HUMBER INSTITUTE OF TECHNOLOGY AND ADVANCED LEARNING

(HUMBER COLLEGE)

BIA 5450 Capstone Project: Final Report

Project Name:

Analysis of Bike Share Toronto Ridership Growth Optimization

GROUP: 0LB TEAM 3 - InsightOps

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Executive Summary

The Bike Share Toronto Ridership Growth Optimization project was created to examine the key challenges and opportunities for improving the city's bike-share service. Bike Share Toronto, operated by the Toronto Parking Authority, is one of Canada's largest bike-share programs, with over 9,000 bikes and 800 stations across the city. Despite strong growth since COVID-19 and its role in promoting active, eco-friendly travel, the system faces several challenges. Membership rates remain low (10% compared to over 80% for BIXI and CitiBike), bikes are underutilized (2.1 rides per day versus 3.2 for CitiBike), ridership drops sharply in winter, and some areas—particularly Etobicoke and North York—have limited bike and station availability. Surveys revealed that users often encounter empty or full stations outside downtown, desire features like baskets, helmets, improved lighting, and want more options such as e-bikes or scooters. Insights from usage patterns show that demand is concentrated in certain high-traffic areas during peak hours, while some neighborhoods are consistently underserved. We chose this topic because it addresses important issues like sustainability, urban mobility, and the use of data to solve real-world problems. Based on analysis, the project recommends data-driven bike redistribution and rider incentives, strategic addition of stations near community hubs and transit, flexible seasonal pricing, introduction of winter-ready bikes, and the "WeBike2Gether" campaign to boost memberships. These actions are designed to improve accessibility, increase ridership, and create a more efficient, user-friendly system that serves Toronto residents year-round.

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Introduction

1.1 Project Discussion and Importance

Bike Share Toronto, operated by the Toronto Parking Authority (TPA), is a rapidly growing city-run bicycle-sharing system. With over 9,000+ bikes and 800+ stations across Toronto's neighbourhoods, it serves as a crucial part of Toronto's transportation infrastructure (Bike Share Toronto, n.d.). According to a report by the Institute for Transportation and Development Policy (ITDP, 2022), bike share programs contribute significantly to:

- Reducing greenhouse gas emissions
- Alleviating congestion
- Enhancing public health
- Encouraging equitable access to mobility

Toronto, like many major cities in North America, saw substantial ridership increases after the COVID period as individuals sought open-air and low-contact travel options. Bike Share Toronto saw a record-breaking 4.6 million trips in 2023—an 80% increase from 2020 (City of Toronto, 2024).

This project is focused on harnessing the potential of this open dataset to develop a comprehensive and interactive dashboard that visualizes historical trends in usage across various metrics. By systematically analyzing the data, we aim to identify key patterns that emerge over time, allowing us to discern fluctuations and correlations that may influence future outcomes. Furthermore, the dashboard will highlight specific opportunities for strategic growth, enabling targeted interventions and informed decision-making. This tool is designed to provide actionable insights that will benefit planners, stakeholders, and the broader public, fostering a greater understanding of the data and its implications for long-term development and investment strategies.

This project bridges that gap by transforming unstructured data into interactive insights, which benefits both the organization and the public sector as listed below:

- **City Planners** - responsible for visualizing demand and optimizing expansion, to allocate resources more effectively by identifying high-demand areas,
- **Policy Analysts** - responsible for evaluating equity and access in policies, programs, and services, to ensure they are inclusive, fair, and effectively serve diverse populations,
- **Environmental Agencies** - responsible for linking transportation trends to sustainability goals, to promote environmentally friendly transit options to reduce emissions and support long-term environmental health, and
- **Public Transit Authorities -** responsible for integrating multimodal transportation options, to increase transparency and civic engagement through accessible transit data.

1.2 Business Problem and Business Requirements Definition

Demand for Bike Share Toronto is increasing. To sustain this growth, ensure user satisfaction, and adapt to the changing transportation environment, the service must evolve strategically. To achieve this, the company must analyze its operational data to develop strategies that address the following challenges:

- How can the Toronto Parking Authority (TPA) develop the most accurate demand forecasting methods to manage fluctuations in demand throughout the year?
- How can the Toronto Parking Authority (TPA) generate more demand both organically and through promotional mechanics to maximize the company's profit?
- How can the Toronto Parking Authority (TPA) improve its operational excellence and user experience to keep pace with increasing demand, enhance its utilization rate to optimize resources?

Business Requirements

1. Key Growth Drivers Identification
    - Analyze which neighborhoods and routes are showing the strongest user growth.
    - Determine peak usage times, trip distances, and other demand indicators.

- Design and distribute a questionnaire to gather user feedback on service quality and identify areas for improvement.

2. Segment Users and Infer Trip Purposes
    - Differentiate user groups: Annual members vs. pay-as-you-go riders, Business (commuters) vs. leisure (recreational) riders, inferred by time of day/week usage, station proximity to business or recreational areas, trip frequency, and duration.
3. Benchmarking Against Other Services
    - Compare Toronto's ridership trends, user mix, infrastructure impact, and operational KPIs with leading bike share programs such as CityBIke (NYC) and BIXI (Montreal) to identify global best practices that could apply in Toronto.
4. Prototype Dashboard or Interactive Map
    - Build a basic visualization tool for internal use to track growth, segment performance, and policy impacts in real-time.
5. Strategy Development. Provide data-driven recommendations to adapt Bike Share Toronto's operations, such as:
    - New station placements in high-growth zones
    - Pricing model adjustments for different user types
    - Tailored marketing campaigns based on user behavior
    - Strategic collaboration with city planners on future bike lane placements

1.3 Scope Statement

Project Objective

This project aims to design and develop four solutions: Data forecasting models, Visualization dashboards, Surveys, and Benchmarking that provide insights to generate recommendations for Bike Share Toronto management and public sector officials.

In Scope

- Collection and cleaning of open-source trip and station datasets from Bike Share Toronto and relevant city infrastructure datasets (e.g., bike lanes).

- Design and development of four solutions to gain insights into the company's service, operations, and customer experience
    - Demand Forecasting Models
    - Visualization Dashboard
    - Surveys
    - Benchmarking
- Delivery of data-driven recommendations for strategic planning (e.g., station placement, pricing strategies).

Out of Scope

- Implementation of the recommendations by Bike Share Toronto.
- Predictive modeling for individual trip behavior.
- Integration with real-time APIs or mobile app development.

Deliverables

- Demand Forecasting Models
- Visualization Dashboards
- Survey results
- Benchmarking against key counterparts (CityBike and BIXI)
- Recommendations for the company
- A final presentation and report outlining key findings and strategic recommendations

Stakeholder and Requirement Analysis

2.1 Stakeholders

The success of the proposed data-driven solution for Bike Share Toronto depends on engaging a wide range of stakeholders, each with distinct interests, priorities, and degrees of influence. This section identifies and briefly describes the key internal and external stakeholders affected by, or interested in, the project outcomes.

- **Bike Share Toronto Executive Team** oversees service development, pricing, and long-term planning. They focus on leveraging infrastructure changes, rider behavior, and best practices to support growth. The team uses project recommendations to guide investment in new stations and bikes, expand into new neighborhoods, and shape partnerships with city agencies.
- **Bike Share Users**, the end users of the service. These users are the most directly impacted by changes in station placement, pricing, service availability, and system enhancements. Their behaviors and feedback form the basis of many key insights.
- **Capstone Project Students**, who oversee the academic integrity, methodology, and scope of the Capstone project. Even though we are not stakeholders of the business solution itself, we are invested in ensuring the project meets academic standards, delivers real-world impact, and offers a solid methodology for data analysis and strategic planning.
- **The City of Toronto's Transportation Services Division** develops bike infrastructure policies, including protected lanes and cycling strategies. They aim to evaluate the impact of these policies on public behavior and transportation outcomes, which can help justify further investments, understand ridership trends, and identify gaps in the cycling network
- **Environmental NGOs and Sustainability Advocacy Groups** such as the Toronto Environmental Alliance and Cycle Toronto, promote environmentally

sustainable urban development, reduced carbon emissions, and active transportation. They advocate for expanding low-emission mobility options, integrating bike share into climate action plans, and improving biking infrastructure with public support. These organizations influence public opinion, assist in grant funding applications, and shape municipal priorities through lobbying and campaigns, and they can partner on educational efforts about cycling benefits.

- **Toronto Residents and the General Canadian Public**, including current and potential Bike Share Toronto users, are key beneficiaries of enhanced bike share services and cycling infrastructure. They contribute essential usage data through their trip behavior and their public sentiment can impact policymakers and city planning priorities, even though they may not directly influence the Capstone project's implementation.

2.2 Analytics Questions

To effectively address the business problem, the following analytics questions are designed, organized into three categories: Descriptive (What happened and why), Predictive (What will happen), and Prescriptive (What should we do).

These questions allow stakeholders to uncover key usage patterns, identify operational challenges, forecast future demand, and guide strategic decisions for improving Bike Share Toronto's service efficiency, accessibility, and profitability.

a. What happened and why

1. How has ridership evolved post-COVID compared to pre-pandemic levels, and which user groups are driving that change?
2. What trip characteristics (e.g., short duration + frequent use = commuters) are predictive of high lifetime value users?
3. What are the peak hours and days for bike usage?
4. Which neighborhoods and routes show the highest and fastest-growing demand?
5. How do usage patterns differ between annual members and pay-as-you-go users?

6. Which stations experience frequent imbalances—either empty or full—during certain periods?
7. Are there disparities in service availability and usage across different socio-economic zones of Toronto? (Is bike access equitable across all areas?)
8. How do Bike Share Toronto's services and utilization rate compare to industry benchmarks in other major North American cities?
9. How do weather patterns and seasonality affect ridership trends?

b. What will happen

1. Which stations are most likely to experience shortages or overflows in the next hour/day/week?
2. What areas are projected to see the highest growth in demand over the next year?
3. How will seasonal changes or upcoming weather conditions impact ridership in the near term?

c. What should we do

1. How can a dashboard be designed to give real-time, actionable insights to stakeholders such as city planners and executives? (What metrics and visualizations would best support decision-making?)
2. Can we infer the likely purpose of trips (commute vs. leisure) based on usage time, duration, and location?
3. Which stations or regions are underserved and could benefit from new station placement?
4. Which operational or service model changes, observed in high-performing peer programs, could be adopted to improve Toronto's system efficiency and rider satisfaction?

