


The logo for UTTRI, featuring the letters 'UTTRI' in a bold, blue, sans-serif font. The 'U' and 'T' are connected, and there are three horizontal lines above the 'I'.

UTTRI

Research Report

How has COVID-19 Impacted Ride-sourcing use in the Greater Toronto Area?

Results from the first cycle of the SiSTM satellite survey

A background image featuring abstract, glowing blue light trails and lines that create a sense of motion and depth, resembling a futuristic or data-driven environment.

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INTRODUCTION

- The pandemic caused by the coronavirus disease (COVID-19) has transformed daily life in cities worldwide
 - Many have changed their daily routines (including where they work, how often they leave home and the reasons why they leave home)
 - The pandemic has also led some to re-examine their travel behaviour (particularly their modal choices) due to changes in the perceived risks associated with travel
- Early studies into the impacts of COVID-19 on travel behaviour have found:
 - A strong preference for private vehicles and active modes (walking and bicycling)
 - An apprehension towards using so-called shared modes (such as public transit, taxis, and ride-sourcing services) (1–4)
- Ride-sourcing services can help improve the accessibility of those without access to a private vehicle or who have concerns about using public transit
- Before the COVID-19 pandemic, the introduction of ride-sourcing services reshaped urban mobility in cities across the world
 - The introduction of ride-sourcing services tends to induce travel demand, influence activity patterns and schedules, and affect how existing modes of travel are used (5–7)
- The growing prominence and use of ride-sourcing increases the potential to produce positive and negative externalities
 - **Negative:** potential to induce travel demand (6), draw demand away from more sustainable modes (e.g., public transit and active modes) (8)
 - **Positive:** can be an “accessibility enhancer” for those without access to a private vehicle (9)
 - Shared ride-sourcing (where customers are offered a discounted fare for sharing their trip with another customer travelling to a similar

destination (10)) have the potential to increase vehicle occupancies and reduce vehicle-kilometers travelled (9,11)

Given the influence that ride-sourcing has already had on urban mobility, and the relative novelty of ride-sourcing services, it is essential to understand how COVID-19 will affect ride-sourcing use, both in the short-term and the long-term.

- To investigate the impacts of COVID-19 on the use of ride-sourcing services in the Greater Toronto Area (GTA), Canada, the Travel Demand Modelling Group at the University of Toronto initiated the *Study into the use of Shared Travel Modes* (SiSTM)

Goals of SiSTM:



Understand the short- and long-term impacts of COVID-19 on ride-sourcing use in the GTA



Examine the influence of attitudinal factors on the use of ride-sourcing

- To support these goals, the SiSTM survey was administered using a web-based survey interface in July 2020
 - **Data collected:** information that provides insights into how ride-sourcing use in the GTA has been affected by the COVID-19 pandemic
 - **Sample size:** 920 GTA residents (first wave)
- This report presents preliminary findings from the first cycle of the SiSTM survey
 - Key questions:
 - How has COVID-19 has affected ride-sourcing usage in the GTA?
 - How are respondents are approaching life during the pandemic?
 - What might ride-sourcing usage look like in the post-pandemic world?



SURVEY METHODS

Survey design

- The SiSTM survey distinguished between *exclusive* ride-sourcing services and *shared* ride-sourcing services
 - **Motivation:** the potential for customers to be paired with other customers when using shared ride-sourcing

Exclusive ride-sourcing	<ul style="list-style-type: none"> • Customers are not matched with other users • <u>Examples:</u> UberX, Lyft Classic
Shared ride-sourcing	<ul style="list-style-type: none"> • Customers are offered a discount in exchange for sharing their ride • <u>Examples:</u> UberPool, Lyft Shared

- To understand the potential short- and long-term impacts of COVID-19 on ride-sourcing usage, the study period was divided into three distinct time periods (*Table 1*)

Table 1: Definition of time periods in the survey

Time Period	Description
Pre-COVID	The period of time prior to the declaration of a state of emergency in Ontario (March 17, 2020) (12)
Pandemic	The period of time between when the state of emergency was declared and the point in time when COVID-19 is no longer considered a public health threat
Post-COVID	The period of time after COVID-19 is no longer considered a public health threat

- Survey sections:
 - Questions about ride-sourcing usage:
 - How often exclusive and shared ride-sourcing are used
 - The types of trips for which ride-sourcing was used
 - How their use of ride-sourcing changed due to the pandemic, and the reason(s) for the change

- Question about attitudes and perceptions:
 - Perceptions of risk
 - Willingness to travel
 - Impact of COVID-19 on travel preferences
 - **Note:** Several of these questions were asked twice – once pertaining to the pandemic period and once pertaining to the post-COVID period – to understand how perceptions and attitudes may change once COVID-19 is no longer considered a public health threat
- Stated preference (SP) experiments:
 - Used to capture the influence of various factors on the decision to use ride-sourcing for different trip purposes and at different periods of time
- Questions about socio-economic and household attributes:
 - **Examples:** age, gender, the municipality in which they reside, and their household income
- Pandemic-specific questions:
 - **Examples:** views on social distancing, how the pandemic has affected their daily routine, and adherence to public health guidelines
- Questions about modal preferences
 - Typical mode(s) used, by trip purpose and time period (see *Table 1*)
 - **Purposes:** commute trips, non-commute trips

Prior to the administration of the survey, a pilot test was conducted by circulating the survey among members of the research team and key stakeholders at the City of Toronto. The feedback was incorporated into the survey.

Survey conduct

The SiSTM survey was conducted in July 2020 using a web-based survey interface. Survey invitations were sent to a random sample of members of a market research panel comprised of GTA residents. The GTA is composed of the City of Toronto and the four surrounding regional municipalities (York, Peel, Durham, and Halton) (see *Figure 1*). Per the 2016

Canadian Census, the GTA is home to approximately 6.4 million residents (13).



