parcel data and operational application.

METHODOLOGY

QFLEET converts real logistics data into QUBO models, solved using the Quantum Approximate Optimization Algorithm (QAOA) on IBM Quantum systems. Results are refined through classical optimizers for higher accuracy. The system integrates APIs for live data, performs hybrid computation, and visualizes optimized routes on the qFleet dashboard, enabling faster, data-driven delivery decisions.

DESIGN



IMPLEMENTATION

The QFLEET prototype integrates quantum computing, classical optimization, and real-world data visualization into a single operational system. It enables logistics planners to input depots, vehicles, and delivery points, then automatically generates optimized routes and analytics through a hybrid backend connected to IBM Quantum Cloud and classical solvers.

Key Implementation Steps:

- Developed QUBO generation and QAOA pipelines using Qiskit.
- Integrated Google Maps and OSRM APIs for live distance and time
- Built Streamlit and React dashboards for real-time visualization and route analytics.
- Deployed hybrid execution with quantum-classical loops for enhanced performance.

OUTCOMES

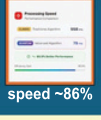
Performance Comparison


Distance ~21%


Delivery time ~26%


Fuel ~21%


cost ~23%


speed ~86%

NOVELTY

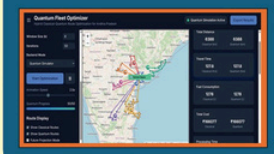
- First quantum–classical routing system for real India Post data.
- Uses QAOA with live geospatial and traffic inputs.
- Features an interactive dashboard for route optimization.
- Handles multi-depot and capacity constraints effectively.
- Shows measurable gains in speed, cost, and fuel efficiency.

IMPACT

- India Post: Optimizes nation-wide parcels routing, cutting costs and delivery times.
- Hospitals: Enables rapid organ and emergency transport through real-time route optimization.
- ANL Logistics: Improves truck scheduling, reducing idle time and trip overlap.
- School Lunch Delivery: Ensures timely meal transport using dynamic routing.

FUTURISTIC

- Multi-Vehicle Mode
- Admin Dashboard with Live Tracking
- Parcel Priority Routing
- Scalable Route Handling
- Smart Automation & AI Integration



REFERENCES

- IBM Quantum Documentation – QAOA and Qiskit SDK
- Google Maps & OSRM API Documentation
- Research papers on Hybrid Quantum-Classical Optimization for VRP
- India Post Annual Reports and Logistics Data

VOTE OF THANKS

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https://voidloop.onrender.com/