Travel Behaviours and Level of Physical Activity in Transit-Oriented Developments

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TRAVEL BEHAVIOR AND LEVEL OF PHYSICAL ACTIVITY IN TRANSIT - ORIENTED DEVELOPMENTS

Supervised Research Project Report
Submitted in partial fulfillment of the Master of Urban Planning degree

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April 2015

Acknowledgements

I would first like to thank my supervisor Ahmed El-Geneidy for his guidance and support throughout my research and my Masters degree. Without you, I would have not become the young professional that I am today. Our collaboration prepared me to enter the employment market. I will always be grateful for your availability and your faith in me.

I am also grateful to Rania Wafi who acted as my second reader and who also gave me strong support on the statistical approach developed. Special thanks to Dea van Lierop, second author of the first chapter, for her review, comments and edits. Her friendship and constant advice helped me become a better researcher and pass through this process. I would also like to express my gratitude to all of the members of the Transportation Research at McGill (TRAM). Their friendship and support is gratifying and extremely humbling.

The last two years have been challenging, wonderful, and rich in academic and professional formation and full of marvellous meetings. I will never forget all those whom I encountered at McGill. Thanks for your support and patience while I learned Shakespeare's language. This experience would not have been the same without you. I hope all these new friendships will last forever. For those who are leaving, I am sure that our paths will surely cross once again…

This research was made possible by funding provided by the Natural Science and Engineering Research Council of Canada (NSERC) and The Netherlands Organization for Scientific research (NOW). I would also like to gratefully acknowledge professor Kees Maat from Delft University of Technology in the Netherlands for his input on the survey design.

Finalement, merci à mes parents et mes proches qui ont su m'écouter lorsque mes doutes prenaient le dessus sur moi. Grace à votre confiance en mes capacités, j'ai su trouver la motivation nécessaire pour mener à terme mes études…du moins pour le moment.

Abstract 1

It is suggested that one of the solutions for mitigating the detrimental effect of motor vehicles on society is to implement Transit-Oriented Development (TOD). This type of development is intended to reduce automobile use and urban sprawl as well as to provide communities with more socially, environmentally, and economically sustainable neighbourhoods that offer a variety of mobility choices. This paper attempts to find out whether new TOD residents adopt more sustainable modes of transportation after their relocation. The analysis determines which factors influence travel mode switching decisions by specifying a multilevel multinomial logistic regression model. Data for the analysis are drawn from a travel behaviour survey conducted on residents in seven different North American TODs in 2013. Our results show that TOD newcomers adopt more sustainable travel modes for amenities and leisure trips, whereas they are less likely to do so for work and shopping trips. To encourage more sustainable travel modes, our findings suggest that transit incentives coupled with workplace parking charges need to be considered. Awareness of the environmental impact of each travel mode, walkability of the neighbourhood and availability of various destinations as well as proximity to transit stops are factors that increase the probability of switching to a more sustainable mode of transportation for new TOD residents. However, larger household size and becoming a homeowner, as well as the addition of a new car, have a negative impact. Findings from this research provide new insights into TOD planning and its link to travel behaviour that can be of benefit to planners, engineers and policy makers adopting this approach of development with the goal of mitigating car usage.

Keywords: Transit-oriented development, travel mode choice, sustainable, multilevel multinominal logistic regression

Résumé 1

L'une des solutions proposées pour atténuer les effets néfastes des véhicules automobiles sur la société est l'aménagement de développements orientés sur les transports (TOD). Ce type de développement vise à réduire l'étalement urbain et à réduire l'usage des voitures tout en augmentant l'accès à d'autres modes de transport. En théorie, les TODs permettent d'offrir des quartiers plus socialement, économiquement et écologiquement durables. Cette recherche tente de découvrir si les nouveaux résidents des TODs adoptent des modes de transport plus durables après leur déménagement. Cette recherche utilise une régression logistique multinomiale à plusieurs niveaux pour déterminer quels sont les facteurs qui influencent la décision de changer de mode de transport. Les données utilisées dans cette étude proviennent d'un sondage, réalisé en 2013, sur les comportements de déplacement des résidents de sept différents *Transit-Oriented Developments* (TOD) nord-américains. Nos résultats montrent que les nouveaux arrivants dans les TODs adoptent des modes de transports plus durables pour leurs déplacements notamment vers diverses aménités et lieux de divertissement. Ils sont néanmoins moins susceptibles d'adopter des modes de transport plus durables pour leur déplacement vers le travail et pour le magasinage. Pour encourager l'utilisation de mode de transport plus durable, nos résultats suggèrent de combiner l'utilisation d'incitatifs au transport collectif avec la mise en œuvre de stationnement payant sur les lieux de travail des individus. Plusieurs facteurs augmentent la probabilité que les nouveaux résidents dans les TODs adoptent des modes de transport plus durables; les gens qui sont sensibilisés aux impacts environnementaux des différents modes de transport, la *marchabilité* des quartiers, la disponibilité de diverses destinations ainsi que la proximité à un arrêt de transport en commun. Cependant, les ménages plus nombreux, ceux qui deviennent propriétaire ou qui font l'acquisition d'une nouvelle voiture voient leur probabilité d'adopter des modes de transport plus durables diminuer. Les résultats de cette recherche permettent de dégager de nouvelles connaissances sur la planification de TODs et sur les liens qui existent entre ce type d'aménagement et les comportements de déplacement des individus. Les résultats de cette recherche guideront les urbanistes, les ingénieurs et les décideurs publics qui voudront aménager et encourager ce type de développements pour notamment atténuer les effets négatifs de l'utilisation des véhicules à moteur sur l'environnement.

Mots clés: Développement orienté sur les transports, choix de mode de transport, développement durable et régression logistique multinomiale à plusieurs niveaux.

Abstract 2

Physical inactivity is a growing concern in developed countries. The economic cost of an inactive lifestyle is a real burden to western democracies. In a world where resources need to be allocated in the most efficient and effective manner, solutions to ameliorate the overall health of individuals require us to be innovative. It is suggested that the promotion of physical activity through non-leisure activity can achieve physical activity levels that provide substantial health benefits. This study attempts to 1) define who achieves the weekly-recommended level of physical activity through their utilitarian trips (school, work and grocery shopping trips), and 2) identify which factors influence individuals' level of physical activity while controlling for seasonality. Two log-linear regressions models are developed to accomplish these objectives. Data for the analysis are drawn from a travel behaviour survey conducted on residents in seven different North American Transit-Oriented Developments (TODs) in 2013. Results indicate many potential interventions and strategies that could be used by planners and policy makers to facilitate and encourage the transition to a more active lifestyle. Environments designed to encourage transit use, such as TODs, seem to be promising since transit users, among all type of commuters, are more likely to be physically active. Negative effects of bad weather conditions on active modes of transportation need to be mitigated by transit agencies and local governments in order to keep people active year-round. The use of reduced transit fare is suggested for individuals at risk of switching to a less sustainable travel mode under unpleasant weather conditions. The study also raises the issue of the growth of teleworking and teleshopping on health since these habits reduce the weekly number of trips and opportunities to exercise for individuals. Finally, findings from this study suggest that special care is needed to remove social stigma related to the need to own an automobile.

Keywords: Physical activity, utilitarian trips, transit, cycling, walking, health, transit-oriented developments

Résumé 2

L'inactivité physique est un sujet d'inquiétude croissant dans les pays développés. Le coût économique engendré par un mode de vie inactif est un réel fardeau financier pour les démocraties occidentales. Dans un monde où les ressources doivent être allouées de la manière la plus efficiente possible, les solutions pour améliorer la santé générale des individus doivent être innovantes. La promotion de l'exercice physique à travers des activités pratiquées en dehors du temps dédié au loisir, comme lors des déplacements, permettrait d'atteindre un niveau d'activité physique ayant des effets positifs sur la santé. Cette étude tente 1) de déterminer qui réussi à atteindre le niveau d'exercice physique recommandé par semaine simplement en effectuant ses déplacements de nature utilitaire (Déplacement vers l'école, le travail et l'épicerie) et 2) d'identifier quels sont les facteurs qui influencent le niveau d'activité physique des individus tout en contrôlant pour l'effet des conditions climatiques. Deux modèles de régressions log-linéaires furent développés pour accomplir ces objectifs. Les données utilisées dans cette étude proviennent d'un sondage, réalisé en 2013, sur les comportements de déplacement des résidents de sept différents *Transit-Oriented Developments* (TOD) nord-américains. Les résultats ciblent plusieurs types d'interventions qui pourraient être utilisées, notamment par les urbanistes, planificateurs et décideurs publics, pour encourager la transition vers un mode de vie plus actif. Les environnements conçus de manière à encourager l'utilisation des transports collectifs (TC), tels que les TODs, semblent prometteurs si l'on tient compte du fait que les usagers du TC sont plus susceptibles d'être actifs. S'ils veulent faire en sorte que les personnes soient actives à longueur d'année, les agences de transports et les municipalités doivent tenter d'atténuer les effets négatifs des mauvaises conditions climatiques sur les transports actifs. Les résultats suggèrent aussi l'adoption d'un tarif de TC réduit ciblant les individus qui sont plus sujets à opter pour l'utilisation d'une voiture lors de conditions climatiques désagréables. Cette étude soulève aussi l'enjeu du télétravail et du magasinage en ligne comme étant potentiellement nuisible au niveau d'activité des individus puisque ces nouveaux comportements réduisent le nombre de déplacements hebdomadaire et donc les opportunités pour actif. Finalement, les résultats de cette étude suggèrent qu'une attention particulière est nécessaire pour enrayer les préjugés sociaux liés à la nécessité d'être propriétaire d'une automobile.

Mots clés: Activité physique, déplacements utilitaires, transport en commun, vélo, marche, santé, développement orienté sur les transports

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Preface:

The human community faces an array of choices about the quality of our lives and the state of the global environment. Each choice we make will determine what kind of world our children will live in. While many international organizations are joining their efforts to conserve biodiversity, reduce the risks of climate change, protect the ozone layer, clean up international water, stop land degradation, and eliminate persistent organic pollutants, local actors can also play a determining role in the attempt of meeting the challenge of sustainability.

Development of efficient and sustainable transport systems and communities is essential to reach sustainability. Sustainable transportation systems have many health, economic, environmental, and social benefits. For instance, increased use of walking, cycling and public transit can:

- Increase physical activity
- Reduce health care costs
- Reduce air pollutants
- Reduce sprawl growth and conserve natural habitat
- Support community-based businesses and increase social interaction

To achieve sustainable transport systems, decision makers, transit agencies and local authorities must try to reverse the trend of rapidly increasing car ownership and use by proposing innovative solutions and new housing developments. Transit-oriented development (TOD) is an exciting approach to build a city and new neighbourhoods, where more people walk, cycle, and use transit than they do today. TODs integrate transportation, land use, and development by concentrating housing, shopping, and employment along a network of walkable and bikeable streets within a five- to ten- minute walk of a transit station. They are intended to provide more sustainable transportation choices, diminish car usage, and improve health through increased physical activity.

This Supervised Research Project (SRP) explores how transportation planning in TODs can advance lasting prosperity by valuing the health of the planet and its people. More specifically, the first chapter of this SRP tries to determine whether new residents alter their travel habits and

start using more sustainable modes of transportation after relocation to a TOD. The first chapter uses a multilevel multinomial modeling technique to better understand the factors leading to changes in individuals' daily mode choices after relocating to a TOD. The first chapter was presented at the 94th Transportation Research Board conference and was accepted for publication in the Transportation Research Record as Langlois, M. van Lierop, D., Wafi, R. & El-Geneidy, A. (2015). Chasing sustainability: Do new TOD resident adopt more sustainable modes of transportation? Using the same data, the second chapter attempts to disciver who achieves the weekly-recommended level of physical activity through their utilitarian trips. It also identifies which factors influence individuals' level of physical activity while controlling for seasonality. This second chapter has two objectives; 1) evaluate whether promotion of physical activity through non-leisure activity can achieve physical activity levels that provide substantial health benefits, and 2) determine to which extent TODs and built environment characteristics can hinder or foster physical activity.

Chapter 1

Chasing Sustainability: Do new TOD residents adopt more sustainable modes of transportation?

Introduction

Urban problems such as congestion, sprawl and greenhouse gas emissions caused by 20th century land use practices have motivated local governments to address these challenges by planning more sustainable neighbourhoods. Transit-oriented development (TOD) is one approach that claims to help reduce automobile dependency by making other modes more accessible and available, by reducing distances between trip origins and destinations, and by designing a more enjoyable walking environment (Cervero, Murphy, Ferrell, Goguts, & Tsai, 2004; Chatman, 2013). TOD is a widely used term that refers to a municipal development strategy aiming to create accessible, diverse, dense and compact communities that are socially, environmentally, and economically sustainable. In other words, it is a development strategy designed to reinforce mass transit use for home-to-work trips, as well as the use of active modes, such as walking and cycling, for daily errands (Still, 2002). The use of active modes is facilitated by the fact that a TOD's area can be covered within a ten-minute walk. TODs are most commonly built surrounding rail stations and attempt to develop these places into visually appealing and multi-functional areas. As an alternative to being developed around rail, TOD can also be built around other major public transportation nodes such as bus rapid transit stations, but this occurs less frequently. TODs' potential benefits are intended to reach the principles of sustainable development.

While studies have long found that households located near rail stations have higher rates of transit use compared to those located farther away (Cervero, Ferrell, & Murphy, 2002; Cervero & Gorham, 1995; Chatman, 2006), to our knowledge there are no studies determining whether new TOD residents alter their habits and start using more sustainable modes of travel. This paper attempts to understand the factors leading to changes in individuals' daily mode choices after they have relocated to a TOD compared to their travel mode choices at their previous residential location. To understand these changes, this analysis uses a multilevel multinomial modeling technique.

Literature review

Travel behaviour has been intensively studied over the last decades. The previous studies presented in Table 1 demonstrate that travel mode decisions are based on multiple influential factors, such as socio-demographics, built environment characteristics, and individual' attitudes.

Household and individual socio-demographics characteristics strongly influence travel mode decisions (Bhat, 1997; Bhat & Sardesai, 2006). According to one study, men are more likely to switch to modes other than private cars, but women are more likely to ride public transit than men (Curtis & Headicar, 1997). Another study shows that age is often positively associated with the use of motorized vehicles and usually negatively related to walking and cycling (Schwanen, Dijst, & Dieleman, 2001). However, the observed relation is different for seniors. For example, Hensher (2007) confirmed the presence of a modal change, which may partly be the result of losing their driver's license, starting at the age of 65. The change goes first from being the driver of a car to being a passenger, and then to using transit. Lower income is usually associated with higher transit use, even when accounting for self-selection (Cao, Mokhtarian, & Handy, 2009). Level of education was also found to be significant in affecting travel mode choice, but findings from the literature are mixed in this case, since education can be an indicator of either poverty or different social-environmental awareness. De Witte, Machanis and Mairesse (2008) found that highly educated people are far more likely to commute by car, while commuters belonging to lower educational level are more likely to use the train. Alternatively, Carse et al.'s (2013, p. 33) results suggest that lower level of education is linked more to car use for leisure, shopping, and short-distance commutes. Possession of a driver's license and access to a car also have a significant effect on changes in mode use (Scheiner & Holz-Rau, 2013). In addition, individuals with more complex commutes (e.g. multiple stops such as dropping off children) or with busy agendas usually prefer to use cars (Eriksson, Friman, Ettema, Fujii, & Gärling, 2010; Strathman & Dueker, 1996; Ye, Pendyala, & Gottardi, 2007).

Characteristics of the built environment also play a prominent role in determining the favoured travel mode choice of individuals for each type of trip. However, individuals with an inclination to commute using public transportation or active modes also tend to locate themselves

in walkable neighbourhoods with sufficient access to transit (Chatman, 2006, 2009; Manaugh & El-Geneidy, 2014). This observed tendency is known as residential self-selection. Controlling for self-selection is important in travel mode choice studies. It can be accomplished by asking which criteria people have considered when choosing their current neighbourhood (Cao et al., 2009; Chatman, 2003; Chatman, 2006, 2009; Krizek, 2003; Manaugh & El-Geneidy, 2014). This control avoids to over- or under-estimate the built environment's characteristics in the analysis (Manaugh & El-Geneidy, 2014). The most studied built environment characteristics are density, land use, pedestrian-oriented design, and accessibility to multiple services (See Table 1). In short, empirical research has found that there is a higher use of active modes and transit in neighbourhoods that are more walkable, have a higher density, and a diverse land use mix (Cervero & Kockelman, 1997; Hess, Moudon, Snyder, & Stanilov, 1999).

Other studies argue that the use of non-motorized modes is more likely where there is more paid parking (Cervero & Kockelman, 1997; Kingham, Dickinson, & Copsey, 2001; Scheiner & Holz-Rau, 2013). For example, in his research on the Chicago Transit Authority's (CTA) rapid transit system, Chung (1997) found that parking availability was one of the most significant factors explaining ridership, while Lari et al. (Lari, Douma, Lang Yang, Caskey, & Cureton, 2014) observed that transit fare incentives coupled with higher parking prices increased ridership. For Carse et al. (2013), free workplace parking and commuting distances were strongly related to car use for commuting trips. As Kingham et al. (2001) made clear, all these studies suggest that increasing the cost of using a car results both in a shift to alternative modes and in a choice to live closer to one's workplace. Longer trips also affect the propensity for transit and car use (Eluru, Chakour, & El-Geneidy, 2012; Nurdden, Rahmat, & Ismail, 2007). Nevertheless, access to transit from home is also a criterion taken into account in studies on travel mode choices (Cervero, 1994; Nurdden et al., 2007). Finally, satisfaction with the mode used for diverse trip purposes, combined with pre-existing attitudes or perceptions towards different travel modes, influence mode switching (Abou-Zeid & Ben-Akiva, 2012; Abou-Zeid, Witter, Bierlaire, Kaufmann, & Ben-Akiva, 2012; Chatman, 2003).