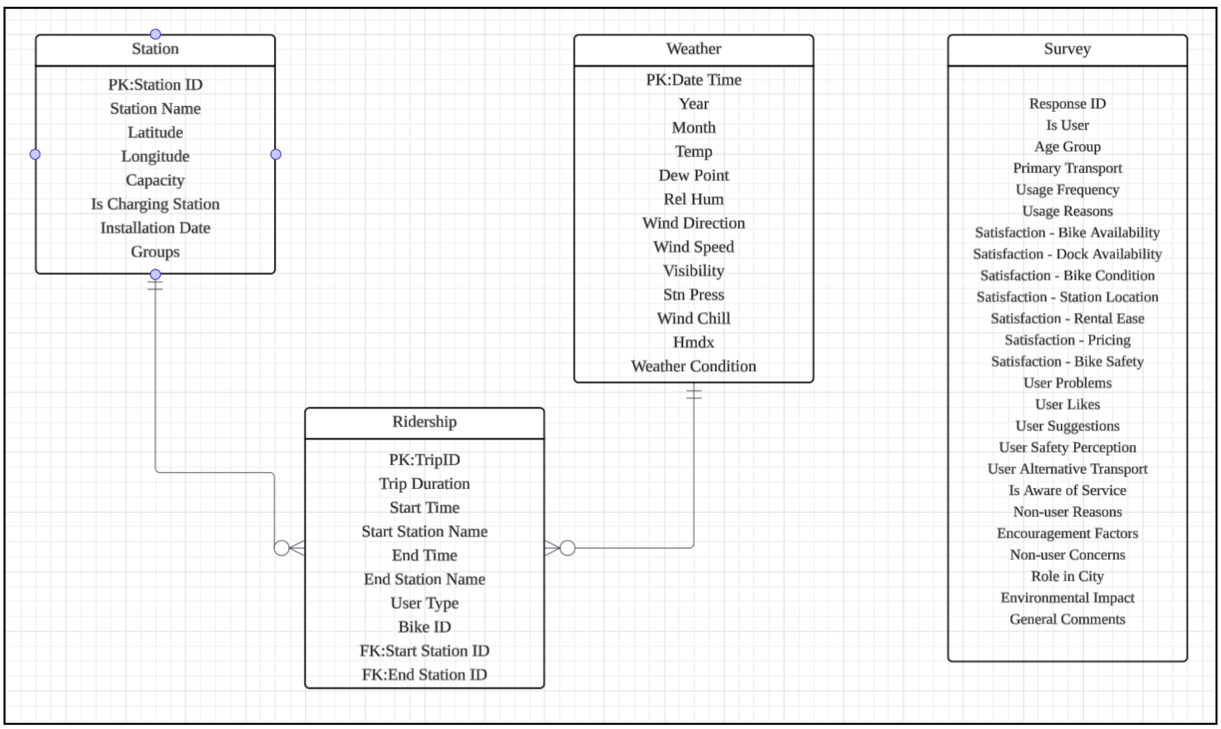
Data Architecture and Sources

3.1 Data Sources

The Toronto Open Data Portal provides ridership data, including trip duration, start/end stations, timestamps, and user type, as well as station data, which includes station location and capacity details. Environment Canada offers historical weather data with hourly records of temperature, precipitation, wind speed, and other conditions. Additionally, survey data provides insights into user experience and feedback through survey responses.

Figure 1

Proposed Entity-Relationship Diagram (ERD) among Three Data Sources



3.2 Data Dictionary and Data Flow

a. Ridership Dataset

Each row in the ridership dataset represents a single bike trip recorded by the Bike Share Toronto system. The dataset captures key behavioral and contextual information about user trips, which can be analyzed to understand ridership patterns and influences. The main data entities include:

- Timestamp-Related Entities
  - Start Time: The specific date and time a bike trip begins, crucial for aligning with hourly weather records and identifying peak periods.
  - End Time: The specific date and time a bike trip ends, allowing for the calculation of trip duration and analysis of time-based usage.
- Trip Characteristics
  - Trip Id: A unique identifier for each bike trip, essential for distinguishing and tracking individual journeys.
  - Trip Duration: The total time of the trip in seconds, reflecting user travel habits and potentially indicating trip purposes, such as short commutes or leisure rides.
- Geographic Entities
  - Start Station Id: A numeric identifier for the station where a trip originates, facilitating linkage to station location and capacity data.
  - Start Station Name: The name of the starting station, providing geographic context for trip origins.
  - End Station Id: A numeric identifier for the station where a trip ends, enabling the analysis of travel routes and station-to-station flow.
  - End Station Name: The name of the ending station, supporting spatial analysis of trip destinations.
- Bike & User Attributes
  - Bike Id: A unique identifier for the bicycle used, allowing for tracking of bike utilization and maintenance needs.
  - User Type: Categorizes users as either Casual or Annual members, aiding in the differentiation between short-term and regular riders' behavioral patterns.

Data Flow

- Each bike trip is recorded through the Bike Share Toronto system, capturing key details like trip time, duration, start/end stations, and user type.
- The trip data is transmitted to Bike Share Toronto's central database, where it is logged and structured.
- The validated data is then published on the Toronto Open Data Portal, enabling access for public use and analytical insights.

Table 1

Data Dictionary for the Ridership Dataset

Field Name	**Unit**	**Data Type**	**Description**	**Example Value**
Trip Id		String	A unique identifier assigned to each individual bike trip.	26682749
Trip Duration	sec	Integer	Total time of the trip, measured in seconds.	2464
Start Station Id		String	Numeric ID of the station where the trip began.	7391
Start Time		date/time	Start date and time of the trip.	01-01-2024 00:05
Start Station Name		String	Name of the station where the trip originated.	Yonge St / Dundas Sq
End Station Id		String	Numeric ID of the station where the trip ended.	7163
End Time		date/time	End date and time of the trip.	01-01-2024 00:46
End Station Name		String	Name of the station where the trip terminated.	Yonge St / Wood St
Bike Id		String	Unique identifier for the bicycle used.	6974
User Type		String	The type of user that took the trip (Casual/Annual)	Casual Member

b. *Weather Dataset*

Each row in the weather dataset represents a single hourly weather observation recorded by Environment Canada at a designated weather station (Environment and Climate Change Canada, n.d.). The dataset captures key environmental conditions that could influence bike ridership behavior. The main data entities include:

- Timestamp-Related Entities
    - Timestamp: Represents the specific hour of observation on a given date. Critical for aligning weather data with hourly ridership records.
- Temperature & Dew Point
    - Temperature: Measures the ambient air temperature in degrees Celsius, crucial for assessing thermal comfort.
    - Dew Point: Measures the temperature at which air becomes saturated and condensation forms, in degrees Celsius. Important for understanding potential for condensation.
- Humidity & Precipitation
    - Relative Humidity: Indicates the moisture percentage in the air, influencing perception of conditions (e.g., muggy or dry).
    - Precipitation: Records the amount of rainfall in millimeters during the observation, significantly affecting bike usage.
- Wind Conditions
    - Wind Direction: The direction from which the wind blows, in tens of degrees.
    - Wind Speed: Speed of the wind in kilometers per hour, impacting cycling comfort and safety.
- Visibility & Pressure
    - Visibility: Measures how far one can see, in kilometers. Poor visibility may deter cycling, especially under adverse conditions.
    - Station Pressure: Atmospheric pressure in kilopascals at station elevation, supporting complex weather pattern analysis.
- Indices & Description
    - Humidex and Wind Chill: Calculated indices reflecting how the weather feels, accounting for humidity or wind, providing a realistic sense of rider comfort.

- Weather Description: A qualitative summary of observed atmospheric conditions (e.g., snow, fog, clear), useful for categorizing rider-friendly vs. unfriendly weather.

These entities collectively define the environmental context in which bike trips occur. They enable the study of how different weather factors affect ridership patterns across hours, days, or seasons.

Data Flow

- The weather station across Ontario records hourly observations (temperature, wind, precipitation, etc.).
- This information is transmitted to Environment and Climate Change Canada's central database, where it's stored and validated.
- The data is made available to the public via the climate data portal and used in weather forecasts and climate monitoring reports.

Table 2

Data Dictionary for the Weather Dataset

Field Name	**Unit**	**Data Type**	**Description**	**Example Value**
Month		date/time	Showing months of the measurement	1
Year		date/time	Showing the years of the measurement	2024
Temp	°C	Float	Temperature in degrees Celsius	2.5
Dew Point	°C	Float	Dew point temperature in degrees Celsius	-3.6
Rel Hum	%	Float	Relative humidity as a percentage	64
Wind Direction	10's deg	Float	The direction from which the wind blows	25
Wind Speed	Km/h	Float	The speed of motion of air in kilometres per hour	28
Visibility	Km	Float	The distance at which objects of suitable size can be seen and identified	16.1
Stn Press	KPa	Float	The atmospheric pressure in kilopascals (kPa) at the station elevation	100.08

Wind Chill		Float	An index to indicate how cold the weather feels to the average person	-6
Hmdx		Float	An index to indicate how hot or humid the weather feels to the average person	27
Weather		String	Observations of atmospheric phenomena, including the occurrence of weather and obstructions to vision	snow, rain, fog

c. Station Dataset

Each row in the station dataset represents a physical bike share station in Toronto. The dataset captures static and dynamic attributes that define station characteristics and usage, enabling analysis of infrastructure efficiency and demand. The main data entities include:

- Identification & Location
    - Station Id: A unique numeric identifier for each station, serving as a key to link with ridership data.
    - Station Name: The textual address or landmark associated with the station, facilitating geographic referencing and user navigation.
    - Latitude: The north-south geographic coordinate (in decimal degrees) for precise mapping of the station location.
    - Longitude: The east-west geographic coordinate (in decimal degrees) for precise mapping of the station location.
- Operational Attributes
    - Capacity: The maximum number of bikes or docks available at the station, critical for evaluating demand-to-capacity ratios.
    - Is Charging Station: A boolean indicator of whether the station includes charging facilities for e-bikes, reflecting infrastructure modernization.
    - Installation Date: The timestamp when the station became operational, useful for analyzing historical usage trends and infrastructure expansion.
- Categorical & Relational Entities

    - Area Category: A classification of the station's land use (e.g., Downtown, Residential, Recreational), aiding in analysis of usage patterns by geographic context.
    - Groups: A textual label indicating the station's belonging to a specific group (e.g., Downtown), supporting comparative analysis across zones.

