Automated Vehicles in the Greater Toronto and Hamilton Area: Overview from a 2016 Consumer Survey

Part A: Summary and Discussion

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1.0 Introduction

This report presents the discussion of findings from a consumer survey conducted in November 2016 on the topic of autonomous vehicles. These results are based on the descriptive findings in *Part B: Data Overview* and are further documented in *Part C: Survey Instrument*.

This report begins by highlighting the context of why understanding implications of automated vehicles (AVs) for cities is important, discussing the current state of knowledge on this topic, and identifying gaps in knowledge on AVs in the Greater Toronto and Hamilton context. Next, the study approach is introduced and major findings are summarized and discussed. This report component (Part A) is designed to provide an overview, whereas more detailed quantitative findings are documented in *Part B* and the detailed survey design is introduced in *Part C*.

1.1 Context

Automated vehicles may dramatically transform urban travel. There is much uncertainty in how this technology will be produced, purchased, used, and how it will affect urban environments.

Production - Different types of automated vehicles include *fully driverless cars* (autonomous vehicles) and *partially-automated vehicles* which still require driver control for many actions.

Purchasing – It remains unclear under what circumstances autonomous vehicle trips are likely to be purchased by consumers as a service (shared autonomous vehicles), like taxi trips, or through purchasing and using a privately owned vehicle (private automated vehicles), like conventional cars.

Use – It is not clear whether automated vehicles are likely to induce users to travel further, take more trips, abandon public transit and walking, or not substantially change their travel behavior. Alternately, transportation system users could forego vehicle ownership and instead use shared driverless cars to augment public transit use and active travel.

These sources of uncertainty have enormous implications for the transportation system and for what types of outcomes the public might begin to expect from public policymaking in the transportation domain. Automated vehicles could yield enormous benefits, from congestion reduction, fewer greenhouse gas emissions, safer streets, and more reliable travel conditions. But they likewise could erode the market share of public transit, threaten the long-term financial outlook of public transit operators, and lead to urban sprawl. Harnessing the positive elements of automated vehicles through policy action while limiting the negative consequences hinges on understanding how consumers are likely to adopt and use this new technology. Differences in how shared autonomous vehicles (SAVs) or privately-held automated vehicles (PAVs) are used

have implications for who benefits from this technology and what the broader impacts will be.

1.2 State of Knowledge

Daily travel behaviour not only depends on travel opportunities and individual characteristics but also upon the services provided by new and evolving technologies. The rise in information technology has led to digital activity participation (Gaspar & Glaeser, 1998; Golob & Regan, 2001) and automated vehicles may represent a new disruptive technology which changes how humans engage in daily activities. Previous theoretical work beginning with Von Thuenen (1826), Christaller (1933), and Alonso (1964) has established the links between transportation technologies, urban function, and urban spatial structure. These expectations have been supported by empirical evidence on how transit has both shaped suburbanization (Warner Jr., 1962) and led to denser cities (Chatman & Noland, 2013), while urban freeways have led to regional growth (Duranton and Turner, 2012) and induced suburbanization (Baum-Snow, 2007). When adopted en masse, new technologies have often led to increased functional spaces - at least for the majority of the population - and reshaped land markets.

Automated vehicles have the potential to change travel behavior and household location decisions. Private-sector companies are investing in advances in automated vehicle technology, however the broader implications of this technology on society, cities, and the environment is poorly understood. To date, only a few studies have investigated how consumers may respond and the impacts of autonomous vehicles remain uncertain – providing limited clarity for public policy to maximize the collective benefits. The studies found that consumers who have high travel intensity or travel long distances (Kyriakidis et al., 2015; Krueger, Rashidi, & Rose, 2016; Robertson, Meister, & Vanlaar, 2016), who are familiar with automated vehicle technology (Shoettele & Sivak, 2014; Kyriakidis et al. 2015), live in urban areas (Bansal, Kockelman, and Singh, 2016; Lavieri et al., 2017), or are technologically-savvy (Bansal, Kockelman, & Singh, 2016; Zmud, Sener & Wagner, 2016; Lavieri et al., 2017) are more willing to adopt new technologies. Shoettele and Sivak (2014) found consumers generally perceive automated vehicles as positive. More specifically, Bansal, Kockelman, and Singh (2016) found that consumers view fewer car accidents as one of the largest benefits to automated vehicle technology. The effect of demographic features, such as age and income on automated vehicle adoption is not clearly understood and current studies disagree on whether a relationship exists (Zmud, Sener & Wagner, 2016; Bansal, Kockelman, & Singh, 2016; Krueger, Rashidi, & Rose, 2016; Lavieri et al., 2017; Deloitte, 2016).

