Public Perception of Automated Shuttles for Last-Mile Connectivity in Montreal

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ABSTRACT

Public Perception of Automated Shuttles for Last-Mile Connectivity in Montreal

Rubel Chandra Kar

This thesis investigates the public perception and acceptance of automated shuttle services for last-mile connectivity in Montreal. Through a comprehensive survey, the study examines key factors influencing acceptance of the autonomous shuttle, including experience, awareness, comfort and safety level, trust in technology, benefits and barriers, and potential integration into urban transportation systems. A survey of Montreal residents (n=52) reveals key insights into demographic trends and attitudes towards autonomous vehicles (AVs). Results indicate a moderate familiarity with AVs (38.6%) compared to the US (70.90%), UK (66%), and Australia (61%). Despite this, Montrealer's expressed positive sentiments towards AVs (54%), slightly higher than the UK and US. Concerns about safety (49% very concerned), legal liability (47.10% very concerned), and data privacy (63.50% very concerned) were prominent. Comfort levels with autonomous technology varied, with 38.45% having heard of autonomous shuttles but only 13.46% having boarded one. Respondents showed preference for level 3 automation (56%) over higher levels. Concerns about interactions with other vehicles, pedestrians, and bikers were noted. Overall, Montreal residents are open to AVs but harbor significant concerns, highlighting the need for targeted interventions to address safety, security, and privacy issues in deploying automated shuttle services effectively.

Keywords: Automated Shuttles, Comprehensive Survey, Urban Transportation, Demographic.

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CHAPTER 1

INTRODUCTION

1.1 Urban Transportation Challenge

Transportation in a big city like Montreal is always a major puzzle to be solved. There has always been a question how can we make it more efficient and people friendly? Several implementations have been done already to make a better transportation system in the city. But what about the last mile connectivity? One solution that is catching attention is automated shuttle. These are self-driving minibuses that can help people to reach their destinations especially in the “last mile” of their journey when it is hard to find a convenient way to reach the destination, where conventional way of transportation options falls short.

Two shuttle pilot projects have already taken place in Montreal, one at the Olympic Park site in October and November 2018 and another at the Hochelaga-Maisonneuve district in summer 2019. The big question we are looking at is: how does Montreal feel about these automated shuttles? Are they ready to hop on board and trust these self-driving vehicles? This is what we call “public perception and acceptance," which is pivotal, as the success of new transportation ideas hinges on public sentiment [6].

The objective of this research is: we aim to explore the sentiment of Montreal residents regarding automated shuttle. Are they excited and welcoming or do they approach this technology with caution? To achieve this objective, we will delve into the factors influencing these feelings. We will investigate whether concerns about safety, cost, convenience, or other factors sway their opinions. In short, our goal is to provide insight into what shapes the public acceptance of these autonomous shuttles.

Our research question which will be our guiding star throughout the thesis: “How do residents of Montreal perceive and accept automated shuttle service for last mile connectivity?” It highlights the core focus of our study, framing our journey to unravel the thoughts, feelings, and factors that underlie the acceptance or hesitation towards autonomous shuttle service in this vibrant city.

Understanding how Montrealer's perceive and accept these innovative shuttles can pave the way for more efficient and sustainable urban transportation. If people trust and welcome automated shuttles, they can play a pivotal role in addressing Montreal's transportation challenges. The findings of this study will not only contribute to academic knowledge but also offer practical insights that can shape the future of transportation in Montreal.

1.2 Research Objectives

Our research aims to explore how Montreal residents feel about automated shuttles and vehicles designed for last-mile travel. We're using survey data from Montreal locals to grasp whether they see these new transportation options in a positive light or if they're more hesitant.

Our main objective is to figure out what factors shape people's opinions about these automated modes of travel. We're looking into aspects like safety, convenience, affordability, and how much trust people have in the technology. By understanding public sentiment, we want to get a complete picture of how Montrealer’s perceive these self-driving vehicles.

Ultimately, our goal is to provide valuable insights that can guide policymakers, city planners, and transportation authorities in developing future transportation plans for Montreal. We hope our findings will contribute to creating transportation solutions that meet the needs and preferences of Montreal residents, ultimately improving last-mile connectivity throughout the city.

1.3 Report Structure

In this thesis, there are seven chapters. The chapters are organized as follows.

Chapter 1 provides an introduction to transportation and autonomous vehicles, highlighting the objectives of the research work.

In-depth coverage of the literature is provided in Chapter 2, which covers a wide range of subjects including what autonomous vehicles are, how they work, why they are useful, what technologies are involved, pilot projects that have been carried out in Montreal, and research gaps in the body of current literature. The study's methodology, including the research strategy, data gathering procedures, and analytical tools used, is described in Chapter 3. Chapter 4, which follows, concentrates on presenting and evaluating the collected data and highlighting the study's findings. Chapter 5 contains the comparative study among 4 regions – U.S., U.K., Australia and Montreal. After presenting the analysis and results from the previous chapter, Chapter 6 goes into a thorough discussion that offers insights, interpretations, and ramifications of the findings. As the study's conclusion, Chapter 7 summarizes the major discoveries and contributions made. It also lays out the possible directions for this field's future research and development, opening the door for more investigation and development of autonomous car technologies and their incorporation into transportation networks.

CHAPTER 2

LITERATURE REVIEW

A literature review, in the context of academic research and thesis writing, serves as a crucial exploration of existing knowledge and research on a particular topic. It's similar to embarking on a journey through the thoughts and findings of others who have ventured into the same realm of study. The aim of a literature review is to not only gain an understanding of the current state of knowledge but also to identify gaps, trends, and insights that will pave the way of the research.

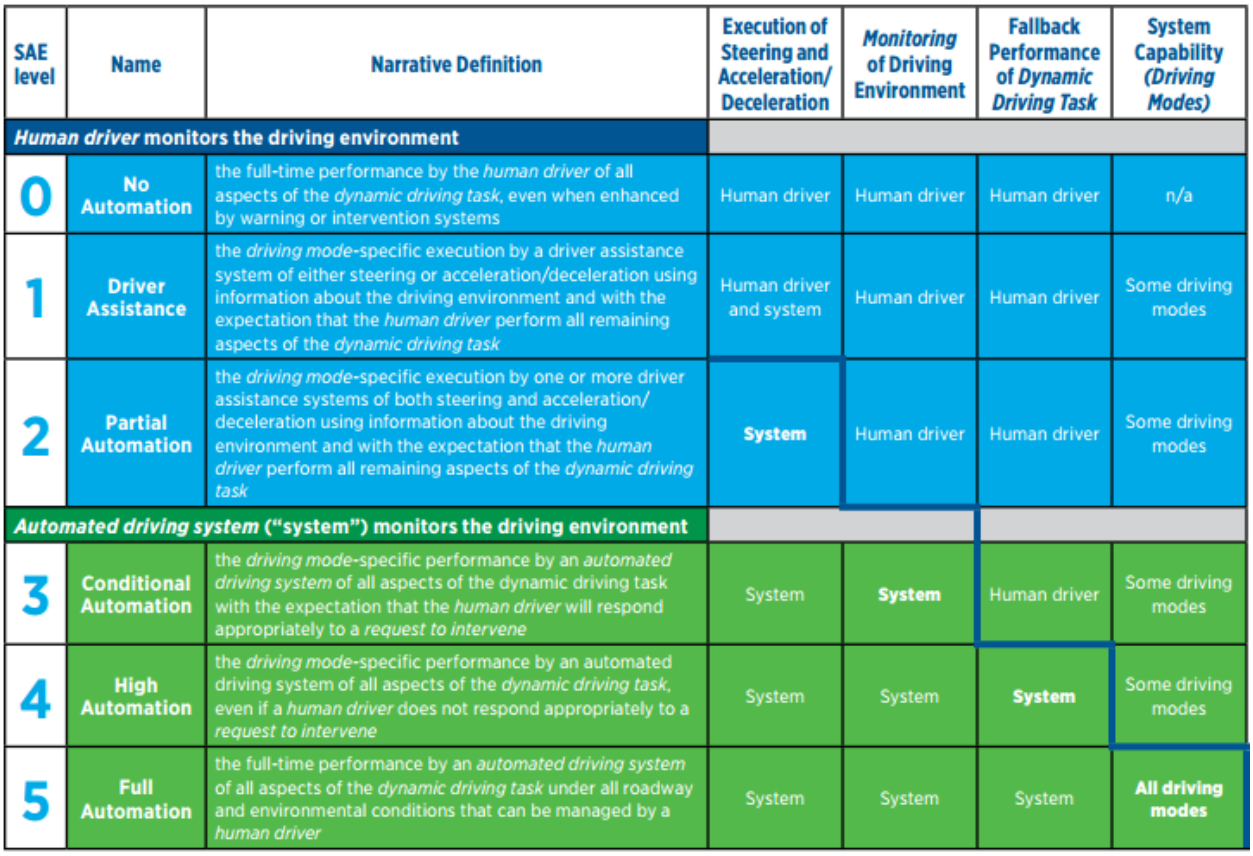
2.1 Definition of AVs

Automated Vehicles are automobiles equipped with technology that enables them to perform certain driving functions without human intervention. These vehicles rely on various sensors, cameras, and advanced software to sense their environment and navigate roads autonomously [14]. According to the Society of Automobile Engineers, there are six levels of automation of AVs.

Table 2. 1 Level of Automation in vehicles (SAE)

Level	Description
Level 0	No Automation: The driver performs all driving tasks without assistance from automated systems.
Level 1	Driver Assistance: Specific functions, such as steering or acceleration, are assisted by automated systems.
Level 2	Partial Automation: Automated systems control both steering and acceleration, simultaneously.

Level 3	Conditional Automation: Vehicles perform driving tasks under certain conditions, but drivers must be available to take control if needed.
Level 4	High Automation: Vehicles operate without driver intervention in specific conditions or areas.
Level 5	Full Automation: Vehicles can perform all driving functions under all conditions without human intervention.



SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Figure 2. 1 Level of Automation in vehicles (SAE)

2.2 Benefits of Autonomous Vehicles

With the potential to completely change the way we travel, autonomous vehicles, or AVs, have garnered a lot of attention lately. These cars provide many advantages that have the potential to significantly improve our daily lives. They are outfitted with cutting-edge sensors, artificial intelligence, and communication system.

- **Increased Security:** AVs' promise to increase road safety is among their strongest justifications. A major contributor to mishaps, human error claims many lives each year and causes a great deal of injury. Because they remove human mistake from the picture, AVs can reduce this danger. Because of their cutting-edge technology, autonomous vehicles (AVs) are able to see threats ahead of time, recognize impediments, and react more quickly than human drivers, which may lead to fewer accidents on our roads [1].
- **Higher Fuel Economy:** AVs have the potential to reduce pollutants and improve fuel economy in addition to providing safety benefits. AVs are able to outperform regular vehicles in terms of fuel efficiency by utilizing advanced algorithms to optimize driving patterns, including acceleration, deceleration, and planning routes. Further enhancing their environmental credentials and supporting sustainability initiatives is the integration of autonomous vehicles (AVs) with electric vehicle (EV) technology [2].
- **Enhanced Accessibility and Mobility:** Automatic vehicles (AVs) provide independence and mobility to people who have trouble moving around or have restricted access to transit. With the use of these cars, seniors, people with disabilities, and other people who have transportation-related obstacles can move more easily and independently. The cars can offer door-to-door transportation services. Improved accessibility has the potential to increase societal involvement and inclusivity.

- **Reduced Traffic Congestion:** Automated vehicles (AVs) provide the capability to enhance traffic efficiency and reduce gridlock on our roads. The possibility of traffic jams and bottlenecks is decreased when autonomous vehicles (AVs) drive more effectively through improved communication and coordination.
- **Improved Productivity and Passenger Experience:** Passengers can make better use of their journey time as autonomous vehicles (AVs) will be doing the driving. During their commute, commuters can work, relax, or partake in recreational activities, which adds to the fun and reduces stress. Furthermore, AVs provide a more comfortable and safe travel experience, freeing up passengers to concentrate on other activities rather than negotiating traffic [3].
- **Enhanced Transportation Services:** The rise of AV technology opens new possibilities for transportation services such as ridesharing and on-demand mobility solutions. AVs can operate autonomously, enabling efficient deployment and utilization of shared transportation resources. This can lead to cost savings, reduced vehicle ownership, and improved access to transportation services, particularly in urban.

2.3 Autonomous Vehicles Technologies

The success of AV technology hinges on various factors and parameters, as well as its underlying sub-technologies, which are crucial for a successful deployment. The following will offer a straightforward explanation of the essential features and technologies behind AVs.

- **Sensors and Perception Systems:** At the heart of AV technology are sensors and perception systems, which provide vehicles with the ability to perceive and interpret their surroundings. These sensors include cameras, LiDAR (Light Detection and Ranging), radar, and ultrasonic sensors, each serving a specific purpose in capturing data about the

vehicle's environment. Cameras provide visual information, while LiDAR, radar, and ultrasonic sensors offer depth perception and object detection capabilities.

- **Artificial Intelligence and Machine Learning:** Artificial intelligence (AI) and machine learning (ML) play a critical role in autonomous vehicle technology, enabling vehicles to make complex decisions based on real-time data and environmental inputs. AI algorithms process sensor data, recognize objects, predict behavior, and plan optimal driving trajectories. Through continuous learning and adaptation, AVs improve their performance and decision-making capabilities over time [1].
- **Localization and Mapping:** Accurate localization and mapping are essential for AVs to navigate safely and effectively. AVs rely on high-definition maps, which contain detailed information about road geometry, lane markings, traffic signs, and other infrastructure features. Simultaneously, localization algorithms use sensor data to determine the vehicle's precise position within the mapped environment, ensuring accurate navigation and route planning.
- **Control and Actuation Systems:** Control and actuation systems translate the decisions made by the vehicle's AI into physical actions. These systems control acceleration, braking, steering, and other vehicle functions to navigate through traffic, avoid obstacles, and adhere to traffic laws. Advanced control algorithms ensure smooth and precise vehicle operation, even in challenging driving conditions [2].
- **Communication and Connectivity:** AVs leverage communication technologies to interact with other vehicles, infrastructure, and the surrounding environment. Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication systems enable AVs to share data, coordinate maneuvers, and receive real-time updates about road conditions, traffic

patterns, and potential hazards. This connectivity enhances situational awareness and improves overall safety and efficiency.

2.4 Early Autonomous Shuttle Pilot Run in Montreal

The dynamic city of Montreal, which is well-known for its diverse population and progressive urban projects, has recently executed two noteworthy pilot programs to explore how autonomous shuttle technology might transform urban transportation. These programs, carried out in partnership with well-known industry players, highlight Montreal's proactive approach to addressing the difficulties related to last-mile connectivity and adopting cutting-edge mobility solutions.

This was the first autonomous shuttle experiment in Montreal, and it took place in the city's well-known Olympic Park from September to December 2018. The success of this project encouraged Montreal to expand its research, and in the summer of 2019 a second pilot project was launched in the Hochelaga-Maisonneuve neighborhood. These pilot programs yielded valuable data regarding the operational viability, security concerns, and public perception of autonomous shuttles in real-world urban environments.

2.4.1 Olympic Park Pilot Project

The second project was initiated by the Olympic Park in collaboration with Desjardins employees. Building on a previous trial conducted in 2017 in partnership with Transdev, during which a manned operator drove a shuttle for four days over a short distance of less than 200 meters, the aim was to expand both the route and duration of the project. This expansion sought to provide Desjardins employees, who had recently relocated to the Montreal Tower, with transportation within the Olympic site, facilitating movement between parking lots and their new offices.

Additionally, the initiative aimed to offer visitors and tourists a complimentary and accessible transportation option between the Rotunda and the Sports Center, Tower, or Planetarium.

2.4.1.1 Shuttle and Route

The route chosen for the test covers about 800 meters and includes four designated stops.

- Entrance to the stadium via ticket street
- Desjardins entrance
- Sports Center stop / Montreal Tower / Rio Tinto Alcan Planetarium
- Metro Viau

Figure 2. 2 Predefined route for the shuttle (photo from NÉArque 2018) [5]

During its pilot period, the NEA's route spanned approximately 800 meters, encompassing four key stops. Commencing at Rue des Billets, the NEA navigated through a mixed zone, accommodating pedestrians, cyclists, motorists, and delivery trucks. Covering over 200 meters,

the route reached the entrance to parking lot P8 at 4553 avenue Pierre-De Coubertin, a pivotal location within the Olympic Park. This site serves as a central access point to the Stadium, its underground and surface parking, and is vital for deliveries and visits. To ensure safety at this intersection, two mandatory stops were integrated into the shuttle's route. Upon crossing the intersection, the NEA continued through a zone allocated for customers of the Stadium's PhysiOsteo physiotherapy clinic. This mixed area posed challenges due to vehicles often encroaching on the route. The final segment of the route was a pedestrian-exclusive area, housing stops at the Desjardins entrance, the Planetarium, and the Viau metro stop. Alterations were made, relocating bike racks and adjusting street furniture to clear adequate passage for the shuttle. Additionally, strategic planning was necessary to accommodate the shuttle's passage in narrow sections and facilitate efficient service.

The details regarding the NEA's route were retrieved from the “Report of the autonomous electric shuttle pilot project at the Olympic Park, 2018”, (NÉArque 2018) report.

2.4.1.2 Shuttle Description

Table 2. 2 Description of the shuttle and project (Data from NÉArque 2018) [5]

Project Timeline	September 10 to December 7
Shuttle Model	Two second generation EasyMile shuttles (EX10 gen 2)
Operating Days	55 days
Total Length of one-way journey	796 meters
Service Time	7 hours a day, from 6am to 10am and 3pm to 6pm, Monday to Friday
Capacity	12 people (6 seated places + 6 standing places)
Total Passengers Transported	2,300
Total km Travelled	1,134 km

Maximum Speed	9 km/h
Commercial Speed	5.4km/h

The vehicles stationed at Olympic Park (Gate A) experienced temperature fluctuations ranging from 30°C to -11°C. Over a span of five days, snowfall varied from light to heavy, while there were 17 days of precipitation ranging from low to high intensity rain. The vehicle specifics at Olympic Park (Gate A) were as follows:

- **Battery Specifications:**
    - Charging Time: 6 hours using accelerated charging
    - Charging Method: Wired, compatible with 110V-230V (16A)
    - Battery Type: Lithium Fer Phosphate (LiFePo4), comprising 4 blocks (30.72 kWh)
    - Range: 16 hours under temperate climate conditions
- **Numerous partners collaborated at Olympic Park to facilitate and implement this pilot project.**
    - Olympic Park – Instigator of the project
    - Transdev – Shuttle operator
    - EasyMile – Shuttle builder
    - City of Montreal – Financial partner
    - Space for life – Partner
    - Government of Quebec – Financial partner

2.4.1.3 Cost of the Project

Total cost associated with the project amount to $205,000. Cost breakdown as below:

- Operator: $22,000

- Vehicle rental (2 months): $100,100
- Transportation
    - Mapping, programming, and training: $25,200
    - Other costs (management, maintenance, Insurance): $32,200

Distribution of Contributions:

- City of Montreal: $60,000
- Olympic Park: $30,000
- Transdev: $115,000

2.4.1.4 Findings of the Project

The findings from the pilot project reveal both successes and challenges in the implementation of autonomous shuttle technology in Montreal. Despite encountering numerous pitfalls, overall user feedback was positive, particularly from Desjardins employees newly installed at the Tower. However, mechanical failures and computer-related issues posed significant challenges, leading to the shuttles being out of service for consecutive days.