Data Flow

- Static metadata (ID, name, coordinates, capacity) sourced from Toronto Open Data Portal or official API.
- Dynamic usage data (e.g., hourly trip counts) derived from ridership dataset via Station ID linkage.
- Merge static and dynamic data into a unified dataset.
- Validate coordinates against geographic information systems (GIS) for accuracy.
- Stored in a relational database (e.g., PostgreSQL) with foreign key links to ridership (Start Station Id, End Station Id).

Table 3

Data Dictionary for the Station Dataset

Field Name	**Unit**	**Data Type**	**Description**	**Example Value**
Station ID		Integer	Unique station identifier	7000
Station Name		String	Full station address or landmark	Fort York Blvd / Capreol Ct
Latitude	°C	Float	North-south coordinate	43.639832
Longitude	°C	Float	East-west coordinate	-79.395954
Capacity	Bikes	Integer	Maximum bikes/docks available	135
Is Charging Station		Boolean	TRUE if station contains charging stations for e-bikes, FALSE otherwise	TRUE
Installation Date		Date	Date station was installed	2017-01-01
Groups		String	Group where the station belongs	Downtown

d. Survey Response Dataset

Each row in the survey response dataset represents an individual user's feedback on their experience with the bike share service. This dataset captures demographic, usage, and satisfaction attributes, enabling comprehensive analysis of user experience and service effectiveness. The main data entities include:

- Demographic Information
  - Id: A unique numeric identifier for each survey submission, ensuring traceability and data integrity.
  - Age Group: The respondent's age bracket (e.g., Under 18, 18-24, 25-34), facilitating demographic segmentation.
  - Gender: The respondent's self-identified gender (e.g., Woman, Man, Non-binary), contributing to diversity analysis.
  - Occupation: The current occupation of the respondent (e.g., Student, Employed full-time), allowing for socio-economic context assessment.
- Usage Patterns and Preferences
  - Postal Code: The first two digits of the respondent’s postal code, used to identify areas lacking bike share stations.
  - Usage: How often the respondent uses the bike share service (e.g., Daily, Few times a week).
  - Requested Type: The respondent's preference for additional vehicle types (e.g., Scooters, Cargo bikes).
- Satisfaction and Feedback
  - Stations: The convenience rating of station locations (scale from 0 to 3).
  - Equipment: Preferences for additional equipment on bikes (numeric scale).
  - Pricing: Sentiment regarding pricing options (numeric scale).
  - Upkeep: Satisfaction with bike and station maintenance (numeric scale).
  - Suggestions or Feedback: Open-ended comments providing qualitative insights into user satisfaction and suggestions.

Data Flow

- Surveys are conducted online/offline, and raw data is captured and stored in Microsoft Forms and Excel.
- Responses are standardized and transformed, such as converting Likert scale responses into numerical values.
- The cleaned data is analyzed for trends and integrated with reports and dashboards to provide comprehensive insights into user experience.

Table 4

Data Dictionary for the Survey Response Dataset

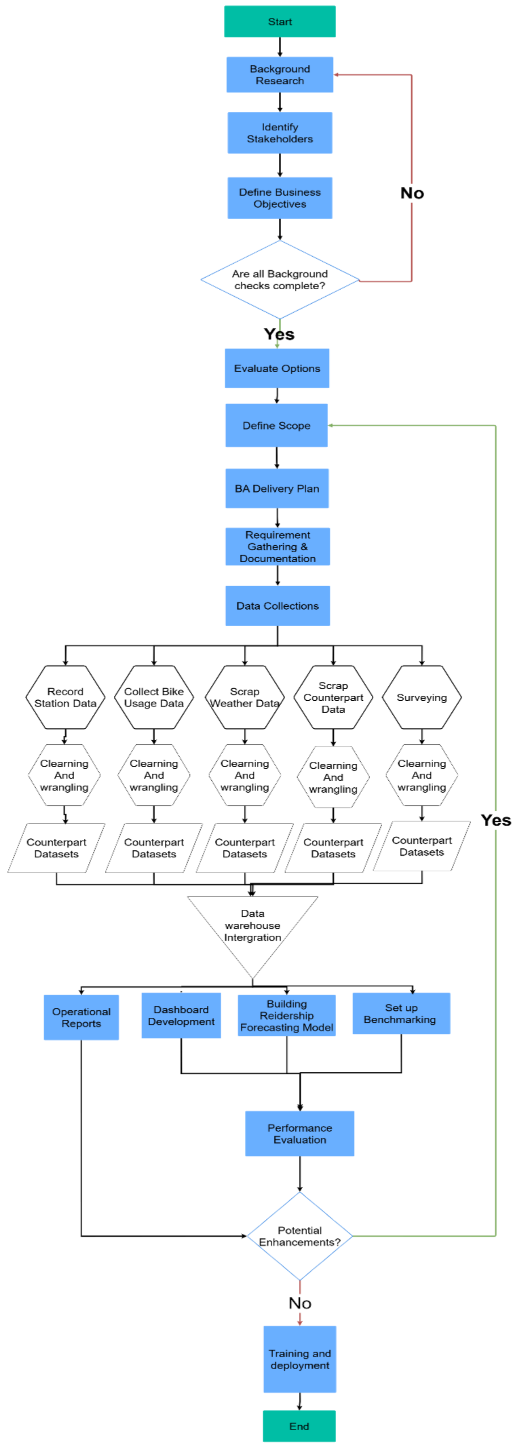
Field Name	**Survey Question**	**Data Type**	**Description**	**Example Value**
Id	-	Integer	Unique identifier for each survey's submission, automatically captured by Microsoft Forms	1, 2, 3
Start Time	-	DateTime	Timestamp on when the respondent started answering the form, automatically captured by Microsoft Forms	7/2/2025 12:37:21 PM
Completion Time	-	DateTime	Timestamp on when the respondent finished answering the form, automatically captured by Microsoft Forms	7/2/2025 12:38:07 PM
Age Group	1	String	Age bracket of respondent	Under 18, 18-24, 25-34
Gender	2	String	Gender of respondent	Woman, Man, Non-binary, Prefer not to say
Occupation	3	String	Current occupation of respondent	Student, Employed full-time, Employed part-time
Postal Code	4	String	The first two digits of respondent's postal code in Toronto. *This will only be used to identify general regions of the city that are lacking bike share stations.*	M1, M2, M3

Usage	5	String	How often has the respondent used the bike share service in the last three months?	Daily, Few times a week, Once a week
Stations	6	Integer	How convenient are the bike share station locations for your local routes or destinations?	0 - Not Sure, 1 - Inconvenient,2 - Convenient, …
Equipment	7	Integer	When using the bike share, what additional equipment do you wish the bikes had?	0 - Not used the bike share service, 1 - I bring my own equipment, 2 - Helmet, …
Pricing	8	Integer	Overall sentiment regarding the pricing and payment options for Bike Share Toronto	0 - Not used the bike share service, …, 5 - No issues
Upkeep	9	Integer	User satisfaction on quality and upkeep of the bikes and docking stations	0 - Not used the bike share service, 1 - Very dissatisfied, …,
Requested Type	10	String	What one other type of vehicle should Bike Share Toronto prioritize adding	Scooters, Cargo bikes, Moped, No other vehicle needed
Suggestions or Feedback	11	String	Final open-ended comments or thoughts.	Any other feedback

3.3 Process Data Diagram

Figure 3

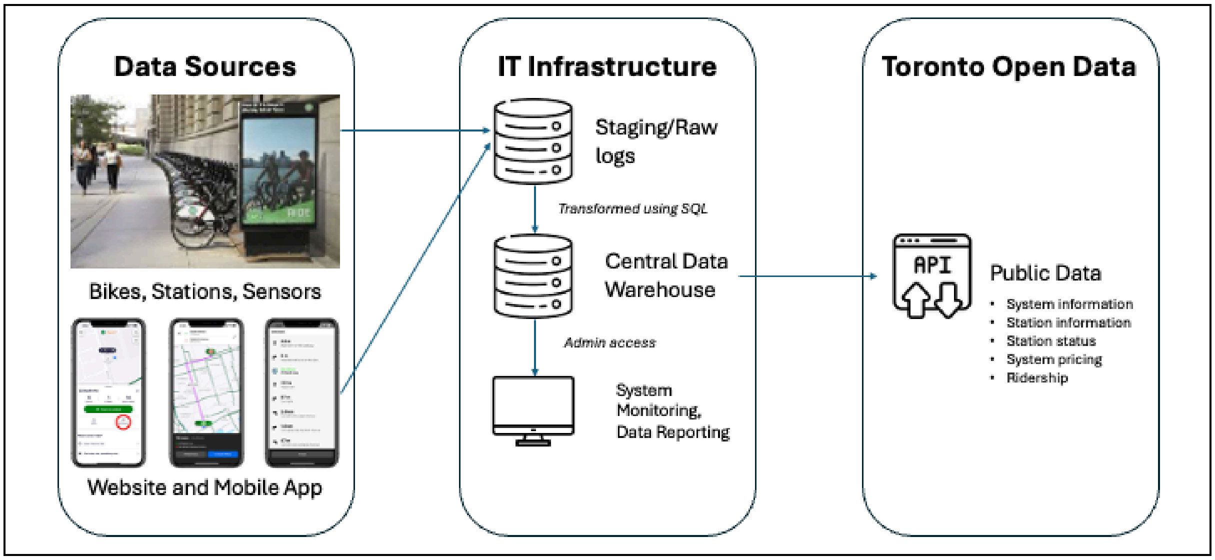
Overview of Process Data Diagram



3.4 Existing IT Architecture

Figure 2

Overview of Bike Share's Existing IT Architecture



Bike Share Toronto is a vital element of the city's transportation network, supported by a sophisticated IT infrastructure that manages a fleet of over 9,000 bicycles. This system combines hardware and software, facilitating seamless bike rentals, trip tracking, and data collection. The user-facing components include a mobile application for iOS and Android, enabling users to find stations, check availability, purchase passes, and unlock bikes using QR codes. Many stations also feature payment kiosks for enhanced user convenience (Bike Share Toronto, n.d).

