Crime Forecasting

& Trend Analysis

Public Safety & Law Enforcement Analytics

PROJECT TITLE:
Crime Forecasting and Trend Analysis

PROJECT SECTOR:
CRIME

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PRESENTED BY:
Group 18

Context & Problem Statement

Strategic Overview

The Context

Urban crime incidents are heavily influenced by **spatial concentration** and **temporal patterns**.

The Problem

Without structured analytical visibility, decision-makers struggle to identify:

- High-risk geographical zones
- Peak crime hours
- Emerging patterns across neighborhoods

Business Objective

To design a KPI-driven analytical dashboard that transforms raw data into insights for operational decision-making (patrol allocation) and strategic planning (policy focus).

Key Analytical Questions

01

Which crime types occur most frequently?

02

Are there identifiable seasonal or yearly trends?

At what hours are incidents most concentrated?

Which neighborhoods have highest density?

DATA ENGINEERING

~400k

raw incidents recorded

1991-2001

Historical Coverage

Variables (Schema)

- TYPE (Crime Category)
- NEIGHBOURHOOD, HUNDRED_BLOCK
- X, Y, LATITUDE, LONGITUDE
- YEAR, MONTH, DAY, HOUR, MINUTE
- FULL_DATE, TIME_OF_DAY, COORDINATE

CLEANING PIPELINE

Ingestion & Reduction 400K → 60K

Initial processing in Google Colab to handle volume. Optimized for performance.

Duplicate Removal UNIQUE

Removed exact duplicate rows in Google Sheets to ensure unique incident integrity.

Random Sampling 10K Subsets

Selected representative subset to maintain distribution while improving dashboard speed.

Missing Value Handling -50 Records

Removed records with invalid locations (e.g., OFFSET, 0 coordinates).

Final Cleaned Dataset **9050 Records**

Ready for visualization and KPI calculation.

Exploratory Data Analysis (EDA)

Comprehensive Spatial & Temporal Crime Patterns

Temporal Trends

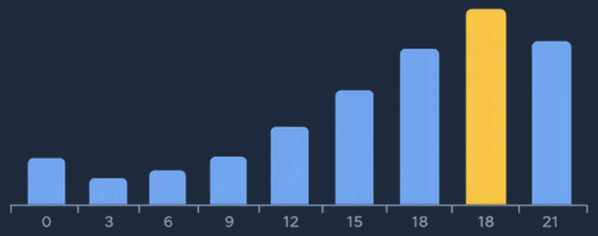
Year-over-Year Volatility

↓ 2003: -17.22% (Decline)

↑ 2010: +14.15% (Rebound)

Hourly Distribution

Peak: 6 PM (691 cases)

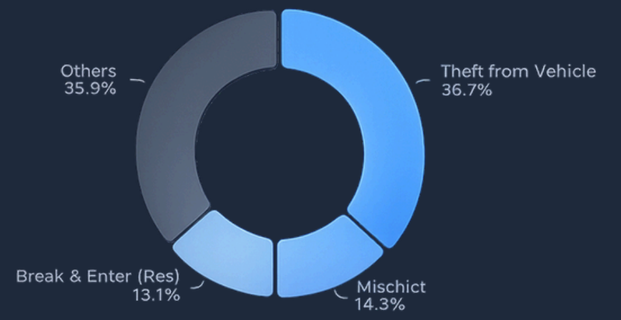


Evening (3PM-9PM) 43. 6%

Night (9PM-5AM) 47.4%

Crime Composition

Dominant Categerics

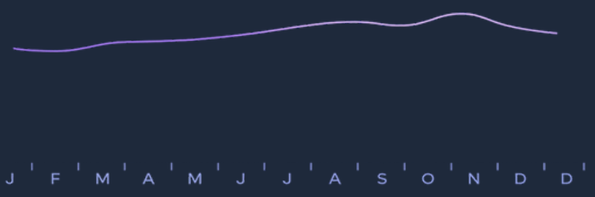


VEHICLE CRIME DOMINANCE

Theft from Vehicle accounts for 36.7% of all incidents, nearly 2.5x higher than the next category (Mischiet at 14%).

