2018

TORONTO VISION ZERO CHALLENGE

PREPARED BY TEAM LOOP

TACKLING TORONTO'S HIGH INJURY NETWORK

ABOUT US

PROJECT LEADER

After graduating from my doctoral program in Ethnic Studies, I used my qualitative research skills to become a marketing professional in the media and entertainment industry. Soon, I became obsessed with using data analysis to solve-real world problems in the public sector. I'm glad to have been able to assemble such a talented team to tackle the Toronto Vision Zero Challenge. I contributed a lot of the ETL, GIS work, and data visualizations in addition to serving as project manager.

Jason Kim | Consultant

DATA ANALYST TEAM

Christopher Kim | Teacher

I am currently a secondary school teacher in Mathematics and Physics with a background in computational physics from my master's program. For the Toronto Vision Zero challenge, I helped in contributing to some of the secondary research, and data visualizations.

As a healthcare professional and engineer, I have 10-years of experience in infrastructure modelling, health policy, and non-profit organizational strategy. I helped in building and running models to predict the impact of our solutions as well as reaching out to healthcare and social workers in helping design our policies.

John Perreira | Doctor

USER RESEARCH TEAM

I'm a UX designer with a background in psychology, a deep appreciation for research, and a passion for objective and simplistic design. My experiences in psychology and human resources have made me a natural learner of human thoughts and behavior. I've always loved learning about the motivation behind human behavior as it helps me to understand how to elicit the desired action.

Christie Zhu | UX Designer

I'm a technology Lawyer and IT Professional with experience in technology law matters, cyber-security, privacy law, corporate commercial law, systems analysis & design, and public policy formulation. I'm also an executive member of the Ontario Bar Association's Privacy and Access to Information Law section. I hope to contribute to the legal and policy development utilizing his unique understanding of technology and legal solutions.

Shan Alavi | Lawyer

Jesse Li | Student

I'm a first year undergraduate student studying finance at McGill. Born and raised in Montreal, I moved to Toronto for a summer internship at Scotiabank. In participating in the Toronto Vision Zero challenge, I wish to bring a positive impact on Toronto citizens. I believe everyone should have the peace of mind to travel freely around the city in a safe and convenient manner. As a young adult, I hope the Toronto Vision Zero challenge will help the city invest in the most innovative and effective solutions to eventually eliminate all fatalities from traffic collisions.

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INTRODUCTION

Our goal for the Toronto Vision Zero Challenge was to create an implementation plan for the City of Toronto that would benefit all four of the priority groups (newcomers, seniors, people living with disabilities, and school children) while also being politically viable.

Therefore, we prioritized solutions that were effective at reducing collisions and KSIs (Killed or Seriously Injured) on our streets, are quick and inexpensive to implement, and are likely to garner widespread political support due to their impact and subtlety.

Fortunately, the City of Toronto has a rich collection of collision and traffic data dating back more than 10 years ago. However, a large part of the challenge was to bring these widely dispersed data together and focus on the data sets that did not require too much pre-processing and cleaning due to the small amount of time and human resources available.

Our team of talented data scientists have constructed numerous models to help identify key areas of the city that need greater safety measures. A key framework to come out of this is the Toronto High Injury Network (THIN), which we hope can serve as the start of a one-year plan to fast track Toronto's Vision Zero efforts.

Our user research group analyzed over thirty different Vision Zero cities and their action plans and narrowed our scope to only the most effective and inexpensive solutions. We also conducted several expert interviews as well as an online survey with nearly 40 respondents from all walks of life to get to the root of the problem.

