ALGONQUIN COLLEGE

CST2111 — Data Visualization

Project Report

Transportation and Mobility:

Analyzing Ontario's Highway Traffic Patterns and Congestion Trends (1988–2021)

GROUP - 12

Shara Khandakar

Murk Asad

Maksuda E Elahi

Anam Vakil

Submitted to: Professor Umer Altaf

Table of Contents

Analyzing Ontario's Highway Traffic Patterns and Congestion Trends (1988-2021)

Shara Khandaker
Student
khan0611@algonquinlive.com

Murk Asad
Student
asad0022@algonquinlive.com

Maksuda E Elahi
Student
elah0010@algonquinlive.com

Anam Vakil
Student
vaki0005@algonquinlive.com

***Abstract*—This project investigates the long-term traffic patterns of Ontario's highways, their seasonal changes, the freight transit activity, and the frequency of collisions through a detailed analysis of the MTO Traffic Volume database, which is estimated to comprise around 57,000 records of 29 attributes dated from 1988 to 2021. The dataset was processed and then visualized in Power BI, where issues of unavailability of data were sorted out, unimportant fields were excluded, and new DAX measures were created to compute AADT growth, seasonal traffic differences, freight share, and collision risk levels. The examination indicates that there has been a steady increase of traffic across the province, with Highway 401 being the most utilized route at all times. The seasonal pattern of traffic indicates that summer is the peak period with tourists and people on recreation being the main contributors, while winter negatively impacts the number of accidents as it takes driving under hazardous conditions to increase their rates. Analyzing the freight traffic reveals that alongside the increase in truck volume in Western and Northern Ontario, which are also experiencing higher safety risks, this pattern is characteristic of those regions. The results provide evidence for the need for improving winter maintenance, freight-corridor safety, and congestion management targeted areas to support the goal of eliminating the adverse effects of safety and efficiency on Ontario's highway network transportation.**

Keywords— Ontario traffic, AADT freight movement, seasonal variation, collision analysis, Power BI

I. BACKGROUND

The MTO Traffic Volume Data (1988–2021), sourced from the Government of Ontario and containing approximately 57,000 records across 29 fields, provides a comprehensive view of long-term traffic patterns on Ontario highways [1]. This project analyzes the dataset to understand trends in traffic volumes, freight movement, seasonal fluctuations, and safety indicators across more than three decades. By examining metrics such as AADT, truck percentages, seasonal daily traffic values (SADT, SAWDT, WADT), and collision rates, the study aims to uncover meaningful patterns that reflect growing congestion and freight activity on key corridors. The analysis addresses the problem of increasing traffic and truck volumes that, when coupled with constrained infrastructure growth, contribute to mobility challenges and higher collision risks. Guided by the hypothesis that rising traffic and truck activity correlate positively with collision rates, the project seeks to generate evidence-based insights that support improved transportation planning, congestion mitigation, and overall mobility and safety across Ontario's road network.

II. METHODOLOGY

All analyses in this study were conducted using the Ontario Ministry of Transportation's Technical Publications Portal dataset [1].

A. Data Cleaning

a) Cleaned and refined dataset using Power BI to ensure analytical accuracy [2]
b) Filtered out anomalies by removing rows where Year = 9999, as they lacked key traffic metrics resulting in ~1% of the dataset being dropped for improved accuracy [1]

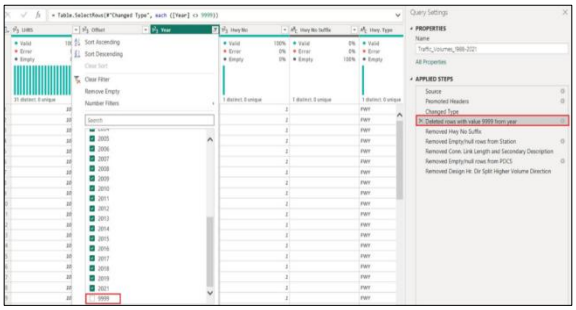


Fig. 1. Data cleaning workflow in Power BI Query Editor [1, 2]

B. Handling Missing Data

To ensure data quality and avoid analytical bias, columns containing approximately 99% null value such as Hwy No Suffix, Connection Link, Length, Secondary Description, Design Hour Split Direction (≈89% null), and Design Hour Direction Split% were removed, as they provided little meaningful information. A small number of records (4–8 rows) missing essential statistical fields such as Station and PDCS were also excluded to maintain dataset integrity. However, Design Hour Volume%, despite having 1.8% missing values, was retained because it represents a key metric critical for analyzing peak-hour traffic congestion. This approach balances the removal of uninformative fields with the preservation of variables essential for robust traffic analysis.

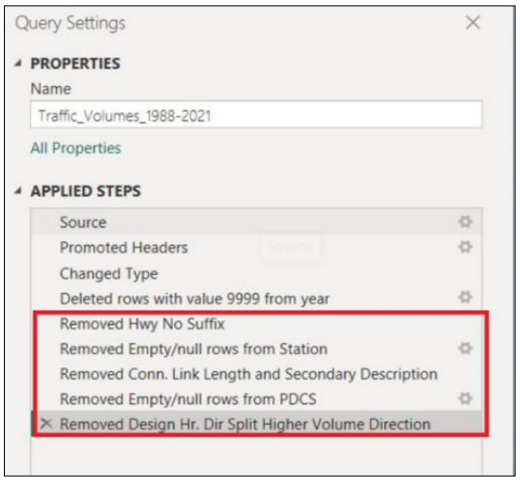


Fig. 2. Missing data handling steps in Power BI Query Editor [1, 2]

C. Data Transformation

- Created a custom DAX measure: Truck Collision % = (Truck Collisions / Total Volume) x 100
- Normalizes collision data across zones with varying traffic levels
- Highlights disproportionately risky areas for trucks