Seasonality

Monthly Peaks



Peak Month: October (~819 cases)

Spatial Hotspots

Top Neighborhoods

1. Central Business District 2,035

Extreme Outlier

2. West End
3. Mount Pleasant
4. Strathcona
5. Grandview-Woodland

Geographic Insight

CBD cases are 2.5x higher than the West End. Heatmap analysis confirms strong clustering in Downtown, West End, and Fairview corridors.

Advanced Analysis: Forecasting

Predictive Modeling & Future Risk Projections (2012-2015)

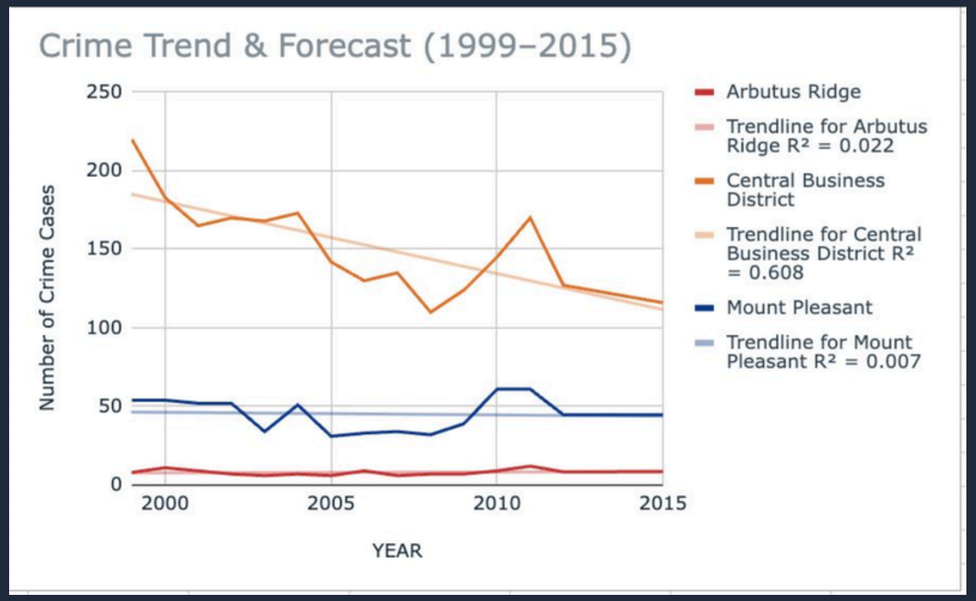
Forecast Methodology

Future = Previous Year × (1 + Growth%)

- Historical Decline (2000-2006)
  Structural reduction in crime incidents, stabilizing mid-decade.
- Rebound Phase (2009-2011)
  Strong resurgence in activity, particularly in commercial zones.
- Growth Projection (2012-2015).
  Model predicts continued upward trajectory based on recent momentum.

Strategic Value

Forecasts serve as an early warning system for budget alignment and proactive patrol planning in high-growth corridors before incidents peak.



Neighborhood Risk Outlook

Central Business District

RISING RISK

Projected upward trend in commercial core. Requires pre-emptive monitoring.

Arbutus Ridge

STABLE

Remains relatively consistent with minor seasonal fluctuations.

Mount Pleasant

STABILIZING

Gradual stabilization after earlier volatility. Monitor for shifts.

KPI & Metrics Framework

Dataset Volume

9,100

Total Incidents Recorded

Cleaned Data

Top Crime Category

Theft from Vehicle

3,370 Incidents

37% of Total

Peak Historical Year

1999

Highest recorded volume

Baseline Year

Primary Hotspot

Central Business District

2,035 Incidents

High Density

High Risk Window

18:00

Peak Hour (6 PM)

