An Exploratory Review of the Societal Impacts of Automated and Connected Vehicles in Canada, with a focus on Women and Indigenous Peoples

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Executive Summary

Autonomous Vehicles/Connected Vehicles (AV/CV) will become increasingly commonplace over the next few decades. These vehicles range from semi-autonomous vehicles that require active driver control depending on the situation (i.e. levels 2 through 4), to fully autonomous vehicles that do not require any driver control regardless of context (i.e. level 5). Developed by industry, vehicles with semi-autonomous capabilities are now starting to be available for the general public.

The goal of this project is to conduct a comprehensive review of existing or emerging research, policies, and regulations on the safety of AV/CV technologies and their interaction with two identified population groups; women and Indigenous peoples. In addition, the work explored research specific to urban, rural, and remote communities and low income related socio-economic factors, which are important considerations affecting all population groups.

AV/CVs are considered by the Society of Automotive Engineers (SAE) to be "vehicles with features which when engaged the human driver is not controlling the vehicle" (Society of Automotive Engineers, 2018). Over time autonomous vehicle technology has evolved and can now be designed to offer many different services to society. Canadians perceive AV/CV technology intended for everyday services in differing ways. Furthermore, different groups will experience unique social and economic implications as a result of this evolution in technology.

Women and Indigenous peoples are two populations which will be significantly affected by these changes. As companies make advancements in the AV/CV sector, it is necessary that Transport Canada (TC) understands how to regulate and supervise these companies to ensure that these technologies will be developed and distributed in an optimal way for all Canadians.

The research related to females and AV/CV technology has considered females acting as driver/operators, passengers, and as other users of the road such as pedestrians. In many cases, the research work found was limited to analysis of perceptions of level 5 vehicles only and has not considered the semi-autonomous intermediary stages. Within the analyzed results, there are many factors that lead to females having a reduced interest in AV/CV technology relative to males. Key factors include differing perception of safety and willingness to take risk, causing men to be more interested and willing to adopt AV/CV technology. Additionally, tendencies for females to trip chain commutes to also include childcare or errands leads to a reduced interest in Shared AVs (SAV) that are positioned for single destination commutes. Lastly, there are also differing perceptions of, emotional response to and perceived benefits of AV/CV vehicles leading to reduced interest for females. It is necessary that any future research considers the AV/CV technology levels prior to level 5 and is further subcategorized to reflect the different types of people that fit into the larger, more frequently used categories. This would be to ensure groups of people such as teenaged women vs. adults or adults vs. elderly women are all being included in the research process of how AV/CV technologies will affect Canadians at different ages.

It is important to identify the effects that AV/CV may have on the Indigenous population, and the importance of an inclusive approach to ensure their opinions and priorities are heard during the development and implementation of this technology. This work found that there is no research literature pertaining to the potential impact of AV/CV technologies and Indigenous peoples in Canada. The lack of research regarding Indigenous populations spans around the world. Future research must also take into consideration the Indigenous communities, and how these types of technologies may alter their everyday lives. It should start with research projects

that directly engage these communities to get the foundational knowledge of their opinion, interest and priorities. Their level of interest and willingness to adopt these technologies must be evaluated because, at this time, there is no available research addressing these issues.

Furthermore, the literature on this topic identified AV/CV-related interest results for other population groupings with unique priorities, including low-income individuals and urban, suburban, and rural communities. These demographics intersect meaningfully with the groupings of women and Indigenous peoples. The research for low-income individuals showed a reduced interest in AV/CV technology, primarily driven by the cost of vehicle ownership in general and specifically the increased expense for AV/CV. People living in urban areas are more likely to adopt AV/CV technology than those is rural areas, driven by higher perceived benefits.

The road use statistics available were found to be greatly lacking in detail to allow any level of understanding on road usage by any of the identified groups. There are no statistics on gender or Indigenous identity and road use, such as annual distance driven. The closest proxy available is registered drivers' licences. The national and some provincial licensing data do show gender, indicating that females represent 48.6% of licensed drivers in Canada, but have no indication of whether a driver identifies as Indigenous.

TC has a mandate to oversee the Government of Canada's transportation policies and programs in the interest of a safe, secure, green, innovative, and efficient transportation system (Transport Canada, 2019e). Regarding AV/CVs, the department recognizes the importance of taking on the role of early international leadership and guidance in this rapidly developing area (Transport Canada, 2019c). Under the mandate, this entails a particular focus on safety and efficiency in the field of autonomous vehicles, as well as the green possibilities presented by this innovation (Transport Canada, 2019b; Transport Canada, 2019d). In order to maximize the

possible benefits from implementing such technologies, TC must ensure that all affected social groups, specifically women and Indigenous peoples, have been fully considered in the development of any and all relevant policies.

The opportunity to use AV/CV technologies will provide companies with the chance to create multiple possible ownership distributions, including SAV. Regardless of whether AV/CVs are privately owned or shared, companies will have to keep in mind that other road users, such as pedestrians and bicyclists, will have to interact with them on a daily basis. The safe and successful deployment of AV/CV on Canadian roads will require informed and inclusive policies and regulations, in order for all Canadians to benefit from the anticipated safety advancements of this new technology.

Acknowledgements

Table of Contents

1.0: Introduction

AV/CV technologies and vehicles are subject to significant media coverage for both the introduction of new features, capabilities, and vehicles; and stories about crashes and issues associated with the technology. This leads to discussions that are currently taking place in the news and around dinner tables across the country on the topic of automated and connected vehicles and how these will fit into the lives of Canadians. However, these discussions are often limited to how safe the vehicles will be and the general utility and desirability of this technology. Not often included is information such as the fact the automotive industry is dominated by men with non-Native backgrounds. This impacts the development process by creating an environment that risks designing technology that does not include the distinct priorities and needs of groups such as women and Indigenous peoples.

This report provides a comprehensive review of existing or emerging research, policies, and regulations for the evolving AV/CV landscape focusing on both possible safety and security benefits and/or risks in relation to women and Indigenous peoples. In addition, it also explores issues identified in the research related to other segmentations of society, including low-income individuals and urban, suburban, and rural communities.

The project used academic databases and a systematic internet search to conduct a national and international environmental scan and analysis of published reports/articles including:

- The impact of introduction of AV/CVs onto public road-ways related to women and Indigenous peoples:
    - including when they are driver's/operators of the AV/CV,
    - passengers of an AV/CV (including driverless taxi/shuttle models),

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- o or in the environment around AV/CVs (as a pedestrian, cyclist, other road user);

- Existing motor vehicle safety or emerging technology policy and/or regulations inclusive of identified population groups;

- Statistics for road users in Canada.