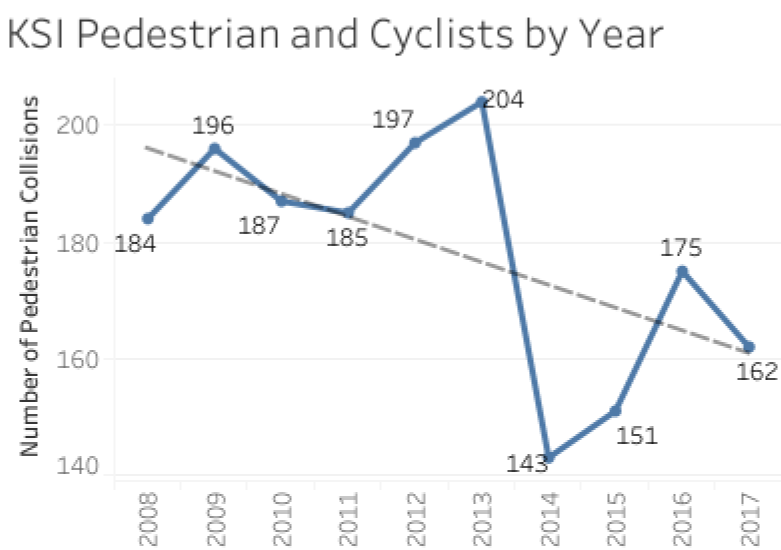
Solution Guidelines

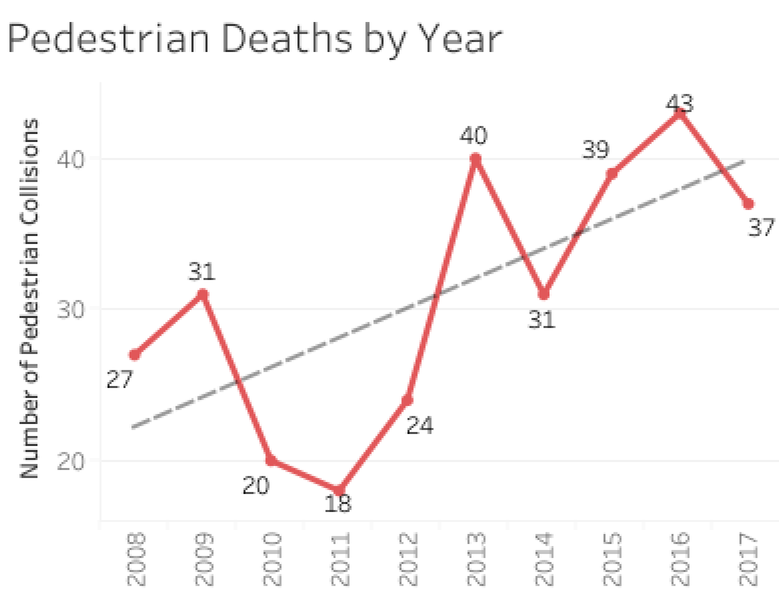
- **Accessible by Default** — Our solutions must be accessible to all users. They must be beneficial to all parts of the community and cannot be limited to a specific group of people.
- **Data Driven** — It is important to address these problems in a fair and logical manner. By using data to shape our solutions, it will decrease costs and increase impact.
- **Sensible** — The financing and timeline to implement these solutions must be reasonable while also being feasible enough to gain the support of the public and City Hall.
- **Measurable** — Only by measuring the progress of our solutions, can we be held accountable the performance and success of the Vision Zero initiatives.

TRENDS

Toronto's track record for KSI collisions -- a collision where a fatality or hospitalization has occurred -- have been declining slightly over a decade, though pedestrian fatalities are alarmingly on the rise.

As the most populous city in Canada, Toronto has the responsibility to keep up with other urban street networks in terms of safety. By finding key trends through data analysis, traffic research, and interviewing users, it is possible to identify the main contributing factors to a collision and implement policies to help reduce them.





TRENDS

See an interactive summary of key stats

Although collisions are distinct events, they don't occur in a vacuum. There is a rich context involved: the individual herself, the street-level context, and the wider context of the neighbourhood. This is why much of our data analysis focused on tying these three levels together in order to predict collisions and create a more user- and data-centric approach to implementing a solution.

In the preliminary analysis, a few trends stood out which helped us to refine our modelling efforts later: **age**, **being a cyclist**, **being in an immigrant community**, **road type**, and **whether the pedestrian was at an intersection**.

The distinct grid-like pattern of collisions seen in the map below gave us our first clue: 65.8% of all collisions occur on major arterial roads -- and it is precisely these long, wide roads which connect parts of the city together in a grid that facilitates faster and more cars.

Contrary to popular imagination, those who cross mid-block ("jaywalkers") are not the problem as they make up the minority of cases. 76.5% of collisions occur at intersections and 61.3% of the time the pedestrian has the right-of-way.

65.8%

of collisions occurred on major arterial roads

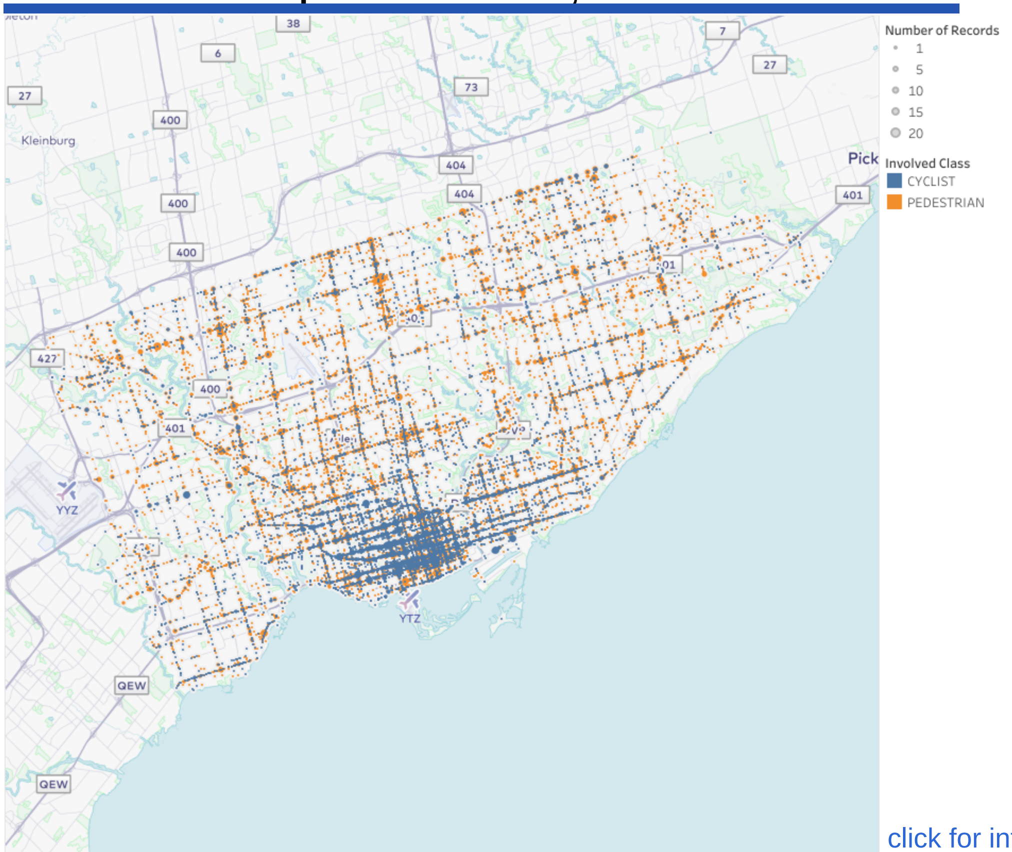
76.5%

of collisions occurred at intersections

61.3%

of people people hit had the right-of-way

All of Toronto's Reported Collisions, 2008-2017



click for interactive version

TRENDS

Seniors (people aged 65+) made up 11% of all collisions and comprised of 24.7% of all KSIs, while children (under 18) were only 0.07% of KSIs. Cyclists comprised 23.2% of KSIs -- a very high number considering they are far outnumbered by other modes of transportation. Although the City does not collect data on the newcomer status or ethnic and linguistic background of collision victims, we found that 49.1% of KSIs take place in neighbourhoods that have more than the city-wide average number of immigrants living in the area.

