



UNIVERSITY OF  
**TORONTO**



# **Transportation Problems and Data Requirements**

## **Report of the Transportation Panel**

**Urban Data Centre  
School of Cities  
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## Executive Summary

This report outlines the findings from the Urban Data Centre (UDC) 2022 Transportation Panel. The panel was undertaken as part of the UDC's development of an Urban Data Catalogue that will document the existence of urban datasets, and a repository for open Canadian urban data. In order to identify the data and data sources to be included in the UDC catalogue, a series of expert panels were conducted on specific topics in urban research, thereby providing a variety of views on the problems currently existing within each area, as well as a wide range of suggestions for the data needed to tackle them.

For the Transportation Panel, representatives from academe, government, and industry were brought together to discuss and share their thoughts and experiences in the domain, with the goal of identifying major transportation research problems and the types of data necessary to address them. Specifically, the panel consisted of two one-hour sessions, held virtually in February and March of 2022. Both sessions were facilitated and recorded, forming the basis of this report.

In order to document the Transportation research problems, the panel transcriptions were analysed to identify broad categories of interest, yielding seven categories: Social, Economic, Environmental, Physical Systems, Transportation Systems, Coordination, and Data Quality. These categories were further broken down into subcategories and within each subcategory, a set of questions emerged, encapsulating the types of inquiries that are being posed by practitioners in the field.

The Transportation Panel also identified data types needed to address these research problems. They were categorised as General Data, Travel Pattern Data, Infrastructure Data, Vehicle Data, Freight Data, and Transit Data and presented in a table in order to more easily navigate the information. The two-column table lists the specific data needs along with examples and/or sources of the corresponding data type, where they exist. Those data types that are either unavailable or difficult to access were identified with an asterisk.

The findings from the Transportation Panel contained in this report will be used to further inform the development and expansion of UDC's data catalogue.

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## Introduction

The development and operation of “smart cities” is predicated on the availability of relevant, accurate urban data. Yet the plethora of sources of urban data, be it open city data, IoT data, or data from 3rd parties, presents both opportunities and challenges: opportunities in what the scale, breadth and depth of the data enables practitioners and researchers to achieve, and challenges in achieving useable results due to issues of quality, sparseness, validity, interoperability, accessibility and relevance of the data.

A goal of the [Urban Data Centre](#) (UDC) is to develop an Urban Data Catalogue<sup>1</sup> that will document the existence of urban datasets and a repository for open Canadian urban data. The Catalogue documents three categories of datasets: 1) datasets stored in the repository in their native format that are openly available for download; 2) datasets not stored in repository but are accessible under separate agreement; and 3) datasets that are accessible by web services (API).

In order to identify the data and data sources to be included in the UDC catalogue, a series of expert panels were conducted on specific topics in urban research, thereby providing a variety of views on the problems currently existing within each area, as well as a wide range of suggestions for the data needed to tackle them.

This report outlines the findings from the UDC’s Transportation Panel, held in the first quarter of 2022.

## Format of Panel

Panel members from academe, government, and industry were brought together to discuss and share their thoughts and experiences, with the goal of identifying the major research problems in the Transportation domain and the types of data necessary to address them.

Specifically, the panel consisted of two one-hour sessions, held virtually in February and March of 2022. Both sessions were facilitated and recorded. In preparation for the first session, panel members were asked to consider a four-point questionnaire, below:

1. What are the main research problems in the area of Transportation?
2. What types of data do you believe are necessary to address these problems?
3. What data types are currently available to you? Where and how can they be accessed?
4. What data types are not available? Where can they be found, if they exist? How can they be accessed?

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<sup>1</sup> <https://urbandatacentre.ca/urban-data-catalogue>

The first panel session, led by the facilitator, centred around these four areas. The recording of the session was subsequently transcribed and distilled into a working document that captured the responses to these questions. This document was shared with the panel members in preparation for the second session. Members were asked to review the summary and provide feedback and additional thoughts in the second session. Again, the session was recorded and transcribed. The working document and the subsequent feedback form the basis of this report.