Figure 1: The Greater Toronto Area (GTA) (14)

The survey received a total of 1,250 responses; after the data was cleaned and invalid responses were removed, a total of 920 responses remained.

- A comparison of the distributions of key sample statistics to the 2016 Canadian census is shown in *Figure 2*
- Current employment status (see *Table 2*):
 - 70% were employed
 - 26% were not employed at the time of the survey
 - 4% selected 'other' when reporting their employment status


 49% of respondents had a bachelor's degree or an advanced degree

Table 2: Work location among those who were employed at the time of the survey

Employment Status	Work Location		
	At workplace	At home	Hybrid
Full-time	27.3%	25.5%	4.7%
Part-time	5.4%	5.9%	0.8%

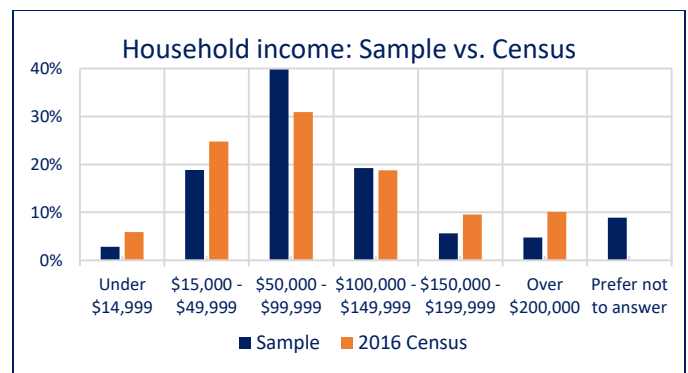
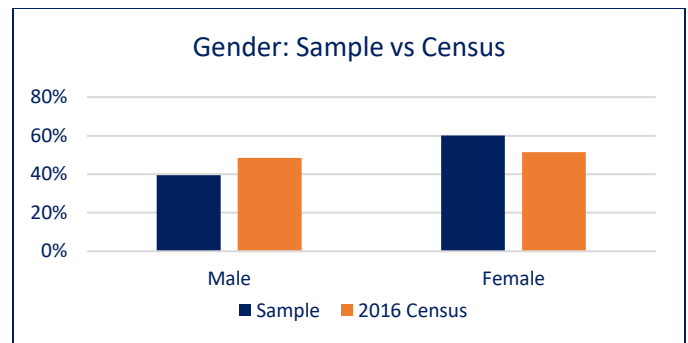
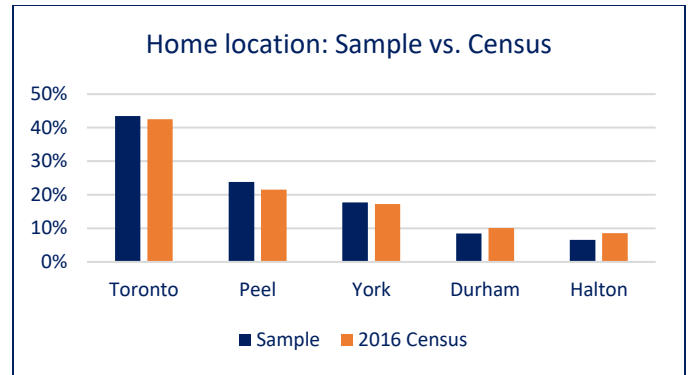





Figure 2: Distribution of key demographic variables

Mobility tool ownership:

-  87% of respondents have a driver's license
-  88% of respondents have access to a private vehicle (as either a driver or passenger)
-  42% of respondents have a transit pass

RIDE-SOURCING USE PRE-COVID

As shown in *Figure 3*, over half of the respondents indicated that they had experience using either exclusive or shared ride-sourcing services pre-COVID.

- Most respondents with ride-sourcing experience have used exclusive and shared services
 - Those with experience using only one type of service were more likely to have used exclusive ride-sourcing
- Before the COVID-19 pandemic, most respondents reported using ride-sourcing services on a relatively infrequent basis
 - This is consistent with the findings of prior studies on ride-sourcing usage (15,16)

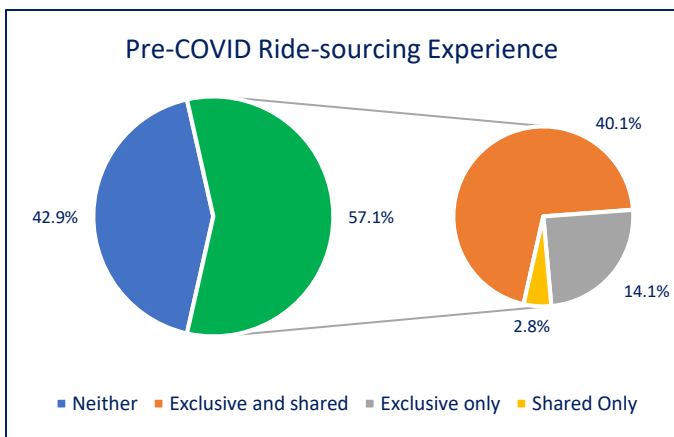


Figure 3: Ride-sourcing experience among respondents prior to the COVID-19 pandemic

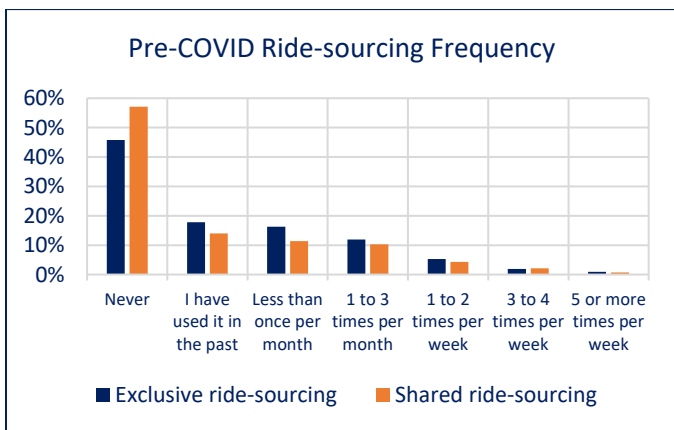


Figure 4: Ride-sourcing frequency pre-COVID

IMPACTS OF COVID-19 ON RIDE-SOURCING

Modal preferences

As shown in *Figure 5*, the percentage of respondents that use ride-sourcing for both commuting and non-commuting trips during the pandemic is roughly half that of the values corresponding to the pre-COVID period.