The report identifies areas that TC may explore for future research, policy analysis, and regulations. The goal is to facilitate the safe and equitable adoption of AV/CV technologies within Canada.

2.0: AV/CV Today

The first AV/CV technologies presented in the automotive industry were related to cruise control (CC), which controls the speed of the car for the driver, and adaptive cruise control (ACC), which controls the speed of the vehicle with the added function of controlling distance from the driver's vehicle to the vehicle in front of them. The first version of CC was introduced in 1958 by Chrysler (Lehman, 2014), while ACC was introduced into vehicles beginning in 1998 (Vollrath et al. 2010).

The Society of Automotive Engineers International (SAE) derived a six-level scale to measure the stages of automation in vehicles. They define level 0 automation features as being "limited to providing warning and momentary assistance" (SAE, 2018), which would refer to vehicles with safety features such as blind spot detection or lane departure warnings. Level 1 describes today's ACC, and is defined by the SAE as "steering or brake/acceleration support" (Society of Automotive Engineers International, 2018). The key implication of the Level 1 definition is that the AV system is responsible for either vehicle speed or direction, but not both.

Automotive companies are beginning to show signs of level 2 automation in their vehicles, which is defined as "steering and brake/acceleration support" (Society of Automotive Engineers International, 2018), and can be seen today in some of the vehicles produced by Tesla and Nissan. While level 2 vehicles are becoming more common, levels 3, 4 and 5 vehicles are not yet available to the general public nor permitted on public roads in nearly all cases. The SAE describes level 3 automation as "self-driving under limited conditions, but requiring drive takeover" (Society of Automotive Engineers International, 2018) and level 4 as "Self-driving under limited conditions" (Society of Automotive Engineers International, 2018). Finally, level 5

would be fully autonomous where the vehicle "drives under all conditions without the need for driver involvement" (Society of Automotive Engineers International, 2018).

When automotive companies add or change safety features on their vehicles, it typically takes three or more decades for the features to be widely in-use in the entire fleet of vehicles. According to Anderson et al., these types of new features would first appear on luxury cars as the older models are replaced with newer ones. Litman (2019) states that most new technologies require decades of technical development and market growth to saturate their potential markets, and in many cases, may never become universal. A significant barrier to wide use is that these new features are initially expensive and unreliable, which can prevent them from being immediately available to the general public.

The presence of fully autonomous vehicles in society will require many new policies and considerations and at the current stage of technological development, there is a small window of time. Assuming fully autonomous vehicles are available for commercial purchase starting in 2020, AV/CV technologies are not expected to come fully standard on new vehicles until the 2050s, and widespread use will not occur until the 2060s or later (Litman, 2019). This possible timeline for distribution can also be affected and lengthened by delayed commercial availability, difficulty solving technical problems, and/or higher than anticipated prices. This uncertainty makes it difficult to predict when fully autonomous vehicles could be available to the public, let alone widely available and affordable as well as in use within the vehicle fleet.

3.0: Gender and AV/CV

This section summarizes the research findings related to AV/CVs for females, including works focused on females as the drivers/operators of the vehicle, as passengers of the vehicle, as well as a variety of other possible interactions with AV/CVs such as being a pedestrian or the use of AV/CV by their family. The section concludes with a consideration of the intersections between gender nonbinary individuals and AV/CV, since there was not enough research into the relationship to warrant an entire independent section.

This review is complicated by the gender definition and methodology used by the authors of any given study. As a result, the terms "gender" and "sex" are used as distinct terms in this report. "Gender" will be used to discuss results where researchers have or are likely to have used a participant's personal/social gender identity associated with femininity or masculinity. "Sex" is used to describe findings where the researchers have or are likely to have used a biological sex identification method. The distinction between gender and sex is difficult to determine in the majority of research, since no methodology is found in many reports to indicate how "man" or "woman" had been determined. Self-declaration would denote gender identification while gender-markers on documentation like drivers' licences, barring individuals who have had theirs changed, would indicate sex. Unfortunately, the non-identification of intersex or non-binary gender people in nearly all research prevents an analysis using a broader definition of gender, and nonbinary individuals from being discussed at any length. For the purpose of this report, unless otherwise specified in in the text, gender rather than biological sex will be the referent for the word "women".

3.1   General Interest of Women in AV/CV

The research consistently shows that women are significantly less interested and more anxious regarding AV/CV as a concept than men. There are three major themes in the explanations for this strong difference in preferences regarding AV/CV technologies: emotional response, risk tolerance and perceived benefits.

In their research, Targhi (2017) establishes that people's willingness to use AV/CV is attributable to their perception, or emotional response. Whether someone identifies as an early adopter of AV/CV is strongly related to their feelings (Buckley, Kaye, & Pradhan, 2018), and women feel more negatively towards autonomous vehicles than men (Charness, Yoon, Souders, Stothart, & Yehnert, 2018; Hulse, Xie, & Galea, 2018; Pettigrew, Fritschi, & Norman, 2018). Payre et al (2014) and Charness et al (2018) suggest that this relationship could be due to males' higher tendency towards "sensation-seeking" behaviour.

Several studies have further investigated the emotional explanation for the difference in attitude and had similar conclusions. Women generally respond to AV/CVs with both less pleasure and more anxiety than men (Buckley et al., 2018; Hohenberger et al., 2016; Qu, Xu, Ge, Sun, & Zhang, 2019). Winter et al (2018), Anania et al (2018a) and Rice and Winter (2019) found that the emotions of anger and happiness, and sometimes fear mediate the opinions of women and men towards these vehicles.

Women are more concerned about safety, and are more likely to avoid risk-taking. Pflugfelder (2018), one of the few studies to consider autonomy less than level 5, found this to be the case for both autonomous and semi-autonomous vehicles, and Hudson et al (2019) found women to be less likely to trust robots in general. Men are greater risk-takers, and are therefore more likely to be early adopters of AV/CV (Payre, Cestac, & Delhomme, 2014; Rice & Winter,

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2019; Wang & Zhao, 2019). This research does not make an explicit distinction between attitudes towards currently available and future autonomous technologies; rather it focuses solely on fully autonomous vehicles without mention of lesser degrees of autonomy. Familiarity with technology decreased perception of risk, so it is possible that women see the technologies available today as less risky than future AV/CV technologies, though this is conjecture based on their conclusions rather than something directly represented in the results. Furthermore, Hulse et al. (2018) found that American men are less likely to see autonomous vehicle technologies as risky, which further increases their willingness to use them.