A key revelation was that the shuttles do not operate freely but follow a virtual rail mapped by manufacturers, causing confusion among visitors who inadvertently obstruct the shuttle's route. While the presence of an operator onboard ensured passenger safety, their role was crucial for providing customer service and adapting to passengers' needs.

The dynamic between the shuttle operator, network operator, and manufacturer highlighted approval delays for route modifications. Additionally, the complexity of repairs, including lengthy delivery times for spare parts, underscored the need for enhanced logistical planning.

Ultimately, the pilot project served as a valuable learning experience, shedding light on the technological limitations and operational considerations associated with autonomous shuttles. It

emphasized the importance of collaboration among stakeholders, the necessity of human presence onboard, and the ongoing evolution of autonomous vehicle technology.

2.4.2 Hochelaga-Maisonneuve Pilot Project

Another pilot project took place in Montreal in 2019, the route was Olympic stadium to the Maisonneuve market. The pilot run duration was from June 21st to August 4, 2019. The automated shuttle was from the supplier Easymile and operating company Trasndev. The shuttle car had the capacity of 12 passengers for one ride. Its route was 1.4 km long with a max speed of 15km/h. The operating hours for the shuttle was Monday to Sunday from 10am to 6pm. Total funding for the project was $5M dollar and it was funded by the Ministry of Municipal Affairs and Housing.

2.5 Previous Research on AV

Because of the heavy traffic, moving around large cities like Montreal can be quite difficult. The "last mile" challenge is another issue we must deal with. It resembles the last part of your trip—the part where you get off a bus or train and walk toward your destination. Determining how to make this portion of the journey both eco-friendly and seamless can be a bit challenging. We are investigating some innovative solutions, such as automated shuttles, to address this problem. These autonomous vehicles, which resemble tiny self-driving buses, train or cars, may contribute to the solution. They might facilitate your final leg of the journey and benefit the environment.

Finding out what people think is essential to the success of self-driving shuttles in urban transportation. Research on public opinion towards autonomous vehicles in general has been wide. However, one aspect of the relationship between self-driving shuttle services—which aim to

simplify the last part of your journey—and the people of Montreal in particular remains not accounted for.

In the automotive and transportation sectors, autonomous vehicles, or AVs, have gained a lot of acceptance lately. With their unique business models aimed at enhancing convenience, safety, and user experience, they offer an innovative chance to redefine how we travel [7]. Alongside other innovations like electric cars, app-based car-sharing, and micro mobility services, AVs are positioned to be leaders in the future of transportation.

The primary benefit of autonomous vehicles (AVs) is their ability to reduce human error, which is the main factor contributing to traffic accidents. This might completely transform our transportation system [9]. Studies show AVs can improve fuel economy and drastically lower the number of accidents [9]. They also provide better mobility alternatives for those who are unable to drive, such as elderly and disabled adults, teenagers, and people with disabilities, which may lessen the need for parking spots in cities [9]. These characteristics set AVs apart as attractive answers to the problems arising from the "last mile" in transportation.

Nevertheless, while autonomous vehicles (AVs) bring forth numerous advantages, it is crucial to acknowledge potential drawbacks and uncertainties. Policymakers' express concerns about the convenience of AVs, enabling passengers to engage in activities such as reading or using smartphones during travel, potentially negatively impacting public transit ridership. The increased utilization of private AVs may contribute to heightened congestion, pollution, and urban sprawl [35].

A significant challenge lies in establishing a robust digital communication infrastructure. AVs depend on real-time data transmission, necessitating low latency and high reliability. It is essential

to note that the growing prevalence of AVs introduces new risks due to the absence of informal communication channels between AVs and other road users, increasing uncertainty and potentially elevating the risk of accidents.

A key factor in the success of self-driving cars (AVs) is public opinion [10]. Age and gender are just two examples of the characteristics that have been the focus of recent research on people's perceptions of AVs [11], [36], [12[13],[14],[15]. Numerous research [16],[17], [18],[14] have revealed that people's attitudes toward AVs are either positive or cautiously positive. But there are differences in this zeal among the nations; China is the most acceptable (87.2%), while Japan is the least (42.9%) [14].

To get a grip on these opinions, most studies used surveys, asking questions based on established models about how people accept new technologies [19],[20]. They found that factors like how useful people think AVs are, how easy they are to use, how much people trust them, and what others think about them all influence how likely people are to use them [21],[22],[23],[24]. Some studies even talked to people who had actually used AVs, but there aren't many of those [25], [26].

In a study conducted by Begg [27], a survey encompassing more than 3500 British transport professionals aimed to grasp their perspectives and concerns regarding the future integration of autonomous transportation in London. The findings revealed that 88% of the participants anticipated the presence of Level 2 vehicles on the U.K. roads by the year 2040. However, this expectation decreased for Level 3 and Level 4 vehicles, with 67% and 30% of respondents, respectively, foreseeing their adoption by the same period. Additionally, about 60% of the surveyed individuals expressed support for driverless trains within the London transportation system. Equally noteworthy, an approximate 60% of the participants believed that autonomous vehicles (AVs) would offer a higher safety standard compared to conventional vehicles.

Underwood [28] conducted a survey involving 217 experts, where 80% held master's degrees, 40% were autonomous vehicle (AV) specialists, and 33% specialized in conventional vehicles (CV). According to these professionals, legal liability emerged as the most challenging obstacle for implementing Level 5 autonomous vehicles—fully automated vehicles without a steering wheel—while consumer acceptance posed the least difficulty. About 72% of these experts recommended that AVs should be at least twice as safe as traditional vehicles before being permitted for public use. Additionally, 55% of respondents doubted the practicality of Level 3 AVs due to concerns that reliance on automated functions might lead to driver complacency, potentially affecting necessary actions. According to Continental's (2015) surveys, they polled 1800 individuals in Germany and 2300 in the United States. Around 60% of those surveyed envisioned utilizing autonomous vehicles (AVs) during high stress driving scenarios, while approximately 50% were of the opinion that AV technology could significantly reduce accidents. Similarly, a comparable percentage expressed their inclination to engage in other activities while being driven in AVs.

Christie et al. [30] demonstrated that a significant majority of users held favorable perceptions of automated minibuses. An assessment conducted on a public road in Switzerland, as evaluated by residents and pedestrians, also reflected predominantly positive sentiments toward an automated minibus [37]. However, participants in this study expressed criticism regarding the minibus's slow speed of 20 km/h and voiced uncertainties regarding its driving predictability. In a recent study by Nordhoff [31], the investigation focused on user acceptance of an autonomous minibus in Berlin. Participants exhibited a notable level of acceptance toward the minibus, providing favorable ratings for its usefulness and expressing satisfaction with the ride experience. Notably, Nordhoff et al. integrated various minibus attributes, such as design and spaciousness, into their

questionnaire, finding a high correlation between these characteristics and the users' intention-to-use.

Payre et al. [18] conducted a study on the perspectives of French drivers regarding fully automated driving, employing an online questionnaire. The research encompassed the attitudes and initial acceptance of fully automated driving technology among 421 drivers (153 males, mean age = 40.2 years, age range = 19 to 73). The findings revealed that 68% of the participants scored above the midpoint (4 on a 7-point Likert scale) on the acceptability scale for fully automated driving. Moreover, the study identified that men and individuals with higher scores on the driving-related sensation seeking scale exhibited more willingness to use and purchase fully automated vehicles. Interestingly, older individuals seemed less inclined to invest in such technology, although they demonstrated higher acceptance levels. Participants showed a preference for using fully automated vehicles on highways, during traffic congestion, and for automatic parking. Notably, 71% of respondents expressed interest in utilizing fully automated driving while impaired (e.g., under the influence of alcohol, drugs, or medication), despite acknowledging their responsibility for both the vehicle and the driving task.

Schoettle and Sivak [14} conducted a study that examined public opinions (N = 1533) in the US, UK, and Australia about self-driving and autonomous vehicles. According to the research, a sizable percentage of the population (60–70%) had heard about autonomous or self-driving cars before, and 57% of them had an overall good opinion of them (scoring from "very negative" to "very positive" on a 5-point Likert scale). Notably, the expected advantages of self-driving cars were reduced crash rates (70%) and emissions (64%), as well as reduced fuel usage (72%).

However, respondents didn’t believe this technology would notably ameliorate traffic congestion (48%) or travel time (43%). Concerns regarding self-driving vehicle technology were evident,

especially in the US, where 26% of respondents expressed being "very concerned" about system/equipment failures and vehicle performance in unforeseen situations, compared to 15% in the UK and 16% in Australia. Yet, when considering all levels of concerns, 75% across all countries harbored some level of apprehension. Issues surrounding legal liability, automated system hacking, and privacy due to data sharing were highlighted. More than 90% of participants expressed concern to some extent over the legal ramifications for owners and operators of self-driving cars. The survey also brought attention to gender disparities, with women being more cautious and expressing more worry about the potential advantages of self-driving cars than men.

Schoettle and Sivak [14] also examined public opinions (N = 1722) on self-driving vehicles in China, India, and Japan. This research indicated that more than 84% of respondents in China and India, and only 43% in Japan, held favorable views on self-driving vehicles. Moreover, a substantial majority of Chinese and Indian respondents (76% and 80% respectively) expressed interest in integrating this technology into their personal vehicles, compared to 41% of Japanese respondents.

A study conducted by Casley et al. [32] examined the public perception of fully automated vehicles among 467 students at Worcester Polytechnic Institute. The students were asked to rank the most significant feature influencing their preference for fully automated vehicles. The survey found that 82% of respondents prioritized safety, 12% highlighted legislation, and 7% considered cost. Interestingly, while a significant portion of students (40%) anticipated a price range of $5000–9999 for a fully automated car in addition to a regular vehicle, over 71% indicated an unwillingness to spend more than $4999 on its purchase. Additionally, the research revealed that nearly 58% of participants lacked familiarity with existing laws governing the testing and operation of automated cars. Despite this, a substantial number (57%) expressed concerns about legislation. Lastly, the

study highlighted a gender disparity, indicating a higher likelihood for men to embrace and enjoy self-driving cars compared to women. Howard and Dai [33] conducted a survey in Berkeley (CA) to delve into public opinion regarding self-driving cars, involving 107 participants. The study utilized both a questionnaire and a video presentation. Notably, safety (75%) and convenience (61%) emerged as the most appealing aspects of automated driving for respondents. Conversely, liability (70%) and cost (69%) were cited as the least favorable elements. Regarding operational preferences, 46% believed self-driving cars should operate alongside regular traffic, while 38% advocated for dedicated lanes, and 11% refrained from expressing a preference. Moreover, over 40% of participants expressed interest in either incorporating self-driving technology in their next vehicle or retrofitting their existing vehicle with such technology. A notable sentiment arose, with 35% supporting subsidized schemes for self-driving cars, whereas 22% opposed such initiatives.

Table 2. 3 Summary of Literature Review

Authors	Location	Methodology	Conclusion/Result
Fagnant & Kockelman (2015)	-	Literature review	AVs can significantly reduce accidents and enhance fuel efficiency. They offer improved mobility options for individuals unable to drive, potentially reducing urban parking demand.
Litman (2020)	-	Research review	Private AV usage might contribute to congestion, pollution, and urban sprawl. Public transit ridership might be impacted.
Begg (2014)	London	Survey of transport professionals	88% anticipate Level 2 AVs by 2040; 67% and 30% anticipate Level 3 and 4 AVs respectively by 2040. 60%

			support driverless trains in London. 60% believe AVs offer higher safety than conventional vehicles.
Underwood (2014)	-	Survey of experts	72% recommend AVs should be twice as safe as traditional vehicles; 55% doubt Level 3 AV practicality due to potential driver complacency.
Continental (2015)	Germany, US	Surveys on public expectations and perceptions of AVs	60% foresee AV usage during high-stress driving; 50% believe AVs can reduce accidents; around 50% would engage in other activities while riding in AVs
Christie et al. (2016), Nordhoff et al. (2018)	Switzerland, Berlin	User perceptions of automated minibuses; investigation of user acceptance	Generally positive perceptions; criticism regarding minibus speed and unpredictability.
Payre et al. (2014)	France	Online questionnaire survey on French drivers' attitudes towards fully automated driving	68% scored above midpoint on acceptability scale; interest in using AVs in various driving conditions.
Schoettle and Sivak (2014a), Schoettle and Sivak (2014b)	US, UK, Australia, China, India, Japan	Public opinion surveys on AVs across countries, assessing perceptions, and concerns	60–70% had prior knowledge of AVs; 57% had overall positive opinions. Concerns include safety, legal liabilities, and hacking risks.
Casley et al. (2013)	Worcester Polytechnic Institute	Survey on students' perceptions of fully automated vehicles	82% prioritize safety; 71% unwilling to spend more than $4999; nearly 58% lack familiarity with existing laws.
Howard and Dai (2014)	Berkeley (CA)	Survey and video presentation	75% found safety appealing; 61% found convenience appealing; 70%

		exploring public opinions on self-driving cars	found liability unappealing; and 69% found cost unappealing.

2.6 Research Gap

Despite all this research, there is a big gap when it comes to understanding how people in Montreal feel about automated shuttles. Nobody has really dug deep into how Montreal's unique city life and mix of cultures might shape what people here think about AVs that are meant to help with the last part of a trip. So, that is what we want to explore—how Montrealer's see and feel about AVs designed for that final stretch of their journey.

In conclusion, in this section, it is identified that: -

- A limited number of articles exist on the study of autonomous vehicles in Montreal, indicating a gap in the current literature focused on this geographical context.
- There is a noticeable absence of articles specifically evaluating Montrealer's' perception and acceptance of autonomous vehicles, highlighting a research gap in understanding the local perspectives on this emerging technology.
- No existing articles have systematically explored last-mile connectivity in Montreal, considering the city's unique blend of culture, urban dynamics, and environmental factors. This reveals a lack of research on how these elements may influence the acceptance and effectiveness of autonomous vehicles in addressing last-mile transportation challenges in the city.

CHAPTER 3

METHODOLOGY

We chose a qualitative method to delve into the intricate realm of public perceptions. Our aim was to grasp individual viewpoints through a systematic process, seeking to comprehend diverse perspectives on the subject. Qualitative methods allow for an in-depth understanding of participants' attitudes, opinions, and experiences regarding autonomous shuttle technology.

3.1 Data Collection

- The primary method of data collection is through a structured survey administered to residents of Montreal.
- The survey is conducted online and social platform to reach a larger and more diverse sample of respondents. Platform used: Linked In, Facebook, Email communication, WhatsApp.
- Data collection is carried out over a specified period to gather responses from enough participants.

3.2 Questionnaire Development

- The survey questionnaire is designed to capture various aspects of public perception and acceptance of automated shuttles. It includes questions related to familiarity with autonomous technology, perceived benefits and concerns, willingness to use autonomous shuttles, and suggestions for improvement.
- Questionnaires were therefore developed to obtain information on the following points:
    - What do people know about autonomous vehicles?

- What is people's position on autonomous vehicles, and how should this vehicle be integrated into city streets?
- Categorization information (age, sex, origin, level of education, etc.)

3.3 Data Analysis

- Qualitative data analysis techniques, such as thematic analysis, are employed to analyze the survey responses. Thematic analysis involves identifying patterns, themes, and categories within the data to extract meaningful insights.
- We used Power BI, Microsoft Excel to interpret the collected responses.

3.4 Recruiting Participants

The survey was completed by 52 people in total. Fifteen women and thirty-seven men were among them. In terms of age distribution, there were two respondents who were under the age of eighteen, nine who were between the ages of eighteen and twenty-four, thirty-eight of whom were between twenty-five to thirty-four, and three in between thirty-five to forty-four. Of the people who responded to the survey, about 6% were finishing high school or studies that were comparable, another 6% were attending college or receiving vocational training, about 19% were finishing a bachelor's degree, the majority were finishing master's degrees (63%), and 6% were going to continue their education at a higher level.

Within the sampled population, the majority, comprising 52%, were engaged in study, whereas 36% held full-time positions. Additionally, 8% identified as part-time position holders, while a minimal 2% reported being not employed, and 2% mentioned other as their employment status.

Analysis of public transportation utilization reveals that 73% of the surveyed people utilize this mode of transport consistently. Moreover, 13% opt for it on a weekly basis, while 12% use it rarely and 2% of the respondents never use public transportation.

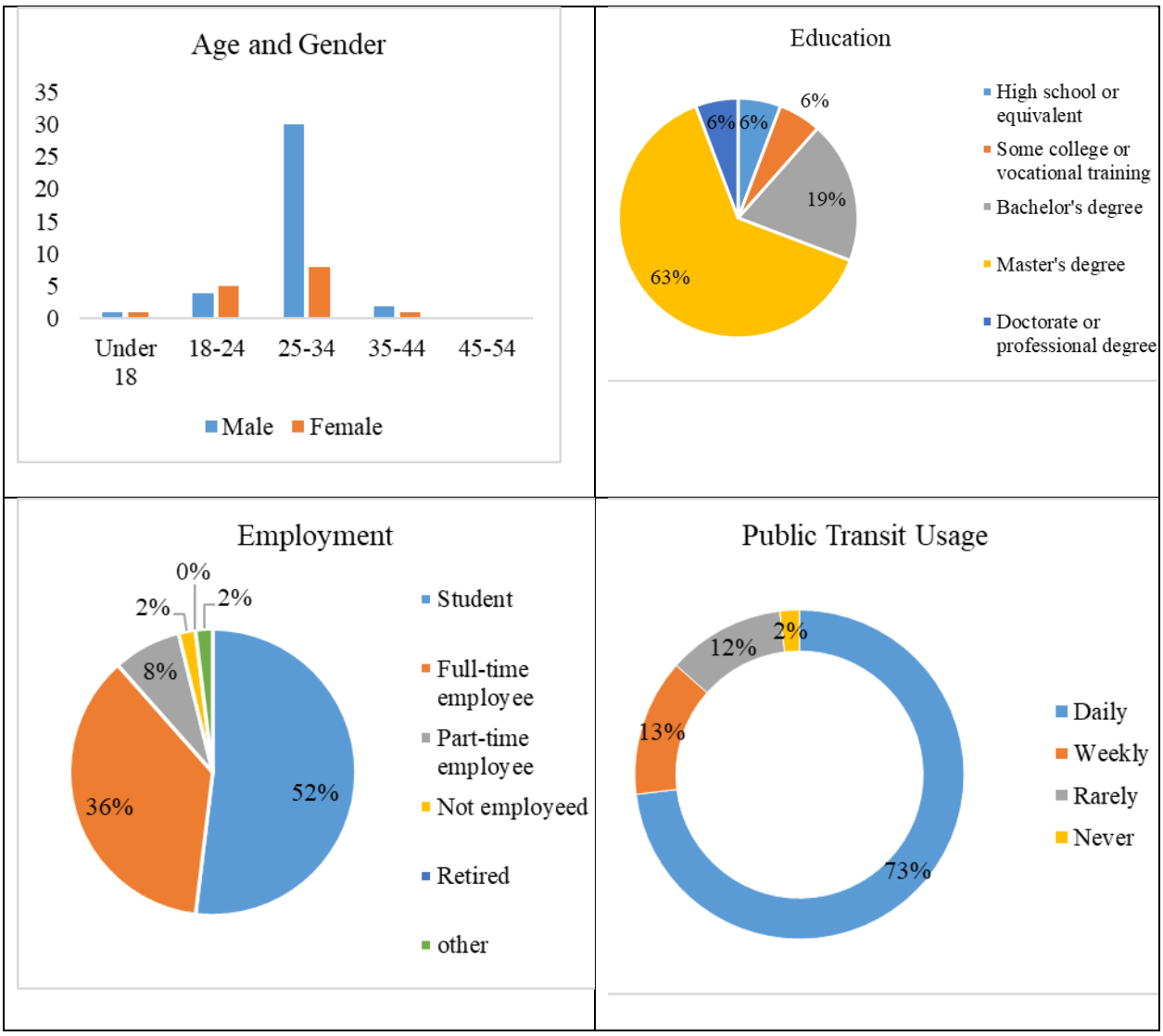


Figure 3. 1 Demographic Information

3.5 Reliability Test

Reliability refers to the consistency and stability of the responses obtained from a questionnaire.

