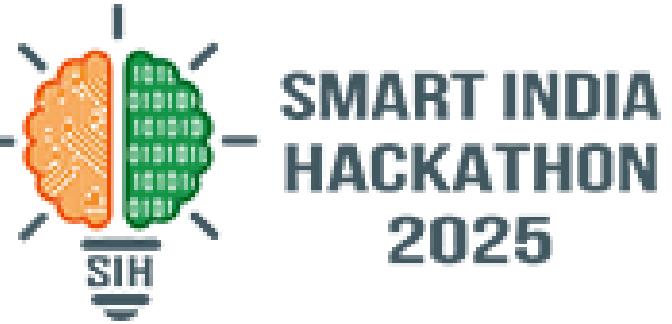
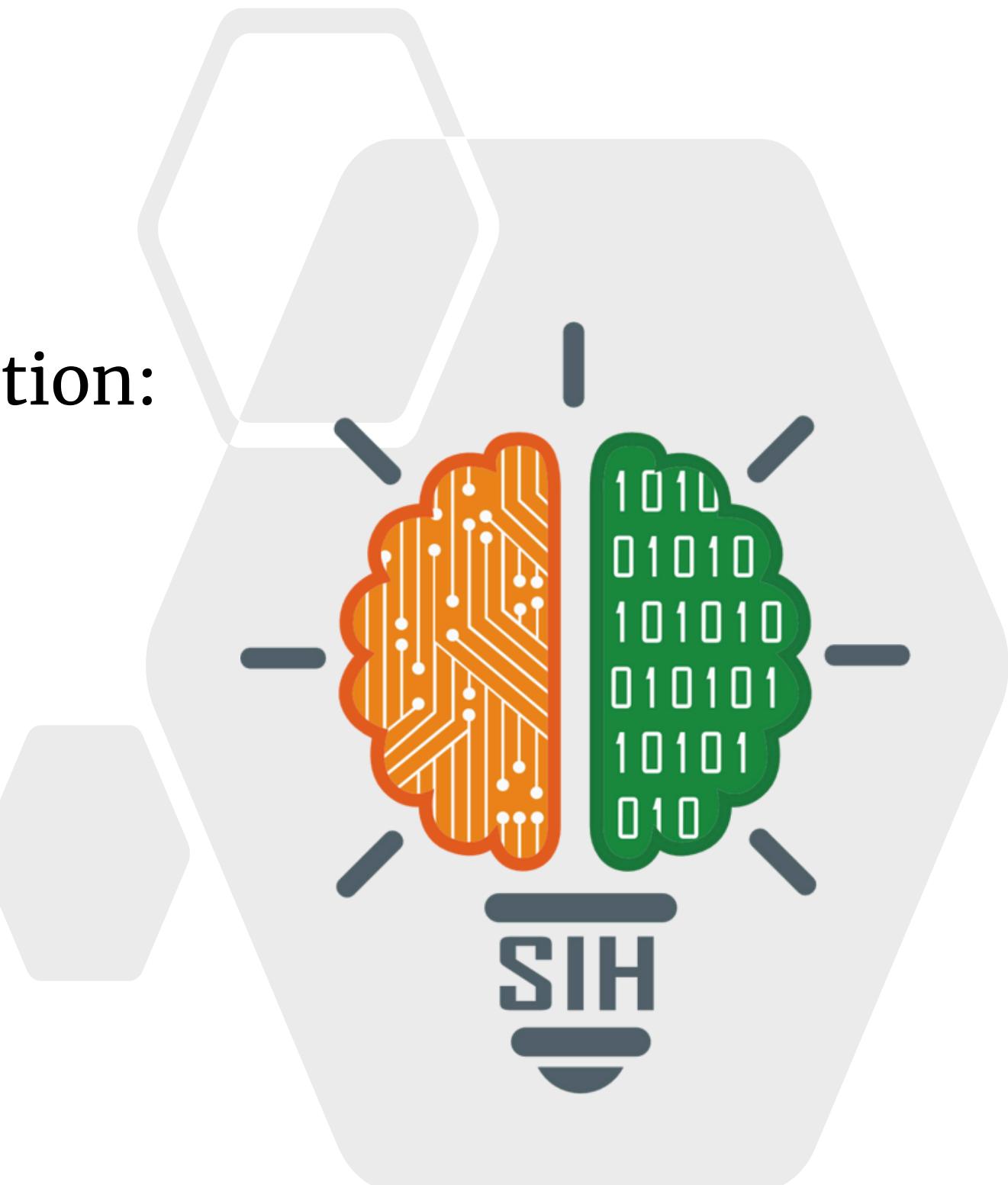