## **Panel Members**

The Transportation Panel was composed of the following experts:

- Jesse Coleman - City of Toronto
- Khandker Nurul Habib - University of Toronto
- Carolyn Kim - Pembina
- Arif K. Rafiq - Esri Canada
- Matthew Roorda - University of Toronto
- Amer Shalaby - University of Toronto
- Shan Sureshan - Province of Ontario

## **Transportation Problems**

In order to document the findings from the panel, the information from the transcriptions was analysed to identify broad categories of research problems. In all, this analysis yielded the following seven categories:

1. Social - issues relating to societal impacts of transportation
2. Economic - issues relating to the economy and transportation
3. Environmental - issues relating to the impact of transportation on climate change, sustainability, and resilience
4. Physical Systems - issues relating to infrastructure, vehicle design, road and land use, and other impacts of physical aspects of the environment on transportation and vice versa
5. Transportation Systems - issues related to different transportation systems, such as freight and transit systems
6. Coordination - issues relating to interrelation between different facets within transportation, such as levels of government
7. Data Quality - issues relating to the reliability of and access to transportation data

These categories were further broken down into subcategories. For each subcategory, a set of questions emerged, encapsulating the types of inquiries that are being posed by practitioners in the field. Please see below for a list of these categories, subcategories, and their respective research questions.

## **SOCIAL**

- Equity - fairness and impartiality associated with transportation
  - How do we achieve equity within the transportation system?
  - What effect do our transportation policies, investments, and emerging technologies and services have on equity?
  - How are our policies impacting historical injustice in our cities?
  
- Accessibility for Disabled and Low-Income Communities
  - How can we improve mobility within the system?
  - How do we help people get where they need to be?
  - Can we reduce the distance they have to go to get to those places?
  - What effect do our transportation policies have on mobility for the disabled and low-income?
  
- Health and Safety - harm and injury associated with transportation
  - How do we make the transportation system safer?
  - How do we protect vulnerable road users?
  - What is the impact of Road Safety programs aimed at eliminating traffic fatalities and severe injuries, such as Vision Zero?
  - How does the transportation system impact human health, e.g. effects of noise pollution, greenhouse gas emissions?
  
- Social impacts, beyond equity - civic justice consequences and challenges associated with transportation
  - Can we better understand and address how transportation infrastructure supplants other land uses?
  - What can we do to protect low income neighbourhoods that have historically been sacrificed for transportation infrastructure?
  - What is the relationship between the transportation system and gentrification?

## **ECONOMIC**

- Economy - regional impacts on wealth and resources associated with transportation
  - How does transportation contribute to the economy?
  - What is the connection between the economy and transportation? E.g. what are the costs of congestion, costs of traffic collisions, health care costs?
  
- Finance - funding of transportation system and projects
  - How do we finance the transportation system?
  - How do we prioritise our investments?
    - Where should we be investing our capital dollars?

## ENVIRONMENTAL

- Sustainability - impacts on maintaining ecological balance associated with transportation
  - Climate change
    - How can Canada achieve its climate goals by mid-century, specifically around transportation? (i.e. meet the Canadian government's commitment to reduce greenhouse gas emissions by 40 to 45% by 2030, where transportation represents a quarter of Canada's total emissions.)
    - What effect do our transportation policies have on the environment, climate?
    - How are our policies advancing our goals in climate?
  - Noise pollution
    - What are the environmental impacts of noise caused by transportation?
  - Emissions, air quality
    - What's the decarbonization curve?
    - How do you abate emissions over time?
    - How do you create carbon budgets?
    - How should new policy levers be introduced in order to reduce freight emissions and passenger travel emissions?
    - How can we help Canada transition to a NetZero economy by 2050?
- Resilience - recovery capacity of the transportation system
  - How do we make the transportation system more resilient? What can we do to mitigate the impact of events such as:
    - Pandemics
    - Weather events
    - Natural disasters
    - Economic events