A practical concern related to safety is perceived benefits, with women not seeing as many benefits of the technology as men do. For example, Qu et al (2019) found this to be the case for AV/CVs, and Acheampong and Cugurullo (2019) found this to be the case for specifically AV/CV technology as well as technological advancements in general. In contrast, Silberg at al., (2013) found women are more interested in AV/CV than men. However, their study employed focus groups and a small sample. Moreover, the difference found between women and men's interest was small and researchers have since agreed that this result was anomalous. The preponderance of evidence indicates that women are less interested in AV/CVs as a concept than men.

3.2   Women as the AV/CV Primary Users

The research has consistently shown that women are less interested in using these vehicles. However, it must be noted that researchers have seemingly ignored the intermediary stages of automation, focusing their studies almost solely on level 5 automation. Subsequent discussion in this section therefore pertains to women's view towards specifically level 5 AV/CV, not the lower degrees of automation.

The willingness to pay for autonomous capabilities is an area of significant research, with a consensus that men are willing to pay more than women (Bansal & Kockelman, 2018; Gkartzonikas & Gkritza, 2019; Hohenberger, Spörrle, & Welpe, 2016; Kyriakidis, Happee, & de Winter, 2015). However, this is a relative measure, since Litman (2019) found that this willingness to pay for autonomous capacity is generally low in the Canadian population overall. The majority of research done in this area is based in the United States, except for that of Targhi's (2017) study based in Alberta.

In a study to specifically look at how attitudes could change as a result of AV/CV technology, Payre et al. (2014) found a significant enthusiasm among men for being able to travel impaired (alcohol consumption), which was not found in women.

Some researchers has highlighted the potential for AV/CV technologies to increase mobility for older females, particularly since elderly women tend to stop driving sooner than men (Harper, Hendrickson, Mangones, & Samaras, 2016). It is suggested that these new technologies could alter this trend by increasing the licensed years for women and their mobility as they age.

3.3   Women as AV/CV Passengers

In addition to being drivers/operators of AV/CV vehicles, the advent of fully autonomous level 5 vehicles introduces the potential for women to be passengers or users of fully autonomous vehicles, such as those providing general transportation and emergency services. Again the research has focused on level 5 fully autonomous vehicles. For example, one study examined the use of fully autonomous ambulances and found that women are also less willing than men to ride in autonomous ambulances, but were more willing to ride in traditional non-autonomous ambulances (Winter et al, 2018).

In addition to making decisions around their own preferences, parents are also presented with decision regarding their children, and multiple researchers have studied the willingness of parents to let their children ride in AV/CVs. Lee and Mirman (2018) found that parents are generally reluctant, especially if the child is alone in the vehicle, and specifically, mothers are four times less likely than fathers. Hand and Lee (2018) came to a similar conclusion that, even among non-parents, women are less willing to allow children to ride in AV/CVs. Anania et al (2018a) came to a similar conclusion regarding autonomous school busses. This was the only available article that discussed the prospect of autonomous school buses and how they would be received by the population.

Overall, it is safe to conclude that women are less willing than men to be passengers in autonomous vehicles or allow their children to do so.

3.4   Females' Safety as Drivers or Passengers

Issues concerning overall and perceived safety are relevant for all vehicle occupants, including passengers and drivers. However, this is one area where aspects of gender vs sex identification must be considered. Studies of the perceptions of safety are reported on the basis of self-identified gender, while issues regarding the design of vehicle safety systems are driven by variations in the human body that are much closer tied to biological sex. This section provides results using both gender and sex terminology, but in order to clarify language, the term "women" will denote individuals who are biologically female—recognizing that this word is not perfectly correlated with those who identify themselves as such.

Both Acheampong & Cugurullo (2019) and Pflugfelder (2018) found that women feel less safe using AV/CV than men, and Koglbauer et al (2018) reached a similar conclusion in people's responses to experience with autonomous emergency brake (AEB) systems. According

to Bansal and Kockelman (2018), while 55% of those who identified their gender as women, are likely to see safety as the biggest concern with AV/CV, only 37% of men feel the same way. Females have good reasons to feel this way considering the male bias in the development of vehicles and the implications of biological difference between the sexes.

Sufficient evidence exists highlighting the male-default approach to research that pervades the scientific community and has led to harmful data gaps which can significantly affect women's health (Perez, 2019). More specifically, the male-dominated nature of transport-related professions risks serious oversights in AV/CV development due to normative masculinity (Pflugfelder 2018; Perez, 2019). For example, Canadian crash protection policy, which applies to autonomous vehicle development, was only adjusted in July 2018 to test female crash test dummies in the driver's seat instead of only ever in the passenger seat (Motor Vehicle Standards, Research and Development Branch, 2018). In their analysis of the relationship between sex and autonomous vehicles, Pflugfelder (2018) argues: "Female drivers may have good reason to believe that autonomous vehicles are not being designed with them in mind, in part because existing automobiles have not often been designed with them in mind." (pp. 106).

Motion sickness has been a significant topic of discussion regarding popular use of autonomous vehicles since drivers, who formerly did not suffer from it due to their ability to anticipate changes in acceleration, will now become susceptible to it (Diels & Bos, 2016; Iskander et al., 2019; Perez, 2019). Women are more at risk of motion sickness and thus, will be more negatively affected by this change than men (Diels & Bos, 2016; Iskander et al., 2019; Perez, 2019). The reasons for this are not fully understood, as the reasons behind motion sickness itself are not well-researched (Diels & Bos, 2016; Iskander et al., 2019). However, there is

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evidence that women's body sway patterns, which vary in conjunction with susceptibility to motion sickness over the menstrual cycle, could be the root cause (Perez, 2019).

Women's safety in traditional vehicles is significant for autonomous ones since they both share the same production and evaluative standards. Unfortunately, design and safety evaluation in vehicles based on male body proportions persists to this day. Until 2011, crash test female dummies did not exist, and even now, they tend to be scaled-down male dummies rather than representative of female body proportions (Perez, 2019). Current Canadian testing standards for automobiles call for use of a 50th percentile male dummy and a 5th percentile female one (Motor Vehicle Standards, Research and Development Branch, 2018). The male dummy is designed to be the size of a median adult male, while the female dummy is designed to be smaller than 95% of women. This female dummy, weighing 46.7-51.25 kg and being 139.7-150 cm tall, is not a sufficient representation of female drivers and, to compound the issue, is used only occasionally in testing (Motor Vehicle Standards, Research and Development Branch, 2018).