It was difficult to find any trends with the disabled community as essentially no data is collected (there are a handful of collision reports that identify the victim as a wheelchair user, but these number less than 20 in a set of over 27,000 records; and of course, not all disabled people are wheelchair users). One proxy variable we examined that could serve as a rough estimate for the disabled community relates to social assistance recipients aggregated by neighbourhood since this measure captures the population receiving Ontario Disability Program support. However, this measure includes people receiving unemployment insurance and other social assistance support, making it a rather poor way to infer trends about the disabled community. To help the city better address accessibility issues, we advocate that all city infrastructure be **accessible by default**. Not only is this safer for everyone, it also helps Toronto be in compliance with the Accessibility for Ontarians with Disabilities Act (AODA), which the City must do by 2025.

24.7%

of all those who die or are hospitalized by a collision are seniors.

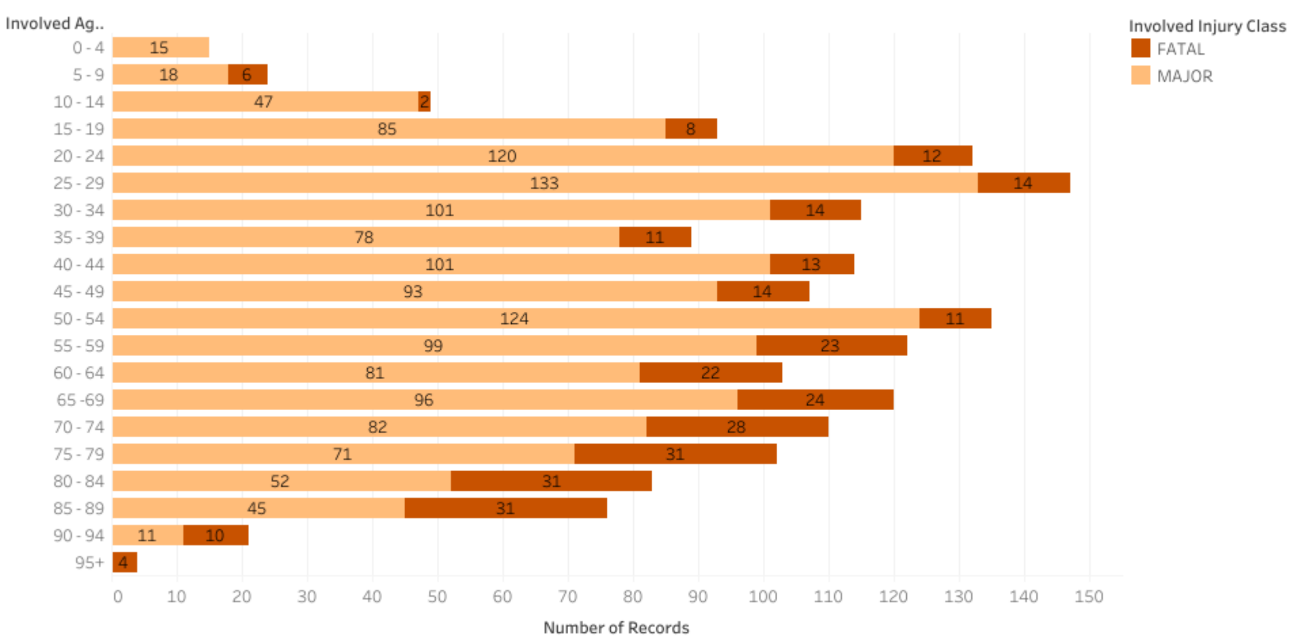
23.2%

of all those who die or are hospitalized by a collision are cyclists.

49.1%

of collisions that result in death or hospitalization occur where newcomers comprise more than 45% of the area's population.

Age Distribution of Major and Fatal Collisions, 2008-2017



USER EXPERIENCE RESEARCH

In order to make sure our design is relevant to our target users, we conducted user research to understand their experiences and any potential needs. We adopted online surveys and direct interviews to ensure our process is an in-depth and extensive learning of our diverse user groups. Online surveys were sent to local Torontonians and online communities as a tool to assess their road safety experiences as pedestrians/cyclists (https://goo.gl/forms/wUOjARYKJjHs4Y6C3). While one-on-one interviews were conducted with other user groups (e.g. elderly, school teachers, and city planners) to gain an in-depth understanding in areas that are difficult to examine through online surveys.

We gathered a total of 37 survey responses from local pedestrians and cyclists. When we asked them "how safe do you feel about Toronto's road safety situation as a pedestrian?" based on a scale of 1 to 5 (1=not safe at all, 5= very safe), most people (27.8%) rated 2 and least people (13.9%) rated 5. Participants were asked to provide an explanation and most of them were about aggressive driver behaviour. More specifically, many pedestrians felt unsafe when crossing with turning traffic, especially cars trying to make a right turn with pedestrians on crosswalks. It was mentioned that turning cars often fail to give pedestrians right of way and they tend to block crosswalks while waiting to turn. Besides aggressive drivers, a few mentioned that aggressive cyclists who failed to obey traffic laws also put pedestrians at risk. However it's harder to look out for aggressive cyclists since "they ride their bikes as if they are both pedestrian and driver, meanwhile they are technically vehicles on their bikes", according to one of the survey responses.

27.8%

of survey respondents rated their safety experience 2 out of 5, which also was the most common response.

Confirming our research, many cited aggressive right turns at intersections as a key problem.