## PHYSICAL SYSTEMS

- Efficiency - productivity and effectiveness of transportation system
  - How can we remove bottlenecks that cause unnecessary congestion?
  - How do we minimise the number of empty trucks and/or trucks with excess capacity on the road within the freight system?
  - How do we maximise the energy efficiency of the trucks on the road, i.e. determine and use the right size of vehicle for its purpose?
- New technologies

- How will connected vehicles change the transportation system? How do we design for them?
  - Green vehicle infrastructure
    - What will be the impact of EVs and alternative fuel technologies, especially in the commercial sector?
  - How will autonomous vehicles change the transportation system?
  - How do we transition to a future of connected and automated vehicle-based mobility systems?
  - What is the impact of new mobility systems, e.g. ride hailing systems, ride sharing, car sharing, and micro mobility systems?
- Transportation Infrastructure
    - Infrastructure has been built around movement of single passenger vehicles. Over the past decade, transportation has changed and evolved significantly with the adoption of cycling, scooters, and active transportation. How will these changes be carried out?
    - How do we improve the coordination of infrastructure improvements, for example a street overhaul, pavement improvements versus bike lanes?
    - How do we design our infrastructure to best address the need for bike parking? Vehicle parking?
    - What other design considerations should we assess, for example with regards to pavement design, track design?
  - Land Use
    - What are the impacts of land use decisions on transportation efficiency and effectiveness?
    - What are also the impacts of transportation infrastructure provision on the development of land?

## TRANSPORTATION SYSTEMS

- Freight
  - How do we understand travel patterns around urban freight, goods movement?
  - How do we work towards reducing emissions for that sector, heavy vehicle pollution?
  - What is the relationship between freight activity and consumer demographics?
    - For example: education, household income, gender, employment, access to internet, frequency of internet use, education level, race, age, occupation, housing density, urban versus rural location, and the number of vehicles that they have in the household.
  - Do we design dedicated infrastructure for freight movement?
  - What are the impacts of intra-urban freight transport e.g. on pollution, safety of large vehicles on urban streets?

- Public Transit
  - Pandemic Recovery
    - How do we stimulate ridership recovery after the massive decline in transit ridership due to Covid-19?
  - Electric Bus Fleets
    - How should transit agencies convert their diesel-powered bus fleets into electric bus fleets?
    - How do they take advantage of both provincial and federal funding programs?
    - How do we schedule the TTC's 2000 buses when they are all electrically powered?
    - How is it going to impact the timetable, the weekend schedule, the drivers' schedules?
  - Resilience
    - How do we design a transit system that is resilient?
    - How do they recover from the recurrent disturbances in the system that occur at various scales?
    - How do we recover from delays?
  - Integrating new mobility services with fixed route services
    - What would be the impact of on-demand transit or demand-responsive transit that many transit agencies are currently exploring?
  - Specifications for transit data
    - What is the standard format for reporting transit data e.g. GTFS (General Transit Feed Specification)?
  - Forecasting Demand in the Transit System
    - How do we predict what may happen in the system, how people may react, and which direction the urban system will go?
    - How do we forecast in the short term, the medium term, the long term?
    - How do we include both strategic and tactical planning?
    - How can we allocate resources equitably?
    - How can we allocate resources efficiently?
    - How do we forecast population changes, technology changes, revolution, and how people will react to these?
    - How do we predict people's reaction to specific policies, to a broad range of overall demand distributions?
- Large-scale Construction Projects

- How do we handle transportation management during these long construction projects, e.g. the disruption to businesses and residents?
- What are the economic impacts on local businesses?

## COORDINATION

- Coordination Between Levels of Government
  - How do we integrate data collection between levels of government?
  - How do we manage the maintenance of infrastructure across different levels of government?

## DATA QUALITY

- Transportation Data Quality
  - How do we assess and/or validate the quality of the transportation data that is available?