Cronbach's Alpha: Cronbach's Alpha is a measure used to check how reliable and consistent a

questionnaire is. The value of Cronbach's Alpha ranges from 0 to 1. The closer the value is to 1, the more reliable the questionnaire is.

Calculation:

Cronbach's Alpha is (α) is calculated using the following formula:

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N} \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

Where:

- N is the number of items
- $\sigma_{Y_i}^2$ is the variance of each individual item
- σ_X^2 is the variance of total score formed by summing all items

Interpretation of Values:

- $\alpha \geq 0.9$: Excellent – The items have excellent consistency.
- $0.8 \leq \alpha \leq 0.9$: Good – The items have good internal consistency.
- $0.7 \leq \alpha \leq 0.8$: Acceptable – The items have acceptable internal consistency.
- $.6 \leq \alpha \leq 0.7$: Questionable – The items have questionable internal consistency.
- $0.5 \leq \alpha \leq 0.6$: Poor – The items have poor internal consistency.
- $0.4 \leq \alpha \leq 0.5$: Unacceptable – The items have unacceptable internal consistency.

The test was applied to check the appropriateness of the question using Cronbach's Alpha, shown in Table 1. The questionnaire's reliability is accepted when its value is at least 0.70. In this study's case, we have the three Likert Chart questions, Q18, Q19, and A20 (questionnaire is added in

appendix 1). To check the reliability of these question we have used IBM SPSS Statistic software, and the value of the Cronbach's Alpha is .913, reflecting an excellent overall reliability factor.

Table 3. 1 Reliability statistics

Cronbach's Alpha
.913

In appendix 2, the step by step calculation is given.

CHAPTER 4

ANALYSIS AND RESULT

4.1 Questionnaire Analysis

In this section, we present the data obtained from the survey conducted among residents of Montreal. The first four questions concern demographic information, which has already been discussed in the methodology section.

4.1.1 Are you a holder of a driver's license?

The survey asked participants whether they held a driver's license. Interestingly, 53.85% of respondents answered affirmatively, indicating they possessed a driver's license. On the other hand, 46.15% of respondents stated that they did not have one.

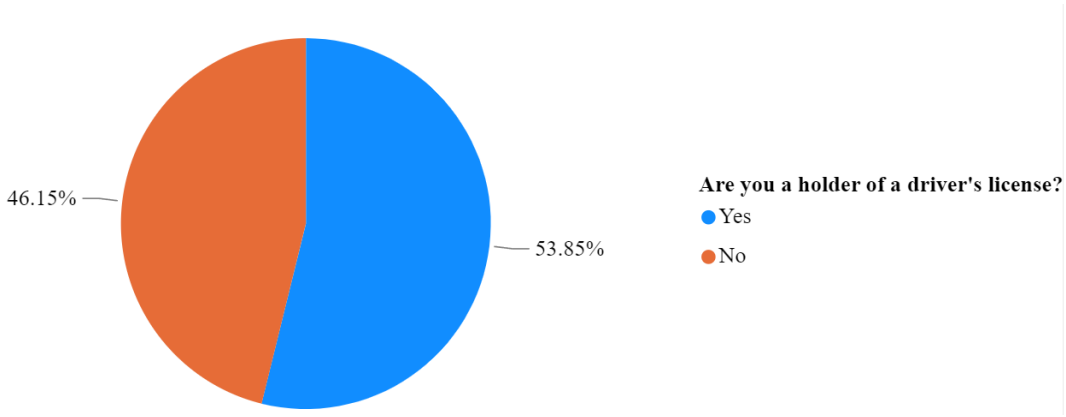


Figure 4. 1 Are you a holder of a driver's license?

4.1.2 Do you own a car?

In response to the question "Do you own a car?" posed to 52 participants, 17.31% indicated that they indeed owned a motor vehicle. Conversely, the majority, comprising 82.69% of respondents, reported not having any motor vehicle.

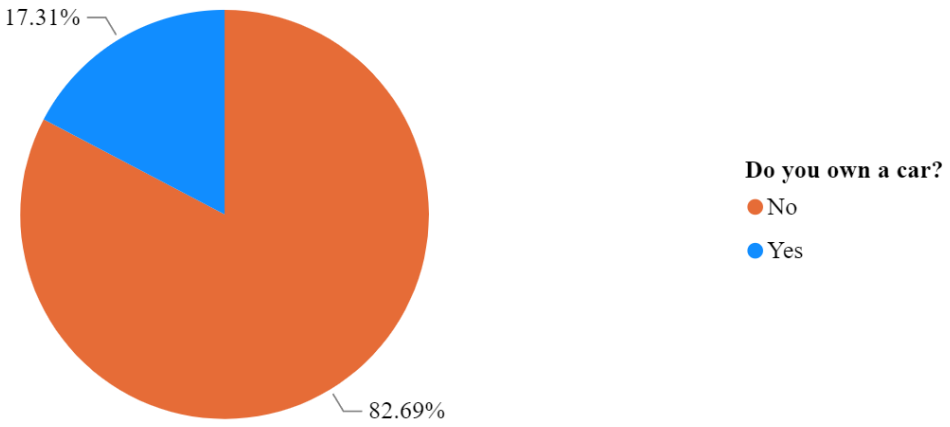


Figure 4. 2 Do you own a car?

4.1.3 How often do you use public transit?

An overwhelming majority of respondents, or roughly 73.08%, said in the study that they regularly use public transportation for their daily commutes. This suggests that public transportation is heavily relied upon by them. Furthermore, a regular but less frequent usage pattern was shown by the 13.46% of participants who reported utilizing public transportation once a week. As for the respondents, 11.54% said they use public transportation little, suggesting that they depend on it seldom or infrequently. A tiny percentage of respondents (1.92%) said they never use public transportation, which may indicate that they prefer other forms of mobility or that public transit is not easily accessible to them.

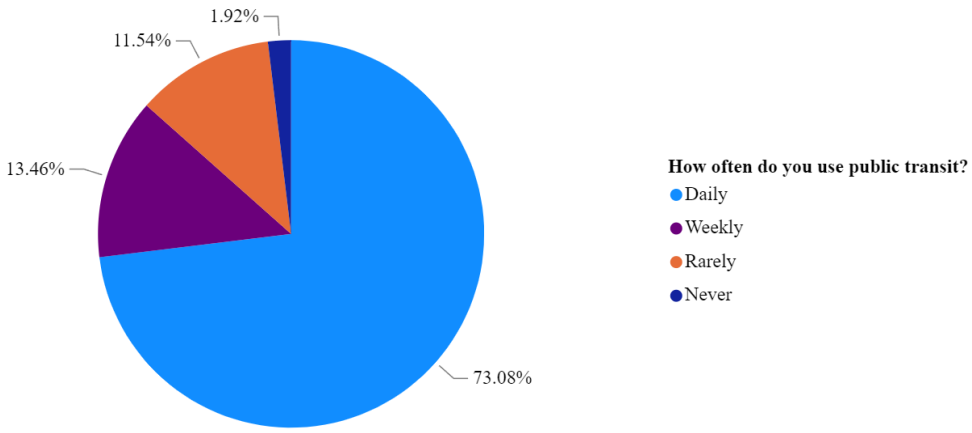


Figure 4. 3 How often do you use public transit?

4.1.4 What is your employment status?

Significantly more than half of the respondent's 52.94 percent identified as students, indicating that many of them are presently enrolled in school. Further evidence that a significant portion of people are actively working full-time comes from the fact that 37.25% of respondents said they were employed full-time. A minority of respondents, at approximately 7.84%, reported working part-time, which is a lesser number. Remarkably, 1.96% of respondents said they were unemployed, indicating a little percentage of the population questioned who are unemployed at the moment.

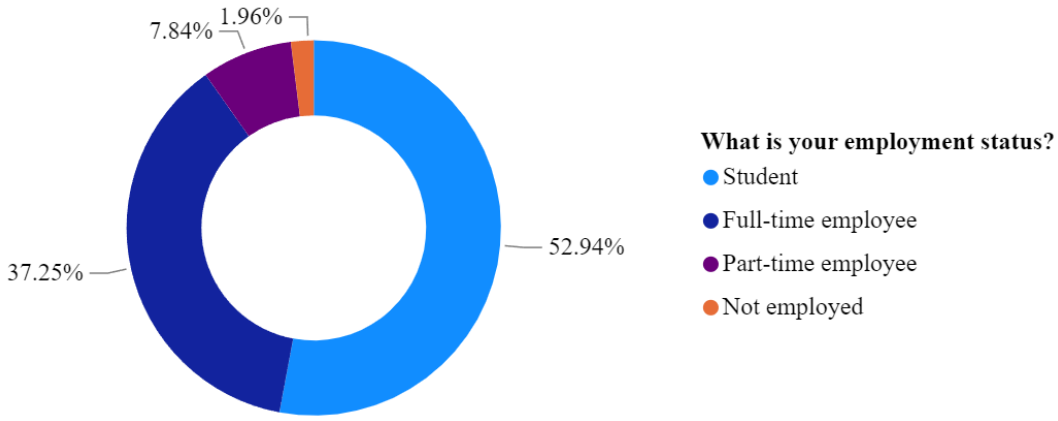


Figure 4. 4 What is your employment status?

4.1.5 Have you heard about the concept of automated shuttles for last-mile connectivity in Montreal before participating in this survey?

When it came to last-mile transportation in Montreal, participants were questioned about their knowledge of the automated shuttle idea. 38.45% of respondents indicated they had already heard of this topic, according to the results. However, the majority of respondents (61.54%) indicated that they did not know about the concept prior to doing the survey.

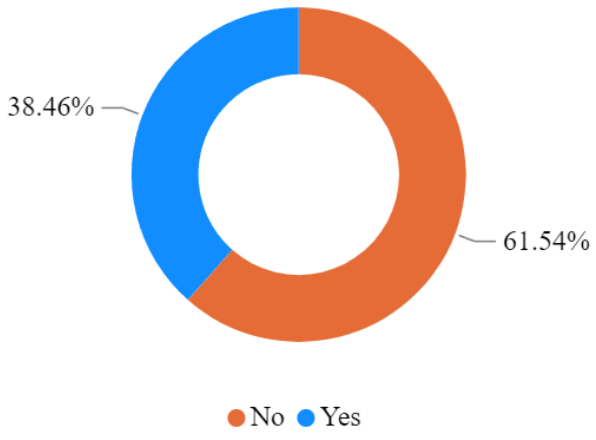


Figure 4. 5 Have you heard about the concept of automated shuttles for last-mile connectivity in Montreal before participating in this survey?

4.1.6 Have you ever boarded an autonomous shuttle?

People were questioned in the study if they had ever used an autonomous shuttle service. The results showed that a little percentage, 13.46% of participants, confirmed that they had, in fact, ridden on an autonomous shuttle at some point. This implies that a certain percentage of the people polled have firsthand experience with this kind of transportation. In contrast, the majority of participants (86.54%) said that they had not yet boarded an autonomous shuttle, suggesting that most respondents were not familiar with this new technology.

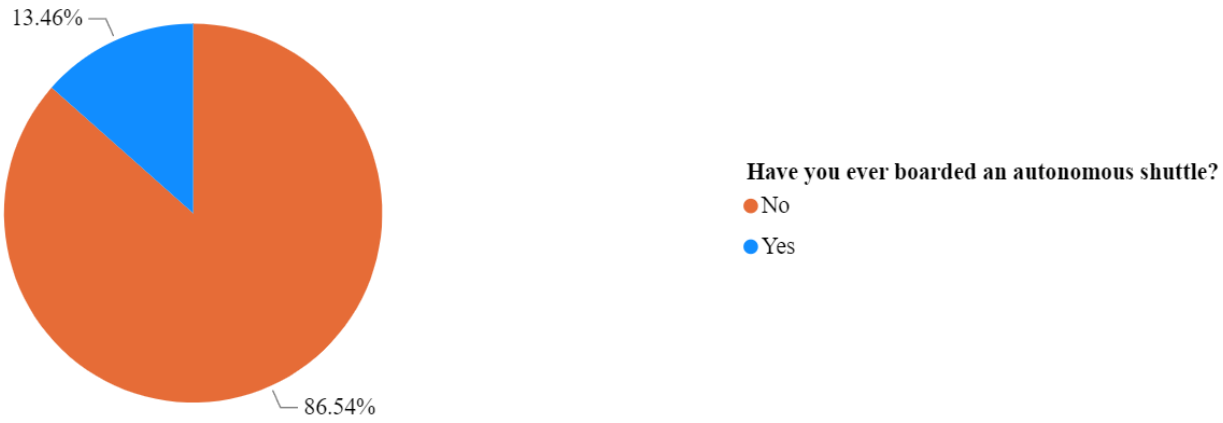


Figure 4. 6 Have you ever boarded an autonomous shuttle?

4.1.7 What is your opinion about autonomous and self-driving vehicles?

The participants' opinions on self-driving and autonomous cars are shown in Figure 4.7. 15% of respondents had a very high impression of this technology, whereas 31% have a slightly positive one. It's interesting to note that 40% of participants, or the majority, took a neutral position. On the other hand, 2% of people had extremely negative opinions on autonomous and self-driving cars, compared to 12% who had a slightly negative opinion. These results demonstrate how different people's opinions on this new technology were among those surveyed.

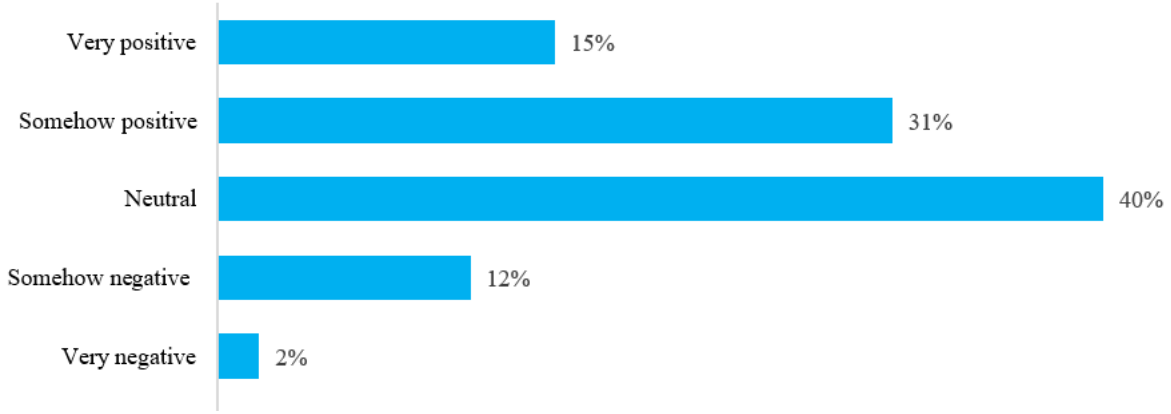


Figure 4. 7 What is your opinion about autonomous and self-driving vehicles?

4.1.8 In your opinion, which level of automated vehicle do you prefer?

Participants were asked about which level of automation they prefer from level 0 to level 5. A short description was given in the questionnaire about the automation level.

Level 0 - No Automation: The driver performs all driving tasks without assistance from automated systems.

Level 1 - Driver Assistance: Specific functions, such as steering or acceleration, are assisted by automated systems.

Level 2 - Partial Automation: Automated systems control both steering and acceleration, simultaneously.

Level 3 - Conditional Automation: Vehicles perform driving tasks under certain conditions, but drivers must be available to take control if needed.

Level 4 - High Automation: Vehicles operate without driver intervention in specific conditions or areas.

Level 5 - Full Automation: Vehicles can perform all driving functions under all conditions without human intervention.

In Figure 8, out of the 52 respondents, 2% prefer Level 0 automation, where drivers handle all driving tasks without help from automated systems. Interestingly, 15% and 4% respectively expressed opinions on Level 1 and Level 2 automation. In Level 1, there's driver assistance, with specific functions like steering or acceleration supported by automated systems. Level 2, known as partial automation, involves automated systems controlling both steering and acceleration alongside the driver. It's notable that 56% of respondents stayed on level 3 automation, representing the majority. Additionally, 13% prefer high automation, where vehicles operate without driver intervention in specific conditions or areas. Finally, 10% prefer Level 5 automation or full automation, where vehicles can handle all driving functions under any condition without human intervention. The responses highlight a diverse range of preferences towards automation levels in driving, with notable interest in higher levels of automation.

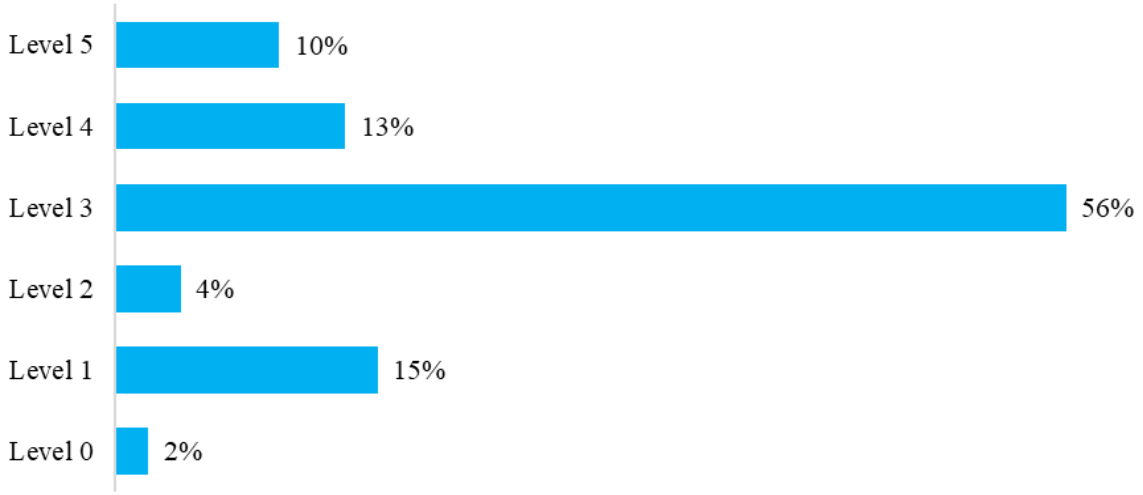


Figure 4. 8 Which level of automated vehicle do you prefer?