Each bicycle is equipped with an RFID tag that updates the central system with its location and status when docked, ensuring real-time data in the mobile app and system map. Although the specifics of the backend server and database technologies are not publicly detailed, the infrastructure handles high transaction volumes across the city. It likely uses ETL (Extract, Transform, Load) processes to ensure raw data is clean, validated, and well-structured.

The core of Bike Share Toronto's data architecture is a closed system except with the ridership, station, and network information shared publicly through an open data portal provided by the City of Toronto. This portal grants public access to current station information, historical ridership data, and station locations. Integrating mobile apps, station kiosks, RFID tracking, and the data portal involves meticulously structured APIs and data synchronization processes, ensuring an efficient user experience and timely, accurate public data availability.

Solution Design

The Bike Share Toronto capstone project aims to create a comprehensive solution that transforms raw ridership data into actionable insights through a multi-faceted dashboard and predictive modeling approach. This solution addresses the business need for strategic planning by visualizing trends, anticipating future demands, and optimizing resource allocation.

4.1 Proposed Solutions Design

The proposed solution is a comprehensive, multi-faceted strategy designed to accelerate the growth of Bike Share Toronto by integrating advanced data analytics, direct user feedback, and in-depth competitive analysis. This approach is built upon four foundational components that work in concert to provide a holistic view of the service's performance and potential.

a. Predictive Modeling

The first component is Predictive Modeling, which employs a suite of models to accurately forecast ridership patterns. By using a multi-model approach that includes Holt-Winters and Linear Regression for seasonal trends, Long-Short Term Memory (LSTM) Neural Network and Facebook Prophet for complex non-linear relationships, and ensemble methods like Random Forest and XGBoost for robust accuracy, the solution moves beyond simple historical analysis. This ensures that predictions are reliable and nuanced, providing a solid foundation for critical strategic planning, such as optimizing bike distribution, planning station expansions, and managing fleet maintenance schedules.

Methodology

1. Data Collection and Preparation. Datasets are gathered, cleaned, normalized, and aggregated on a monthly level to ensure compatibility with the ridership forecasting models.
2. Model Selection and Training. The aggregated ridership data was split with months from 2019 to 2023 (60 months) as the training set and January to

September 2024 (9 months) as the testing set, employing hyperparameter tuning to improve accuracy and cross-validation to enhance model generalizability.

3. Model Evaluation. Assess the tuned models using accuracy metrics such as RMSE (Root Mean Squared Error), MAE (Mean Absolute Error), and MAPE (Mean Absolute Percentage Error) to select the best-performing model or ensemble of models.
4. Deployment and Monitoring. Implement the chosen model and continuously monitor its performance, updating it as new data becomes available.

b. Analytics Dashboard

Next, an Interactive Dashboard, built on Power BI, will serve as the central hub for data visualization and exploration. This user-centric tool is engineered to transform vast amounts of raw trip, station, and weather data into clear, actionable insights. It empowers stakeholders, from urban planners to operational managers, to dynamically explore trends, drill down into station-level performance, identify service inefficiencies, and understand the complex interplay of factors affecting ridership, all within a real-time, intuitive interface.

Methodology

1. Data Integration. Connect to historical trip and weather data to create a unified data model in PowerBI.
2. Visualization Development. Convert raw data into interactive charts, maps, and key performance indicators.
3. Feature Implementation. Enable filtering, slicing, and drill-down capabilities to support user-led analysis.
4. User-Centric Design. Tailor views and insights for different stakeholders, such as urban planners and transportation authorities.

c. User Survey and Feedback

To ensure the service evolves in line with user needs, the solution incorporates a User Survey and Engagement program. This component utilizes a mixed-method approach, combining quantitative analysis of structured questions with qualitative analysis of open-ended feedback. This dual perspective provides a complete picture of the user experience, revealing not only what users are doing but why. By understanding the motivations and pain points behind user behavior, Bike Share Toronto can implement targeted improvements that resonate with its customer base, from simple equipment requests to significant service enhancements.

Methodology

1. Questionnaire Drafting. Develop the survey questionnaire, incorporating a mix of question types to capture both quantitative and qualitative data.
2. Pilot Testing. Conduct a pilot test of the survey with Humber students to identify any ambiguities and refine questions for clarity.
3. Survey Rollout. Distribute the finalized questionnaire through both online (e.g., in-app, email) and offline (e.g., at stations) channels to reach a broad user base.
4. Response Analysis. Use descriptive statistics to analyze responses from pre-set questions and identify key trends. Review open-ended feedback to identify common themes, suggestions, and user pain points.
5. Synthesized Reporting. Combine quantitative and qualitative findings to provide a comprehensive understanding of user sentiment and actionable recommendations.

d. Industry Benchmarking

Finally, Competitive Benchmarking will provide external context and identify best practices from industry leaders. By systematically comparing Bike Share Toronto's Key Performance Indicators (KPIs)—such as ridership growth, utilization rates, and membership models—against those of BIXI in Montreal and Citi Bike in New York, the project will uncover performance gaps and opportunities. This analysis goes beyond mere numbers to study the successful strategies these services have implemented, offering a roadmap of proven tactics that can be adapted to accelerate Bike Share Toronto's growth.

Methodology

1. Selection of KPIs. Identify key metrics for comparison, including ridership growth, utilization rate, and membership trip proportion.

2. Data Collection. Gather historical data on the selected KPIs for all benchmarked services.
3. Gap Identification. Compare performance across each metric to pinpoint areas for improvement.
4. Study of Best Practices. Analyze the methods used by industry leaders to develop strategies for Bike Share Toronto.

4.2 The Fit of the New Solution into the Existing IT Architecture

The new solution is meticulously designed for seamless integration into Bike Share Toronto's current IT environment, ensuring that its powerful new capabilities enhance, rather than disrupt, existing systems. This approach prioritizes efficiency, scalability, and cost-effectiveness by leveraging the infrastructure already in place.

A core principle of the design is non-disruptive data and systems Integration. The solution will connect directly to established data sources, including the mobile app, smart bikes, and station kiosks. It will utilize the existing central data warehouse and established ETL (Extract, Transform, Load) processes, ensuring a continuous and reliable flow of data for analysis without requiring a costly overhaul of current data collection and storage mechanisms.

The dashboard and model deployment will be executed within the existing IT framework. Predictive models will be deployed on current computational resources, while the Power BI dashboard will plug directly into the existing data pipelines. This allows for real-time data updates and provides secure, role-based access to stakeholders through familiar platforms, thereby maximizing the return on previous technology investments and minimizing the learning curve for users.

The survey and feedback loop is designed to feel like a natural extension of the user experience. Post-ride surveys will be delivered through the existing mobile app, and the collected feedback will be channeled through the same data pipelines that handle trip information. This method directly links user sentiment to specific vehicles, stations, and times, allowing maintenance and operations teams to view and act upon this feedback within the dashboards they already use daily.

Lastly, the benchmarking as an overlay component will function as an intelligent analytical layer that sits on top of current systems. It will interface with existing databases and Business Intelligence (BI) tools via APIs to gather the necessary data. The resulting comparative insights and best-practice recommendations will be visualized within the same dashboards that decision-makers already rely on, ensuring that this strategic analysis is easily accessible and fully compliant with existing data governance and security frameworks.

4.3 Impact Analysis

To ensure a smooth and successful implementation, a thorough impact analysis will be conducted to proactively identify and mitigate potential risks. This strategy is centered on three key areas: rigorous testing protocols, meticulous management of system updates, and a clear plan for adapting operational processes.

Risk mitigation through testing is the first line of defense against unforeseen issues. The solution will undergo two phases of comprehensive testing before deployment. Functionality Testing will technically validate every component, ensuring that data integrates correctly, predictive models generate accurate outputs, and the dashboard is responsive and error-free. Following this, User Acceptance Testing (UAT) will be conducted with key stakeholders, allowing them to evaluate the solution in real-world scenarios to confirm it meets all business requirements and provides tangible value for their roles.

All system and security updates will be carefully managed to maintain the integrity and stability of the IT environment. This includes verifying all IP addresses and ports associated with new data links to prevent network conflicts, proactively updating firewall rules to accommodate new data flows without compromising security, and reviewing all software licenses to ensure the new components are fully compliant and properly licensed.

Finally, the analysis accounts for managing operational changes that will arise from the new features. The introduction of potential new vehicle types like e-scooters or cargo bikes, as suggested by user surveys, will require coordinated updates across multiple business functions. The mobile app interface will need to be redesigned, docking station firmware may require adjustments, and maintenance workflows will need to be adapted with new training and procedures. This forward-looking planning ensures that the organization is fully prepared to support the new features from day one.

Data Preparation and Management

Effective data cleaning and management were critical to ensuring the accuracy, consistency, and reliability of the datasets used for the Bike Share Toronto Ridership Growth Optimization project.

5.1 Data Sources

Data was sourced from:

- **Toronto Open Data Portal:** Historical ridership and station datasets.
- **Survey Responses:** Primary data collected through targeted user feedback.

