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Will you ride the train? A combined home-work spatial segmentation approach

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Abstract: While the influence of land use and transport networks on travel behavior is known, few studies have jointly examined the effects of home and work location characteristics when modelling travel behavior. In this study, a two-step approach is proposed to investigate the combined effect of home and work location characteristics on the intent to use a new public transport service. Using data from the 2019 Montreal Mobility Survey (n=1698), this study examines the intent to use the Réseau Express Métropolitain (REM), a light rail under construction in Montreal, for commuting. A segmentation analysis is first conducted to characterize commuters based on their home and work location characteristics, resulting in six distinct home-work clusters. The clusters are then included in an ordered logistic regression modelling the intent to use the REM, along with socio-economic and attitudinal characteristics. Results from a dominance analysis reveal that the clusters are the third most important determinants of the intent to use the REM, even when controlling for individual characteristics. The addition of the clusters leads to a significant improvement of the model (likelihood of -2388.9 improved from -2400.7, p-value < 0,05). All other clusters have a significantly lower probability (between 32 and 51% less likely) of intent to use the REM than the *typical commuters* (who commute from the suburbs to downtown, often by transit), at a 95% confidence interval. These findings underscore the implications of pursuing radial public-transport networks, illustrating the ability of the proposed approach to identify which groups are likely to benefit from a public-transport project and to propose recommendations anchored in joint home and work location patterns.

Keywords: Intent to use, light rail, built environment, segmentation analysis, commuting, travel behavior

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1 Introduction

With growing pressure to foster sustainable mobility, cities are investing in large-scale public transport infrastructure to increase public transport usage and reduce car dependency. The impacts of such projects are necessarily unevenly distributed across population groups and regions. Understanding how individuals respond to and benefit from these investments is key to improve travel demand models and understand the equity implications of large-scale projects (Guthrie et al., 2017). In the context of large-scale public transport projects understanding behavioral intentions during the often-long development process provides an indication of future use (Fraszczyk & Mulley, 2017; Heinen et al., 2015; Sener et al., 2020) and is of relevance to inform planning and decision-making.

Previous research on intention to use has shown that a variety of factors influence individuals' intention to use a future service. These studies initially focused on attitudinal factors and socio-demographic characteristics to later include spatial and contextual factors (De Vos et al., 2020; Dirgahayani & Sutanto, 2020; Zailani et al., 2016). To incorporate the latter, studies on intentions to use have focused either on home location or, to a smaller extent, on work location, but few have tested the combined effects of home and work locations. Yet, home and work locations are expected to jointly affect the intention to use public transport services, as they determine travel time and frequency of service at both ends of the trip.

The Greater Montreal area is a large Canadian metropolitan area that will see major changes in its public transport network in the next few years, serving as an excellent case study to investigate the intention to use large-scale public transport infrastructure. A new automated light-rail network, called the Réseau Express Métropolitain (REM), is currently under construction across the region. This network will have high frequency in both directions, long service span, extensive spatial coverage and dedicated right of way. Those characteristics have the potential to create a modal shift and improve trip satisfaction for individuals who might not be satisfied with the present public transport options. Yet, it is still unclear whether the REM will deliver such advantages and who will benefit from it.

This study specifically aims to examine the combined effect of home and work locations on the intention to use the REM for commuting. We use data from the 2019 Montreal Mobility Survey which collected travel behavior data, including intentions to use the REM once in operation, as well as attitudinal, trip and socio-economic characteristics. After combining the survey data with spatial variables, a cluster analysis was conducted to segment individuals based on their combined home and work location characteristics. The relationship between home-work clusters and the reported likelihood to use the REM was then assessed through descriptive statistics and an ordered logistic model controlling for socio-economic and attitudinal characteristics. The study proposes an innovative approach to deepen our understanding of the combined effect of home and work locations on the likelihood of using specific public transport services in a region. The segmentation approach, combined with a regression analysis, provides researchers and planners with a tool to identify which individuals are most likely to benefit from projected public transport investments and to propose recommendations anchored in joint home and work location patterns.

2 Literature review

This section first presents an overview of the literature on the determinants of the intention to use public transport. It then expands on the determinants of mode choice, with a focus on spatial and contextual factors.