- These values could return to approximately pre-COVID levels in the post-COVID era
- This decrease is partially due to the reductions in travel that resulted from the implementation of stay-at-home orders
 - It may also stem from the belief that the risk associated with using ride-sourcing (and transit) is greater than the risk associated with using private vehicles and active modes (4)
- The results suggest that ride-sourcing demand may not return to pre-COVID levels until the pandemic is over; this can largely be attributed to:
 - The impact of the pandemic on the perception of risk when travelling, and
 - The likelihood that some version of stay-at-home orders may be in place while COVID-19 is still a public health threat

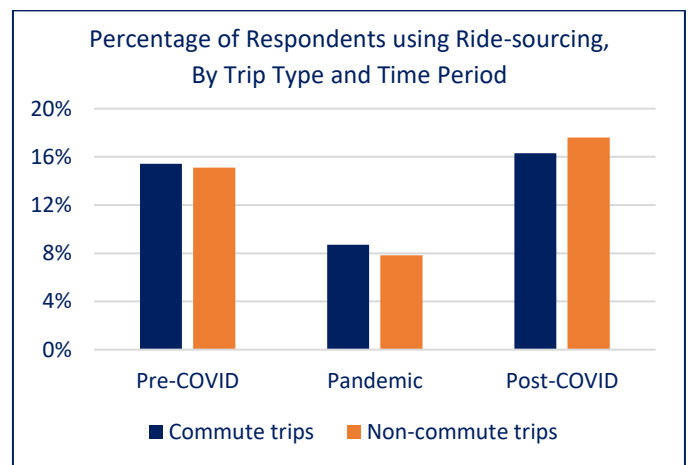


Figure 5: Percentage of respondents indicating they used/would use ride-sourcing

Frequency of Ride-sourcing Usage

As part of the SiSTM survey, respondents were asked a series of questions regarding their use of ride-sourcing during the pandemic.

- A small percentage (1.5%) of respondents began using ride-sourcing services during the pandemic
 - This may reflect the need to still travel during the pandemic, coupled with a reluctance or inability to use their usual mode of travel
- Among those with ride-sourcing experience in the pre-COVID period, roughly half have not used ride-sourcing since the start of the pandemic (see Figure 6)
 - While the trend shown in Figure 6 implies that ride-sourcing use has decreased during the pandemic, about 1 in 5 respondents increased their use of ride-sourcing during the pandemic (see Figure 7).

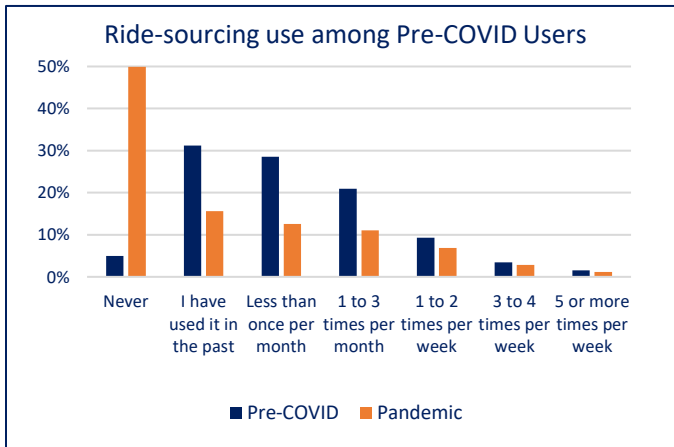


Figure 6: Ride-sourcing frequency of pre-COVID users, pre-COVID and during the pandemic

- Respondents who reported changing their ride-sourcing use during the pandemic were asked about the factors that led to their decision
 - Among those who reduced their use of ride-sourcing during the pandemic:
 - The most common reason was that they were travelling less overall (see Figure 8)

- Concerns related to the potential risk of exposure to the virus (including concerns about health, shared surfaces, and the cleanliness of the vehicles) also appear to have motivated respondents to reduce their ride-sourcing use
- It also appears that some respondents have turned to private vehicles and active modes as alternatives to ride-sourcing, which is consistent with modal shifts in other jurisdictions (1,2)

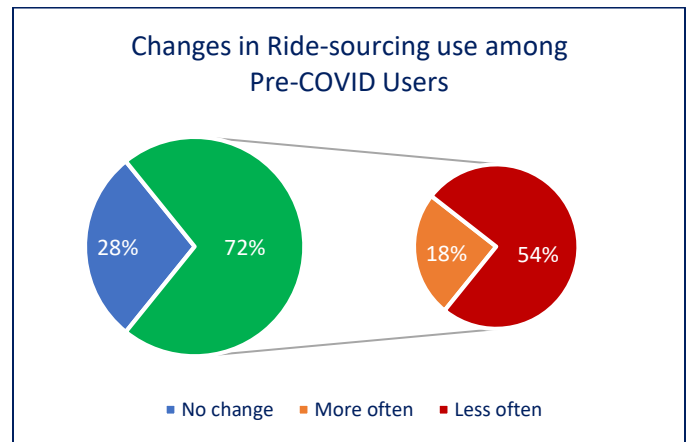


Figure 7: Changes in ride-sourcing usage during the pandemic compared to the pre-COVID period