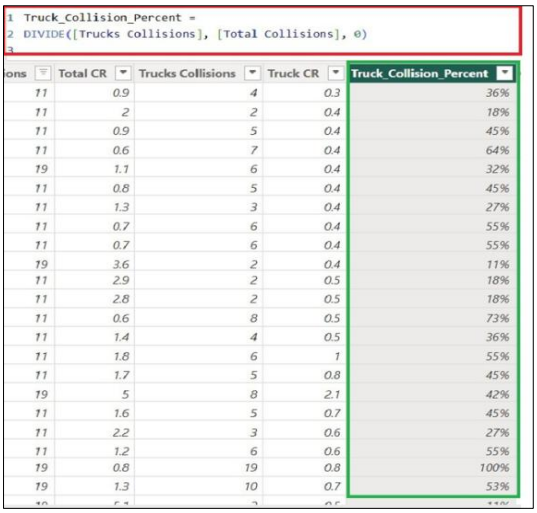


Fig. 3. Transforming Clean Data into Risk Indicators [1, 2]

- Grouped regions into risk levels based on collision percent Used DAX logic to assign:
  - High Risk: > 30%
  - Medium Risk: 15– 30%
  - Low Risk: < 15%

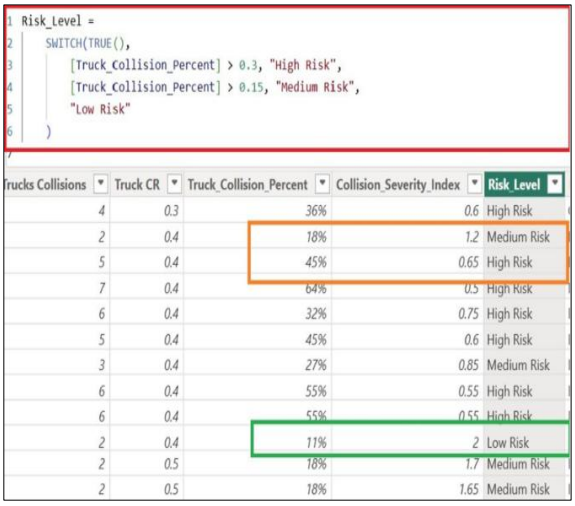


Fig. 4. Turning Percentages into Actionable Risk Categories [1, 2]

- Combined Severity Index and Truck Collision Percent to assign Risk Levels Grouped granular regions into broader Region Groups:
  - Northern Ontario Central Ontario Western Ontario Eastern Ontario
  - Enables planners to compare safety risks across major zones
  - Supports targeted interventions and resource allocation

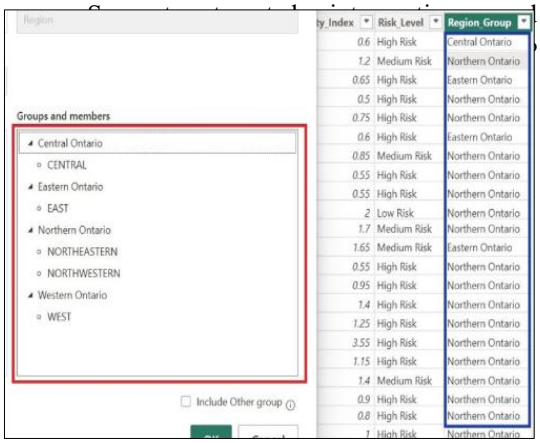


Fig. 5. Final Risk Mapping Across Ontario Regions [1, 2]

D. Data Modeling

In Power BI Desktop [2], a comprehensive data model was developed, including the creation of key measures and supporting dimension tables. Using the Power Query Editor, the raw Traffic_Volumes_1988–2021.csv file was thoroughly cleaned and transformed to ensure accuracy and consistency before analysis. Leveraging DAX (Data Analysis Expressions), several custom measures were created such as Average Collision Rate, AADT Growth %, High Risk Percent, and Freight Share % to enable deeper

insights into traffic patterns, safety trends, and freight activity across Ontario's highway network.

- Key DAX Measures
  - Traffic Trend Analysis: Avg AADT, AADT by Region, YoY Growth %, 3-yr MA
  - Freight Analysis: Avg Freight %, Max Truck AADT + Year, Top Freight Region, Selected Yr Freight Share
  - Safety Analysis: Avg Collision Rate, High-Risk % & Count, Low/Med-Risk % & Count, Total Locations

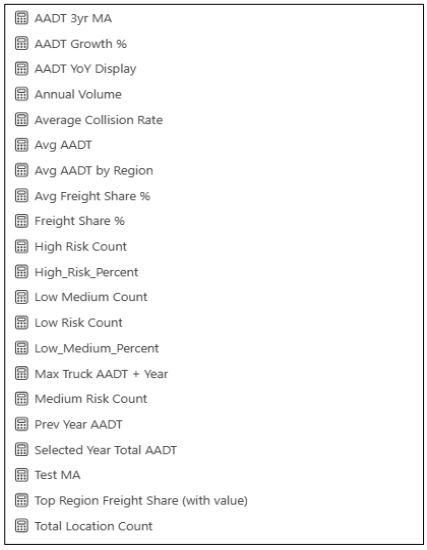


Fig. 6. Final Risk Mapping Across Ontario Regions [1, 2]

- Dimension Table

  Added a new table named Traffic_Pattern to support insights and analysis (supporting data obtained from MTO Traffic Metadata)

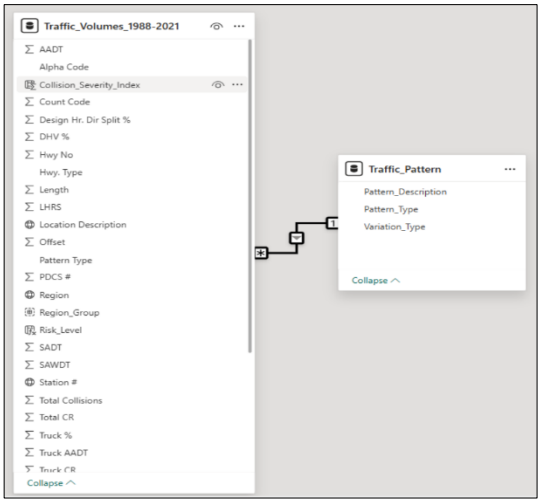


Fig. 7. Data model with Traffic_Pattern table [1, 2]

III. ANALYSIS

1. Traffic Trend Analysis:

- Understanding Long-Term Traffic Growth and Regional Demand Patterns.