City Staff

We approached city staff one-on-one to seek their insights on the problem and why from the outside it looks as if the City has been spinning its wheels on the issue of pedestrian safety. After extensive research of various policy documents provided by the Challenge as well as our own deep dive into internal traffic studies, pilot projects, and the City's own Vision Zero documents and extensive findings in the Complete Streets Guidelines, we came away with the suspicion that the City knew full well what it needed to do, but had problems with implementation and prioritization. We confirmed this suspicion with our one-on-one discussions. For instance, we found that the City had already done an internal study on the effectiveness of Leading Pedestrian Intervals (LPIs) many years ago in 2005. We asked why such a well-researched and low cost measure has failed to gain adoption in the City (see Solutions section), and the response was that things get easily bogged down at City Hall and budgets change. This validated for us the fact that the key part of this Challenge is not in identifying what to do, but how and where to do it and evaluating the political risk of solutions.

School Children

click to see the Metrolinx School Travel in the GTHA Report

We talked with teachers and parents involved in the pedestrian safety programs at their schools, as well as conducted our own extensive research on the matter. They confirmed the overwhelming trend of parents today choosing to drop off and pick up their kids by car. For instance, a Metrolinx study found that the number of students in the GTHA who are driven to or from school have increased by about two-fold since 1986. Our interview subjects shared with us that schools, many of which were built prior to this proliferation of student travel by car, are poorly equipped to deal with this increased strain on their local transportation system. David Hornell Junior School, located in a sleepy section of Mimico, exemplifies this problem.

A student at David Hornell Junior School was struck last year in front of the school on the street pictured above. In many ways, this is the picture of the ideal neighbourhood school with technically a low risk of a collisions: the lanes are narrow which slows down cars, the area in front of the school is at the standard school zone limit of 40 km/h, and the area has many dead ends, sheltering it to some extent from traffic. But imagine this street with frantic parents dropping off and picking up their children and commuters attempting to dodge traffic on arterial roads, and you can clearly see the built environment is not meant to take on this added capacity. And when a system is over capacity, it will eventually break.

Seniors

Seniors make up a disproportionately large amount of the most serious collisions, with nearly a quarter of all KSIs involving a senior. The seniors we surveyed and talked to shared with us that they felt that drivers were too aggressive (drive too fast or carelessly), an observation shared across all four user groups. Not only that, the data analysis was very clear when it came to showing a strong, significant relationship between older age and KSI risk. It is for this reason we took extra effort to map out where seniors live in the City due to their vulnerability.

DATA CLEANING & PRE-PROCESSING

12
Datasets

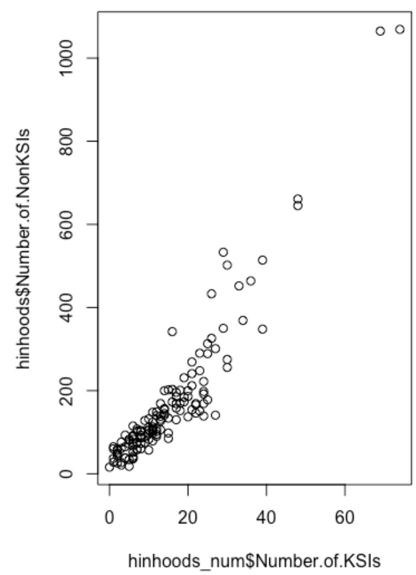
3
Datasets

We performed hundreds of cleaning and pre-processing operations on various datasets. By modifying these initial datasets, we were able to tailor all the gathered information to be feasible for analysis of the challenge. Although numerous processes were used to modify the datasets, we will describe how we performed the major operations to give a good sense of our methodology. All the cleaned and transformed datasets can be found in our GitHub with a detailed RMD file for re-creating our process in R as well as a revised data dictionary.

Approach to Data Analysis

In selecting which datasets to use in the short amount of time available, we prioritized datasets which could give us the most information regarding our two outcome variables of interest (KSIs per road km and whether a KSI occurred or not) with the least amount of pre-processing and cleaning.

The predicted KSI per road km in a given neighbourhood or street is a regression problem that looks to predicts KSI density, while predicting a KSI outcome as defined as the probability of a collision leading to either a death or major injury (aka Killed or Seriously Injured) is a classification problem.



Both approaches were used due to the nature of the Vision Zero Challenge - successful cities that have adopted Vision Zero like New York City prioritize high KSI zones, but there is a highly significant relationship between KSIs and non-KSIs in Toronto, so much so that there is likely co-linearity at work (p-value < 0.05, Pearson's R of 0.93). This led us to prioritize KSI probability and KSI density rather than just plain frequency of collisions as the outcome we are most interested in.

Joining & Cleaning Datasets

We opted to use the collisions dataset provided by the challenge rather than the Toronto Police Service’s KSI dataset (Killed or Seriously Injured) since it contained far more records and allowed us compare collision events resulting in a KSI vs. those which did not. Using Hive, we filtered out all collisions that did not involve pedestrians, wheelchairs, or cyclists as well as collisions that did not occur on major arterial, minor arterial, local, and collector road types since these excluded types were not designed for pedestrian use, e.g. expressways, on-ramps, etc.

Using Tableau Prep, we manually cleaned different spellings of street names for the street1 field in order minimize the amount of records that had data entry errors and because we needed to use the street name as a key to perform a join (more on this below). For example, all records with “SPADINA AV” were manually regrouped to read “SPADINA AVE.” An automated approach was attempted using Tableau Prep since it has the convenient option of re-grouping text strings by pronunciation or similar characters using an algorithm, but this led to many errors since many of Toronto’s most trafficked streets have only slight variations in their names (e.g. Dundas St. E and Dundas St. W).

Associating Collisions to Geo-data: Neighbourhood Areas

Next we associated each collision event with one of Toronto’s 140 neighbourhoods which the City uses for planning purposes. These neighbourhoods are created from census tracts and their boundaries do not change over time to make neighbourhood-by-neighbourhood comparisons over time possible. Many of the City’s open access datasets also use these neighbourhood areas as their unit of analysis, which means if every collision is associated with a neighbourhood, one can easily join neighbourhood-level data and analyze the wider socio-demographic context in which a collision occurred. With the diverse user needs of the City and Challenge, we felt we had to extend the collisions dataset with the neighbourhood-level data to see what neighbourhood-levels factors influence the probability of a KSI and the KSI per road kilometres (aka KSI density).

