Exploring the Problem

❖ Restating the problem

As a member of the transportation infrastructure team the goal is to create a logic-based safety system that closes the gates or opens the gate when a train approaches/leaves the designated area or when there is any type of object (vehicles, living beings, any form of physical object) in the track blocking the trains path. Ensuring the safety of the passengers in the train and outside the train tracks.

❖ Inputs and outputs of the system

❖ **Input**

1. **Train approaching: Sensor are set at different distance (500, 200, 50) meter where once the train cross the sensor is triggered indicating that the train is heading towards the gate to prepare the system to act for lowering the gate.**
2. **Train cleared: Once the train has crossed the gate the 3 sensors once again inform the system that the system has left the area, and it is safe to open the gate unless there is another train incoming.**
3. **Vehicle on track: A camera detects if there is any vehicle on the track and if the train is inside the distance of 500 to 50 to slow down the train to avoid any collision between the train and vehicle.**

❖ **Output**

1. **Gate status: Once the criteria is met the system either closes the gate or opens the gate.**
2. **Signal for vehicle: A stop light indicates in 2 colors (red, green) to inform any oncoming vehicle to stop, slow or go.**
3. **Signal for train: Using led (red = vehicle on track, green = vehicle not on track) we can avoid collision between train and vehicle.**

❖ Context

1. **Purpose: Prevent accidents at railway crossings by automatically closing gates when trains approach or vehicles are stuck.**
2. **Location: Road-rail intersections in urban/rural areas.**
3. **Problem: Human error (ignoring warnings) or system failures can cause deadly crashes.**
4. **Solution: A fully automated, fail-safe gate control system that reacts faster than humans.**

❖ Constraints

1. **Technical constraints**
    1. **Sensor Reliability: Must work in all weather (rain, snow, fog).**
    2. **Response Time: Gates must close before the train arrives (minimum warning time).**
    3. **Maintenance: Must be easy to inspect and repair.**
2. **Economic constraints**
    1. **Cost: Must be affordable for government/railway budgets.**
    2. **Longevity: Should last 10+ years with minimal repairs.**
    3. **Energy Use: Should consume little power.**
3. **Social constraints**
    1. **Public Acceptance: People must trust the system.**
    2. **Accessibility: Must accommodate pedestrians, cyclists, and disabled users.**
    3. **Noise Pollution: Alarms should be loud enough to warn but not disturb nearby homes.**
4. **Environmental constraints**
    1. **Weather Resistance: Must work in extreme heat, cold, storms.**
    2. **Eco-Friendly Materials: Avoid toxic components (e.g., lead batteries).**
    3. **Wildlife Protection: Should not harm animals crossing tracks.**
5. **Legal & safety constraints**
    1. **Compliance: Must follow railway safety laws (e.g., FRA (USA) or ERA (EU) standards).**
    2. **Fail-Safe Design: If system fails, gates must default to close (never stay open).**
    3. **Data Privacy: If using cameras/AI, must comply with privacy laws.**

❖ Stakeholders

Stakeholder	Interest/Concern
Railway Companies	Safety, cost, maintenance
Government (Transport Dept.)	Regulations, funding, public safety
Drivers & Pedestrians	Fast, reliable warnings; no false closures
Local Communities	Noise, traffic delays, visual impact
Maintenance Crews	Easy repairs, clear error alerts
Emergency Services	Quick alerts if accidents happen
Environmental Groups	Wildlife protection, eco-impact
Technology Suppliers	Profits, innovation, contracts