TELEWORKING EFFECTS ON TRANSPORTATION BEHAVIOUR IN A POST-COVID-19 CONTEXT:
10 case studies from Montréal, Canada

Supervised Research Project Report
Submitted in partial fulfillment of the Masters of Urban Planning degree
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May 12th 2021

Abstract

Over the last thirty years, advances in internet communication technologies have enabled information-based economic sectors to decentralize their work activities, enabling their employees to adopt teleworking practices on an occasional basis. Simultaneously, growing concerns over the effects of energy consumption on global warming and climate change have led some researchers to explore the potential of teleworking as a travel demand management strategy, based on the assumption that it eliminates commute-related trips on teleworking days. With the onset of the COVID-19 pandemic, a significant proportion of knowledge workers in Canada and around the world started working from home in March 2020, which presented a unique opportunity to study the potential transportation and mobility effects of telework when undertaken at a larger scale. As such, this memoire presents the results of ten qualitative interviews with workers in Montreal who have been teleworking since the onset of the pandemic, which aimed to understand how, and to what extent, this practice has altered their transportation habits, in light of recent studies and empirical research. As it turns out, teleworking can have diverging or neutral effects on transportation behaviour depending on a multitude of other factors. For instance, while it seems to be associated with a reduction in vehicle miles traveled (VMT) for workers with long commute distances who previously drove to work, for others, full time telework has enable a flexibility that has increased demand for leisure trips to rural areas which requires the acquisition of a private vehicle. Further, for full time teleworkers who previously commuted by public transport, telework has resulted in the abandonment of this mode of transport, which could have long term consequences for its financing. Long term mobility outcomes will also depend heavily on the weekly frequency (e.g., two-three days/week) at which telework is implemented for different workers, in the future. Ultimately, planners should implement adequate land use and transport policies in parallel to the uptake of telework in order to promote more sustainable transport habits.

Résumé

Au cours des trente dernières années, les avancements en technologies de l'information et de la communication ont permis à certains secteurs économiques basés sur l'information de décentraliser leurs activités de travail, permettant à leurs employés d'adopter des pratiques de télétravail sur une base occasionnelle. Parallèlement, les préoccupations croissantes concernant les effets de la consommation d'énergie sur le réchauffement de la planète et le changement climatique ont mené certains chercheurs à explorer le potentiel du télétravail en tant que stratégie de gestion de la demande de transport, en partant de l'hypothèse qu'il élimine les déplacements liés au trajet domicile-travail, les jours de télétravail. Dès le début de la pandémie de COVID-19, une proportion importante de travailleurs du savoir au Canada et dans le monde ont commencé à faire du télétravail en mars 2020, ce qui a présenté une occasion unique d'étudier les effets potentiels du télétravail sur le transport et la mobilité lorsqu'il est entrepris à plus grande échelle. À ce titre, ce mémoire présente les résultats de dix entretiens qualitatifs avec des travailleurs montréalais en télétravail depuis le début de la pandémie. Celles-ci visent à comprendre comment, et dans quelle mesure, cette pratique a modifié leurs habitudes de transport, à la lumière d'études et de recherches empiriques récentes. Il s'avère que le télétravail peut avoir des effets divergents ou neutres sur les comportements de transport en fonction d'une multitude d'autres facteurs. Par exemple, alors qu'il semble être associé à une réduction des kilomètres parcourus en voiture (VMT) pour les travailleurs ayant de longues distances entre leur résidence et leur lieu de travail et qui se rendaient au travail en voiture, pour d'autres, le télétravail à temps plein a permis une flexibilité qui a augmenté la demande de voyages de loisirs dans les zones rurales, ce qui nécessite l'acquisition d'un véhicule privé. Par ailleurs, pour les télétravailleurs à temps plein qui se déplaçaient auparavant en transports publics, le télétravail a entraîné l'abandon de ce mode de transport, ce qui pourrait avoir des conséquences à long terme sur son financement. Les résultats en matière de mobilité à long terme dépendront aussi fortement de la fréquence hebdomadaire (par exemple, deux-trois jours par semaine) à laquelle le télétravail sera mis en place pour différents travailleurs. Enfin, les urbanistes devraient mettre en œuvre des politiques d'aménagement du territoire et de transport adéquates parallèlement à l'adoption du télétravail, afin de promouvoir des habitudes de transport plus durables.

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1.0 Introduction

The high levels of material and energy consumption in the Global North and its associated waste and greenhouse gas emissions (GHG) have long been identified as important contributors to the ongoing environmental crisis. These externalities and high-consumption lifestyles are deeply interwoven with the development of post-war suburban areas distant from central business districts (CBD) (Kahn, 2000). This type of low-density development was driven by and in turn sustains private motor vehicle ownership and use as a necessity in suburban landscapes (Filion, 2018). This automobile hegemony, however, has created other negative externalities, including road congestion, air pollution and traffic accidents (Gössling, 2020). Movements such as New Urbanism emerged as countercurrents to suburbanization, aiming to reduce automobile dependence by fostering Transit-Oriented Developments (TOD), walkability and mixed-use neighbourhoods (Lukez, 2007).

At the same time, the advancement of communications and internet technology has increasingly given firms the possibility of implementing more flexible workplace policies such as telework (i.e. working away from the usual place of work), one or more days a week, for their employees (Eurofound, 2020). As such, several studies have aimed to explore the effects of telework on transportation behaviour and mobility. One of the stated advantages of teleworking is that it reduces the frequency of commute trips and work-related travel and can thus potentially be used as a travel demand management strategy and a GHG emissions reduction strategy (Mohammad Abu, 2020). On the other hand, teleworking might pull households towards more suburban residential areas, involving longer commutes (Zhu, 2013), and enable more household-level trips to non-work destinations, in which case automobile travel might not subside but might actually increase (Kim et al., 2015).

In the context of the COVID-19 pandemic, a significant proportion of Canadian knowledge workers have been working from home in order to respect public health guidelines. This presents an unprecedented opportunity to study the potential impacts of a larger uptake in teleworking practices on travel behaviour and the urban landscape. In this context, this study aims to understand the impacts of this uptake in teleworking practices on transportation and mobility patterns, by undertaking qualitative interviews with white collar workers in Montreal, Canada, who were forced to telework due to the COVID-19 pandemic.

It is important to consider the impacts of telework on mobility and activity patterns since it is a practice that will likely persist in the long-term. These shifts could have significant impacts on demand for local services, on travel demand for different transportation modes (use and ownership), and even on Vehicle Miles traveled (VMT). Workplace flexibility could thus be explored as a potential Travel Demand Management (TDM). However, even if telework does have an impact on reducing motor vehicle trips to work, whether that actually translates to significant reductions in total GHG emissions depends on various elements. For instance, the extent to which telework is adopted at a societal level, the weekly ratio (i.e., how many days a week) at which it is implemented, and the proportion of car commuters versus transit commuters who adopt it, will influence the overall impact on VMT and any potential reduction in GHG emissions. Further, whether an uptake in telework leads to other behavioural changes such as relocation to suburban locations and car-dependent lifestyles, and whether the elimination of the commute to work leads to more non-work trips by car, will also influence the impact of telework as a TDM strategy.

Therefore, it is important to try and understand how policymakers and planners can harness flexible telework to optimize its potential as a TDM strategy. Most empirical studies have used quantitative methods and are mainly based on scenarios with lower weekly rates of telework (i.e., only once or twice a week). The qualitative study presented here complements these studies by exploring the reasoning and motivations behind certain transport- and mobility-related changes due to telework practices and assess to what extent these various scenarios are possible, in the context of the ongoing COVID-19 crisis.

This memoire will begin with a review of the literature pertaining to telework, transportation behaviour, and recent changes brought on by the COVID-19 pandemic, followed by a brief methodology and a data summary table. Then, the results are analyzed, supported by textual evidence, and discussed with reference to empirical and contemporary studies. Finally, the conclusion presents potential paths for teleworking and planning policy to harness this practice as a TDM strategy.

2.0 Literature Review

2.1 Empirical research on telework and transportation

2.1.1 Telework and car use

Over the last few decades, many studies have assessed the potential impacts of teleworking on various outcomes, including travel behaviour. Different aspects of travel behaviour including vehicle miles traveled (VMT) and travel mode choice, for example, have been assessed, in order to determine whether telework is a viable means of managing the demand side of the travel demand equation (Urban Analytics Institute, 2020). There seem to be conflicting findings around the effect of telework on VMT and travel modes: while some suggest a substitution effect between commuting and telework and thus a reduction of overall travel by more polluting modes, others suggest a complementarity effect, where overall automobile travel increases, at the household level, due to the new opportunities presented by the flexibility of telework.

Choo et al.'s (2005) empirical findings on the impact of home-based telecommuting on passenger VMT, using U.S. nationwide travel data, for example, suggest that telecommuting has the potential to reduce VMT, by around 0.8%. They argue that despite the marginal effects of teleworking, it represents a more cost-effective travel demand management strategy, in contrast with investment in public transit. More recently, Shabanpour et al. (2018) modelled an uptake of teleworking by 50% of the workforce in Chicago and found that this could result in a reduction of daily total VMT by up to 0.7% and a reduction of hours travelled by up to 2.09%, pointing to a greater potential impact in terms of traffic relief than on trip distance and frequency.

Lachapelle et al. (2018) looked at the impact that different teleworking arrangements (working from home only, part-day telecommuting from home or working from a variety of locations) have on overall travel and on active transportation outcomes, in the Canadian context. They find that telework was associated with a reduction in overall travel times (by 13 minutes on average) and greater odds of achieving 30 minutes of physical activity by sustainable travel modes. Part-day working from home was not strongly associated with sustainable travel outcomes or important reductions in travel time and working remotely from a combination of locations was associated with an increase in overall travel times by about 10 minutes. Further, all types of teleworking arrangements were associated with lower chances of peak-time travel, which could explain the reductions in travel times and point to the potential of telework to help

relieve traffic congestion. Overall, they find that while a rebound effect might exist related to non-work travel, it is outweighed by the reduction in work-related travel. Full day working from home is the arrangement, they argue, that would provide the best results in terms of sustainable travel outcomes. Similarly, Saxena and Mokhtarian (1997) found that teleworkers were more likely to travel to destinations closer to their residences on teleworking days, associated with shorter distances and active transportation.

Other studies observe a clearer rebound effect from teleworking where VMT and trip frequency increase following the onset of teleworking practices. Zhu and Mason (2014) explore the effects of teleworking on total daily vehicle miles traveled (VMT) using data from the 2001 and 2009 National Household Travel Surveys in the United States. They find that workers with the option to telework tend to drive more on a daily basis for both work- and non-work trips and that VMT increases over time when workers have the option to telework. They also find that workers residing in suburban areas tend to have longer daily VMT for work trips and that urban residents had significantly shorter non-work trip VMT. Overall, telecommuting had a significantly positive impact on worker's daily total trip VMT, in both years. They found, however, that the non-work trip VMT of non-working members of a teleworking household were unaffected by the other household members' teleworking practices. This is in contrast to the results found by Kim et al. (2015), whose study aims to understand household-level travel behaviour impacts of the adoption of teleworking by the head of household (HH). They find that while telecommuting reduces VMT for the HH's work trips, this reduction is offset by an increase in VMT for non-work trips for both the teleworking HH and the other non-teleworking household members. Interestingly, they find that the effect on non-telecommuting household members' travel behaviour is only significant in households with less than one vehicle per working household member, which they explain by the fact that as the HH teleworks, this makes the vehicle which was previously used to commute available to be used by other household members for all types of trips and by the HH for non-work trips outside of peak travel times. This also suggests that telework might reduce the need for a second automobile, as it becomes easier to share this limited resource between household members as their needs become less conflicting.

A recent study by O'Brien and Aliabadi (2020) provides a review of the literature and makes an important point regarding the effects of telework. They argue that in order to properly account for the net impact of transport-related changes from telework on energy savings and GHG emissions, rebound effects in terms of home office energy use, the Internet, office building energy use and long-term transportation and residential choices must also be assessed. They find that while the majority of studies indicate a

negative net effect of telework on energy and emissions savings, this isn't the case across the board and more recent studies tend to find a lower benefit from telework.