691 Incidents

Seasonal Peak

October

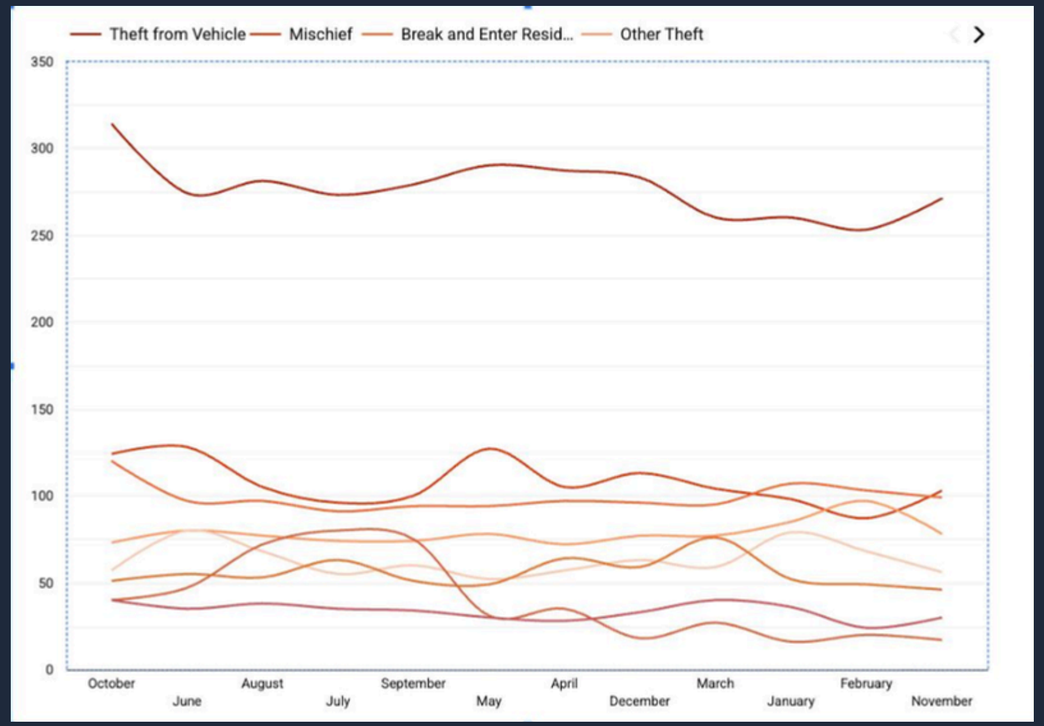
Highest monthly activity

Autumn Seasonality

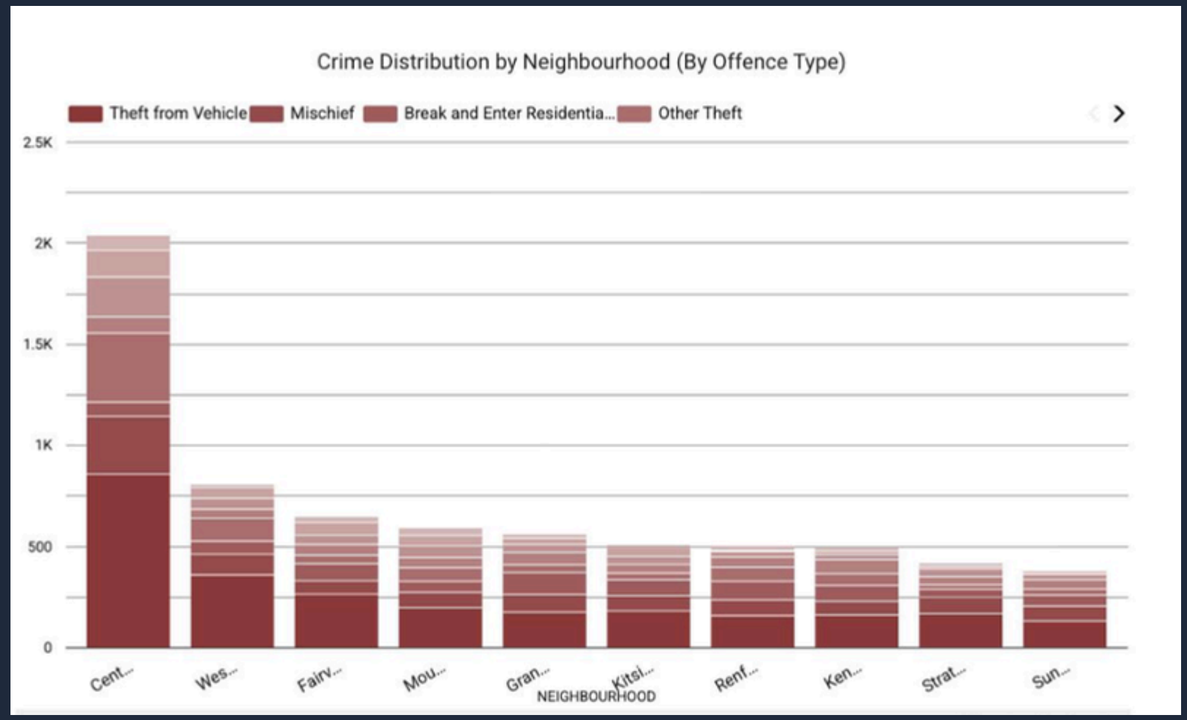
Dashboard Walkthrough