4.1.9 What is your comfort level with the fact that no one controls the steering wheel in an autonomous vehicle?

The study found different opinions among respondents when it came to how comfortable they were with no one handling the steering wheel in an autonomous vehicle. Only 7.69% of participants, as shown in Figure 9, said that they would feel extremely comfortable in this situation. Furthermore, 13.46% and 30.77%, respectively, would have a moderate level of comfort. But 32.69% of respondents said they would be at least a little uneasy if an automated system were to manage the steering wheel alone. Furthermore, 15.38% of respondents said they would find a highly or totally autonomous vehicle extremely uncomfortable if there was no human interaction.

The responses to the question about comfort levels with no one controlling the steering wheel in autonomous vehicles highlight a spectrum of perspectives among respondents. While a small percentage feels very comfortable with this scenario, a larger portion expresses varying degrees of discomfort. These findings underscore the importance of considering individual comfort levels and preferences in the development and adoption of autonomous vehicle technology.

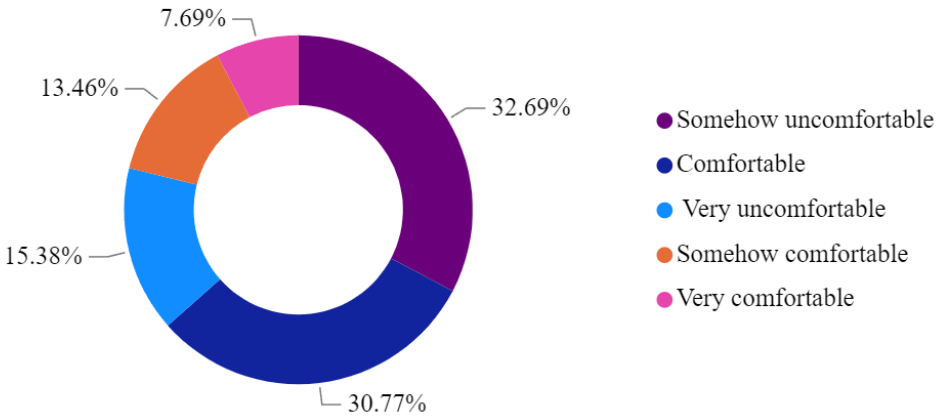


Figure 4. 9 What is your comfort level with the fact that no one controls the steering wheel in an autonomous vehicle?

4.1.10 Are you in favor of integrating autonomous shuttles into city streets?

If the participants were in favor of autonomous shuttles being introduced into city streets, they were questioned. Figure 10 shows that 55.77% of respondents, or the majority, had positive opinions on its inclusion. This suggests that adding automated cars to the mix with other forms of transportation is a good idea. 11.54% of participants, or a tiny minority, gave a negative answer to this query. However, 17.31% of participants are still unclear regarding the incorporation of self-driving cars into urban streets. Remarkably, 15.38% of participants said that they had never thought about this issue before.

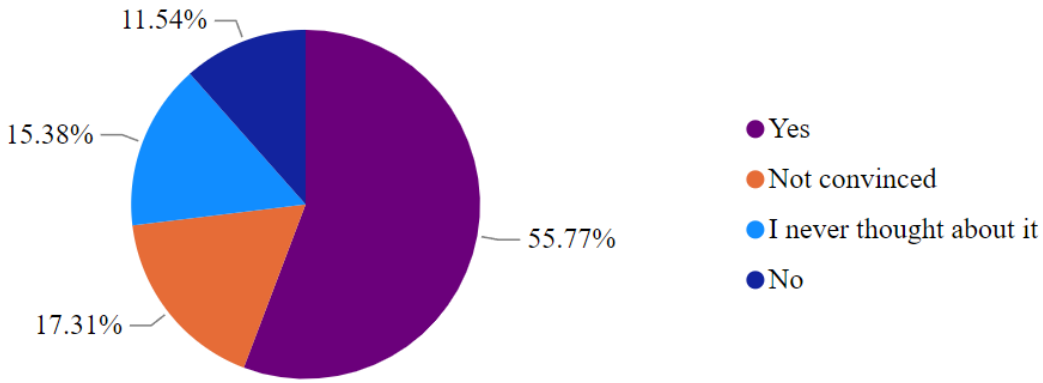


Figure 4. 10 Are you in favor of integrating autonomous shuttles into city streets?

4.1.11 Which locations or scenarios would you prefer for using autonomous shuttle services?

Participants were asked, “Which locations or scenarios would you prefer for using autonomous shuttle services?” A breakdown of the preferred locations and scenarios mentioned by the respondents:

- **Residential Neighborhoods:** A number of participants said that they would prefer autonomous shuttles in residential areas, suggesting that these vehicles may be used to transport inhabitants to and from neighboring amenities or for internal transportation.
- **Healthcare Facilities:** A lot of respondents indicated that their favorite places for autonomous shuttle services were hospitals and clinics. This implies that the ease of use and accessibility that driverless shuttles could offer to patients and guests has been acknowledged.
- **Recreational Areas:** Parks and sports facilities were among the locations that respondents emphasized as recreational areas. This shows that there is a need for driverless shuttles to make it easier to get to recreational locations and outdoor activities.
- **Metro and Train Transit Stations:** A sizable portion of participants stressed how crucial it is to incorporate autonomous shuttles into the current public transportation networks, especially at metro and train transit stations. This implies that autonomous shuttles might play a part in last-mile connection to and from transit hubs.
- **Shuttle to Airport:** Respondents also shared their interest for a automated shuttle service to Montreal-Pierre Elliot Trudeau International Airport. Which will help to lower the traffic on the road as many people use their personal vehicle or take ride from the relative or local available option to reach the airport. With automated shuttle residents of Montreal will have the flexi to travel to the airport with ease.
- **Commercial Districts:** The fact that respondents indicated that they preferred commercial districts shows that they understood the potential of autonomous shuttles to facilitate shopping and travel in crowded urban regions.

- **Educational Institutions:** A lot of respondents indicated that their favorite places for autonomous shuttle services were universities and colleges. This implies that there may be a perceived requirement for staff, instructors, and students to have access to quick and easy transit choices.
- **Downtown Areas:** Respondents frequently selected downtown areas, suggesting a need for autonomous shuttle services in busy city centers for both travel and recreation.
- **Night Service:** The fact that respondents said that they preferred night service indicates that they understood how important it was to offer dependable and safe transportation alternatives at night.
- **Highway Straight Roads:** A few respondents said that they would like to use autonomous shuttles on highway straight roads, suggesting that they may be interested in long-distance autonomous transport.
- **Public Transport and Emergency Vehicles:** A few respondents expressed a desire for autonomous shuttle services to be combined with emergency vehicles and public transportation, pointing to possible areas of overlap and cooperation.

4.1.12 Do you believe that integrating autonomous shuttles with existing bus routes would improve the overall efficiency of the transportation system in Montreal?

In order to improve transportation efficiency in Montreal, the survey asked participants what they thought of combining autonomous shuttles with current bus lines. Of the participants, a smaller percentage (7.69%) disagreed with the proposal, while a greater share (38.46%) stayed neutral, meaning they had no strong feelings either way. On the other hand, 42.31% of respondents said that this kind of integration could raise productivity levels overall. Further evidence of a high

degree of confidence in the prospective advantages came from the 11.54% who strongly agreed with this concept. These findings show that opinions on how well autonomous shuttles perform in Montreal's transportation system are divided, with a sizable percentage of respondents believing that it will increase productivity.

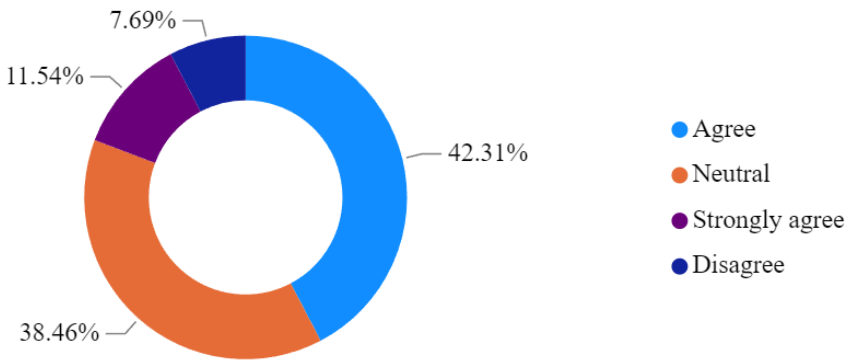


Figure 4. 11 Opinion on integrating Autonomous shuttles with existing bus route

4.1.13 When considering autonomous shuttles, which one do you find preferable?

Which kind of autonomous shuttle—autonomous car shuttle, autonomous railway shuttle, both, or other—did the participants prefer? Of the participants, half said they would rather use the autonomous railway shuttle. On the other hand, 23.08% said they preferred the autonomous car shuttle. Remarkably, 26.92% of respondents said they liked both autonomous shuttle options. Overall, the replies show that participants' preferences for different kinds of autonomous shuttles vary.

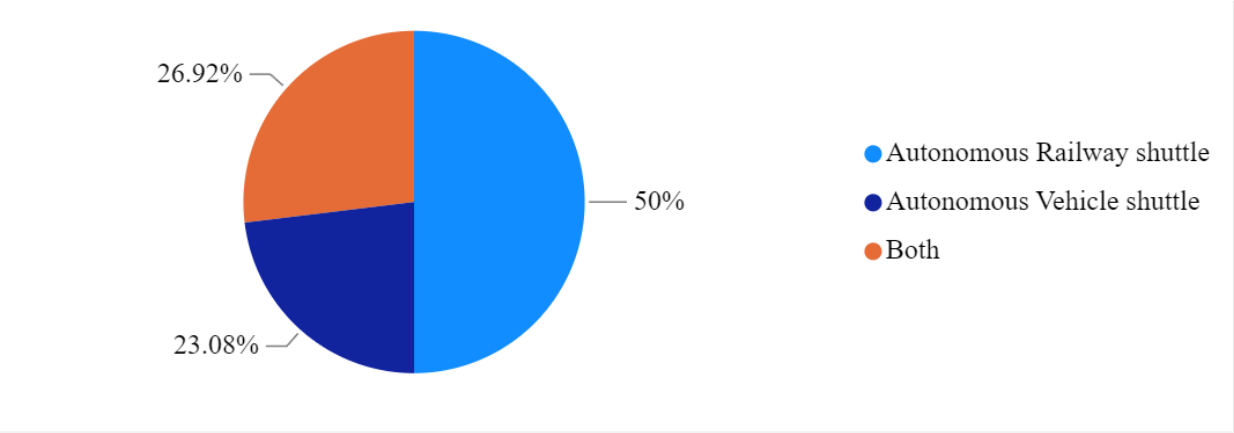


Figure 4. 12 When considering autonomous shuttles, which one do you find preferable?

4.1.14 How likely do you think the following benefits will occur when using a completely self-driving automated shuttle (Level 4)?

"How likely do you think it is that the following benefits will occur when using completely self-driving vehicles (Level 4)?" was the question posed to the respondents. In a list of anticipated benefits for fully autonomous vehicles, they were asked to choose "very likely," "somewhat likely," "somewhat unlikely," or "very unlikely" for each item (Level 4). Below are summaries of the answers.

- **Fewer crashes:** The majority of respondents, comprising 80.4%, indicated that they believe it is likely or very likely that there will be fewer crashes with the use of completely self-driving automated shuttles.
- **Reduced severity of crashes:** A sizable number of respondents (82.4%) said they thought it was possible or very likely that there would be a lessening of crash severity.
- **Improved emergency response to crashes:** A substantial proportion of participants, amounting to 86.3%, expressed their belief that the introduction of fully autonomous self-driving shuttles will probably or definitely enhance emergency response to collisions.

- **Less traffic congestion:** Of those surveyed, the majority (78.5%) were confident that using fully autonomous automated shuttles will result in decreased traffic congestion.
- **Shorter travel time:** Fully autonomous shuttles will cut down on travel time, according to a sizable portion of respondents (82.3%), who think this is feasible or quite likely.
- **Lower vehicle emissions:** The majority of respondents, totaling 83.7%, indicated that they believe it is likely or very likely that there will be lower vehicle emissions with the use of completely self-driving automated shuttles.
- **Better fuel economy:** A considerable portion, accounting for 76.4% of respondents, expressed the opinion that it is likely or very likely that there will be better fuel economy with the implementation of completely self-driving automated shuttles.

These responses collectively highlight a positive outlook among participants regarding the potential benefits of utilizing completely self-driving automated shuttles in improving various aspects of transportation, including safety, efficiency, and environmental impact.

Table 4. 1 Percentage of responses, "How likely do you think the following benefits will occur when using a completely self-driving automated shuttle (Level 4)?"

Expected benefits	Response	
Fewer crashes	Very likely	31.40%
	Somewhat likely	49%
	Somewhat unlikely	15.70%
	Very unlikely	3.90%
Reduced severity of crashes	Very likely	37.30%
	Somewhat likely	45.10%
	Somewhat unlikely	13.70%

	Very unlikely	3.90%
Improved emergency response to crashes	Very likely	35.30%
	Somewhat likely	51%
	Somewhat unlikely	11.80%
	Very unlikely	2%
Less traffic congestion	Very likely	37.30%
	Somewhat likely	41.20%
	Somewhat unlikely	21.60%
	Very unlikely	0%
Shorter travel time	Very likely	33.30%
	Somewhat likely	49%
	Somewhat unlikely	15.70%
	Very unlikely	2%
Lower vehicle emission	Very likely	30.60%
	Somewhat likely	53.10%
	Somewhat unlikely	12.20%
	Very unlikely	4.10%
Better fuel economy	Very likely	27.50%
	Somewhat likely	49%
	Somewhat unlikely	19.60%
	Very unlikely	3.90%

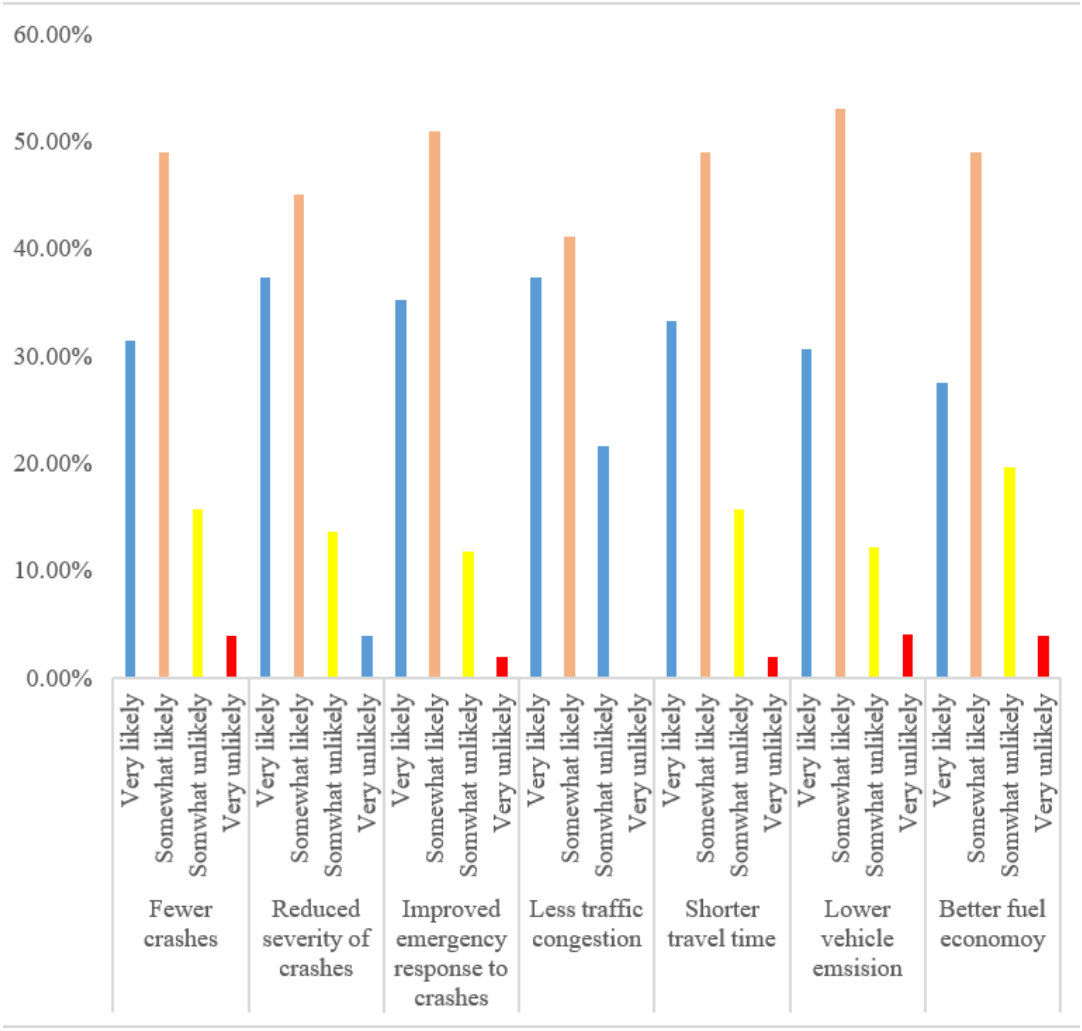


Figure 4. 13 Summary of responses "How likely do you think the following benefits will occur when using a completely self-driving automated shuttle (Level 4)?"

4.1.15 How concerned are you about the following issues related to a completely self-driving automated shuttle (Level 4)?

Respondents were asked: "How concerned are you about the following issues related to a completely self-driving automated shuttle (Level 4)?". Figure 14 presents a complete summary of the responses.

Table 4. 2 Percentage of responses, “How concerned are you about the following issues related to a completely self-driving automated shuttle (Level 4)?”