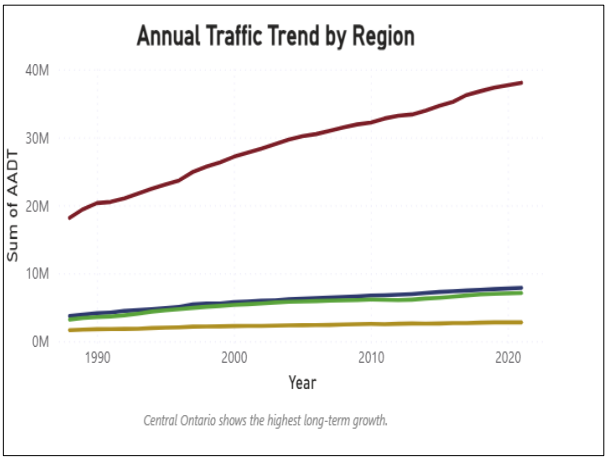


Fig. 8. Annual Traffic Trend by Region [1, 2]

This analysis focuses on identifying how Ontario's highway traffic volumes change over a period of more than thirty years as expressed by AADT (Annual Average Daily Traffic), the main measure of long-term monitoring of traffic. The objective is to gain an insight into the annual increase, the distribution of traffic in different regions, and the provincial highway system's most utilized routes [1].

- AADT is used to capture overall traffic demand across all 1,600+ highway locations included in the dataset [1]. The following measures and visuals were used to examine long-term trends:
  - **Total AADT:** Aggregates daily traffic volume across all stations
  - **YoY (Year-over-Year) Growth %:** Shows how traffic changes annually
  - **Regional AADT Distribution:** Breaks down traffic across Ontario's geographic regions
  - **Highway-Level AADT:** Identifies corridors with the highest travel demand (Top 10 busiest highways)

- **The Regional Distribution of AADT:**
  Here the analysis illustrates how traffic volume is shared across Ontario's major geographic zones. Central Ontario accounts for the largest portion of total traffic, reflecting dense populations and heavy commuter flows, while Eastern and Western Ontario contribute more moderate shares. Northern Ontario carries the lowest proportion of traffic due to its lower population

density and reduced highway activity. This distribution helps identify where long-term infrastructure demand is highest [1].

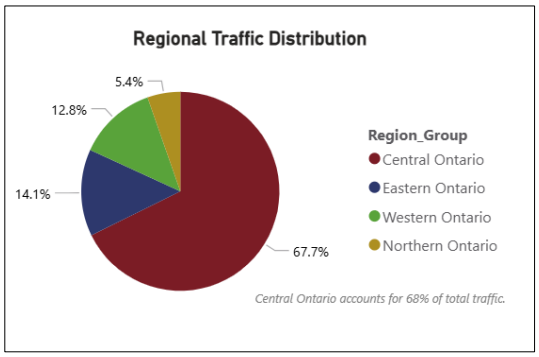


Fig. 9. Regional Traffic Distribution in Ontario [1, 2]

- **Top 10 Busiest Highways:**
The ranking of the streets with the most traffic in Ontario gives a hint about the routes with the highest daily travel demand. The Top 10 list based on cumulative AADT for all the years available showcases the main commuting and freight corridors which are very important for the movement of people and goods in the province. The east-west main road through the Greater Toronto Area is Highway 401, which has the heaviest traffic volume that is miles ahead of all other highways in the province. Highways 1, 417, 404, and 403 are other favorable routes in the Top 10 as they complete the heavy travel, commercial and town-to-town traffic.

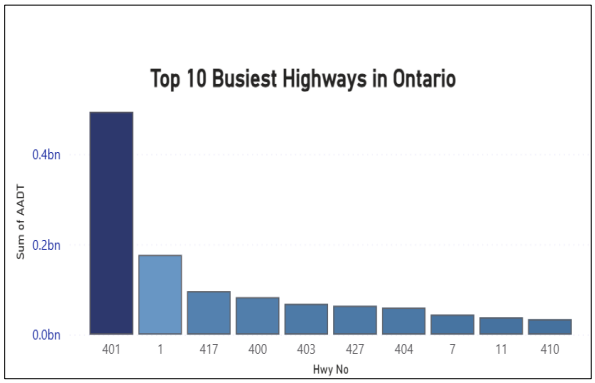


Fig. 10. Top 10 Busiest Highways in Ontario based on AADT [1, 2]

The most crowded corridors of Ontario point out the places where the long-lasting congestion problem is the highest, the demand for the existing infrastructure is the strongest and the traffic flow contributes the most to the provincial transportation system. The results of this analysis are planning decisions for capacity expansion, safety improvements, and future demand for mobility [1].

- **AADT Trend based on Highway:**
The traffic volumes on Highway 401 have been the highest in Ontario consistently; thus, it has been the most important mobility corridor of the province. There has been added a special visualization to show the long-term growth pattern of the highway. The trend indicates a gradual increase in AADT from around 27 million in the late 1980s to over 56 million in 2021, which is a result of population growth, heavy commuter traffic, and large-scale freight activities in the area. This specific perspective has made it clearer that the demand on Highway 401 has increased over time, thereby asserting its role to be important in transportation planning of the province [1].

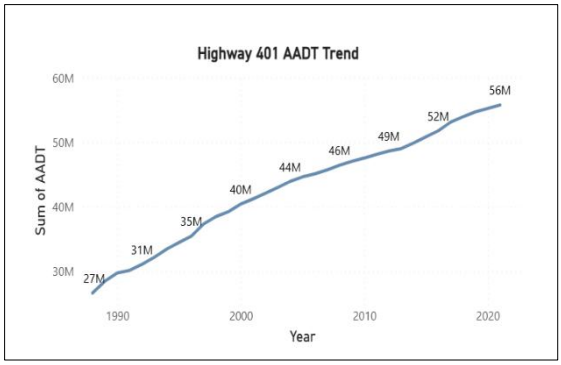


Fig. 11. Highway 401 AADT Trend (1988-2021) [1, 2]

- **The YoY Growth % :**
This YoY growth indicator indicates the yearly change in traffic volume for Ontario, thus revealing periods of rapid growth or decline. It also shows the long-term trends, e.g., the steady growth of the 1990s and 2000s, the temporary drops during the economic slowdowns, and the latest recovery patterns. Users can do this by selecting a specific year using the slicer and having a quick comparison of annual variations across the regions and how the regions react to population growth, infrastructure development, or other factors. Year-on-year analysis facilitates a more profound comprehension of the traffic demand dynamics throughout the province [1].