SMART INDIA HACKATHON 2025



TITLE PAGE

- **Problem Statement ID – 25138**
- **Problem Statement Title – Student Innovation: Swadeshi for Atmanirbhar Bharat**
- **Theme – Transportation & Logistics**
- **PS Category – Software**
- **Team ID – 102098**
- **Team Name (Registered on portal) – RailOptimus**



IDEA TITLE

Idea/Solution

- An **AI-powered decision**- assists section controllers in **real-time train scheduling** and **precedence decisions**.
- Uses **operations research algorithms** to generate conflict-free, optimized schedules under **multiple constraints** (track availability, train priorities, platform capacities, and safety rules.)
- Integrates a **predictive AI engine** (reinforcement learning) to forecast train delays, ETAs, and dynamic speed guidance.
- Provides **interactive scenario simulations**, allowing controllers to test “**what-if**” situations.
- **Dashboard-centric approach:** Visualizes live train states, performance KPIs, and route analytics through interactive maps, charts, and a user-friendly interface.
- **Rapid re-optimization engine** adapts instantly to real-time disruptions (breakdowns, delays, weather).
- **Modular architecture** allows seamless integration with existing railway control systems, making the solution production-ready while retaining flexibility for future scaling and additional ML-driven features.



Problem Resolution



- Replaces manual, intuition-based decisions with **precise, data-driven recommendations**.



- **Resolves conflicts** across multiple trains, priorities, and infrastructure constraints.



- Resolves conflicts at **complex junctions & platforms** to prevent cascading delays.



Unique Value Proposition

- **AI Predictor Card**



Delay/ETA insights directly on dashboard.

- **Interactive Map & Simulation**



Visual exploration + rapid scenario testing.