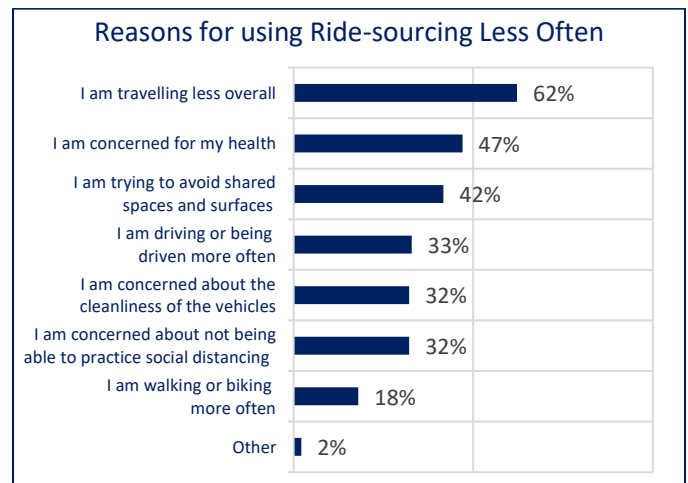


Figure 8: Reasons why ride-sourcing users have decreased their usage during the pandemic

- Among respondents whose ride-sourcing usage increased during the pandemic:
 - The most common reasons stemmed from concerns about public transit (see Figure 9)

- Respondents also cited concerns about reliability and crowding, as well as a reluctance to use public transit
- Similar results regarding concerns about using public transit have also been found in other studies about the impacts of COVID-19 on travel behaviour (3,4,17)
- Being unwilling or unable to use a private vehicle or active modes also influenced the decision to increase ride-sourcing use during the pandemic

➤ This may stem from the familiarity that users have with ride-sourcing services

- When asked about the health and safety measures they would like to see implemented, the most popular responses were:

- Mask mandates for both drivers and passengers (both of which were instituted at the beginning of the pandemic (18)) and,
- Providing hand sanitizer and disinfectant wipes to customers

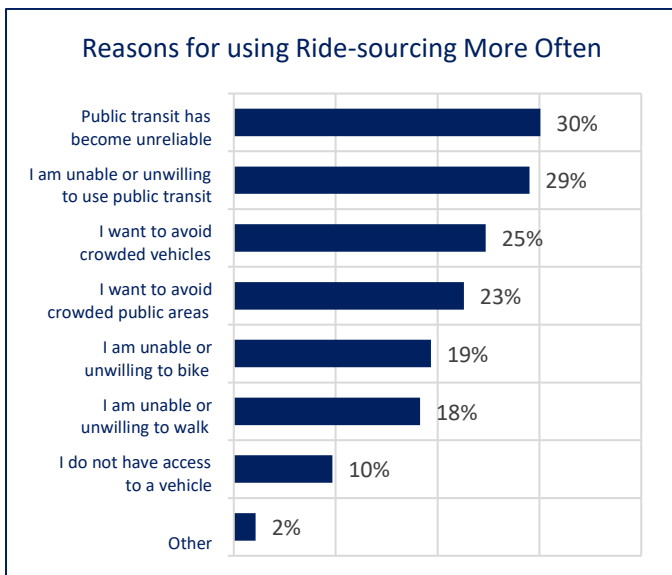


Figure 9: Reasons why ride-sourcing users have increased their usage during the pandemic

Willingness to use Ride-sourcing

The willingness to engage in an activity is an important factor in the decision of whether or not to actually engage in the activity. With this in mind, respondents were asked questions regarding the factors that would affect their willingness to use (or consider using) ride-sourcing services. First, respondents were asked whether the implementation of health and safety measures would increase their willingness to use ride-sourcing during the pandemic (see *Figure 10*).

- It is clear that the implementation of such measures would have a greater impact on those with ride-sourcing experience than those without

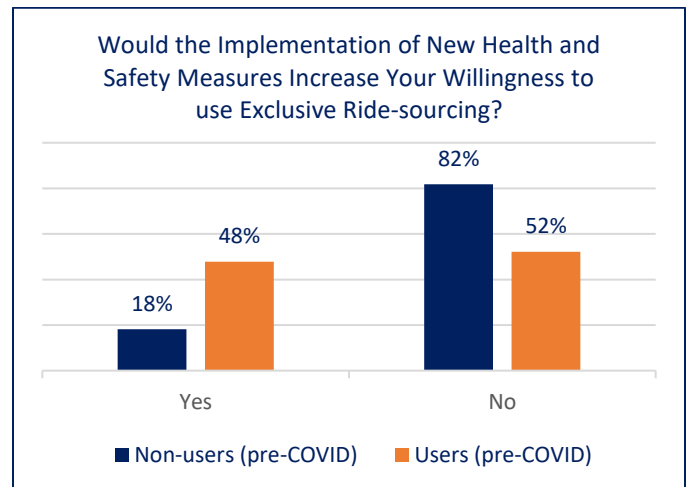


Figure 10: Impacts of additional health and safety measures on the willingness to use ride-sourcing

- To gauge how the progression of the pandemic would affect the decision to use ride-sourcing, respondents were asked to indicate the earliest point in time that they would consider using exclusive and shared ride-sourcing (summarized in *Figure 11*)

- The response options were partially based on the framework for “re-opening the province” (by lifting pandemic-related restrictions) that was developed by the Government of Ontario (19)
- The framework outlined a three-stage plan to lift restrictions on gatherings and the types of businesses and establishments that are allowed to operate (see *Table 3*) (20)

Table 3: Key aspects of the plan released by the Government of Ontario

Stage	Description
Stage 1	<ul style="list-style-type: none"> Select businesses that can maintain physical distancing re-open
Stage 2	<ul style="list-style-type: none"> Small public gatherings allowed More workplaces re-open Physical distancing still required
Stage 3	<ul style="list-style-type: none"> All workplaces re-open Physical distancing continues

- At the time of the survey, the GTA was in stage 2 of the re-opening plan; the GTA entered stage 3 just after the survey was completed
 - Note:** on November 3, 2020, the provincial government replaced their three-stage plan with a “five-tiered, colour-coded system” to modify pandemic-related restrictions based on incidence rates, the capacity of the healthcare system, and the capacity of local public health units (12,21)