When asked to justify this gross under-representation of women, Suzanne Tylko, Chief of Crashworthiness Research at TC, claimed that the sheer complexity of human bodies makes it impossible to test for all possible variances (Sommerfeld, 2016). However, while testing all possible bone densities, for example, would indeed be excessive and an illogical standard, writing off half the population as too complicated is an unreasonable burden to place on women (Perez, 2019). Perhaps the best evidence that this testing approach endangers women is, as Perez (2019) states, "when a woman is involved in a car crash, she is 47% more likely to be seriously injured than a man, and 71% more likely to be moderately injured, even when researchers control for factors such as height, weight, seat-belt usage, and crash intensity. She is also 17% more likely to die" (pp. 227-228 (eBook)).

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Another way that women are placed at risk is inaccurate testing of airbags. Although they are frequently lifesaving and have advanced far since their initial introduction, there have been cases of people dying specifically as a result of the airbag deployment (German, Dalmotas, Tylko, Comeau, & Monk, 2003). Transport Canada (2009) claims the victims have no unifying factor other than sitting too close to the wheel. However, investigation of the supporting evidence shows that "all four of the fully-restrained, fatally injured drivers were female, of short stature, and had their seats adjusted to forward-of-middle positions" (German et al., 2003, pp. 15-16). Women are on average shorter, and so "tend to sit further forward when driving", making them "out of position drivers" (Perez, 2019, pp.228 (eBook)). While airbag safety has improved in the past decades, close proximity to the wheel remains a greater risk factor to women than men (Perez, 2019).

Women must be considered and properly accounted for at all stages of vehicle development. Existing standards apply to today's increasingly autonomous vehicles, and it appears they will continue to do so beyond level 2 and towards higher levels of autonomy. As a result, physical endangerment of females disproportionate to males in today's vehicles will continue in AV/CVs unless standards are re-evaluated. It is up to designers to mitigate motion sickness risk, but their work should include research into the factors which cause it to appear more in women so as to not inhibit that population from fully partaking in AV/CV. Additionally, dummy standards must be updated to accurately reflect the entire adult population rather than just half.

3.5   Vulnerable Road Users

This report defines vulnerable road users as any non-driving person making use of the road alongside vehicles. Examples of these vulnerable users include pedestrians, cyclists, motorcyclists, and other individuals near the roads.

To date, there has been limited research addressing interactions of AV/CV with vulnerable road users (Straub & Schaefer, 2019). The primary research thrust has been into drivers' opinions on autonomous technology, but other road users tend to perceive AV/CV as less useful and have more concerns for their interactions with the vehicles than drivers (Qu et al., 2019). Regarding people who do not drive, men have been found to be more receptive than women, paralleling the results found for gender differences in overall opinion on AV/CV (Deb et al., 2017). The explanation posited for this relationship is that women's interpersonal socialization makes them uncomfortable interacting with a driverless vehicle, or at least one where the person in the driver's seat is not in control (Deb et al., 2017).

Regarding typical pedestrian behaviour, it appears that men are at higher risk than women, as they accept a smaller critical gap between them and oncoming traffic when deciding to cross a street, but may still take a longer time to cross than women (Deb, Strawderman, & Carruth, 2018; Rodríguez Palmeiro et al., 2018). However, this is where differences between men and women end. In an experiment to test possible communication methods between autonomous vehicles and pedestrians, Deb et al (2018) found no gender differences in preferred means.

AV/CVs must be able to identify and predict the actions of all road users they encounter, so developers must be careful to include all possible human shapes (Ess, Schindler, Leibe, &

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Van Gool, 2010). If implicit biases are included during the vehicle's programming process, then people could be at serious risk when interacting with them.

3.6   Shared Autonomous Vehicle Services

A shared autonomous vehicle (SAV) is a distinct ownership and use model for AV/CVs and refers specifically to a particular model of ownership and usability of AV/CV vehicle through a vehicle sharing service. A privately-owned AV (PAV) would fill the role of most of today's vehicles, with the only change in use being the move to the AV role as driver. Under the SAV model, people would own personal or family AV/CVs and use them whenever they wish, paying for fuel and upkeep. A SAV model would be closer to today's ridesharing services such as Uber or Lyft, only without the driver, or shared vehicle services such as VirtuCar.

In an SAV service model, users would summon an autonomous vehicle when needed, potentially sharing some or all of the ride with other users. Payment could be done on a ride-by-ride basis, a subscription-based system, or some combination thereof. The growing popularity of ridesharing and vehicle-sharing today indicates that the introduction of AV/CVs will affect this market.

It is important to pay particular attention to SAVs in relation to women in order to understand the barriers or opportunities that will arise in attempting to implement SAVs as a transportation alternative. Based on the current research, SAVs appear to be the application of AV/CVs with the greatest socially optimal outcomes. Lavieri et al (2017) found that a system predominantly consisting of PAVs is likely to increase the empty vehicle-miles travelled (VMT), increasing both traffic congestion and emissions. On the other hand, shared vehicles may reduce both of these as well as parking space requirements. Anderson et al (2014) found that vehicle ownership would decline if driverless taxis became available as a practical alternative. To

quantify the effect, Parida et al (2019) found that "by allowing household vehicles to serve multiple residents, […] they could reduce vehicle ownership up to 43% and increase travel per vehicle up to 75%, but these impacts are difficult to predict" (pp. 322).

To benefit fully from the possibilities of SAVs, companies must find a way for more women to be more interested in this idea of AV/CV technology usage, otherwise this system will not be successful within society. The literature is split on how women compare to men in their willingness to use SAVs.

Some studies found that women were more likely than men to use shared services. For example, Bansal and Kockelman (2018) found this to be the case, although their study was the only study to find a direct link. It has been fairly well established that car users will continue to use their present mode of ownership, even with the shift from traditional to autonomous cars (Lavieri et al., 2017; Bansal & Kockelman, 2018; Pettigrew et al., 2018). Since women are slightly more likely to use ridesharing and carpooling as a transportation method, it suggests that women may be more inclined to use SAV when available (Kooti et al., 2017; Matsuo, 2019). Additionally, people who currently walk, bike, or use public transport are more likely to take advantage of SAVs (Lavieri et al., 2017). Since these modes of transportation are more common among women versus men, female interest in shared services is likely to be higher (Perez, 2019). Finally, SAV is a more environmentally friendly alternative to private ownership of AV/CV (Lavieri et al., 2017). Since women have demonstrated a greater preference for greener vehicles than men, this factor could influence women towards using SAV (Lavieri et al., 2017; Sovacool & Axsen, 2018; Acheampong & Cugurullo, 2019). This evidence, both direct and indirect, seems to point to women being more likely to embrace SAV services than men.