Possible Concern	Response	
Safety consequences of equipment failure or system failure	Very concern	49%
	Moderately concern	39.20%
	Slightly concern	5.90%
	Not at all concerned	5.90%
Legal liability for drivers/owners	Very concern	47.10%
	Moderately concern	37.30%
	Slightly concern	7.80%
	Not at all concerned	7.80%
System security (from hackers)	Very concern	64.70%
	Moderately concern	25.50%
	Slightly concern	3.90%
	Not at all concerned	5.90%
Vehicle security (from hackers)	Very concern	58.80%
	Moderately concern	31.40%
	Slightly concern	3.90%
	Not at all concerned	5.90%
Data privacy (location and destination tracking)	Very concern	63.50%
	Moderately concern	23.10%
	Slightly concern	9.60%
	Not at all concerned	3.80%
Interacting with non-self-driving vehicles	Very concern	44%
	Moderately concern	38%
	Slightly concern	14%
	Not at all concerned	4%
Interacting with pedestrians and bicyclists	Very concern	45.10%
	Moderately concern	39.20%

	Slightly concern	7.80%
	Not at all concerned	7.80%
Learning to use self-driving vehicles	Very concern	23.10%
	Moderately concern	48.10%
	Slightly concern	21.20%
	Not at all concerned	7.70%
System performance in poor weather	Very concern	54%
	Moderately concern	32%
	Slightly concern	12%
	Not at all concerned	2%
Self-driving vehicles getting confused by unexpected situations	Very concern	60%
	Moderately concern	26%
	Slightly concern	10%
	Not at all concerned	4%

- **Safety consequences of equipment failure or system failure:** Nearly half of the respondents (49%) expressed being very concerned about potential safety consequences resulting from equipment or system failure, with an additional 39.20% moderately concerned.
- **Legal liability for drivers/owners:** A significant portion (47.10%) indicated being very concerned about legal liability for "drivers" or owners of self-driving vehicles, while 37.30% were moderately concerned.
- **System security (from hackers):** A majority of respondents (64.70%) expressed very high concern about system security from hackers, with an additional 25.50% moderately concerned.

- **Vehicle security (from hackers):** Similarly, a significant percentage (58.80%) expressed very high concern about vehicle security from hackers, with 31.40% moderately concerned.
- **Data privacy (location and destination tracking):** Concerns regarding data privacy, particularly related to location and destination tracking, were prevalent, with 63.50% expressing very high concern and 23.10% moderately concerned.
- **Interacting with non-self-driving vehicles:** A notable portion of respondents (44%) expressed very high concern about interacting with non-self-driving vehicles, with an additional 38% moderately concerned.
- **Interacting with pedestrians and bicyclists:** Similar concerns were expressed regarding interacting with pedestrians and bicyclists, with 45.10% very concerned and 39.20% moderately concerned.
- **Learning to use self-driving vehicles:** Concerns about learning to use self-driving vehicles were relatively lower, with 23.10% expressing very high concern and 48.10% moderately concerned.
- **System performance in poor weather:** The majority of respondents (54%) expressed very high concern about system performance in poor weather conditions, with an additional 32% moderately concerned.
- **Self-driving vehicles getting confused by unexpected situations:** A significant percentage (60%) expressed very high concern about self-driving vehicles getting confused by unexpected situations, with 26% moderately concerned.

Overall, the responses highlight a range of concerns among participants regarding various aspects of completely self-driving automated shuttles, with issues related to safety, security, and system performance being particularly prominent.

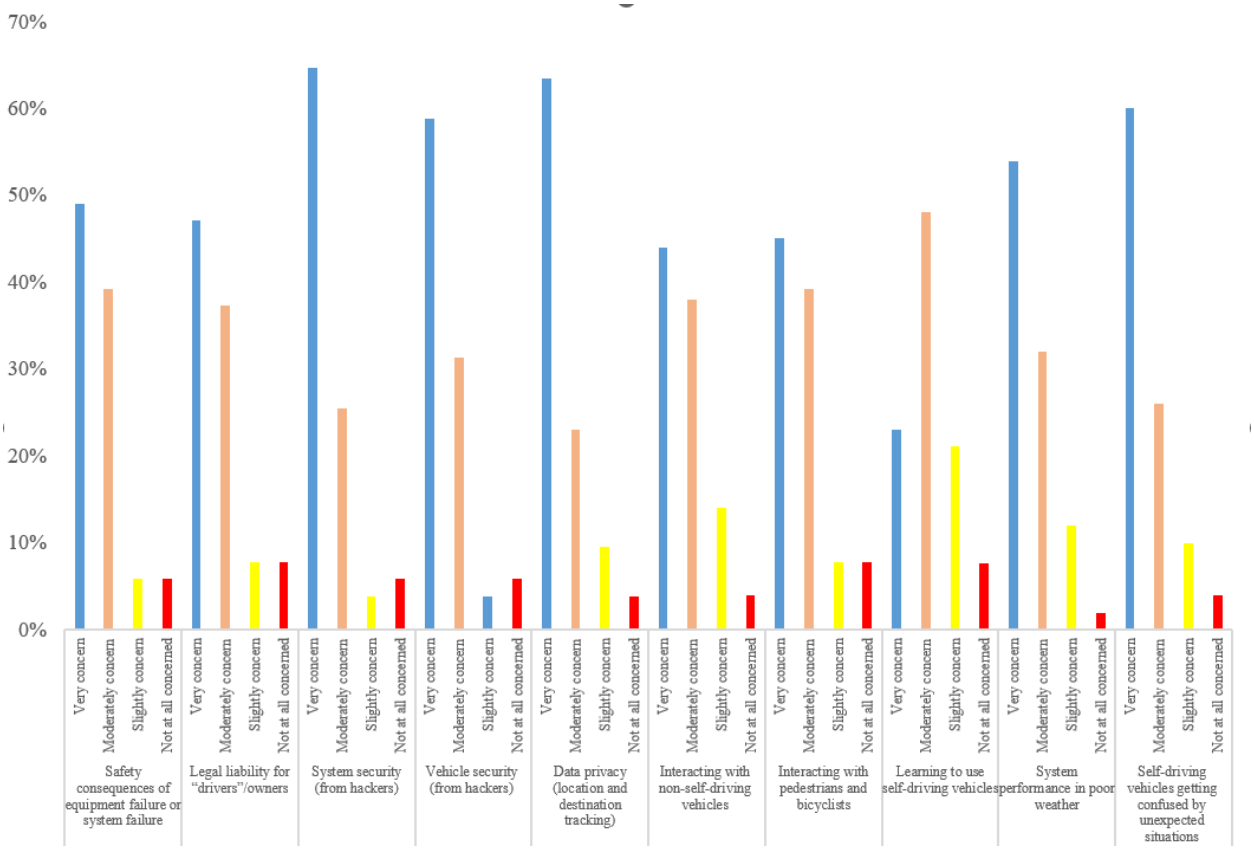


Figure 4. 14 Summary of responses "How concerned are you about the following issues related to a completely self-driving automated shuttle (Level 4)?"

4.1.16 How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?

Respondents were asked: "How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?". They were asked to select "very concerned," "moderately concerned," "slightly concerned," or "not at all concerned" for each item

in a list of possible scenarios involving different methods of using or deploying self-driving vehicles. Table 3 presents a complete summary of the responses.

Table 4. 3 Percentages of responses "How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?"

Possible Concern	Response	
Riding in a vehicle with no driver controls available (no steering wheel, no brake pedal, and no gas pedal/accelerator)	Very concern	39.2%
	Moderately concern	39.2%
	Slightly concern	11.8%
	Not at all concerned	9.8%
Self-driving vehicles moving by themselves from one location to another while unoccupied	Very concern	29.4%
	Moderately concern	37.3%
	Slightly concern	23.5%
	Not at all concerned	9.8%
Commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving	Very concern	44%
	Moderately concern	34%
	Slightly concern	14%
	Not at all concerned	8%
Public transportation such as buses that are completely self-driving	Very concern	46.2%
	Moderately concern	32.7%
	Slightly concern	9.6%
	Not at all concerned	11.5%
Taxis that are completely self-driving	Very concern	31.4%
	Moderately concern	45.1%

	Slightly concern	9.8%
	Not at all concerned	13.7%

- Riding in a vehicle with no driver controls available: A significant percentage of participants, or 39.2%, indicated that they were extremely concerned about riding in a vehicle without driver controls. Likewise, moderate anxiety was expressed by another 39.2%.
- Self-driving vehicles moving by themselves while unoccupied 29.4% of respondents were extremely anxious and 37.3% were moderately concerned about autonomous vehicles running on their own while empty.
- Commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving: A sizable majority of respondents (44%) indicated extremely high worry regarding these kinds of vehicles. Furthermore, 34 percent expressed moderate concern.
- Public transportation such as buses that are completely self-driving: A significant portion of respondents (46.2%) expressed very high concern while 32.7% expressed moderate concern about fully autonomous buses.
- Taxis that are completely self-driving: A notable portion of respondents, comprising 31.4%, expressed very high concern about completely self-driving taxis. Similarly, another 45.1% indicated moderate concern.

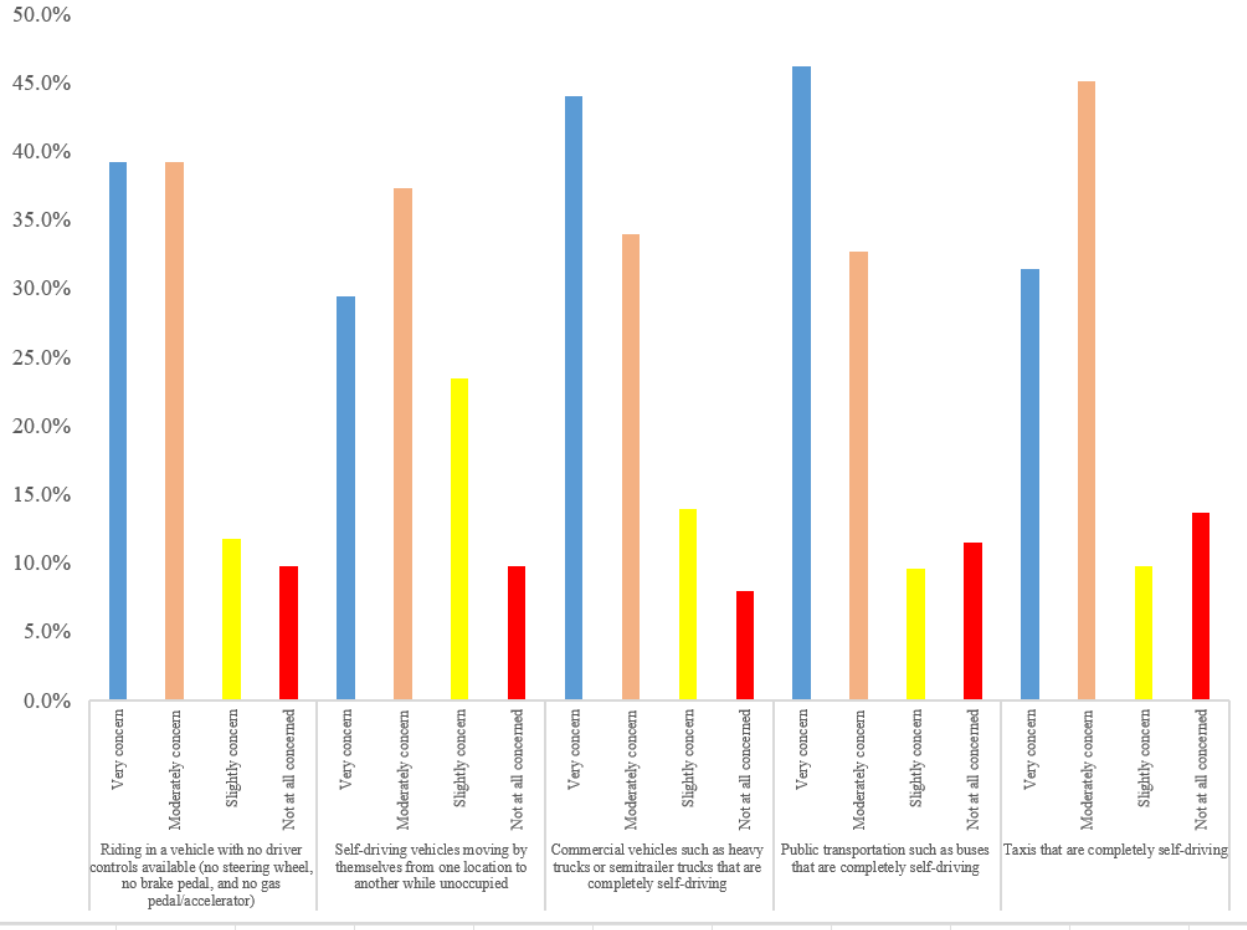


Figure 4. 15 Summary of responses "How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?"

4.1.17 How much would you be willing to pay for a single trip on an autonomous shuttle for last-mile connectivity?

In order to provide last-mile connection, participants were asked if they would be ready to pay for a single ride on an autonomous shuttle. Figure 16 provides a summary of the responses. A significant proportion of participants (57.69%) expressed their willingness to spend less than $5 for each trip. Furthermore, according to 32.69% of participants, they would spend $5 to $10 each

trip. Less people—5.77% and 3.85%, respectively—said they would be ready to spend between $10 and $15 and more than $15 each trip.

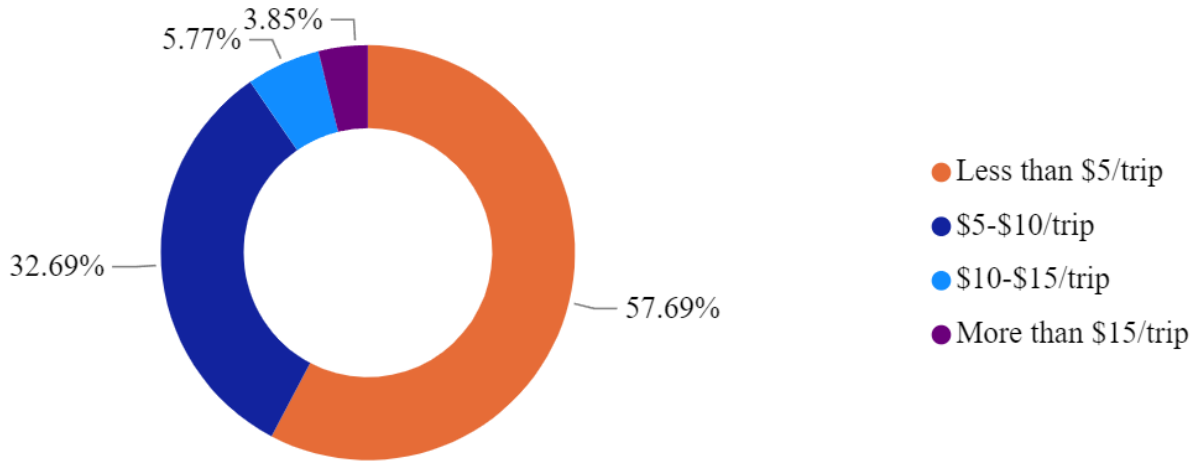


Figure 4. 16 Summary of responses "How much would you be willing to pay for a single trip on an autonomous shuttle for last-mile connectivity?"

4.1.18 What safety features do you believe are essential for ensuring a secure travel experience in an autonomous shuttle?

The survey aimed to understand which safety features are essential for secure travel in autonomous shuttles, with input from 52 participants. The responses highlighted a variety of safety concerns in autonomous transportation.

Many participants emphasized the need for emergency stop buttons, giving passengers a direct way to act in emergencies. Additionally, there was strong support for 360-degree cameras, which help monitor surroundings for better situational awareness and passenger safety.

Passenger emergency communication systems were also seen as crucial for direct communication during emergencies. Collision avoidance technology was recognized as important for preventing accidents and improving safety.

Respondents also stressed the importance of clear emergency response protocols. They also preferred remote supervision and having onboard operators, indicating a desire for human oversight to ensure safety. In summary, the survey revealed a broad range of safety features deemed necessary for autonomous shuttles, highlighting the complexity of ensuring safety in this mode of transportation.

4.2 Perception, Expectation, and Gap Scores

The expectations and perceptions scores for each dimension were computed using descriptive statistics to determine the mean. The gaps were also computed using the gap analysis formula as below.

$$\text{Gap} = \text{Expectation} - \text{Perception}$$

Here, in the Q18, we have used Likert scale of “very likely = 4”, to “very unlikely=1”, and for Q19 and Q20, we have used Likert scale of “not at all concerned = 4”, to “very concerned = 1”.

Table 4. 4 Likert scale range

Q18	Q19 and Q20
Very likely = 4	Not at all concerned = 4
Somewhat likely = 3	Moderately concerned = 3
Somewhat unlikely = 2	Slightly concerned = 2
Very unlikely = 1	Very concerned = 1

Points to consider for the Table 4.5,

- Perception is the average of the responses for each item
- 4 is the best score, which is expectation
- Difference close to zero means better
- Gap means we have rooms to improve

Expectations for Q18, Q19, and Q20 are at 4. From the Table 4.5, we see that there is gap for all the items for Q18, Q19, and Q20, which means that the general perception of the features of automated vehicles or shuttles is unsatisfactory. Participants are mostly concerned about riding in an automated vehicle.

Looking at the table below, we see that there are gaps for the items of Q18, with number 7 equal to 1, which is relatively high. This indicates that participants are not convinced that automated vehicles will have reduced fossils fuel consumption.

For Q19, all the items have gap as well, with all of them having a gap score of more than 2, except for number 15 which has a gap score of 1.9. According to the gap analysis of Q19, participants are more concerned about system security, data privacy, and vehicle security.

In Q20, all the items have gap like the other two, with three of them having a gap score of more than 2, and two of them having a gap score of 1.9 and 1.98. Considering individual items, it was learned that people are mostly concerned about commercial vehicles such as heavy trucks and semitrailers that are completely self-driving, public transportation such as buses that are completely self-driving, and riding in a vehicle with no driver controls available.

Table 4. 5 Mean of expectations, perceptions, and gaps for all questions.

Question	No	Item	Expectation	Perception	Gap
Q18	1	Fewer crashes	4	3.06	0.94
	2	Reduced severity of crashes	4	3.14	0.86
	3	Reduced emergency response to crashes	4	3.18	0.82
	4	Less traffic congestion	4	3.18	0.82
	5	Shorter travel time	4	3.14	0.86
	6	Lower vehicle emissions	4	3.10	0.9
	7	Reduced fossils fuel consumption	4	3	1
Q19	8	Safety consequences of equipment failure	4	1.64	2.36
	9	Legal liability for drivers/owner	4	1.72	2.28
	10	System security	4	1.46	2.54
	11	Vehicle security	4	1.52	2.48
	12	Data privacy	4	1.51	2.49
	13	Interacting with non-self-driving vehicles	4	1.76	2.24
	14	Interacting with pedestrian and bicyclists	4	1.78	2.22

	15	Learning to use self-driving vehicles	4	2.10	1.9
	16	System performance in poor weather	4	1.65	2.35
	17	Self-driving vehicles getting confused by unexpected situations	4	1.57	2.43
Q20	18	Riding a vehicle with no driver controls available	4	1.88	2.12
	19	Self-driving vehicles moving by themselves from one location to another while unoccupied	4	2.10	1.9
	20	Commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving	4	1.82	2.18
	21	Public transportation such as buses that are completely self-driving	4	1.82	2.18
	22	Taxis that are completely self-driving	4	2.02	1.98

CHAPTER 5

COMPARATIVE ANALYSIS

5.1 Introduction

This chapter does a comparative study of public attitudes of autonomous shuttles using information from polls carried out in Montreal, Canada, and a key paper by Brandon Schoettle and Michael Sivak. With the title "A Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia," the study offers insightful information about attitudes and perceptions toward autonomous transportation in the United States (N=501), the United Kingdom (N=527), and Australia (N=505). We hope to have a thorough grasp of the parallels and discrepancies in public opinion on autonomous shuttle technology among various geographic regions by comparing the results of our poll conducted in Montreal with those of Schoettle and Sivak's study. we endeavor to contribute to the broader discourse on the societal acceptance and adoption of autonomous mobility solutions.