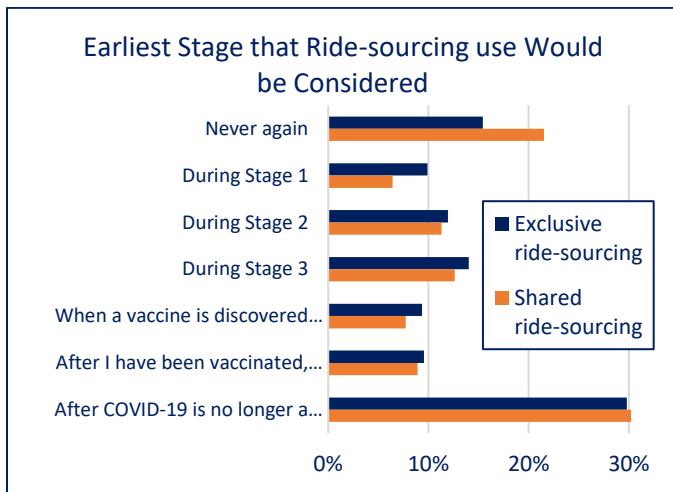


Figure 11: The Earliest Stage of the Pandemic that Respondents Would Consider using Ride-sourcing

- As shown in *Figure 11*, roughly one-quarter of respondents indicated that they would not consider using ride-sourcing until the end of the COVID-19 pandemic
- The lifting of pandemic-related restrictions appears to be associated with a greater willingness to consider using ride-sourcing

➤ This could stem from the impact that the lifting of restrictions has on the perception of risk or increases in travel demand that resulted from the re-opening of businesses and establishments and easing of restrictions on public gatherings

- There is also a portion of respondents that indicated that they will never consider using ride-sourcing (although the majority of these responses came from respondents who did not use ride-sourcing pre-COVID)
- These results, coupled with the reductions in travel demand that have resulted from pandemic-related restrictions and stay-at-home campaigns, mean that ride-sourcing demand is unlikely to return to pre-pandemic levels until the post-COVID period
- It is also possible that lingering apprehension towards shared surfaces and shared spaces results in a gradual return to pre-pandemic levels of utilization post-COVID
 - This was observed by (22) in their study of transit ridership in Taiwan in the wake of the severe acute respiratory syndrome (SARS) outbreak

RIDE-SOURCING USAGE IN THE POST-COVID PERIOD

The unprecedented nature of the COVID-19 pandemic, coupled with the relative novelty of ride-sourcing services, makes it difficult to anticipate how ride-sourcing use may be affected by the pandemic long-term.

- To shed light on what ride-sourcing use may look like in the post-COVID world, respondents who used ride-sourcing pre-COVID were asked to anticipate how they may use ride-sourcing once the pandemic is over (the results are summarized in *Figure 12*)

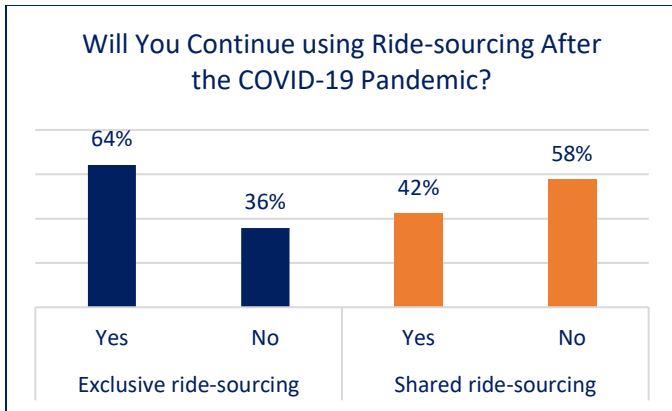


Figure 12: Anticipated Use of Ride-sourcing Post-COVID Among Respondents with Ride-sourcing Experience

- Somewhat surprisingly, the continued use of ride-sourcing appears to be far from a sure thing
 - Because these responses are a snapshot of how the respondents felt at the time of survey, and given how quickly the pandemic situation has changed at times, it is possible that their decision to use ride-sourcing post-COVID may differ from what they indicated in their responses
- A greater percentage of respondents indicated that they would not use shared ride-sourcing after the pandemic, which is understandable given the potential for one to have to share the ride with another customer
 - These results could stem from the perceptions of the risks associated with using ride-sourcing at the time of the survey
 - The results could also suggest that there may be residual concerns about shared spaces and surfaces or that these respondents have found alternatives approaches to satisfying their mobility needs
- Respondents who indicated that they would continue to use exclusive or shared ride-sourcing in the post-COVID period were asked if they believe that their use of these services will change compared to how often they used them in the pre-COVID period (the results are summarized in *Table 4*)
 - Roughly half of the respondents who indicated that they will continue to use ride-sourcing in the

post-COVID period believe that they will not change how often they use ride-sourcing

Table 4: Anticipated Change in Ride-sourcing Use in the Post-COVID Period Compared to the Pre-COVID Period

Change in Ride-sourcing Use	Exclusive Ride-sourcing	Shared Ride-sourcing
More often	20%	23%
Less often	24%	18%
No change	56%	58%

- Respondents who believe they will use ride-sourcing less often in the post-COVID period were asked to report the modes that they will use instead
 - As shown in *Figure 13*, most respondents indicated that private vehicles would be used to make some of the trips that they made using ride-sourcing services pre-COVID
- Interestingly, a small percentage of respondents said that they will not make some of the trips that they made using ride-sourcing services pre-COVID
 - This suggests that the introduction of ride-sourcing in the GTA did induce travel demand pre-COVID
- In addition, roughly one-third of respondents indicated that they will walk instead of using ride-sourcing
 - This substantiates concerns that ride-sourcing is (to a certain extent) replacing trips made by more sustainable modes of travel (i.e., public transit and active modes) (8,9,23)

IMPACTS OF COVID-19 ON ATTITUDES AND PERCEPTIONS

Given the unprecedented nature of the COVID-19 pandemic and the uncertainty surrounding it, it is important to understand how the pandemic has affected perceptions and attitudes. With this in mind, respondents were asked a series of attitudinal questions pertaining to the pandemic, including their perceptions of risk, their willingness to travel, and their preferences when they do travel. Respondents were also asked to complete a similar set of questions based on how they believe they will feel once the pandemic is over. Respondents were asked to indicate their level of agreement with a series of statements using a five-point Likert scale (1: strongly disagree, 5: strongly agree).