5.2 Data Cleaning

To ensure accuracy, consistency, and readiness for analysis, all raw datasets—comprising trip data, station metadata, and user survey responses—underwent a structured data cleaning process.

- **Ridership Data**:
  The raw trip datasets contained missing values, inconsistent date formats, and station name variations. We standardized date and time formats, aligned station names, corrected location mismatches, and removed invalid or duplicate entries. Outliers in trip durations and distances were reviewed and retained or excluded based on plausibility checks.

- **Survey Data**:
  The initial survey data contained incomplete, duplicated, and inconsistently formatted responses. Cleaning steps included:
  - Removing duplicates and irrelevant entries.
  - Standardizing column names and answer formats.
  - Handling missing values via imputation or exclusion depending on their impact.

    - Aligning categorical options (e.g., merging equivalent responses like "E-bike" and "Electric bike").

    This process produced a clean, consistent dataset ready for integration with other data sources.

5.3 Data Storage and Security

- All raw and processed datasets were stored in a shared Google Drive repository with restricted access to project members.
- Regular backups were maintained on local drives for redundancy.
- Processed datasets were stored separately from raw data to ensure data integrity.

5.4 Data Output

The processed datasets served as the foundation for two separate analytical outputs:

- **Ridership Dashboard**:
  Built using the cleaned ridership and station data, this dashboard focused on operational and usage trends. It enabled exploration of:
    - Trip volumes, popular start and end stations, user type distribution, seasonal patterns, and yearly growth.
- **Forecasting using multiple predictive models** (Holt-Winters, Neural Networks, Random Forest, XGBoost, Linear Regression, and SVM) to capture seasonal fluctuations and complex non-linear patterns, supporting strategic decision-making.
- **Survey Dashboard**:
  Designed using only the cleaned survey dataset, this dashboard captured user perceptions, preferences, and improvement suggestions. It provided insights into satisfaction levels, preferred bike types, trip purposes, and demographic patterns, helping contextualize ridership trends with qualitative feedback

Implementation and Testing

6.1. Solutions Implementation

This strategy outlines our approach to forecasting ridership, enhancing operational efficiency, and boosting user satisfaction. Key pillars include predictive modeling, real-time dashboards, targeted surveys, and benchmarking against leaders like BIXI and CitiBike. Together, these efforts support data-driven decision-making, operational refinement, and strategic growth.

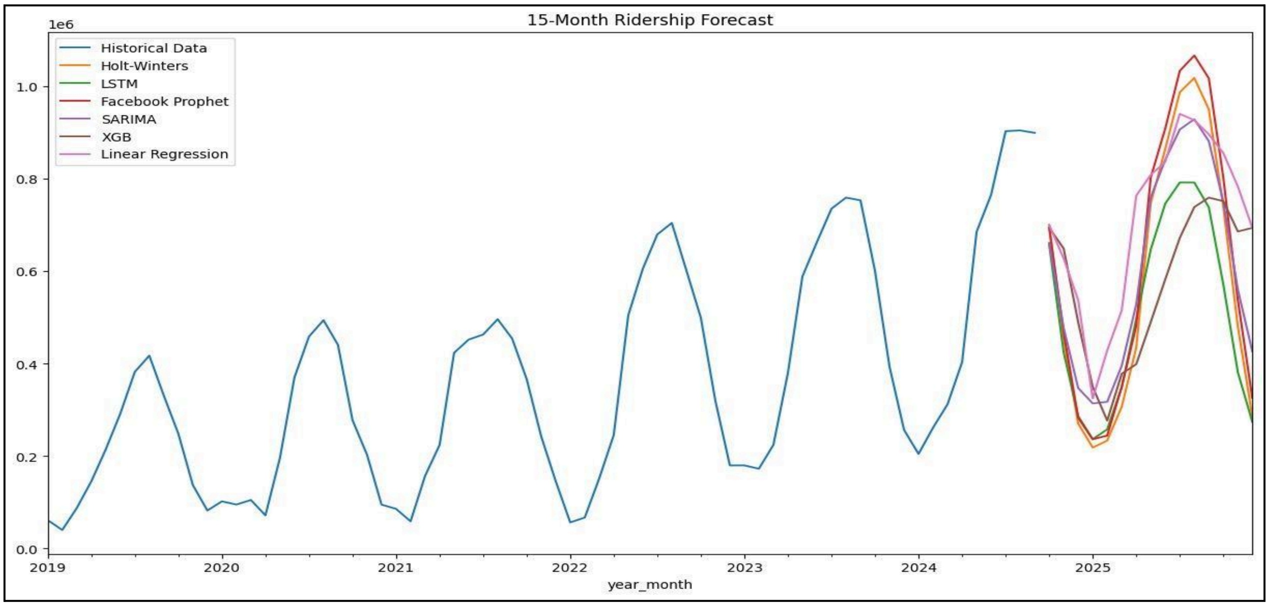
a. Model Development

The team implemented multiple forecasting models—**Holt-Winters, Facebook Prophet, SARIMA, LSTM, XGBoost, and Linear Regression**—to capture both linear and nonlinear patterns

- **Data Preparation:** Integrated Bike Share Toronto ridership records with weather data. Applied cleaning, normalization, and feature engineering.
- **Training & Validation:** Used cross-validation and parameter tuning to optimize accuracy and prevent overfitting.
- **Performance:** Holt-Winters and SARIMA excelled at seasonality, Facebook Prophet performed strongly on both trend and seasonality, LSTM captured complex patterns but showed some sensitivity, while Linear Regression and XGBoost showed more divergence during volatile periods (Hyndman & Athanasopoulos, 2021; Taylor & Letham, 2018).

Figure 3

Model Forecasts compared to Historical Ridership Data



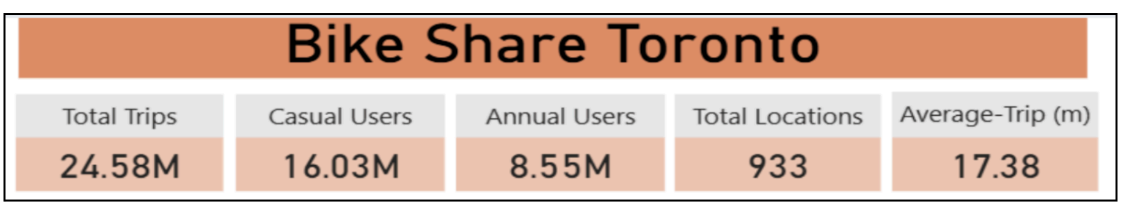
- **Seasonality:** Holt-Winters, SARIMA matched historical peaks/troughs.
- **Trend Tracking:** Prophet aligned well with real movements.
- **Complexity Handling:** LSTM promising, but needs stability tuning.

b. Dashboard Development

An interactive Power BI dashboard centralizes key metrics, enabling stakeholders to visualize ridership patterns and act in real time.

Figure 4

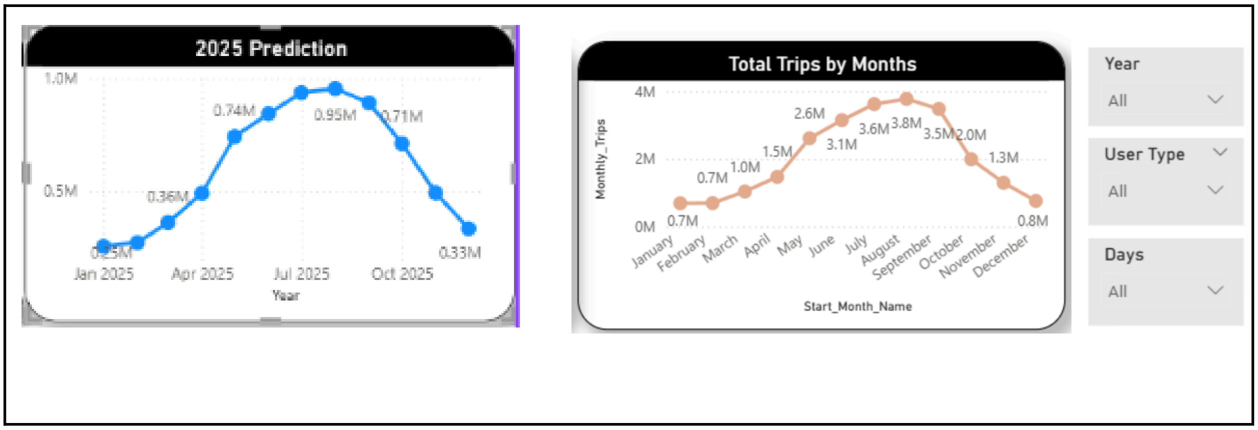
Dashboard Snapshot 1



Trip records, user types, station metadata, and temporal variables (year, month, day of week) combined into a unified model.

Figure 5

Dashboard Snapshot 2



Key Features

- **Headline KPIs:** Total trips, member vs. casual user share, average trip duration, active stations.
- **Temporal Trends:** Year-over-year growth, seasonal peaks (June–Aug), and weekend demand spikes to guide rebalancing.
- **Segmentation Tools:** Pie charts and slicers for quick breakdowns by user type and time period.
- **Multi-Layer Insights:** Month-year matrix for detecting anomalies or saturation points.

The dashboard also integrates **model outputs and survey feedback**, functioning as a **strategic decision-support system** for operations, marketing, and planning teams.

c. Survey Implementation

Purpose: Gather user feedback to guide service enhancements. Integrated directly into the Bike Share Toronto app for seamless participation.