However, there has also been significant research which points to women being less likely to use SAV. This relationship was found by both Maurer et al (2016) and Targhi (2017) to be dependent on number of children, household size, and income. Ge et al (2016) found that discrimination female riders may face with existing ridesharing services such as UberX and Lyft may discourage women from using them today, reducing their usage of SAV in the future. The discrimination was based on the fact that drivers took woman riders on longer, and thus more expensive, rides (Ge et al 2016). However, the researchers were primarily focusing on race in their work, so they did not investigate this finding further. The most significant factor found predicting lower usage by women is what kind of drive SAVs are used and marketed for. Shared vehicle systems are more likely to be marketed and designed for commuting rather than other forms of trips, but women are less likely to use them for a daily commute (Nazari, Noruzoliaee, & Mohammadian, 2018; Lavieri & Bhat, 2019). Not only do women overall spend less time commuting, but they also tend to trip-chain, combining errands and family care trips with their commute as needs arise (Hudson, Orviska, & Hunady, 2019; Lavieri & Bhat, 2019; Perez, 2019). This tendency discourages them from carpooling or using other shared services for commutes, since the fluctuating and time-sensitive nature of trip-chained tasks makes them non-ideal for a transportation system that is, in part, dependent on others.

Despite the mixed research, there are some key takeaways. Pettigrew et al (2018) directly state that the preference is uncertain but emphasized that knowing who is interested in SAVs is important to be able to ensure adoption of this new technology. It appears that women are more likely than men to adopt SAVs rather than privately owned vehicles, but only for certain kinds of travel. If shared services are implemented with a focus on use for commutes, men will likely be the majority of users, but if they are framed as an option for social trips or other everyday drives,

then female usage will be noticeably higher. This fact reinforces the need to encourage women to trust autonomous vehicles in general, as, if women do not adopt SAV, then a broader societal shift towards ridesharing from privately-owned vehicles will be significantly more difficult.

3.7 Gender Perceptions in Automobility

The role of gender stereotypes is significant in the development of AV/CV due to the male dominance of the automotive industry, as well as automobility's long history of association with masculine identity (Perez, 2019; Sovacool & Axsen, 2018). Transport in general, and particularly the automotive industry, are male dominated. In other words, the majority of people developing, programming, and testing autonomous vehicles are men (Perez, 2019). This skew means that there is a significant risk of the gender biases of those individuals, especially the programmers, being included in supposedly neutral processes (Hildebrand & Sheller, 2018). Algorithms naturally carry the implicit biases of their coders, which Danks and London (2017) point out is significant in the realm of AV/CV. Howard and Borenstein (2018) take this idea further, concluding that implicit bias in data skews artificial intelligence (AI) decisions along those lines, requiring autonomous vehicles to be analyzed for implicit bias and be subject to rigorous ethical scrutiny. This bias may appear in many different ways; however, the AV/CV ethical question which has seen the most discourse, the moral and ethical dilemma of how these vehicles should prioritize lives in a crash situation, is not likely to be one of them, as women have been found to not be different from men in their responses to such dilemmas (Smith, 2019).

Beyond ethics, the issue and perpetuation of gender stereotypes are also highly relevant. Cars have long been framed as masculine, a view which persists to this day (Sovacool & Axsen, 2018). However, the introduction of AV/CV will result in a shift in the gendered traits associated with vehicles. Male-associated traits such as control, self-determination, and driving fun will be

lost as AV/CVs progressively control more vehicle functions previously commanded by drivers (Balkmar & Mellstrom, 2018). The shift in masculinity has been given different names in the two articles published on this issue, but both have the same essence. Balkmar and Mellstrom's (2018) "working class" to "white collar" and Redshaw's (2018) "combustion" to "hydraulic" masculinity shifts describe a change away from more aggressive male traits being attributed to automobility and towards more controlled and sophisticated traits. People strongly associate gendered stereotypes with vehicles and, while these traits may change with the introduction of AV/CVs, they will likely continue to exist.

This fluctuation in gendering affords an opportunity to shift gender norms to a more egalitarian position. An experiment by Lee et al (2019) found that people are more likely to perceive using an AV/CV system as easier if the systems voice agent follows expected gendered roles, informative male and social female, than if they do not. Additionally, Niu et al (2018) found that people are more likely to trust AV/CVs which are treated as human-like rather than as inanimate objects, with traits like faces, names, genders, and personalities. However, while users apply their cultural stereotypes on the systems with which they interact, those systems can also be used to influence those same stereotypes in turn (Lee et al., 2019). When designing user interfaces for AV/CVs, it is up to producers to decide the amount to which they subscribe to traditional gender roles. What they choose could have a long-term impact on gendered stereotypes surrounding cars and automobility.

Unfortunately, preliminary advertising for AV/CVs indicates a maintenance of the status quo on this front. In concept advertisements for future autonomous technologies, both Nissan and Volvo have shifted fully to the newer set of masculine associations (Hildebrand & Sheller, 2018). Men are in the primary seat (no longer driver's seat) in large areas with no surrounding

traffic, demonstrating mastery over their environment (Hildebrand & Sheller, 2018). Nissan's slogan in their advertisements of a "perfect partnership of man and machine" not only clearly demonstrates their gendered assumptions, but communicates the equality of both elements in their conception (Hildebrand & Sheller, 2018). In contrast, when women are included in advertisements for assistive technologies like AV/CV or even parking-assist, they are in crowded environments, implying their reliance on the technology in an imbalanced relationship (Redshaw, 2018). Furthermore, women in these advertisements are often paired with a tagline involving the word "sexy", so in such cases, the women are not included to represent end-users but the slogan itself to sell the technology to men (Redshaw, 2018).

Although the significant shift from traditional to self-driving vehicles presents an opportunity to affect gender stereotypes and re-gender transportation as a whole, the industry appears content to perpetuate the strong association between masculinity and vehicles. For instance, very few, if any, automobile commercials feature a pregnant woman driving.