Part 1: Crime Distribution & Spatial Analysis

CRIME TYPE PERCENTAGE

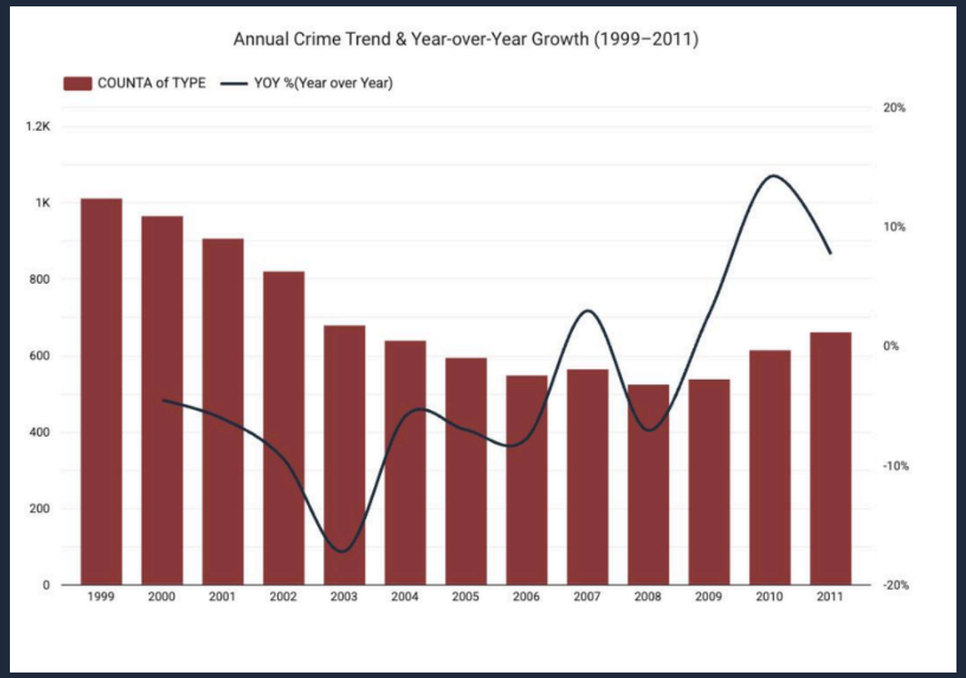


Neighborhood Density



Part 2: Temporal Patterns (Yearly, Hourly & Seasonal)