- **Disruption-Ready**



Re-optimizes schedules under emergencies

- **Polished UX**

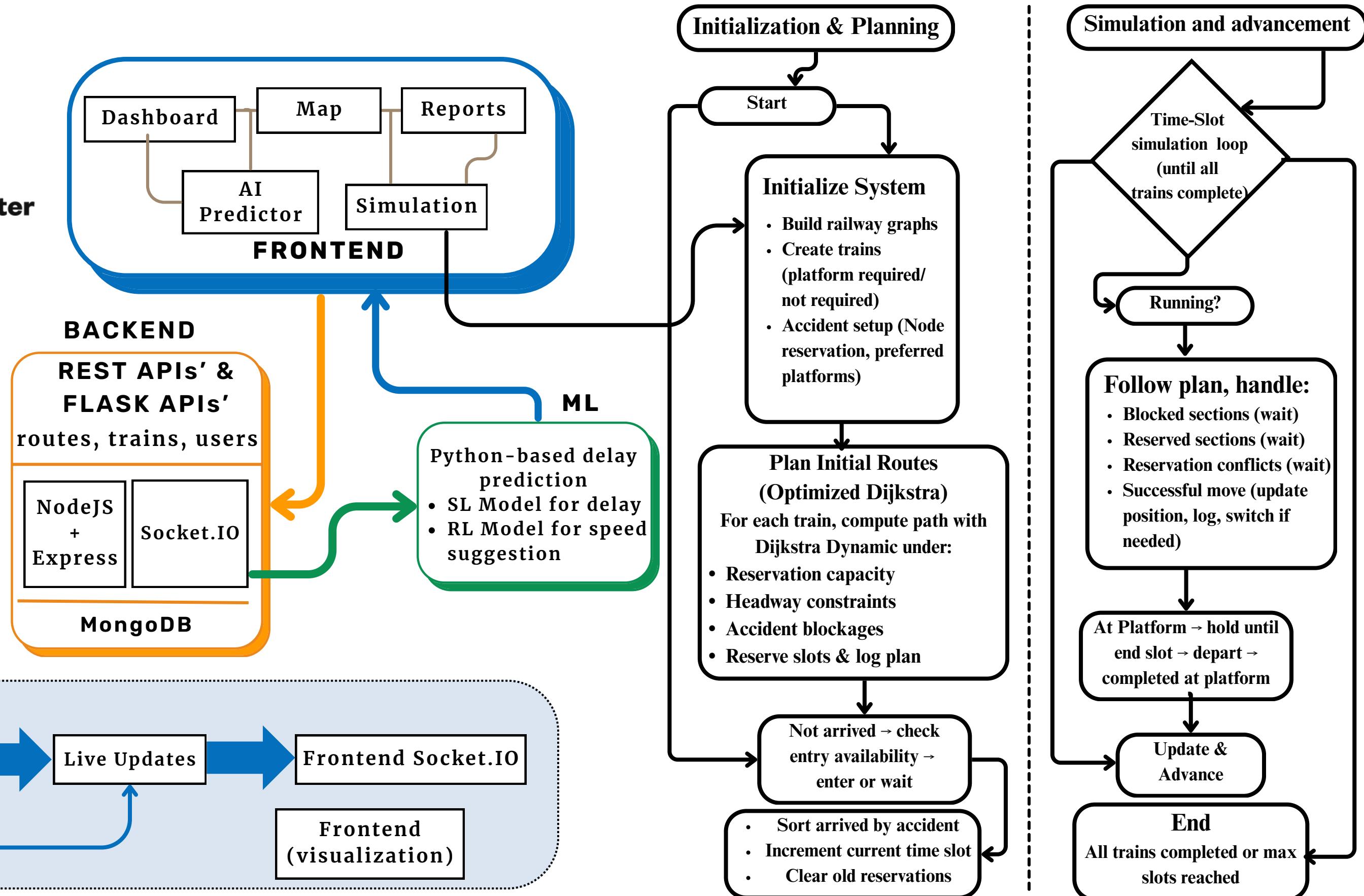
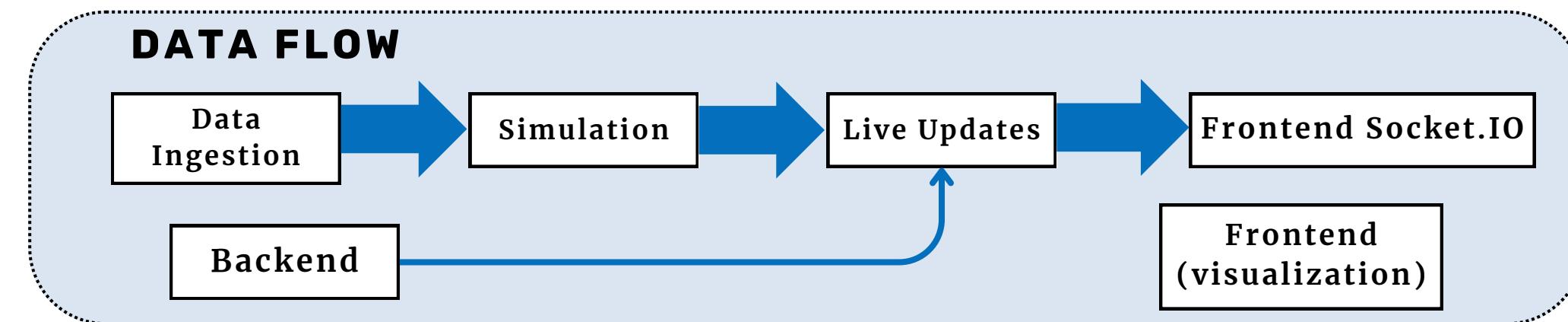
Responsive, intuitive, mobile-aware interface.