Thus, we performed a spatial join between the collisions dataset and the neighbourhood boundaries shapefile using QGIS. Each collision point was plotted using their longitude and latitude in one layer and the neighbourhoods were imported as polygons into another. Each point within a polygon was then spatially joined creating a new collisions dataset with two new fields: the unique neighbourhood ID and the name of the neighbourhood. This ID was the key that made it possible to join six other datasets to it.

OUT-OF-BOUNDS COLLISIONS

For a small amount of points primarily along the northern and western edges of the City’s boundaries that were out-of-bounds of a neighbourhood area, we snapped these points to the nearest neighbourhood using K-Nearest Neighbours. Only 157 out of 27,119 collisions could not be properly associated with a neighbourhood after using the above methods

Associating Each Collision with Toronto Centreline

Although neighborhood areas provide crucial socio-demographic information, they are a coarse unit of analysis since they are so large and because it would be inefficient to implement solutions on an area-by-area basis. As a result, we decided to also incorporate street-level data into the collisions dataset to get a better picture of which traffic corridors were the most dangerous.

1. CALCULATING STREET LENGTHS

Using QGIS, we converted the Toronto Centreline shapefile from WGS84 projection to North America Equidistant Conic projection to produce accurate street lengths in metres. Using an SQL query in QGIS, we created a new total length field which summed the lengths of all line segments by their unique ID and converted this value into kilometres.

2. CONNECTING STREET SEGMENTS

We then dissolved all line segments in the Toronto Centreline shapefile by each street's unique ID (LFN_ID), which made it so that each street had a single, continuously connected line segment rather than a grouping of many small segments as in the original shapefile. This made it easier to map the streets in Tableau.

3. JOINING STREETS

Unlike in the case of neighbourhoods, a spatial join was not feasible for the centrelines because no collision points intersected exactly with the line segments and K-Nearest Neighbours would have taken several hours to perform with no guarantee of accurate results. So instead of a spatial join, we performed a join on the long form name of each street (LF_NAME) stored in the shapefile and the street1 field stored in the collisions dataset.

4. EXCEPTIONS

Thus, we manually cleaned the LF_NAME in the shapefile using Tableau Prep so that its street names matched the spelling found in street1 in the collisions dataset. This process minimized the number of unmatched records as much as possible, with only 847 out of 27,119 records unable to be joined.

As a result, two additional fields were added to the collisions dataset: total length in kilometers and the unique ID for each street (LFN_ID), allowing us to join the collisions dataset with the Toronto Centreline shapefile.

Creating the Toronto High Injury Network Datasets (Neighbourhoods & Streets)

With all of the joins done, we used Hadoop and Hive to create two new datasets out of our existing datasets in order to facilitate identification of the most problematic neighbourhood areas and streets. The Hive queries can be found in the Data Dictionary supplied on GitHub, but essentially what this did was create two new spreadsheets: one which grouped all the collisions by Toronto's 140 neighbourhoods, and the other by over 2000 unique streets.

In short, by aggregating the original collisions dataset of 27,000+ collision events in this way, we could see which neighbourhoods and streets had unusually high amounts of KSIs per kilometre of road, or the most collisions involving seniors and schoolchildren, among other uses for mapping the Toronto High Injury Network (more below).

Benefits of Using Our Datasets

As a result of the above transformations and joins, the default collisions dataset’s usability and relevance to the challenge was extended greatly.

- Nearly every collision now includes a unique street and neighborhood ID to use on joins. These operations allowed us to move away from using the limited GPS coordinates found in the original collisions datasets, which only contain longitude and longitude and are thus not intuitive for users and stakeholders.
- The collisions in our dataset can be mapped to neighborhood boundaries as well as street centrelines, which were used to construct our Toronto High Injury Network
- Thanks to our careful cleaning and pre-processing operations, it is now possible to analyze 243 different attributes across six datasets in addition to our transformed collisions dataset.

243 ATTRIBUTES

A data dictionary of these attributes is available in our Github repo, but for the sake of brevity, the additional attributes we examined were of the following broad categories: demographic data such as age and household size, income level, mode of work travel, newcomer status, language spoken at home, civic measures like voter turnout, and transportation measures like number of TTC stops.

CREATING THE TORONTO HIGH INJURY NETWORK

After a review of the academic literature, the Vision Zero Action Plans of 30 cities, as well as the City of Toronto's own design guidelines and traffic safety documents, we created a High Injury Network (HIN) as a core part of our data-driven implementation plan designed to accelerate the City's Vision Zero efforts.

BENEFITS OF A HIGH INJURY NETWORK (HIN)

According to traffic research and the best practices of successful Vision Zero cities, cities use High Injury Networks to prioritize interventions ensuring that high impact solutions are implemented first in areas that need them the most. Toronto's Vision Zero plans and other documents from the Transportation Department reveal that the City is already well-aware of what needs to be done to achieve Vision Zero. What it lacks, however, is a clear path to implementing solutions in a lean and timely manner.

To this end, our High Injury Network is made up of streets and neighbourhoods in the top 80th percentile of the most collision-prone areas of the city. We ranked the relative risk of KSIs and priority level for intervention for every street and neighbourhood in the city by creating a composite score we are calling the High Injury Composite Score.

The High Injury Composite Score

click for scores by neighbourhood
by street

The High Injury Composite Score is a measure we created to simplify and expedite traffic safety implementations. It assigns a numerical value to problematic streets and neighbourhoods which the City should prioritize first due to risks it poses to vulnerable users and past collision activity.