Year-over-Year Trend Analysis

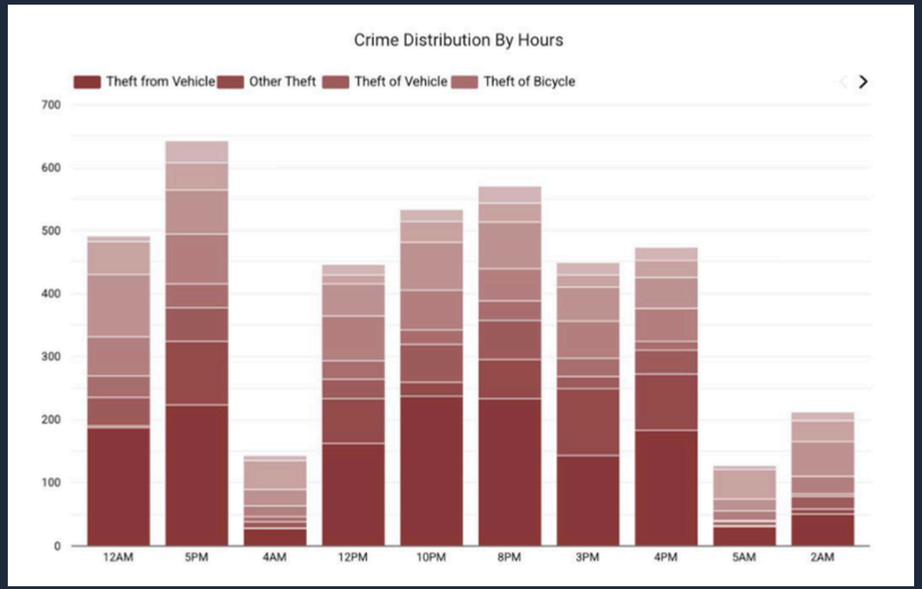


Temporal Insight

A distinct 3-phase pattern emerged: Structural decline from 1999-2006 (peaking with a -17.38% drop in 2003), followed by stabilization, and a concerning resurgence phase (+14.13%) starting in 2010.

Hourly Risk Profile

Peak: 17:00 - 21:00



Monthly Seasonality

Peak Month — **October**

Low Activity Window — **00:00-5:00AM**

Seasonal Pattern

Moderate fluctuations observed. No extreme anomalies, but consistent uptick in late autumn months.

Recommendations

Proposed Interventions & Strategic Policy Shifts

Operational

Immediate tactical deployment & resource management

Evening Patrol Reinforcement

Concentrate visible patrol units during the 17:00–21:00 peak operational window.

Targeted Hotspot Deployment

Prioritize resource allocation to the Central Business District and high-density commercial zones.

Theft-Focused Surveillance

Prioritize resource allocation to the Central Business District and high-density commercial zones.

STRATERGIC

Long-term policy, infrastructure & prevention

Infrastructure Enhancement

Install enhanced lighting and CCTV monitoring in identified high-risk spatial clusters.

Theft Prevention Policies

Launch public awareness campaigns and mandate security standards for commercial parking operators.

Urban Planning Interventions

Collaborate with city planners to address environmental design factors in persistent high-crime corridors.

Impact & Value

Quantifiable Benefits & Strategic ROI

Operational Impact

Efficiency gains in day-to-day enforcement activities.

- Data-backed patrol allocation reduces response times.
- Proactive interventions during rising trend phases.
- Specialized response units deployed based on dominant crime types.
- Evidence-based shift planning aligns manpower with risk.

Strategic Value

Long-term planning and policy formulation advantages.

- Enables rigorous long-term policy evaluation.
- Functions as an early warning system for crime resurgence.
- Supports smart city initiatives and predictive policing goals.
- Facilitates transition from reactive to proactive enforcement.

Business Value

Broader organizational and community benefits.

- Enhanced public safety through optimized coverage.
- Optimized resource utilization reduces overtime costs.
- Improved community trust via transparent, data-driven policing.
- Justifiable budget allocation for infrastructure upgrades.

Limitations & Next Steps

Current Constraints & Future Project Roadmap

Current Limitations

Constraints affecting the current analytical model

Restricted Time Coverage

Dataset spans 1999–2011 only. Recent trends (post-2012) and modern behavioral shifts are not captured.

Lack of Socio-Economic Variables

Absence of demographic, income, or housing data limits causal analysis of crime drivers.

Reporting Bias

Analysis reflects only reported incidents; unreported crimes (dark figure of crime) remain invisible.

No Severity Weighting

All incidents are treated equally in count aggregations, regardless of impact severity.

Next Steps

Strategic roadmap for system enhancement

Data Integration (2012–2026)

Ingest recent incident logs to update baselines and capture contemporary crime dynamics.

Advanced Forecasting Models

Implement ARIMA, Prophet, and Machine Learning algorithms for predictive monthly forecasting.

Demographic Enrichment

Layer census data (unemployment, population density) to identify root cause correlations.

Real-Time System Integration

Connect dashboard to live police dispatch feeds for real-time situational awareness.