- **Backend-Ready**



Easy integration with REST APIs without UI changes.

TECHNICAL APPROACH



FEASIBILITY AND VIABILITY

Feasibility Analysis

Technical:

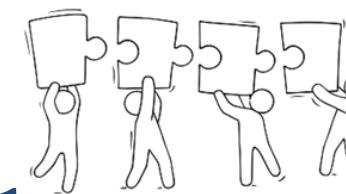
- Enterprise-grade stack (React + TypeScript, Node.js + Express, MongoDB, Python ML)
- Real-time decision engine powered by Socket.IO enables continuous conflict resolution under live traffic conditions.
- AI-powered forecasting & reallocation (SL + RL) directly addresses combinatorial scheduling challenges of mixed-priority trains.
- Microservices architecture allows independent scaling of optimization, visualization, and data services across sections.
- API-first integration with signalling & TMS ensures smooth coexistence with existing Indian Railways infrastructure.

Financial:

- Open-source foundation → zero licensing costs, sustainable in the long run.
- Leverages existing IT infrastructure of Indian Railways, minimizing upfront CAPEX.
- Automation-driven efficiency lowers recurring operational costs compared to manual-only control.

Market / Operational:

- Seamless adoption with controller workflows → minimal training required.
- Throughput maximization under congestion by dynamically prioritizing various trains.
- Scenario simulation & what-if dashboards for both daily control decisions and higher-level policy analysis.
- High adoption potential due to tangible KPIs.
- Audit trails & reporting ensure accountability and continuous operational improvement.



Challenges



- Technical: Real-time conflict resolution between mixed-priority trains across limited tracks and platforms.

- Financial: Maintenance costs at the scale of Indian Railways' vast network.

- Operational / Market: User training for controllers, adoption resistance, regulatory compliance with safety norms.

Technical: Modular microservices, scalable WebSocket layer, offline-first fallback.