3.8   Gender Nonbinary Individuals

Gender does not exist only as a binary between man and women, but on a spectrum that has only recently received widespread acknowledgement. There has been no research done on the implications of AV/CV for gender non-binary individuals to date.

By and large, researchers limit themselves to a binary understanding of gender when conducting their research, which prevents them from finding any information on nonbinary individuals. In some cases, individuals identifying themselves outside the binary model may be written off during analysis, as in the case of Acheampong & Cugurullo (2019). In others, this information is lost in the data coding stage, such as in Krueger et al (2016) where "one respondent indicated to be of other gender", but "this observation was assigned to the female

category" (pp. 347). This example demonstrates how the extremely limited framework that researchers impose on respondents' gender can affect the results they obtain.

Not all researchers limit themselves to the gender binary in their analyses, but they are a minority. Notably, both Hohenberger et al (2016) and Pflugfelder (2018) use gender-inclusive language into their AV/CV research. For example, Hohenberger et al (2016) specify "biological sex" when referring to men and women, even going so far as to use the phrase "the two dominant biological sexes", acknowledging the existence of intersex individuals (pp. 375).

The only specific element of AV/CV which has a demonstrated relevance to nonbinary individuals is the gendering of the vehicles themselves as they are attributed human-like qualities. Since people have a strong tendency to attribute gender to autonomous technology, and even trust it more when they have done so, there is an opportunity for greater nonbinary representation in the public eye (Maurer, Gerdes, Lenz, & Winner, 2016). Corporations, however, are unlikely to do this.

Nonbinary gender has only recently entered the public consciousness, so it is not surprising that minimal research has been done to find connections between it and AV/CVs. In order for any meaningful conclusions to be reached, researchers must expand their gender frameworks to allow for more diverse identities to be included.

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4.0: Indigenous Individuals and AV/CV

As of September 2019, there has been no research examining Indigenous communities of any colonized nation and their interest or concerns regarding AV/CV technologies. When working with Indigenous populations, frameworks and concepts originating in the dominant Canadian culture cannot simply be applied to Indigenous peoples. Therefore, it is necessary to apply a cultural competence framework, such as that defined in *Standards and Indicators for Cultural Competence in Social Work Practice* by the National Association of Social Workers as

> The process by which individuals and systems respond respectfully and effectively to people of all cultures, languages, classes, races, ethnic backgrounds, religions, spiritual traditions, immigration status, and other diversity factors in a manner that recognizes, affirms, and values the worth of individuals, families, and communities and protects and preserves the dignity of each (pp. 13).

Therefore, if researchers have an interest in the possibility of a connection, it is important that they remain culturally competent when working with the Indigenous peoples. Researchers will also have to take into consideration that the Indigenous populations may have different priorities when it comes to transport other than having access to AV/CV technologies, problems such as "dirt roads and broken bridges" (Arizona State Legislature, 2014).

As a result, when doing research that includes the Indigenous population, we must also follow the principle of the 4 R's; relational accountability, respectful representation, reciprocity and rights & regulations. These principles were originally written by Renee Pualani Louis, and are now used by Carleton University's 'Community First' research ethics. These ethics help to assure that research is done in a balanced way that respects the Indigenous population and does not automatically orient itself from a western-based view. The 4 R's work together to assure that

both parties in the research benefit from the process and the results. *Relational accountability* is best understood as having interdependent accountability between all those involved in any given research project with regards to the evolution of the project and its knowledge base. *Respectful representation* is how the researchers represent the information they are using and being understanding of the decisions that Indigenous peoples make about what knowledge to share and when they want to provide it. In addition to *reciprocity* that is about making sure that the Indigenous populations benefit just as much as the researchers do from the project being conducted. Finally, *rights and regulations* involves the ability for researchers to recognize that the Indigenous population has their own protocols about participating in research. It is important to both recognize and respect these protocols, and prioritize the collaboration between the Indigenous people and the researchers conducting the project.

Maurer et al (2016) say that the ethicality of an AV's decisions is judged based on "the standards and ethics of the society in which they operate", indicating that there is a socio-cultural distinction in ethical decision-making (pp. 87). On a more explicit level, Anania et al have demonstrated in two studies (2018a; 2018b) that adults from India, a collectivist culture, have different attitudes towards AV/CV than adults from the United States, an individualistic culture. These results indicate a clear possibility that Canadian Indigenous peoples would have a different take on AV/CV and their ethical judgements than the dominant colonial population. This possibility warrants research, seeing as none has been done at the time of writing.

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Capteurs et analytique de suivi mobilité-mémoire

5.0: Statistics on Road Users in Canada

There is a significant lack of Canadian data regarding active driver demographics, e.g. what percentage of the drivers on the road are men, women, or other. The closest accessible proxy for driver proportion is the number of active driver's licenses, which is reported nationally and in some cases provincially. This measure is not a perfect proxy, since it does not account for how much individuals drive (e.g. someone who got a licence and never drove again would appear the same as someone who drives for work) or individuals who drive unlicensed. Nor do licenses provide an accurate measure of either gender or sex. The M or F "gender" marker on licenses is subject to petition for change, so while in most cases it indicates biological sex (e.g. cis-gendered people, nonbinary or transgender people who have chosen not to change it, or those who wish to do so but have not yet), in others it indicates gender, meaning it measures both gender and sex, thus representing neither in its entirety. Since it is, however, predominantly a measure of sex due to the low instance rate of changes to "gender" markers, that is the language which will be used in this section. Some large-scale data gathered are sex-segregated, but others are not, preventing meaningful sex analysis of much of these datasets. As Perez (2019) says, "transport authorities are compounding the existing gender data gap by failing to separate the data they do have by sex" (pp. 54 (eBook)). Available statistics universally measure both sex and gender on a traditional binary model, so no data is available regarding non-binary or even intersex drivers.

Across Canada in 2017, according to Transport Canada (2019a), there were over 13.4 million male and 12.6 million female licensed drivers, making a nearly equal driver population of 51.4% men and 48.6% women. This proportional distribution varies between 46.7-49.9% female across age cohorts with no significant trend associated with age. Province-specific data is

unreliably available. In some cases no licence registration data is accessible, such as Nova Scotia and PEI, while in other cases like BC the data is available but not sex-segregated (Highway Engineering Services: Road Safety, 2006; Government of British Columbia, 2017; Government of Prince Edward Island, 2017). In those provinces where sex-segregated data is available, the driver distribution by sex parallels the federal data (Road Safety Research Office, 2014; Saskatchewan Government Insurance, 2015; Manitoba Public Insurance, 2017; Société de l'assurance automobile du Québec, 2018; Government of Alberta, 2019).