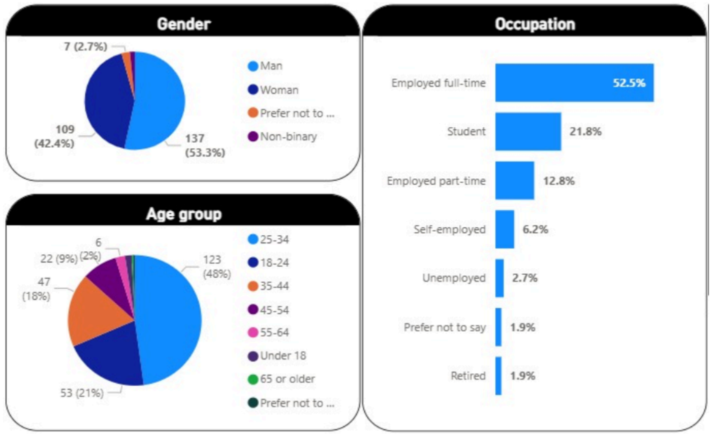


Figure 6.4: Dashboard snapshot 4

Methodology:

- **257 Responses** collected via automated post-ride pop-ups, re-prompted after 7 days if declined.
- **Content:** 11 concise questions covering demographics, usage behavior, and open-ended feedback.

Key Demographics:

- **Gender:** 53.3% male, 42.4% female.
- **Age:** 25–34 years most represented (48%).
- **Occupation:** 52.5% full-time employed, 21.8% students.

Insights:

- Weather-related docking struggles.
- Demand for cargo bikes.
- Feature requests: baskets (33.8%), helmets (22.2%).
- 23% “never used” → outreach opportunity.
- 21.8% high-frequency users (3–6 rides/week) → peak-hour resource needs.

Survey data feeds directly into the dashboard, linking feedback with trip details for targeted actions.

d. Benchmarking Analysis

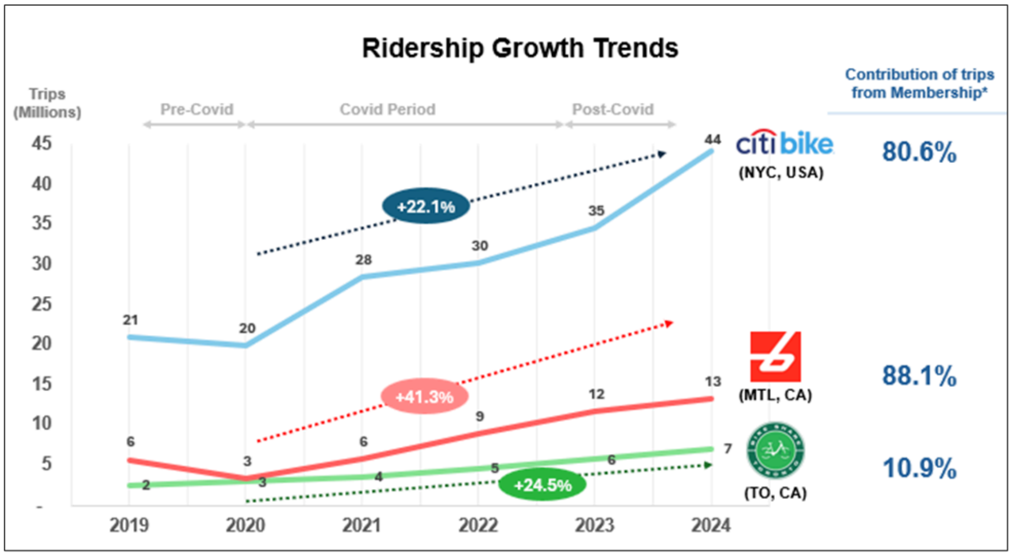
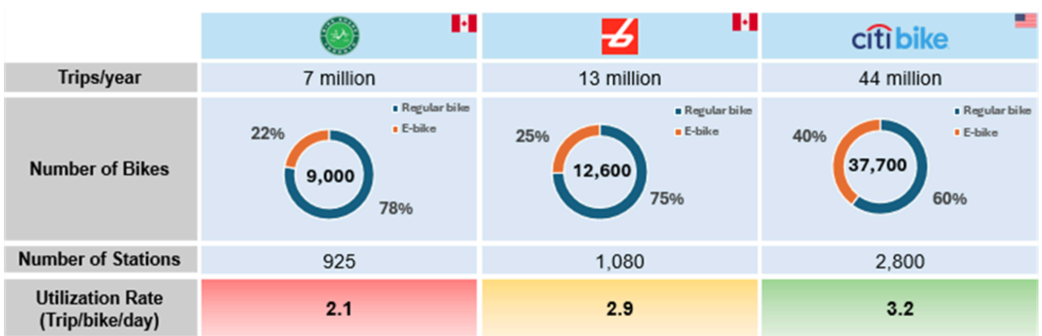


Figure 6.6: Ridership Growth Trends (2019-2024)

- All systems saw dips during early COVID (2020).
- **Post-COVID Growth:** Strong recovery; BIXI had the highest percentage growth.
- **Membership Contribution:** 10% for Bike Share Toronto compared to 80% for BIXI and CitiBike.



			citi bike
Trips/year	7 million	13 million	44 million
Number of Bikes	9,000 (Regular bike 78%, E-bike 22%)	12,600 (Regular bike 75%, E-bike 25%)	37,700 (Regular bike 60%, E-bike 40%)
Number of Stations	925	1,080	2,800
Utilization Rate (Trip/bike/day)	2.1	2.9	3.2

Figure 6.7: Utilization Rate Comparison

CitiBike leads in utilization with 3.2 trips/bike/day, surpassing BIXI at 2.9 and Bike Share Toronto at 2.1. The analysis will explore how BIXI achieved the highest growth during COVID-19 and why both BIXI and CitiBike have over 80% membership contributions compared to just 10% for Bike Share Toronto. It will also investigate how CitiBike maintains high utilization despite having only a moderately higher station count than the other two systems.

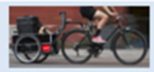
Pricing Plan	- One-Way Pass - Day Pass - Annual Memberships	- One-Way Pass - **Monthly Membership** - **Seasonal Membership**	- One-Way Pass - Day Pass - Annual Membership
Vehicle	Bike / E-bike		
Station	Solar-powered stations / E-station		
Safety Gear	-		
Rental Equipment	-	Bike Trailer 	-
Additional Services offered	- Valet Service at high traffic location	- Regular bikes are modified with studded tires and non-slip pedals to handle winter conditions.	- Valet Service at high traffic location
Challenges	- **Ridership tends to decline in winter due to harsh weather conditions.** - Dock Outages / insufficiency - Bike Maintenance		- Dock Outages / insufficiency - Bike Maintenance

Figure 6.8: Platform Comparison

- **BIXI:** Seasonal memberships (Apr–Nov), winter-modified bikes (studded tires, non-slip pedals), bike trailers for cargo.
- **CitiBike:** Extensive station network in NY/NJ, flexible pricing.

  Best Practices: Both prioritize membership growth and high fleet utilization through flexible plans, strategic station placement, and community engagement.

Key Takeaways:

1. **Model Accuracy:** Prophet leads for balanced trend and seasonality; Holt-Winters/SARIMA excel at seasonality; LSTM promising for complexity.
2. **Dashboard Impact:** Real-time KPIs and segmentation tools improve operational agility.
3. **Survey Insights:** Direct user input highlights feature demands, pain points, and growth opportunities.
4. **Benchmarking Lessons:** Higher membership rates and utilization can be driven by targeted pricing, seasonal strategies, and fleet adaptation.

6.2. Outcome Testing and Reviewing

a. Model Evaluation

Predictive models were assessed using RMSE, MAE, and MAPE to ensure accuracy and reliability.

- **RMSE**: Measures the standard deviation of prediction errors; lower = more precise predictions.
- **MAE**: Captures average absolute error magnitude; smaller = better accuracy.
- **MAPE**: Expresses errors as % of actual values; lower = better alignment.

	Model	RMSE	MAE	MAPE
4	Facebook Prophet	33662.263026	26184.943380	0.060306
5	SARIMA	55273.145546	42017.160431	0.073607
0	Holt-Winters	59157.774053	48607.775188	0.091600
1	Tuned LSTM	60529.938297	48462.815759	0.136365
8	XGB	111998.098270	98747.218750	0.170981
6	Linear Regression	112432.729930	89777.822222	0.172557
2	Tuned Neural Network	133309.814701	76498.631486	0.243215
3	Tuned Random Forest	191183.721512	170163.922033	0.438076
7	SVR	273776.084805	212902.572410	0.282708

Table 6.1: Comparative Results Based On Error Metrics

- **Best Performance:** *Facebook Prophet* achieved the lowest RMSE (33,662.26), MAE (26,184.94), and MAPE (0.0603), showing high consistency and accuracy.
- **Strong Alternatives:** *SARIMA* and *Holt-Winters* performed well but with slightly higher errors.
- **Competitive Potential:** Tuned *LSTM* effectively modeled complex nonlinear trends with marginally higher error than Prophet.
- **Less Suitable:** *XGB*, *Linear Regression*, and *Tuned Neural Network* had higher errors. *Tuned Random Forest* and *SVR* performed weakest, requiring tuning or alternative approaches.

b. Survey Evaluation (survey sample = 257)

Findings revealed both strengths and improvement areas:

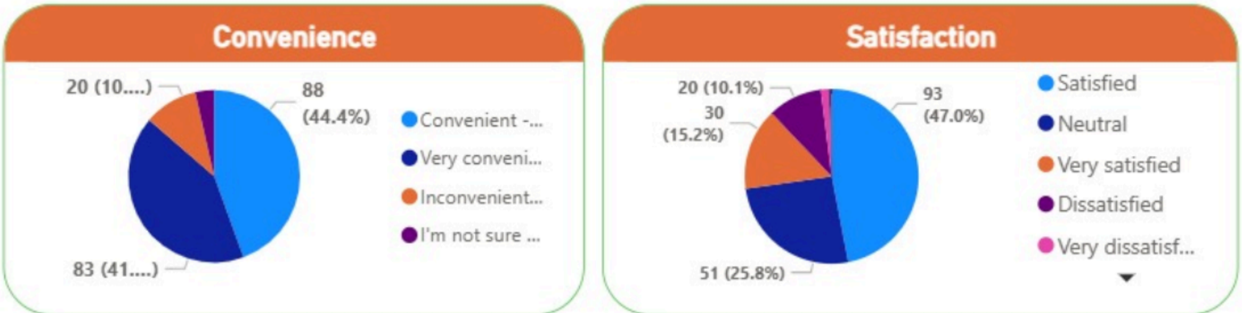


Figure 6.9: Survey Snapshot 1

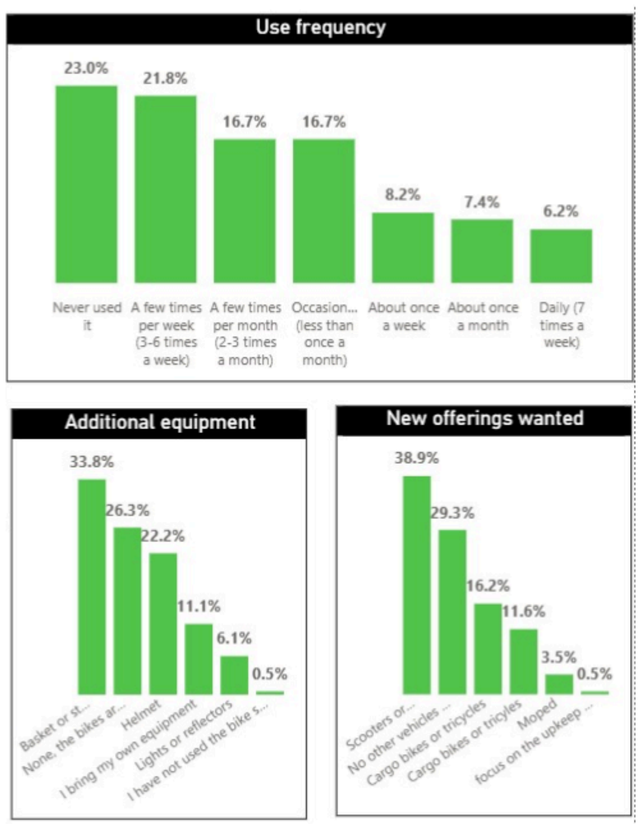


Figure 6.10: Survey Snapshot 2

- **Convenience:** 44.4% rated rides “Convenient” and 41% “Very Convenient.”
- **Satisfaction:** 47% “Satisfied” and 15.2% “Very Satisfied,” leaving a significant portion neutral or dissatisfied.
- **Desired Features:** 33.8% requested baskets; 22.2% wanted helmets.

- **Usage Gaps:** 23% “Never used” the service (outreach potential); 21.8% rode 3–6 times weekly (necessitating peak-hour rebalancing).
- **Qualitative Themes:** Weather-related docking issues, interest in cargo bikes, and feature requests linked to convenience scores.

Action Integration:
Survey insights and model forecasts feed into a **real-time Power BI dashboard**, allowing stakeholders to monitor trends daily and respond swiftly with targeted operational or marketing strategies.

6.3 Optimization

Our optimization plan focuses on improving performance, efficiency, and user satisfaction by refining predictive models, integrating real-time data, and leveraging user feedback. Benchmarking against industry leaders ensures strategic adaptation and innovative membership models to meet evolving needs.

a. Model Refinement

- **Advanced Parameter Tuning:** Apply grid/random search, dropout, and batch normalization to optimize LSTM/XGBoost performance and stability.
- **Expanded Data Integration:** Add real-time weather and event data to capture short-term ridership dynamics.
- **Performance Monitoring:** Track RMSE, MAE, and MAPE to maintain high forecasting accuracy.
- **Automated Updates:** Retrain models continuously with new data to adapt to emerging trends.

b. Dashboard Enhancements

- **Predictive Insights:** Integrate ML into Power BI to forecast high-demand periods for proactive resource allocation.
- **User Interaction:** Offer personalized notifications and interactive tutorials.

- **Geo-Visualization:** Map potential high-demand areas for optimal station placement.
- **Real-Time Data:** Provide live updates for immediate, data-driven decisions.

c. Continuous Feedback Integration

- **Dynamic Surveys:** Refresh questions regularly to align with shifting user needs.
- **Real-Time Feedback:** Enable in-app channels for instant responses and improvements.
- **Incentive Optimization:** Tailor rewards to boost survey participation.
- **Mobility Expansion:** Explore scooter integration, with 38.9% user interest.
- **Urban Planning Support:** Use data to identify underserved areas (23% “never used”) for network growth.

d. Strategic Benchmarking

- **Pricing & Promotions:** Continuously compare with industry benchmarks.
- **Competitor Insights:** Monitor and adapt to competitor strategies.
- **Best Practices:** Adopt proven tactics from leaders like BIXI and CitiBike, including flexible memberships and community outreach.

These measures collectively drive improved forecasting, targeted resource deployment, enhanced engagement, and competitive positioning in the bike-sharing market.

Challenges and Recommendations

7.1 Challenges

a. Integrating External Datasets

A significant hurdle encountered was the integration of Bike Share Toronto data with external datasets. Aligning the system's operational data with disparate sources—encompassing bike lane maps, meteorological data, and demographic information—presented notable technical complexities. The variability in data formats, update frequencies, and semantic inconsistencies across these external sources necessitated extensive data harmonization efforts to ensure accurate correlation and analysis.

b. Benchmarking with Other Cities

Conducting comparative assessments against bike-share programs in other cities proved challenging due to the absence of standardized metrics. Without uniform performance indicators—such as ridership density, station utilization rates, or service coverage benchmarks—meaningful global benchmarking was impeded. This lack of standardization hindered the identification of best practices and the objective evaluation of Bike Share Toronto's competitiveness within the international landscape.

c. Multidisciplinary Synergy as a Requirement

The project underscored the criticality of multidisciplinary collaboration. While combining data science, urban planning, and sustainability expertise enhanced the project's depth and real - world impact, orchestrating these distinct disciplines posed inherent challenges. Aligning analytical rigor (data science), spatial planning objectives (urban planning), and environmental goals (sustainability) required deliberate coordination to ensure cohesive strategy development and implementation.

7.2 Opportunities and Recommendations

a. Bike Redistribution Optimization

User feedback highlights dissatisfaction stemming from bike unavailability at stations and full docking points, particularly in areas outside the downtown core. To mitigate this, data - driven redistribution strategies should be expanded. Leveraging ridership patterns, weather forecasts, and temporal demand fluctuations, resources should be reallocated to underserved regions, with a focus on transit hubs to improve first - and last - mile connectivity.

Current rebalancing initiatives are overly concentrated in the downtown area during peak hours. A more geographically and temporally diversified approach is needed. By extending rebalancing operations to suburban and emerging demand zones—and calibrating schedules to off - peak periods—system efficiency and user accessibility will be enhanced.

Implement a user-incentive program, analogous to New York City's Bike Angels initiative. Rewarding riders for assisting in network rebalancing (e.g., relocating bikes from overstocked to understocked stations) can crowdsource redistribution efforts, fostering a sense of community ownership and improving system resilience.

b. Expanding Bike Fleet and Station Network

User input indicates a pronounced need for additional bikes and stations in Etobicoke and North York. Prioritizing expansion in these regions aligns with broader mobility goals, reducing reliance on personal vehicles for short - distance trips.

New stations should be sited near key community assets—including schools, libraries, and grocery stores—to promote active transportation for local errands. Additionally, transit hubs (e.g., Line 2, York University, upcoming Line 5 and 6 LRTs), major parks, and hospitals represent high - impact locations. These placements will integrate bike - share services into existing urban mobility ecosystems, encouraging multimodal travel and reducing carbon emissions.

By addressing these challenges and pursuing targeted enhancements, Bike Share Toronto can elevate service quality, expand its user base, and solidify its role as a sustainable transportation pillar in the city.

Conclusion

8.1 Summary of Key Outcomes

Bike Share Toronto has experienced strong ridership growth, showing a clear upward trend with summer peaks from June to August and sharp declines in winter, though usage saw a boost during the COVID-19 period. The majority of riders are casual users—primarily tourists or occasional riders—with the core demographic being men (53%), young adults aged 25–34 (48%), and full-time workers (52.5%). Usage patterns reveal weekday commuter peaks between 8–9 AM and 4–6 PM, while weekends are dominated by leisure trips, with activity concentrated in the downtown core. Benchmarking against systems like BIXI and CitiBike shows Toronto's lower share of rides from registered members compared to their 80%+ member usage, as well as a lower utilization rate (3.2 trips/bike/day for CitiBike). Best practices from these systems—such as flexible monthly and seasonal plans aligned with weather, winterized bikes with studded tires, and commuter-friendly add-ons—offer clear opportunities for improvement. While 85% of users find the service convenient and 73% are satisfied, 25% remain neutral or dissatisfied, citing requests for baskets or storage (33.8%), helmets (26.3%), better lighting (22.2%), scooters or e-bikes (38.9%), and more stations (29.3%). To drive growth, the service could focus on targeting non-users, converting occasional riders to frequent members, diversifying equipment and offerings, and expanding beyond the downtown core.

8.2 Suggestions

a. "WeBike2Gether" campaign plan

Marketing Issues: Low user acquisition and engagement, limited brand visibility, and moderate satisfaction due to unmet feature expectations.