Table 1. Literature review

Type of variables	Expected relation on: Driving	Transit	Active mode	References
Socio-economic				Bhat 1997, Bhat and Sardesai, 2006; Schimek, 1996; Shen, 2000.
Sex (Female)	-	+		Curtis & Headicar, 1997; Nurdden et al. 2007.
Age	+	-	-	Hensher, 2007; Mercado et al., 2010; Scheiner & Holz-Rau, 2013.
Household size	+	-		Scheiner, 2010.
Education level	M	M	M	Carse et al., 2013; Schwanen et al., 2001; Tacken, 2008; de Witte et al. 2008.
Income	+	-		Chatman, 2006; Mercado et al., 2012; Moniruzzaman & Paez, 2012; Schimek, 1996.
Number of vehicle in household	+	-		Scheiner & Holz-Rau, 2013, chatman, 2013.
Constraints (Children, busy agendas, trip chaining)	+			Eriksson et al. 2010; Strathman & Dueker 1996, Ye et al., 2007; Scheiner, 2010; Hensher and Reyes, 2000.
Driver's license	+	-		Chatman, 2006.
Built environment				
Mixed-use environment	-	+	+	Boer et al. 2007; Cervero & Gorham, 1995; Frank et al,. 2000; Kockelman, 1997; Hess et al. 1999; Srivasan & Ferrreira 1999; Saelens et al., 2003; Scheiner & Holz-Rau, 2013.
Origin density	-	+	+	Chen, 2008; Kitamura et al., 1997; Kockelman, 1997; Hess et al., 1999; Messenger & Ewing,1996; Ross & Dunning, 1997; Saelens et al., 2003; Scheiner & Holz-Rau, 2013; Strathman and Dueker, 1996.
Destination density	-	+	+	Cao, Mokhtarian, & Handy (2009), Chen, 2008; Frank et al., 2000; Messenger & Ewing 1996; Schimek, 1996.
Employment density	-	+	+	Buch & Hickman, 1999; Ewing 1997.
Pedestrian environment (Pedestrian connectivity, Ease of street crossing, Safe surroundings, etc.)			+	Cervero & Kockelman 1997. Chatman 2006; Greenwald and Boarnet, 2001; Greenwald, 2003.; Hess et al., 1999; Saelens et al., 2003.
Time, distance and accessibility				
Travel distance	+	-	-	Carse et al., 2013; Scheiner, 2010.
Travel time	+	-	-	Eriksson et al. 2010; Eluru et al., 2012; Nurudden et al., 2007; Limtanakool et al., 2006.

Employment & amenities accessibility			+	Kockelman, 1997; Krizek, 2003.
Transit access at origin & destination	-	+	+	Cervero, 1994; 2007; Cervero & Gorham, 1995; Chatman, 2006; Evans et al. 1997; Kitamura et al., 1997; Nurdden et al., 2007; Schneiner & Holz-Rau, 2013.
Number of transfer		-		Eluru, Chakour & El-Geneidy, 2012.
Initial waiting time		-		Scheiner & Holz-Rau, 2013; Elur et al., 2012.
Parking and Cost				Cervero, 1994; Cervero & Kockelman 1997; Kuzmyak et al. 2010; Marsden, 2006; Lari et al., 2014.
Parking availability	+	-	-	Chatman, 2006, 2013; Chung, 1997; Scheiner & Holz-Rau, 2013.
Parking cost	-	+	+	Chatman, 2001, 2006; Strathman and Dueker, 1996; Carse et al., 2013; Scheiner & Holz-Rau, 2013.
Cost of using a car	-	+	+	Eriksson, 2011
Discount or free transit pass	-	+		Lari, 2014; de Witte et al., 2008.
Commute satisfaction				Abou-zeid et al., 2012; Kingham et al. 2001.
Car satisfaction	+			
Transit satisfaction		+		
Active mode satisfaction			+	
Control variables				
Self-selection				
Pre-existing travel preferences	M	M	M	Boarnet & Sarmiento 1998, Chatman, 2006, 2009; Krizek, 2003; Manaugh & El-Geneidy, 2014; Cao et al. 2009.
Attitudinal				
Attitude towards different travel modes				Chatman, 2003.
Positive attitude-> transit		+		Vredin Johansson et al., 2006 (environmental prefererences).
Positive attitude->active mode			+	
Perceived difficulty to use transit		-		Eriksson et al. 2010.
Perception of reliability & flexibility		+		Abou-zeid et al., 2012; Vredin Johansson et al. 2006; Kingham et al., 2001; Bhat & Sardesai, 2006.

Note: "M" means that literature results are mixed.

Data and Methodology

The main objective of this study is to understand and identify the factors that affect TOD newcomers' decisions to adopt modes of transportation that are either more or less sustainable after relocation. To achieve this objective, this study uses a multilevel multinomial logistic regression to compare the travel mode choices of survey respondents for two time periods: before and after moving to a TOD, while controlling for socio-economic, built environment and self-selection variables.

Data

The data used comes from a comparative survey conducted by an inter-disciplinary research group: Transportation Research at McGill (TRAM) in Montreal, Canada, in collaboration with Delft Technical University in the Netherlands. The survey was completed by 586 people from seven different TODs: Rosslyn Station (Arlington), Virginia Station, USA; South Orange Station, New Jersey, USA; Berkeley Station, California, USA; Mockingbird Station and Downtown Plano station, Dallas, Texas, USA; Equinox Station, Toronto, Ontario, Canada; and Joyce-Collingwood Station, Vancouver, British Columbia, Canada. TOD study locations were chosen based on a review of the literature of the most successful TODs. 5000 addresses within an 800-meter buffer were randomly purchased from private companies for each American TOD. The buffer had to be increased to 1600 meters for each Canadian TOD in order to obtain 5000 addresses from Canada Post. While this paper employs the term "relocation to a TOD", readers should keep in minds that, for Canadian respondents, it is actually a relocation "near or in" a TOD.

In the fall of 2013, postcards were sent to the selected addresses to invite individuals to participate in the survey, and prizes where used as incentives. Not all of the postcards were successfully delivered, with several dozen returned to the sender. While we received many of the postcards that were returned to the sender, we suspect that many undelivered American postcards were not returned to our Canadian return address, as it would have been considered international mail. Due to financial constraints we were unable to send a second round of postcards to remind

TOD residents to participate in the study. Therefore, determining an actual response rate is not possible. A conservative estimate of response rates, assuming all cards were delivered, should be 2 % for Rosslyn Station, 1.4% for South Orange Station, 3% for Berkeley Station, 1.5 % for Mockingbird Station, 1.7% for Downtown Plano Station, 1.7% for Toronto, and 2.2% for Vancouver, which is an average of 83.7 mail surveys per TOD. In reality, response rates are likely much different given the number of postcards that did not reach their final destination. Fortunately, the overall number of participants is sufficient to conduct statistical analysis.

To participate in the survey, participants where directed to the online survey which included general questions to capture information such as the respondents' previous and current utilitarian and non-utilitarian travel modes, individual socio-demographic characteristics, as well as previous and current home location, and current work location. The survey included a series of guided questions to capture detailed information about different aspects of respondents' trips as well as their levels of satisfaction. Finally, the survey was designed to capture seasonality in travel choices, allowing individuals who switch modes to provide the details of their trips during different weather conditions.

From the total collected data, 108 surveys were rejected due to incompletion. The final dataset included information from 478 participants. Spatial measures were calculated for each respondent using secondary data sources in a geographical information system. For instance, the population density by zip code (postal code in Canada) of each respondent's home and previous home was calculated from data on population and land use from the American and Canadian censuses. Shapefiles of sidewalks and amenities for the seven TODs analyzed were not available to create walkability indices such as the ones presented by Frank et al. (2005), or Krambeck (Krambeck, 2006). Consequently, the Walk Score of each respondent's current and previous addresses were used as a proxy to neighbourhood diversity and local accessibility using the online Walk Score tool (Walk Score, 2014). This tool, which assigns each addresses a "Walk Score" between 0 and 100, has been demonstrated to be valid for estimating neighbourhood walkability by measuring access to different facilities (Carr, Dunsiger, & Marcus, 2010). For each address, the tool analyzes hundreds of walking routes to nearby amenity categories such as retail, recreation and leisure opportunities. Points are awarded based on the distance to amenities

in each category. Amenities within a five minutes walk (0.25 miles or 0.4 km) are given maximum points. The tool uses a decay function to attribute points to more distant amenities, but stops giving points for attractions beyond a 30-minute walk. It also measures pedestrian friendliness by analyzing variables such population density and block length. Data sources used by this tool include Google, Education.com, Open Street Map, Census and Localeze (Walk Score, 2014). In a study comparing the explanatory power of four walkability indices, Manaugh and El-Geneidy (2010) found that the Walk Score index explains the variation in walking trips to various destinations as well as other walkability indices used in the literature. In addition, differences in the explanatory power amongst the examined indices were negligible.

The resulting dataset was transformed into long format, in order to be able to use the trips' purposes as the unit of analysis instead of the respondents' (wide format). "In the wide format, the individuals observed are the observations of a dataset, while the variables are their characteristics" (Kohler & Kreuter, 2012, p. 328). In contrast, in the long format, the observations are the individuals *usually at a specific point in time* – the trip purpose in our case – and the variables are the observed characteristics (Kohler & Kreuter, 2012). The benefit of this transformation is that it increased the number of observations from 478 to 2459, thus allowing us to perform more advanced statistical analyses.

Six different trip purposes are analyzed in this study: (1) trip to work; (2) to the gym, to indoor recreation, or to a community center; (3) to a service provider (bank, post-office, medical-clinic, pharmacy, etc.); (4) to a café, bar, or restaurant; (5) to the main shopping street or mall, and (6) to entertainments (movie, theater, gallery, etc.). It is important to consider that the number of trip purposes varies for different survey respondents. For instance, some of survey participants have only four different types of trips while others provided information for each of the six trips. People reported their primary mode of transportation to reach the above-mentioned destinations before and after moving to a TOD. A primary mode of transportation refers to the type of transportation taken for the longest portion of a single trip. Responses were recoded into three different categories: automobile (as a driver or passenger), public transit, and active modes such as walking and cycling. Next, three more dummy variables were created to classify the different travel mode choices made by the respondents once they had moved to a TOD: (1) a

switched to a less sustainable mode of transportation, (2) no switch, and (3) a switched to a more sustainable mode of transportation. Figure 1 shows how these variables were generated.

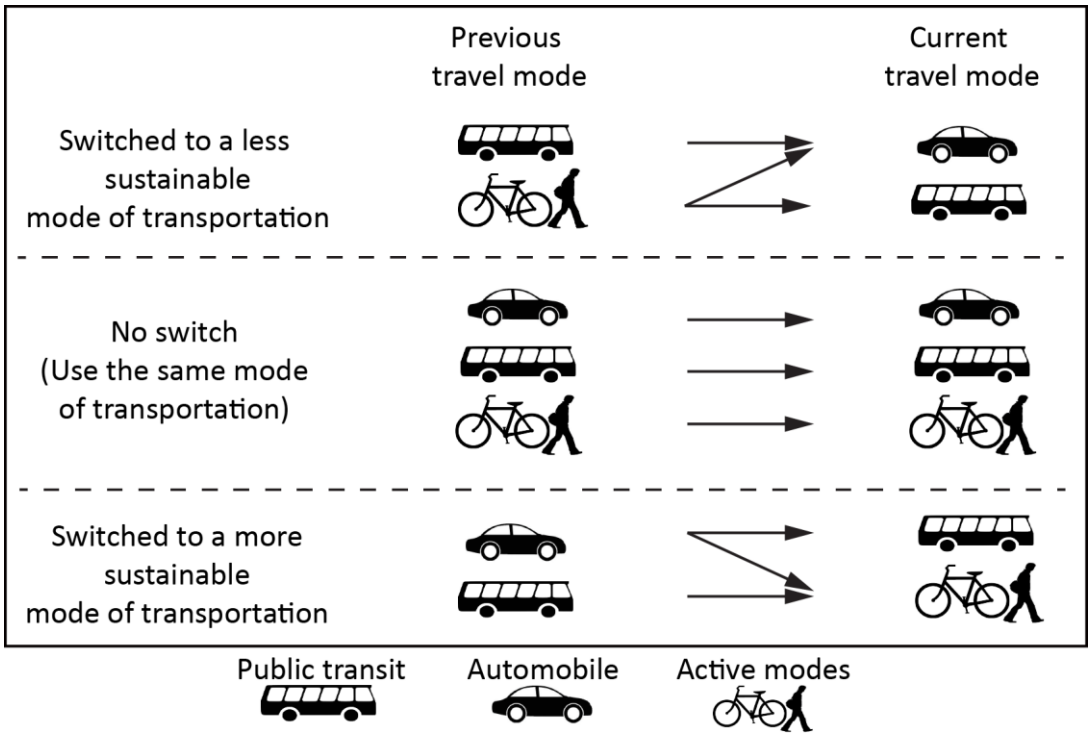


Figure 1. Classification of the travel mode changes made by newcomers to TODs.

Methodology

This study employs a multilevel multinomial logistic regression model that controls for correlations between responses from individual survey respondents; it is a mixed linear model with linear predictors (McCullagh & Nelder, 1989). This type of model is used when the dependent variable exhibits more than two categories that cannot be ranked, and when the dataset is organized on more than one level or structure (Bickel, 2012; Gelman & Hill, 2006).

The present database is organized by different structures represented by the different trip purposes of the survey respondents (each individual is repeated by the number of different types of trips they reported). A likelihood ratio test was used to determine if the multilevel multinomial logistic regression model is more appropriate for the analysis than regular multinomial logistic regression model. The multilevel model allows us to accurately control for correlation between an individual's responses and provides a fit for the analyzed data that is more appropriate for the

type of data used than a regular multinomial logistic regression model. In other words, having more than one observation coming from the same person causes a bias in the output if the regular multinomial model is used. Controlling for this bias is achieved through the multilevel modeling technique, where the software understands that some of the data are obtained from the same person. In addition, we also tested having two levels, individual and neighbourhood (in this case the TOD), yet the neighbourhood was not found to be significant. Therefore, only one level, which is the individual, is used in our analysis.

In this study, the unordered categorical dependent responses refer to the type of switch made by the respondents for their various trip purposes, and are categorized as: *switch to a more sustainable mode of transportation, switch to a less sustainable mode of transportation, or no switch*. In the multilevel multinomial logit model used for this analysis, the *no switch* category represents the reference (base outcome). Table 2 defines the variables used in the analysis and tested in the model. Only variables with an asterisk (*) are kept in the model. The others were eliminated from the study because they were not significant (Likelihood ratio test) and/or because they were highly correlated (with a Person coefficient greater than 0.5) with other variables. For example, when we tested the relationship between socio-demographic variables and the probability of switching either to a more or less sustainable mode of transportation, all relevant socio-economic variables according to the literature, except for household size, were revealed to be insignificant. This may indicate that the initial choice of a travel mode is partly conditioned by socio-demographic characteristics, as previously shown in the literature. However, the decision to switch from one's original mode is not. Also, the final model does not account for modal time and cost of each trip.

Table 2. Descriptive statistics.

Variables	Description	Obs	Mean	SD	Min	Max
Gender	DV: 1 "Female"; 0 "Male"	2406	0.49	0.50	0	1
Age	Continuous	2420	43.27	14.28	18	86
Years spent in a TOD	Continuous	2459	9.22	10.04	0	68
Children in the household	Discrete	2443	1.18	0.56	1	6
Household size*	Discrete	2447	2.44	1.56	1	20
Vehicle in the household	Discrete	2454	1.48	0.81	1	7
Employed	DV: 1 "Employed"; 0 "Unemployed"	2459	0.79	0.41	-	
University degree	DV: 1 "University degree"; 0 "otherwise"	2459	0.46	0.50	-	
Household income >$80,000*	DV: 1 "Annual gross income household >= $80,000"; 0 "otherwise"	2088	0.51	0.50	-	
Driver's license	DV: 1 "Driver's license"; 0 "otherwise"	2459	0.92	0.28	-	
Increased in number of vehicle*	DV: 1 "Number of vehicles in the household increased when I moved"; 0 "otherwise"	2459	0.20	0.40	-	
New homeowner*	DV: 1 "I became owner of my residence after moving"; 0 "otherwise"	2459	0.20	0.40	-	
Rent	DV: 1 "Household unit is rented"; 0 "otherwise"	2459	0.42	0.49	-	
Previously rented	DV: 1 "Previous household unit was rented"; 0 "otherwise"	2389	0.69	0.46	-	
Reduced transit fare*	DV: 1 "Access to a free or reduce transit fare"; 0 "otherwise"	2459	0.22	0.41	-	
Free parking at work*	DV: 1 "Access to free car parking at work or at school"; 0 "otherwise"	2459	0.27	0.44	-	
Current Walk Score	Discrete	2439	73.76	16.85	12	100
Previous Walk Score	Discrete	2366	66.78	26.12	0	100
Increased in Walk Score*	DV: 1 "Current Walk Score > Previous Walk Score"; 0 "otherwise"	2355	0.43	0.50	-	
Density (km^2)	Continuous	2032	4.44	2.21	0.09	14.12
Previous density (km^2)	Continuous	1951	4.47	5.25	0.00	38.70
Density variation	Continuous (Density - Previous density)	1916	-0.13	5.72	-36.50	7.55
Increased in density	DV: 1 "Density > Previous density"; 0 "otherwise"	2459	0.26	0.44	-	
Walking time to grocery (min)*	Continuous	2453	35,98	59.52	0.83	891.93
Nearest transit stop (min.)*	Continuous	3984	6.81	6.31	0.00	51.00
Walk more	DV: 1 "I would like to walk more than I currently do"; 0 "otherwise"	2459	0.70	0.46	-	
Transit more*	DV: 1 "I would like to take transit more than I currently do"; 0 "otherwise"	2459	0.30	0.46	-	
Drive more	DV: 1 "I would like to drive more than I currently do"; 0 "otherwise"	2459	0.15	0.36	-	
Comfort	DV: 1 "I feel comfortable using transit"; 0 "otherwise"	2459	0.82	0.39	-	
Privacy	DV: 1 "When planning a trip my personal privacy is imp."; 0 "otherwise"	2459	0.46	0.50	-	

Price of fuel is imp.	DV: 1 "When planning a trip the price of fuel is imp."; 0 "otherwise"	2459	0.54	0.50	-
Environmental impact*	DV: 1 "When planning a trip the environmental impact of my chosen mode is imp."; 0 "otherwise"	2459	0.56	0.50	-
Enjoyment is imp.	DV: 1 "Overall enjoyment of the trip is imp."; 0 "otherwise"	2459	0.73	0.45	-
Health is imp.	DV: 1 "Long-term effect of my trips on my health is imp."; 0 "otherwise"	2459	0.62	0.48	-
Reason for moving 1*	DV: 1 "I needed less space"; 0 "otherwise"	2459	0.05	0.21	-
Reason for moving 2	DV: 1 "I wanted to be closer to my work"; 0 "otherwise"	2459	0.16	0.36	-
Reason for moving 3	DV: 1 "I wanted to be closer to my partner/spouse's work"; 0 "otherwise"	2459	0.06	0.24	-
Reason for moving 4*	DV: 1 "I couldn't afford my previous home any more"; 0 "otherwise"	2459	0.04	0.19	-
Reason for moving 5*	DV: 1 "I wanted to be closer to public transit"; 0 "otherwise"	2459	0.20	0.40	-
Reason for moving 6	DV: 1 "The cost of parking are lower"; 0 "otherwise"	2459	0.01	0.10	-
Reason for moving 7	DV: 1 "The cost of transport to work/school are lower"; 0 "otherwise"	2459	0.05	0.22	-
Chose neighbourhood based on:					
Proximity to work/school	DV: 1 "Proximity to work/school"; 0 "otherwise"	2342	0.84	0.37	-
Proximity to public transit	DV: 1 "Proximity to public transit"; 0 "otherwise"	2389	0.83	0.37	-
Cost of travelling	DV: 1 "Cost of travelling'; "otherwise"	2318	0.70	0.46	-
Possibility of less driving	DV: 1 "Being in a location where I could drive less"; "otherwise"	2296	0.72	0.45	-
Neighbourhood walkability*	DV: 1 "The walkability/bikeability of the neighbourhood'; "otherwise"	2387	0.81	0.39	-
Proximity to schools	DV: 1 "The proximity to quality schools for my children"; "otherwise"	1373	0.70	0.46	-
Work*	DV: 1 "Trip to work "; 0 "otherwise"	2459	0.12	0.33	-
Gym or indoor recreation	DV: 1 "Trip to gym or indoor recreation"; 0 "otherwise"	2459	0.13	0.34	-
Service provider	DV: 1 "Trip to a service provider (bank, pharmacy, etc.)"; 0 "otherwise"	2459	0.19	0.39	-
Cafe, bar or restaurant	DV: 1 "Trip to cafe, bar or restaurant "; 0 "otherwise"	2459	0.19	0.39	-
Main shopping street or mall*	DV: 1 "Trip to the main shopping street or shopping mall"; 0 "otherwise"	2459	0.19	0.39	-
Entertainment	DV: 1 "Trip for entertainment purpose (theater, cinema, etc.)"; 0 "otherwise"	2459	0.18	0.38	-

Notes: * variables used in the model. Other variables were not kept because of insignificance.

a. Nearest transit stop is defined as the closest transit stop to the respondent's home on foot (walking time in minutes).
b. “DV” is an abbreviation for dummy variable.