Fig. 12. YoY Traffic Growth for Selected Year (2000) [1, 2]

- Finally, the Traffic Trend Power BI dashboard [2] provides an interactive view of long-term traffic growth across Ontario's highway network. Key insights include:
    - Central Ontario consistently carries the highest traffic volumes, accounting for nearly 70% of all AADT, driven by dense population and major commuter corridors [1].
    - Highway 401 remains the busiest highway in the province, far surpassing all other routes and showing steady growth from 27M AADT in 1988 to over 56M by 2021 [1].
    - Most regions show steady traffic growth over the past three decades, reflecting rising mobility needs, population expansion, and increasing travel demand [1].
    - The Top 10 busiest highways highlight that commuter-heavy routes dominate Ontario's transportation network [1].
    - The YoY Growth % indicator enables users to isolate annual changes, helping identify years with notable increases or declines in traffic activity [1].

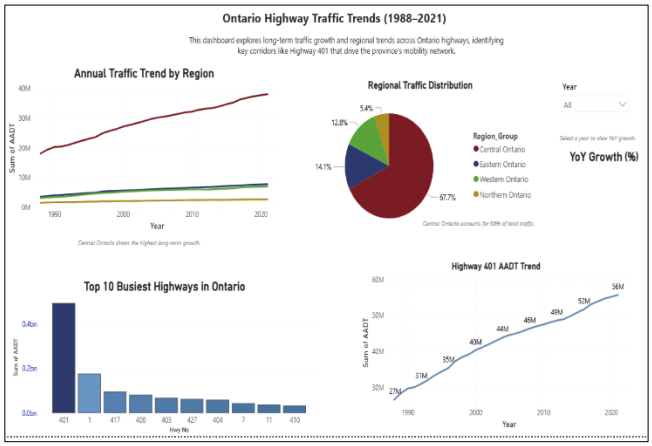


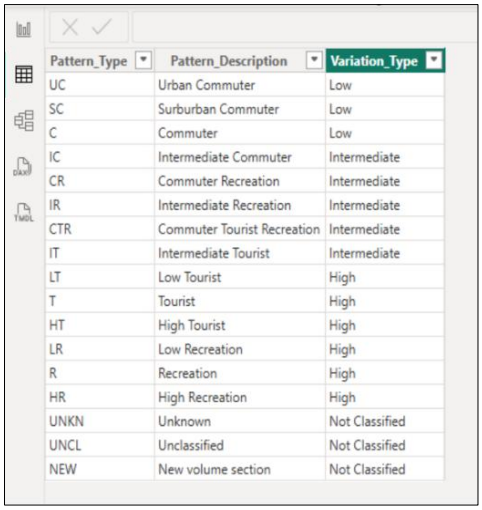
Fig. 13. Ontario Highway Traffic Trend Analysis Dashboard [1, 2]

2. Seasonal Analysis:

- Impact of Seasonal Variations and Commuter type on Traffic Volume:

  This analysis focuses on understanding how traffic volumes fluctuate across different seasons. Three key measures in the dataset help capture these variations [1]:
    - SADT (Summer Average Daily Traffic): Represents traffic during July and August.
    - WADT (Winter Average Daily Traffic): Represents traffic during December, January, February, and March.
    - Pattern Type: Describes the nature of traffic flow (commuter, tourist, recreational, etc.) and its variation type, categorized as Low, Intermediate, or High, indicating the degree of difference between summer and winter traffic.

There are 14 distinct pattern types in total [1]. To better interpret this information, a separate reference table was created containing the Pattern Type, Pattern Description, and Variation Type. This new table was linked to the primary traffic dataset using a one-to-many relationship based on the Pattern Type as the primary key.



Pattern_Type	Pattern_Description	Variation_Type
UC	Urban Commuter	Low
SC	Surburban Commuter	Low
C	Commuter	Low
IC	Intermediate Commuter	Intermediate
CR	Commuter Recreation	Intermediate
IR	Intermediate Recreation	Intermediate
CTR	Commuter Tourist Recreation	Intermediate
IT	Intermediate Tourist	Intermediate
LT	Low Tourist	High
T	Tourist	High
HT	High Tourist	High
LR	Low Recreation	High
R	Recreation	High
HR	High Recreation	High
UNKN	Unknown	Not Classified
UNCL	Unclassified	Not Classified
NEW	New volume section	Not Classified

Fig. 14. Seasonal Traffic Pattern Classification Table [1, 2]

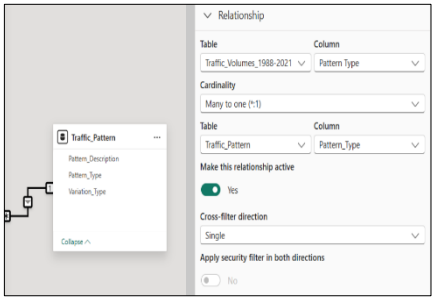


Fig. 15. Table Relationship of Traffic Pattern Type [1, 2]

- **Impact of Commute Type on Seasonal Traffic:** A clustered bar chart compares Summer (SADT) and Winter (WADT) traffic sums across different pattern types. This visualization illustrates how various commute types influence seasonal traffic changes. For example, recreational or tourist traffic shows a noticeable increase during the summer months compared to winter.
  The chart is complemented by a variation filter and a reference table displaying each pattern type's abbreviation, full description, and corresponding summer and winter traffic totals [1].

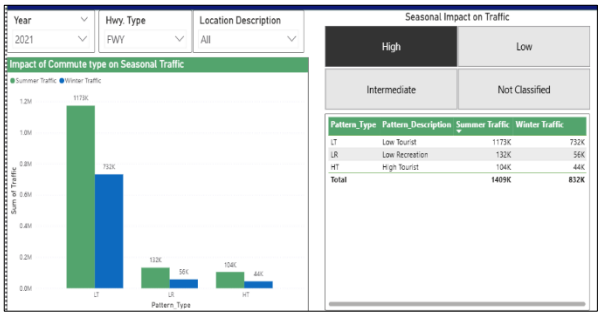


Fig. 16. Seasonal Traffic Comparison by Pattern Type [1, 2]

- **Traffic Growth per Year:**
  A line chart shows how summer traffic consistently exceeds winter traffic over time. For instance, in 2010, a significant rise in summer traffic was observed, particularly for high-variation categories such as tourist and recreational routes [1].