2.1 Intention to use

Recent transport studies have examined the determinants of intention of usage to understand future travel behavior. Such studies build on the theory of planned behavior that posits that an individual's behavioral intention is a strong predictor of future behavior (Ajzen, 1991). In the context of travel behavior, researchers have demonstrated that the intention to use a mode is effectively linked to future use (Heath & Gifford, 2002; Sottile et al., 2019). Stemming from the field of psychology, studies on the intention to use public transport have typically focused on psychological factors and individual characteristics (Eriksson & Forward, 2011; Irtema et al., 2018; Schikofsky et al., 2020; Zailani et al., 2016). Building on this stream of literature, recent studies have directly examined the intention to use in the context of the introduction of a new public transport service (Halawani & Rehimi, 2021; Villafuerte-Diaz et al., 2023), new public transport lines where there is an existing service (Long et al., 2011; Sener et al., 2020; Sottile et al., 2019) or service increase in an existing public transport network (Zhou et al., 2017).

With respect to psychological factors, attitudes and perceptions have been shown to have a significant influence on the intent to use a transportation service. These include attitudes toward public transport, perceptions about the quality of the service and perceptions about the ease of use (Irtema et al., 2018; Long et al., 2011; Van et al., 2014; Zailani et al., 2016). For example, for light rail services, two studies showed that the intention to use the light rail increased when respondents had a positive opinion about the public transport service (De Vos et al., 2020; Sener et al., 2020). More specifically, one study found that the perception of the benefits of public transport for the environment and for the general health can influence the intent to use the new service (Sener et al., 2020). Similarly, another study found that perceived norms about whether it is good to use public transport and whether public transport is good for the city and the neighborhood can also influence positively the intent to use public transport (Dirgahayani & Sutanto, 2020). Further, research found that positive perceptions associated with the ease of use and functionality (e.g., ability to go where you want when you want, easy to use the service regularly) increase the intent to use new services or an existing one (Eriksson & Forward, 2011; Long et al., 2011; Shiwakoti et al., 2019; Zailani et al., 2016).

Socio-economic characteristics have also been shown to influence the intention to use a transportation service. Many studies identify household income, age, and gender as factors that influence the intent to use (Halawani & Rehimi, 2021; Sener et al., 2020; Villafuerte-Diaz et al., 2023; Zhou et al., 2017). While some studies found that women were more willing to switch to public transport than men (Halawani & Rehimi, 2021) and had a better opinion of it (van de Coevering et al., 2019), another one found that women were less likely to intend to use light-rail in the Montreal region (Villafuerte-Diaz et al., 2023). In another study, Sener et al. (2020) identified ethnicity, job status and physical health as important determinants of the intent to use a new tramway line. However, the same study did not observe a significant association between the intent to use and socio-economic factors such as age, gender and income, and found that psychological factors were more influential than socio-economic factors (Sener et al., 2020).

While most studies on the intention to use public transport have focused on psychological and socio-economic factors, more recently, researchers have examined the

influence of spatial and contextual variables. Such studies have shown that the residential built environment and transport context plays a role on individuals' intentions. For instance, a study conducted in Houston, US showed that proximity to light rail lead to a greater intention to use it (Sener et al., 2020). Another study in Saudi Arabia added residential population density as a variable to explain the intention to shift to public transport (Halawani & Rehimi, 2021). In line with these two studies, van de Coevering (2019) found that proximity to public transport and population density increased the positive opinion people have of public transport, which can in turn lead to a greater intention to use it. Overall, proximity to public transport services, density and diversity at home have been identified as significant determinants of the intent to use public transport.

The land use and transport characteristics at the destination have also been examined, although to a much lower extent. To the authors' knowledge, only a few studies have examined the relationship between the spatial characteristics of the destinations and the intention to use public transport. A recent study included the spatial characteristics of the destination, namely accessibility to public transport and ease of parking, and showed that parking fee and the difficulty to find parking at the destination increased the intent to use the light rail service (Dirgahayani & Sutanto, 2020). Another study about the first and last mile experience asked questions about the perceived walking route conditions and safety at both stations and showed that unsafe station surroundings reduced the intent to use public transport (Park et al., 2021).