Results

Descriptive Analysis

Before their relocation, a large proportion (51.71%) of trips made by respondents were already being made using sustainable modes of transportation. Alternatively, 49.29% of the trips were made by automobile (See Table 3). The high presence of people already travelling by sustainable modes indicates the presence of self-selection occurring in the sample. However, the results from the descriptive statistics suggest a positive change in the travel choices of people once they have relocated to a TOD, despite the fact that, on average these respondents previously had more sustainable travel behaviour habits than the average individual (They used their automobile only for 49.29% of their trips). The proportion of people choosing to travel by automobile is reduced, while the proportion of people commuting by foot rises significantly (Table 3).

The TODs included in this study are built around rail stations, but findings show that, contrary to what one would expect, the proportion of people using public transit remains practically the same compared to the use at respondents' previous home locations. Despite these results, TODs do have a strong effect on a switch to active modes for trips to reach amenities.

Table 3. Travel mode choice before and after moving to TOD, by trip's purpose (%).

	Travel mode choice					
	Automobile		Public transit		Active mode	
Trip purpose	**Previous**	**Current**	**Previous**	**Current**	**Previous**	**Current**
Work	43.85	48.5	37.54	36.21	18.6	15.28
Gym or indoor recreation	40.73	39.51	9.12	5.17	50.15	55.32
Service provider	46.74	41.74	9.78	7.39	43.48	50.87
Café, bar or restaurant	47.39	43.48	9.35	8.91	43.26	47.61
Main shopping street or mall	56.10	56.32	16.49	16.06	27.41	27.62
Entertainment	56.79	49.32	18.55	18.55	24.66	32.13
Total (%)	49.29	46.73	15.86	14.56	34.85	38.71

In total, while 45% of respondents switched to a more sustainable mode, 39 % switched to a less sustainable mode for at least one of their trip types after moving to a TOD. But, 29% of the respondents did not modify their travel mode choice habits after residential relocation to a TOD.

Table 4 presents the percentage of switches to a more sustainable mode of transportation, sorted by trip purpose. Overall, 20.41 % of the trips in the study use a more sustainable mode, while 17.36% use a less sustainable mode compared to the mode they used in their previous residential location. The difference in percentage between these two is statistically significant at a 98% confidence interval. This overall improvement is due to a positive shift in the proportion of sustainable travel mode choices made when travelling to different amenities. Indeed, the travel mode choice used to reach neighbourhood amenities ((1) gyms, (2) service providers, (3) bars/cafés/restaurants or (4) any other entertainment destinations) has improved, in the sense that a more sustainable travel mode is chosen by people after they moved to a TOD. Independent sample t-test results show that there is a statistically significant difference between the percentages of people who switched to a more sustainable travel mode, compared to those who made the reverse decision for the four previously mentioned trip to amenities. The number of shoppers switching to a less sustainable mode of transportation is not significantly greater than the number of shoppers who switched for a more sustainable mode according to an independent t-test. However, for commuting trips, a statistically significant independent sample t-test shows that a higher proportion of people choose to use a less sustainable mode of transportation after their move. A careful analysis allows us to minimize the importance of the above-mentioned results, since about 30% of the workers who have switched to a less sustainable mode had switched from walking to using transit. While less sustainable than walking, using public transit is still considered to be a more sustainable mode of transportation than travelling by car (Lorek & Spangenberg, 2001).

Table 4. Previous travel mode used by type of switch and trip purpose (%).

Trip purpose	Previous travel mode	Switched to		
		More sustainable	The same	Less sustainable
Work	Automobile	31.06	68.94	0.00
	Public transit	14.16	53.10	32.74
	Active mode	0.00	25.00	75.00
	Total	18.94	54.82	26.25
Gym or indoor recreation	Automobile	37.31	62.69	0.00
	Public transit	60.00	26.67	13.33
	Active mode	0.00	70.91	29.09
	Total	20.67	63.53	15.81
Service provider	Automobile	38.14	61.86	0.00
	Public transit	57.78	26.67	15.56
	Active mode	0.00	67.00	33.00
	Total	23.48	60.65	15.87
Café, bar or restaurant	Automobile	37.16	62.84	0.00
	Public transit	30.23	44.19	25.58
	Active mode	0.00	67.34	32.66
	Total	20.43	63.04	16.52
Main shopping street or shopping mall	Automobile	23.28	76.72	0.00
	Public transit	16.88	55.84	27.27
	Active mode	0.00	56.25	43.75
	Total	15.85	67.67	16.49
Entertainment	Automobile	31.87	68.13	0.00
	Public transit	25.61	48.78	25.61
	Active mode	0.00	55.05	44.95
	Total	22.85	61.31	15.84
Total		**20.41**	**62.22**	**17.36**

Multilevel Multinomial Logistic Regression

Table 5 displays the results of the multilevel multinomial logit regression. It determines the probability of an individual switching to a more or to a less sustainable mode of transportation. The model uses the *no switch* variable as the reference group. We used relative-risk ratios (RRRs) to further interpret the effect of each variable. For a unit change in the predictor variable, the relative-risk ratio of outcome *X* relative to the referent group is expected to change by a factor of the respective parameter estimate given the variables in the model are held constant. An RRR greater than or less than one shows an increase or a decrease in probability, respectively.

Table 5. Results of the multilevel multinomial logistic regression on the probability of switching to a more or switching to a less sustainable mode of transportation.

	More sustainable vs No switch				Less sustainable vs No switch			
			Confidence interval (95%)				Confidence interval (95%)	
Independent variable	**RRR**	**Z**	**Lower**	**Upper**	**RRR**	**Z**	**Lower**	**Upper**
Household income >$80,000	0.69	-1.33	-0.92	0.17	1.08	0.24	-0.57	0.73
Household size	0.74	-2.49**	-0.54	-0.06	1.09	0.67	-0.17	0.34
Increased in number of vehicle	1.43	0.92	-0.40	1.11	2.96	2.95***	0.36	1.81
New homeowner	1.16	0.52	-0.42	0.72	2.15	2.26**	0.10	1.43
Increase in Walk Score	1.99	2.54**	0.16	1.22	0.24	-3.85***	-2.14	-0.69
Free parking at work	0.50	-2.16**	-1.33	-0.06	3.73	3.30***	0.53	2.10
Reduced transit fare	1.71	1.66*	-0.10	1.17	0.26	-3.65***	-2.07	-0.62
Environmental impact	2.45	3.07***	0.32	1.47	0.38	-2.82***	-1.63	-0.29
Neighbourhood walkability	1.96	1.79*	-0.06	1.41	0.51	-1.44	-1.60	0.25
Transit more	0.53	-2.05**	-1.23	-0.03	1.08	0.21	-0.65	0.80
Reason for moving 1	4.37	2.65***	0.38	2.56	1.95	0.65	-1.37	2.71
Reason for moving 4	0.15	-2.21**	-3.57	-0.22	2.01	0.87	-0.88	2.28
Reason for moving 5	2.39	2.73***	0.25	1.50	0.79	-0.62	-0.99	0.52
Walking time to grocery (min)	0.99	-2.77***	-0.02	0.00	1.00	0.66	0.00	0.01
Nearest transit stop (min)	0.92	-2.71***	-0.14	-0.02	1.04	1.33	-0.02	0.10
Shopping trip	0.37	-4.41***	-1.42	-0.55	1.59	1.81*	-0.04	0.97
Working trip	1.19	0.72	-0.30	0.65	2.87	3.84***	0.52	1.59
Previous mode: automobile	12.38	8.93***	1.96	3.07	0.00	-0.01	-9391.35	9340.21
Constant	0.04	-3.11***	-4.22	-2.00	0.49	-0.69	-1.88	0.48
N=1941								
LR chi^2 (42)=1045.14 Pseudo R^2=0.30								
var(M1[id])	2.93	0.59	1.98	4.36				
var(M2[id])	3.06	0.75	1.89	4.96				
cov(M2[id],M1[id])	-0.32	-0.64	-1.29	0.66				

Note: No switch is the reference (Base outcome) of the model, and it means that the person uses the same travel mode after relocation.

*** p<.01; **p<.05; *p<.10.

The estimated variances of the two random effects in the model are 2.93 and 3.06, implying a standard deviation of 5.81 and 6.07. Thus, a 1-standard-deviation change in the random effect amounts equals 333.6 and 432.6 change in the relative-risk ratio. The effect is both practically significant and from the output, statistically significant. The covariance is estimated to be -0.32, therefore the estimated correlation equals to -0.107.

Switching to a More Sustainable Mode of Transportation VS Not Switching

As expected, several factors are negatively associated with a switch to a more sustainable mode of transportation, including household size, access to free workplace parking, walking time to the grocery store, as well as walking time to the closest transit station. In contrast, an increase in Walk Score, access to reduced or free transit fare, and the awareness of the environmental impact of the chosen travel mode used are positively associated with a switch to a more sustainable travel mode. The probability of switching to a more sustainable travel mode versus not switching is 50% lower for people with free workplace parking; 26% lower for each additional member in a household; 1% lower for each additional minute separating the respondent's house from his preferred grocery store, and 8% lower for each additional minute separating the respondent's house from the nearest transit stop. It appears that proximity to transit within TODs makes little difference in the probability of adopting a sustainable mode of transportation relatively to the other factors studied. The probability of switching to a more sustainable travel mode versus keeping the same mode is about two times greater if the Walk Score of the current address is higher than the previous one; 1.71 times greater for a person with access to a reduced or free transit fare, relative to someone who does not have one; and 2.45 times greater for a person aware of the environmental impact of each mode, relative to someone who is not.

People who have decided to relocate to a TOD partly in order to be closer to public transit or because they needed less housing space are respectively 2.39 and 4.37 times more likely to use a more sustainable travel mode after their relocation than the referent group. However, people who have moved due to incapacity to afford their previous residence are 85% less likely to adopt a more sustainable travel mode, as compared to those who did not switch modes. These results

might be explained by the fact that these people did not modify their travel mode habits as they may already have used either public transit or another active mode due to their financial situation. *Ceteris paribus*, the respondents who chose their current location based on the neighbourhood's walkability are almost twice as likely to switch to a more sustainable mode versus keeping the same mode, relative to those who did not choose their neighbourhood based on that criterion. The desire to use public transit more frequently is negatively associated with a positive change in travel mode. The probability of switching to a more sustainable mode of transportation versus not switching is 47% lower for people who have such desires, relative to those who do not. This finding may indicate that the desire to commute more by public transit does not come from drivers, but rather from people who already use transit or walk and will continue to do so.

Finally, shopping trips to a "main street" or mall are negatively associated with a sustainable change in travel mode. Relative to all other trip purposes studied, the probability of switching to a more sustainable mode versus not switching is 63% lower when respondents travel to the main shopping street or mall. This suggests that people are not willing to switch to a more sustainable mode for this particular trip type. This result, however, is not unexpected, as often shopping includes carrying bags, and stores and malls usually provide inexpensive or free parking facilities.

Switching to a Less Sustainable Mode of Transportation VS Not Switching

The acquisition of a new vehicle, becoming a new homeowner and having access to a free parking spot at work all increase the probability of switching to a less sustainable mode of transportation. In contrast, an increase in Walk Score, the possession of a free or reduced transit fare, and an awareness of the environmental impact of the travel mode used reduce an individuals' likeliness to switch to a less sustainable mode. Regarding vehicle ownership, the relative risk of switching to a less sustainable mode of transportation versus keeping the same travel mode is 2.95 times greater for each additional vehicle acquired after the relocation to a TOD; 2.15 times greater if the respondent becomes a homeowner; and 3.73 times greater if a free parking spot is provided at his or her work. This finding suggests that "settling down" in life negatively impacts the propensity of switching to sustainable travel modes. However, an increase in Walk Score lowers the probability of adopting a less sustainable mode by 76%, and reduced or

free transit fare by 74%. In contrast, being conscious of the environmental impacts of varying modes reduces this propensity by 62% in comparison with someone who is not aware of the impact, if all other variables in the model remain constant. Finally, in this model, shopping trips and work commutes are positively associated with switching to a less sustainable mode of transportation. The former increases the risk of switching to a less sustainable mode, versus not switching by 1.59 times, while the latter increases the risk by 2.87 times.

Despite the fact that socio-economic characteristics, parking access, transit incentives and neighbourhood preferences have a strong effect on mode switching, the descriptive analysis and the model presented in this paper reveal that TOD can encourage the use of more sustainable travel modes, even if it is not for every type of trip, by providing good access to transit and a walkable environment with desired destinations.

Conclusion

Do TODs actually lead to less driving and, therefore, more sustainable transportation behaviour? The results of this study make clear that individuals alter their travel modes after relocating to a TOD. TODs encourage more sustainable mode choices; at least 45% of the respondents switched to a more sustainable mode of transportation for one of their trip types after relocation. This finding shows that the implementation of TODs can reduce automobile use. However, our findings suggest that this effect only applies for trips to certain amenities.

The number of respondents who commute to work by automobile increased after their relocation to a TOD. This finding is alarming, but not surprising as Chatman (Chatman, 2013) recently reported that rail access is not the principal factor explaining lower rates of auto ownership and the probability of commuting by automobile in TODs. Fortunately, results from the multilevel multinomial logistic regression offer a solution for solving this disappointing reality; transit incentives coupled with charging for parking or setting a limit on the number of free parking spots at work need to be considered. Accordingly, the former reduces the risk of switching to a less sustainable mode of transportation while increasing the probability of switching to a more sustainable mode. In contrast, by reducing free parking availability, the latter

could positively alter travel mode choices. Regarding these findings, local governments can reconsider their parking policy requirements at some job locations. Revised by-laws could potentially contribute to reduce automobile commuting in cities, and not just for TOD residents. In addition, while the TODs analyzed are supposed to be well designed, implementing more measures encouraging alternative transportation mode-use to transit stations as well as reducing the number of free parking available may also reduce the number of TOD residents that commute to work by car. Regarding shopping trips to a main street or to a mall, results of the model reveal that people are less likely to adopt more sustainable modes of transportation for shopping trips after their relocation to TOD. Therefore, in the short-term, policies, especially those related to planning the implementation of TODs, need to emphasize actions effecting commuting habits, while changes in travel mode choice for shopping trips and consumer behaviours should be further analyzed to determine which factors would promote the use of active modes of transportation and transit for shopping trips.

Regarding trips to amenities (gyms, service providers, restaurants and entertainments), results from this study show that many actions could be taken to reduce automobile usage among residents. First, planning strategies need to focus on denser mixed-use developments with pedestrian- and cycle-friendly infrastructure, and should offer better access to various amenities. Indeed, survey respondents in this study appeared to temporally adjust their modal choices to their new spatial setting. For example, moving to an area with a higher Walk Score compared to their previous residential location doubled the likelihood of switching to a more sustainable mode. Second, since individuals who are conscious of the environmental impacts of their chosen mode are also more likely to switch to more sustainable modes, policies that promote the benefits of sustainable modes need to target these residents, while educating and informing individuals. This would allow people to make more informed travel mode choices and could increase the number of pro-environmentally inclined individuals, who are more likely to switch to sustainable modes. However, it should be recognized that without suitable infrastructure, this type of policy cannot be fully successful. Yet, TOD implementation is one method of overcoming the travel option deficit in cities. They enable people who prefer to use transit, cycling and/or walking to do so more often. In addition, findings from this research can also be of interest to transportation planners and policy makers. It appears that transit agencies should consider how to accommodate

and accompany people throughout their lives as well as how to increase users' transit ridership retention since lifecycle changes have been shown to negatively impact the propensity to use sustainable travel modes even in TODs.

More generally, future research that assesses travel mode switching for utilitarian and non-utilitarian trips in TODs needs to account for the travel time and cost needed to reach desired destinations. The absence of such variables is a limitation of this study. Additionally, our research fails to explain mode specific factors that encourage sustainable switching due to sample size limitations. Nevertheless, the increased proportion of people using active modes of transportation for reaching diverse amenities after relocating to a TOD is promising. This indicates that TODs not only foster the realization of social and environmental goals, but that they promote healthier life habits by enabling residents to be more active in their daily lives. The implementation of TODs seems to be a positive step on the journey towards a sustainable future.

Chapter 2

Healthy living: Can TODs help achieve weekly-recommended level of physical activity?