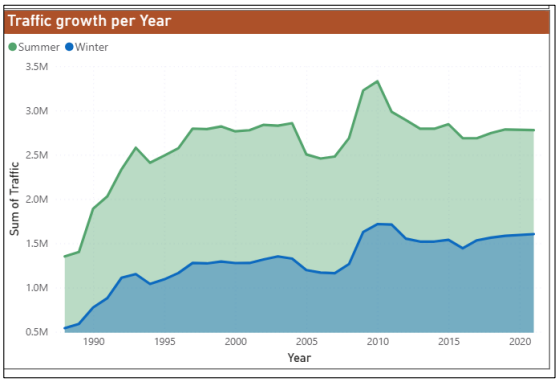


Fig. 17. Yearly Traffic Growth: Summer vs. Winter [1, 2]

- **Total Traffic: Summer vs. Winter:**
  A donut chart visualizes the overall traffic distribution, with approximately 2 billion total vehicles recorded in summer and 1 billion in winter across the entire dataset [1].

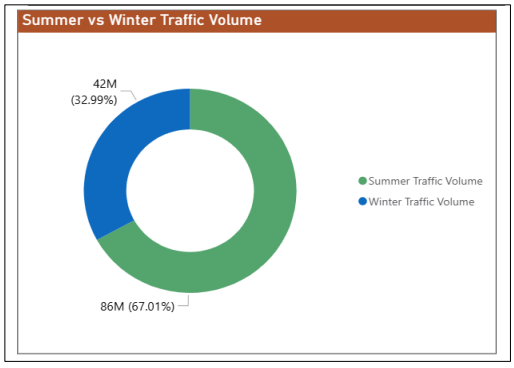


Fig. 18. Seasonal Distribution of Traffic Volume [1, 2]

- **Summer Traffic Analysis:**
  A clustered bar chart representing total traffic by year with traffic patterns as legends. The graph below spikes in the year 2010 and continues in the same level till 2021, with most of the traffic type containing tourists and recreational travelers [1]. This means that tourism and recreational activities have increased in last 10 years in Ontario and occupies major portion of traffic specially during the summer season.

Impact on Collision Rate during Summer-
Overall collision rate has been reduced significantly over the past 10 years during the summer season. This shows that there might be a positive impact of improved road infrastructure causing lesser collisions.

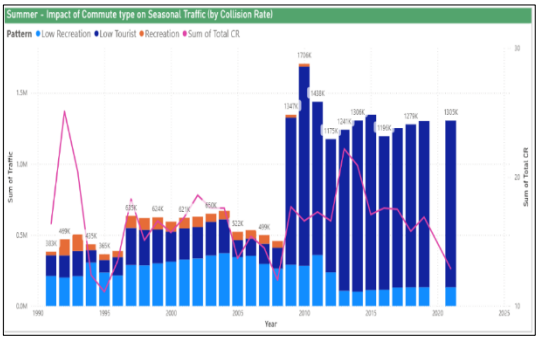


Fig. 19. Summer Traffic and Collision Rate [1, 2]

- **Winter Traffic Analysis:**
  The tourism and recreational activities also emerge in the winter season and most of the people commuting are the ones with the intention of joining recreational activities or visiting the province.

Impact on Collision Rate during Winter:
Overall collision rate has been increased significantly over the past 10 years during the winter season [1]. We assume that this is due to global warming, environmental changes and rise in temperatures during the winter season. Snowstorms, slippery wet roads and low visibility can be some of the major reasons for higher collisions in winter.

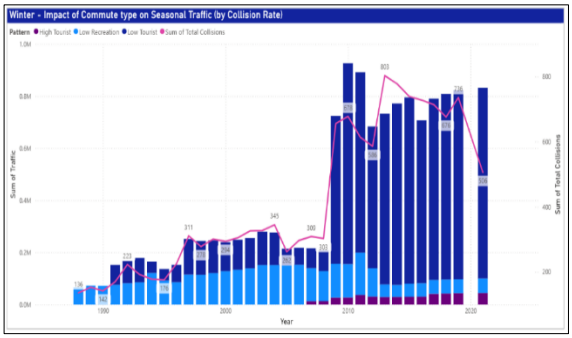


Fig. 20. Winter Traffic and Collision Rate [1, 2]

- The overall Power BI dashboard [2] enables dynamic filtering for deeper insights; some are defined as below:
  - In 2021, the dashboard shows that summer traffic was approximately 28 million, while winter traffic was about 14 million, indicating much higher travel activity during summer months [1].
  - The seasonal breakdown shows that tourist and recreational travel dominate summer traffic, while commuter traffic remains strong across both seasons [1].
  - Total traffic has increased steadily over the last decade, supported by the growth of tourism, recreation, and regional mobility within Ontario [1].
  - The summer collision rate has decreased over the past 10 years, suggesting improvements in road design, maintenance, and infrastructure [1].
  - Winter collision rates remain higher than summer, mainly due to severe weather conditions, poor visibility, icy roads, and increased safety risks [1].