Overall, a wide array of variables influences individuals' intentions, including psychological, socio-economic and spatial variables. However, the review of the literature has shown that, whereas the literature on attitudinal and perception factors is abundant, fewer studies have examined the influence of spatial factors. Nonetheless, as highlighted by Grisé and El-Geneidy (2018) , including built environment and network variables contributes to understanding the potential benefits of various investments in public transport infrastructure at a finer spatial level.

2.2 Mode choice

Spatial and contextual factors have more widely been incorporated in mode choice studies. Knowing that the intention to use and mode choice are closely related, this section presents the spatial determinants of mode choice identified in the literature. The large body of research on the determinants of mode choice has revealed that several land use and transport characteristics, in addition to socio-economic characteristics, play a role in the decision on the mode used by individuals (van Acker et al., 2010). The link between the built environment and mode choice has been widely disseminated by Frank and Pivo (1994), followed by the coining of the "3-Ds" concept (density, diversity and design) in a further meta-analysis by Cervero and Kockelman (1997). The first study showed that population density (at the origin) and employment density (at the destination) influence mode choice (Frank & Pivo, 1994). The second study revealed that population density, land use mix (entropy) and street connectivity at both ends of the trip have been shown to have an important impact on mode choice. In a more recent study conducted in Houston, US, Lee et al. (2014) found that population and employment density near home influenced commuters' mode choice. Interestingly, Frank and Pivo observed that the employment density had a greater impact when measured at the destination than at the origin (Frank & Pivo, 1994). Similarly, Ding et al. (2018) found that the built environment at the workplace was more important than the built environment at home in terms of predicting power.

Following the "3-Ds" concept, Ding et al. (2018) identified two other Ds that influence mode choice, namely: Distance to public transport (rail stations and bus stops density) and Distance to Central Business District (CBD) for both home and workplaces. The study demonstrated that the distance from home to public transport was an important predictor of car usage. It also showed that the distance between the workplace and the CBD was a bigger predictor of car usage than the distance from the residence to the CBD. Further, a synergistic relationship between the built environment and transport policies was observed (Ding et al., 2018). For instance, free parking at work made the car a more likely choice for commuting.

Mode choice research has covered more broadly built environment variables as compared to intent to use studies, thereby highlighting the importance of land use and transport characteristics both at the origin and at the destination. Examining the mode choice literature helps identify potential land use and transport determinants to be included in the present study.

2.3 Prior study about the REM

A recent study showed that the REM will be used for a variety of motives and on different days of the week in the Greater Montreal area (Dent et al., 2021). The study revealed that the people who were the most likely to use the REM were the "Leisure and Airport User" who saw in the REM a great way to avoid parking problems. The "transit-friendly user" were the second more enthusiastic group (Dent et al., 2021). A study by Villafuerte-Diaz et al. (2023), further nuanced this finding, noting that the increased intent to use the REM for leisure purposes was significantly higher for men than for women. Dent et al. (2021) also observed a clear relationship between the proximity of the station, whether on foot or by public transport, and the likelihood to use the REM. They concluded that the main reason for not intending to use the REM was either that it did not go where needed or that it was too far away from their origin. This study focused on individuals' responses and did not include spatial variables.

The current study builds on this previous study by examining further how spatial and contextual factors influence the intention to use the REM. The literature has demonstrated that both home and work location characteristics influence mode choice, yet few intention to use studies have used built environment variables. Furthermore, very few studies, both for the intent to use and the mode choice, have combined home and work location spatial characteristics into a single variable. Therefore, this study aims to propose a clustering methodology to assess the joint effects of home and work location on the intention to use a projected public transport service. The proposed approach is of relevance to provide a nuanced understanding of the potential impacts of new public transport infrastructure across a region on different types of commuters. The case of the future REM is an excellent opportunity to test this methodology and the proposed approach can be applied to other contexts.

3 Case study

This section provides information about the Greater Montreal area and the characteristics of the REM to help the reader better understand the context of this study.