2.1.2 The potential impact of telework on the environment

Yaropud et al.'s (2019) analysis of 2016 Canadian Census data finds that since 1996, the number of commuters in Canada has increased by 30%, following an increase in the number of jobs by 33.5%[1] and a 20% growth in total population during that same time period. They point out that the majority of commutes to work in 2016 were done by car, mainly as drivers (74%) but also as passengers (6%). The number of total car commuters increased by 3% between 2011 and 2016 and 7% of commuters experienced long commutes (60 minutes of travelling to work) in 2016, the majority of which were car commuters. Since the onset of the COVID-19 pandemic, however, Canadian cities have experienced sharp drops in commuter numbers and traffic congestion (Clarke, April 2020), and the mode share of cars for commuting to work dropped from 74% to 67% (Savage and Turcotte, 2020), pointing to the fact that essential workers, who tend to have lower access to cars for commuting, have continued to leave their home to go to work throughout the pandemic, while white collar workers have generally been able to switch to telework.

Kitou and Horvath (2006) analysed the air pollution effects of a 1-day telework scenario based in California. They also incorporate other non-transportation-related impacts such as home electronic use and office space lighting and heating in order to provide a complete assessment of the effect of telework on air pollution. They find that telework has the greatest impact on reducing greenhouse gas air emissions when it is used to substitute long commutes, especially by passenger vehicle and commuter train, and that this effect is multiplied as teleworking frequency increases. They noted, however, that the reduction in air pollutants is negligible in the case of short commute distances. They propose increasing the frequency of telecommuting as one way of maximizing its environmental benefits. They also point out that, since airplanes are one of the more polluting transport modes, if telework allows for in-person business trips requiring air travel to be replaced by virtual conferences, this can save a significant amount of CO2 and other greenhouse gases from being emitted.

In 1999, the U.S. congress passed the National Air Quality and Telecommuting Act which put in place ecommute (teleworking) programs in five major American cities, under which companies could generate

[1] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410002301

emissions credits by reducing their employees' VMT as a result of telework, the results of which have been evaluated by Nelson et al. (2007). They find that greenhouse gas emissions savings from all averted vehicle trips were relatively small, mainly due to the emissions characteristics of the vehicle fleet which were mainly light-duty, clean vehicles, and that improvements in vehicle technology over the next 20 years will continue to reduce the emissions benefits from each day of telework. They do claim, however, that a large-scale increase in teleworking could result in significant emissions savings especially in highly polluted areas. Notably, they suggest that the greatest social benefits from teleworking might accrue from traffic congestion reduction, given that the social costs generated automobile trips are much greater in terms of congestion than in terms of pollution and that construction costs for additional roads and highways are relatively high. However, gains in terms of traffic congestion reductions should be examined with caution: when the cost of congestion is perceived to be low, this can simply induce car travel by people who previously used other modes or travelled at different times to avoid traffic and eventually bring traffic levels back up above the congestion threshold (Downs, 2004). Further, a report for the World Wildlife Fund finds that if telework was incorporated at scale with 30-45% of workers teleworking at a weekly ratio of 2 to 4 days, it could help save, over a few decades, more than 3 billion metric tons of CO_2 emissions (Buttazzoni, 2009). On the other hand, Zhu and Mason (2014), who study the effect of telecommuting on work and non-work VMT using U.S. National Household Travel Surveys of 2001 and 2009, find that teleworking actually results in an increase in GHG emissions, despite gains in vehicle fuel efficiency, due to increases in total daily VMT and travel behaviour changes at the household level when teleworking is introduced. They also concluded, however, that teleworking could potentially reduce GHG emissions related to aviation and other subsectors.

Giovanis (2018) analysed the relationship between teleworking and both air quality and traffic using individual and household level data from the Swiss Household Panel Survey between 2002 and 2013. He finds that an involvement of 8.43% of the sample in teleworking practices is associated with a reduction of overall traffic volume by 1.9% and thus has a small but positive impact on air quality as it reduces air pollutants such as nitrogen dioxide and carbon monoxide. He also finds that teleworking reduces the number of single-occupant vehicles on the road, which has benefits in terms of traffic and air pollution reduction. Overall, his findings support the position of teleworking as an effective travel demand and pollution management strategy and emphasize the time- and cost-effectiveness of teleworking as opposed to other strategies such as investment in roads and mass public transit investment.

Clearly, determining the impact of telework on greenhouse gas emissions is no simple matter, as there are many factors which this outcome depends on, including commute distance, type of residential area (i.e. urban or suburban), proportion of teleworkers, teleworking frequency, vehicle technology, and existing levels of congestion. Ultimately, it should be adopted as a tool to complement other GHG-reducing strategies, for optimal results.

2.1.3 Telework and metropolitan development

Research has also been undertaken to understand how telework impacts residential location choices and the development of metropolitan areas. In 1991, Nilles found that telecommuting was not the main factor influencing residential relocation, but that it does modify the decision process by reducing the cost of commuting and that telecommuting was only associated with significant moves away from the main work location for a small fraction of teleworkers. Nevertheless, this study was undertaken at a time when communication technologies weren't nearly as developed as they are today, now that adequate home internet and cellphone communications accommodate telework a lot better. A more recent study by Mokhtarian et al. (2004), which looked at changes over a ten-year period for 218 employees of California government agencies which had participated in a teleworking pilot program, found that while one-way commute distances were higher for teleworkers than for non-teleworkers, total commute distances were lower for teleworkers, pointing to a tendency for workers engaged in teleworking to reside in locations that are further from urban employment centres and to telework at a high enough weekly ratio to compensate for the longer commute. Similarly, Muhammad et al. (2007), analyse the impact of teleworking on commute distances and how this affects residential preferences, based on the official Netherlands' housing demand survey of 2002. Details on the extent and frequency of telework were unavailable, and therefore teleworkers were identified as respondents who answered yes to working from home in combination with having a fixed working address elsewhere. Overall, they find that teleworkers have longer commute distances and commute at lower frequencies and that teleworkers are more likely to reside in rural areas, further pointing to the possibility that while telework may reduce VMT, it might also increase urban sprawl, which implies more energy-intensive lifestyles. Further, while telework facilitates longer commute distances, traditional factors such as life cycle stages and household type still play a predominant role in determining residential location. Specifically, they distinguish between two types of teleworkers: a larger group of middle- and old-aged, well-educated professionals earning middle and higher incomes, residing in family households and tending towards rural green residential locations; and another group of young, highly educated professionals who aren't earning high incomes yet and have

a clear preference for urban residential locations. Nevertheless, neither of these studies could account for causal direction, causing uncertainty as to whether it is teleworking that prompts workers to relocate to further residential locations or whether workers in suburban and rural areas have a greater propensity to adopt teleworking practices.

Similarly, Ettema (2010) investigates the heterogeneity between the residential preferences of commuters and telecommuters using the Dutch housing demand survey database. He finds that teleworkers can be divided into two groups: one which includes relatively more rural teleworkers and homeowners and is sensitive to commute distance and another with relatively more young telecommuters who are less sensitive to commute distance. Understanding how telework impacts residential patterns, he argues, requires taking the heterogeneity of teleworkers into account. The findings also suggest that as a whole, teleworkers are not more likely to relocate than non-teleworkers, but that they tend to have a preference for urban green and outer city residential areas.

2.1.4 Telework and car ownership

Although there is limited empirical research focusing on teleworking practices' effect on automobile ownership, some evidence points to the potential of telework to reduce overall levels of private automobile ownership at the household unit.

Through in her survey of the literature, Mokhtarian (1991) finds a resurging hypothesis that the ability to work remotely may eliminate the need for a vehicle, but most likely the need for a second vehicle, in the medium term. This seems to have been confirmed by the results of a more recent empirical study focusing on household-level responses to a vehicle-reduction scenario in the context of teleworking households in a mid-sized Canadian city undertaken by Andrey et al. (2004), which suggests that flexible working arrangements combined with excess auto capacity enabled households to adapt relatively easily to a one-vehicle scenario without making significant changes to their activity patterns. Nevertheless, dependence on automobile travel persisted, which might be explained by psycho-social factors as well as place-based variables such as city size and density.

2.1.5 Millennials, life cycle stages and automobility

Klein and Smart's (2017) analysis of U.S. household automobile ownership data point out that Millennials own, on average, 13% fewer cars than families whose head of households are from older generations,

which they attribute to Millennials' more precarious economic situation of decreased employment, lower incomes and less wealth, compared to older generations. However, they find that Millennials who are economically independent own slightly more cars than would be expected, given these economic factors. They also note that Millennials are much more likely to reside in denser urban areas and in transit-rich neighbourhoods, which suggests that even if they do own a car, they likely use it a lot less than their counterparts.

Lafleur writes in a 2013 National Post article that more and more young professionals in Canada desire to live in urban centers, in proximity to amenities, rather than having to endure long commutes to and from work. He adds that Americans aged 18 to 34 accounted for 11% of the automobile market, compared to 17% in 2007, and that the percentage of Americans aged 20 to 24 who had a driver's license dropped from 92% in 1983 to 81% in 2010. It has also been shown that Millennials are more likely than the preceding generation to be active and public transport users, and that transit users are more likely to adopt alternatives to car ownership, such as car-sharing and ride-hailing services (Lee et al. 2019).

However, the above also points to the importance of life cycle events as determinants of car ownership and use, which could transcend any effects that teleworking might have on car-ownership reduction. As such, Clark et al. (2016) find that having a child increases the likelihood of acquiring a car for households who didn't previously own one, especially for first-time parents, and that moving into employment and an increase in household income also increase the likelihood of purchasing a first car. Additionally, the influence of the built form and public transport accessibility appear significant as moving to an area with a greater number of bus stops was associated with greater chances of relinquishing car ownership.

Gu et al. (2019) find that in the case of new employment for a household member, as commuting distance increases, so does the probability of purchasing another vehicle, and that the acceptance of e-bike and car sharing programs are highly influenced by commute distance. This suggests that if teleworking is adopted at a full-time rate, demand for additional vehicles might decrease and there might be more acceptance of alternatives such as car sharing programs, instead. On the other hand, if teleworking leads some households to relocate to peripheral residential areas involving longer commutes, automobility and car dependency could persist.

Thus, if policymakers want to harness the advantages of teleworking to attempt to reduce automobile dependence, it is important to also consider the life stages and other exogenous variables that influence

car ownership and car use. Further, if telework is to be harnessed as a strategy to reduce VMT and greenhouse gases, such a societal shift needs to be accompanied by planning policies that prevent urban sprawl and promote the densification of already built-up areas.

2.2 The current COVID-19 context

2.2.1 The rise of telework

At the onset of the COVID-19 pandemic, in March 2020, 39% of the Canadian workforce reported working from home. Almost a year later, at the start of 2021, 32% of the workforce was still performing the majority of their work activities from home, according to Statistics Canada[2] (2021). Comparatively, this was only the case for 4% of the workforce five years earlier, in 2016. Amongst new teleworkers, 90% indicated accomplishing at least the same amount of hourly work from home as they previously did from the office. In terms of future telework arrangement preferences, 80% of new teleworkers indicated that they would prefer to work at least half of their hours from home once the pandemic was over (41% would prefer working about half their hours from home, while 39% would prefer working the majority or all of their hours from home). Similarly, an international study by Rubin et al. (2020) found that about a third of respondents would choose to continue teleworking in the future and the preferred scenario was one in which there would be a mix between days teleworking and working on-location, within a work week. Also, Capgemini recently published a report[3] based on surveys with 500 organizations and 5,000 employees around the world and found that a hybrid work model is likely to be most common, going forward, as 30% of organizations expected more than 70% of their employees to work remotely in the next two to three years, and 45% of employees think they will spend at least three days a week working remotely, in the future. Further, the Urban Analytics Institute (2020) point to the widespread public endorsement of teleworking practices by some of the world's largest companies such as Twitter, Zillow and Shopify and to the fact that historically, societal or economic shocks have resulted in radical changes in human behaviour, suggesting that the COVID-19 pandemic might be a shock that changes how and where we work, in the long term. They estimate that between 12% and 39% of Canadian workers, mostly employed in the knowledge economy, will continue to telework even after the pandemic. Occasional work away from the office, however, is not a novel practice, as Shearmur et al. (2020) point out that before the pandemic, workers already spent, on average, 31% of their work time in a location other than their usual

[2] https://www150.statcan.gc.ca/n1/pub/45-28-0001/2021001/article/00012-eng.htm
[3] https://www.capgemini.com/wp-content/uploads/2021/03/The-Future-of-Work_Final.pdf

place of work. Thus, the pandemic has prompted a real-world experiment in the uptake of telework at a large scale, rather than the discovery of an entirely novel practice.