1.3. Research Gaps and Opportunities

There is much speculation in the discourse about the future of automated vehicles. Policymakers must nevertheless grapple with the likelihood of alternate futures, their implications, and what policy actions are necessary to manage such a technology in a way to improve broader social and

environmental objectives. There is a significant need for research to disentangle the hype to inform policy as to how actual people are likely to respond to the new technology. The need to identify and test alternate implications on travel behavior are particularly important when exploring the likely social outcomes of a new technology, which so dramatically changes the mobility landscape.

A consumer survey was deployed in November 2016 to estimate how Greater Toronto-Hamilton Area (GTHA) residents are likely to adopt, use, and respond to automated vehicles. This survey focuses each on the vehicle ownership, travel behavior, and location decision elements of consumer choice to explore the relative impact of automated vehicles and their attributes on future travel behaviour. Adoption, use, and implications of automated vehicles will be differentiated between the two different ownership models. *Private automated vehicles* (PAVs) are owned by individuals and could be either semi-autonomous (still needing a driver sometimes) to fully-autonomous (no driver needed). *Shared autonomous vehicles* (SAVs), function very similarly to taxis or technology-enabled mobility products (e.g. Uber or Lyft) – except there is no driver. The potential role of policy will be discussed in the context of harnessing positive opportunities of AVs while limiting potential negative consequences.

2.0 Approach

A survey was conducted in November, 2016, focusing on four core research questions:

1) Under what conditions are GTHA consumers likely to adopt either PAVs or SAVs?
2) If PAVs or SAVs are adopted, how are transportation system users likely to change their travel behaviour?
3) How are residents likely to change their choices regarding location and urban form?
4) What role could planning and policy play in managing automated vehicle adoption and use, to maximize benefits and minimize negative consequences?

The data was obtained through an online survey of 3,201 adults in the Greater Toronto and Hamilton Area, age 18 to 75. Survey participants were recruited from a panel managed by Research Now. To reasonably represent the regional population, the survey was administered with hard targets for respondents within each of the two cities (Hamilton and Toronto) and four

regional governments (Durham, Halton, Peel and York Regions). Those targets were:

Durham Region - 400
Halton Region - 300
Hamilton - 300
Peel Region - 500
Toronto - 1200 (300 in each of the four operational districts)
York Region - 500

After data collection, results were adjusted based on the sample age groups, gender and region of residence to align with 2011 Statistics Canada estimates of the underlying population. The proportions of each of these groups was weighted to align with the observed proportions of the respective gender/age/region group based on Statistics Canada estimates. As the 2011 Statistics Canada data used as a reference only had female/male descriptors for gender, adjustments to this group reflect the mean gender-specific adjustments for each age group in each region.

Each individual in the survey represents, on average, 1,498 individuals, depending on the relative survey frequency of any given gender/age/region group combination.

3.0 Summary

Results in this report are descriptive in nature. Two other reports (one complete and one still pending as of March 9, 2018) from this project further explore causal and predictive interpretations based on both modeling and focus group research.

Findings from descriptive analyses provide guidance with regards to the four core issues: *consumer adoption*, *AV use and travel behaviour*, potential impacts on *location decisions and urban form*, and *policy implications*. Each of these is briefly discussed below.

Consumer Adoption (*Under what conditions are GTHA consumers likely to adopt either PAVs or SAVs?*)

- Most (84%) respondents have heard of AVs
- Half (52%) are at least somewhat interested in regularly using AVs
- Younger respondents are more interested in purchasing and using AVs
- Willingness to purchase AVs is affected by how much more expensive they are than conventional vehicles. For example, with a $15,000 premium, 8.0% indicate willingness to adopt fully driverless cars, while with only a $1,000 premium, 51.3% indicate willingness to adopt. One-quarter (25.2%) are completely uninterested in purchasing AVs, regardless of price.