## Transportation Data Needs

The following table conveys the data types identified that are needed to address the major research problems in the Transportation domain. Data needs were grouped within the table in order to more easily navigate the information. The groupings are General Data, Travel Pattern Data, Infrastructure Data, Vehicle Data, Freight Data, and Transit Data. The left-hand column of the table lists specific data needs within each group. The right-hand column provides examples and/or sources of the corresponding data, where it exists. Those data types that are either unavailable or difficult to access are identified with an asterisk.

**Table 1: Transportation Data Needs**

Data Needs	Examples/Sources
* Barriers to access or unavailable	
GENERAL DATA	
Household data <ul style="list-style-type: none"> <li>● Demographics               <ul style="list-style-type: none"> <li>○ Income</li> <li>○ Age</li> <li>○ Education, etc</li> </ul> </li> </ul>	Census, StatsCan
Housing data <ul style="list-style-type: none"> <li>● Price</li> <li>● Size, e.g., bedrooms</li> </ul>	Real Estate Market data

Data Needs	Examples/Sources
* Barriers to access or unavailable	
Economic data <ul style="list-style-type: none"> <li>● Regional Economic Indicators</li> </ul>	Provincial data
Emissions data <ul style="list-style-type: none"> <li>● Performance measures</li> <li>● Commercial Vehicle Emissions               <ul style="list-style-type: none"> <li>○ Time</li> <li>○ Location</li> <li>○ Type of emission</li> <li>○ Engine type</li> </ul> </li> <li>● Personal Vehicle Emissions               <ul style="list-style-type: none"> <li>○ Time</li> <li>○ Location</li> <li>○ Type of emission</li> <li>○ Engine type</li> </ul> </li> <li>● *Urban freight Greenhouse Gas emissions by city</li> </ul>	Federal data Provincial data
TRAVEL PATTERN DATA	
Individual Travel Pattern Data <ul style="list-style-type: none"> <li>● Household members</li> <li>● Trips taken</li> <li>● Time of day</li> <li>● Mode</li> <li>● Purpose (e.g., business, school, pleasure)</li> </ul>	Household travel surveys, <ul style="list-style-type: none"> <li>● E.g., Transportation Tomorrow Survey, GTHA, National Household Travel Survey, USA</li> </ul> Travel diaries * Cell phone data
Transportation Mode data <ul style="list-style-type: none"> <li>● Travel by               <ul style="list-style-type: none"> <li>○ vehicle,</li> <li>○ transit,</li> <li>○ active transportation, such as pedestrian and cycle transport</li> </ul> </li> <li>● Time</li> <li>● Location</li> <li>● Characteristics of people travelling</li> </ul>	Physical counts <ul style="list-style-type: none"> <li>● Vehicles, cyclists, pedestrians moving through a street/intersection</li> </ul> Automatic intersection count devices <ul style="list-style-type: none"> <li>● Cyclists, pedestrians through an intersection</li> </ul> * Micro mobility data, e.g., Uber, Lyft
Travel Demand data <ul style="list-style-type: none"> <li>● How many vehicles using the street</li> </ul>	