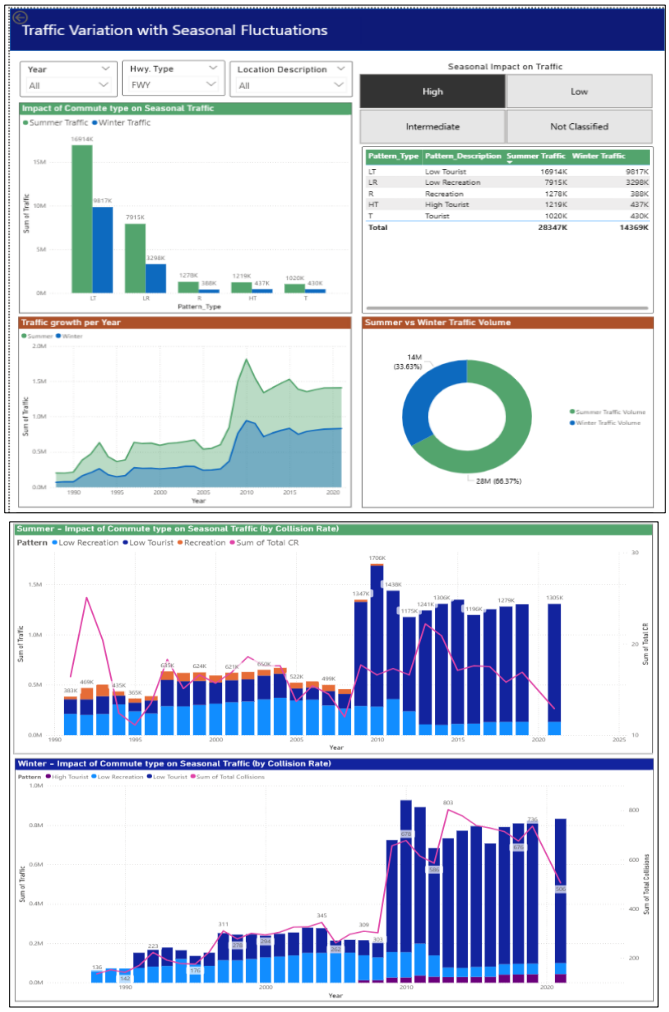


Fig. 21. Ontario Traffic Trend and Seasonal Variation Dashboard [1, 2]

3. Truck and Freight Analysis:

- The truck and freight analysis focuses on the long-term freight movement on highways in Ontario from 1988 to 2021 [1]. The main indicators included in this research are Max Truck AADT, the most contributing region to freight, and the average freight share which together give a picture of the freight intensity in the most recent year of the study i.e. 2021. These KPIs not only indicate which regions have the greatest truck demand but also give an idea of how freight patterns change with the economic activity in the province.

Fig. 22. Freight Traffic KPI Summary (2021) [1, 2]

- **Regional Truck AADT Trends:**
  The AADT trend analysis is focused on the evolution of the truck traffic volumes across the different regions of Ontario between the years 1988 and 2021 [1]. The trend lines indicate that the Central part of Ontario has, without exception, the highest truck AADT, indicating a lot of industrial and cross-border freight activities in that area. The Eastern and Western parts of the province exhibit a moderate but constant increase, while the Northerly areas show a relatively low volume. The long-term trends demonstrate not only how freight demand maps out but also how it is in line with the economic growth of the region and the major trade corridors.

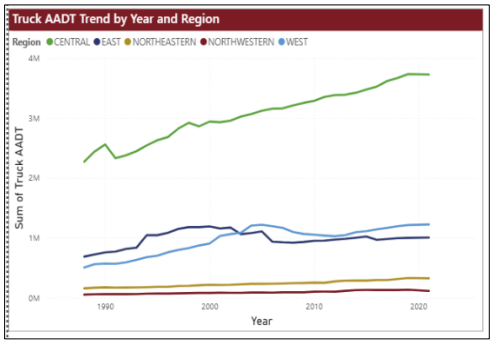


Fig. 23. Truck AADT Trend by Year and Region [1, 2]

- **Regional Freight Contribution :**
  The freight share by region reveals a considerable variation of truck-based freight activity over Ontario's main geographic zones. The northwestern and western parts of Ontario account for the greatest shares of freight movement, which goes hand-in-hand with the fact that these areas are very industrially active, resource-based operations are taking place, and long-distance trucking is heavily used in these corridors. Eastern Ontario gets a moderate share of the movement while Northeastern Ontario is slightly below

Eastern Ontario due to its smaller population centers and less freight-intensive routes. Central Ontario has the lowest freight share, which is consistent with higher commuter traffic but lower overall reliance on truck transport for goods compared to other parts of Ontario. This distribution pattern not only reveals the areas with the heaviest freight loads but also indicates where the transportation infrastructure needs to support the greatest freight demand [1].

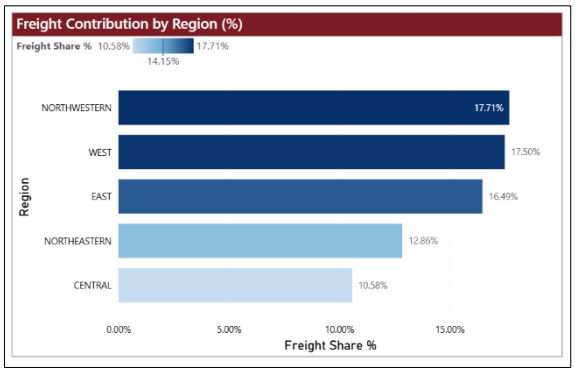


Fig. 24. Freight Distribution Across Ontario Regions [1, 2]

- **Long Term Growth of Total and Truck AADT:** The trend comparison of total AADT and truck AADT from 1988 to 2021 reveals that there has been a gradual and consistent long-term increase in both overall highway demand and freight-specific activity [1]. Total traffic volume rises every ten years, and truck AADT goes up as well, which is a sign of increasing reliance on road-based freight transport. The trend's similarity points to the fact that freight transport is still a significant part of the Ontario highway system and its growth is in direct proportion to overall mobility and economic development.

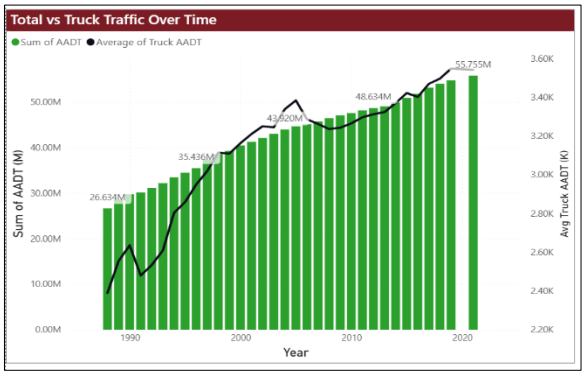


Fig. 25. Trends in Total AADT and Truck AADT (1988–2021) [1, 2]

- **Regional Group Contribution to Freight Activity:** The distribution of freight share by region group indicates where truck activity is mostly concentrated in Ontario's geographical regions. Western Ontario is the largest of the regions in terms of freight movement, and this is followed by Eastern and Northern Ontario, which shows that these corridors are highly industrialized and commercialized. Central Ontario, on the other hand, has the least supply, which is consistent with the fact that it has fewer freight-intensive routes in comparison to other regions. Thus, this summary grouping gives the overall picture of how freight demand corresponds to the main economic zones and infrastructure networks.