Introduction

Physical inactivity is growing in North America and active leisure times are decreasing (Transportation Research Board, 2005). Many factors and societal patterns explain this trend including the growth of white-collar jobs, the wide spread use of automobile as a primary travel mode and urban sprawl (Brownson & Boehmer, 2004; Ewing, Schmid, Killingsworth, & Raudenbush, 2003). Physical inactivity is a serious source of health care utilization and expenditure in developed countries (Sari, 2009). In 2001, the total economic costs of physical inactivity and obesity represented 2.6% and 2.2%, respectively, of the total health care costs in Canada (Katzmarzyk & Janssen, 2004). The direct cost of physical inactivity and obesity in the United States of America, calculated by Colditz (1999), amounted to approximately $ 24 billion (2.4%) and $ 70 billion (7%), respectively, of U.S. health care expenses.

In order to overcome this costly societal problem, the idea of promoting physical activity (PA), such as walking, through non-leisure activity has flourished in the last couple of decades. Policy makers, transportation and health professionals are now targeting travel behaviour changes in daily and weekly utilitarian trips as one way to increase the population's level of PA. The hypothesis behind their actions is that changing trip-making behaviour to include more non-motorized trips can translate into favourable public health outcomes. Indeed, transportation mode choices have been shown to significantly affect the amount of PA that commuters experience during the course of a typical workday without planned or coordinated exercise programs (Wasfi, Ross, & El-Geneidy, 2013).

The purpose of this study is to better understand who meets the recommended level of weekly physical activity through their utilitarian trips (school, work and grocery shopping trips) and identify which factors affect individuals' level of physical activity while capturing seasonality in travel choices. Using data from a comparative travel behaviour survey conducted in seven North American Transit-oriented developments (TODs) and in their vicinity, two log-linear regression models are developed to further define the relationship between PA and travel behaviours.

The paper is organized into four main sections. The first section introduces the reader to the reasoning behind policies promoting PA through non-leisure activities as well as the benefits of an active life. It then presents an overview of the literature focusing on travel mode choice and level of PA. Next, the data and methodological framework are described. A presentation of the results follows. The final section discusses some of the implications of the results and how they relate to current understanding of individuals' level of PA activity and travel behaviours while mentioning some policy recommendations.

Background Information and Literature Review:

Integrating additional walking or cycling time into one's daily routine, such as during commute time, seems for many, a better public health strategy than creating programs that encourage people of being active during their leisure times. The reason is two-fold; first, walking is the cheapest PA and the most widely available since no attendance at a facility is required to perform the activity (Lee & Buchner, 2008). Second, programs altering people's daily routine have been shown to be less effective in promoting PA than strategies that can be integrated into daily routines without adding much time costs (Owen, 1996; Sallis, Bauman, & Pratt, 1998; World Health Organization, 2002).

Recommended Level of Physical Activity and Health Benefits:

There is a strong and well-established scientific basis for linking PA to health outcomes. PA is defined as any body movement that results in energy expenditure (Caspersen, Powell, & Christenson, 1985). Regular PA reduces the risk of developing several leading chronic illnesses, including cardiovascular disease (e.g., heart attacks, strokes), colon cancer, and non-insulin-dependent diabetes, as well as their precursors such as high blood pressure and hypertension (MacDonald, Stokes, Cohen, Kofner, & Ridgeway, 2010; Sallis et al., 1998; Sallis, Frank, Saelens, & Kraft, 2004; Thune & Furberg, 2001; Warburton, Nicol, & Bredin, 2006). Even low amounts of PA reduce the risk of premature mortality (USHHS, 2008). Other benefits of PA include reducing the risk of obesity osteoporosis, and depression. PA may also improve psychological well-being, appearance and quality of life (Blair & Brodney, 1999; Edwards, 2008;

Frank, Andresen, & Schmid, 2004; Lindström, 2008; MacDonald et al., 2010; McAuley, 1994; Oja, Vuori, & Paronen, 1998; Transportation Research Board, 2005).

Health-enhancing PA for adults aged between 18 and 64 has been defined as an accumulation of 30 minutes or more of moderate- to vigorous-intensity PA on most, preferably all, days of the week (CSEP, 2012; Oja et al., 1998; Pate et al., 1995; USHHS, 2008). A minimum of five days of 30-minute exercise of moderate- to vigorous- intensity PA is required to be considered active. The 30 minutes can be built up over a day. Ideally, aerobic activity should be performed in episodes of at least 10 minutes to achieve the daily recommendation of physical activity (USHHS, 2008).

Literature Review

Four types of variables are linked to physical activity in the literature; the social environment (social values, norms and preferences in term of PA), individual characteristics (genetic and socio-demographics), individual preferences (time allocation and lifestyle preferences), and the built environment (Handy, 2005).

Recent research efforts in urban planning have focused on the idea that land use and design policies can be used to increase transit use as well as walking and bicycling (Handy, 1996). The new urbanism movement and the concept of Transit-Oriented Development (TOD) emerged from these efforts. Both aim at creating a physical environment more conducive to active transportation (Killingsworth, de Nazelle, & Bell, 2003). TODs are specifically implemented with the goal to make walking and cycling a feasible, safe and attractive option. However, research into the role of the built environment and transportation systems on the level of PA is still relatively new.

Nevertheless, for many, the built environment and a transportation system that supports walking and bicycling can facilitate or hinder physical activity and more active lifestyles. For example, some studies have shown that residents of more walkable places report higher levels of physical fitness and lower levels of obesity than residents of more automobile-oriented

communities (Frank et al., 2004; Handy, Boarnet, Ewing, & Killingsworth, 2002). Rundle et al. (2007) found Body Mass Index (BMI) to be inversely associated with the density of bus stops, subway stops, and population around New York City. In another study, based in Australia, Ming Wen & Rissel (2008) found that men who cycled to work or who used public transit were significantly less likely to be overweight and obese, 38.8% and 44.6% respectively, compared to those who commute by automobile. When assessing the effect of light rail transit (LRT) use on BMI, obesity, and weekly level of recommended physical activity (RPA), MacDonald et al. (2010) found that LRT use was associated with a reduction in BMI and higher odds of meeting the weekly RPA.

A few other studies have shown that the use of public transit or walking as commuting mode is associated with an increased likelihood for an individual to meet daily RPA (Besser & Dannenberg, 2005; MacDonald et al., 2010; Morency, Trépanier, & Demers, 2011; Renne, 2005; Stokes, MacDonald, & Ridgeway, 2008; Wasfi et al., 2013; Wener & Evans, 2007). The degree to which public transportation may improve health, primarily because of the need to walk to or from the station, is also a relatively new research area. The following is a brief overview of this topic.

In a cross-sectional study using pedometers, Wener and Evans (2007) found that the average New York City train commuter walked about 9,500 steps per day, roughly 2000 or 30% more steps than the average car commuter. The additional 2000 steps could save up to $9,500 per person in health care expenditure in the United States. According to their findings, roughly 40% of train commuters, compared to only 15% of car commuters, meet the commonly recommended criterion of walking at least 10,000 steps per day to be classified as “active” (Tudor-Locke & Bassett, 2004).

In a cross-sectional study with self-reported survey data, Lachapelle and Frank (2009) attempt to assess whether transit and car trips are associated with meeting the recommended levels of PA in Atlanta, Georgia, United States. The authors were the first to assess the association between walking distance and the use of an employer-sponsored public transit pass. Results from their multinomial logistic regression showed that transit users were more likely to

meet the daily RPA than driver. In calculating individual levels of PA, the authors included all working trips without differentiating between trips that were shorter or longer than ten minutes. The interpretation of their results can be questioned because only walking trips longer than ten minutes really garner health benefits (CSEP, 2012; USHHS, 2008). In addition, their study failed to account for self-selection and individual preference for an active lifestyle.

Drawing on the US National Household Travel Survey to assess the relationship between walking and transit use at the national level, Besser & Dannenberg (2005) found that about one third of transit users achieve at least 30 minutes of PA a day by walking to and from transit stations. Their models do not differentiate trip purposes and do not incorporate transit service characteristics such as headways and transit types. An individual is more likely to walk longer distances for a more frequent and efficient transit service (El-Geneidy, Tetreault, & Surprenant-Legault, 2010). Also, large variations in walking distance to stations according to trip purpose were observed in many studies (Larsen, El-Geneidy, & Yasmin, 2010; Yang & Diez-Roux, 2012). These results highlight the importance of modeling different trip purposes separately, as each trip purpose is distinct and interacts differently with the environment (Saelens, Sallis, & Frank, 2003).

In a paper estimating the amount of daily walking that can be achieved when commuting by public transportation, Wasfi et al. (2013) improved on the current body of knowledge by addressing all the aforementioned issues. They found that approximately 11% of commuters achieved the 30 minutes of RPA just through walking to and from public transit stops when commuting to work or school. In addition, they found that commuter train users are more likely to achieve public health recommendations than any other transit users. Findings from Wasfi et al. (2013) corroborate findings from previous study (Lachapelle & Noland, 2012). Lachapelle and Noland (2012) also found significant differences in walking frequency between transit modes (bus vs. train/subway/light rail).

This brief overview demonstrates that most studies in the field are based on a cross-sectional design due to a lack of better and more reliable data. This type of research uses existing variation in land use and urban design, across different neighbourhoods, to examine the

difference in walking behaviour. Cross-sectional studies prevent researchers from drawing clear conclusions on a causal link between transit use or built environment characteristics and an increased in walking because of self-selection bias. Change in residential location is often associated with life-cycle changes that can confound the effect of the new built environment on travel behaviour and on PA (Boarnet, 2003). Several of the aforementioned studies on the health consequences of the built environment face problems of selection bias associated with confounding effects of residential choice, preferences and transportation decisions (eg. (Frank et al., 2004; Lachapelle & Frank, 2009; Lachapelle & Noland, 2012; Wener & Evans, 2007). Although this paper is also a cross-sectional study (among residents of various TODs), it controls for self-selection by testing several variables that target why survey respondents moved to their present residence. This study also tests several built environment variables to come to a better understanding of their relationships with individual PA.

Methodology

This study has three main objectives: 1) to understand who among the TOD residents meets the recommended weekly level of physical activity vis-à-vis their utilitarian trips (school, work and grocery shopping trips), through the use of descriptive statistics; 2) to identify which factors among the built environment, attitudinal and socio-economic characteristics affect individuals' level of weekly PA, while controlling for self-selection, using a two log-linear regression models; and 3) to understand the seasonal effects on PA levels, by testing the models under both pleasant and unpleasant weather conditions. We hypothesize that exposure to built environment variables, such as high street connectivity, high Walk Score, and high density, will have positive effects on the amount of PA individuals perform weekly. The frequency of trips, the travel mode chosen, and personal characteristics and attitudes will also affect the level of PA. We also assume that seasonality has an influence on travel mode choice and therefore on the level of PA.

Data

Study Area and Sample Size:

Most of the data for the analysis are drawn from a travel behaviour survey conducted on residents in seven different North American TODs in 2013. Five TODs are located in the United States: 1) Rosslyn Station, Arlington, Va.; 2) South Orange Station, South Orange, N.J; 3) Berkeley Station, Berkeley, Calif.; 4) Mockingbird Station and 5) Downtown Plano Station, Dallas, Tex. The two others are Canadian: 1) Equinox Station, Toronto, Ont., and 2) Joyce-Collingwood Station, Vancouver, B.C. These seven TODs were chosen based on a review of the literature of the most successful TODs.

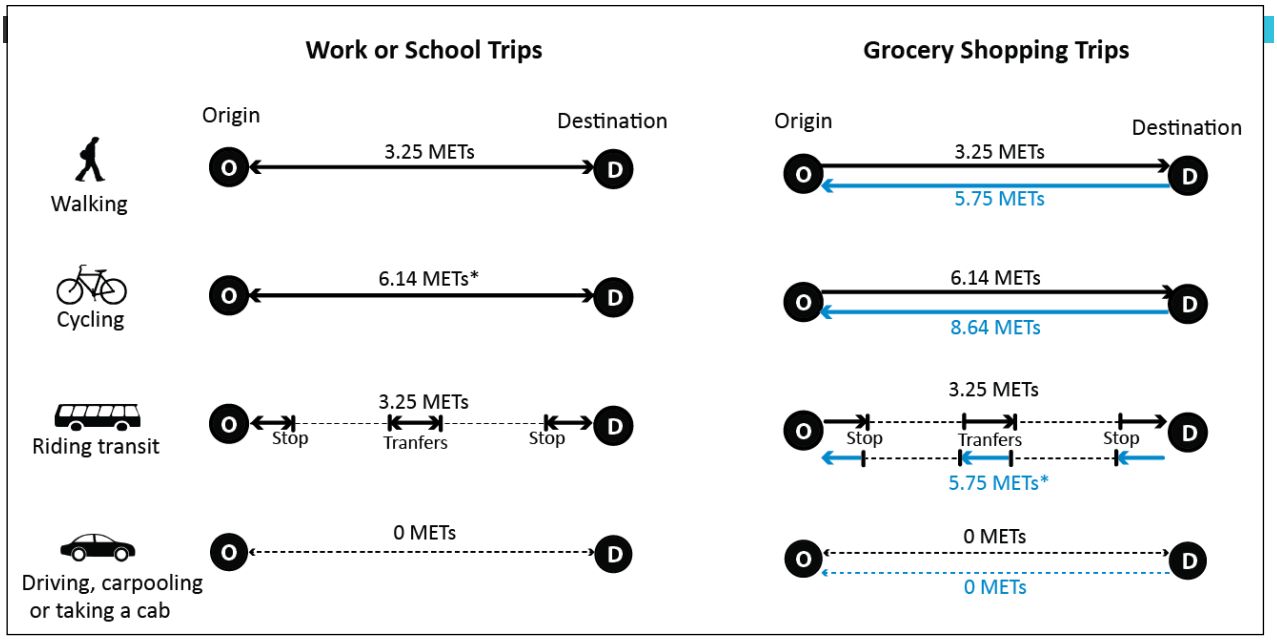
5000 addresses within an 800-meter buffer were randomly acquired from private companies for each American TOD to send survey requests. The buffer had to be increased to 1600 meters for each Canadian TOD in order to obtain 5000 addresses from Canada Post. Due to the difference in buffer length and possible errors in American addresses, readers should keep in mind that respondents are actually "near or in" a TOD. In total, 30 000 survey requests were mailed. To participate in the survey, participants were directed to the online survey, which included general questions to capture information on the respondents' previous and current utilitarian and non-utilitarian trip modes, current grocery store and work locations, individual socio-demographic characteristics, as well as previous and current home locations. The survey included a series of guided questions to capture detailed information about different aspects of respondents' trips. Finally, the survey was designed to capture seasonality in travel choices, allowing individuals that switch modes to provide the details of their trip under different weather conditions. Among the 586 received responses, 108 were rejected due to incompletion. The final dataset includes surveys with mostly completed information from 478 participants.

A conservative estimate of response rates, assuming all survey requests were delivered, should be 2% for Rosslyn, 1.4% for South Orange, 3% for Berkeley, 1.5 % for Mockingbird Station, 1.7% for Downtown Plano Station, 1.7% for Toronto, and 2.2% for Vancouver, which is an average of 83.7 mail survey responses per TOD. Although response rates are low, this is based on the assumption that all survey requests were delivered, which is in fact not true, due to the

quantity of returned mail.

Dependent Variable: Level of Physical Activity

To measure the level of PA, the present analysis uses the Metabolic Equivalent of Task (MET) presented in the Compendium of Physical Activity (Ainsworth et al., 2011; Ainsworth et al., 1993; Ainsworth et al., 2000). MET can be define as the ratio of the work metabolic rate to the resting metabolic rate. This measure expresses the intensity and energy expenditure of activities that allows for a comparison among persons of different weights. In other words, the Compendium was developed to facilitate a comparison between physical activities. One MET equals one Kcal/kg/hour, which is the equivalent to the energy cost of sitting quietly. Activities are listed in the Compendium as multiples of the resting MET level and they range from 0.9 METs (sleeping) to 23 METs (running at 14 mph). In this study, the use of the MET measure allows the comparison between the average level of PA exhibited by an individual cycling or walking to their destination. However, the Compendium was not developed to determine the precise energy cost of PA within individuals, but instead to provide an activity classification system that standardizes the MET intensities of PAs (Ainsworth et al., 2000). Individual differences in energy expenditure (e.g. joules) for the same activity (e.g. walking to work) can be significant and the true energy cost for a person may vary from the stated mean MET level presented in the Compendium since it depends on the person's body mass. However, since the resting metabolic rate is dependent on body mass in a similar way, the inventors of this measure assumed that the ratio of energy cost to the resting metabolic rate of each person remains stable for the specific activity and thus is independent of each person's weight (Ainsworth et al., 2000).



Notes a) In order to take into account the fact that people carry groceries, 2.5 METs were added to each walking or cycling segment of a grocery-shopping trip on the way back (blue arrows) according to the Compendium. For example, regular walking trip amount to 3.25 METs, but on the way back, when an individual carries groceries, the level of physical activity goes up to 5.75 METs. b) For the access segments of public transit trips, 3.25 MET were attributed to individuals walking to the stops, 6.14 MET to individuals cycling, and 0 MET for those driving to the stop.

Figure 2. METs by trip purpose and travel mode choice.

Figure 2 presents how METs were attributed. The travel times of each individual for every trip purpose were estimated using Google Maps. The walking speed used by Google is 4.8 km/h (2.98 mph) and the cycling speed was 16 km/h (9.94 mph), which respectively correspond to 3.25 METs and 6.14 METs according to the Compendium (Ainsworth et al., 2011). 2.5 METs were added, again according to the Compendium, to each walking or cycling segment of a grocery-shopping trip on the way back in order to take into account the fact that people carry groceries (see blue arrows in Figure 2). Due to unavailability of data, walking time to a respondent's parked car was not considered. To calculate the weekly MET of each survey respondent ($_i$), this formula was used:

$$\text{Weekly MET}_i = F_{qi}\,(M_{si}{*}t_{i1}) + F_{qi}\,(M_{wi}{*}\,t_{i2}) + F_{qi}\,(M_{gi}{*}\,t_{i3})$$

Where, M_{si} is the METs associated with the travel mode to school; M_{wi} is the METs associated with the travel mode to work; M_{gi} is the METs associated with the travel mode to the preferred grocery store of the respondent; F_{qi} is the frequency of the trip per week, and t_{ix} the total travel time in hours (walking or cycling) to go and come back from the destination. For example, someone that walks to work five days a week (50 minutes of walking round-trip) and that goes to

the grocery store once a week by public transit with an walking access time of 6 minutes and an egress walking time of 2 minutes will have a weekly MET of 14.74 [5*(3.25 METs*50/60) + 1((6+2)/60*3.25METs + (6+2)/60*5.75METs)]. To meet the recommended level of PA through travel habits, a person must at least walk 30 minutes a day, five times a week, which is equal to a total of 8.125 METs.