2.2.2 Changes in traffic congestion and emissions

Data[4] provided by GPS service provider TomTom shows that Montreal experienced a 9% reduction in traffic congestion levels in 2020 compared with 2019. As expected, the greatest reductions in congestion occurred in the months of April and May, when COVID-19 restrictions were the strictest, but congestion levels climbed back up to near-normal levels between June and September, when restrictions were less severe. Morning and evening rush hour congestion remained at lower-than-normal levels throughout the year and saw a 22% and 21% reduction, respectively, compared to the previous year. However, the fact that rush hour congestion decreased a lot more than overall congestion levels suggests that car trips may have simply shifted to different times of the day to avoid rush hour traffic, but not necessarily that drivers are making less trips than before nor that this translates to a decrease in emissions. Indeed, 2020 saw an overall drop of 7% in global CO2 emissions due to the lockdown measures imposed to contain the spread of COVID-19 (Newburger, 2020). A few months into the pandemic, however, once certain restrictions started to loosen, emissions bounced back strongly, and energy-related emissions were even higher in December 2020 than the year before. Further, another study[5] by EY, which surveyed over 3,300 consumers across nine countries, found that global per capita work-related travel emissions fell by 56% and emissions associated with private car travel fell by 51%, after the onset of the pandemic. However, the share of overall car-related emissions has since risen from 59% before the pandemic to 65%. This suggests that while overall car trips and distances may have declined due to pandemic-related restrictions, the reliance on private cars as a main travel mode seems to have increased mainly due to health concerns.

2.2.3 Car use and ownership

A recent study[6] on the car buying habits of Canadians (2021) by Canadian Black Book (CBB) found that 76% of respondents (n=1000) agreed they were driving less since the onset of the pandemic. Those who agreed they were driving less due to working or learning remotely reported having cut back their driving by almost 50%, on average, compared to their pre-pandemic levels. Relatedly, the intention to purchase a new vehicle within the next two years has declined from 52% in 2019 to 44% with 20% of respondents

[4] https://www.tomtom.com/en_gb/traffic-index/montreal-traffic/
[5] https://www.ey.com/en_gl/automotive-transportation/how-mobility-can-help-build-a-better-post-covid-19-world
[6] https://www.canadianblackbook.com/blog/cbb-research-amid-pandemic-shows-effects-on-car-buying-trends/

stating having put off, delayed or postponed the purchase of a vehicle. Similarly, Deloitte's 2020 Ontario automotive consumer study[7] (n= 1,022) found that 43% of respondents planned to drive either significantly (17%) or somewhat (26%) less, in general, than before the pandemic, which they suggest may be related to telework given the fact that 41% of respondents planned to work from home either a couple of times a week (17%) or every day (24%) in the long term. Further, KPMG's (2020) report found that COVID-19 caused a sharp drop in VMT in April 2020 in the U.S., mainly due to reductions in commuting and shopping trips, which normally account for about 40% of yearly overall miles travelled. They estimate that continued work from home could reduce miles driven by between 70 and 140 billion each year and that car ownership could fall to 1.87 vehicles per household, from 1.97. This could translate into the removal of between 7 million and 14 million vehicles off of U.S. roads, if these trends persist.

The cause of these shifts, however, may be attributed more directly to the uncertainty caused by the COVID-19 pandemic than to teleworking habits themselves and it is unclear how these trends might evolve once the pandemic is over and business and social activities resume, but teleworking practices remain in place.

Further, EY's study found that work-related journey numbers have fallen by 61%, associated with the high proportion (73%) of respondents reporting working from home at least 60% of the time. Interestingly, the number of journeys for the longest work commutes have fallen to a much greater extent than for shorter commutes. Commutes of two hours or more have fallen by 94% and those of between 30 and 60 minutes have fallen by 73%. On the other hand, commutes of less than 30 minutes have only fallen by 18%. This suggests that workers with longer commutes have a preference for and might benefit most from teleworking while those with shorter commutes likely aren't as hesitant to work on-location, since the cost of commuting is lower for them, especially if this short commute involves some form of physical activity. Short trips (30 minutes or less) related to leisure and entertainment and household and social activities, however, have increased substantially, by 79% and 57%, respectively, pointing to a shift towards more local living and basic necessities in light of the travel restrictions put in place due to the pandemic.

While those who already own cars might be driving less than before in the context of teleworking and the pandemic, there is also conflicting evidence that more people are interested in acquiring a car due to public health concerns related to the pandemic. The CBB study found that the pandemic has led some

[7] https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/consumer-industrial-products/ca-en-2020-ontario-automotive-consumer-study.pdf

(15%) of respondents to either acquire a car or consider it in order to avoid the use of public transport or ride-sharing services. Similarly, Deloitte's study found that overall, 38% of respondents were somewhat or very interested in acquiring a vehicle as a way to maintain social distancing when traveling. Further, EY's study found that 31% of people who didn't own a car intended to buy one within the next six months and 78% of respondents said they will more likely travel by car in a post-pandemic context. Unexpectedly, Millennials made up 45% and 52% of those categories, respectively. This renewed interest in car ownership is reflected in Goodcarbadcar's data[8], which shows that while car sales were down to about 334 000 in the first quarter of 2020, relative to 418 000 the year before (-20%), sales seemed to bounce back in the remainder of 2020, and were up to 379 000 in Q1 2021, having recovered almost half of the losses of 2019 to 2020.

Thus, while teleworking may reduce distances travelled, car commute frequencies, it seems that cars are currently the preferred mode of transportation due to COVID-related concerns. Further, telework likely won't eliminate the need for car ownership entirely, as other types of trips, such as shopping, visiting family, or even weekend leisure trips outside of the city to second homes, for example, might require the comfort and convenience of an automobile, especially for household with greater responsibilities such as young children. Further, the pandemic and the concern over COVID-19 transmission is a factor that has further pushed people, including Millennials, towards car ownership and driving as a main mode of transportation and could counter any gains in VMT reductions from teleworking, at least in the short term.

2.2.4 Urban exodus

One of the narratives that dominated media headlines from the onset of the pandemic is that of a mass exodus from urban centers towards suburban and rural areas where households have more space, are closer to nature and feel safer from the threat of COVID-19. One article (Hughes, 2020), for example, pointed to a significant increase in moves, for both renters and owners, from New York to more suburban states such as Connecticut (74%), New Jersey (38%) and Long Island (48%) between March and April of 2020. In the case of New York City, evidence seems to indicate that moves were of a temporary nature, mostly comprised of wealthy individuals escaping to vacation homes and young adults moving back to their family home (Quealy, 2020). Hughes also points out that New York City experienced a similar exodus after the 9-11 terrorist attacks, which was short-lived, pointing to the potentially temporary nature of these moves. It also seems that the increase in moves in the U.S. was concentrated in a few big cities such

[8] https://www.goodcarbadcar.net/2021-canada-vehicle-sales-figures-by-brand/#quarterlysalestable

as New York City and San Francisco, many of which were to other large metropolitan areas such as Seattle and Los Angeles (Patino, 2020). A recent study[9] found that some 20% of all moves in the U.S. in 2020 were related to the pandemic, of which 28% were due to teleworking, and that most moves happened between cities and other metropolitan areas, rather than towards suburban areas (Density, 2021). Thus, it seems that the shock of the pandemic and its socio-economic consequences may have simply accelerated pre-existing trends towards more affordable and more spacious housing.

In Montreal, the pandemic and the flexibility of telework seem to have accelerated a tendency for households to relocate towards suburban areas, where more living and private outdoor space can be acquired at a relatively lower cost. A recent report[10] found that the proportion of single-family homes in the suburbs purchased by households coming from the island of Montreal has increased to 28.8%, from a 24.2% average between 2015 and 2019, which they mainly attribute to the pandemic and to the uptake in telework (Cortellino, 2021). Interestingly, they found that it was mainly households living relatively further from the city center, in boroughs such as Ahuntsic-Cartierville, Pointe-aux-Trembles or Lachine who moved to suburban locations, while those living in central neighbourhoods tended to stay in the city. This indicates that households who already experience a relatively longer commute to the downtown area are willing to move to the suburbs to acquire a single-family home without a significant change in commute time. Certain Regional county municipalities (MRC) also experienced increases in transactions from households from the Montreal Metropolitan Region (MMR) in 2020. Further, data[11] released by Statistics Canada (2021) shows a record-breaking number of nearly 25,000 people leaving from the Montreal CMA to surrounding areas, about 11,000 more compared to 2019. Similar trends were also present in the CMAs of Toronto and Vancouver, while urban sprawl continued to grow around these three cities (Lundy, 2021). Overall, moves from the Montreal CMA towards the rest of the province grew relatively fast in 2019-2020, while moves towards Montreal from the rest of Quebec decreased significantly relative to 2018-2019, resulting in a low growth rate of 2.3% compared to 18% the year before, according to the ISQ[12]. These trends point to the pandemic restrictions making big cities less attractive to live in and perhaps also to telework as a factor minimizing the cost of commuting and

[9] https://www.density.io/blog/urban-exodus

[10] https://assets.cmhc-schl.gc.ca/sites/cmhc/data-research/publications-reports/housing-market-insight/2021/housing-market-insight-montreal-68726-m03-fr.pdf?rev=73968551-a24b-4a23-9658-58bd4e19eb3e

[11] https://www150.statcan.gc.ca/n1/daily-quotidien/210114/dq210114a-eng.htm?HPA=1

[12] https://statistique.quebec.ca/fr/fichier/population-regions-administratives-quebec-2020.pdf

increasing households' desire to move even further where gains can be made in terms of space and affordability.

Trends of households moving away from city centers towards outer areas are not new, however, and have long been tied to many push factors including worsening housing affordability, lack of open green spaces and traffic congestion in metropolitan areas and pull factors in smaller cities and towns such as lower housing costs, proximity to nature and green space and family-friendly environments (Vachon, 2020). Thus, it can be said that telework and the pandemic are merely exacerbating a pre-existing trend, but whether these trends persist in the long-term remains to be seen.

2.2.5 The threat of public transport's stagnation

Another consequence of the pandemic, its restrictions and telework has been a significant decline in public transportation (PT) ridership and diminishing fare revenues for big city transit agencies, causing concern over the long-term financing of such services. The onset of the COVID-19 pandemic in March 2020 saw Canada's public transit ridership fall by almost half (-45.6%), according to Statistics Canada data[13], as severe restrictions were put in place, limiting outings to essential needs and services. Reductions of more than 80% followed in April and May 2020, and while ridership slowly increased throughout summer months as restrictions eased, it still remained 60% below 2019 levels throughout the remainder of 2020. Accordingly, total operating revenues have declined drastically, down 61.3% to $131 million in December 2020 compared to $207 million the year before, leading to huge budget shortfalls requiring billions of dollars in federal and provincial aid and a reduction in the level of service to about 87% in December 2020 (Spurr, 2021).

In the case of Montreal, the Société de Transports de Montréal (STM) has reported[14] (2021) an overall reduction in ridership of 54.2% in 2020, relative to 2019, due to the pandemic's sanitary measures, remote work and remote learning. The decline was greatest during the month of April, with only 14% of the ridership observed the year before, but progressively climbed back up to 40% throughout the summer. Nevertheless, the STM has decided to maintain its 2019 level of service at least for the next two years, to support essential workers and enable physical distancing. Similar ridership trends were also experienced between April and August of 2020 by the Toronto Transit Commission (TTC), which has been providing a

[13] https://www150.statcan.gc.ca/n1/en/daily-quotidien/210225/dq210225f-eng.pdf?st=GSOWP6fx
[14] http://www.stm.info/sites/default/files/pdf/fr/ra2020.pdf

level of service at around 85% capacity, despite the city's workforce relying more heavily on public transport than any other CMA in the country (Toronto Foundation, 2020). While an important share of the reduction in transit use can be attributed to the pandemic restrictions and concerns over health and safety from COVID-19, it is important to consider whether the long-term financing of public transportation will be jeopardized by the perpetuation of teleworking practices beyond the pandemic, especially considering that the TTC's annual operating budget, for example, relies on fares for two thirds of its revenue (Spurr, 2021).

A Statistics Canada study[15] from June 2020 revealed that 42% of workers who previously used public transportation for commuting to work switched to teleworking, while 34% switched to another mode (mainly personal motor vehicles and some active transportation) (Savage and Turcotte, 2020). Only 24% of previous public transit users were still using this mode in June 2020. Similarly, a study from the city of Toronto shows that only 24% of higher-income ($80,000 to $125,000+) households, associated with high-paying jobs and the ability to telework, were still using public transit in May 2020 compared to 41% for lower-income ($0 to $40,000) households (Toronto Foundation, 2020). This points to the reliance of public transportation systems on knowledge workers, who are more likely to work in downtown offices and commute using PT, but also more prone to telework, as an important share of ridership and source of fare revenues.