5.2 Familiarities with Autonomous and Self-driving Vehicles

The majority of the participants in each has heard of autonomous of self-driving vehicles before the survey. Figure 5.1 presents the summary of the responses. The U.S. had the highest percentage that they had heard about autonomous vehicles (70.90%) before participating in the survey, followed by UK (66%), Australia (61%), and Montreal (38.46%).

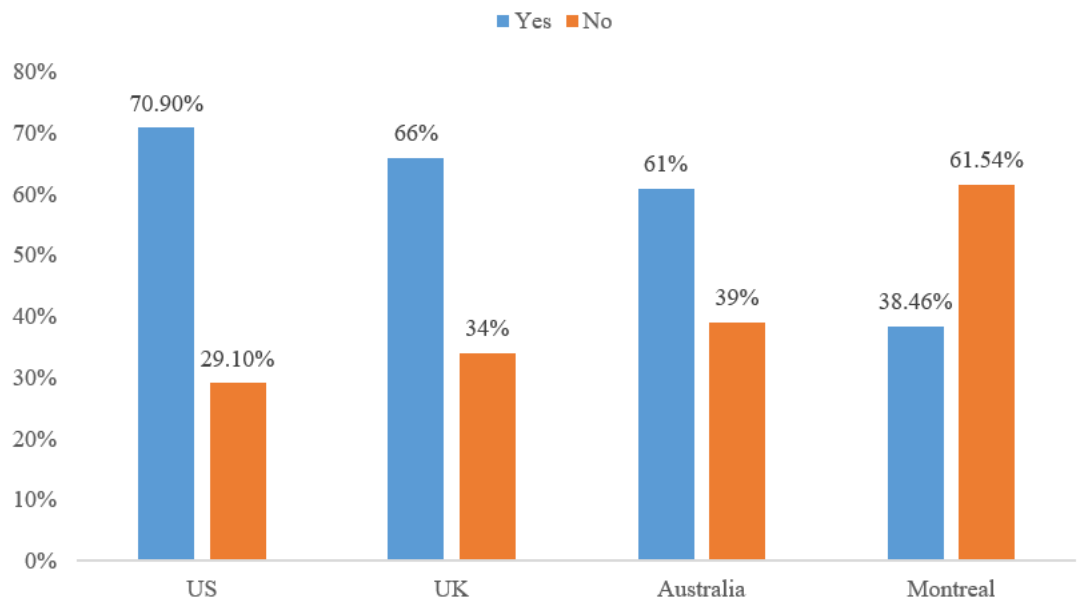


Figure 5. 1 Summary of responses, on the question of familiarity with autonomous or self-driving vehicle

5.3 General Opinion on Autonomous Vehicle

A survey was conducted to find out the participants' opinions on driverless automobiles. Table 5.1 presents an extensive overview of different viewpoints, whereas Figure 5.2 presents simplified summaries by classifying answers as either positive or negative. In general, the vast majority of participants conveyed favorable opinions regarding the technology. With 61.9% of positive comments, Australia had the greatest percentage, followed by the United States (56.3%), the United Kingdom (52.1%), and Montreal (46%). On the other hand, mere minority of participants expressed unfavorable opinions; the United States recorded the highest occurrence of this, at 16.4%, followed by Montreal at 14%, the United Kingdom at 13.7%, and Australia at 11.30%. Additionally, a significant portion of respondents maintained a neutral stance towards autonomous vehicles, with Montreal having the highest proportion at 40%, followed by the U.K. at 34.20%, the U.S. at 27.30%, and Australia at 26.70%.

Table 5. 1 Percentage of response “What is your general opinion about autonomous and self-driving vehicles?”

Response	U.S.	U.K.	Australia	Montreal	Total
Very positive	22%	13.90%	16.20%	15%	17%
Somewhat positive	34.30%	38.30%	45.70%	31%	37%
Neutral	27.30%	34.20%	26.70%	40%	32%
Somewhat negative	12.40%	11.20%	8.30%	12%	11%
Very negative	4%	2.50%	3%	2%	3%

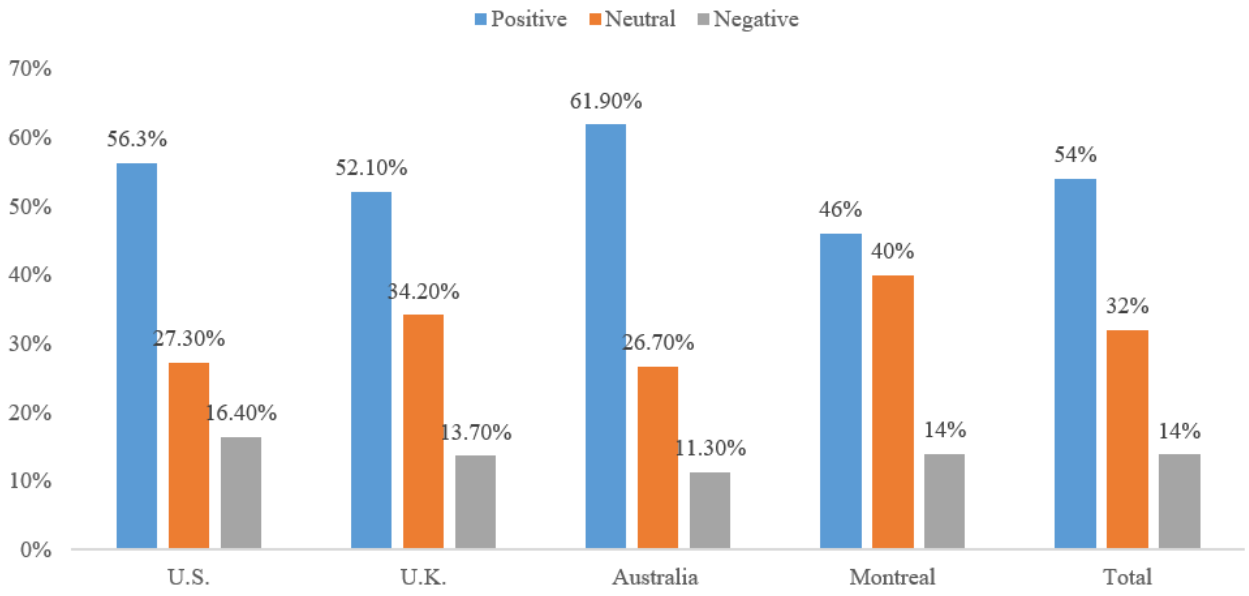


Figure 5. 2 Summary of responses (collapsed), “What is your general opinion about autonomous and self-driving vehicle?”

5.4 Expected Benefits of Autonomous and Self-driving Vehicles or Shuttles

In the survey, participants were asked to assess the likelihood of various benefits associated with completely self-driving vehicles (Level 4). Options such as "very likely," "somewhat likely," "somewhat unlikely," or "very unlikely" were given to them for every benefit. Table 5.2 presents the detailed responses, and Figure 5.3 shows a summary of the likely and unlikely results. "Somewhat likely" was the most often given response for all benefits across all locations. All things considered, most respondents were confident that self-driving cars would bring about these advantages, with the exception of less traffic and faster travel times in the US, UK, and Australia. Interestingly, compared to respondents from other places, Montreal respondents were more upbeat about the likelihood of enjoying reduced traffic congestion and quicker travel times with self-driving vehicles.

Table 5. 2 Percentage of response "How likely do you think the following benefits will occur when using a completely self-driving automated shuttle (Level 4)?"

Expected benefits	Response	U.S.	U.K.	Australia	Montreal	Total
Fewer crashes	Very likely	26.1%	23.5%	24.2%	31.40%	26%
	Somewhat likely	41.7%	47.6%	48.1%	49%	47%
	Somewhat unlikely	22.2%	21.6%	21.4%	15.70%	20%
	Very unlikely	10.0%	7.2%	6.3%	3.90%	7%
Reduced severity of crashes	Very likely	25.0%	21.8%	23.6%	37.30%	27%
	Somewhat likely	43.9%	50.9%	49.9%	45.10%	47%
	Somewhat unlikely	20.8%	20.9%	20.2%	13.70%	19%
	Very unlikely	10.4%	6.5%	6.3%	3.90%	7%

Improved emergency response to crashes	Very likely	32.5%	18.8%	23.0%	35.30%	27%
	Somewhat likely	39.1%	41.4%	45.7%	51%	44%
	Somewhat unlikely	21.2%	29.6%	24.4%	11.80%	22%
	Very unlikely	7.2%	10.2%	6.9%	2%	7%
Less traffic congestion	Very likely	19.2%	15.2%	15.2%	37.30%	22%
	Somewhat likely	30.5%	32.1%	32.3%	41.20%	34%
	Somewhat unlikely	32.9%	37.4%	36.2%	21.60%	32%
	Very unlikely	17.4%	15.4%	16.2%	0%	12%
Shorter travel time	Very likely	16.8%	11.0%	13.3%	33.30%	19%
	Somewhat likely	29.1%	28.3%	31.5%	49%	34%
	Somewhat unlikely	36.9%	44.2%	40.2%	15.70%	34%
	Very unlikely	17.2%	16.5%	15.0%	2%	13%
Lower vehicle emission	Very likely	21.2%	23.0%	16.8%	30.60%	23%
	Somewhat likely	42.3%	44.2%	45.5%	53.10%	46%
	Somewhat unlikely	26.1%	26.4%	27.5%	12.20%	23%
	Very unlikely	10.4%	6.5%	10.1%	4.10%	8%
Better fuel economy	Very likely	25.3%	27.5%	21.0%	27.50%	25%
	Somewhat likely	44.7%	48.4%	49.1%	49%	48%
	Somewhat unlikely	21.2%	19.7%	22.6%	19.60%	21%
	Very unlikely	8.8%	4.4%	7.3%	3.90%	6%

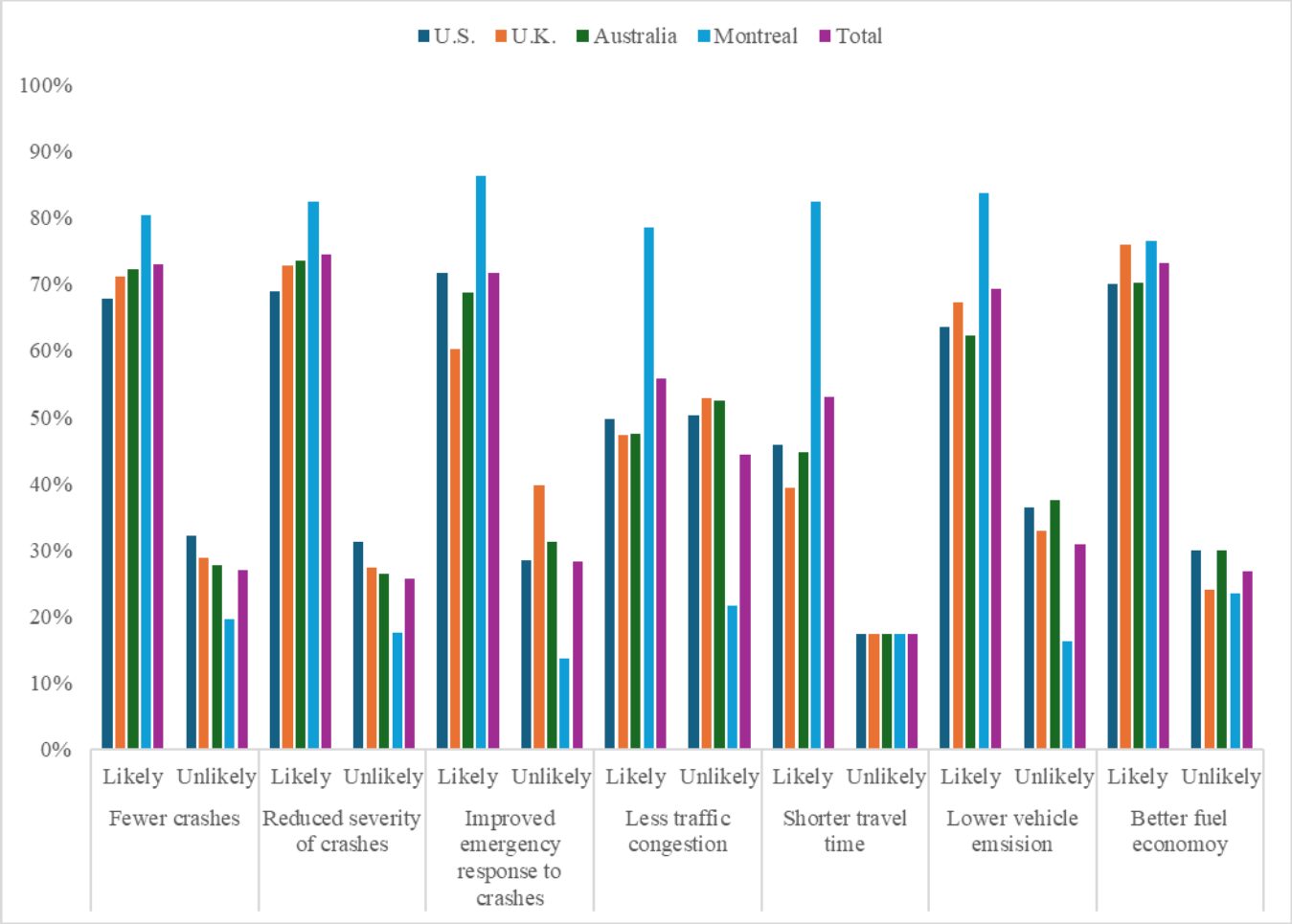


Figure 5. 3 Summary of responses (collapsed), “How likely do you think the following benefits will occur when using a completely self-driving automated shuttle (Level 4)?”

5.5 Concerns About Autonomous and Self-driving Vehicles

Participants were asked, 'How concerned are you about the following issues related to a completely self-driving automated shuttle?' They were given options to select from: 'very concerned,' 'moderately concerned,' 'slightly concerned,' and 'not at all concerned' for each item listed. The complete summary of responses from all regions is presented in Table 5.3. The most common responses varied between 'very concerned' and 'moderately concerned,' depending on the specific

issue. Overall, there was consensus across all four regions regarding the predominant level of concern for each issue.

- **Safety consequences of equipment failure or system failure:** A sizable percentage of respondents worldwide voiced "extreme concern," with the U.S. accounting for the majority (51.10%), followed by Montreal (49%), the U.K. (44.80%), and Australia (44.30%).
- **Legal liability for "drivers"/owners:** The majority of concerns (47.10%) came from Montreal, while the U.S. (41.10%) was next in line for most concerns over legal liability. It's interesting to note that 42.50% of respondents from the United Kingdom and 39.60% from Australia said they were "moderately concerned."
- **System security (from hackers): Respondents** showed varying degrees of concern, with percentages ranging from 30.7% in the U.K. to 64.7% in Montreal, displaying the highest level of concern.
- **Vehicle security (from hackers):** From 29.2% in the U.K. to 58.8% in Montreal, concerns regarding vehicle security were common.
- **Data privacy (location and destination tracking):** Concerns about data privacy were evident; respondents from Montreal expressed the greatest level of anxiety (63.5%), followed by those from the United States (38.7%), Australia (28.1%), and the United Kingdom (23.9%).
- **Interacting with non-self-driving vehicles:** Moderate concerns were raised about the interaction between self-driving cars and other vehicles. A participant from Montreal expressed the greatest level of anxiety (44%), with the United States (40.1%), Australia (30.7%), and the United Kingdom (29.6%) following closely after.

- **Interacting with pedestrians and bicyclists:** With percentages ranging from 33.4% in the U.K. to 45.1% in Montreal, respondents showed moderate to high levels of anxiety.
- **Learning to use self-driving vehicles:** Concerns about autonomous car usage of self-driving vehicles ranged from moderate in the United States (30.3%) to high in Montreal (48.10%).
- **System performance in poor weather:** Concerns about system performance in poor weather conditions varied, ranging from 18.4% in the U.S. to 54% in Montreal.
- **Self-driving vehicles getting confused by unexpected situations:** High levels of concern were evident, with percentages ranging from 38.1% in the U.K. to 60% in Montreal.

Table 5. 3 Percentage of response "How concerned are you about the following issues related to a completely self-driving automated shuttle (Level 4)?"

Possible Concern	Response	U.S.	U.K.	Australia	Montreal	Total
Safety consequences of equipment failure or system failure	Very concerned	51.10%	44.80%	44.30%	49%	47%
	Moderately concerned	30.70%	36.80%	34.30%	39.20%	35%
	Slightly concerned	14.60%	14.60%	17.40%	5.90%	13%
	Not at all concerned	3.60%	3.80%	4%	5.90%	4%
Legal liability for "drivers"/owners	Very concerned	41.10%	30%	33.10%	47.10%	38%
	Moderately concerned	36.10%	42.50%	39.60%	37.30%	39%
	Slightly concerned	15.40%	20.10%	20.40%	7.80%	16%
	Not at all concerned	7.4%	7.4%	6.9%	7.80%	7%
	Very concerned	40.1%	30.7%	34.9%	64.70%	43%

System security (from hackers)	Moderately concerned	30.7%	36.4%	33.3%	25.50%	31%
	Slightly concerned	19.8%	23.5%	23.4%	3.90%	18%
	Not at all concerned	9.4%	9.3%	8.5%	5.90%	8%
Vehicle security (from hackers)	Very concerned	39.9%	29.2%	33.7%	58.80%	40%
	Moderately concerned	30.7%	37.2%	32.7%	31.40%	33%
	Slightly concerned	20.6%	23.1%	23.2%	3.90%	18%
	Not at all concerned	8.8%	10.4%	10.5%	5.90%	9%
Data privacy (location and destination tracking)	Very concerned	38.7%	23.9%	28.1%	63.50%	39%
	Moderately concerned	30.7%	37.8%	32.1%	23.10%	31%
	Slightly concerned	20.0%	23.3%	26.5%	9.60%	20%
	Not at all concerned	10.6%	15.0%	13.3%	3.80%	11%
Interacting with non-self-driving vehicles	Very concerned	40.1%	29.6%	30.7%	44%	36%
	Moderately concerned	35.5%	37.4%	35.8%	38%	37%
	Slightly concerned	16.8%	25.6%	24.0%	14%	20%
	Not at all concerned	7.6%	7.4%	9.5%	4%	7%
Interacting with pedestrians and bicyclists	Very concerned	42.1%	33.4%	35.6%	45.10%	39%
	Moderately concerned	32.9%	35.5%	29.9%	39.20%	34%
	Slightly concerned	18.0%	23.1%	25.1%	7.80%	19%
	Not at all concerned	7.0%	8.0%	9.3%	7.80%	8%
	Very concerned	29.1%	15.4%	20.8%	23.10%	22%

Learning to use self-driving vehicles	Moderately concerned	30.3%	33.0%	31.9%	48.10%	36%
	Slightly concerned	25.7%	30.2%	26.9%	21.20%	26%
	Not at all concerned	14.8%	21.4%	20.4%	7.70%	16%
System performance in poor weather	Very concerned	39.7%	18.4%	25.9%	54%	35%
	Moderately concerned	33.7%	37.0%	33.7%	32%	34%
	Slightly concerned	19.2%	30.2%	28.9%	12%	23%
	Not at all concerned	7.4%	14.4%	11.5%	2%	9%
Self-driving vehicles getting confused by unexpected situations	Very concerned	53.1%	38.1%	43.5%	60%	49%
	Moderately concerned	29.1%	34.2%	29.1%	26%	30%
	Slightly concerned	13.2%	22.0%	21.6%	10%	17%
	Not at all concerned	4.4%	5.7%	5.9%	4%	5%

5.6 Concerned About the Possible Scenarios with a Completely Self-driving Automated Shuttle (Level 4):

Survey participants were asked to express their level of concern regarding various scenarios involving completely self-driving vehicles (Level 4). They were given options to indicate whether they were "very concerned," "moderately concerned," "slightly concerned," or "not at all concerned" for each scenario. A detailed summary of responses categorized by country is provided in Table 5.4.