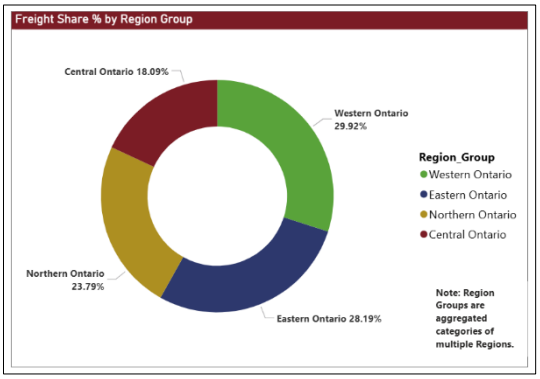


Fig. 26. Freight Share Distribution by Region Group [1, 2]

- Overall, the freight traffic Power BI [2] dashboard provides an interactive, year-by-year view of how truck movement and freight intensity have evolved across Ontario's highway network from 1988–2021. The key insights include:
  - Western and Northwestern Ontario always rank first in the freight share percentages which implies strong industrial activities, long-haul routes, and the locations of main trade corridors [1].
  - Over the last thirty years, the total truck AADT has risen gradually, indicating the increase in the demand for goods movement, the growth of supply-chain operations, and Ontario's reliance on trucking for commercial transport [1].
  - The Truck AADT Trend visual portrays that Central and Eastern Ontario are still very active but only moderately so in the freight market while the Northern regions are characterized by low freight volumes, which can be attributed to smaller populations and fewer freight-intensive roads [1].
  - The Freight Contribution and Freight Share % charts go hand in hand showcasing the regions which carry the bulk of freight and the manner in which provincial freight consumption is distributed geographically [1].
  - The dashboard's KPI indicators (Max Truck AADT, Top Freight Region, Avg Freight Share %) furnish instant performance feedback and empower the users to easily determine the freight intensity for any specified year [1].
  - The interactive slicers (Year and Region Group) add to the analytical depth by allowing the users to analyze how freight patterns move geographically and temporally.

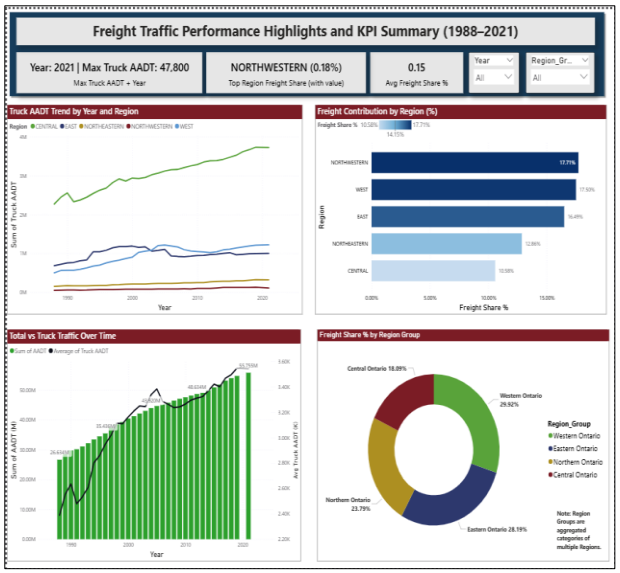


Fig. 27. Freight Traffic Performance Dashboard (1988–2021) [1, 2]

4. Safety and Congestion Analysis:

- The analysis of collision risk starts with a bunch of high-level KPIs that give an overview of the network safety conditions in general. The indicators consist of the Average Collision Rate (0.95), Truck Collisions (181K), and Total Collisions (1M+), giving a very quick overview of the number of collisions affecting the whole province of Ontario through all the highways [1]. These KPIs are very useful in determining whether the number of collisions is in line with the traffic levels and also, they are giving the users the possibility to quickly tell the overall safety environment.

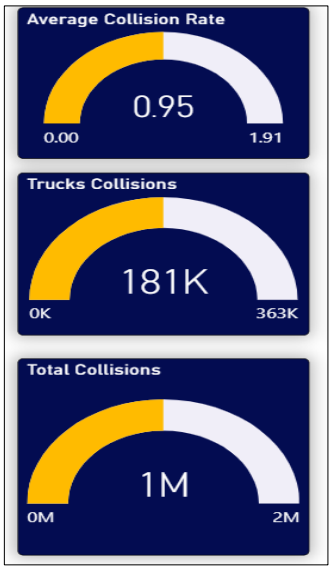


Fig. 28. Collision Risk KPI Indicators [1, 2]

- **Collision Flow Across Regions and Risk Levels:** This collision flow analysis not only reveals how total collisions spread via Region Group, Risk Level and AADT but also shows the behavior of risk at different traffic volumes. Collisions classified as High-Risk are the most numerous in Northern Ontario, which has a low AADT, thus suggesting the role of environmental and geographic factors. The situation is quite different in Central and Western Ontario where there are more Medium-Risk and Low-Risk accidents, which indicates that the area has a lot of commuters and the roads are in good condition. Eastern Ontario consistently exhibits the lowest risk for all categories. This distribution is helpful for planners in that it informs them about the regions that need to be prioritized for interventions [1].

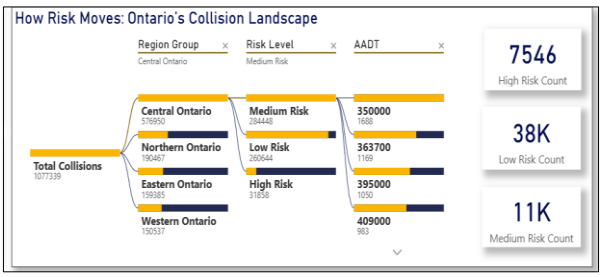


Fig. 29. Collision Risk Flow Across Ontario Regions [1, 2]

- **Total Collision Risk by Region Group:**

Total collision risk is more or less same across Ontario's regions but not in the same magnitude. The CR in the Northern region of Ontario (29K) [1] is the highest despite lower traffic volumes, which shows that environmental and road conditions are the major factors. In Central Ontario, the risk is low (10K) [1], whereas Eastern (7K) [1] and Western Ontario (6K) [1] areas are considered completely safe in terms of collision and have the lowest risk of all. These differences indicate the area's safety improvement needs, which assist in focusing those efforts.

