**Step 2: Exploring Alternatives**

***1.Brainstorm at least two different logic-based solutions:***

**Solution 1: Basic Safety-First Logic**

**How it works:**

The system constantly checks two things:

Is a train coming? (Train sensor = ON)

Is a vehicle stuck on the tracks? (Vehicle sensor = ON)

If either sensor detects danger (train OR vehicle), the gates lower immediately.

Warning lights and alarms turn on to alert people.

The gates only rise again when both sensors are clear (no train AND no vehicle).

**Emergency override:** If a manual emergency button is pressed, gates stay down no matter what.

**Pros:**

Simple, reliable, and fail-safe (defaults to "gates down" if something goes wrong).

Easy to maintain and troubleshoot.

**Cons:**

Could cause unnecessary delays if the vehicle sensor gets stuck.

Doesn’t prioritize train speed—gates might lower too early or late if timing isn’t adjusted.

**Solution 2: Smart Timing & Cross-Verification Logic**

**How it works:**

The system checks:

Train distance and speed (to predict arrival time).

Vehicle presence (with a secondary sensor to reduce false alarms).

Gates lower only if:

A train is close enough (e.g., 30 seconds away), OR

A vehicle is confirmed to be on the tracks (two sensors agree to prevent errors).

Gates rise only if:

The train has fully passed AND no vehicle is detected for an extra 5 seconds (safety buffer).

Emergency mode: Manual button forces gates down, but system logs the incident for review.

**Pros:**

Reduces false alarms by cross-checking sensors.

Adjusts gate timing based on train speed for smoother traffic flow.

Adds a delay before raising gates to ensure safety.

**Cons:**

More complex (needs train speed sensors and backup checks).

It is slightly higher cost due to extra sensors.

***2.One real-world example***

One real-world example is **Network Rail’s Automatic Half-Barrier (AHB) crossings** in the UK. These systems use track circuits to detect approaching trains, triggering lower gates and alarms. **Key features:**

* **Sensors:** Track circuits detect trains up to 2 km away.
* **Logic:** Gates lower automatically when a train is detected and only rise after the train passes *and* the track is clear.
* **Safety:** Redundant systems ensure gates default to "down" if power fails.
* **Limitation:** AHB relies on drivers obeying signals, as full barriers are safer but costlier.

AHB strikes a balance between safety and cost for lower-traffic areas.

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