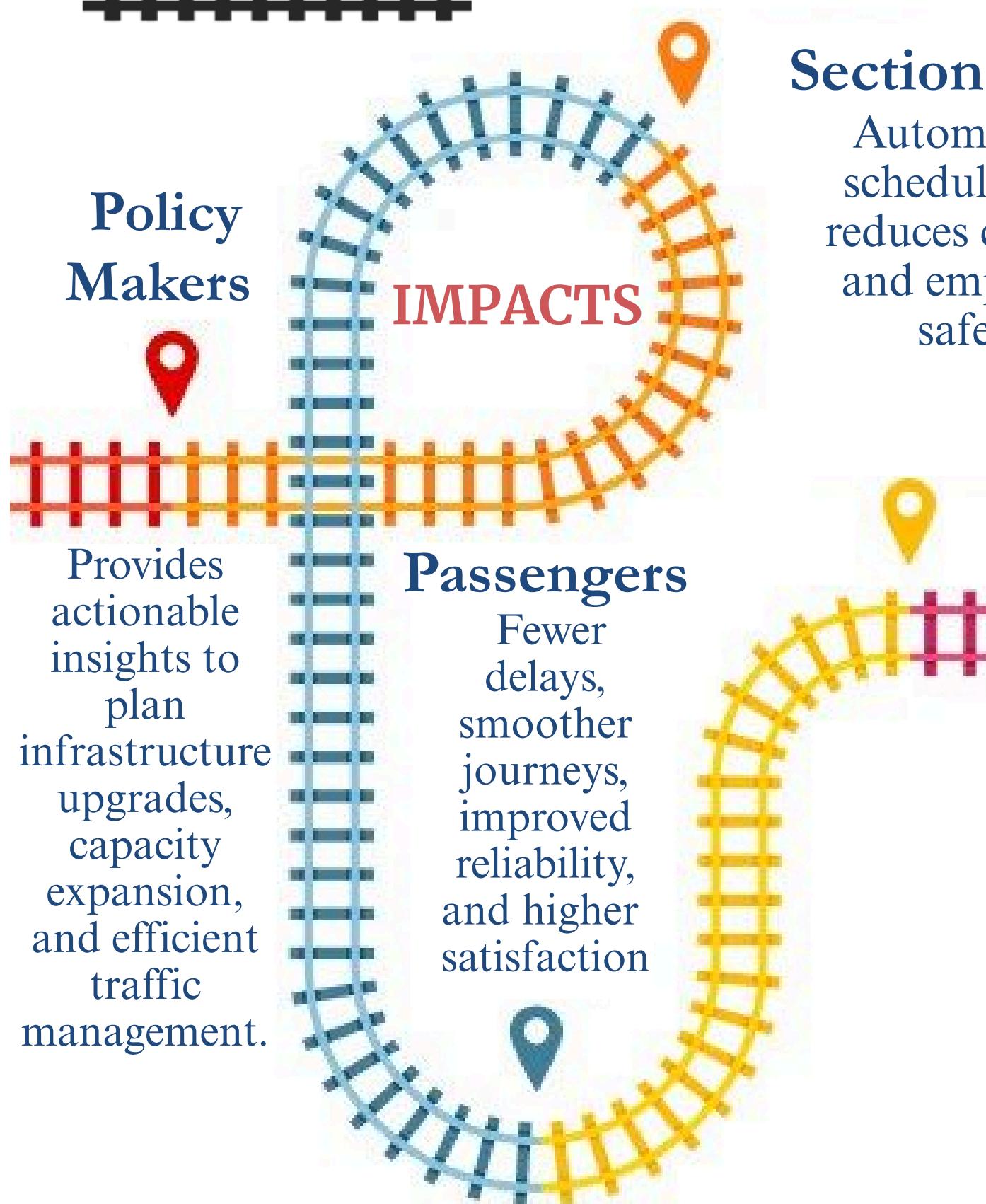
Financial: Cloud deployment for reduced infrastructure cost, gradual rollout.

Algorithms: AI/ML for ETA prediction, OR-based optimization for schedules, conflict-aware simulation engine.

Operational: Intuitive UI, scenario simulations for training, secure APIs for seamless integration.

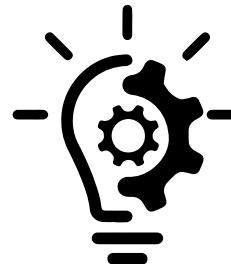
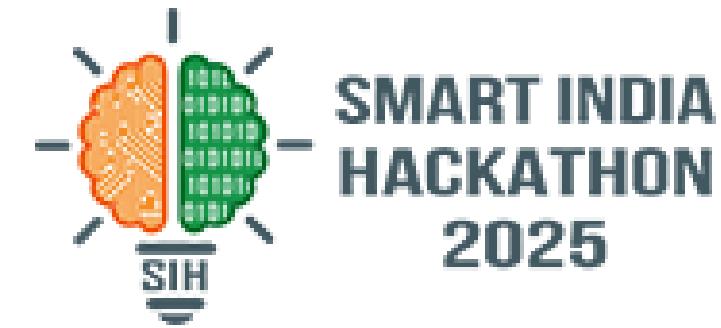
Strategies to overcome