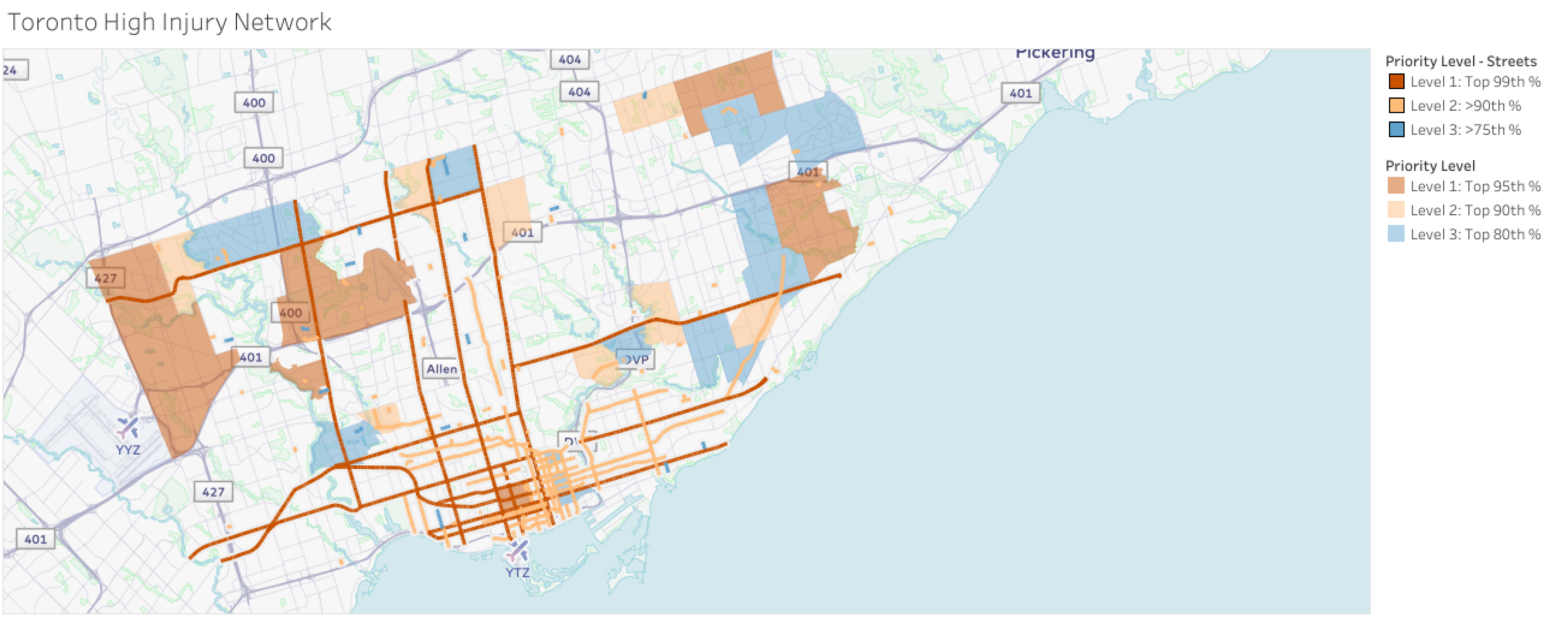
It is calculated by using the average of all the min-max normalized values of attributes either correlated to KSI density or related to priority users multiplied by 100. KSI density is used because it was established as the overall best outcome variable since there is little risk of co-linearity and because it is good at predicting the risk. That is, if a street or area has high KSI density, that means it is also likely to have an unusually high collision density no matter the characteristics of the street or area. The KSI density also minimizes the effect of particularly long streets or large neighbourhoods, which is particularly needed in Toronto's case due to the prevalence of long streets and large neighbourhood boundaries. The scores for neighbourhoods were calculated using the normalized values for the following variables:

- **# of Collisions Involving Seniors (65+) & Children**
- **Total % of households who speak non-official language at home**
- **% of Residents that are Seniors or Children**
- **Population Density**
- **KSI and Collision Density**
- **Total % of low income households**
- **% of Residents who primarily commute to work by car**

The scores for streets were calculated using the normalized values for the following variables:

- **# of Collisions Involving Seniors (65+) & Children**
- **Collision & KSI Frequency**
- **KSI and Collision Density**

Toronto's High Injury Network (THIN)



click for interactive map (recommended)

Each area which falls within the top 80th percentile and each street in the top 75th percentile of composite score is assigned a different colour, representing a priority level. Basically, the THIN suggests in what order which specific streets and areas should be prioritized for safety improvements, taking into consideration the age of the population, KSI and collision density, and all the other factors use to come up with the the score outlined above.

IMPLEMENTATION

ROAD DIETS

Road diets involve multiple countermeasures to reduce traffic collisions. It involves a reduction in the number of travel lanes by adding new curb extensions and/or landscaping. The features reduce the corner radius and narrow the roadway, thus improving motorist vision and increase driver attentiveness, ultimately encouraging slower speeds. Additional techniques in street diets include adding street trees, urban furniture, special roadway markings and lighting infrastructure.

Breakdown

Cost	● ● ●
Political Support	● ● ○
Complexity	● ● ●
Scalable	● ● ○

A SIDE BENEFIT

Road diets can provide a pleasing aesthetic feature to the surrounding environment. By adding new infrastructure such as lighting, public benches and plants, road diets not only decrease vehicle speeds but also enrich the neighbourhood without using speed bumps.

USER GROUPS

ESTIMATED COSTS

Lighting (each)
$19800

Crosswalk Paint
$880

Sidewalk (sq m)
$440

Bicycle Lane (per km)
$88000

Yield Line (each)
$330

Curb Extension (each)
$14300

Impact

The main components of an effective road diet vary depending on the surrounding neighborhood and traffic. Nevertheless, there exists fundamental building blocks to constitute a cost-effective road diet that can be applied universally.