Duration: 3 months

Goals:

- Achieve 100,000 trips during the campaign
- Increase frequent usage from 30% to 60% (2–3 times/week)
- Raise membership trip contribution from 11% to 40%
- Improve high satisfaction rating from 45% to 80%
- Grow social media followers from 6,000 to 20,000

Key Initiatives

1. **Referral Program** – $20 gift card for both referrer and referee; milestone rewards with ride credits or free month memberships at 3, 5, and 10 referrals.
2. **Influencer Partnerships** – Collaboration with 200 sustainability, health, and lifestyle influencers (5K–200K followers) for reels, ride-alongs, and hashtag campaigns; exclusive referral codes to track conversions.
3. **Social Engagement** – User-generated content contests (best ride photo/scenic route wins a free month), interactive polls/stories, and branded hashtags **#WeBike2gether** and **#BikeShareTO**.
4. **Community Pop-Ups** – Weekend events in high-traffic areas (e.g., Nathan Phillips Square, Eaton Centre, UofT campus) featuring free trials, live demos, safety tips, and partnerships with local vendors and biking communities.

b. Bike Redistribution

Users face bike shortages and full stations, particularly outside the downtown core, as rebalancing efforts remain overly focused on central areas during peak hours. To resolve this, Bike Share Toronto should leverage data-driven strategies to guide bike redistribution to underserved locations, with a focus on areas near key transit hubs, and introduce a user incentive program—similar to NYC's Bike Angels—that rewards riders for helping move bikes to stations where they are most needed.

c. More Bikes, More Actions

Users in Etobicoke and North York face an operational challenge due to a lack of bikes and stations, which limits access and often forces reliance on cars for short local trips. To address this, Bike Share Toronto should add stations near schools, libraries, and grocery stores to encourage active transportation for daily errands, while prioritizing expansion in strategic locations such as major transit hubs (Line 2, York University, and the upcoming Line 5 and Line 6 LRT), as well as parks and hospitals, to improve connectivity and accessibility across these underserved areas

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Appendix A: Survey Questionnaire

Bike Share Toronto User Experience and Preference Survey

Good day!

We are a group of Business Insights and Analytics students from Humber Polytechnic and we are conducting this research project to better understand the user experience and preferences related to Bike Share Toronto. This survey will take approximately 2 minutes to complete, and your responses will help us gain valuable insights for our project and to identify opportunities in improving the bike share network.

Please be assured that this survey is completely anonymous. All responses will be aggregated and used solely for the purpose of our academic research. This study is an independent project by Humber Polytechnic students and is not funded by, or initiated by, Bike Share Toronto. Thank you.
When you submit this form, it will not automatically collect your details like name and email address unless you provide it yourself.

I. About You

1. What is your age group?

- ☐ Under 18
- ☐ 18-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ 65 or older
- ☐ Prefer not to say

2. What is your gender?

- ☐ Woman
- ☐ Man

- ☐ Non-binary
- ☐ Prefer not to say

3. What is your occupation?

- ☐ Student
- ☐ Employed full-time
- ☐ Employed part-time
- ☐ Self-employed
- ☐ Unemployed
- ☐ Retired
- ☐ Prefer not to say
- ☐ Other

4. What are the first two digits of your postal code in Toronto?

- ☐ M1
- ☐ M2
- ☐ M3
- ☐ M4
- ☐ M5
- ☐ M6
- ☐ M7
- ☐ M8
- ☐ M9
- ☐ Prefer not to say

5. In the last three months, how often do you use the bike share service from Bike Share Toronto?

- ☐ Daily (7 times a week)
- ☐ A few times per week (3-6 times a week)
- ☐ About once a week
- ☐ A few times per month (2-3 times a month)
- ☐ About once a month

☐ Occasionally (less than once a month)

☐ Never used it

II. User Experience and Preferences

6. How convenient are the current bike share station locations for your local routes or destinations?

☐ Very convenient - stations are near my home/work/school/transit

☐ Convenient - stations are within walking distance from my home/work/school

☐ Inconvenient - stations are too far from my home/work/school

☐ I'm not sure / I don't know where the stations are

7. When using the bike share service, what additional equipment do you wish the bikes had?

☐ Helmet

☐ Basket or storage

☐ Lights or reflectors

☐ None, the bikes are well-equipped

☐ I bring my own equipment

☐ I have not used the bike share service

8. What is your overall sentiment regarding the pricing and payment options for Bike Share Toronto?

☐ Affordable and easy to use

☐ Pricing is reasonable, but the payment process could be easier

☐ Payment process is easy, but the service is too expensive

☐ Payment process is confusing and the service is expensive

☐ No issues

☐ I have not used the service or have no opinion on its pricing

9. How satisfied are you with the quality and upkeep of the bikes and the docking stations?

☐ Very satisfied

☐ Satisfied

- ☐ Neutral
- ☐ Dissatisfied
- ☐ Very dissatisfied
- ☐ I have not used the service / Not sure

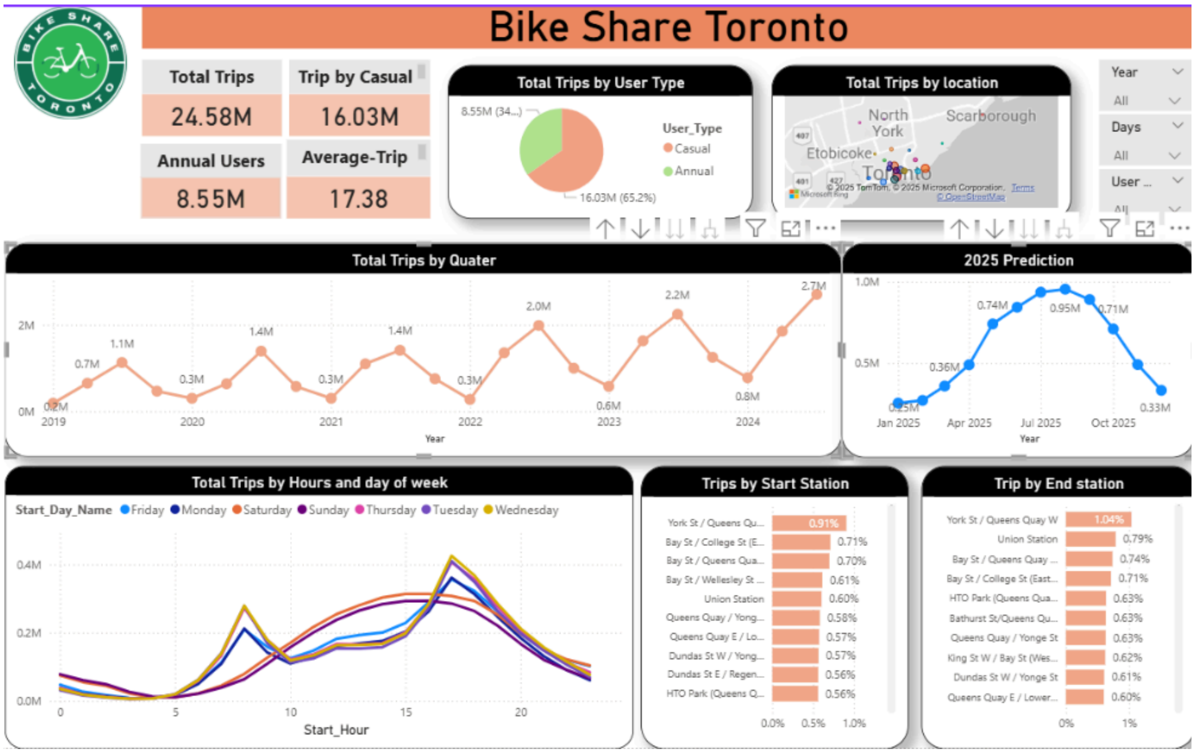
10. Besides the current classic and e-bikes, what ONE other type of vehicle should Bike Share Toronto prioritize adding?

- ☐ Scooters or e-scooters
- ☐ Cargo bikes or tricycles
- ☐ Moped
- ☐ No other vehicles are needed
- ☐ Others: ________

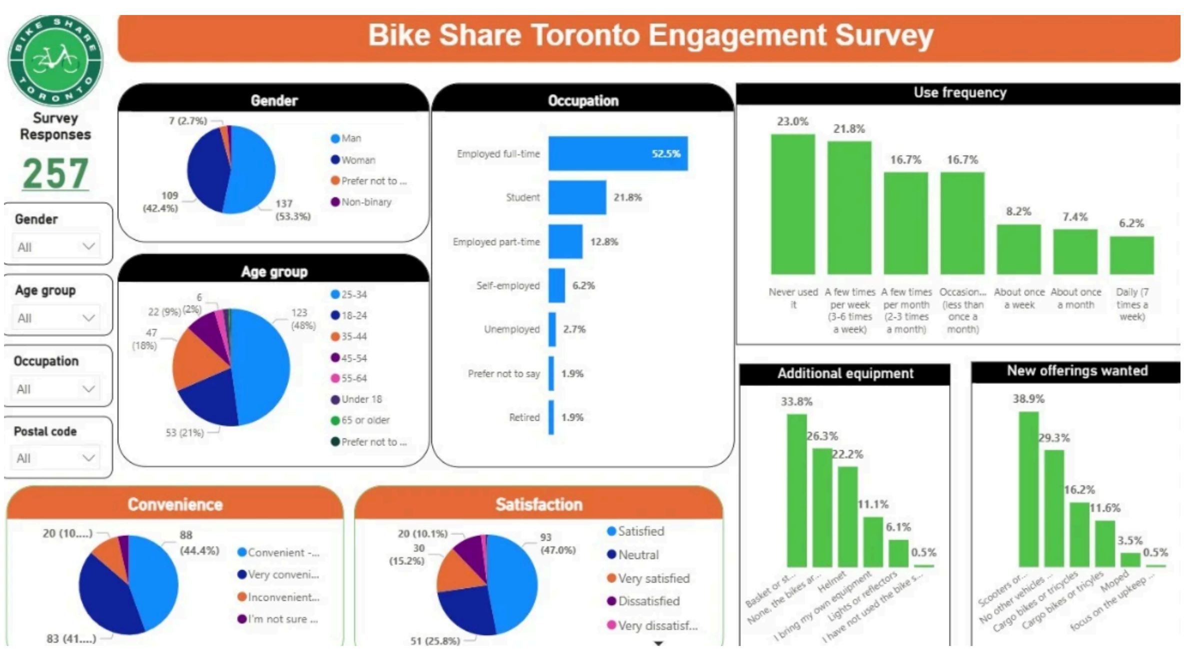
III. Suggestions and Feedback

11. Do you have any other suggestions or feedback to help us improve the Bike Share Toronto service? (Short answer)

Appendix B: Final Dashboard Screenshots



Bikeshare Ridership Dashboard



Survey Dashboard