3.1 Greater Montreal area

The Greater Montreal area, located in Québec, Canada comprises around 4 million residents, half of which live on Montreal Island where the urban core (Montreal – downtown) and central neighborhoods (Montreal – center) are located (Figure 1). The

second-largest island of the region is entirely occupied by the second-largest city of the region: Laval. Large suburban municipalities are located on the south shore and many smaller suburban municipalities are located in the outer suburbs. Most of the region's employment is found in the CDB, mostly office work, and its surroundings (downtown and center). Other big employment clusters can be found in the west and east parts of Montreal Island, mostly in the manufacturing sector (Autorité régionale de transport métropolitain ARTM, 2019). Smaller employment clusters, in the manufacturing sector, healthcare, and customer service, are disseminated across the whole region (Lachapelle et al., 2020).

The region has an extended road network consisting of several highways and more than 20 bridges to cross the various bodies of water. The region is also covered by four metro lines, mostly located in the central neighborhoods and connected to Laval and the south shore, and six suburban train lines connecting the CBD to some of the more distant suburbs (Autorité régionale de transport métropolitain, 2021). The annual ridership of the metro system was 283.5 million boarding in 2019 (STM, 2020). The region is also covered by an extensive bus network. However, the service quality outside of rush hours is much better on Montreal Island than outside of it (Lachapelle et al., 2020).

Since the region is expected to experience a moderate population growth in the next few decades (Institut de la Statistique du Québec, 2019) and that the government wishes to increase the modal share of public transport (Autorité régionale de transport métropolitain ARTM, 2019), several public transport projects are planned. For instance, a Bus Rapid Transit (BRT) line on the Pie-IX boulevard, the extension of the metro network and many other smaller or less advanced projects are planned, in addition to the REM (Autorité régionale de transport métropolitain, 2021).

3.2 The Réseau Express Métropolitain (REM) project

The REM is the biggest public transport project under construction in the Montreal region. It will consist of 26 stations located along 67 km of dedicated right of way tracks. The network will connect the downtown area to the west of Montreal Island (Montreal – west), Laval, the south shore and the northern outer suburbs (Figure 1). It will be fully automated with four-car trains and will offer services 20h per day, seven days per week. The expected headway varies from two to five minutes on the main trunk to five to 15 minutes on secondary branches (Réseau express métropolitain, 2021). Interestingly, one of those branches and part of the main trunk will completely replace the most popular commuter train line, as illustrated on Figure 2. Compared to the former commuter rail service, the REM will be universally accessible throughout and will run more frequently, especially outside of the peak hours (every 15 minutes instead of every hour). In line with this higher frequency, the trains will be smaller and have fewer seats. The stations will also be equipped with automatic platform screen door and the network will be characterized by a complete grade separation from road traffic. Some of the stations will have a bus terminus and parking facilities. Because the REM is built as a kind of "Public-Public" partnership (between the provincial government and the provincial pension found), it is associated with a vast non-compete zone where the bus service must exclusively serve the REM stations (Autorité régionale de transport métropolitain, 2018). This means that for many people the REM will be the only option to reach downtown by public transport. Buses will not be allowed to reach downtown directly or to directly reach the metro system for instance. This is important to interpret the intention of usage of potential future users. According to consultants' projections, 45 million boarding per year is expected on the REM once it is complete and operational (Steer Davies Gleave,

2017). The REM should be completed by the end of 2024. The project was announced in 2016 and construction began in 2018 (Réseau express métropolitain, 2021).