IMPACT AND BENEFITS



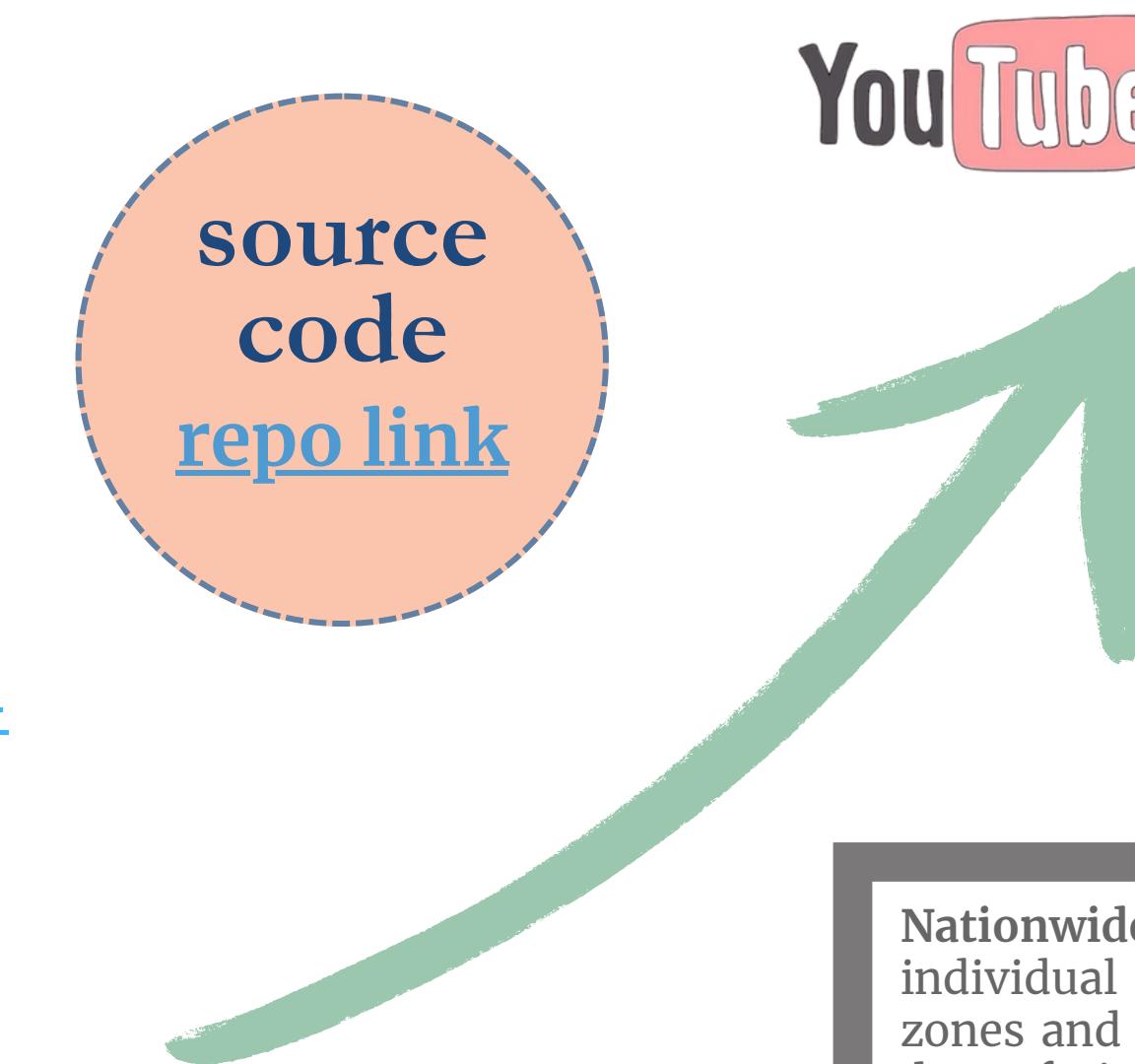


RESEARCH AND REFERENCES



Research & References

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- <https://www.sciencedirect.com/science/article/pii/S0305054821001842>



[Demo Link](#)



source
code
[repo link](#)

Multimodal Integration → Optimize not just rail, but also freight, metro, and intercity connections for a unified transport ecosystem.

Adaptive Learning Engine → ML models continuously improve from real-time and historical traffic data.

Nationwide Scalability → Extend from individual sections to cover all railway zones and corridors across India, including dense freight + passenger mixes.

Cloud + Edge Hybrid Deployment → Scalable architecture ensures real-time performance at the edge while keeping nationwide coordination in the cloud.

AI-Powered Policy Simulation → Simulate “what-if” strategies (e.g., new express corridors, timetable shifts) before implementation.

**Future Scope/
Scalability**