# **PROBLEM SOLVING AND DESIGN THINKING**

**PROJECT TITLE: AI-TRAFFIC FLOW OPTIMIZATION**

**PROBLEM STATEMENT:**

Urban centres are increasingly facing challenges with traffic congestion, Especially during the peak hours. The existing traffic signal systems in many areas are static, leading to inefficient vehicle flow, long waiting times at the intersections and increased fuel consumption. Emergency vehicles often get delayed and public transport loses efficiency due to unpredictable traffic patterns. There is a critical need for a dynamic, data-driven traffic management solutions that can adapt in real time to changing conditions and optimize traffic flow.

This project is focus on optimizing Traffic Flow in the area by collecting real-time or historical traffic data, analysing vehicle movement patterns and simulating adaptive traffic signal control.

**TARGET AUDIENCE:**

* Urban commuters using personal vehicles or public transport.
* Traffic control authorities and Urban planners.
* Public transport agencies
* Emergency response teams **(**ambulance, Police, Fire**)**
* Environmental regulators focused on air quality and emissions.

**OBJECTIVES:**

* To develop an AI based system that dynamically controls traffic lights based on real time traffic data.
* To reduce average Vehicle wait time and improve traffic flow.
* To prioritize emergency vehicles and support public transport scheduling.
* To simulate, test and validate traffic management algorithms using tools like **SUMO** and **PYTHON.**

**DESIGN THINKING APPROACH:**

**EMPATHIZE:**

Through interviews with commuters , traffic police and city planners, we learned that thebiggest frustrations are unpredictable delays, poorly synchronized signals and inefficient handling of high-traffic areas. People want smoother commutes and faster emergency vehicles response times.

**KEY USER CONCERNS:**

* Long delays at signals even with little opposing traffic.
* Poorly coordinated traffic lights leading to unnecessary stops.
* Inability of current systems to adapt to special events or accidents.
* Delays in emergency vehicles response due to congestion.

**DEFINE:**

The system should use real time traffic data **(e.g.**, from cameras, sensors and GPS**)** . Dynamically adjust signal timings to current traffic congestions. Prioritize vehicles like ambulances or public buses were needed. Reduce average wait times and improve commuter experience. Provide analytics to city officials for long term improvements.

**KEY FEATURES REQUIRED:**

* Real time data collection via sensors or simulated input.
* Machine learning algorithm **(e.g.,** Genetic algorithm or Reinforcement learning**)** for adaptive signal control.
* Traffic flow simulation environment **(e.g., SUMO)** for testing.
* Emergency vehicle prioritization logic.
* Dashboard to visualize traffic metrics and decisions.

**IDEATE:**

Some potential ideas for this solution include:

* An emergency vehicle detection and prioritization module.
* Integration with public transport data for bus route optimization.
* A web dashboard for city planners to monitor traffic metrics live.
* By using some apps to find the best way in the traffic sectors.

**PROTOTYPE :**

Develop a simplified prototype of an AI driven traffic signal system for a 4 way intersection in SUMO. The prototype will:

* Simulate varying in traffic volumes at each approach.
* Use a Genetic algorithm to optimize signal phase durations.
* Show visual outputs of queue lengths and waiting times.
* Include a trigger event to prioritize an emergency vehicle path.

**KEY COMPONENTS:**

* SUMO simulation network(urban intersection)
* Python + TraCI interface for controlling signals in simulation.
* Optimization algorithm to adjust timings dynamically.
* Data collection and visualization module.
* Report of performance metrics(e.g., average delay, queue lengths)

**TEST:**

Theprototype will be tested under various simulated condition:

* Peak vs off-peak hours
* Sudden influx of traffic(accident or event simulation).
* Emergency vehicle approaching intersection.
* Comparison of fixed-timing vs AI-optimized signals.

**TESTING GOALS:**

* Validate that the AI reduces average vehicle delay compared to fixed signals.
* Confirm proper emergency vehicle prioritization.
* Test stability and response time of the optimization model. Assess user-friendliness of visualization dashboard for traffic authorities.

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