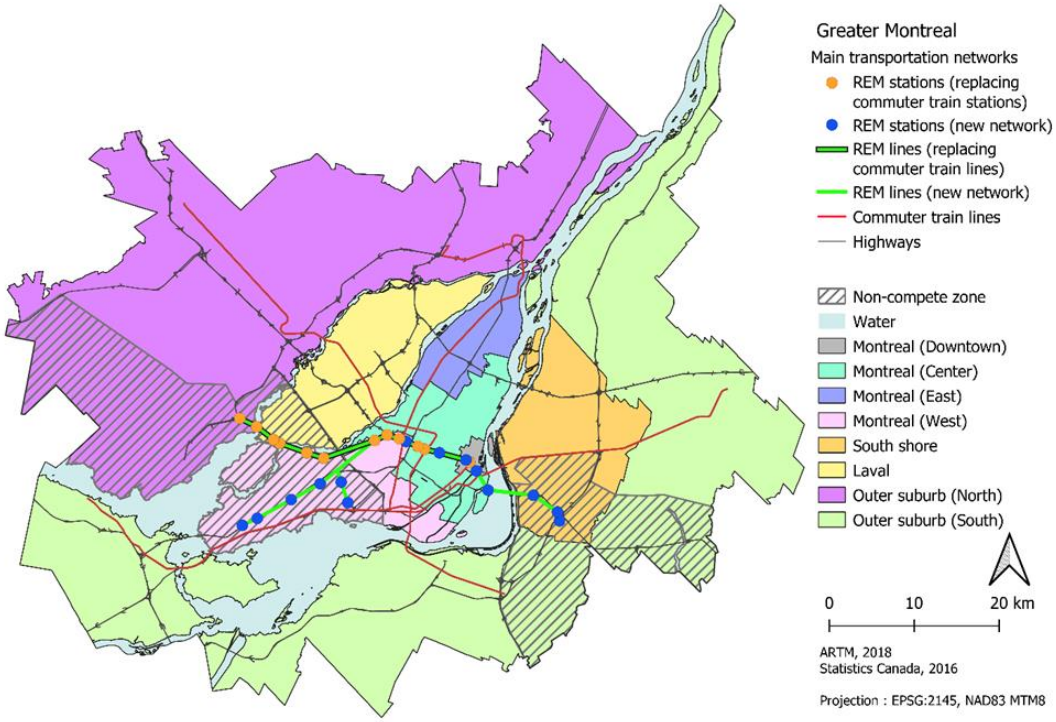


Figure 1. Map of the Greater Montreal area

4 Data and methods

This section covers the main data sources used in this study, together with the data manipulation and summary statistics. The methods are then presented, starting with the cluster analysis and followed by the ordered logistic regression modelling the intent to use the REM.

4.1 Data

The main data source of this study is the Montreal Mobility survey conducted in fall 2019 in the Greater Montreal. The recruitment targeted people in the vicinity of the projected REM stations and the general population by advertisements in social media, in person recruitment and through a proprietary panel (See Dent et al., 2021, for more details). One of the objectives was to obtain information about potential users' perceptions and intentions regarding the REM. The survey was conducted both in French and English and is representative of the Montreal population with the exception of an over-representation of women aged 25-35 and an underrepresentation of people of 75 and older (Dent et al., 2021). The home and work locations of the respondents, provided at the dissemination area level, were included in this study, together with variables about the perceptions about and intention to use the REM, travel behavior and trip

characteristics, and socio-economic characteristics. Dissemination areas are standard subdivisions of the Canadian census, where between 400 and 700 people live.

Secondary data sources were obtained to generate spatial and contextual variables. These include public transport service data obtained via the General Transit Feed Specification (GTFS) data, a 2018 bus service compilation of all the transport agencies of the Greater Montreal provided by the Agence Régionale de Transport Métropolitain (ARTM), Walk Score data (Walk Score Professional, 2021) and employment and population data from the 2016 Canadian census (Statistics Canada, 2017). The Walk Score is a proprietary algorithm which provides a measure on a scale from 0 to 100, based on the proximity of local amenities and services and the walking routes to such destinations. Distances from public transport stations (commuter train, metro, REM) were calculated using network distances and based on a 1 km threshold, as commonly considered for transit-oriented development (CMM, 2012; Yap & Goh, 2017). The total number of bus trips passing within 1 km from the home and work locations during morning rush hours was also considered.

The survey data and spatial data were joined based on the dissemination area. Overall, 3683 complete responses were collected after removing unrealistic responses (too long travel time, unrealistic age, etc.). Out of these responses, 1698 responses (46% of the sample) were included in this study, after excluding responses from non-workers, workers without a valid home or work location and those for whom all socio-economic or spatial variables were not available.