Data Needs	Examples/Sources
* Barriers to access or unavailable	
<ul style="list-style-type: none"> <li>● Number of vehicles cutting through a specific street</li> <li>● Route of vehicles travelling through an area</li> </ul>	
<p>Volume data</p> <ul style="list-style-type: none"> <li>● Municipal streets</li> <li>● Provincial highways</li> <li>● Rural roadways</li> <li>● Congestion - delays</li> </ul>	<p>Count information</p> <ul style="list-style-type: none"> <li>● Automatic on-street count devices</li> <li>● Short-term on-street counts</li> <li>● Provincial traffic counts</li> </ul> <p>Tracking information</p> <ul style="list-style-type: none"> <li>● From onboard GPS</li> </ul> <p>Camera information</p> <ul style="list-style-type: none"> <li>● Captures vehicles travelling or parked in a specific location</li> </ul>
INFRASTRUCTURE DATA	
<p>Commercial/Personal Vehicle Infrastructure data</p> <ul style="list-style-type: none"> <li>● Street grid</li> <li>● Highways</li> <li>● Toll roads</li> <li>● Lane configurations</li> <li>● Traffic Signals and Signs <ul style="list-style-type: none"> <li>○ Location</li> <li>○ Type</li> </ul> </li> <li>● Parking</li> <li>● Speed limits</li> <li>● Curbside information</li> </ul>	<p>GIS data</p> <p>Municipal data</p> <p>Provincial data</p>
<p>Transit Infrastructure data</p> <ul style="list-style-type: none"> <li>● Bus lanes</li> <li>● Streetcar tracks</li> <li>● Subway lines</li> <li>● Transit Signals</li> <li>● Transit Stops</li> </ul>	<p>GIS data</p> <p>Transit Organisations</p>
<p>Active Transit Infrastructure data</p> <ul style="list-style-type: none"> <li>● Bicycle lanes</li> <li>● Cycling routes</li> </ul>	<p>GIS data</p> <p>Municipal data</p>

Data Needs	Examples/Sources
* Barriers to access or unavailable	
<ul style="list-style-type: none"> <li>● Bicycle racks</li> <li>● Sidewalks</li> <li>● Pathways</li> </ul>	
Infrastructure Conditions data <ul style="list-style-type: none"> <li>● Pavement conditions</li> <li>● Road performance metrics</li> <li>● Age of infrastructure</li> <li>● Condition over time</li> </ul>	Pavement cracking detection information OEM vehicle devices
VEHICLE DATA	
Vehicle Collision data <ul style="list-style-type: none"> <li>● Location</li> <li>● Date/time</li> <li>● Vehicle Types</li> <li>● Collision Type</li> <li>● * Equity data, e.g., race, immigration status, disability/accessibility, age</li> </ul>	Provincial data Police data
Vehicle Speed data <ul style="list-style-type: none"> <li>● Location</li> <li>● Date/time</li> <li>● Vehicle Type</li> </ul>	Sensor-based information <ul style="list-style-type: none"> <li>● E.g., Bluetooth, Bluetooth sniffers or detectors</li> </ul>
Vehicle Environmental Features data <ul style="list-style-type: none"> <li>● Energy saving features</li> <li>● Greening features</li> <li>● Pollution controls</li> <li>● Aerodynamic features</li> </ul>	Provincial goods movement data (freight vehicles)
FREIGHT DATA	
Freight Travel data <ul style="list-style-type: none"> <li>● Method of transport               <ul style="list-style-type: none"> <li>○ Commercial vehicle,</li> <li>○ Rail</li> <li>○ Air</li> <li>○ Marine</li> </ul> </li> <li>● Commodity data</li> </ul>	Surveys <ul style="list-style-type: none"> <li>● Commercial vehicle operator surveys               <ul style="list-style-type: none"> <li>○ Origin</li> <li>○ Destination</li> <li>○ Purpose</li> <li>○ Freight Content</li> </ul> </li> </ul>