AV Use and Travel Behaviour (*If PAVs or SAVs are adopted, how are transportation system users likely to change their travel behaviour?*)

- Consumers respond to the cost of SAV trips. While one-third (31%) are unwilling to use SAVs even at a price of $0.50 per kilometer, at prices of $1.00 or $1.50 per kilometer, respectively, 56% and 70% of individuals indicate no interest in using SAVs for trips (excluding to access/egress transit).
- At a cost of $1.50 per kilometer, 2.6% of respondents indicate an interest in either selling or not replacing their current vehicle. One-quarter (28.0%) of respondents indicate an interest in either selling or not replacing their current vehicle should the price of an SAV be at most $0.50 per kilometer.
- A majority of respondents opt not to use shared driverless cars in their commute, with costs of operation of $1.00/km or more
- Approximately equal shares of respondents indicate interest in sharing a driverless car with another passenger at a reduced price (34.0%), uncertainty (27.4%), or unwillingness to do so (38.6%).

Location Decisions and Urban Form (*How are residents likely to change their choices regarding location and urban form?*)

- If AVs are faster than conventional vehicle travel
    - 58.6% of respondents are willing to travel further to work in a faster driverless car, especially in Hamilton, Toronto, and Peel
- AVs appear likely to change travel behavior and housing/work location decisions even if they are not faster than conventional vehicles
    - 47.5% of respondents willing to travel further to work in a driverless car even if it is not faster than a conventional car
    - Urban residents (Hamilton and Toronto) are most interested in travelling further with AVs even if they are not faster
    - Younger participants are more willing to travel further if AVs are available
- Approximately half of respondents indicate interest in locating to a neighbourhood with good shared AV services (on-demand technology-enabled mobility delivered by an autonomous car)
    - Toronto and Peel residents are most interested in neighborhoods with high-quality SAV services

Policy (*What role could planning and policy play in managing automated vehicle adoption and use, to maximize benefits and minimize negative consequences?*)

- Strong public preference (47.9%) for monitoring the use of AVs and responding when necessary. One-quarter (24.5%) prefer active encouragement of AVs, while less than ten percent prefer discouragement of AVs (5.9%) or an uninvolved public sector which leaves AV management to market forces (9.4%).
- Approximately half of respondents support (47.1%) public investment to encourage, support, or regulate AVs, but 61.5% indicate that additional taxes should not be proposed towards this end.
- One-third of respondents indicate interest (35.5%) in the public sector acting as an innovator and taking the lead on AVs
- Little support (14.9%) for additional taxes to support AVs and lack of support increases with age
- Among those willing to fund public spending on AVs, respondents expect public sector funding to increase more for roads than for transit or demand management

4.0 Discussion

Overall findings indicate several themes:

Younger residents are persistently more interested in AVs – regardless of type of use or ownership model.

- Age is associated with several attitudes related to AVs, including:
    - Interest to adopt (younger residents are more interested)
    - Travel behavior (older residents are less interested in commuting further)
    - Government preferences (older residents are less interested in government action related to AVs)

However, it is unclear whether the links between AV interest and age are related to cohort differences (which are embedded in generations even as they age) or age group-related differences (which are related to general responsibilities and lifecycle change).

The most urban areas appear poised to experience both disconnects between jobs and housing and higher premiums for high-quality SAV neighborhoods.

- Urban residents of Hamilton, Toronto, and Peel appear to be more willing to commute further should they be able to multitask or travel faster in an AV

- Likewise, urban residents of Toronto and Peel are also more interested in locating in neighborhoods with high-quality SAV services

Respondents expect a soft role for the public sector in preparing for autonomous vehicles.

- Currently there is an expectation for an observational, reactive stance from government
- There is some support for government investment in AVs, but strong opposition to increased taxes to do so
- Given the potential impacts of AVs, there is stronger support for increased government funding for roads than for public transit or demand management. But respondents indicate an expectation that AVs will have implications for public policy across modes
- There is strong support for government to play a regulatory role, but general uncertainty for a role as innovator and leader in overseeing AV use

Consumers are still learning about automated vehicles.

Respondents are still learning about automated vehicle technology, with just over 50% aware of the Google Car – indicating a potential public role in disseminating information to the public

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