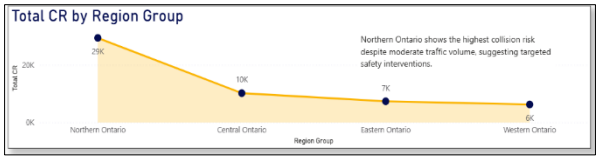


Fig. 30. Total Collision Risk by Region Group [1, 2]

- The Ontario Collision Risk Power BI [2] Dashboard provides a comprehensive and interactive overview of how collision risk varies across the province's highway network. Using KPI indicators, risk-flow mapping, and region-level comparisons, the dashboard highlights the key safety patterns that influence provincial transportation planning. Key insights include:

- The overall safety in the network has not changed considerably, signifying that the average collision rate of 0.95, 181K truck related collisions, and more than 1 million incidents, in total, are simply a reflection of the nature of the whole dataset [1].
- The Collision Flow visual divides the distribution of collisions into Region Group, Risk Level and AADT.
- The number of high-risk collisions in Northern Ontario is the highest, even though the traffic volume is low, which means that environmental factors and the state of the roads in rural areas are the major contributors to the problem [1].
- Central and Western Ontario have higher numbers of medium-risk and low-risk collisions, which are a consequence of heavy commuter traffic and good infrastructure [1].
- The Total CR by Region Group chart, depicting the risk of collision by region, indicates that Northern Ontario has the highest overall risk of collision, which necessitates the implementation of safety programs and mitigation measures in the low traffic but high-risk areas [1].
- The KPI counters for high-risk, medium-risk, and low-risk categories give an immediate view of how the severity of collisions is distributed throughout the network [1].
- The use of the interactive slicers (Region Group, Risk Level, AADT) makes the dashboard versatile for conducting scenario analyses and allows planners to study the geographic and traffic condition changes that lead to different collision patterns.

Fig. 31. Ontario Collision Risk Landscape Dashboard [1, 2]

IV. Results

Finally, the integrated Power BI [2] dashboard offers a thorough overview of the entire highway network of Ontario by merging the analysis of long-term mobility trends, seasonal traffic patterns, freight demand, and collision risks from 1988 to 2021 [1]. The findings indicate that traffic volumes have increased gradually in all regions, with Central Ontario always bearing the highest AADT. The seasonal analysis uncovers significantly higher summer traffic, caused by tourism and recreational travel. The freight activities are mainly in Western and Northwestern Ontario, which indicates the presence of a strong industrial base and cross-border movement. The patterns of collision risks imply that Northern Ontario has the highest risk, although the traffic is low, which points to environmental and road conditions being the main factors, whereas Central and Western Ontario have more moderate risk levels. Altogether, the integrated insights reveal a rising demand for mobility, an uneven freight distribution, and safety issues specific to each region, thus giving a solid ground for the strategic planning of infrastructure priorities [1].

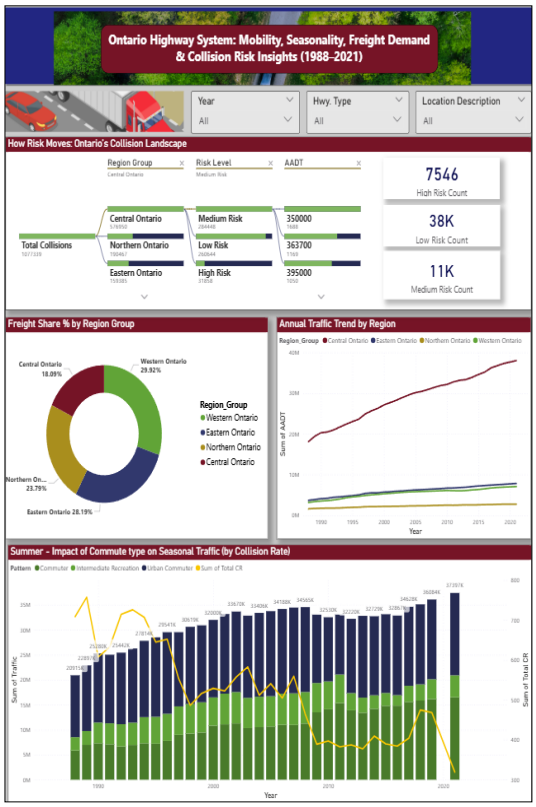


Fig. 32. Integrated Ontario Highway System Insights Dashboard [1, 2]

V. Conclusion and Recommendations

The overall analysis looked into the highway system of Ontario from the year 1988 to 2021 [1], considering the long-term mobility trends, seasonal traffic variation, freight demand, and collision risk, altogether. Central Ontario has been revealed as the area with the highest overall traffic volumes, summer months have been identified as the time with significantly higher travel activity, while Western/Northwestern Ontario are the regions with the largest share of freight movement. The situation is the opposite in Northern Ontario where there is less traffic but the highest collision risk, which is a sign that the environment, weather, and road conditions influence this risk.

Recommendations

- Increase safety in Northern Ontario by conducting infrastructure improvements, introducing weather-related systems, and doing targeted law enforcement.

- Build up the capacity along the main commuter routes, especially in Central Ontario and on Highway 401.
- Fortify the summer operations, especially in those corridors that have the highest demand during summer.
- Ensure the freight movement is reliable along the key trade routes in Western and Northwestern regions.
- Keep the integrated monitoring system in place using dashboards that will help to determine the policy and investment decisions based on the data.

APPENDIX A: TEAM CONTRIBUTIONS

Shara Khandakar - Traffic Trends Analysis

Murk Asad - Seasonal Analysis

Maksuda E Elahi - Truck and Freight Analysis

Anam Vakil - Safety and Congestion Analysis

REFERENCES

[1] Ontario Ministry of Transportation, "Technical Publications Portal." Accessed: Nov. 22, 2025. [Online]. Available : https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/tvSplash.aspx

[2] *Microsoft Corporation*, "Microsoft Power BI." Accessed: Nov. 22, 2025. [Online]. Available: https://powerbi.microsoft.com/