The most frequent response across all regions was "very concerned" for all scenarios. Overall, the highest level of concern was observed for scenarios involving riding in a vehicle with no driver

controls available (50.5% "very concerned" overall) and commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving (51.7% "very concerned" overall).

In particular, respondents from the U.S. expressed the highest level of concern (60.1%) regarding riding in a vehicle with no driver controls available, followed by the U.K. (51.8%), Australia (51%), and Montreal (32.2%). Similarly, for commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving, the majority of concern was from the U.S. (58.2%), followed by Australia (53%), the U.K. (51.7%), and Montreal (44%).

In addition, a considerable number of respondents (41.5%) from the United States expressed serious concerns about autonomous cars traveling from one place to another when empty, with responses coming from Australia (39.4%), the United Kingdom (36.6%), and Montreal (36.7%). Furthermore, 46% of respondents overall indicated great anxiety about fully autonomous buses and other forms of public transit. Once more, the United States expressed the greatest amount of anxiety (49.7%), followed by Montreal (46.2%), Australia (44.1%), and the United Kingdom (44%).

All told, 40% of respondents said they were "very concerned" about fully autonomous taxis, with Americans accounting for the majority of those who voiced fear (45.7%).

Table 5. 4 Percentage of response “How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?”

Possible Concern	Response	U.S.	U.K.	Australia	Montreal	Total
Riding in a vehicle with no driver controls available (no steering wheel, no	Very concerned	60.1%	51.8%	51.0%	39.2%	50.5%
	Moderately concerned	25.7%	26.2%	27.4%	39.2%	29.6%
	Slightly concerned	10.4%	14.6%	14.5%	11.8%	12.8%
	Not at all concerned	3.8%	7.4%	7.1%	9.8%	7.0%

brake pedal, and no gas pedal/accelerator)						
Self-driving vehicles moving by themselves from one location to another while unoccupied	Very concerned	41.5%	36.6%	39.4%	29.4%	36.7%
	Moderately concerned	31.3%	29.5%	31.9%	37.3%	32.5%
	Slightly concerned	16.6%	20.0%	17.7%	23.5%	19.5%
	Not at all concerned	10.6%	13.9%	11.0%	9.8%	11.3%
Commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving	Very concerned	58.2%	51.7%	53.0%	44%	51.7%
	Moderately concerned	24.4%	25.7%	23.6%	34%	26.9%
	Slightly concerned	12.2%	15.0%	16.1%	14%	14.3%
	Not at all concerned	5.2%	7.6%	7.3%	8%	7.0%
Public transportation such as buses that are completely self-driving	Very concerned	49.7%	44.0%	44.1%	46.2%	46.0%
	Moderately concerned	28.1%	28.5%	26.6%	32.7%	29.0%
	Slightly concerned	15.4%	16.3%	19.5%	9.6%	15.2%
	Not at all concerned	6.8%	11.3%	9.7%	11.5%	9.8%
Taxis that are completely self-driving	Very concerned	45.7%	41.3%	41.7%	31.4%	40.0%
	Moderately concerned	31.4%	28.8%	29.4%	45.1%	33.7%
	Slightly concerned	15.9%	19.2%	19.4%	9.8%	16.1%
	Not at all concerned	7.0%	10.7%	9.5%	13.7%	10.2%

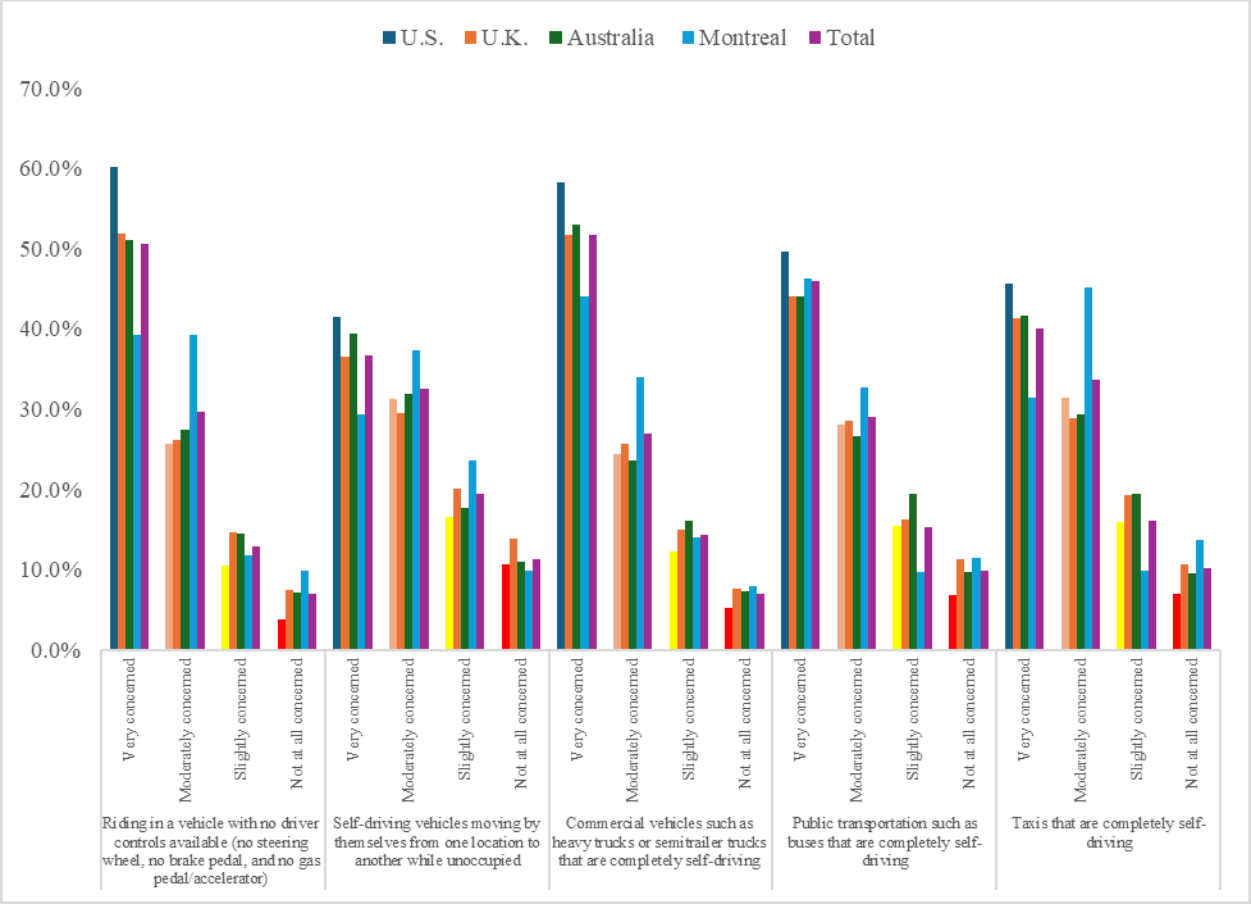


Figure 5. 4 Summary of responses (collapsed), "How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?"

CHAPTER 6

DISCUSSION

This section contains a thorough analysis of the information gathered from the survey that was given to Montrealer’s to find out about their opinions, preferences, and worries about automated shuttles.

Initially, survey respondents' demographic information was collected. Thirteen women and thirty-seven men participated in the poll, which had fifty-two respondents. The ages of the respondents varied greatly: 9 were between 18 and 24, 2 were under 18, the majority (38 persons) were between 25 and 34, and 3 were between 35 and 44.

About 6% of the respondents were enrolled in high school or courses equivalent to it, and another 6% were pursuing a college degree or vocational training program. A majority of respondents were working to a master's degree, with about 19% obtaining a bachelor's degree. Furthermore, six percent were going to college to better their education.

The majority of those surveyed (52%) had student employment status, showing that a sizeable section of the population was actively pursuing education. About 36 percent of those surveyed were full-time workers, and 8 percent said they were part-time workers. Just 2% of respondents said they were jobless, and 2% more stated they were engaged in some other capacity.

73% of the respondents regularly use public transit for their daily commutes, according to an analysis of survey data on this topic. Furthermore, 13% of respondents choose it weekly, 12% use it infrequently, and 2% never utilize public transit.

53.85% of the 52 respondents said they were in possession of a driver's license, indicating a sizable section of the populace is qualified to drive. Furthermore, out of the participants, 17.31% claimed to be car owners, but 82.69% did not.

38.45% of respondents had previously heard of autonomous shuttles for last-mile connection in Montreal, which is a noteworthy finding. That being said, just 13.46% of participants said they had boarded an autonomous shuttle, suggesting that most respondents had little experience with this new technology.

The survey's findings indicated that participants' views on self-driving and autonomous cars ranged widely. Forty percent were neutral, thirty-one percent felt slightly positive, and fifteen percent had a very good impression. By contrast, 2% of respondents felt negatively about autonomous cars, while 12% had a somewhat negative opinion of them.

When asked about their preference for different levels of automated vehicles, 56% of respondents preferred level 3 automation, representing the majority. However, 13% expressed a preference for high automation (Level 4), while 10% preferred full automation (Level 5), suggesting a growing interest in advanced automation technologies

The degree to which participants felt at ease with autonomous vehicles lacking a human driver differed. 13.46% felt somewhat comfortable, 30.77% felt comfortable, and 7.69% felt very comfortable. There is a variation in comfort levels with autonomous technology, though, as 32.69% reported feeling slightly uncomfortable and 15.38% reported feeling extremely uncomfortable. Concerns about autonomous vehicles included data privacy (63.50% very concerned), system and vehicle security from hackers (64.70% and 58.80% very concerned,

respectively), legal liability (47.10% very concerned), and safety repercussions of equipment failure (49% very concerned).

The majority of respondents (55.77%) said they were in favor of introducing autonomous shuttles into city streets, however they had different opinions regarding how they would be deployed. Residential communities, medical facilities, shuttle to airport, parks, business districts, metro stations, downtown regions, educational institutions, and highways were among the preferred places. Furthermore, the participants expressed their inclinations towards several categories of self-governing shuttles, with half of them favoring self-governing train shuttles.

Respondents recognized many advantages with fully autonomous automated shuttles (Level 4), such as shorter travel times (82.3% likely or very likely), less traffic congestion (78.5% likely or very likely), fewer collisions (80.4% likely or very likely), a decrease in crash severity (82.4% likely or very likely), improved emergency response (86.3% likely or very likely), lower vehicle emissions (83.7% likely or very likely), and better fuel economy (76.4% likely or very likely). In response, there were frequently issues expressed over safety, legal liability, data privacy, automotive and system security, interactions with other vehicles, pedestrians, and bikers, as well as worries about how the system would perform in inclement weather and unforeseen circumstances.

Regarding willingness to pay for a single trip on an autonomous shuttle for last-mile connectivity, 57.69% of respondents were willing to pay less than $5 per trip, while 32.69% were willing to pay between $5 and $10 per trip.

Participants identified several essential safety features for ensuring a secure travel experience in autonomous shuttles, including emergency stop buttons, 360-degree cameras, passenger

emergency communication systems, collision avoidance technology, clear emergency response protocols, remote supervision, and onboard operators.

The gap analysis shows that perceptions regarding various aspects are generally negative. Participants are particularly worried about riding in automated vehicles, doubting their safety and performance. Concerns include fuel economy, system security, data privacy, and vehicle security. Specifically, there's apprehension about heavy trucks, semitrailers, and buses being completely self-driving, as well as riding in vehicles with no driver controls.

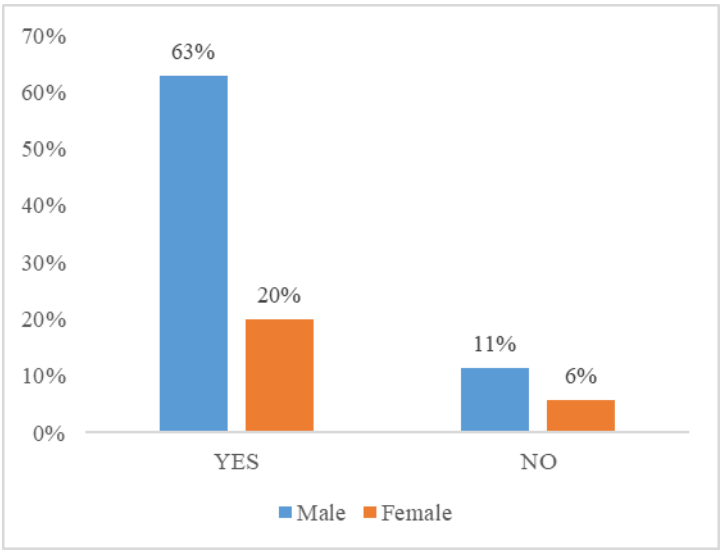


Figure 6. 1 Positive vs Negative attitudes towards AV based on gender

Gender analysis clearly indicates that men are more favorable towards automated shuttles compared to women. Specifically, 63% of men expressed a positive opinion on implementing automated shuttles on the road, while only 20% of women shared this positive viewpoint.

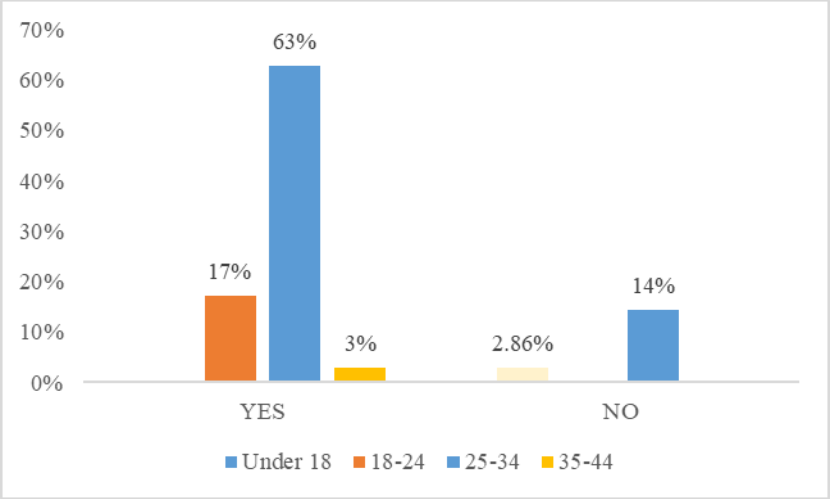


Figure 6. 2 Positive vs Negative attitudes towards AV based on age

Based on the figure 6.2, we can observe that 63% of individuals aged 25-34 are positive about implementing autonomous vehicles (AV) on the road. Conversely, 14% of people in this age group have a negative view on the implementation of AV.

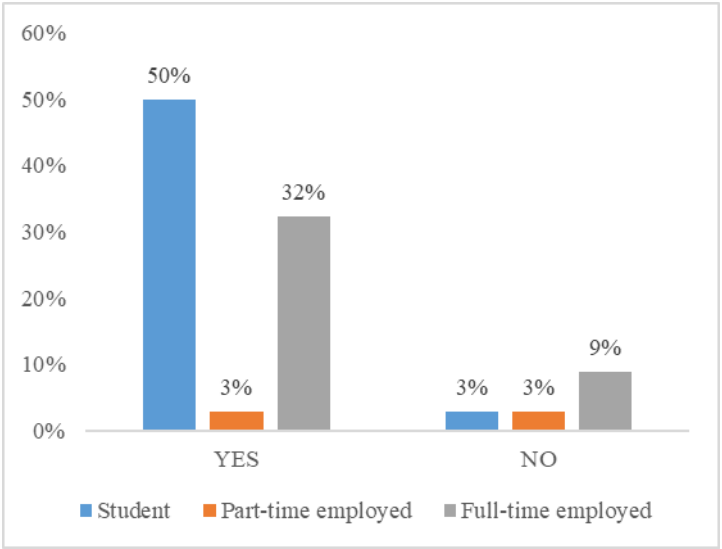


Figure 6. 3 Positive vs Negative attitude towards AV based on employment

Figure 6.3 shows that students are more positive while asked about implementing automated shuttle into the street compared to other respondents.

6.1 Comparative Analysis Result (U.S, U.K. Australia, and Montreal)

- **Familiarity with Autonomous and Self-Driving Vehicles**

One finding from comparative analysis is the varying levels of familiarity with autonomous vehicle across region. In Montreal, 38.6% respondents reported being familiar with autonomous vehicles, whereas U.S. had the highest percentage of familiarity at 70.90% followed by the U.K. (66%) and Australia (61%). This suggests differing level of exposure and awareness regarding autonomous technology, which could influence public perception and attitudes towards its adoption.

- **General Opinion on Autonomous Vehicle**

Overall, the majority of respondents across all regions expressed positive sentiments towards autonomous vehicles. In Montreal, 54% of respondents held positive views, whereas Australia led with 61.9% positive responses. However, it's noteworthy that Montreal displayed a slightly higher percentage of positive responses compared to the UK and the U.S. Conversely, negative views were relatively low across the board, indicating a general openness towards autonomous technology, albeit with varying degrees of enthusiasm.

- **Expected Benefits of Autonomous Vehicles**

In general, the research indicates differing levels of optimism about the expected advantages of self-driving cars. The respondents from Montreal said that they were most likely to anticipate benefits like fewer collisions, less severe collisions, better emergency response to collisions, less traffic, shorter travel times, lower vehicle emissions, and higher fuel efficiency. Conversely, the United States demonstrated a marginally more pessimistic perspective, particularly with regard to advantages such as a decrease in crash frequency and severity.

It's interesting to note that respondents from Montreal had the highest confidence in autonomous vehicles' ability to reduce traffic congestion and shorten travel times, suggesting that they strongly believe this technology may ease the problems associated with urban mobility. Furthermore, the possibility of benefits linked to better emergency response to crashes, reduced car emissions, and increased fuel economy was universally acknowledged by respondents from all areas. Nonetheless, there were noticeable variances in opinions about how likely it was that particular advantages would emerge, highlighting the significance of taking local attitudes and situations into account when evaluating the possible effects of autonomous car technology.

- **Concerns About Autonomous Vehicle**

The survey reveals a range of regional worries regarding autonomous vehicles. Respondents' top concern is the potential for safety consequences from equipment or system failure, particularly in the United States and Montreal. Another major fear is legal liability for drivers or owners; the U.S. and Montreal lead in expressing high levels of concern, while the U.K. and Australia indicate more moderate levels of concern. Security of vehicles and systems from hackers is a critical problem; respondents from Montreal expressed the greatest degree of concern. After the United States, Australia, and the United Kingdom, Montrealers are most concerned about data privacy, especially with relation to tracking of location and destination.