Some preliminary data causes concern over the longer term transportation habits of public transport users: Deloitte's study[16] of Canadian post-pandemic behaviour, for instance, found that while 62% of respondents reported using public transit at least on rare occasions (21% of which used it at least once a week), just 60% of these intended to maintain their use of public transit and 33% intended to use it somewhat to significantly less often, going forward. Further, Statistics Canada's survey found that the majority of previous transit commuters who had switched to teleworking or other modes of transport were concerned about using it again in the future mainly due to fear of contracting COVID-19. Stantec also conducted a survey[17] with over 3,500 office workers in the United States asking about expected travel behaviour changes in the near future, according to which 29% of respondents who identified as transit users expected to use transit less frequently moving forward, while 67% expected no change. Further, they estimate that respondents will decrease the days they commute to work by car and by transit by 11%

[15] https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00069-eng.htm
[16] https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/consumer-industrial-products/ca-en-2020-ontario-automotive-consumer-study.pdf
[17] https://www.stantec.com/en/ideas/stantec-survey-how-will-commuting-patterns-change-due-to-covid-19

and 19%, respectively. They also find that expected reductions in transit trips were greatest (-24%) for workers who live in suburban areas and work in urban areas, who also reported the biggest increase in teleworking practices and the least expected amount of overall behavioural changes related to transportation, which points to the lack of alternative transportation options available in such locations. Nevertheless, it remains unclear whether these short-term preferences will translate into long-term patterns.

The declining revenues and service cutbacks are most likely to hurt cities' most vulnerable users: low-income, people of colour and women with small children, for whom public transit is more often a necessity for commuting to work and other trips, rather than a choice (Toronto Foundation, 2020). Thus, to avoid detrimental long-term consequences for major cities' public transport systems, policy efforts should focus on changing people's perceptions on the safety of public transport, on providing incentives and on using teleworking policies in a way that will still support public transport use for teleworking employees.

While immediate shifts in travel behaviour such as decreased traffic congestion, reductions in VMT and residential relocation seem to have followed the onset of the pandemic, signs seem to indicate that many of these trends are temporary and likely reversible in a post-pandemic context. It is important to remember that stated preferences around post-pandemic behaviour must be taken with precaution, as respondents likely underestimate how quickly their attitudes may change once pandemic-related restrictions and fears disappear. At this stage, however, it remains difficult to distinguish between shifts caused by teleworking, which may have longer term consequences, and those caused by the pandemic and its broader socio-economic implications, which are more likely of a temporary nature.

3.0 Methodology

A first set of interviews (40) were conducted in May and June 2020 under the supervision of Professor Richard Shearmur, with the objective of understanding how the uptake in teleworking practices due to the COVID-19 pandemic was impacting different aspects of workers' lives and what the future of work might resemble. For instance, respondents were asked about how they had adapted their living space and routine to remote work, their perceived advantages and disadvantages of teleworking and whether they would continue to telework in the future, and to what extent, if given the opportunity. Participants were recruited in Montreal and Calgary using a snowball sampling method where the initial participants were obtained from the research assistant's inner circle, who then referred them to someone else in their circle, and so on and so forth.

In January 2021, using the previously obtained ethics approval, follow-up interviews were conducted with ten (10) of the initial participants from Montreal, this time focusing on the theme of transportation behaviour in the context of teleworking during the pandemic. Respondents were asked about their residential locations, their travel mode choices (and why) and the types of destinations visited before taking up telework, whether they had experienced a shift in these since teleworking and, what they expected these might look like moving forward, assuming teleworking is maintained at least part of the work week. All interviews lasted between 30 and 45 minutes, were conducted via Zoom and transcribed with the help of artificial intelligence software. Each interview was then carefully analyzed and coded in order to form the basis of the themes emerging in this paper. This paper will mainly build off of the data obtained from the second set of interviews but may also refer to some data obtained from the preliminary interviews.

Simply put, these interviews can be understood as case studies of ten people currently teleworking and how their travel behaviour has changed during the pandemic. The results from the interviews will allow to verify, to some extent, certain trends recently reported around mobility and transportation during the pandemic and to better distinguish between shorter term pandemic-related shifts and longer-term trends related to teleworking more specifically. Without being able to generalise, these case studies will allow to comment on these wider trends and possible future scenarios and shed light on the motivations and circumstances behind such behaviour. Further, other themes which have not been picked up by recent quantitative studies may also emerge and provide clues for further research directions.

4.0 Data

The ten interviewees that participated in the second round of interviews have two main things in common. They all live within the Greater Montreal area and have taken up teleworking due to the onset of the COVID-19 pandemic in March 2020. Their circumstances and characteristics vary, however, in terms of household composition, residential location and their main travel mode to work and other destinations, among other things.

Respondent 1, for instance, is a female in her mid-twenties who lives in a suburban area in a single-family home with her parents and two siblings. She previously had a long commute which is one of the factors that had pushed her to purchase a car, which she used as her main mode for work and non-work trips. She has been teleworking full time since March 2020 and has since reduced her car use significantly.

Respondent 3 is also a female in her mid-twenties. She lives in a small apartment in the heart of downtown Montreal with her partner and also works in the CBD. She previously walked to work and to most other destinations and as a household, they did not own or have access to a car. She has been teleworking full time since March 2020.

Respondent 5 is a female in her mid-twenties living in a condo with her mother and two younger siblings in an outer-city neighbourhood. Her work location was in the CBD and she previously used her car for work and most non-work trips. She sold her vehicle just before the onset of the pandemic, but still has occasional access to her mother's car. She has been teleworking full time since March 2020 and had temporarily relocated to California at the time of the interview.

Respondent 8 is a male in his mid-twenties who had temporarily relocated to his parents' house in an outer-city neighbourhood. He had been teleworking full time since March 2020 but has gone back to working at the creative studio in a flexible manner shortly before the interview took place. While he previously used his bicycle for work and non-work trips, he had recently purchased a car due to his longer commute and in order to get out of the city for leisure trips.

Respondent 9 is a female in her late forties living with her husband and two older sons in a rural area off the island of Montreal. Her work location is also rural, and she previously used her car for work and non-work trips. She has been teleworking nearly full time since March 2020, with occasional visits to the office, and has since reduced her car use significantly, walking a lot more for non-work trips, instead.

Respondent 11 is a male in his mid-twenties who recently moved from his parents' home into an inner-city apartment with his partner. He previously commuted using his parents' car and used public transport for most other trips. He has been teleworking full time since March 2020 which has enabled him to put off buying his own car, for the time being, and subscribe to a car-sharing service, instead.

Respondent 12 is a male in his mid-forties who lives in a single-family house in a rural area with his wife and two children. His office is also located in a rural area, 2km away from his home. He had been teleworking full time in March 2020 which has gradually evolved into a hybrid working arrangement. As a household they own two cars, which they use for commuting as well as for non-work trips.

Respondent 14 is a male in his mid-thirties living in a condo in an inner-city neighbourhood with his partner and two young daughters. He previously commuted to the CBD using public transport but has been teleworking full time since March 2020. They own one vehicle which they have and continue to use for most non-work trips.

Respondent 15 is a male in his mid-twenties living in the upstairs of an inner-city neighbourhood attached house with his younger brother, with his parents living downstairs. He previously commuted mainly using public transport, but occasionally using his car. He also used public transport for non-work trips, but has recently been making more use of his car in the context of the pandemic. He had been teleworking full time since March 2020 but recently has been going into work once a week, for which he uses his car.

Respondent 19 is a female in her early forties who lives alone in an inner-city neighbourhood apartment. She previously commuted to the CBD using public transport but has been teleworking full time since March 2020. For non-work trips, she previously mainly used her car, but has since been walking a lot more instead.

As a step in the process of post-interview analysis and interpretation, detailed information corresponding to each respondent was assembled into Table 1. This table presents their main characteristics, the main transport-related changes they have experiences since March 2020, and the main takeaways from each interview. The information in the table is meant to bring together key characteristics and findings and can be referred to when reading through the results section to get a better understanding of each respondents' particular circumstances and characteristics.

Respondent	Main characteristics	Main changes since March 2020	Main deductions
R1	• Female, mid-20s • Suburban residential location (Laval) • Suburban work location (South Shore) • Lives with parents and two siblings in single-family house • Owns a car (not paid off yet) • Total household vehicles: 4 • Previous one-way commute to work: ~ 50 minutes by car • Currently no commute; teleworking 5 days/week • Previously used car as main mode for non-work trips	• Better home office setup with desk, chair and screen • Driving a lot less frequently for both work and non-work trips • Not visiting/trip-chaining to downtown area anymore • No more trips to the mall due to online shopping • A lot less physically active • Considering getting rid of her car due to reduction in use and large monthly expense, but living in suburban area makes it difficult to live without a car (mainly uses it to visit boyfriend) • No more work-related travel. Now done virtually and will likely remain so in the future • Would prefer to maintain a teleworking arrangement of at least 4 days/week in the future, due to commute distance.	• Important reduction in VMT[18] due to the elimination of the commute to work • Car cost/savings is an important factor determining car ownership for younger Millennials(?) • Telework might have less impact on car ownership for suburban dwellers due to car-dependent built environment and lack of transportation alternatives • *Prioritizing telework for workers in suburban locations who commute by car might have greatest benefits in terms of reducing VMT, traffic congestion and GHG emissions, although it might have minimal effect on car ownership*
R3	• Female, mid-20s • Downtown residential location (Ville-Marie) • CBD work location • Lives with partner in one-bedroom apartment • Does not own or have access to a car • Previous one-way commute to work: 10-minute walk • Currently no commute; teleworking 5 days/week • Previously walked as main mode for non-work trips	• Temporary relocation on one occasion (one month to parents' house) • No more trip-chaining after work for errands • Less frequent outings: will bulk up more at grocery store & online shopping to avoid having to go out as much • Walking more for leisure • Considering permanent relocation to rural area • Considering purchasing vehicle in case of relocation or just to be to get out of the city and visit nature • Increasingly missing social interaction with clients and co-workers • Employer got rid of office space completely, will use We Work spaces for employees to use flexibly • Would prefer using We Work spaces a few days/week rather than full time teleworking, in the future.	• Telework policies that enable full-time telework could push urban dwellers to move away from the city on a temporary or permanent basis • *Encourage more frequent in-person work activities for workers who have inadequate home work spaces and/or live within walking-distance of their work location* • *Target inner-city teleworkers for carsharing programs to discourage car ownership*

[18] **VMT** = Vehicle miles traveled

R5	• Female, mid-20s • Outer-city residential location (LaSalle) • CBD work location (started new job since first interview) • Lives with mother and two siblings in condo • Previous one-way commute to work: ~ 20 minutes by car (main); or ~ 60 minutes by public transport (occasional) • Currently no commute; teleworking 5 days/week • Sold her car right before pandemic; still has occasional access to household vehicle • Total household vehicle(s): 1 • Previously used car as main mode for non-work trips	• Remains satisfied with working from home • Temporary relocation to California for 1+ month • Desisted from buying a car (to replace the one she had sold) in order to save money • No more trip-chaining downtown after work and during lunch time (errands, gym, social activities) • A lot fewer non-work trips • Purchased an electric scooter in the summer for personal transportation • A lot less physically active; impact on well-being • Would prefer a teleworking scenario of two-three days hybrid* between telework and working on-location, which is most likely. • Plans on eventually buying a car for independence, and comfort, for both work and non-work trips (unless she ever moves downtown)	• Residential location and proximity to public transport are critical in determining car ownership outcomes • Telework (on full-time basis) can lead to temporary relocation/travel • Lack of walking-distance access to alternative transport options and basic amenities could result in car use for work and non-work trips despite teleworking • Personal-mobility options could present viable alternatives to car ownership and use for younger Millennials/urbanites/non-HH[19]
R8	• Male, mid-20s • Outer-city residential location (Rosemont-Est) (changed since first interview) • Work location: Mile-End (central neighbourhood) • Lives with parents and sibling; will be moving into an apartment with roommates shortly next to Beaubien metro • Owns a car (since summer 2020) • Total household vehicle(s): 3 • Previous one-way commute to work: 18 minutes by bicycle	• Changed residential locations: moved into his parents' house but will be moving out again shortly to a TOD area. • Changed residential locations temporarily to work from his employer's country house (2 weeks at a time; from September to October 2020) • Purchased a (used) vehicle for long trips outside of the city and for commuting to work • Now that he owns a car, using it for non-work trips as well as work trips (mainly due to residential location, pandemic restrictions) • In the long-term, will mainly keep going to work on-location with	• Millennials may own car but use it a lot less if adequate transportation alternatives are available near residential location • The flexibility that telework enables may entice car ownership for temporary relocation and/or trips outside of the city. • Despite telework option, residential location preference is nearby work location • Residential location is very important in determining car use and ownership • *Target younger teleworking Millennials for carsharing*

[19] **HH** = Head of household

* **Hybrid working arrangement**: Having a roughly even mix between teleworking and working on location in a typical work week (i.e. two-three days teleworking and vice-versa.