Overall, according to the number of registered licenses, women make up slightly less than half of drivers today. There are currently no measures in place to record the actual amount driven by all individuals, so the exact proportion of VMT cannot be determined. There is also no data available regarding the number of non-driving road users such as pedestrians and cyclists.

According to 2016 census data from Statistics Canada (2017), at that time there were about 1.7 million people in the country who identify as Aboriginal, making up 4.9% of the Canadian population. Information on Indigenous road users is even sparser than women since there is no public record of how many Indigenous individuals hold valid drivers' licenses, let alone what proportion of road users they constitute on any given day.

It would be in the best interest of future advancement in this area if transport data was gender-disaggregated, or at least more reliably sex-disaggregated. Reliable provincial-level information on licensed drivers is necessary to better understand the landscape of transport in anticipation autonomous of vehicles. Information on Indigenous drivers will be more complicated to track in a sensitive but legitimate manner, but attempts must be made to do so.

6.0: Other segmentations

There are particular demographics which are independent from the groupings of women or Indigenous peoples, but are still relevant to understanding those relationships. These factors are distinct from either group, but intersectional trends in segments of identity make their inclusion valuable for this project.

6.1   Low Income

In today's society, one way to measure the socioeconomic status of the population is by using the Low Income Measure After Tax (LIM-AT), this is explained as "as a fixed percentage (50%) of median adjusted after-tax income of households observed at the person level, where 'adjusted' indicates that a household's needs are taken into account" (Statistics Canada, 2016). According to the LIM-AT, women are more financially disadvantaged than men in Canada. While 12.0% of men between the ages of 18-64 are low-income, according to LIM-AT 13.8% of women are identified as low-income (Statistics Canada, 2016). The disparity is even larger for seniors 65 and over, with 12.5% of men and 16.7% of women respectively being low-income (Statistics Canada, 2016). This is even more significant when considering the Indigenous population in comparison to the population at large. According to LIM-AT, 14.2% of the whole population is classified as low-income, while 23.6% of Indigenous individuals are. The whole population percentage includes Indigenous peoples, so the disparity between Indigenous and non-Indigenous individuals could be even higher than apparent in these numbers.

Like women, low-income families are not risk-takers (Wang & Zhao, 2019), so their interest in AV technologies is reduced. To compound the issue, Gkartzonikas and Gkritza (2019) discuss how people with higher household incomes are more willing to spend their money on AV technologies.

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Sensors and Analytics for Monitoring Mobility and Memory
Capteurs et analytique de suivi mobilité-mémoire

A link can be drawn between higher-use of public transport and an individual being low-income. The high expenses that come along with owning and operating a vehicle make it difficult for those falling in the low-income bracket to do so. One draw of public transport is that people execute other tasks throughout their commute, for example texting, sending emails and getting work tasks finished (Anderson et al, 2014). As AV/CVs become available for those with more disposable income, ridership of public transit will decrease (Anderson et al, 2014). This will result in some combination of increased fares and/or reduced service by transit systems, both of which negatively impact the ability of low-income individuals to travel (Anderson et al, 2014).

Furthermore, in the cases where people choose to own a vehicle, there is a direct correlation between an individual's socioeconomic status and the safety features included in their car. As companies add more features to their vehicles to bring them closer to being autonomous only those with higher incomes will be able to afford to purchase these vehicles initially. According to Litman (2019), if an average middle-income family wanted to buy a new AV, it probably would not be before the 2040s or 2050s, and for lower-income families it would be even later since they would need to wait for "used" AV/CVs to be available for purchase.

Overall, this evidence shows that interest in and ability to partake in AV/CV are disproportional among different income levels, especially effecting women and Indigenous peoples because of the socioeconomic inequalities that exist within society.

6.2   Urban, Suburban, and Rural Communities

The area in which an individual lives can impact whether they consider the idea of AV/CV and are willing to use them when they become available. People live in communities that are considered urban, suburban or rural, depending on how built and central the surrounding

environment is. Researchers have compared the opinions of Canadians in these different communities to see their level of interest in AV/CV technologies. None of this research has identified any sub-groups within the communities (Indigenous, immigrant, etc) nor is it clear that any specific sub-groups were included in or excluded from the research. As an example, although many Indigenous individuals live in rural areas, there is no indication that they have even been included in the aggregate results of research into rural perspectives. In addition, the opinion of other rural communities cannot be generalized and assumed as the opinion of the rural Indigenous communities.

Work by Lavieri et al (2017) and Deb et al (2017) says that residents in urban areas are more likely to adopt AV/CV than suburban and rural residents. This is similar to Bansal and Kockelman (2018) who say that people in urban areas are more interested in AVs than others. Research into these populations also looked into the favouring of shared service models in comparison to private ownership. Lavieri et al. (2017) found that not only do urban individuals show more interest in early adoption, but also in shared-based models of AV technologies.

Rural residents include both females and people identifying as Indigenous, to a limited extent, this analysis demonstrates a likelihood that rural resident females and Indigenous peoples are less receptive to AV/CV than their urban counterparts. However, the rural population cannot be equated with the Indigenous population, so this relationship must be treated as a suggestion of further research and not as a conclusion.

7.0: Recommendations and Further Research

Through a comprehensive review of all the related literature, it is clear that interest in more advanced AV/CV features and the importance of safety are directly related to gender. Therefore, gender has a recognizable impact on the way individuals interact with these technologies. Furthermore, the research demonstrates that vehicles are not made or tested with women in mind, compromising the safety of women in their own vehicles on a daily basis. Companies must begin to safety-test normal vehicles with women in mind, so that when AV/CVs are tested they will be safe for all Canadians.

In addition, there is a significant literature gap pertaining to the direct relationship between AV/CV technologies and Indigenous peoples in Canada. The lack of research regarding Indigenous populations and their interest in AV/CV technologies spans around the world. Furthermore, as a society, we must ensure that Indigenous communities are included when discussing AV/CV technologies, in order to avoid the assumption that they share a strong desire to distribute AV/CV into the Canadian society.

Further research is needed to better understand how to encourage people, especially women, to use AV/CV. Targeted policies will be able to both increase adoption and help shift people to the societally optimal outcome of widespread SAV usage (Pettigrew et al., 2018). There are many possibilities for women presented by AV/CV. However, these possibilities will not be seen in practice without action encouraging women's adoption of AV/CVs.