- In most cases, about three-quarters of respondents believed (i.e., agreed or strongly agreed) that there was an increased risk associated with using shared travel modes during the pandemic
 - Similarly, only 38% of respondents would feel safe using ride-sourcing during the pandemic (36% said the same about taking a taxi)
 - Bicycle sharing services appear to be one exception; only 57% of respondents believe that the risk associated with using this service was higher than before the pandemic
- When asked about the level of risk in the post-COVID period compared to the pre-COVID period, slightly more than half of the respondents believed that there was an increased risk associated with using exclusive and shared ride-sourcing (52% and 59%, respectively)
 - This is lower than the value corresponding to the pandemic period, which suggests that the level of perceived risk could remain above pre-pandemic levels even after the end of the COVID-19 pandemic

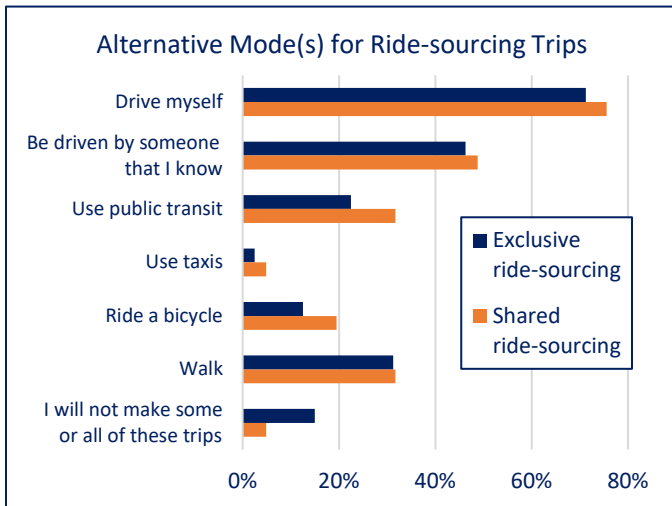


Figure 13: Anticipated Alternative Mode(s) for Ride-sourcing Trips (select all that apply)

- Respondents were also asked whether they would like to see various health and safety measures kept in ride-sourcing vehicles in the post-COVID period
 - As shown in *Figure 14*, there is strong support from both users and non-users to keep these measures
 - Providing customers with hand sanitizer and disinfectant wipes were among the most popular measures among respondents

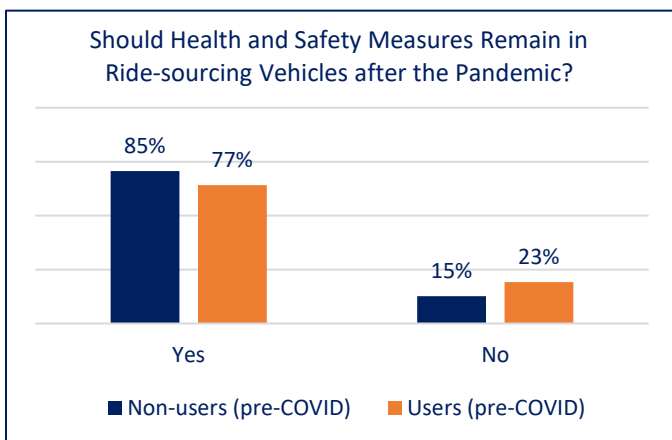


Figure 14: Support for Keeping Pandemic-related Health and Safety Measures in Ride-sourcing Vehicles in the Post-COVID era

Percentage of respondents who believe that COVID-19 has led to an increased risk when:



- A similar result is shown in *Table 5*, where respondents appear to be less willing to travel and spend time outside their homes than they were prior to the pandemic, even during the post-COVID period

51% of respondents believe they will be less likely to use modes where they are likely to encounter others post-COVID than they were pre-COVID

Table 5: Respondent Travel Preferences During the Pandemic and Post-COVID

Statement	% of respondents who agree with the statement	
	Pandemic	Post-COVID
I am less willing to spend time outside of my home than before the pandemic	60%	41%
I am less willing to spend time travelling than before the pandemic	66%	43%
I am less willing to visit places far from my home than I was before the pandemic	69%	46%

STATED PREFERENCE (SP) EXPERIMENTS

To better understand the factors that influence the mode choice process during the pandemic and in the post-COVID period, respondents were asked to complete 12 SP questions. Respondents were presented with four sets of choice experiments – one for each combination of trip purpose and time period. For each set of choice experiments, respondents were presented with three SP questions.

In each question, respondents were asked to choose from one of eight modes. The experiments were designed based on the average travel times (motorized modes) and the 95th percentile trip distances (active modes) in the most recent iteration of the regional household travel survey, the Transportation Tomorrow Survey (24).

The SP questions were designed by applying the d-efficient experimental design approach in the software Ngene. *Table 6* shows the attributes in the SP experiments that pertained directly to COVID-19.