Clear road markings are a relatively inexpensive method to help improve the safety of our streets. Distinct road markings help indicate crosswalks, thus alerting drivers how far to stop in front of an intersection. In addition, road markings can help create new narrower lanes (especially for turning) to help alleviate pressure from the driver turning during pedestrian crossings.

By narrowing the road, new space is created for pedestrian walkways in addition to bike paths. These provide better accessibility to all pedestrian and cyclists. Empirical evidence has been shown to not have a significant effect on commute times for motorists. In addition, they encourage installation of new plants and more eco-friendly methods of commute which will likely be supported by the public. Road diets are not seen as a direct attack on drivers to reduce their speed but rather to enhance the neighborhood accessibility as well as improve overall safety.

Short-term Plan

- Re-paint brighter and clearer road markings in critical high injury networks areas, more specifically yield lines, crosswalks and lane separation.
- Add new signage and lighting in areas of poor visibility during the night.
- Install green infrastructure in major arterial roads with high risk of collision. These include sidewalk plants, flowers, trees, park benches, bike racks, trash cans, decorations, etc.

Medium-term Plan

- Install median island crossings to in seniors zones to help crossings.
- Add curb extensions to slow down vehicle turning speed as well as accessibility ramps for the disabled.
- Install hybrid crossing beacons to indicate when pedestrians are crossing the street.

Long-term Plan

- Widen existing sidewalks and add new sidewalks to arterial roads with only sidewalks on one side of the street.
- Build a new separate bike lane to segregate cyclists from motorists as well as to encourage greener modes of transport.

CHILDREN

Road diets help widen sidewalks to promote safer walking for children. In addition, road diets allow crossing distances to be shorter for children be narrowing the road.

CYCLISTS

By narrowing the road, new bike lanes can be created for cyclists. Moreover, new infrastructure such as plants, concrete barriers can provide a separation between motorists and cyclists for increased safety.

SENIORS & DISABLED

By installing islands and street medians, road diets will help seniors and people living with disabilities cross wide arterial roads, which tend to be more dangerous. Better road markings will also help signal crosswalks for seniors.

IMPLEMENTATION

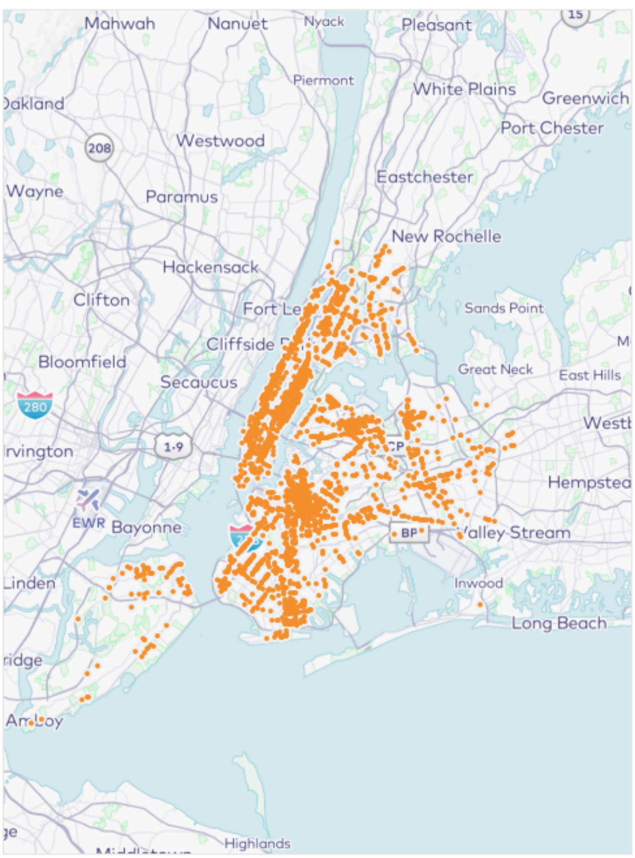
LEADING PEDESTRIAN INTERVALS

Leading pedestrian intervals are a very inexpensive and simple solution shown to reduce traffic collisions by 45% according to the US Federal Highway Administration. They give pedestrians a head start when crossing an intersection, which combats aggressive left and right turns -- a key problem identified in our survey research as well as our analysis of the collision dataset. The THIN can be used to install LPIs in order of priority in the zones that need them the most.

Breakdown

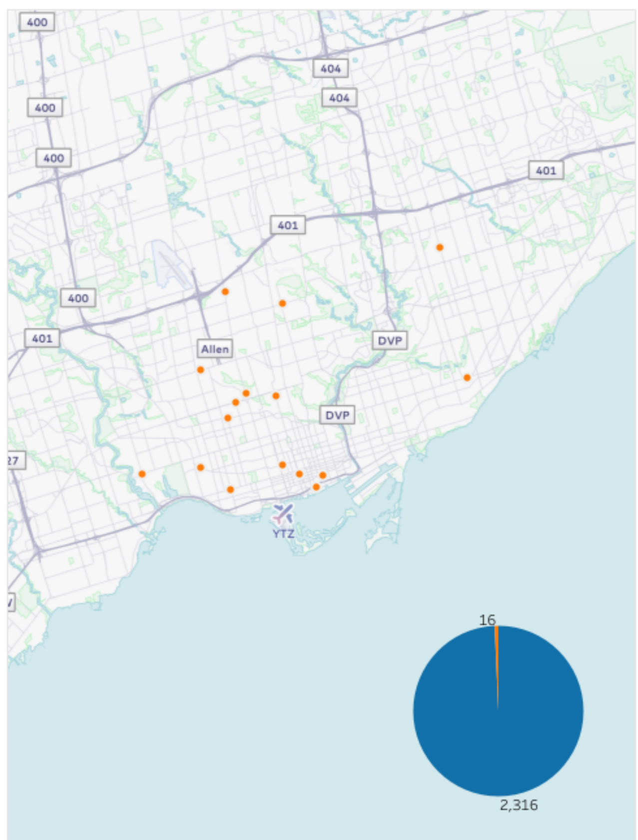
Cost	● ○ ○
Political Support	● ● ○
Complexity	● ○ ○
Scalable	● ● ●

LPI Signals in NYC



2,402 Intersections with LPI
out of 12,460 Signalized Intersections (19.3%)

LPI Signals in Toronto



16 Intersections with LPI
out of 2,332 Signalized Intersections (0.0069%)

Non-LPI LPI

Short-term Plan

- Install LPIs at all intersections on streets that are Priority Level 1 on the THIN

CHILDREN

LPIs benefit children since it gives them more time to cross and reduces conflict with oncoming cars. Children are also made more visible in the intersection due to the head start.

