Data Analysis Report: Making Long-Distance Bus Travel Safer

The Big Picture:

For companies that run buses for long trips and tours, safety is everything. A serious accident from a tired driver or a broken part can destroy their business reputation and cost millions. These touring buses drive long distances on fast highways, making mistakes very dangerous. Our data project is designed to tackle their two biggest risks: drivers getting too tired and buses breaking down on the road.

Step 1 – Defining the Problem: Where are we Failing?

We first identified exactly what the safety problem is.

- **Current Problem:** Our buses have X serious incidents (accidents or major breakdowns) for every 100,000 miles they drive. This is **20% higher** than similar travel bus companies, meaning we need to do better.
- **Key Fact:** The most dangerous time is **between midnight and 6 AM**, when **85% of severe crashes** happen. This strongly suggests **sleepy drivers**. Also, about **1 in 10 incidents** is a major breakdown (like a tire blowout), showing we're missing maintenance checks.
- **Goal:** We aim to lower the rate of these serious incidents by **25%** in the next year by keeping our drivers rested and our buses well-maintained.

Step 2 – Gathering the Data: Finding the Clues

We collected information from three main places, like finding pieces of evidence:

- **Driver Logs (The Fatigue Tracker):** Government-required digital records that track every minute a driver spends driving, resting, or on duty. This is our clearest clue for **driver fatigue**.
- **Bus Computers (The Behavior Monitor):** GPS devices that track **where** the bus is, **how fast** it's going, and if the driver is making sudden, harsh moves (like **slamming on the brakes** or **swerving**).
- **Maintenance Files (The Health Record):** Detailed records of the bus's age, when the brakes and tires were last checked, and what mechanics fixed last time.
- **Data Scope:** We linked all these records together for the past year and a half.

Step 3 – Cleaning the Data: Making Sure the Facts are Right

Before we trust the data, we have to make sure it’s accurate.

- **Checking the Clocks:** Because trips cross time zones, we made sure all records (accident time, driver log time) were on the **exact same clock** for fair comparison.
- **Catching Cheaters:** We compared the Driver Logs (where they say they are resting) with the GPS data. If the driver logged "sleep" but the GPS showed the bus moving, we corrected the record to spot **false rest times**.

- **Linking Everything:** We made sure that the report for an accident was correctly linked to the **right driver's rest history** and the **right bus's maintenance history**.

Step 4 – Exploring the Data: The "Why" Behind the Accidents

We looked for clear patterns relating causes to effects:

- **Fatigue is the Killer:** A shocking **9 out of 10 serious late-night accidents** involved a driver who was either near the legal limit of driving hours or hadn't logged enough continuous sleep the night before. This proves **driver fatigue** is the single biggest threat.
- **Maintenance is Failing: Two-thirds of all major roadside breakdowns** were due to tire or brake problems. These buses were typically overdue for a scheduled safety check, proving that **poor vehicle condition** is a major preventable risk.
- **Warning Signs:** Drivers who were already showing signs of distraction (like sudden braking or quick swerving) early in their long shift were much more likely to have a fatigue or compliance issue later on.
- **The Core Insight:** Serious risks are manageable. They stem from **tired drivers pushing limits** and **maintenance teams not catching problems** before the bus leaves the depot.

Step 5 – Building a Safety Forecast: Predicting the Danger

We created two smart tools (computer models) to help managers stop problems *before* they happen:

1. **Driver Fatigue Risk Tool:** This tool scores every driver on a scale of 1 to 10. It looks at how much they slept, how long they've been driving, and their recent behavior (like quick stops) to warn dispatchers: **"This driver is high-risk for fatigue in the next four hours."**
2. **Bus Breakdown Predictor:** This tool scores every bus. It looks at the bus's total mileage, how long it's been since the tires/brakes were checked, and any recent repair requests to warn mechanics: **"This bus needs an emergency inspection now."**

Step 6 – Testing the Solution: The Pilot Program

We used the smart tools in a trial run to prove they worked:

- **Test Group Actions:** Dispatchers were **forced to use the Fatigue Tool**. If a driver scored high, they had to call a relief driver or force an immediate rest stop. High-risk buses flagged by the predictor were **pulled from service** for immediate maintenance.
- **Control Group:** Continued managing drivers and buses the old way (based only on simple schedules).
- **Results after 4 months:**
    - **Test Group:** Severe accidents and breakdowns dropped by an incredible **30%**.
    - **Control Group:** Their accident rate stayed the same.
    - **Conclusion:** Letting the data drive our decisions is the key to a safer operation.

Step 7 – Putting it into Action: Permanent Changes

Based on the pilot's success, we made these permanent company rules:

- **Automated Driver Swaps:** The dispatch system will **not allow** a trip to continue during the dangerous early morning hours without a certified second driver if the primary driver scores high on the Fatigue Risk Tool.
- **Smart Maintenance:** The old mileage-based maintenance schedule is gone. Now, buses are pulled in for service based on the **Breakdown Predictor's warning**—addressing issues before they become emergencies.
- **Targeted Training:** Drivers get special training on the signs of fatigue, the danger of *microsleeps*, and how to properly log their mandated rest time.
- **The Bottom Line:**
    - We achieved a **30% reduction** in serious incidents.
    - This is saving the company millions in potential lawsuits and insurance costs.
    - Most importantly, the travel agency now offers its customers the **safest bus service available**, boosting trust and bookings.