- As shown in *Figure 15* and *Figure 16*, the time period did not have a significant impact on the percentage of choice tasks in which ride-sourcing was the chosen mode
- For both trip purposes, the most significant difference in modal shares between the pandemic and post-COVID periods is the reduction in the *drive yourself* mode and the increase in the *public transit* mode
 - This likely stems from a reluctance to use public transit during the COVID-19 pandemic

Trip purposes

- Commuting trips (e.g. to work or school)
- Non-commuting trips

Time periods

- During the pandemic
- Post-COVID

Mode choices

- Drive yourself (AD)
- Be driven by someone you know (AP)
- Public transit (PT)
- Exclusive ride-sourcing (ER)
- Shared ride-sourcing (SR)
- Taxi (T)
- Bicycling (B)
- Walking (W)

Table 6: Pandemic-related Attributes in the SP Experiments

Pandemic-related Attribute	Alternative			
	PT	ER	SR	T
Level of crowding	✓			
Passengers and operators required to wear masks [Y/N]	✓	✓	✓	✓
Vehicles are disinfected at the end of each day [Y/N]	✓	✓	✓	✓
Physical barrier between the driver and passengers [Y/N]		✓	✓	✓

- Interestingly, the share of choice tasks where ride-sourcing is chosen for non-commute trips is greater in the post-COVID period, which may be the result of the tendency for ride-sourcing to be used primarily for social and recreational trips (6,7,25)

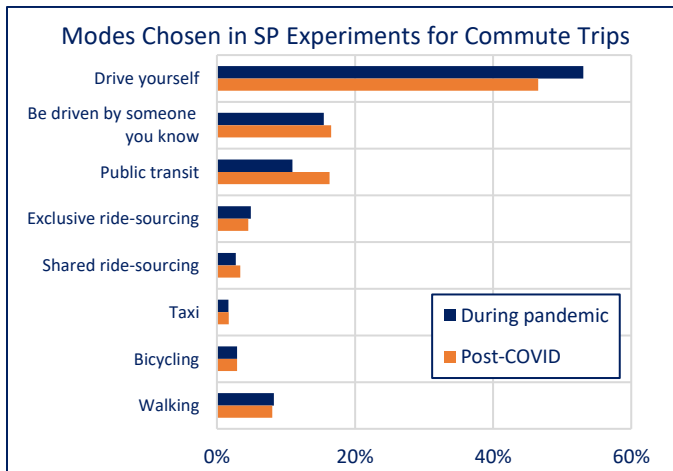


Figure 15: Distribution of Modal Choices in the SP Experiments (Commuting Trips)

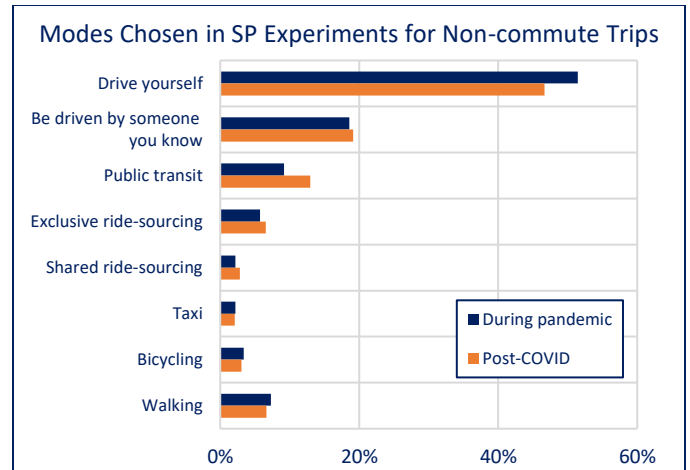


Figure 16: Distribution of Modal Choices in the SP Experiments (Non-commuting Trip)

CONCLUSIONS

This report presents the preliminary findings of a study that aims to understand the impacts of the COVID-19 pandemic on the utilization of ride-sourcing services in the Greater Toronto Area (GTA). The data used for this study were obtained through a web-based survey of GTA residents, which collected information on ride-sourcing use, perceptions and attitudes, and socio-economic attributes.

Besides, the survey asked the respondents to complete a series of stated preference (SP) experiments. The study results aim to provide insights into the short- and long-term impacts of COVID-19 on the use of ride-sourcing services, which should be of interest to policymakers given the impact of ride-sourcing on urban mobility prior to the pandemic.

- Overall, the preliminary results of the study suggest COVID-19 has led to reduced ride-sourcing demand, as well as a reduced willingness to use ride-sourcing
- However, a subset of respondents reported increasing their ride-sourcing use during the pandemic, citing concerns about using public transit, avoiding coming into contact with others, and not having access to a private vehicle
 - Although reductions in ride-sourcing demand can be partly attributed to reductions in overall travel

demand, it appears that these reductions have also been influenced by perceptions of risk and concerns about shared surfaces

- The preliminary results also suggest that COVID-19 may have long-term impacts on the perceived risks associated with the use of modes with shared surfaces (such as public transit and ride-sourcing) and on the willingness to spend time away from home
 - In particular, the potential for habits, behaviours, and perceptions developed during the COVID-19 pandemic to persist even after COVID-19 is no longer a public health threat
 - With regards to ride-sourcing, this would imply that demand is unlikely to return to pre-pandemic levels right after COVID-19 ceases to be a public health threat
 - Furthermore, it is unclear whether the perceived risks associated with the use of ride-sourcing (as well as other so-called shared modes) will return to pre-pandemic levels once the post-COVID period has been reached

The second cycle of the SiSTM survey will collect information on how perceptions and attitudes have evolved over the course of the pandemic in order to shed light on if and when they will return to something similar to their pre-pandemic state.

The data collected through the first cycle of the SiSTM survey will be used to estimate econometric models, which can provide insights into the impacts of COVID-19 on the use of ride-sourcing, how these impacts vary based on socio-economic and household attributes, and the influence of perceptions and attitudes on ride-sourcing usage.