Independent variables

Table 6 defines all variables used and tested in the analysis and models to better understand who achieves the weekly-recommended level of physical activity through their utilitarian trips (school, work and grocery shopping trips), and to identify which factors influence individuals' level of physical activity while controlling for seasonality.

Socio-demographics:

The study includes five socio-demographic variables: "Age"; "Gender"; access to "Reduced transit fare"; "Low income", which differentiates households below the poverty line from others; "University degree", which indicates whether respondents have obtained a university degree or higher; and "Years spent in a TOD", which indicates the number of years respondents have lived in current TOD. We hypothesize that the longer an individual has been exposed to a certain environment the more likely the effects of the built environment will be reflected in his or her travel behaviours.

Self-selection and Attitudinal Variables:

The self-selection bias is a constant concern in behavioural studies. In the present research, the question raised is whether active people move to highly walkable neighbourhoods, or if living in such neighbourhoods makes it more likely that people will be active? To control for that bias two variables were used: the "Walkability" variable, which indicates that the individual has chosen his or her current neighbourhood based on its walkability and bikeability, and the "Proximity to transit" variable, which accounts for people that have chosen their current neighbourhood based on proximity to public transit.

Table 6. Variable used to perform the analysis.

Variables	Description
Socio-demographics	
Age	Continuous
Gender (Female)	DV: 1 "Female"; 0 "Male"
Years spent in a TOD	Continuous
Low income (<$40,000)	DV: 1 "Annual gross income household < $40,000"; 0 "otherwise"
University degree	DV: 1 "University degree"; 0 "otherwise"
Reduced transit fare	DV: 1 "Access to a free or reduced transit fare"; 0 "otherwise"
Attitudinal	
Need of a car	DV: 1 "I need a car to do many of the things I like to do."; 0 "otherwise"
Walk more	DV: 1 "I would like to walk more than I currently do."; 0 "otherwise"
Health	DV: 1 "Long-term effect of my trips on my health is important."; 0 "otherwise"
Environment	DV: 1 "Environmental impact of my chosen mode is important."; 0"otherwise"
Self-selection	
Walkability	DV: 1 "I chose my neighbourhood based on its walkability and bikeability." ; "otherwise"
Proximity to transit	DV: 1 "I chose my neighbourhood based on its proximity to transit"; 0 "otherwise"
Travel mode used (%)	
Automobile trips	Percentage of weekly trips (includes work, school & grocery shopping) by car
Transit trips	Percentage of weekly trips (includes work, school & grocery shopping) by transit
Walking trips	Percentage of weekly trips (includes work, school & grocery shopping) on foot
Bicycle trips	Percentage of weekly trips (includes work, school & grocery shopping) by bicycle
Frequency	
Grocery shopping trip	Discrete: Frequency of grocery shopping trip in a week
Work or school trip	Discrete: Frequency of work or school trip in a week
Built environment	
Cul-de-sacs	Discrete: Number of dead-ends in a network of 800 meters around the residence
Intersections	Discrete: Number of intersections in a network of 800 meters around the residence
Connected node ratio (CNR)	Continuous: Number of street intersections divided by the number of intersections plus cul-de-sacs
Density (km^2)	Continuous
Walk Score (residence)	Discrete: Walk Score of the residential location
Walk Score (destination)	Discrete: Walk Score of the work or school location
Distance to work/school	Continuous: Distance to work or school in kilometers
Other	
Meet the weekly RPA	DV: 1 "The Individual meets the weekly RPA"; 0 "otherwise"

Note: "DV" is an abbreviation for dummy variable.

In addition, to better understand how people's attitudes and beliefs affect their level of PA, four dummy variables were developed. The "Need of a car" variable identifies the respondents for whom owning a car is necessary to feel free and do all the things they like. The "Walk more" variable distinguishes individuals that want to walk more frequently than they currently do from those who do not feel the need to exercise more. People that are concerned with the long-term effect of their travel habits on their health are identified by the "Health" variable. Finally, individuals for whom the environmental impact of their chosen travel mode is important are identified by the "Environment" variable.

Travel Mode Choices and trip frequencies:

In order to take into account the effect of travel mode choices on the level of individuals' PA, four variables were created: "Automobile trips", "Transit trips", "Walking trips", and "Bicycle trips". These variables are expressed as percentages. In other words, they represent the mode share of each individual, during a typical week, for all their utilitarian trips (work, school and grocery shopping trips). The study also takes into account the weekly frequency of trips to work or school ("Work or school trip") and to the grocery store ("Grocery shopping trip") made by each respondent.

Built Environment Variables:

Spatial measures were calculated for each respondent using secondary data sources in a geographic information system. First, the population density by zip code (postal code in Canada) for each respondent was calculated from the data obtained on population and land use from the American and Canadian censuses. Second, the distance (in km) from each respondent's residence to his or her work or school was calculated using Google Maps. Third, a measure of street network connectivity around each individual's residence was developed to test the hypothesis that as connectivity increases travel distances decreases and route options increase. Greater connectivity allows for more direct travel between destinations and therefore increases the opportunities a person can reach via active modes of transportation. The measure computed in the present study adds to Dill (2004) and Tresidder (2005)'s work on connected node ratios (CNR). The CNR is the number of street intersections divided by the number of intersections plus cul-de-

sacs (Dill, 2004). A value of 1.0 is a perfect score, which means that there are no dead-ends in the areas. The idea behind this measure is that a well-connected network has many short links, multiple intersections, and minimal cul-de-sacs. Dill and Tresidder (2005) use simple buffers or census boundaries to calculate the number of intersections and dead-ends in a location. Our study uses a service area buffer of 800 meters (0.5 miles), around each respondent's residential location across the seven different TODs, which was calculated using the street network tool in ArcGIS. The measure is therefore based on actual network walking distances for each resident. By calculating connectivity measurements, the study focuses on the local street network where ideally bicycle use is legal and pedestrians are expected. Datasets for road networks were easily obtained in most jurisdictions through open sources (OpenStreetMap (2015); New Jersey Geographic Information Network (2014); Alameda County Open Data (2014); Arlington County GIS Data (2014)). However, local street networks do not always equate to the bicycle and pedestrian network and reliable open source data for bicycle routes and sidewalks are not available in each of the seven TODs. The connectivity measures used in this study are not able to indicate the level of biking or walking suitability.

Finally, the Walk Score of each respondent's current residential address is used as a proxy for neighbourhood diversity of opportunities and local accessibility, and was gathered using the online Walk Score tool (Walk Score, 2014). This tool, which assigns addresses a "Walk Score" between 0 and 100, is a method used for estimating neighbourhood walkability by measuring access to different facilities (Carr et al., 2010). For each address, the tool analyzes hundreds of walking routes to nearby amenity categories such as retail, recreation and leisure opportunities. Points are awarded based on the distance to amenities in each category. Amenities within a five-minute walk (0.25 miles or 0.4 km) are given maximum points. The tool uses a decay function to attribute points to more distant amenities, and stops giving points to attractions that are beyond a 30-minute walk. It also measures pedestrian friendliness by analyzing variables such as population density and block length. Data sources used by this tool include Google, Education.com, Open Street Map, Census and Localeze (Walk Score, 2014)

Choice of models

To better understand which factors have an influence on the level of PA achieved through

utilitarian trips, this study uses two log-linear regression models and tests them under pleasant and unpleasant weather conditions. The dependent variable, weekly level of PA (calculated in METs), is not normally distributed. Three tests were performed to reject the normality hypothesis; Shapiro-Wilk test, Pearson's test and Fisher's skewness coefficient test. A logarithm transformation was therefore conducted on this dependent variable. All the assumptions of multiple regressions (normality of residual, linearity, homoscedasticity, multicollinearity, etc.) were also tested to ensure the conformity of the models to statistical theory. The use of a hierarchical model to account for the fact that the respondents come from six different cities was also tested. However, this technique did not result in a better fit for the model (Likelihood ratio test $p > 0.05$).

Results

Descriptive Analysis:

Who Meets the Weekly-Recommended Level of Physical Activity?

Among the 418 respondents that answered all the questions from the survey required for this research, 82 (19.62%) meet the weekly-recommended level of physical activity (RPA) solely by travelling to work or school and to their preferred grocery store. During unpleasant weather conditions this amount falls to 72 (17.2%). Table 7 describes and compares two groups of individuals: those who meet the weekly RPA and those who do not. As can be seen in the table, the survey respondents that are the most physically active and who meet the RPA tend to be younger men who are relatively less affluent and have a university degree. On average, 33% of those who meet the RPA have access to a reduced transit fare compared to only 17% for those who do not meet the weekly RPA. This difference is highly significant at the 99% confidence level. This finding is similar to Lachapelle and Frank's results that showed that Atlanta residents with employer-sponsored transit passes were more likely to meet physical activity time recommendations than those who did not have passes (Lachapelle & Frank, 2009). The average number of days in a week that individuals who achieve the weekly RPA commute to work or school is also significantly higher than those who do not meet the RPA. This seems to indicate that teleworking could have a negative impact on the overall level of PA. Individuals that work most of the time at home have fewer opportunities to exercise because they travel less frequently outside their residence. Individuals who meet the weekly RPA also tend to be more aware of the

detrimental effect of motor vehicle usage on the environment. However, active and inactive individuals are not statistically differentiated by their concern regarding the long-term effects of their travel mode choice on their health. Those who meet the weekly RPA are also less concerned with the need to have a personal vehicle to do the things they like. Conversely, less active individuals are more likely to say that they would like to walk more than they currently do. In addition, respondents that meet the weekly RPA are likely to ride transit or cycle more frequently for their utilitarian trips than all other respondents. Finally, it seems that the Walk Scores of work or school locations associated with those who are considered physically active are statistically higher than less active individuals, while the level of street connectivity (Connected nodes ratio) is not statistically different between these two groups of individuals.

Table 7. Description of individuals' attributes using t-test for equality of means.

	Do not meet the weekly RPA		Meet the weekly RPA			
Variables	**M**	**SD**	**M**	**SD**	***t*-test**	
Socio-demographics						
Age	44,214	15,227	39,519	12,711	4,695	**
Gender (Female)	0,514	0,501	0,380	0,488	0,134	*
University degree	0,423	0,495	0,549	0,501	-0,126	**
Low income	0,489	0,501	0,620	0,489	-0,130	**
Reduced transit fare	0,176	0,381	0,329	0,473	-0,154	***
Attitudinal						
Need of a car	0,402	0,491	0,183	0,389	0,219	***
Walk more	0,726	0,447	0,537	0,502	0,190	***
Health	0,619	0,486	0,683	0,468	-0,064	n.s.
Environment	0,530	0,500	0,634	0,485	-0,104	*
Self-selection						
Walkability	0,784	0,412	0,863	0,347	-0,079	n.s.
Travel mode used (%)						
Transit trips (%)	18,870	35,329	63,747	33,617	-44,876	***
Walking trips (%)	16,302	33,234	20,824	30,721	-4,522	n.s
Bicycle trips (%)	4,099	17,487	8,477	25,483	-4,377	**
Automobile trips (%)	60,728	44,601	7,868	10,907	52,860	***
Frequency						
Grocery shopping trip (F)	1,702	1,106	1,869	1,428	-0,167	n.s.
Work or School trip (F)	3,360	2,160	4,695	1,204	-1,335	***
Built environment						
Walk Score (destination)	55,713	36,836	75,110	24,572	-19,396	***
Walk Score (residence)	73,529	17,103	74,317	15,296	-0,789	n.s.

Connected Node Ratio (CNR)	0,907	0,006	0,921	0,006	-0,014	n.s.

* p<0.05 , ** p<0.01, *** p<0.001

The Seasonality Effect

Table 8 shows that unpleasant weather has a negative effect on the weekly level of PA. On average the level of PA of each respondent decreases by 0.57 METs per week during unpleasant weather conditions and this relationship is statistically significant at the 99% confidence level. Conditions considered unpleasant vary by individuals and geographic location. For instance, respondents located in Canada or in northern American TODs are mainly concerned by ice and snow on the ground. Regarding bad weather, 54.5% of the respondents checked "heavy rain" as unpleasant weather, 37.8 % the presence of "ice on the ground", 30.1 % the presence of " snow on the ground", 16.5% "heavy wind", and 11.7% "light rain". Temperature is also a factor to consider. Many admit that too hot (24.4% of the respondents) or too cold (22.2%) temperatures may alter their travel mode choice or modify their trip schedule. During bad weather, the average weekly proportion of trips by foot and by bicycle diminishes by 4.4% and 2.8% respectively, while the proportion of trips by automobile (either as driver or passenger) increases by 6.3% on average. Clearly people tend to opt for a travel mode option that offers full protection against bad weather conditions.

Table 8. Description of individuals' level of PA and travel mode by weather conditions.

	Pleasant weather		**Unpleasant weather**			
	M	**SD**	**M**	**SD**	***t*-test**	
Weekly level of PA (METs)	4.290	6.233	3.704	6.557	0.586	***
Meet the weekly RPA	0.196	0.398	0.172	0.378	0.024	**
Transit trips (%)	27.674	39.249	28.454	39.525	-0.781	n.s
Walking trips (%)	17.189	32.770	12.829	28.081	4.360	***
Bicycle trips (%)	4.958	19.360	2.147	13.213	2.811	***
Automobile trips (%)	50.358	45.419	56.617	44.649	-6.258	***

* p<0.05 , ** p<0.01, *** p<0.001

Which Factors Influence the Level of PA?

As aforementioned, two different log-linear models were developed to understand which factors most influence the weekly level of PA (Table 9). The first model includes variables on travel mode choice (percentage of trips by automobile, transit, walking and bicycle during a typical week), while the second does not. Another difference is that the first model does not include built environment variables. It was impossible to have the built environment and travel mode choice variables in the same model (model 1) since individual travel mode choice is a direct function of built environment characteristics. The second model was therefore developed to evaluate the effect of various built environment variables computed in GIS and presented in Table 6. However, the second model only displays the Walk Score variables since they have more explanatory power than CNR and density measures. While having a positive effect on PA, population density (km^2) is too highly correlated with the two Walk Score measures to be incorporated in the same model ($r>50$). The improved version of the connected node ratio (CNR) measure developed in this study has a positive effect on the level of PA and is not overly correlated to the Walk Score measures ($r = 34$). Nevertheless, the CNR measure is found to be unstable in presence of the Walk Score measures and has overall less explanatory power. It was therefore removed from the second model. In addition, the number of years spent in a TOD and the distance to work or school were also excluded from the second model due to insignificance. Finally, some socio-economic and attitudinal variables such as “Low income” “Age”, “University degree”, “Health”, and “Environment” are insignificant in both models. They were therefore excluded from the final models.

Table 9. Log-linear regressions of the level of PA (in METs) by weather conditions.

	Pleasant Weather Conditions		Unpleasant Weather Conditions	
Variables	Model 1	Model 2	Model 1	Model 2
Years spent in a TOD	0.00829***		0.00426	
	(0.00259)		(0.00272)	
Grocery-shopping trip (f.)	0.09156***		0.08944***	
	(0.02585)		(0.02765)	
Work or school trip (f.)	0.09249***		0.07735***	
	(0.01458)		(0.01349)	
Walkability	0.16037**	0.28809**	0.09824	0.22759*
	(0.06797)	(0.11961)	(0.07388)	(0.11750)
Need of a car	-0.13535**	-0.44643***	-0.12129**	-0.36601***
	(0.05491)	(0.10158)	(0.06041)	(0.09716)
Walk more	-0.13079**	-0.31355***	-0.13280*	-0.29995***
	(0.06245)	(0.11151)	(0.06925)	(0.11467)
Transit trips (%)	0.02174***		0.01929***	
	(0.00082)		(0.00088)	
Walking trips (%)	0.01735***		0.01895***	
	(0.00091)		(0.00118)	
Bicycle trips (%)	0.01423***		0.02103***	
	(0.00271)		(0.00382)	
Distance to work/school	0.01065***		0.00946**	
(km)	(0.00325)		(0.00401)	
Female		-0.20752**		-0.04200
		(0.09691)		(0.09588)
Reduced transit fare		0.39543***		0.50683***
		(0.12722)		(0.13129)
Walk Score (residence)		0.01004***		0.00929***
		(0.00287)		(0.00288)
Walk Score (destination)		0.00914***		0.00855***
		-0,00136		-0,0014
Constant	-0.50387***	-0.06263	-0.37315***	-0.20874
	(0.10575)	(0.29252)	(0.11182)	(0.29975)
Observations	404	393	400	389
R-squared	0.76802	0.27425	0.73127	0.25816

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

According to model 1, the more years an individual has spent in a TOD, the more likely his or her level of PA will be higher. Actually, each additional year increases the level of PA by 0.8%. Under unpleasant weather conditions however, the exposure to a certain environment or

neighbourhood does not seem to have any special effect on level of PA. The frequency of trips for shopping, work or school also has a positive effect on the level PA. Each additional grocery-shopping trip increases the individual METs by 9.2%, while each additional work or school trip increases it by 9.3%. These positive effects tend to be smaller during unpleasant weather.

The "Walkability" variable, which controls for self-selection, explains 16% of the level of PA in the first model and 29% in the second model. During unpleasant weather conditions, this variable becomes statistically insignificant for the first model, it but remains significant for the second model and explains 23% of the level of PA. The variable "Proximity to transit", which accounts for people that have chosen their current neighbourhood based on proximity to public transit, was also tested but was revealed to be insignificant.

Individuals who expressed a need for a car to do many things they like are less likely to be physically active. This finding is consistent in both models. The need for a car reduces an individual's level of PA by 13.5% in model 1 and by 44.6% in model 2. The effect of this variable is weaker under unpleasant weather. Respondents that are conscious of their physical inactivity and who reported needing to walk more than they do currently during their utilitarian trips are also less likely to be physically active than others. The level of PA for individuals with such a desire is 13% lower according to the first model and 31.4% according to the second compared to individuals without this desire. The effect of this variable remains relatively consistent during bad weather conditions.

Overall, transit usage has a greater positive effect than any other mode on the level of PA. Due to sample size limitation, this study does not differentiate between the effects of various transit modes (Bus, subway, train, etc.). But, under good weather conditions, Model 1 shows that a 1% increase in an individual's transit mode share is associated with an almost 2.2% increase in PA. A similar increase in "walking trips" or in "bicycle trips" only results in an increase of the weekly level of PA by 1.7% and 1.4% respectively. To illustrate, an individual with a weekly PA level of 4.4 METs that made four trips to work by transit and two trips to the grocery store by car may gain 1.6 additional METs (+36.52 %) by going to the grocery store once a week by transit (Figure 3).