Concerns of interacting with non-self-driving cars are also present; respondents from Montreal, the United States, Australia, and the United Kingdom are the most reserved. Concerns about interactions with bikers and pedestrians range from moderate to high, with Montrealers expressing the highest levels. All regions are concerned about learning to utilize self-driving cars, but Montreal respondents are most wary. There are differing concerns over the performance of the system during bad weather, with Montreal being the most vocal. Lastly, there is a great deal of

worry about unexpected scenarios confusing self-driving cars, with Montrealers expressing the greatest level of unease. These results highlight the various worries that individuals, affected by local attitudes and situations, have regarding the widespread use of autonomous vehicles.

- **Concerns about Possible Scenarios with Autonomous Shuttles**

All things considered, the most concerning scenarios were those involving commercial vehicles like as large trucks that were fully autonomous and traveling in a car without any driver controls. Specifically, respondents from the US were the most concerned about being in a car without any driving controls, followed by those from the United Kingdom, Australia, and Montreal. In a similar vein, the US worries about fully autonomous commercial cars outnumbered those from Australia, the United Kingdom, and Montreal.

Us were the country most concerned about self-driving cars traveling on their own when empty, with respondents from Australia, the United Kingdom, and Montreal coming in second and third. Concerns regarding self-driving buses and other public transit were also very high, with the United States, Montreal, Australia, and the United Kingdom voicing the most concerns. The majority of respondents 40% were "very concerned" about fully autonomous taxis, with Americans expressing the greatest level of worry.

6.2 Réseau Express Métropolitain (REM) – A Solution-Oriented Approach to the Survey Study

REM, also known as the Réseau Express Métropolitain, is major public transportation project in Montreal, Quebec. It is an automated light rail project that was introduced to serve greater Montreal area and to response to the raising need to the more public transportation and improve connectivity between different neighbourhoods.

One of the most exciting features of the REM project is its extensive coverage. Once fully operational, it will span over 67 kilometers with 26 stations, connecting area such as downtown Montreal, the South Shore, the West Island, and the Montreal-Pierre Elliot Trudeau International Airport. It will be fully automated with four-car trains and will offer services 20h per day, seven days per week. The expected headway varies from two to five minutes on the main trunk to five to 15 minutes on secondary branches [38]. This network is expected to significantly reduce the travel time, reduce traffic congestion, and reduce owning private vehicles.

The uniqueness of the REM is its automated technology. Unlike traditional rail system, it is self-driving and is being operated through automated technology.

Another noteworthy feature is its connectivity with the existing public transportation system. REM will seamlessly connect with Montreal's existing metro transit system, bus network and commuters' trains, offering commuters a convenient and efficient way to travel across the region.

- **Autonomous shuttle awareness and boarding an autonomous shuttle**

Ther familiarity of Autonomous shuttle in Montreal is very less compared to other countries, like the US (70.90%), the UK (66%), and Australia (61%), on the other hand in Montreal it is only 38.45% based on the survey result. Also, survey result showed only 13.46% of the people had the experience in boarding an AV, which is comparatively very less.

45 million boarding per year is expected on the REM once it is completely operational [39]. Since REM has started its operation from 31st July 2024, with 880 hours of service, over 1 million trips completed [40]. So, REM will be changing the scenario in Montreal about the awareness among people.

- **General opinion on AV**

15% of the respondents had very high impressions on this technology and 31% have a slightly positive one. Since REM has been operational from July 2023, in its first 880 hours of service it only had 6 service interruptions (8 hours), over 1 million trips, and a peak ridership in September 2023 with 35,000 trips, daily average is 30,000 trips over the entire operating period [40]. The reliability rate during that service period 99%, which is surely going to help to improve the positive impression among the people of Montreal.

- **Locations and Scenario preference from survey participants**

The respondents were asked about the preference of the location for autonomous vehicles in Montreal. Most respondents asked about residential neighbourhood, healthcare facilities, recreational areas, metro and train transit station, commercial district, educational institutions, downtown arears, night service, highway straight road, public transport, and emergency vehicles. Figure shows that the new REM is integrated with the current network of STM and Exo, which will actually give greater flexibility to the public transportation user travel from one place to another place with ease. REM is going to connect downtown Montreal, the South Shore, the West Island, and the Montreal-Trudeau International Airport. Maximum of the places in the greater Montreal area will be easily accessible once the REM will be fully functional.

- **Connection to Montreal-Pierre Elliot Trudeau International Airport**

As of now the only available public transport option is the 747 Express Airport Shuttle operated by STM. The 747 Express Airport Shuttle service runs 24 hours a day, 7 days a week. There are two stations from downtown to catch the 747 Express Airport Shuttle. One is Berri-UQAM metro station, and another is Lionel Groulx metro station, east of downtown Montreal. Frequencies vary

though the day, from one bus every 7-10 minutes to two buses per hour. The 747 Express Airport Shuttle route is shown in Figure 6.4.

The metro does not serve Montreal-Pierre Elliot Trudeau International Airport. Passengers can go to Berri UQAM or Lionel Groulx by using metro and then pick up the 747 Express Airport Shuttle. The good news is that REM is going to offer the direct communication to the airport when it will be fully operational. According to the Figure 6.5, REM is going to connect to the metro line through three major stations, Bonaventure, McGill and Edouard-Montpetit. So, there will be more flexibility for the residents of Montreal to reach the airport using public transportation, especially the automated shuttle REM.

Figure 6. 4 Available public transportation to Montreal-Pierre Elliot Trudeau International Airport (source – STM website)

- **Autonomous railway shuttles or Autonomous car shuttles?**

When participants were being asked about their preference between autonomous railway shuttles and autonomous car shuttles, half of the participants were positive about the railway shuttle and almost 23% of the respondents were positive about the autonomous car shuttle and rest were with both. As REM is automated light rail system, it is compiling with the expectation of the respondents.

- **Expected benefits of using Autonomous shuttles or vehicles**

When we asked people about the advantages of using autonomous shuttles, they mentioned several key benefits. These included fewer accidents, less severe accidents when they do happen, improved emergency response times, reduced traffic jams, shorter travel durations, lower vehicle emissions, and improved fuel efficiency.

The REM, as a light rail transit system, offers all these benefits and more. It's anticipated that REM will significantly reduce road congestion by connecting greater Montreal and carrying an estimated 45 million passengers annually once it's running at full capacity. Since REM is fully electric and Quebec relies heavily on clean energy, it produces no greenhouse gas emissions and requires no fuel. Additionally, light rail systems like REM generally have lower fatality rates, enhancing overall safety.

- **Transit Fare**

We asked about how much participants are willing to pay for taking the service of an autonomous shuttle. A significant proportion of participants (57.69%) expressed their willingness to spend less than $5 cad for each trip. REM fare is same as the existing metro fare. For a single trip in one zone costs $3.75 cad.

Figure 6. 5 REM map, integrated into the current network (STM, exo – source REM website)

CHAPTER 7

CONCLUSION AND FUTURE WORKS

7.1 CONCLUSION

This research aims to explore how Montreal people feel about automated shuttles and vehicles and do a comparative study on the acceptance and perception of people among U.S., U.K., Australia, and Montreal. We have used survey data from Montreal locals and the data from a published paper named "A Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia," by Brandon Schoettle and Michael Sivak.

- 38.5% of the participants had previously heard of autonomous od self-driving vehicles, had positive initial opinion of the technology, and had high expectations about the benefits of the technology.
- However, majority of the respondents expressed positive impression about self-driving vehicles, whereas 40% of the respondents were neutral on this topic.
- Majority of the respondents preferred Level 3 automation. Level 3 automation is - Conditional Automation: Vehicles perform driving tasks under certain conditions, but drivers must be available to take control if needed.
- However, the majority of the respondents expressed high level of concern about riding in self-driving vehicles, security issues related to data privacy, system and vehicle security from hackers, legal liability, and safety repercussions of equipment failure.
- The majority of the respondents were in favour of introducing autonomous shuttle or autonomous vehicles into the city streets. Residential communities, medical facilities,

parks, business districts, metro stations, downtown regions, educational institutions, and highways were among the preferred places.

- Between autonomous vehicles and autonomous railway shuttle, respondents preferred autonomous railway shuttle mostly.
- Respondents recognised many benefits of using autonomous shuttle, such as shorter travel times, less traffic congestion, fewer collisions, a decrease in crash severity, improved emergency response, lower vehicle emissions and better fuel economy.
- In addition, participants identified several essential safety features for ensuring a secure travel experience, including emergency stop button, 360-degree cameras, passengers emergency communication system, collision avoidance technology, clear emergency response protocol, remote supervision and onboard operators.
- Gap analysis shows that concerns mainly revolve around riding in automated vehicles and doubts about their safety and performance. Specific worries include fuel economy, system security, data privacy, and vehicle security. Notably, there's apprehension about heavy trucks, semitrailers, and buses being fully self-driving, as well as riding in vehicles without driver controls.

In comparison to the respondents in the U.S., U.K., Australia and Montreal,

- People's familiarity with autonomous vehicles varies by region, with Montreal showing moderate familiarity compared to the U.S., U.K., and Australia.
- Overall, there is a positive sentiment towards autonomous vehicles across regions, with Montrealers slightly more positive than the U.K. and U.S.

- Montreal respondents expect various benefits from autonomous vehicles, such as reducing traffic congestion and improving emergency response, but there are differences in optimism across regions.
- Concerns about safety, legal liability, data privacy, and interactions with non-self-driving vehicles are prevalent, with Montrealers particularly concerned about system performance in bad weather and unexpected scenarios.
- The most concerning scenarios regarding autonomous shuttles involve fully autonomous commercial vehicles and cars without driver controls, with respondents from the U.S. expressing the highest level of concern.

The study's overall findings emphasize how crucial it is for the general public's perspective and acceptability to play a key role in determining how autonomous transportation develops in Montreal. Establishing legislative frameworks, resolving privacy and safety concerns, raising awareness, and encouraging trust are all important components of creating a favorable climate for AV adoption.

The results of this study add to the body of knowledge in academia and provide policymakers, urban planners, and transportation authorities with useful information. Through the integration of public feedback and the resolution of recognized obstacles, Montreal has the potential to establish a transportation ecosystem that is more effective, sustainable, and user-friendly, thereby augmenting last-mile connection and elevating the standard of urban living in general. In Montreal's changing transportation scene, achieving the full potential of autonomous mobility requires ongoing research, coordination among stakeholders, and proactive initiatives.

7.2 FUTURE WORKS

- Future studies could be done by studying how people actually behave around self-driving vehicles in real life to understand their preference better.
- Simulation could be conducted to evaluate the barriers, challenges, potential benefits, and potential risks.
- More studies could be done on the possible approaches for enhancing public awareness about AV technologies.
- Conduct follow-up surveys at regular intervals to track changes in public attitudes towards automated shuttles and autonomous vehicles. This will help understand how perceptions evolve over time.
- Future studies could be evaluating how autonomous vehicles can reduce emissions and congestion, study their impact on the environment and transportation system.
- Future studies could be done on developing ethical guidelines for autonomous vehicles technologies, addressing privacy, data management, and decision-making ethics.
- Investigate how autonomous vehicles can improve accessibility for the people with disabilities and enhance last-mile connectivity.
- Future studies could be done conducting cost-benefit analyses to evaluate the economic viability and social impact of integrating autonomous shuttles into urban transportation systems.
- Future studies could be extending the comparative analysis to include more regions or cities to identify regional variations in public sentiment towards autonomous vehicles.

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Appendix 1, Survey on " Public Perception of Automated Vehicles and Automated Shuttles"

Survey on " Public Perception of Automated Vehicles and Automated Shuttles"

Welcome to our survey on "Public Perception of Automated Shuttles for Last-Mile Connectivity in Montreal." Your valuable insights will contribute to a better understanding of how the community perceives and accepts automated shuttles as a solution for last-mile connectivity in Montreal's transportation system.

This survey consists of four parts, covering your:

1. Demographic information
2. Opinions on autonomous vehicles
3. Linkage of AV to overall connectivity
4. Advantages and barriers of the autonomous shuttle/vehicle.

Your responses are crucial to informing future developments in urban transportation. Thank you for taking the time to participate!

Part A – Demographics Information

1.Email Address:

- Enter Your Answer

2. Age:

- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 or Old

3.Gender

- Female
- Male
- Prefer not to say

4.Education

- High School or equivalent
- Some College or Vocational Training
- Bachelor's Degree
- Master's Degree
- Doctorate or Professional Degree

5.Are you a holder of a driver's license?

- Yes
- No

6.Do you own a car?

- Yes
- No

7.How often do you use public transit?

- Daily
- Weekly
- Monthly
- Rarely
- Never

8.What is your employment status?

- Student
- Part-time employee
- Full-time employee
- Retired

Part B – Autonomous Vehicle

9. Have you heard about the concept of automated shuttles for last-mile connectivity in Montreal before participating in this survey?

- Yes

- No

10. Have you ever boarded an autonomous shuttle?

- Yes
- No

11. What is your opinion about autonomous and self-driving vehicles?

- Very negative
- Somehow negative
- Neutral
- Somehow positive
- Very positive

12. In your opinion, which level of automated vehicle do you prefer?

- Level 0: No Automation: The driver performs all driving tasks without assistance from automated systems.
- Level 1: Driver Assistance: Specific functions, such as steering or acceleration, are assisted by automated systems.
- Level 2: Partial Automation: Automated systems control both steering and acceleration, simultaneously.
- Level 3: Conditional Automation: Vehicles perform driving tasks under certain conditions, but drivers must be available to take control if needed.

- Level 4: High Automation: Vehicles operate without driver intervention in specific conditions or areas.
- Level 5: Full Automation: Vehicles can perform all driving functions under all conditions without human intervention.

13. What is your comfort level with the fact that no one controls the steering wheel in an autonomous vehicle?

- Very uncomfortable
- Somehow uncomfortable
- Comfortable
- Somehow comfortable
- Very comfortable

Part C – Linkage to the Overall Connectivity

14.Are you in favor of integrating autonomous shuttles into city streets?

- Yes
- No
- Not convinced
- I never thought about it

15.Which locations or scenarios would you prefer for using autonomous shuttle services? (Select all that apply)

- Downtown areas
- Residential neighborhoods
- Commercial districts
- Shuttle to airport
- Educational institutions (e.g., universities, colleges)
- Healthcare facilities (e.g., hospitals, clinics)
- Recreational areas (e.g., parks, sports facilities)
- At the exit of the metro and train transit
- Night service

16.Do you believe that integrating autonomous shuttles with existing bus routes would improve the overall efficiency of the transportation system in Montreal?

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

17.When considering autonomous shuttles, which one do you find preferable?

- Autonomous Railway shuttle
- Autonomous Vehicle shuttle
- Both

Part D – Advantage and Barriers

18.How likely do you think the following benefits will occur when using a completely self-driving automated shuttle (Level 4)?

Please select one response per row.

	Very Likely	Somewhat likely	Somewhat unlikely	Very unlikely
a. Fewer crashes	☐	☐	☐	☐
b. Reduced severity of crashes	☐	☐	☐	☐
c. Improved emergency response to crashes	☐	☐	☐	☐
d. Less traffic congestion	☐	☐	☐	☐
e. Shorter travel time	☐	☐	☐	☐
f. Lower vehicle emissions	☐	☐	☐	☐
g. Better fuel economy	☐	☐	☐	☐

19.How concerned are you about the following issues related to a completely self-driving automated shuttle (Level 4)?

Please select one response per row.

	Very concerned	Moderately concerned	Slightly concerned	Not at all concerned
a. Safety consequences of equipment failure or system failure	☐	☐	☐	☐
b. Legal liability for “drivers”/owners	☐	☐	☐	☐
c. System security (from hackers)	☐	☐	☐	☐
d. Vehicle security (from hackers)	☐	☐	☐	☐
e. Data privacy (location and destination tracking)	☐	☐	☐	☐
f. Interacting with non-self-driving vehicles	☐	☐	☐	☐
g. Interacting with pedestrians and bicyclists	☐	☐	☐	☐
h. Learning to use self-driving vehicles	☐	☐	☐	☐
i. System performance in poor weather	☐	☐	☐	☐
j. Self-driving vehicles getting confused by unexpected situations	☐	☐	☐	☐

20.How concerned are you about the following possible scenarios with a completely self-driving automated shuttle (Level 4)?

Please select one response per row.

	Very concerned	Moderately concerned	Slightly concerned	Not at all concerned

a. Riding in a vehicle with no driver controls available (no steering wheel, no brake pedal, and no gas pedal/accelerator)	☐	☐	☐	☐
b. Self-driving vehicles moving by themselves from one location to another while unoccupied	☐	☐	☐	☐
c. Commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving	☐	☐	☐	☐
d. Public transportation such as buses that are completely self-driving	☐	☐	☐	☐
e. Taxis that are completely self-driving	☐	☐	☐	☐

21.How much would you be willing to pay for a single trip on an autonomous shuttle for last-mile connectivity?

- Less than $5/trip
- $5-$10/trip
- $10-$15/trip
- More than $15/trip

22.What safety features do you believe are essential for ensuring a secure travel experience in autonomous shuttle? (Select all that apply)

- Emergency stop buttons
- 360-degree cameras for monitoring

- Passenger emergency communication systems
- Collision avoidance technology
- Emergency response protocols
- Remote supervision
- Onboard operator

Appendix 2

Equation to calculate Cronbach's Alpha:

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N} \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

Where:

- N is the number of items
- $\sigma_{Y_i}^2$ is the variance of each individual item
- σ_X^2 is the variance of total score formed by summing all items

Steps to perform Reliability Test in SPSS

- Number of Items: N= 22
- Variance of each individual item ($\sigma_{Y_i}^2$):

Items	**Variance**
Fewer crashes	0.556
Reduced severity of crashes	0.479
Improved emergency response to crashes	0.416
Less traffic congestion	0.546
Shorter travel time	0.556
Lower vehicle emissions	0.653
Better fuel economy	0.707
Safety consequences of equipment failure or system failure	0.618

Legal liability for “drivers”/owners	0.648
System security (from hackers)	0.598
Vehicle security (from hackers)	0.595
Data privacy (location and destination tracking)	0.646
Interacting with non-self-driving vehicles	0.686
Interacting with pedestrians and bicyclists	0.746
Learning to use self-driving vehicles	0.722
System performance in poor weather	0.625
Self-driving vehicles getting confused by unexpected situations	0.693
Riding in a vehicle with no driver controls available (no steering wheel, no brake pedal, and no gas pedal/accelerator)	0.876
Self-driving vehicles moving by themselves from one location to another while unoccupied	0.890
Commercial vehicles such as heavy trucks or semitrailer trucks that are completely self-driving	0.839
Public transportation such as buses that are completely self-driving	1.015
Taxis that are completely self-driving	0.839

- Variance of total score, σ_X^2 = 116.35
- Cronbach’s Alpha value: The Cronbach’s Alpha calculated using the above is approximately 0.913, which indicates excellent reliability.