REFERENCES

1. Molloy J. MOBIS-COVIF19/05: Results as of 04/04/20 [Internet]. ETH Zurich. 2020 [cited 2020 May 7]. Available from: https://ivtmobis.ethz.ch/mobis/covid19/reports/mobis_covid19_report_en_2020-05-04.html
2. Beck MJ, Hensher DA. Insights into the Impact of COVID-19 on Household Travel and Activities in Australia - The Early Days of Easing Restrictions. *Transp Policy*. 2020;99:95–119.
3. de Haas M, Faber R, Hamersma M. How COVID-19 and the Dutch ‘intelligent lockdown’ change activities, work and travel behaviour: Evidence from longitudinal data in the Netherlands. *Transp Res Interdiscip Perspect* [Internet]. 2020;6:100150. Available from: <https://doi.org/10.1016/j.trip.2020.100150>
4. Shamsiripour A, Rahimi E, Shabanpour R, Mohammadian A (Kouros). How is COVID-19 reshaping activity-travel behavior? Evidence from a comprehensive survey in Chicago. *Transp Res Interdiscip Perspect* [Internet]. 2020;7:100216. Available from: <https://doi.org/10.1016/j.trip.2020.100216>
5. Alemi F, Circella G, Mokhtarian P, Handy S. Exploring the latent constructs behind the use of ridehailing in California. *J Choice Model* [Internet]. 2018;29(July):47–62. Available from: <https://doi.org/10.1016/j.jocm.2018.08.003>
6. Clewlow RR, Mishra GS. Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States. *UC Davis Inst Transp Stud* [Internet]. 2017 Oct; Available from: <https://escholarship.org/content/qt82w2z91j/qt82w2z91j.pdf>
7. Wang H, Yang H. Ridesourcing systems: A framework and review. *Transp Res Part B Methodol*. 2019 Nov;129:122–55.
8. Gehrke SR, Felix A, Reardon TG. Substitution of Ride-Hailing Services for More Sustainable Travel Options in the Greater Boston Region. *Transp Res Rec*. 2019;2673(1):438–46.
9. Lavieri PS, Bhat CR. Investigating objective and subjective factors influencing the adoption, frequency, and characteristics of ride-hailing trips. *Transp Res Part C Emerg Technol* [Internet]. 2019;105(May):100–25. Available from: <https://doi.org/10.1016/j.trc.2019.05.037>
10. Brown AE. Who and where rideshares? Rideshare travel and use in Los Angeles. *Transp Res Part A* [Internet]. 2020;136(March):120–34. Available from: <https://doi.org/10.1016/j.tra.2020.04.001>

11. Tirachini A. Ride-hailing, travel behaviour and sustainable mobility : an international review. *Transportation (Amst)* [Internet]. 2019;1–37. Available from: <https://doi.org/10.1007/s11116-019-10070-2>
12. Nielsen K. A timeline of the novel coronavirus in Ontario [Internet]. 2020 [cited 2020 Nov 15]. Available from: <https://globalnews.ca/news/6859636/ontario-coronavirus-timeline/>
13. City of Toronto. City Halls - GTA municipalities & municipalities outside of the GTA [Internet]. 2017 [cited 2020 Jul 28]. Available from: <https://www.toronto.ca/311/knowledgebase/kb/docs/articles/311-toronto/information-and-business-development/city-halls-gta-municipalities-and-municipalities-outside-of-the-gta.html>
14. Wikimedia Commons. File:Greater toronto area map.svg [Internet]. 2006 [cited 2020 Nov 19]. Available from: <https://commons.wikimedia.org/w/index.php?curid=1268021>
15. Conway M, Salon D, King D. Trends in Taxi Use and the Advent of Ridehailing, 1995–2017: Evidence from the US National Household Travel Survey. *Urban Sci.* 2018;2(3):79.
16. Deka D, Fei D. A comparison of the personal and neighborhood characteristics associated with ridesourcing, transit use, and driving with NHTS data. *J Transp Geogr* [Internet]. 2019;76:24–33. Available from: <https://doi.org/10.1016/j.jtrangeo.2019.03.001>
17. Teixeira JF, Lopes M. The link between bike sharing and subway use during the COVID-19 pandemic: The case-study of New York’s Citi Bike. *Transp Res Interdiscip Perspect* [Internet]. 2020;6. Available from: <https://doi.org/10.1016/j.trip.2020.100166>
18. Bussewitz C, Koenig D. Face mask rules grow but enforcement proves a challenge [Internet]. *The Associated Press.* 2020 [cited 2020 Jul 20]. Available from: <https://apnews.com/8d4122b90ed06c5736eda01ca52d8f42>
19. Government of Ontario. A Framework for Reopening our Province [Internet]. Toronto; 2020. Available from: https://files.ontario.ca/mof-framework-for-reopening-our-province-en-2020-04-27.pdf?fbclid=IwAR0Of1o6qaOL7SbFcreoltrC_3f8ydeWLyzf44KfinI-An8VJzv78my9Geo
20. Government of Ontario. Archived - Reopening Ontario in stages [Internet]. 2020 [cited 2020 Nov 20]. Available from: <https://www.ontario.ca/page/reopening-ontario-stages#section-0>
21. Government of Ontario. COVID-19 Response Framework: Keeping Ontario Safe and Open - Lockdown Measure [Internet]. Toronto; 2020. Available from: <https://files.ontario.ca/moh-covid-19-response-framework-keeping-ontario-safe-and-open-en-2020-11-20-v2.pdf>
22. Wang K-Y. how change of public transportation usage reveals fear of the SARS virus in a city. *PLoS One.* 2014;9(3).
23. Alemi F, Circella G, Sperling D. Adoption of Uber and Lyft, Factors Limiting and/ or Encouraging Their Use and Impacts on Other Travel Modes among Millennials and Gen Xers in California. In: (No 18-06713). 2018.
24. Data Management Group. Design and Conduct of the Survey [Internet]. Toronto; 2018. Available from: http://dmg.utoronto.ca/pdf/tts/2016/2016TTS_Conduct.pdf
25. Acheampong RA, Siiba A, Okyere DK, Tuffour JP. Mobility-on-demand : An empirical study of internet-based ride- hailing adoption factors , travel characteristics and mode substitution effects. *Transp Res Part C* [Internet]. 2020;115(March):102638. Available from: <https://doi.org/10.1016/j.trc.2020.102638>