Demonstration example:

1. Current share of transit trips (%): (4/6)*100=66.7 %
2. Share of transit trips (%) with one additional transit trip: (5/6)*100= 83.3 %
3. 83.3 % - 66.7 % = 16.6 %
4. 2.2 % * 16.6 = 36.52 % *(Gain in PA from the additional transit trip)*
5. 0.3652 * 4.4 METs =1.606
6. 4.4 +1.6 = 6 METs *(New weekly METs after the change in travel mode choice)*

Figure 3. Demonstration of how change in travel mode choice can affect individuals' level of PA.

Under bad weather conditions, each additional percentage of "bicycle trips" increases the overall PA level by 2.1 %, while similar increases in "transit trips" and "walking trips" increase the level of PA by 1.9 % and 1.89% respectively. The variables "Distance to work/school" and "Distance to the preferred grocery store" in kilometers were also tested. While the latter is not significant, the former is for the first model. A one-kilometer increase in the distance from home to school or work during good weather conditions increases the PA level of an individual by 1.07 %. This effect reduces by 0.94% during bad weather conditions. This relationship is however not linear. Over a certain threshold, people adopt another travel mode and the distance has little effect on the level of PA.

In model 2, the variable "female" indicates that the level of PA will be 20.8 % lower for a female than a male. However, gender does not seem to explain much of the variability between individuals' levels of PA during unpleasant weather since females only are 4.2 % less physically active than men during such weather conditions. The second model also shows that people with access to a reduced or free transit fare are 39.5% more active than those who do not. Under unpleasant weather conditions these individuals are 50.7% more physically active than anybody else, which suggests that the implementation of free or reduce transit fare may be a good retention measure of transit users during unpleasant weather conditions. Individuals benefiting from this type of incentive are probably less likely to switch to car usage (as passenger or driver) during bad weather.

Finally, the "Walk Score" at the residence location and at the work or school location are the two most statistically significant variables regarding the built environment variables tested. A ten points increase in Walk Score at home and work (which ranges from 0-100) increases the level of PA by 10% and 9%, respectively, during pleasant weather. The "Walk Score" effects at home and at work are slightly lower when weather conditions are unpleasant.

Discussion and Conclusion

Results from this study clearly demonstrate that PA levels that provide substantial health benefits can be reached through various utilitarian trips. The results suggest that self-selection is a factor underlying individual' levels of PA, but it is not decisive with regard to meeting the recommended levels of PA. Results can help planners and policy makers target interventions to 1) facilitate the transition to a more active lifestyle and 2) mitigate the social issues related to inactivity.

First, special care is needed to remove social stigma related to the need to own an automobile. According to the findings, those who feel this need are less likely to be physically active. With the increased popularity of car sharing programs, it is now easier than ever for those who do not own personal vehicles to reach destinations and opportunities outside the transit network perimeter of a region. To help modify people's vision on automobiles, transit agencies should keep enhancing their network to allow greater access to more destinations in various parts of a region and not just central locations, since the use of transit as a travel mode has been shown in this study to have a significant positive effect on the level of PA. Better, more frequent, and reliable transit links between work destinations and residential locations across urbanized areas and outside traditional peak hours is essential to serve various segments of the population (Anderson, Owen, & Levinson, 2012; Kim & Kwan, 2003; Legrain, Buliung, & El-Geneidy, 2015).

Second, bad weather conditions have a negative impact on the level of PA of individuals. On such days, many who would usually walk or cycle would choose to travel by car instead. It is important to note that most respondents analysed in this study are choice riders, since each

household has access to at least one personal vehicle. Transit agencies should promote and advertise transit usage as a safe alternative during days of unpleasant weather; especially in places where ice and snow are the reason why people opt for their automobile as travel mode. Efficient sidewalk snow removal policies around stations can complement transit agencies' efforts to better promote their services. Better shelters, more convenient facilities around stops, and air-conditioned vehicles can also potentially encourage people to use transit during very rainy, cold or hot days where active modes are less desirable. According to the results of this study, transit agencies should also consider the implementation of reduced or free transit fare programs for the segment of their customers more at risk of switching to car usage during unpleasant weather conditions.

Third, social changes in the employment market, educational system and in shopping behaviours influence the level of PA. Regular employment is no longer confined in one work place, especially for professionals, managers and other white-collar workers (Felstead, Jewson, & Walters, 2005a, 2005b). Telecommuting and telework is a situation in which an employee works in an environment other than employer workplace (mainly from home) and communicates with the company by email, telephone, and video conferencing. The expansion of mobile phones, laptops, and internet connectivity means that a lot of work can be done in any connected location and any time (Ruiz & Walling, 2005). These new communication methods have also allowed the multiplication of long-distance courses and training opportunities offered online. Online degrees, which are produced at almost no cost compared to regular in-class courses, are becoming more trendy as shown by online enrolment records (Allen & Seaman, 2013). These social changes in workforce behaviours and in the educational system have tremendous effects on city planning and transportation demand management (Helling & Mokhtarian, 2001). They can have a potentially negative impact on individual levels of PA as suggested in the results of this study. The rise in popularity of remote working and schooling may increase physical inactivity in the population if the level of PA performed during a commute is not replaced. Encouraging the use of transit, especially rail services, for professionals when they need to go to the office, and branding them as places where commuting time can be productive and useful rather than lost, are strategies that can potentially increase the level of PA of the population as well as increase transit ridership. Similar strategies can be applied to encourage students to maximize their study time in transit.

Furthermore, these strategies are in line with the new workforce market and assess the fact that work or study is now being detached from conventional places.

Furthermore, the expansion of grocery delivery and teleshopping has an impact on behaviours related to grocery shopping trips and commercial development. The present study suggests that every shopping trip not carried out by an individual reduces the likelihood of meeting an individual's weekly level of recommended physical activity. Therefore, one way to keep people active is to make grocery-shopping trips more desirable, especially by active modes and transit. Changing the perception of grocery shopping from a chore to a more enjoyable experience might also be needed to keep people from using their car or grocery delivery and teleshopping services.

Fourth, many strategies can be implemented to encourage people to go to work, school or grocery store by active mode of transportation, including walking, cycling, and transit. The built environment variables tested in this study suggest that the more walkable an environment is and the more opportunities an immediate environment has the more likely people living in it will use active travel modes. Removing built environment barriers seems to be essential to foster active lifestyles. Environments designed to encourage transit use, such as TODs, seem to be promising as transit users among all commuters are more likely to have higher levels of PA. In addition, any strategies aimed at reducing distance between people and opportunities (e.g., work locations, groceries stores, service providers and entertainment) or transforming the built environment to make it more conducive to active modes of transportation needs to be explored in order to limit the negative effects of physical inactivity. This research does not address PA performed during non-utilitarian trips (E.g., trips to recreational purposes). Further research should be performed to evaluate the potential benefits of these trips on health while identifying the factors that positively affect the level of PA.

Finally, the travel experience needs to be redefined to encourage more active travel behaviours. Rather than be exclusively defined as a cost (monetary, time, and opportunity cost, etc.), the travel experience should also be described as procuring some gains. Among those potential gains are health benefits, private time to think, decompress, explore and discover the

environment, financial gains due to the work performed while travelling, and opportunities for social exchanges. Nevertheless, one should bear in mind that family and social networks behaviours are often seen as the seedbed of a physically active lifestyle as they can encourage and facilitate PA (Eyler et al., 1999; Sallis, Prochaska, & Taylor, 2000; van der Horst, Paw, Twisk, & van Mechelen, 2007). Development of active role models by transit agencies, transportation planners, health professionals, local governments and decision makers should be initiated to complement all the aforementioned policy recommendations to shun inactivity with active travel behaviours within well-designed environment.

Afterword

The chapters presented in this study bring attention on how better designed environments can encourage more active lifestyles and develop more sustainable neighbourhoods. There are no ready-made recipes that will alter individual travel behaviour, but the main findings from this project lead to a better understanding of the critical areas and highlight several potential solutions.

Environments more conducive to walking, cycling and transit use, such as TODs, seem to have promising benefits in term of sustainability and health. Results from chapter one, show that new TOD residents adopt more sustainable and therefore more active travel modes for amenities and leisure trips, which suggests that an increase in health benefits is possible. They are less likely to do so for work and shopping trips. To encourage more sustainable travel modes, the findings suggest that transit incentives coupled with workplace parking charges need to be considered. Awareness of the environmental impact of each travel mode, walkability of the neighbourhood and availability of various destinations as well as proximity to transit stops are factors that increase the probability of switching to a more sustainable mode of transportation for new TOD residents. Important events in life such as having a new baby, becoming a homeowner, and buying a new car, have a negative impact on the probability of adopting more sustainable travel modes. Decision makers and transit agencies need to tackle this issue in order to increase retention of transit users.

While sustainable travel mode options, such as cycling and walking, can help alleviate congestion and reduce pollution, they can also increase individual level of PA. The second chapter has shown that the ability to cycle and walk around communities is becoming an important transportation alternative. Negative effects of bad weather conditions on active modes of transportation need to be mitigated by transit agencies, transportation planners and local governments in order to keep people active year-round. Neighbourhoods must be planned and designed according to their geographical location and climate in order to be more conducive to active modes of transportation. The use of reduced transit fare is suggested for individual at risk

of switching to a less sustainable travel mode under unpleasant weather conditions. The study also raises some concerns regarding the growth of teleworking and teleshopping habits. While potentially being positive for the environment, these new consumptions and work behaviours reduce the weekly number of transportation trips and opportunities to exercise of individuals, assuming that their level of leisure exercise remain unchanged. Finally, this project suggests that special care is needed to 1) remove the social stigma related to the need to own an automobile, and 2) increase awareness of the detrimental effects of automobile usage on the environment. Evolution of mentalities is a key ingredient for a well-functioning, healthier and more sustainable society.

References

Abou-Zeid, M., & Ben-Akiva, M. (2012). Travel mode switching: Comparison of findings from two public transportation experiments. *Transport Policy*, *24*, 48-59. doi: 10.1016/j.tranpol.2012.07.013

Abou-Zeid, M., Witter, R., Bierlaire, M., Kaufmann, V., & Ben-Akiva, M. (2012). Happiness and travel mode switching: Findings from a Swiss public transportation experiment. *Transport Policy*, *19*(1), 93-104.

Ainsworth, B., Haskell, W., Herrmann, S., Meckes, N., Bassett, D., Tudor-Locke, C., . . . Leon, A. (2011). 2011 compendium of physical activities: A second update of codes and MET values. *Medicine and science in sports and exercise*, *43*(8), 1575-1581.

Ainsworth, B., Haskell, W., Leon, A., Jacobs, D., Montoye, H., Sallis, J., & Paffenbarger, R. (1993). Compendium of physical activities: Classification of energy costs of human physical activities. *Medicine and science in sports and exercise*, *25*(1), 71-80.

Ainsworth, B., Haskell, W., Whitt, M., Irwin, M., Swartz, A., Strath, S., . . . Emplaincourt, P. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine and science in sports and exercise*, *32*(9; SUPP/1), S498-S504.

Alameda County Data Sharing Initiative. (2014). Alameda County streets centerlines. Retrieved in February 2015 https://data.acgov.org

Allen, E., & Seaman, J. (2013). Changing course: Ten years of tracking online education in the United States: BABSON Survey Research Group and Quahog Research Group.

Anderson, P., Owen, A., & Levinson, D. (2012). *The Time Between: Continuously-defined accessibility functions for schedule-based transportation systems.* Paper presented at the 1st European Symposium on Quantitative Methods in Transportation Systems.

Arlington County GIS Data. (2014). Regional street network. Retrieved in February 2015 http://gisdata.arlgis.opendata.arcgis.com

Besser, L., & Dannenberg, A. (2005). Walking to public transit: Steps to help meet physical activity recommendations. *American journal of preventive medicine*, *29*(4), 273-280.

Bhat, R. (1997). Work travel mode choice and number of non-work commute stops. *Transportation Research Part B: Methodological*, *31*(1), 41-54.

Bhat, R., & Sardesai, R. (2006). The impact of stop-making and travel time reliability on commute mode choice. *Transportation Research Part B: Methodological*, *40*(9), 709-730.

Bickel, R. (2012). *Multilevel analysis for applied research: It's just regression!* : Guilford Press.

Blair, S., & Brodney, S. (1999). Effects of physical inactivity and obesity on morbidity and mortality: Current evidence and research issues. *Medicine and science in sports and exercise*, *31*, S646-S662.

Boarnet, M. (2003). The built environment and physical activity: Empirical methods and data resource. *University of California Transportation Center*.

Brownson, R., & Boehmer, T. (2004). Patterns and trends in physical activity, occupation, transportation, land use, and sedentary behaviors. *TRB Special Report: Does the built environment influence physical activity? Examining the evidence*.

Cao, X., Mokhtarian, P., & Handy, S. (2009). Examining the impacts of residential self-selection on travel behaviour: A focus on empirical findings. *Transport Reviews*, *29*(3), 359-395.

Carr, J., Dunsiger, I., & Marcus, H. (2010). Walk score™ as a global estimate of neighborhood walkability. *American journal of preventive medicine, 39*(5), 460-463.
Carse, A., Goodman, A., Mackett, R., Panter, J., & Ogilvie, D. (2013). The factors influencing car use in a cycle-friendly city: The case of Cambridge. *Journal of transport geography, 28*, 67-74.
Caspersen, C., Powell, K., & Christenson, G. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public health reports, 100*(2), 126.
Cervero, R. (1994). Transit-based housing in California: Evidence on ridership impacts. *Transport Policy, 1*(3), 174-183.
Cervero, R., Ferrell, C., & Murphy, S. (2002). Transit-oriented development and joint development in the United States: A literature review. *TCRP research results digest*(52).
Cervero, R., & Gorham, R. (1995). Commuting in transit versus automobile neighborhoods. *Journal of the American Planning Association, 61*(2), 210-225.
Cervero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment, 2*(3), 199-219.
Cervero, R., Murphy, S., Ferrell, C., Goguts, N., & Tsai, Y. (2004). TCRP Report 102: Transit Oriented Development in the United States. Experiences, challenges, and prospects *Transportation Research Board, National Research Council*, (pp. 481). Washington, DC.
Chatman, D. (2003). How density and mixed uses at the workplace affect personal commercial travel and commute mode choice. *Transportation Research Record: Journal of the Transportation Research Board, 1831*(1), 193-201.
Chatman, D. (2006). *Transit-oriented development and household travel: A study of California cities*: Institute of Transportation Studies, School of Public Affairs, University of California, Los Angeles.
Chatman, D. (2009). Residential choice, the built environment, and nonwork travel: Evidence using new data and methods. *Environment and planning. A, 41*(5), 1072.
Chatman, D. (2013). Does TOD need the T? On the importance of factors other than rail access. *Journal of the American Planning Association, 79*(1), 17-31.
Colditz, G. (1999). Economic costs of obesity and inactivity. *Medicine and science in sports and exercise, 31*(11 Suppl), S663-667.
CSEP. (2012). Canadian physical activity guidelines: For adults. Toronto: Canadian Society for Exercise Physiology.
Curtis, C., & Headicar, P. (1997). Targeting travel awareness campaigns: Which individuals are more likely to switch from car to other transport for the journey to work? *Transport Policy, 4*(1), 57-65.
de Witte, A., Macharis, C., & Mairesse, O. (2008). How persuasive is free public transport?: A survey among commuters in the Brussels Capital Region. *Transport Policy, 15*(4), 216-224.
Dill, J. (2004). *Measuring network connectivity for bicycling and walking.* Paper presented at the 83rd Annual Meeting of the Transportation Research Board, Washington, DC.
Edwards, R. (2008). Public transit, obesity, and medical costs: Assessing the magnitudes. *Preventive medicine, 46*(1), 14-21.
El-Geneidy, A., & Manaugh, K. (2010). *Validating walkability indices: How do different households respond to the walkability of their neighbourhood?* Paper presented at the Transportation Research Board 90th Annual Meeting.

El-Geneidy, A., Tetreault, P., & Surprenant-Legault, J. (2010). *Pedestrian access to transit: Identifying redundancies and gaps using a variable service area analysis.* Paper presented at the Transportation Research Board 89th Annual Meeting.

Eluru, N., Chakour, V., & El-Geneidy, A. (2012). Travel mode choice and transit route choice behavior in Montreal: Insights from McGill University members commute patterns. *Public Transport, 4*(2), 129-149.

Eriksson, L., Friman, M., Ettema, D., Fujii, S., & Gärling, T. (2010). Experimental simulation of car users' switching to public transport. *Transportation Letters, 2*(3), 145-155.

Ewing, R., Schmid, T., Killingsworth, R., & Raudenbush, S. (2003). Relationship between urban sprawl and physical activity, obesity, and morbidity. *American journal of health promotion, 18*(1), 47-57.

Eyler, A., Brownson, R., Donatelle, R., King, A., Brown, D., & Sallis, J. (1999). Physical activity social support and middle-and older-aged minority women: results from a US survey. *Social science & medicine, 49*(6), 781-789.

Felstead, A., Jewson, N., & Walters, S. (2005a). Changing places of work: London: Palgrave Macmillan.

Felstead, A., Jewson, N., & Walters, S. (2005b). The shifting locations of work new statistical evidence on the spaces and places of employment. *Work, Employment & Society, 19*(2), 415-431.

Frank, L., Andresen, M., & Schmid, T. (2004). Obesity relationships with community design, physical activity, and time spent in cars. *American journal of preventive medicine, 27*(2), 87-96.

Frank, L., Schmid, T., Sallis, J., Chapman, J., & Saelens, B. (2005). Linking objectively measured physical activity with objectively measured urban form: Findings from SMARTRAQ. *American journal of preventive medicine, 28*(2), 117-125.

Gelman, A., & Hill, J. (2006). *Data analysis using regression and multilevel/hierarchical models*: Cambridge University Press.

Handy, S. (1996). Understanding the link between urban form and nonwork travel behavior. *Journal of planning education and research, 15*(3), 183-198.

Handy, S. (2005). Critical assessment of the literature on the relationships among transportation, land use, and physical activity. *Transportation Research Board and the Institute of Medicine Committee on Physical Activity, Health, Transportation, and Land Use. Resource paper for TRB Special Report, 282*.

Handy, S., Boarnet, M., Ewing, R., & Killingsworth, R. (2002). How the built environment affects physical activity: Views from urban planning. *American journal of preventive medicine, 23*(2), 64-73.