SENIORS & DISABLED

LPIs benefit both seniors and people living with disabilities since it gives them more time to cross and reduces conflict with oncoming cars. They are also made more visible in the intersection due to the head start.

Medium-term Plan

- Install LPIs at all intersections on streets that are Priority Level 2 and 3 on the THIN.

Long-term Plan

- Study the effect of LPIs and the actual reduction rate of KSIs and collisions and re-evaluate LPI implementation strategy going forward.

IMPLEMENTATION

AUTOMATED ENFORCEMENT

The Toronto City Council recently adopted measures that through a resolution would double the number of red-light cameras and automated enforcement in conjunction with the 2019 budget process. Consequently, it is necessary to discuss the topic of implementing automated fining based on lessons learned from other jurisdictions.

Breakdown

Cost	● ● ●
Political Support	● ● ○
Complexity	● ● ○
Scalable	● ○ ○

Impact

Traffic enforcement depends greatly on the concept of deterrence. General deterrence and specific deterrence are two processes by which traffic enforcement influences driving behaviour. General deterrence involves the perception by the public that traffic laws are enforced and that a risk of detection and punishment exists when traffic laws are violated. Specific deterrence arises from actual experiences with detection, prosecution and punishment of convicted offenders. The deterrence effect is magnified by the use of surveillance equipment that is not visible as it would have the following two effects on potential traffic violators,

“First, that there is a probability of given magnitude associated with his violation and an apprehension for that violation. Second, since the driver cannot precisely locate the surveillance source, he will gradually start observing the rules also elsewhere than in the immediate vicinity of the surveillance source.”

Therefore, the use of traffic cameras at key intersections coupled with automated finding based on Owner Liability would create a strong deterrence effect against speeding and reduce traffic incidents.

AUTOMATED ENFORCEMENT

Implementation

There are two methods by which to assign liability when utilizing automated enforcement, through Owner Liability, and Driver Liability. Ultimate responsibility for violations registered with automated enforcement systems is with the owner of the vehicle. Driver liability leaves the driver of a vehicle ultimately responsible. Owner liability requires only an image or video with a readable license plate on a vehicle together with violation data such as time, location, nature of the violation, etc. is legally sufficient for prosecution. Driver liability is more problematic. An image or video of a vehicle with a recognizable face of the driver and a license plate is required in order for a violation to be legally valid and thus prosecutable. As demonstrated by countries with driver liability programmes, (Germany, Sweden, Switzerland, Denmark and Japan), who take violation photos or videos of the front of the vehicle and through front window of the vehicle can be problematic due its greater technical complexity. Owner liability requires the processing of a large number of violations resulting from automated enforcement programmes and can be completed very efficiently with little human intervention by utilizing ANPR (Automatic Number Plate Recognition). Driver liability is labour intensive and costly due to the matching requirement of the vehicle owner with the face of driver at the time of violation. Due to various factors including lighting conditions, glare, coatings on car windows or intentional obstruction, the recognisability of the face of the driver on an evidence photo is difficult and would require more expensive equipment and slower prosecution rates ultimately leading to the programs failure.

According to the City of Toronto's Traffic Monitoring Policy sub-section 4.1, the city of Toronto traffic camera system is utilized for traffic engineering purposes and incident response only. It is not used for tracking or monitoring individual vehicles or people. This implies that the system would require substantial upgrades and re-engineering to implement either Owner liability or Driver liability, with driver liability, which requires higher resolutions cameras, to be the costliest options.

Several camera enforcement programmes were terminated due to problems with data integrity. Evidence data integrity is essential to any camera enforcement program. Detailed tests are needed to confirm that the digital evidence is secured with data encryption, authentication and/or integrity standards during data registration, transfer, storage and retrieval. Once registered there needs to be certainty that violation data is:

1. Confidential,
2. Secure,
3. Permanent, Read-only, and
4. Rendered invalid when changed.

AUTOMATED ENFORCEMENT

Take Aways for the City of Toronto

All elements of the enforcement chain must be properly implanted in order for automated enforcement to be effective.

The first step would be to determine where to place a red-light camera system. We have provided recommendations on what streets should be prioritized in the THIN.

Second, the City of Toronto needs to create an information system that will process said photographs, associating a given license plate to an individual, and then fining said owner of the vehicle for the infraction accurately with proof that their vehicle had committed the infraction. This is important as the system will need to have the following features:

A. Secure Privacy and data integrity.
B. Have little human interaction to allow for speed efficiencies.
C. Store photographs
D. Be able to interface with a vehicle registry system without bottlenecks and data breaches
E. Maintain evidence integrity to allow for swift and easy prosecution.

A strong information system is required in order to ensure efficient and effective prosecution. The Ontario Highway Traffic Act authorises the use of photo-radar system evidence provided that the photograph:

1) Show the vehicle and the number plate displayed on the vehicle; and
2) Show or have superimposed upon it an indication of the rate of speed at which the vehicle was being driven when the photograph was taken and the date on which and time at which the photograph was taken.

For use at trial, to gain a conviction, the photograph must be presented at trial or the person accused consents to the photograph not being adduced at trial.