	• Current commute: ~ 40 minutes by car • Future commute: 20-minute walk • Previously bicycled and/or walked for most non-work trips; public transport was second option	possibility for half-day and occasional telework • From new residential location, commute to work will consist of a 20-minute walk; After this, intends to mainly use vehicle for out-of-city trips	*programs with marketing and special offers; for longer trips as well*
R9	• Female, 50s • Suburban/rural residential location (Rigaud) • Suburban work location (Ile Perrot) • Lives with husband and two older children in single-family house • Owns a car (fully paid off) • Total household vehicle(s): 2 • Previous one-way commute to work: ~25 minutes by car • Currently commuting to work once a week at most (still 20 minutes by car); teleworking 4-5 days/week • Previously used car as main mode for non-work trips	• Has adapted better to telework • Household got rid of one car (down from 3 to 2) because of telework • A lot less VMT and car trips since telework • Trip-chaining after work has been replaced mainly by walking to stores (i.e., going to the grocery store, pharmacy) during lunch break in order to get out of the house and move • Walking a lot more for leisure and for non-work trips • Still driving to work on commute days • Walking around/discovering neighbourhood and Mont Rigaud for the first time • Will maintain current telework arrangement of mainly teleworking and going into the office on occasion.	• Important reduction in car use due to the elimination of the commute to work • Teleworking can potentially reduce the total number of household vehicles or deter the acquisition of an additional vehicle especially in households where both HH telework • *Prioritize telework for workers in suburban locations who commute by car (might have the greatest potential in terms of reducing VMT, traffic congestion and GHG emissions)*
R11	• Male, 20s • Inner-city residential location (Outremont) (moved from parents' house since first interview) • Lives with partner in apartment • Suburban work location (West Island) • Does not own a car, occasional access to parents' car • Previous one-way commute to work: ~ 45 minutes by car (would borrow parents' car, since he lived with them) • Currently no commute; teleworking 5 days/week	• Put off plans to buy first car due to telework • Acquired membership with carsharing service (Communauto) instead • No longer using public transport (mainly due to pandemic restrictions and public health concerns) • A lot fewer total trips for all modes and type of trips (due to pandemic restrictions) • Limiting trips to within 2km radius from home • Return to work will likely involve a two-to-three-day ratio • Considering buying a car in the context that he is no longer teleworking five days a week	• Commute distance and availability (or lack) of transportation alternatives strongly affect car ownership and car mode for commuting to work • Despite living in the city and being a frequent public transport user, having a long enough commute to work can lead to car acquisition • *Promote carsharing to complement teleworking as a viable alternative to car ownership especially for younger Millennials.*

	• Previously used public transport as main mode for non-work trips		
R12	• Male, mid-40s • Suburban/rural residential location (Île Perrot) • Lives with wife and two children in a single-family house • Suburban/rural work location (Île Perrot) • Self-employed/Business owner • Owns a car • Total household vehicle(s): 2 • Previous one-way commute to work: 2 minutes by car • Current commute: 2 minutes by car; hybrid work arrangement • Previously used car as main mode for non-work trips	• Implementation of more flexible telework policies for his employees • Construction of new headquarters for his business: downsizing and reorganization of office space given that many of his employees will continue to telework to a certain extent • Personal preference for a hybrid working arrangement between the office and home/other locations • No major changes in terms of travel behaviour (driving for work and non-work trips) • Still need two cars because wife does not telework and needs car to get to work. • Consideration of getting bigger house that has an extra room for an office, but not acting on it.	• Teleworking might have a moderate effect on VMT in suburban areas if it is not on a full-time basis • Teleworking might have no effect on car ownership in suburban areas due to car-dependent built environment • Teleworking might only help reduce total household vehicles in scenarios where both HH have access to teleworking or one HH teleworks on a full-time basis.
R14	• Male, mid-30s • Inner-city neighbourhood (Verdun) • Lives with partner and two young children in a condo • CBD work location • Owns a car (lease) • Total household vehicle(s): 1 • Previous one-way commute to work: ~ 30 minutes by public transport • Currently no commute; teleworking 5 days a week • Previously used car as main mode for non-work trips • Previously, public transport was used mainly for going to work/downtown	• Suspension of public transport yearly pass since the onset of telework • As a household, have considered downsizing the type of vehicle they lease for something more economical/fuel efficient • Employer has said that a flexible teleworking arrangement will be a possibility in the future • Has better adapted to teleworking; now prefers a hybrid working arrangement, as opposed to only one telework day/week as stated during first interview • No major changes in terms of travel mode and frequency for non-work trips (still the car) • Less opportunities to be physically active	• Teleworking could potentially help promote the shift towards the use of more fuel-efficient vehicles • Teleworking could help reduce the chances of the acquisition of an additional household vehicle • Other responsibilities, such as childcare, would likely outweigh any potential effect of teleworking on reducing household car ownership to 0 cars • Teleworking at a high weekly ratio could result in a decline in public transport use/financing • Virtual events could potentially replace in-person events that require air travel, in the long run, which would have positive

		• Taking more walks with the family during lunch, evenings and/or weekends • Would return to using public transport for commuting to work in the scenario of a (partial) return to the office; or biking in the summer • No more commercial activity downtown on lunch breaks • Virtual event instead of air travel – successful • More local living: commercial/leisure activities around neighbourhood	effects in terms of GHG emission reductions.
R15	• Male, mid-20s • Inner-city neighbourhood (Verdun) • Lives with brother in a duplex (parents live downstairs) • CBD work location • Lives within once block radius of metro and bus routes • Owns a car (paid off) • Total household vehicle(s): 2 (his and his parents' car) • Previous one-way commute to work: ~ 20 minutes by public transport • Currently no commute 4 days/week; once a week 20 minutes by car • Previously used public transport as main mode for non-work trips; except for when heavy loads to carry, would use car	• Commuting to work once a week; by car instead of public transport (mainly due to public health concerns) • Has not renewed monthly transit pass since start of telework • Shifted to car for most other trips instead of public transportation, mainly due to the pandemic and health risks • Increase in active transport for leisure in the summer months • Intends to return to using public transport in the long-term • Considered selling his vehicle, but likely won't be due to sunk cost and low monthly cost • Would like to change residential locations to be even closer to downtown/place of work, because of the fact that he still goes in to work once a week.	• Getting rid of vehicle is less likely if sunken cost has already been incurred • Teleworking at a high weekly ratio could result in a decline in public transport use/financing and a shift towards car as a mode for non-work trips • Teleworking might not have long-term exodus effect on city dwellers if working on-location some days/week is still required

R19	• Female, mid-40s • Inner-city neighbourhood (Rosemont) • Lives alone in apartment; daughter studies in Sherbrooke and comes home on weekends/holiday • CBD work location • Owns a car • Total household vehicle(s): 2 (including daughter's) • Previous one-way commute to work: ~ 40 minutes by public transportation • Currently no commute; teleworking 5 days a week. • Previously used car as main mode for non-work trips • Previously, public transport was used mainly for going to work/downtown	• Has adapted better to telework in terms of home setup and morale • Working a lot more than before (evenings, weekends) • Has not used/renewed monthly transit pass • Driving less for non-work trips • Walking a lot more for leisure and for non-work trips • No more trip chaining: no commercial activities in downtown area • Instead, more local living: walking and shopping within neighbourhood • Employer has said that teleworking will be an option, in the future, a few days a week • Would return to using public transport for commuting to work in the context of a (partial) return to the office; or biking in the summer	• Teleworking could help promote physical activity for leisure and active transportation for non-work to compensate for lack of physical activity of telework • Teleworking at a high weekly ratio could result in a decline in public transport use/financing • Teleworking could transplant commercial activity from downtown to residential neighbourhoods • *Long-term effects of telework on public transport use decline could be reversed if workers who tend to commute by public transport return to the office two-three days a week*

5.0 Results

The 10 follow-up interviews centered around changes in transportation behaviour and mobility due to new teleworking arrangements during the COVID-19 pandemic. Respondents' characteristics varied in terms of age, residential location, household composition, etc. (full details available in the table above). Due to the differences in these exogenous variables, these interviews can be understood as case studies that provide hints and clues towards the potential effects that telework might have on various aspects of transportation behaviour and mobility, bearing in mind the general context presented in section 2.0. Following these findings, some broad policy recommendations are formulated that could harness teleworking as a tool to help promote more sustainable transportation behaviour. The main themes that emerge include car ownership, car use, public transportation use, and residential relocation.

5.1 General adaptation to WFH

Since the first interviews, most respondents seem to have adapted even better to working from home, as some were able to better accommodate their home office spaces, or others simply found better ways to disconnect and create boundaries between the spheres of home and work.

> "[…] before I was really just working from my room and from my kitchen table, from the sofa. And so, now I actually have a desk with a keyboard, a mouse, and another screen. So, it makes it like as if I'm actually at work. So that's better." (R1)

> "At first, I had a hard time adapting and being concentrated. Now, I'm able to concentrate better. Of course, my work hours have remained the same, but […] I feel more comfortable. At first, it was more of an adaptation period and now I've accepted that I don't have colleagues. However, during this second confinement, we've had possibilities to share. We have more virtual meetings with my colleagues to do certain activities. We're starting to like this new way of doing things because we hadn't adapted before and now we have." (R19)*

> "I had a hard time adapting because I had a hard time separating my being at home life from working life, but I definitely have adapted. And now I prefer this way. I have established a routine. I do it as if I were leaving the house, I just don't leave the house. [So yes] it's going much better." (R9)

Nonetheless, the absence of casual interactions and socialization that on-location office work activities make possible was still the main element lacking in the context of full-time telework.

> "I still love [working from home]. But I find that I'm missing more and more the interactions with my team as well as clients. It's like this whole new world where we're meeting new clients, like via zoom, and all of these conference applications. So, it's like this whole other skill set that you need to have in order to, you know, meet these new people and, like, interact. And […] I'm kind of fed up of meeting new people and like, those awkward phases where you need to introduce and like, you're talking over everyone, like I find that's really having a toll." (R3)

> "Really the only missing aspect is being able to collaborate with colleagues in-person, seeing people and the social aspect of being at work with other people, but otherwise I'm able to do the same job and be just as productive [working from home]." (R14)*[20]

[20] * Respondents are identified as Rxx. A star indicates that the quote has been translated from French.

Given the fact that there seem to be advantages to both telework and working in offices, many respondents expressed preferences for weekly work arrangements that would resemble a sort of “hybrid” form of work, where work is done remotely on two to three days a week, and on-location the other two to three days.

> “I don't like the idea of being full time working from home. I feel privileged that I actually can go to the office because of the type of business that we do: physical goods being transported. So, I like the hybrid because working from home is great when you need to be focused and undisturbed in the projects.” (R12)

> “The best of both worlds would be for me to be able to go into the office for say like two days a week or three days a week, at my own discretion, like for me to decide when I would go in.” (R5)

> “[…] I would like to be able to go back to work, you know, even if it's like, part time have to go in the office and part time stay home.” (R3)

These findings confirm the results of recent grey literature on the future of teleworking, mentioned in section 2, which find an important proportion of respondents envisioning a ‘hybrid’ working arrangement moving forward.

5.1.1 Possible future teleworking arrangements

Generally, respondents seemed open to the idea of maintaining teleworking practices, to a certain extent, as part of their weekly work routine, in the long term. All respondents reported that telework would likely continue to be an option offered by their employer, moving forward.