Data Needs	Examples/Sources
* Barriers to access or unavailable	
<ul style="list-style-type: none"> <li>● Location data</li> <li>● Route data</li> <li>● Speed data</li> </ul>	<ul style="list-style-type: none"> <li>○ Vehicle specs</li> <li>○ E.g., Road-side intercept surveys</li> <li>● Shipper and receiver surveys <ul style="list-style-type: none"> <li>○ Purpose of transit, why transportation is happening</li> </ul> </li> <li>● Carrier-based surveys</li> </ul> <p>Commercial vehicle telematics information</p> <ul style="list-style-type: none"> <li>● E.g., engine sensors</li> <li>● GPS</li> </ul> <p>Border crossing data Commodity flow studies, municipal Cordon counts HERE Technologies datasets</p> <ul style="list-style-type: none"> <li>● Performance data, measuring commercial vehicle speeds at five minute intervals</li> </ul> <p>* Rail data, detailed * Air data detailed * Marine data detailed</p> <p>Electronic loggers on commercial vehicles, private</p>
<p>Freight Vehicle data</p> <ul style="list-style-type: none"> <li>● Specifications</li> <li>● Condition</li> <li>● Environment-specific features</li> </ul>	<p>Provincial goods movement data Weigh In Motion data Optical sensors</p> <ul style="list-style-type: none"> <li>● E.g., to detect tire inflation</li> </ul> <p>* GHG emissions</p>
<p>Freight System data</p> <ul style="list-style-type: none"> <li>● Inputs to freight system</li> <li>● Cause for freight transportation</li> <li>● Elements that affect freight system</li> <li>● Including <ul style="list-style-type: none"> <li>○ Number of establishments in each industry class</li> <li>○ Location of establishments</li> <li>○ Employment per industry</li> <li>○ Consumer purchasing behaviour</li> </ul> </li> </ul>	<p>Surveys</p> <ul style="list-style-type: none"> <li>● Commercial Vehicle survey, provincial</li> <li>● Origin-Destination Transportation survey, federal</li> </ul> <p>Commercial establishment datasets</p> <ul style="list-style-type: none"> <li>● Listing of Canadian companies</li> <li>● Industry classification</li> <li>● Employment information</li> </ul> <p>Federal datasets, including Transport Canada and Statistics Canada</p>

Data Needs	Examples/Sources
* Barriers to access or unavailable	
<ul style="list-style-type: none"> <li>○ Labour availability</li> <li>○ Industry trends by sector</li> </ul>	<ul style="list-style-type: none"> <li>● Freight statistics</li> <li>● For-Hire survey, annual</li> <li>● Canadian Internet Use survey</li> <li>● Rail Commodity Origin-Destination</li> </ul> <p>* Curbside use data</p> <p>* Breakdown between medium and heavy-duty vehicle travel</p> <p>* Comprehensive view of system</p> <ul style="list-style-type: none"> <li>● Picture of every truck on the roadway, including <ul style="list-style-type: none"> <li>○ Freight load</li> <li>○ Reason for transport</li> <li>○ Origin</li> <li>○ Destination</li> <li>○ Position in broader supply-chain</li> </ul> </li> </ul>
TRANSIT DATA	
<p>Transit Vehicle data</p> <ul style="list-style-type: none"> <li>● Location data</li> <li>● Electric Bus Fleet data <ul style="list-style-type: none"> <li>○ State of performance</li> <li>○ State of charge</li> <li>○ Performance under different conditions, e.g., weather, traffic, occupancy</li> </ul> </li> </ul>	<p>AVL (Automatic Vehicle Location)</p> <p>Canadian Urban Transit Research and Innovation Consortium data portal</p> <ul style="list-style-type: none"> <li>● Support planning, scheduling, and management of electric bus fleets</li> </ul>
<p>Transit Ridership data</p> <ul style="list-style-type: none"> <li>● Passenger volume</li> <li>● Rider satisfaction</li> </ul>	<p>APC (Automatic Passenger Count)</p> <p>AFC (Automatic Fare Collection)</p> <p>Customer Satisfaction surveys</p>
<p>Transit System data</p> <ul style="list-style-type: none"> <li>● Route data</li> <li>● Stop data</li> <li>● Delay data</li> <li>● Track occupancy data <ul style="list-style-type: none"> <li>○ Location and movement of trains</li> </ul> </li> <li>● OnDemand Transit Pilot Projects data</li> </ul>	<p>Delay logs</p> <ul style="list-style-type: none"> <li>● Length of delay</li> <li>● Type</li> <li>● Location</li> <li>● Affected area(s)</li> </ul> <p>*CCTV feeds (UAv)</p> <p>*WiFi data (UAv)</p>

<b>Data Needs</b>	<b>Examples/Sources</b>
<b>* Barriers to access or unavailable</b>	
<ul style="list-style-type: none"><li>○ Performance data</li><li>○ Economic data</li></ul>	