There are a couple of different factors which limit adoption, mainly centring around lack of trust in automation and safety concerns (Körber, Baseler, & Bengler, 2018; Nazari et al., 2018). Significantly, women's reluctance to use AV/CV is a barrier to introducing and popularizing them (Rice & Winter, 2019). Awareness campaigns can increase the level of

information people have on AV/CV (Bansal & Kockelman, 2018). These would both allow the government to shape the public conception of autonomous vehicles and increase the likelihood of their acceptance via greater knowledge and interaction (Penmetsa, Adanu, Wood, Wang, & Jones, 2019). Targeting women's concerns over AV/CV in particular will help to eliminate the difference between men and women in their likelihood to adopt these new technologies. Hohenberger et al (2016) found that addressing anxiety-related effects reduces the gender difference in young people.

Campaigns should aim to evoke positive emotions and feelings of security (Hohenberger et al., 2016). They also suggest the inclusion of emergency takeover buttons and implementation of end-user training to ease anxiety (Hohenberger et al., 2016). Lee & Mirman (2018) similarly suggest targeting practical considerations in awareness campaigns. Factors like reliability and safety are additionally important (Stoiber, Schubert, Hoerler, & Burger, 2019). Such efforts will benefit all users, while carrying the benefit of increasing the likelihood of adoption by women. Automotive safety standards need to include women equally alongside men, with a "focus on user-centred, iterative testing with a broad range of human bodies and performances in mind" (Pflugfelder, 2018, pp. 108). For women, increased perception of safety increases their receptivity toward the entire technology. Therefore, alongside improving women's health outcomes, this altered approach would aid in the overall adoption of AV/CV (Deb et al., 2018).

In order to encourage widespread adoption of AV/CV technology, further research is needed into a few key areas. First, in order to develop optimal public awareness campaigns, researchers must determine exactly what messages are needed to encourage women to partake in the technology equally alongside men. Second, more representative safety regulations need to be developed in order to eliminate the disproportionate risk that women face in vehicles. Finally,

pilot research is needed into how nonbinary individuals relate to all the issues discussed in this report so as to gain a more complete understanding of the needs of the population at large. Further analysis of intersectional identities with regards to women could be a beneficial topic for future research. Significant intersections could include gender and disability, age, or new Canadian status.

Popularizing SAV will be more difficult than doing so for private AV/CV for a few reasons. First, changing to a primarily shared vehicle system is a substantial shift away from how people currently view automobility, which will make it difficult to introduce the concept in place of already popular private ownership (Sovacool & Axsen, 2018). Second, SAVs will likely be more expensive than private ownership for people travelling more than 5000 km a year, and will be less comfortable and private as well (Litman, 2019). Third, several large companies have already begun to advertise future autonomous technologies, and none of them are including SAVs in promotional materials (Hildebrand & Sheller, 2018). Without imminent information, they will have complete control over the AV/CV narrative (Pettigrew et al., 2018).

There are actions which the government can take to encourage SAV uptake, however. Pettigrew et al state that "it is in governments' interests to encourage and facilitate a swift migration to a shared autonomous fleet and reduce the likelihood of widespread private ownership", and that this can be achieved through careful subsidies and taxes to signal relative benefits to consumers (Pettigrew et al., 2018). Ensuring that SAV marketing targets more functions than just commuting will additionally increase its adoption, as that would ensure women are not excluded from the new systems.

Further research is required on this front as well. A greater understanding of women's travel patterns, especially in regard to trip-chaining, would enable SAV systems to be more

effective for all possible users. Additionally, Targhi recommends research to estimate the fleet size needed to service SAV demand so as to ensure that systems are accurately sized when they do become available for users.

Public communication regarding AV/CVs will be highly interconnected between private corporations and different levels of government. Advertisement is likely to be predominantly private-driven, so it is necessary to encourage socially optimal representation. The most effective method of encouragement is likely to be financial, given the profit-driven nature of industry. For less financially-motivated public information dissemination, government-run campaigns will be beneficial. Once SAVs enter the market, similar steps should be taken in order to nudge the new industry towards the representation and approach determined in this report to be the most socially effective.

Information on Indigenous peoples' stance regarding AV/CV is both strongly needed and severely lacking. As a significant and unique part of the Canadian population, their voices must be heard on this issue in order to correctly formulate relevant policy. One core debate around autonomous technology is the question of ethical decision-making and how such vehicles should behave in a crash scenario. Although there has been no research done on Indigenous opinions on AV/CV and their ethical implications, there is evidence to support that different cultural origin results in different ideas on what is or is not ethical behaviour. Therefore, there is a clear possibility that Canadian Indigenous peoples would have a different take on AV/CV and their ethical judgements than the dominant colonial population. Before any policy on this front is developed, researchers must determine where these cultural distinctions lie and how best to accommodate them in the implementation of autonomous vehicles.

Since further research involving Indigenous peoples in this area will be starting from nothing, we must begin simply. We recommend conducting public opinion research into Indigenous perspectives on AV/CV in order to determine their level of interest in the technologies and gain an understanding of their priorities. Beyond initial opinion research, the sections detailed in this report regarding women can provide a framework for areas worth investigating. As found above, these sections include physical safety; interactions with AV/CVs as vulnerable road users; perspective on SAVs and their use models; and perceptions of AV/CVs, which will likely have cultural significance. Using the pattern found in gender-based research provides insight into directions worth pursuing.

Putting it simply, the social implications of AV/CV, commonly termed as "driverless cars" are not well-understood today. To quote Peter W. Singer, quoted in *Autonomous Driving: Technical, Legal, and Social Aspects*, "We are still at the 'horseless carriage' stage of this technology, describing these technologies as what they are not, rather than wrestling with what they truly are" (Maurer et al, 2016, pp. 81). Extensive research is needed into all the implications AV/CVs will have for people in society today, so that we are as prepared as possible for the introduction of increasingly autonomous vehicles.

8.0: Glossary

ACC   Adaptive Cruise Control

AEB   Autonomous Emergency Brake

AI   Artificial Intelligence

AV/CV   Autonomous Vehicle/Connected Vehicle

CC   Cruise Control

LIM-AT   Low Income Measure After Tax

PAV   Privately-owned AV

SAE   Society of Automotive Engineers

SAV   Shared Autonomous Vehicle

TC   Transport Canada

VMT   Vehicle Miles Travelled

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