> “So, our employer is looking to modify, to reorganize the way things are in the office, when the pandemic does end. I think that we're going to be more, the option of working from home is going to be available to more people.” (R5)

> “It was communicated to us that in the future, telework will be an important element of what we’ll have access to. We’ll be able to manage our own schedule. I’m not sure if we’ll have access to 100% telework or not, but we’ll definitely be able to access it.” (R14)*

One respondent, who actually runs his own business and manages a dozen employees, has re-evaluated the need for office space in the process of designing their new headquarters.

> "We're in the process of choosing land and building 10,000 to 12,000 square feet of office and warehouse. We are asking ourselves […] well, okay, not everybody needs an office now, because of this new mobility. So, we probably will have an area for shared desks, if you will, and then those that really need to be physically here so the operations are running, shipping orders and whatnot, those would have fixed offices or desks at the warehouse." (R12)

The evidence from the interviews points towards telework being an option that employers will continue to offer employees long after the COVID-19 pandemic and further confirms recent study findings, making it that much more important to understand its potential impact on workers' transportation behaviour and mobility patterns.

5.2 Car use and VMT

While six of the ten respondents already owned a personal vehicle at the onset of the COVID-19 pandemic, the type of trips they used it for and the frequency with which they used it varied. A couple of respondents, who, at the time of the interview both lived in suburban locations, were working from home full-time (five days a week), and previously relied on their vehicles for commuting to work, noticed a significant change in their level of car use ever since they started teleworking.

> "Honestly, the car barely leaves during the week [anymore]." (R9)

> "I'm definitely not using my car a lot. Like I'm quite proud, because let's just say in the first year that I used my car to go to work […] I drove over 40,000 kilometers within the first year. So, within the past year, I really feel like I'm taking more care of my car because I'm not using it." (R1)

Thus, commuting to work by car seems to have represented the majority of their VMT, given the suburban nature of their residential environments and the distances between their home and work locations. The elimination of their commute as a result of teleworking has reduced their VMT significantly, which aligns with recent studies by the CBB, KPMG and EY, which found important reductions in driving behaviour since the onset of the pandemic and working from home. Thus, this points to the potential of telework in reducing work-related VMT for workers who rely on their cars for commuting to work.

While driving to work seems to be on the decline, this doesn't seem to be the case for other types of trip, as other car-owning respondents' level of car use for non-work trips seems to have remained relatively steady.

> "[…] going to the grocery store, running errands in other stores that are currently open, yeah it hasn't really changed, [we still go by car]." (R14)*

> "[for non-work trips, the main mode we use] is pretty much the car [and this hasn't changed]." (R12)

It's important to note that respondent 14 lives in a household with two young children, and that respondent 12 lives in a rural area, and thus these factors likely have a strong influence on their choice to use the car for these trips. Personal preferences may also be important, however, as respondent 9 who has shifted to more walking also lives in a rural area, for example.

Further, respondent 15 previously used public transportation for most work and non-work trips, despite owning a car and paying for parking at his work location, due to the high levels of accessibility from his residential location to work and other destinations by public transportation. Recently, however, he started going into his place of work once a week and has slightly shifted to driving for work and non-work trips, rather than using public transportation.

> "I don't think there was a significant change, maybe a little bit more towards the vehicle when I understood the impacts of the pandemic." (R15)

The impact of public health concerns over the COVID-19 pandemic itself, rather than telework per se, is non-negligible in terms of its impact on the prevalence of car use, as is reflected in EY's recent studies which predicted greater intentions of driving moving forward, in light of the pandemic's risks.

5.3 Car Ownership

Beyond affecting private vehicle use and mileage, it seems that telework could also potentially impact car ownership levels. A few respondents seemed to have already considered the possibility of getting rid of their vehicle as their needs changed within the context of the pandemic, its restrictions and working from home.

Respondent 1 pointed out that the significant reduction in her car use due to teleworking five days a week in parallel with the significant monthly expense that her vehicle represents brought her to consider selling it.

> “In a way, sometimes I think about getting rid of my vehicle because I'm home most of the time. I don't need to go to places as often as I did. Like, it's kind of useless having my car there. Because I am paying like maybe $300 a month for just the car. And then there's another $100 for insurance, so that’s $400 a month. And then with other like, you know, maintenance fees and stuff like that. Like right now I'm at $450 a month, give or take $20 a week for gas. Before, when I was going to work, I was using my car every single day. I was maybe at like $700 [a month].”

For the time being, however, this remained a mere consideration, as she still required her car for other non-work trips.

> “…the one issue [with selling my car] is that like, I don't live with my boyfriend and I go see him. That's like the only place I've been going. And that's what I'm using my car for.” (R1)

She later points to the car-dependency she and her inner circle experienced growing up and to the fact that most trips are rather difficult to make without a car, in the suburban area she resides in.

> “…even like at 16, my sister had a car. I didn't have a car until like two or three years ago, but like, everyone was always picking me up for doing something. Because [by] bus, it would take me at least an hour to get anywhere, even [within] Laval.”

This illustrates that car ownership and car use is also heavily dependent on residential location and on the level of public transport accessibility (Clark et al., 2016), such that teleworking may have little to no effect on these decisions for workers residing in suburban and rural locations, in many cases.

Similarly, respondent 15 mentioned having considered the option of getting rid of his vehicle. However, given the fact that the sunk cost of his car had already been incurred and his monthly car payments were minimal, he seemed less inclined to sell it than he otherwise might have been.

> “Yeah, I've considered [selling my car]. But it's come to the point where I already own [it]. I've owned it for, I think it's been like five or six years already since it's been solely mine. And I don't use it as often, that's true. So, there isn't that much more of a need, and since I can borrow one, from time to time, I would consider selling it, sure. […] [But] the bulk of the cost is paid for and after, you know, driving for over 10 years, the cost of insurance is like, it's minimal, right. (R15)

Thus, in this case, the benefits of holding onto the vehicle outweighed the costs, such that even at a high teleworking rate letting go of the vehicle was not a reasonable choice.

Another clue also pointed towards the potential of telework in reducing the total number of household vehicles, in the case that both HHs partake in telework. This was the case for respondent 9. Living in a suburban area outside the island of Montreal, their household previously counted a total of three cars: one for each head of household commuting to work and one belonging to their eldest son. Since the onset of the pandemic, however, she has been and will continue to telework, while her husband was recently laid off, so is mainly at home as well. In this context, they decided to get rid of one vehicle.

> "We did have a second car. It was my parents' old car; it was a used car. So, [my husband] was taking that car to go to work and I had my current car. […] after he was laid off, we didn't have a need for this car, so we got rid of it. […] Before COVID, you know, we definitely would have needed the two cars if [my husband] had stayed in Ottawa, for sure. But now given that he's not working in Ottawa anymore, and I am working from home, one car is definitely going to be enough." (R9)

However, getting rid of one car was likely also a short-term cost-saving strategy due to the job loss of one of the heads of household. Whether this household will maintain a lower level of car ownership when the second head of household eventually gets a job remains uncertain.

Similarly, respondent 11, was able to forgo purchasing a new vehicle as a result of teleworking five days a week, after moving out from his parents' house, where he previously had access to their vehicle for commuting from the Mile-End to the West Island for work, to an apartment in Outremont with his partner. Since he started working from home full time, however, he realised that purchasing a vehicle once he moved out would no longer be necessary and has decided to put it off for the time being.

> "So, the original plan was to move out in July [2020], and then basically, get a car, like a used car, so that I could go to work, because before I moved out, the arrangement was I could use my parents' car to go to work, but after moving out, it's kind of no longer the case. But now that we haven't been working from the office, and we're at home, there was no need to buy a car." (R11)

Due to the long distance between his previous residence and work location and the lack of convenient public transportation alternatives, he previously chose to commute to work using his parents' car, which he had access to.

> "I guess the only other option would be public transit, but for me it was quite a pain because of the location it would probably take me close to an hour and a half." (R11)

Instead of purchasing a car, he and his partner have now subscribed to a car sharing service available in proximity to their residence in order to have access to a vehicle for occasional use without incurring the full costs of car ownership.

> "But we still felt like occasional [car] use would be good. So, we got a plan on Communauto. […] It's worked out perfectly. We literally have a parking lot of like four [cars] right next door." (R11)

He also pointed out that as long as he continued to work from home five days a week, purchasing a vehicle would remain unnecessary.

> "Yeah, as long as things continue the way they are, there's no need to [buy a car]." (R11)

He did mention, however, that his employer had recently given an update on the future of telework and that the likely arrangement would require employees to work two days in the office and three days from home:

> "In that case, I would probably go ahead and buy a car. Something practical, but yeah, I would probably buy a car. And even though it's for two days, because I would still be able to use it on the weekend as well." (R11)

In his case, the commute distance and the lack of accessibility by public transportation are strong enough to induce car ownership in the hypothetical scenario where he has to commute to work as little as two days a week. This speaks to the importance of prioritizing teleworking at higher ratios (i.e., a teleworking frequency of 4 to 5 days/week) for employees with the longest commute distances, in order to reduce VMT, greenhouse gas emissions and the need for car ownership.

Another respondent (5) reported having sold her vehicle before the onset of the COVID-19 pandemic, despite using it as her main mode of transportation to work. The motivating factors behind her decision were not directly related to teleworking at first, but it seems that the context of the pandemic and working from home further justified her decision and pushed her towards finding other transportation alternatives, instead of eventually purchasing another vehicle. She was also living with her mother and siblings in LaSalle, an outer-city borough with relatively poor accessibility to the city center by public transport, had some access to her mother's vehicle, and worked in the CBD.

> "…the reason [I sold my car] was because I work in the downtown district, I didn't necessarily need a car to get to work. So, the car was just like a bonus, I guess, for weekends or whatnot. But I didn't need a car to get around per se. And it's just too much to have a car in the

> wintertime. So, I sold it before the winter because I wanted to avoid having to shovel my car out. And I'm so glad I sold it because it would have been awful to have to step outside to shovel my car even though I don't need to step outside to go to work." (R5)

Soon after selling the car, however, she started thinking about purchasing another car for the convenience it provides for making non-work trips.

> "[…] as soon as I sold it, […] the idea started getting back into my head that I might need a car to run some errands. Because running errands that are in proximity, I actually stopped doing them because I didn't have a car and I guess I was becoming a little lazy because as soon as it gets cold outside, you don't want to step outside just for a little errand [...] And so, I figured maybe I'll get a car, but I ended up not getting one just to save money. And I'm glad I didn't." (R5)

The concern over saving money comes up recurringly and seems to be an important factor pushing people, especially younger adults, away from automobile ownership, which confirms findings by Klein and Smart (2017) that lower rates of automobile ownership for Millennials can largely be attributed to economic reasons. Thus, for young professionals who aren't yet financially independent, teleworking practices could be a factor that further pushes this generation away from automobility.

Ultimately, however, she did not purchase another car, and instead was able to find alternatives to owning and driving a car. One solution was to use her mother's vehicle, but this was mainly an option during the period of time when she was not going into work either. Eventually, she opted for purchasing an electric scooter to meet her transportation needs and reach destinations not reachable within walking distance.

> "The only reason why the car was not coming into conflict [with our schedules] during the pandemic is because my mom was not working. […]. And there was a time where she actually had to work and I had to get the car to run errands or go to places that were way too far. And that's where my scooter came in. I would get on the scooter, I would go to the mall, or like the pharmacy or like run little errands that I needed to." (R5)

Not only the scooter a mode of transport in itself, but it also enabled multimodal connections in order to access her mother's car at her place of work, when necessary.

> "But if I needed the car, I would go to my mom's work with my scooter, pick up the car, and then go do my errands […]. The scooter really is like the midpoint in terms of like, errands that need to be done that are not too far, but far enough for me to not do if I didn't have a scooter." (R5)

However, when asked about her preferred commute mode in the face of an eventual return to the office (two-three days a week) she was still inclined towards the car, as she envisaged herself stepping into a new income bracket, getting older and eventually having more responsibilities. The main concerning factor remained the possibility of saving more money while owning a car still isn't a necessity. So, teleworking in the context of the pandemic seems to have provided a window of opportunity for exploring other transportation alternatives, at least in the short term.

> "I would like to say a car because I'm thinking I have a new job so I can maybe afford to have a car more. And also, the fact that I'm a little bit more grown up, I have more responsibilities so having a car would be better. But then again, I also want to keep saving money. So, I don't know if I want to get a car. So, it just depends on that. But if I were to have a good deal on a car, I would 100% take a car, even if it's one day a week to go into the office." (R5)

She did mention, however, that her desire to own a car was also largely due to the fact that she does not live in proximity to mass public transit.