Helling, A., & Mokhtarian, P. (2001). Worker telecommunication and mobility in transition: Consequences for planning. *Journal of Planning Literature, 15*(4), 511-525.

Hensher, D. (2007). Some insights into the key influences on trip-chaining activity and public transport use of seniors and the elderly. *International Journal of Sustainable Transportation, 1*(1), 53-68.

Hess, P., Moudon, A., Snyder, M., & Stanilov, K. (1999). Site design and pedestrian travel. *Transportation Research Record: Journal of the Transportation Research Board, 1674*(1), 9-19.

Katzmarzyk, P., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: An update. *Canadian journal of applied physiology, 29*(1), 90-115.

Killingsworth, R., de Nazelle, A., & Bell, R. (2003). Building a new paradigm: Improving public health through transportation. *ITE Journal, 73*(6), 28-32.
Kim, H., & Kwan, M. (2003). Space-time accessibility measures: A geocomputational algorithm with a focus on the feasible opportunity set and possible activity duration. *Journal of Geographical Systems, 5*(1), 71-91.
Kingham, S., Dickinson, J., & Copsey, S. (2001). Travelling to work: will people move out of their cars. *Transport Policy, 8*(2), 151-160.
Kohler, U., & Kreuter, F. (2012). *Data analysis using Stata* (Third ed.): Stata Press.
Krambeck, V. (2006). *The global walkability index.* Massachusetts Institute of Technology.
Krizek, K. (2003). Residential relocation and changes in urban travel: Does neighborhood-scale urban Form matter? *Journal of the American Planning Association, 69*(3), 265-281. doi: 10.1080/01944360308978019
Lachapelle, U., & Frank, L. (2009). Transit and health: Mode of transport, employer-sponsored public transit pass programs, and physical activity. *Journal of Public Health Policy*, S73-S94.
Lachapelle, U., & Noland, R. (2012). Does the commute mode affect the frequency of walking behavior? The public transit link. *Transport Policy, 21*, 26-36.
Lari, A., Douma, F., Lang Yang, K., Caskey, K., & Cureton, C. (2014). Innovative parking pricing demonstration in the twin cities: Introducing flexibility and incentives to parking contracts (pp. 106): Humplhrey School of Public Affairs, University of Minnesota.
Larsen, J., El-Geneidy, A., & Yasmin, F. (2010). Beyond the quarter mile: Re-examining travel distances by active transportation. *Canadian Journal of Urban Research, 19*.
Lee, I., & Buchner, D. (2008). The importance of walking to public health. *Medicine and science in sports and exercise, 40*(7 Suppl), S512-518.
Legrain, A., Buliung, R., & El-Geneidy, A. (2015). Who, what, when, and where: Revisiting the influences of transit mode share. *Transportation Research Record*.
Lindström, M. (2008). Means of transportation to work and overweight and obesity: A population-based study in southern Sweden. *Preventive medicine, 46*(1), 22-28.
Lorek, S., & Spangenberg, J. (2001). Indicators for environmentally sustainable household consumption. *International Journal of Sustainable Development, 4*(1), 101-120.
MacDonald, J., Stokes, R., Cohen, D., Kofner, A., & Ridgeway, G. (2010). The effect of light rail transit on body mass index and physical activity. *American journal of preventive medicine, 39*(2), 105-112.
Manaugh, k., & El-Geneidy, A. (2014). *Disentangling self-selection and transit availability influences in mode choice decision making*. Paper presented at the World Symposium on Land use and Transport (WSTLUR), Delf in the Netherlands. http://tram.mcgill.ca/Research/Publications/Self selection.pdf
McAuley, E. (1994). Physical activity and psychosocial outcomes. In C. Bouchard, R. Shephard, & T. Stephens (Eds.), *Physical activity, fitness and health: the consensus knowledge.* (pp. 551-568). CHampaign (IL): Human Kinetics.
McCullagh, P., & Nelder, J. (1989). Generalized linear models.
Ming Wen, L., & Rissel, C. (2008). Inverse associations between cycling to work, public transport, and overweight and obesity: Findings from a population based study in Australia. *Preventive medicine, 46*(1), 29-32.

Morency, C., Trépanier, M., & Demers, M. (2011). Walking to transit: An unexpected source of physical activity. *Transport Policy, 18*(6), 800-806.
New Jersey Geographic Information Network. (2014). New Jersey Road Centerlines GIS Data. Retrieved In February 2015 https://njgin.state.nj.us/NJ_NJGINExplorer/jviewer.jsp?pg=ROADS
Nurdden, A., Rahmat, R., & Ismail, A. (2007). Effect of transportation policies on modal shift from private car to public transport in Malaysia. *Journal of applied Sciences, 7*(7), 1013-1018.
Oja, P., Vuori, I., & Paronen, O. (1998). Daily walking and cycling to work: Their utility as health-enhancing physical activity. *Patient education and counseling, 33*, S87-S94.
OpenStreetMap and its contributors. (2015). Vancouver, Toronto and Dallas metropolitan areas. Retrieved in February 2015 http://www.openstreetmap.org
Owen, N. (1996). Strategic initiatives to promote participation in physical activity. *Health Promotion International, 11*(3), 213-218.
Pate, R., Pratt, M., Blair, S., Haskell, W., Macera, C., Bouchard, C., . . . King, A. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Jama, 273*(5), 402-407.
Renne, J. (2005). Physical activity and use of suburban train stations: An exploratory analysis. *Journal of Public Transportation*, 89.
Ruiz, Y., & Walling, A. (2005). Home-based working using communication technologies. *Labour market trends, 113*(10), 417-426.
Rundle, A., Diez Roux, A., Freeman, L., Miller, D., Neckerman, K., & Weiss, C. (2007). The urban built environment and obesity in New York City: A multilevel analysis. *American journal of health promotion, 21*(4s), 326-334.
Saelens, B., Sallis, J., & Frank, L. (2003). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of behavioral medicine, 25*(2), 80-91.
Sallis, J., Bauman, A., & Pratt, M. (1998). Environmental and policy interventions to promote physical activity. *American journal of preventive medicine, 15*(4), 379-397.
Sallis, J., Frank, L., Saelens, B., & Kraft, K. (2004). Active transportation and physical activity: Opportunities for collaboration on transportation and public health research. *Transportation Research Part A: Policy and Practice, 38*(4), 249-268.
Sallis, J., Prochaska, J., & Taylor, W. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and science in sports and exercise, 32*(5), 963-975.
Sari, N. (2009). Physical inactivity and its impact on healthcare utilization. *Health Economics, 18*(8), 885-901.
Scheiner, J., & Holz-Rau, C. (2013). A comprehensive study of life course, cohort, and period effects on changes in travel mode use. *Transportation Research Part A: Policy and Practice, 47*, 167-181. doi: 10.1016/j.tra.2012.10.019
Schwanen, T., Dijst, M., & Dieleman, F. (2001). Leisure trips of senior citizens: Determinants of modal choice. *Tijdschrift voor economische en sociale geografie, 92*(3), 347-360.
Still, T. (2002). Transit-oriented development: Reshaping America's metropolitan landscape. *On Common Ground: REALTORS & Smart Growth*, 45.
Stokes, R., MacDonald, J., & Ridgeway, G. (2008). Estimating the effects of light rail transit on health care costs. *Health & place, 14*(1), 45-58.

Strathman, J., & Dueker, J. (1996). *Transit Service, Parking Charges and Mode Choice for the Journey-to-Work: An Analysis of the 1990 NPTS.* Paper presented at the 75th Annual Meeting of the Transportation Research Board, Washington, D.C.

Thune, I., & Furberg, A. (2001). Physical activity and cancer risk: Dose-response and cancer, all sites and site-specific. *Medicine and science in sports and exercise, 33*(6 Suppl), S530-550; discussion S609-510.

Transportation Research Board. (2005). Does the built environment influence physical activity? *TRB Special Report* (Vol. 282). Washington, DC: Transportation Research Board.

Tresidder, M. (2005). *Using GIS to measure connectivity: An exploration of issues.* Portland State University, Portland, OR, USA.

USHHS. (2008). *2008 physical activity guidelines for Americans.* Washinghton: U.S. Department of Health and Human Services.

van der Horst, K., Paw, M., Twisk, J., & van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine and science in sports and exercise, 39*(8), 1241.

Walk Score. (2014). Find your neighborhood walk score. Retrieved May, 2014, from http://www.walkscore.com

Warburton, D., Nicol, W., & Bredin, S. (2006). Health benefits of physical activity: The evidence. *Canadian medical association journal, 174*(6), 801-809.

Wasfi, R., Ross, N., & El-Geneidy, A. (2013). Achieving recommended daily physical activity levels through commuting by public transportation: Unpacking individual and contextual influences. *Health & place, 23*, 18-25.

Wener, R., & Evans, G. (2007). A morning stroll levels of physical activity in car and mass transit commuting. *Environment and Behavior, 39*(1), 62-74.

World Health Organization. (2002). A physically active life through everyday transport with a special focus on children and older people. Copenhagen: WHO Regional Office for Europe.

Yang, Y., & Diez-Roux, A. (2012). Walking distance by trip purpose and population subgroups. *American journal of preventive medicine, 43*(1), 11-19.

Ye, X., Pendyala, R., & Gottardi, G. (2007). An exploration of the relationship between mode choice and complexity of trip chaining patterns. *Transportation Research Part B: Methodological, 41*(1), 96-113.

Appendix 1: Survey Questionnaire

Transit-Oriented development Comparison Study

The inter-disciplinary research group, Transportation Research at McGill (TRAM) in Montreal, Canada, in collaboration with the Technical University of Delft in the Netherlands is currently conducting a comparative study to better understand the travel behaviour of residents living in TOD areas. The comparative analysis of TODs in North America and Europe will assess how the built environment of TODs affects residents' travel behaviour in their daily commutes as well as in other activities.

Your participation in this study is greatly appreciated and gives you the chance to win great prizes, including:

- 3 iPad 2s
- 2 iPad minis
- 4 iPod nanos
- 20 $10 coffee cards

The North American project team includes Prof. Ahmed El-Geneidy (McGill) and Dea van Lierop (PhD student, McGill) and the Dutch project team includes Prof. Kees Maat (TU Delft).

This survey will take approximately 10 minutes to complete. Participation is voluntary, and you may exit the survey at any time. Completing the survey indicates consent to participate in this study. All survey responses will remain confidential, stored on password-protected computers, and participants will not be identified in any publications or reports. Identifiers such as email addresses will be removed from the data before any analysis is initiated. Because of the anonymous nature of the survey, once the data has been collected, participants can no longer withdraw from the study. The data may be kept for future related research purposes and will only be accessible by researchers working at Transportation Research at McGill.

If you have any questions or concerns regarding this research project, please send an email to tram.urbanplanning@mcgill.ca. If you need urgent assistance, you may call TRAM at 1-514-398-4058. If you have any questions or concerns regarding your rights or welfare as a participant in this research study please contact the McGill Research Ethics Officer at 514-398-6831 or lynda.mcneil@mcgill.ca

Thank you for your participation! Please print a copy of this consent form for your records.

Part 1: Information about your daily trip

1. Where do you live?
*Please choose **only one** of the following:*

- Berkeley, California, USA
- Dallas, Texas, USA: Downtown Plano
- Dallas, Texas, USA: Mockingbird Station
- Hayward, California, USA
- Rosslyn (Arlington), Virginia, USA
- South Orange, New Jersey, USA
- Toronto, Ontario, Canada
- Vancouver, British Columbia, Canada
- Barendrecht, the Netherlands
- Leiden, the Netherlands
- Pijnacker Zuid, the Netherlands

2. On the following map, please adjust the zoom and drag the pin to your current home location:
Please write your answer here:

_____

3. What describes you best:
*Please choose **only one** of the following:*

- Employed
- Unemployed
- Student
- Retired

4. Do you work outside of your residence?
*Please choose **only one** of the following:*

- Yes, I **work outside** of **home**
- Yes, **sometimes I work outside** of my home and **sometimes I work from home**
- No, I **work at home**

5. Do you go to school outside of your residence?
*Please choose **only one** of the following:*

- Yes, I attend **school outside** of **home**
- Yes, **sometimes I attend school** outside of my home and **sometimes** I attend school at **home**
- No, I take courses **at home**

6. How many days a week on average do you go to work outside of your home?
*Please choose **only one** of the following:*

- 1

- 2
- 3
- 4
- 5
- 6
- 7

7. How many days a week do you on average go to school outside of your home?
*Please choose **only one** of the following:*

- 1
- 2
- 3
- 4
- 5
- 6
- 7

8. Do you have access to:
*Please choose **all** that apply:*

- a vehicle that is provided by your work or school?
- a bicycle that is provided by your work or school?
- free car parking at work or school?
- free or reduced transit fare?
- other reduced travel costs?
- none of the above

Part 1A: Information about your work location

9. On the following map, please adjust the zoom and drag the pin to your most frequent work location:
Please write your answer here:

_____

Part 1B: Information about your school location

10. On the following map, please adjust the zoom and drag the pin to your most frequent school location:
Please write your answer here:

_____

Part 2A: On a typical day with pleasant weather conditions (work)

In order to better to understand your travel behaviour we would like to ask you several questions regarding your tolerance to different weather conditions. These questions will ask you about your travel behaviour during pleasant and unpleasant weather. Unpleasant days are defined as weather conditions that hinder you and have an effect on your travel behaviour. We will start this section by asking you questions about your travel habits during pleasant weather conditions.

11. At what time of day do you usually leave your home to go to work on a typical day with pleasant weather conditions?
*Please choose **only one** of the following:*
[DROP DOWN: 6:00 – 0:00 - 5:45 by 15 minute increments]

12. At what time of day do you usually leave work to return back home on a typical day with pleasant weather conditions?
*Please choose **only one** of the following:*
[DROP DOWN: 15:30 – 0:00 – 15:15 by 15 minute increments]

13. How long does this trips usually take in minutes?
[DROP DOWN: 15:30 – 0:00 – 15:15 by 15 minute increments]

14. On a typical day with pleasant weather conditions, which mode from the following list do you use as your primary mode when you travel to work? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- Other: _____

15. On a typical day with pleasant weather conditions, do you use other modes beside your primary mode when you travel to work? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle

- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- No, I only use one mode
- Other: _____

16. How do you get to the transit station (train, light rail) on your way to work, on a typical day with pleasant weather conditions?
*Please choose **only one** of the following:*

- I walk
- I use a bicycle
- I drive and park
- I get a ride and am dropped off
- I take another mode of transit
- Other: _____

17. On a typical day with pleasant weather conditions, how long does it take you to get from you're your home to the transit station (train, light rail) on your way to work?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

18. When you get off the train or light rail, how do you get from the train station to work?
*Please choose **only one** of the following:*

- I walk
- I use a bicycle
- I drive and park
- I get a ride
- I take another mode of transit
- Other: _____

19. How long does it take you to get from the train or light rail station to our work location?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

20. On a typical day with pleasant weather conditions, do you regularly stop on your way to work for any of the following purposes?
*Please choose **all** that apply:*

- Drop children off at school/day care/etc.

- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.
- I don't stop on my way to work for any purpose
- Other: _____
-

21. Please rate your agreements with the following statements about your trip to work on a typical day with pleasant weather conditions using the primary mode you selected earlier.
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree	Not applicable
I am **satisfied** with the **travel time** of my trip to work						
The **travel time** of my trip to work is **consistent**						
My trip is **comfortable**						
During my trip, I feel **safe** from **crime** and **unwanted attention**						
The **cost** of my trip is **reasonable**						
Overall, I am **satisfied** with my **trip to work**						
I am **satisfied** with my **transfer time**						

22. How much do you agree with the following statements?
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
On a **typical** day with **pleasant weather** conditions, I feel **stressed** during my trips to **work**					
On a **typical** day with **pleasant weather** conditions, **my trip** to work **negatively impacts** my					

punctuality/attendance/working hours					
On a **typical** day with **pleasant weather** conditions, I feel **energized** when I arrive **at work**					

Part 2B: On a typical day with pleasant weather conditions (school)

In order to better to understand your travel behaviour we would like to ask you several questions regarding your tolerance to different weather conditions. These questions will ask about your travel behaviour during pleasant and unpleasant of weather. Unpleasant days are defined as weather conditions that hinder you and have an effect on your travel behaviour. We will start this section by asking you questions about your travel habits during pleasant weather conditions.

23. At what time of day do you usually leave your home to go to school on a typical day with pleasant weather conditions?
*Please choose **only one** of the following:*
[DROP DOWN: 6:00 – 0:00 - 5:45 by 15 minute increments]

24. How long does this trip usually take in minutes?
[DROP DOWN: 0 – more than 200 minutes]

25. At what time of day do you usually return back home on a typical day with pleasant weather conditions?
*Please choose **only one** of the following:*
[DROP DOWN: 15:30 – 0:00 – 15:15 by 15 minute increments]

26. On a typical day with pleasant weather conditions, which mode from the following list do you use as your primary mode when you travel to school? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- Other: _____

27. On a typical day with pleasant weather conditions, do you use other modes beside your primary mode when you travel to school? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- No, I only use one mode
- Other: _____

28. How do you get to the transit station (train, light rail) on your way to school, on a typical day with pleasant weather conditions?
*Please choose **only one** of the following:*

- I walk
- I use a bicycle
- I drive and park
- I get a ride and am dropped off
- I take another mode of transit
- Other: _____

29. On a typical day with pleasant weather conditions, how long does it take you to get from you're your home to the transit station (train, light rail) on your way to school?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

30. When you get off the train or light rail, how do you get from the train station to school?
*Please choose **only one** of the following:*

- I walk
- I use a bicycle
- I drive and park
- I get a ride
- I take another mode of transit
- Other: _____

31. How long does it take you to get from the train or light rail station to your school location?
*Please choose **only one** of the following:*

[DROP DOWN: 1-200 minutes]

32. On a typical day with pleasant weather conditions, do you regularly **stop on your way to** school for any of the following purposes?
*Please choose **all** that apply:*

- Drop children off at school/day care/etc.
- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.
- I don't stop on my way to work for any purpose
- Other: _____

33. On a typical day with pleasant weather conditions, do you regularly stop **on your way back** home for any of the following purposes?
*Please choose **all** that apply:*

- Drop children off at school/day care/etc.
- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.
- I don't stop on my way to school for any purpose

34. Please rate your agreements with the following statements about your trip to work on a typical day with pleasant weather conditions using the primary mode you selected earlier.
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree	Not applicable
I am **satisfied** with the **travel time** of my trip to school						
The **travel time** of my trip to school is **consistent**						
My trip is **comfortable**						
During my trip, I feel **safe** from **crime** and **unwanted attention**						
The **cost** of my trip is **reasonable**						
Overall, I am **satisfied** with my **trip to school**						
I am **satisfied** with my **transfer time**						

35. How much do you agree with the following statements?
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
On a **typical** day with **pleasant weather** conditions, I feel **stressed** during my trips to **school**					
On a **typical** day with **pleasant weather** conditions, **my trip** to work **negatively impacts** my **punctuality/attendance/schooling hours**					
On a **typical** day with **pleasant weather** conditions, I feel **energized** when I arrive **at school**					

Part 3: During unpleasant weather conditions (differences)

36. In your region, which of the following weather conditions do you consider as unpleasant and as affecting your decision to use a certain mode of transportation?
*Please choose **all** that apply:*

- When it's too **hot**
- When it's too **humid**
- When it's too **cold**
- When there is **snow on the ground**
- When there is **ice on the ground**
- When there is **heavy wind**
- When there is **heavily raining**
- When it's **lightly raining**
- Weather **does not impact** my mode choice
- Other: _____

37. Compared to your trip during pleasant weather conditions, do you make changes to your trip to work during unpleasant weather?
*Please choose **only one** of the following:*

- No
- Yes, I use (a) **different mode**(s) when I travel to work/school **during unpleasant** weather conditions compared to my commute during pleasant weather
- Yes, I leave for work/school earlier or later, or wait for the **weather conditions** to improve
- Yes, I tend to work from home more frequently during **bad weather**

Part 3A: On a typical day with unpleasant weather conditions (work)

In order to better to understand your travel behaviour we would like to ask you several questions regarding your tolerance to different weather conditions. These questions will ask you about your travel behaviour during pleasant and unpleasant weather. Unpleasant days are defined as weather conditions that hinder you and have an effect on your travel behaviour. We will start this section by asking you questions about your travel habits during unpleasant weather conditions.