> "I think that if I lived right next to a metro […] I'd be less likely to have a car or want a car. And it's because I live far from a metro and I have to take a bus. And it's the bus that's really a setback, that's it. Like often I've been saying it, you know, having a car is only essential when you're away from a metro." (R5)

Ultimately, her testimony confirms the importance of other factors such as proximity to public transportation, and car costs in determining automobile ownership and use, especially for Millennials, and these factors could easily outweigh any impact that telework may have on automobile ownership.

Additionally, other factors can come into play meaning that getting rid of a vehicle is not an option despite the ability to telework of one or more household members. For respondent 12, for example, getting rid of one of their two household vehicles was not a consideration, given that his wife did not have access to telework and required a vehicle for commuting to work and that he chose to drive to work on occasion, given his hybrid teleworking arrangement.

> "I would say no, [getting rid of the car] hasn't been considered. My wife is a teacher, so she needs to be physically present where she works. Aside from that little period, where it was closed. And I, because of the hybrid nature of my work for being physically present, we still are considering two cars, but not more." (R12)

He also added that active modes of transportation are available options for him, given the short distance of 1 km (2 minutes by car; 10-minute walk) between his residential and work locations. Despite this, he still mainly chooses to drive due to habit and convenience.

> "I've walked, but it was exceptions over the years. But I've looked at biking or walking just for health objectives. […] I think [I drive to work out of] habit, convenience. Also, I will carry things back and forth from my office to my house, whether it's files, folders. Sometimes, because it's my business, I use storage there. […] So, transporting boxes and stuff." (R12)

Further, the presence of young children in a household and the convenience of an automobile for non-work trips are such that abandoning car ownership completely seems quite unlikely, in such cases.

> "As for the car, we don't want to get rid of it because it's practical. In our case, our family doesn't live in Montreal. So, when we'll be able to go visit them again, we'll need the car. And for doing errands it's also more practical. But maybe downgrading the type of car –right now we have an SUV– so maybe going back to something more economical, we have thought about it, yes." (R14)

For this household, having a vehicle allows for a level of comfort and convenience for leisure trips which cannot be afforded by other modes, despite both HHs commuting to work by public transit and living in an inner-city neighbourhood.

5.4 Permanent and temporary urban exodus

In accordance with current trends of households moving from the Island of Montreal towards suburban or rural locations, two respondents mentioned having at least considered the possibility of permanently leaving the city or that the ability to telework could influence the type of location that they would eventually relocate to.

> "Now, because working from home is a large option, and a lot of companies are doing so, I think it gives us more options to choose where we would want to live because I feel like we don't necessarily need to be in the city. You know, I haven't been in the city for over a year. So, it's not necessary. And so like, other places are becoming, you know, more attractive. […]. Working from home has given us the benefit of being able to look anywhere for where to live. (R1)

> "Yeah so, we've considered leaving the city, as a lot of people. Just, we saw, like a lack in being able to access nature, and get away and just be completely free, you know, outside of the city. So, we've definitely considered leaving the city and going into I would say, not even

> suburbs more like, big lands with forest in the back and like, an extreme compared to the city, we've really realized that that's something that we want and like need access to." (R3)

Respondent 3 also mentioned that this was closely tied to feeling the need for an escape from their small apartment situated in a dense urban area, exacerbated by the context of the pandemic.

> "Because obviously, we weren't equipped, like [before] knowing that COVID was happening and working from home was happening, we wouldn't have [moved downtown]. Like we would have, you know, chosen somewhere different and like taken a lot of things into consideration, whereas now we're living in a very small space." (R3)

Moving was also a consideration for respondent 12, not in terms of geographic location, but simply in terms of upsizing their living space in order to better accommodate a home office.

> "I like the location, but now I wish we had an extra room for my office. So not a strong enough need to do so, but it was a consideration: Oh, I'm wondering if we should buy a bigger house for this room". (R12)

However, this also seemed to be due largely to the fact that his children were also learning remotely at the time, which would not be the case any longer in a post-pandemic context, and thus might change this preference.

> "I think what makes that consideration possible is that the kids, after the holidays, had a week or two of remote learning, from home. So, we have a basement, so technically, I thought in the past about creating an office for myself in the basement. But now it's really the two spots that are kind of little nooks and crannies, one for my daughter and one for my son, and those are their desks, if you will." (R12)

Overall, the majority of respondents stated having no intention of changing residential locations due to their ability to work from home, at least for the time being, which puts into question sensational narratives around 'mass city exodus'. A few did mention that it had allowed them to relocate on a temporary basis, however.

> "I did go to my parents' place because I just needed to change environments. And they have much more space and like closed areas where I can host my meetings and like, have a bit of a more effective work environment. So, there was like, a month or so that I went there, not more than a month that I spent there. And I actually really enjoyed it, because I had my space. And I had, you know, like, all of that stuff." (R3)

Two other respondents also mentioned having relocated temporarily due to the freedom granted by their full-time teleworking situation.

> "I decided to relocate for the time being. I am currently in California right now. So, I left about a month ago, and I decided to work from home from here. So, I'm in Los Angeles. [...] my decision to travel [here] is something that I've always wanted to do, but now I'm actually able to do it for a longer period of time because of the fact that I can work from home." (R5)

> "From September to October, I was given the opportunity [to work at my employer's cottage] in the woods. Since we're a creative studio, we said let's try to meet up and get out of the city and go work [there]. We had all the tools we needed, we brought our computers, we brought our creative tools. And since all our clients are delocalized, they're not in Montreal but across Canada, that allowed us to really get out. We were four and a half hours away, in the Pontiac region." (R8)*

Thus, telework provides an unprecedented flexibility in terms of geographic location. If telework is performed full-time, for example, this could result in car acquisition, if households decide to relocate outside of the city or if it increases their desire for short-term outside-city trips. A full-time arrangement could also incentivize more energy-intensive air travel to various destinations, as seen above, given the ability to work from any location. In that case, telework might have a negative effect on VMT and GHG emissions.

In other cases, telework did not seem to have an impact on relocation decisions. One respondent actually reported the desire to move closer to his place of work, since telework would not occur on a full-time basis in the long term and therefore had little to no impact on his residential location preference.

> "Yeah, [I'd like to be closer to my work location] only for the fact that I still need to go in. I think that if that wasn't the case, then I would be okay with where I am. […] The reason would be [to live] somewhere even more accessible, although it already is. The closer to the university or, the workplace, for me is ideal." (R15)

Similarly, another respondent was planning a residential move to an inner-city neighbourhood, located next to a metro station and within walking-distance of his place of work, despite having access to telework now and in the future.

> "Personally, since COVID-19 started, I'm trying to have access to as many transportation options as possible. I know that I can telework and I'm comfortable with it, but at the same time I feel the necessity to have access to the studio [where I work]. I'd like to be able to be

> close-by and get there easily or be able to work from home comfortably and just have access to all these options at my doorstep." (R8)*

Both of these respondents are in their mid-20s and previously commuted to work by active and public transportation. This points to the influence of personal preferences in determining residential location, and especially the tendency for Millennials to prefer urban living and public and active modes of transportation (Lafleur, 2013; Lee et al., 2019; Klein and Smart, 2017), suggesting that for their generation, telework might have less of an impact on residential location.

5.4.1 Urban exodus and car acquisition

Evidence from some of the respondents suggests, however, that these trends of temporarily escaping urban areas could lead to an uptake in car ownership and car use. Respondent 8, for example, mentioned having acquired a personal vehicle over the summer, since moving back in with his parents in an outer-city area, and that one of the main factors influencing this decision was the prospect of being able to drive back and forth to his employer's cottage where they were all working from for some time.

> "I also purchased the car to give myself the opportunity to go to my employer's cottage. It was a bit like an outside-city studio. It was four and a half hours away from here and I had to be able to go without depending on anyone else. […] we'd go back and forth: I'd go for two weeks, then come back to Montreal one week and work from home, and then go back for another two weeks. So, I preferred to buy a car." (R8)*

Similarly, respondent 3, had been considering purchasing a car with her partner in order to be able to take leisure trips and escape the city to be in nature.

> "I have thought about [getting a car] just because being in the city during the pandemic, and working from home, I like to get out as much as possible. And I feel like we've considered it just to be able to go out in the country and go on hikes and sort of get out of where we're living. So, I guess in that sense, yes, I considered getting a car. Not an STM pass, obviously, because that wouldn't bring me far enough to go on a hike or experience nature. But yeah, it was really just with the motive of being able to get out of the city and having that sort of flexibility." (R3)

Of course, the restrictions brought on by the pandemic likely fuelled this need further, as workers spent months stuck in their homes and regular leisure and social activities had mostly come to a halt.

Nevertheless, these types of activities outside of the city require the speed, comfort and flexibility of driving, which public transport is usually inadequate for.

5.6 Public transportation

In the context of the pandemic, public transportation use has fallen substantially, and the long-term prevalence of teleworking practices may pose a threat to the long-term sustenance of mass public transportation systems. In accordance with recent reports of falling transit ridership by Statistics Canada (2020) and the STM (2020), all of the respondents who previously commuted to work by public transport reported no longer or rarely using public transport for all types of trips since taking up full time telework at the onset of the pandemic.

> "I think it's been a while since I recharged my public transit pass. If I do go out using public transit, which is rare, I will just pay the fare." (R15)

> "[Since I've been working from home] I use the metro less. I don't use it at all, I don't need to use it. Since the confinement I've been able to avoid buying a metro pass, in March it'll be a year already." (R19)*

> "My [yearly] public transport pass has already been – not cancelled but suspended. They suspended them for those who wanted it. As long as I'm working from home [that'll be the case] and I'll be able to reactivate it as needed." (R14)*

Further, of all ten respondents, the only ones who previously purchased monthly public transport titles were those who used it for commuting to work in the CBD. These titles were mainly used for commuting to work or occasionally going downtown, but rarely for any other type of trip, supporting data analysed by Savage and Turcotte (2020) and the Toronto Foundation (2020) which pointed towards the prospect of downtown office workers representing an important share of regular transit users and of fare revenues.

> "I used public transport mostly for going downtown. But if I was going anywhere outside of downtown, I would use the car." (R19)*

> "It was pretty rare [that I'd take public transport other than to go to work]. It was maybe for the occasional outing when you know you can't drive, to go to a restaurant and have a few drinks, for example." (R14)*

Nevertheless, all previous public transport users stated that in the context of a hybrid working arrangement, they would likely return to their previous commuting habits, albeit with some slight variance, contrarily to recent studies which find some reticence to go back to this mode in the long term (Deloitte, 2020; Gobeille and Raque, 2020).

> "I think I'll eventually go back to using public transportation to get to work, unless I have to transport certain volatile substances, so about 10% of the time I'd take my car." (R15)

> "In the event of a return to [in person] work, public transport will remain the main mode of transport I'll use. I'll likely change the type of travel pass I buy, but it'll depend on what the telework to office ratio will be." (R14)*

> "I would go back to my previous mode of transportation, the metro and walking to the metro, because it's very difficult to find parking at my place of work in the old port and because I want to prioritize public transport, too. If we go back to [in-person] work this summer, if there is a possibility to do two or three days at work, I'd look into the possibility of going to work by bicycle. It could take me about 45 minutes to one hour." (R19)*

For the two respondents (both male, mid-20s and inner-city residential location) who did previously use public transport for non-work trips, the recent reduction in use of this mode can mainly be attributed to the context of the COVID-19 pandemic and public health concerns, over any other factors, in accordance with Statistics Canada's findings (Savage and Turcotte, 2020).

> "Well, it's not necessarily because of working from home, it's more because of the whole pandemic situation. Because I never use public transit [nowadays]. I think I used it one time since the whole pandemic." (R11)

> "In the last few months, I don't think there was a significant change [in terms of my mode of transportation] maybe a little bit more towards the vehicle when I understood the impacts of the pandemic." (R15)

Thus, the short-term decline in public transport use may not translate into a long-term trend. Levels of public transportation use may return to near normal levels once the general population is vaccinated and COVID-19 pandemic health concerns become null, but this still remains uncertain. It seems, however, that the partial return of previous transit users to their downtown offices is a crucial element in ensuring the long-term viability of mass public transportation systems.

5.7 Active transportation

Since working from home has become more prevalent, for some respondents, active transportation has taken on a new importance not only as a mode of transport for nearby necessities, but as a leisure activity to help counter some of the downsides to working from home during the COVID-19 pandemic: the sense of isolation and lack of physical movement.

> "I'll still walk, but it's less with a purpose of like getting groceries or getting whatever, I'll just walk for fun and like just to get out of the house and like, add a bit of, you know, interaction, I guess, and like just seeing what's out there and not being stuck in this little place all day." (R3)

Respondent 9, who expressed a reduction in VMT work, also expressed walking a lot more for her non-work-related trips. Whereas she previously partook in trip-chaining activities, stopping for errands on her way home from work by car, she has instead shifted towards walking as a means of transportation and of simultaneous physical activity.

> "When I started working from home, as well, I would tend to work through my lunch or maybe take half an hour instead of an hour... But more recently, I would say that four times a week, I prefer to go out and have my walk at lunch. So that's when I would go and get if I needed something for supper at the grocery store. I would go on my lunch to get out and move. Or if I didn't need anything at the grocery store, I would just go and do my hour walk." (R9)

Similarly, respondent 19, a female in her 40s living alone in an inner-city neighbourhood who previously commuted to work by public transportation, claimed to have shifted from mainly using her car for non-work trips to walking, instead.

> "I'm using the car less. The car, I really just use it when I need things that are really far from my home. […]. I try to do smaller trips, to walk, to shop much closer to my home. Before, I'd take the car to go buy something, but now I try not to take it. I try to take the opportunity to walk, to buy something a bit further but to walk there. I also avoid taking public transportation, since I'm home all day, and when I get the chance to get out of the house, I'd rather take a walk." (R19)*

This point to the potential of working from home to promote physical activity, in line with Lachapelle et al.'s (2018) research, and active modes of transportation to non-work locations for both suburban and inner-city neighbourhood residents. It also highlights the importance of providing quality active transport

infrastructure along with walking-distance essential amenities within residential neighbourhoods, especially in areas more favourable to car ownership and use.

5.8 Online shopping

Some respondents also reported resorting a lot more to online shopping than before. Since trip-chaining is no longer a viable practice while working from home full time, online shopping makes it easier to avoid outings for a single purpose.

> "And, you know, I guess I do, like, when I can, I'll buy online, you know, just to avoid having to step out." (R3)

> "I have not been to the mall since March of last year […] [because I've been] online shopping. (R1)

This is in line with KPMG's findings that shopping trips by car in the U.S. have declined since the pandemic partly due to the practicality of online shopping. Nevertheless, online shopping doesn't translate to net reductions in traffic congestion and pollution, as it implies packaging and emissions from delivering packages to consumers' doorsteps (Chung, 2018).

5.9 Work-related air travel

Though not a predominant theme, some discussion around the future of work-related air travel did arise and provides some clues towards the potential of virtual conferences and events in replacing some in-person meetings and air travel. Thus, this type of behavioural change could have an impact on greenhouse gas emissions if adopted at a large enough scale.

> "Yes, [the virtual conference] went well. It was the same inscription method as before, and you chose the sessions you wanted to attend. It hasn't changed, but what was nice is that instead of it being just me travelling to this event, now they made it free, so I was able to share it with many of my colleagues and we were able to watch some sessions together and discuss them. This was made possible since the event was free. […] I do think that [these conferences could continue to be done virtually in the future]." (R14)*

This theme also came up in the first round of interviews in June 2020, earlier on in the pandemic:

> "I think there will be a reduction in the number of meetings that expect people to be there in person. So, I don't think that we'll go back to flying to Toronto for one-day meetings again. I think it was a bit of a test, and it turns out that [virtual meetings work]." (R21)

> "Even from an environmental standpoint, for example, [telework] involves a lot less consumption in transportation, fuel, etc. and now with COVID I think it will accelerate this process […] There's also the question of air travel, trips and flights. There are many activities that now people are saying it probably isn't necessary to spend a fortune to go to a meeting if it can take place virtually. So yes, I think it will have an important positive impact in terms of resource and time savings, the environment and quality of life." (R17)*

Thus, not only do virtual conferences and meetings have the potential of reducing GHG emissions by replacing in-person encounters and reducing related air travel, but they also present other advantages such as becoming accessible to a wider public by virtue of being accessible online. This also aligns with research findings by Kitou and Horvat (2006) and Zhu and Mason (2014) which point to the potential of telework as a GHG reduction strategy.

6.0 Discussion

Overall, the type of effect that telework may have on transportation behaviour seems to depend on a variety of external variables, including household composition, residential location and the frequency of teleworking days in a week. Several threads emerged from the ten interviews, some of which shed some light on the broader themes and findings from recent literature.

For instance, reductions in VMT seem to be greatest for respondents who live in suburban or rural areas and previously commuted by car or who simply had very long commutes, regardless of their residential location. This aligns with recent survey findings of people reporting driving a lot less in the context of the pandemic, and points to the absence of long car commutes due to teleworking as a potential source of these savings.

Further, evidence from the interviews calls into question the validity of narratives around 'mass city exodus', as nearly all respondents reported having no intention of relocating to a suburban or rural area, with the exception of one respondent. This suggests that moves away from cities might have been of a temporary nature, as seen in some of the literature, or that the pandemic simply accelerated pre-existing trends or preferences for outside-city living, rather than causing a major, long term shift.

Additionally, respondents who previously commuted by public transport to the CBD all reported no longer using this mode, suggesting that the important reductions in public transport ridership and fare revenues across North America may be in part related to the prevalence of white-collar workers working from home. However, these respondents also welcomed the idea of shifting back to using public transport once they returned to working on-location and once the pandemic risk was null. This provides a sign of hope that public transport ridership levels may return to near-normal levels in a post-pandemic context, provided that white-collar workers eventually return to offices at least part of the work week.

Also, evidence from the interviews seems to point to the potential of telework and online meeting spaces in reducing the need for work-related meetings and conferences which require air travel, which could result in some benefits in terms of greenhouse gas emissions reductions.

On the other hand, the flexibility that full time telework enables may also result in more energy-intensive transport behaviour. For instance, some evidence indicated an increased demand from urbanites for short and longer outside-city leisure trips, given their ability to work from any location, which seemed to induce

demand for car ownership, in order to achieve this. Indeed, the desire to travel to remote locations, on a regular and flexible basis, while being able to transport equipment (i.e., skis, bicycles, etc.) is not easily accommodated by other modes nor by car sharing services. Evidence of temporary relocation to rural areas is in line with evidence of wealthier New York City residents leaving to second homes on a temporary, rather than permanent basis. Further, this signals that urbanites wanting to escape the city might be another explanatory factor behind survey findings of intentions of buying a car in the near future, rather than simply being attributed to pandemic-related fears around shared modes. Thus, if an increased demand for outside-city trips is enabled by full time teleworking practices, automobile ownership and use may follow and lead to an increase in VMT and GHG emissions.

Some evidence also suggested that teleworking full time enabled the possibility of traveling by air and working from any location, which would inevitably imply greater energy-consumption related to air travel, if this behaviour is taken up by enough workers.

Additional points also emerged from the interviews which haven't been pin-pointed in recent surveys findings but that provide supplementary clues regarding the effect of telework on transportation behaviour.

For instance, some evidence points towards teleworking as an additional factor that may push younger professionals, or Millennials, away from automobility. That is, the commute seems to be an important factor determining the necessity of owning a car. Thus, eliminating the commute, through full time telework, may eliminate the need for car ownership for a few younger respondents, at least in the short term, as a few respondents were able to put off the purchase of a vehicle or considered getting rid of theirs. Instead, full time teleworking seems to have provided a window of opportunity for exploring other transportation alternatives to car use and ownership such as car-sharing services and e-scooters, in order to meet needs regarding non-work and leisure trips.

Further, some evidence also confirms the importance of additional factors, such as proximity to major transit stops and the cost of car ownership, in determining car ownership and use, especially for Millennials. For instance, some evidence suggests that in a full-time teleworking scenario, a young professional is less likely to get rid of a car that is fully paid off than of one which involves important monthly payments. Some evidence also aligns with existing literature pointing towards young professionals' tendency to prefer living in urban areas and traveling by active and public transport. This

suggests that teleworking may have less of an impact on the desire of Millennials to relocate outside of urban areas. It also suggests that if Millennials who don't own a car also have good access to public transport, they may be less inclined to shift to automobility if they take up teleworking, especially if car ownership represents a high enough cost relative to their income.

In other cases, however, teleworking and the pandemic seemed to have little effect on car ownership or car use. This was especially the case for respondents living in suburban areas with poor access to transportation alternatives. For others, especially larger households with children, private vehicles served an important purpose for non-work trips such as running errands or visiting family, which isn't easily afforded by other transport modes. Additionally, some evidence suggests that even for Millennials, having a long commute alone is enough to entice car ownership, such that it would only be avoided in the context of full time telework.

7.0 Conclusion

While the long-term impacts of teleworking on society and transportation behaviour remain uncertain, the evidence from this study indicate that telework could potentially be a factor, among others, that helps gear people towards more sustainable transportation habits and lifestyles. If not carefully implemented, however, it could also have a reverse or neutral effect, and lead to more energy-intensive behaviour.

Specifically, teleworking full time seems to have potential in reducing work-related miles driven for workers with long commutes, especially those residing in non-urban areas with poor access to public transportation. It also seems to have potential in reducing work-related air travel for meetings and conferences, as these are replaced with virtual meetings. Further, full time telework shows potential in pushing younger professionals away from automobile ownership, or at least post-poning this event.

On the other hand, it seems that telework could lead to reductions in public transit ridership if taken up full time by workers who commute by this mode, which could result in service cuts which would hurt low-income and vulnerable populations, who rely on this service, the most. Further, full time teleworking could also lead to a greater demand for short-term trips or permanent relocation outside urban areas, both of which involve more car-dependent lifestyles. Further, teleworking may have little to no effect on car use and ownership for workers residing in suburban or rural areas and for workers with children or other responsibilities.

Given the dependence of teleworking effects on the built environment, there is a role for planning and policy to help harness the benefits of telework and mitigate the undesirable effects that may arise from its uptake. For instance, in order to retain teleworkers in urban areas, planners should prioritize investment in existing inner-city neighbourhood amenities and public spaces, especially in the creation of 'third places' such as coffee shops, which can accommodate teleworking practices while enabling passive social behaviour. Further, planners should aim to promote walking and cycling for short trips within suburban and rural areas by improving active transportation infrastructure (i.e., bicycle paths, safe crosswalks, street furniture, etc.) such that these modes become pleasant and convenient options instead of driving for teleworkers already living there. In order to limit urban sprawl, planners should implement strict green belt policies, place firm limits on the development of agricultural land and develop programs to densify existing suburban neighbourhoods. Transport agencies should also implement more flexible and advantageous fare systems to ensure the sustained use of public transport by teleworkers and help

retain younger professionals away from automobility. Lastly, transport planners should improve high-speed inter-urban and regional public transport infrastructure in order to better meet the needs of urban dwellers wanting to travel outside of the city for leisure purposes.

It's important to interpret the outputs of this study bearing in mind that teleworking practices were juxtaposed with the effects of the pandemic and its related restrictions, such as the ban on social gatherings, the closure of most places of commercial activity and recreation and the 8 p.m. curfew that has been in place in Quebec since January 9th 2021. Therefore, the impact on non-work trips was severely curtailed. Further, the follow-up interviews (10) do not focus on a specific type travel mode to work or residential location, instead, each one serves as a case study to be interpreted in light of recent findings. Additionally, most of the recent findings from surveys on post-pandemic behaviour rely on stated preferences and impressions, which don't necessarily reflect actual future decisions and outcomes. Similarly, interview questions about future work, residential and travel behaviour may be distorted. For instance, a hybrid work arrangement, in the future, may be more complicated in reality than respondents currently imagine. For example, holding group meetings may be more difficult with half the employees being in person and the other half online. Further, workers who are home and not at the office may feel that they are missing out on efficient exchanges of information, casual interactions and the general work environment (Cohen, 2021). On the other hand, telework may also prove to be easier post-pandemic, when childcare and children being at home instead of at school is no longer an issue.

It is difficult at this stage to explicitly distinguish between effects brought on by the COVID-19 pandemic and those brought on more directly by teleworking practices, which poses limitations on the interpretations of the results of this study. In time, once we enter a post-pandemic context, assuming that teleworking practices are maintained, studies will better be able to determine the direct effect of telework on transportation behaviour. Further research could also aim to distinguish between the effects of teleworking on workers in different types of locations and between workers with different transport modes to work.

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