38. At what time of day do you usually leave your home to go to work on a typical day with unpleasant weather conditions?

*Please choose **only one** of the following:*
[DROP DOWN: 6:00 – 0:00 - 5:45 by 15 minute increments]

39. At what time of day do you usually leave your work to return back home on a typical day with unpleasant weather conditions?

*Please choose **only one** of the following:*
[DROP DOWN: 15:30 – 0:00 – 15:15 by 15 minute increments]

40. On a typical day with unpleasant weather conditions, which mode from the following list do you use as your primary mode when you travel to work? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- Other: _____

41. On a typical day with unpleasant weather conditions, do you use other modes beside your primary mode when you travel to work? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- No, I only use one mode
- Other: _____

42. How do you get to the transit station (train, light rail) on your way to work, on a typical day with unpleasant weather conditions?
*Please choose **only one** of the following:*

- I walk
- I use a bicycle
- I drive and park
- I get a ride and am dropped off
- I take another mode of transit
- Other: _____

43. On a typical day with unpleasant weather conditions, how long does it take you to get from you're your home to the transit station (train, light rail) on your way to work?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

44. When you get off the train or light rail, how do you get from the train station to work?
*Please choose **only one** of the following:*
- I walk
- I use a bicycle
- I drive and park
- I get a ride
- I take another mode of transit
- Other: _____

45. How long does it take you to get from the train or light rail station to our work location?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

46. On a typical day with unpleasant weather conditions, do you regularly stop on your way to work for any of the following purposes?
*Please choose **all** that apply:*
- Drop children off at school/day care/etc.
- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.
- I don't stop on my way to work for any purpose
- Other: _____

47. On a typical day with unpleasant weather conditions, do you regularly stop on your way back home for any of the following purposes?
*Please choose **all** that apply:*
- Drop children off at school/day care/etc.
- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.

- I don't stop on my way to work for any purpose
- Other: _____

48. Please rate your agreements with the following statements about your trip to work on a typical day with unpleasant weather conditions using the primary mode you selected earlier
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree	Not applicable
I am **satisfied** with the **travel time** of my trip to work						
The **travel time** of my trip to work is **consistent**						
My trip is **comfortable**						
During my trip, I feel **safe** from **crime** and **unwanted attention**						
The **cost** of my trip is **reasonable**						
Overall, I am **satisfied** with my **trip to work**						
I am **satisfied** with my **transfer time**						

49. How much do you agree with the following statements?
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
On a **typical** day with **unpleasant weather** conditions, I feel **stressed** during my trips to **work**					
On a **typical** day with **unpleasant weather** conditions, **my trip** to work **negatively impacts** my **punctuality/attendance/working**					

hours					
On a **typical** day with **unpleasant weather** conditions, I feel **energized** when I arrive **at work**					

Part 3B: Changes to your trip

50. Compared to your trip during pleasant weather conditions, do you make changes to your trip to work during unpleasant weather?
*Please choose **only one** of the following:*

- No
- Yes, I use (a) **different mode**(s) when I travel to work/school **during unpleasant** weather conditions compared to my commute during pleasant weather
- Yes, I leave for work/school earlier or later, or wait for the **weather conditions** to improve
- I tend to work from home more frequently during **bad weather**

Part 3C: On a typical day with unpleasant weather conditions (school)

In order to better to understand your travel behaviour we would like to ask you several questions regarding your tolerance to different weather conditions. These questions ask you about your travel behaviour during pleasant and unpleasant weather. Unpleasant days are defined as weather conditions that hinder you and have an effect on your travel behaviour. We will start this section by asking you questions about your travel habits during unpleasant weather conditions.

51. At what time of day do you usually leave your home to go to school on a typical day with unpleasant weather conditions?
*Please choose **only one** of the following:*
[DROP DOWN: 6:00 – 0:00 - 5:45 by 15 minute increments]

52. At what time of day do you usually leave you school to return back home on a typical day with unpleasant weather conditions?
*Please choose **only one** of the following:*
[DROP DOWN: 15:30 – 0:00 – 15:15 by 15 minute increments]

53. On a typical day with unpleasant weather conditions, which mode from the following list do you use as your primary mode when you travel to school? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus

- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- Other: _____

54. On a typical day with unpleasant weather conditions, do you use other modes beside your primary mode when you travel to school? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- No, I only use one mode
- Other: _____

55. How do you get to the transit station (train, light rail) on your way to school, on a typical day with unpleasant weather conditions?
*Please choose **only one** of the following:*

- I walk
- I use a bicycle
- I drive and park
- I get a ride and am dropped off
- I take another mode of transit
- Other: _____

56. On a typical day with unpleasant weather conditions, how long does it take you to get from you're your home to the transit station (train, light rail) on your way to school?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

57. When you get off the train or light rail, how do you get from the train station to school?
*Please choose **only one** of the following:*

- I walk

- I use a bicycle
- I drive and park
- I get a ride
- I take another mode of transit
- Other: _____

58. How long does it take you to get from the train or light rail station to your school location?
*Please choose **only one** of the following:*
[DROP DOWN: 1-200 minutes]

59. On a typical day with unpleasant weather conditions, do you regularly stop on your way to school for any of the following purposes?
*Please choose **all** that apply:*

- Drop children off at school/day care/etc.
- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.
- I don't stop on my way to work for any purpose
- Other: _____

60. On a typical day with unpleasant weather conditions, do you regularly stop on your way back home for any of the following purposes?
*Please choose **all** that apply:*

- Drop children off at school/day care/etc.
- Grocery shopping
- Buy coffee/meal
- Stop at the gym
- Stop at bank/post office/ etc.
- I don't stop on my way to work for any purpose
- Other: _____

61. Please rate your agreements with the following statements about your trip to work on a typical day with unpleasant weather conditions using the primary mode you selected earlier.
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree	Not applicable
I am **satisfied** with the **travel time** of my trip to school						
The **travel time** of my trip to school is **consistent**						

My trip is **comfortable**						
During my trip, I feel **safe** from **crime** and **unwanted attention**						
The **cost** of my trip is **reasonable**						
Overall, I am **satisfied** with my **trip to school**						
I am **satisfied** with my **transfer time**						

62. How much do you agree with the following statements?
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
On a **typical** day with **unpleasant weather** conditions, I feel **stressed** during my trips to **school**					
On a **typical** day with **unpleasant weather** conditions, **my trip** to work **negatively impacts** my **punctuality/attendance/schooling hours**					
On a **typical** day with **unpleasant weather** conditions, I feel **energized** when I arrive **at school**					

Part 4A: Grocery shopping during pleasant weather conditions

63. How often do you usually get groceries?
*Please choose **only one** of the following*:

- Daily
- Three times a week
- Twice a week
- Once a week
- Twice a month
- Once a month
- Other: _____

64. On the following map, please adjust the zoom and drag the pin to the location where you most frequently buy your groceries on a typical day with pleasant weather conditions.

65. At what time of day do you usually go grocery shopping?
*Please choose **only one** of the following:*
[DROP DOWN: 8:00 – 0:00 – 7:00, hour increments]

66. On a typical day with pleasant weather conditions, which mode from the following list do you use as your primary mode when you go grocery shopping? (Your primary mode is the type of transportation that you take for the longest part of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- I don't use a mode, because I get my groceries delivered to my home
- Other: _____

67. On which day(s) do you usually do your grocery shopping?
*Please choose **all** that apply:*

- Mondays
- Tuesdays
- Wednesdays
- Thursdays
- Fridays
- Saturdays
- Sundays
- I don't go shopping on a particular day

Part 4B: Grocery shopping during unpleasant weather conditions

68. Do you use the same mode(s) of transportation during unpleasant weather conditions when you go grocery shopping as you do during pleasant weather conditions?
*Please choose **only one** of the following:*

- Yes, I travel using the same mode(s) of transportation when I go grocery shopping during unpleasant weather conditions
- No, I use (a) different mode(s) when I go grocery shopping during unpleasant weather conditions

69. On a typical day with unpleasant weather conditions, which mode from the following list do you use as your primary mode when you go grocery shopping? (Your primary mode is the type of transportation that you take for the longest part of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus)
- Moped or scooter
- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- I don't use a mode, because I get my groceries delivered to my home
- Other: _____

Part 5: Opinion questions

70. How important are the following factors when planning a trip to work or school?
Please choose the appropriate response for each item:

	Extremely important	Somewhat important	Neutral	Somewhat unimportant	Extremely unimportant
My personal privacy					
The travel habits of my family					
The travel habits of my friends and colleagues					
The opportunity to multi-task (eg. reading, calling, email, exercise etc.)					
The price of fuel					
The cost of parking					
The environmental impact of my chosen mode					
The overall enjoyment of the trip					
The long-term effect on my health					

71. How much do you agree with the following statements?
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
I would like to walk more than I currently do					
I would like to cycle more than I currently do					
I would like to transit more than I currently do					
I would like to drive more than I currently do					

72. How much do you agree with the following statements?
Please choose the appropriate response for each item:

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
I prefer to organize my errands so that I make as few trips as possible					
I need a car to do many things I like to do					
I am familiar with the transit network in my region					
I feel comfortable using the transit network in my region					

Part 6: Information about your home location

73. In what year did you start living in your current residence?
*Please choose **only one** of the following:*
[DROP DOWN: 2013-1900]

74. Why did you move to your current residence?
*Please choose **all** that apply:*

- I have lived at my current home all my life

- The structure of my family changed
- I needed more space
- I needed less space
- I retired
- I wanted to be closer to my work
- I wanted to be closer to my partner/spouse's work
- My work/school location has changed
- I couldn't afford my previous home any more
- I wanted to own my place
- I wanted to live closer to family and friends
- I wanted to be closer to public transit
- I didn't like my old neighborhood
- It was a good investment
- The cost of parking are lower
- The cost of transport costs to work/school are lower
- Other:_____

75. When you moved into your current residence, how important were the following factors in your decision?
Please choose the appropriate response for each item:

	Extremely unimportant	Somewhat unimportant	Neutral	Somewhat important	Extremely important	Not applicable
I have lived at my current home all my life						
The structure of my family changed						
I needed less space						
I needed more space						
I retired						
I couldn't afford my previous home any more						
I wanted to own my own space						
Proximity to my work/school						
Proximity to my partner's or spouse's work/school						
Proximity to groceries						
Proximity to public transit (bus, rail stations, etc.)						

Cost of travelling to work or school (excluding the cost of parking)						
I wanted to be closer to my family and friends						
Being in a location where I could drive less						
The walkability/bikeability of the neighborhood						
The sense of community in the neighborhood						
Proximity to quality and/or type of schools for my children						
The availability of parks and green space						
I didn't like my old neighborhood						
The fact that your current place is new or recently constructed						

76. Do you own or rent your current place of residence?
*Please choose **only one** of the following:*

- I (or a member of my household) own my current residence
- I (or a member of my household) rent my current residence
- Other

77. Which mode(s) of transportation do you usually use to reach the following facilities in your neighborhood?
Please choose the appropriate response for each item:

	Walk	Bicycle	Transit	Car	Other	Not applicable
Daycare						
Gym, indoor recreation, or community center						
A service provider (bank, post-office, medical clinic, pharmacy, etc.)						
Café, bar, restaurant						

Entertainment (movie, theater, gallery, etc.)						
Park or outdoor public place						
Place of worship (church, temple, mosque, etc.)						
Main shopping street or shopping mall						
A friend's home						
A family member's home						

78. How do the prices of the services and groceries in your neighborhood compare with those in other neighbourhoods in your city?
*Please choose **only one** of the following:*

- Much lower
- Slightly lower
- About the same
- Slightly higher
- Much higher

Part 7: Your previous home

The following questions ask you about your **previous place of residence**. (The **home** you **lived in before** you **moved** to your current place of residence.)

79. For how many years did you live at your previous place of residence before you moved to your current home?
*Please choose **only one** of the following:*
[DROP DOWN: "I have always lived in my current home" & 1 – 100 years]

80. On the following map, please adjust the zoom and drag the pin to your previous home location:
81. In the past, when you lived at your former place of residence, before you moved to your current home, which mode from the following list did you use as your primary mode when you travelled to work or school during pleasant weather conditions? (Your primary mode is the type of transportation that you take for the longest portion of your trip.)
*Please choose **only one** of the following:*

- Walk
- Bicycle
- Transit (train, light rail, SkyTrain, metro, subway)
- Transit (tram, street car)
- Transit (bus
- Moped or scooter

- Motorcycle
- Private automobile
- Carshare (Zipcar, Car2Go, Greenwheels, etc.)
- Carpool
- Taxi
- Other: _____

82. Did you own or rent your previous place of residence?
*Please choose **only one** of the following:*

- I (or a member of my household) own my current residence
- I (or a member of my household) rent my current residence

83. When you lived at your previous place of residence, dis you work or go to school in the same location as you currently do?
*Please choose **only one** of the following:*

- Yes
- No
- Not Applicable

84. At your previous place of residence, before you moved to your current home, which mode of transportation did you usually use to reach the following facilities in your previous neighbourhood?
Please choose the appropriate response for each item:

	Walk	Bicycling	Transit	Car	Other	Not Applicable
Daycare						
Gym, indoor recreation, or community center						
A service provider (bank, post-office, medical clinic, pharmacy, etc.)						
Café, bar, restaurant						
Entertainment (movie, theater, gallery, etc.)						
Park or outdoor public place						
Place of worship (church, temple, mosque, etc.)						
Main shopping street						

or shopping mall						
A friend's home						
A family member's home						

Part 8: Your future home

85. Have you considered or are you thinking about moving in the near future?
*Please choose **only one** of the following:*

- Yes, I am considering moving
- No, I have not considered moving
- I have not given this any serious thought

86. What would be your reason for moving in the near future?
*Please choose **all** that apply:*

- The structure of my family changed
- I needed more space
- I needed less space
- I retired
- I wanted to be closer to my work
- I wanted to be closer to my spouse's work
- My work location has changed
- I couldn't afford my previous home any more
- I wanted a place of my own
- I wanted to live closer to my family and friends
- I wanted to be closer to public transit
- I didn't like my old neighborhood
- Other: _____

Part 9: Household Information

87. Select all the following that apply to you
*Please choose **all** that apply:*

- I have a **driver's license**
- I have a monthly/seasonal/annual **transit pass**
- I have a **carshare membership** (Zipcar, Car2Go, Greenwheels, etc.)
- I have a **bicycle**
- **None** of the above

88. How many automobiles are available for use by members of your household (not including car-sharing programs such as Zipcar, Greenwheels, or Car2Go)?
*Please choose **only one** of the following:*

- None
- 1 automobile

- 2 automobiles
- 3 automobiles
- 4 automobiles
- 5 automobiles
- 6 automobiles
- 7 automobiles
- 8 automobiles
- 9 automobiles
- 10 automobiles
- More than 10 automobiles
- Prefer not to answer

89. Where do you park your car(s) at home?
*Please choose **only one** of the following:*

- My own property, personal garage, carport, or driveway
- Private (underground) parking garage
- Public garage
- Reserved parking on the street
- Free on-street parking
- Other: _____

90. Did the number of cars available to your household decrease or increase when you moved to your current place of residence?
*Please choose **only one** of the following:*

- It decreased
- It stayed the same
- It increased

91. How many licensed drivers are in your household, including yourself?
*Please choose **only one** of the following:*

- None
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- More than 10
- Prefer not to answer

92. How many people are in your household, including yourself?
*Please choose **only one** of the following:*
[DROP DOWN: “None” & 1-20 & “More than 20” & “Prefer not to answer”]

93. How many children under the age of 18 are in your household?
*Please choose **only one** of the following:*
[DROP DOWN: “None” & 1-20 & “More than 20” & “Prefer not to answer”]

94. What type of home do you currently live in?
*Please choose **only one** of the following:*

- Apartment or condo
- Row-house or town-house
- Semi-detached house
- Detached, self-standing house
- Other: _____

95. What is the highest level of education that you have completed?
*Please choose **only one** of the following:*

- No formal education
- Elementary school
- High school
- College
- Diploma (technical)
- Undergraduate degree
- Graduate degree
- Other: _____

96. What is your annual gross household income (before taxes)?
*Please choose **only one** of the following:*

- Less than $20,000
- Between $20,001-$40,000
- Between $40,001 - $60,000
- Between $60,001 - $80,000
- Between $80,001 - $100,000
- Between $100,001 - $120,000
- More than $120,00
- Prefer not to answer

97. You are
*Please choose **only one** of the following:*

- Male
- Female
- Prefer not to answer

98. What year were you born?
*Please choose **only one** of the following:*
[DROP DOWN: 1995 – 1920]

Part 10: Further Comments

99. Do you have any further comments?
Please write your answer here:

_____

_____

100. In order to be included in the draw for prizes, please provide us with your email address
Please write your answer here:

_____

_____