4.2 Methods: Cluster analysis and ordered logistic regression

As a first step, a cluster analysis was conducted to segment individuals based on their combined home and work location characteristics. Seven variables, computed at home and at work locations, were included to reflect the 5 D identified in previous research, for a total of 14 variables. First, three dummy variables about the presence of a train, metro or REM station within a 1 km network distance were included to capture the "Distance to public transport". The distance to the REM was included despite the fact that it is not yet opened as we are intending to use the clusters to model intent to use (i.e., future travel behavior) and not actual travel behavior. We therefore posited the hypothesis that the proximity to the REM will have an effect on the intent to use the REM. In addition, the number of bus departures during the AM period (6 am to 9 am) within 1 km network distance of the home and work location was included to capture the intensity of the bus service. Second, a continuous variable measuring the straight-line distance between the home or work location and the CBD was also added. For all these variables, the distances were measured based on the dissemination area centroids. Third, to account for diversity, density and design, the average Walk Score of the dissemination area were computed. Further, population density for home location and employment density for work location were generated, again at the DA scale. While high Pearson correlation were found between some variables at the home and work location (i.e., Walk Score and bus service were correlated at 0.877 at work and 0.82 at home locations), we chose to keep all variables as they conceptually reflected different concept from the 5 Ds. This decision might have put more weight on certain components of the 5 Ds. Related limitations are discussed at the of the paper.

Using these 14 variables, the Partitioning Around Medoids (PAM) was then used to cluster individuals based on home and work location characteristics. The PAM method was selected given its efficiency with datasets containing both categorical and numerical variable and reducing the effect of outliers (Beltrán & Carlos, 2020). The 14 variables represent distinct land use and transport characteristics. Based on the scree plot and the

silhouette plot, it was decided to conduct a sensitivity analysis with five, six, seven and eight clusters. Test with these different number of clusters showed that using only five clusters made them hard to distinguish. On the other hand, having seven and eight clusters did not provide any additional pertinent information compared to having six clusters. This is mainly because the seventh and eighth clusters were mostly generated by splitting one of the clusters in two based on a distance threshold. Given theses observations, it was decided to use six clusters. The outputs of the clustering process are presented in the results section. The clusters are first described with summary statistics and then represented spatially. Further, the intention to use the REM and the perceptions about the REM are analyzed distinctly for each cluster.

To observe the relationship between belonging to one of the six home-work clusters (and thereby the joint effect of home and work location characteristics) and the intention to use the REM while controlling for individual characteristics, we then proceeded to an ordered logistic regression model. The dependent variable was derived from the following question: "How likely are you to use the REM when it is complete and operational?" The answers were distributed on a five-level Likert scale (very unlikely, unlikely, neutral, likely, very likely).

First, we modeled the intention to use the REM as a function of the six home-work clusters alone, which showed a significant association between the cluster and the intention to use the REM. To isolate the effect of the home-work clusters, socio-demographic, travel and attitudinal characteristics were included in a stepwise approach. Table 1 presents the distribution of the variables included in the final model. It is important to note that car ownership was excluded due to collinearity problems with other variables such as the cluster and the household income. Furthermore, the household size was not significant alone, but became significant when we isolated the effect of having a baby (and the model remained stable). This is further discussed in the results. Current travel habits were included, namely the time of the trip to work and the possession of a public transport pass. To control for attitudinal and perception factors, three questions regarding the perceptions of individuals about the REM were included in the model. Odd ratio and percent variation (calculated as the opposite of 1 minus the odd ratio) were included to understand the effect of those variables on the intent to use the REM. Finally, a dominance analysis was conducted to highlight the independent variables that contributed the most to the regression models (Azen & Budescu, 2006).

Table 1. Summary statistics

		True	% True (1698 obs.)
Intention to use the REM			
	Very likely	383	23%
	Likely	515	30%
	Neutral	164	10%
	Unlikely	339	20%
	Very unlikely	297	17%
Cluster			
	1: Typical commuter	345	20%
	2: Urban car user	202	12%
	3: Suburbanite	304	18%
	4: Urban commuter	389	23%
	5: Car-free urbanite	301	18%
	6: Atypical commuter	157	9%
Home location			
	Montreal (Downtown)	65	4%
	Montreal (Center)	738	43%
	Montreal (East)	106	6%
	Montreal (West)	260	15%
	South Shore	152	9%
	Laval	91	5%
	Outer Suburb (North)	196	12%
	Outer Suburb (South)	89	5%
Work location			
	Montreal (Downtown)	691	41%
	Montreal (Center)	571	34%
	Montreal (East)	44	3%
	Montreal (West)	219	13%
	South Shore	65	4%
	Laval	47	3%
	Outer Suburb (North)	43	3%
	Outer Suburb (South)	17	1%
Household income			
	Less than 30k $	89	5%
	30-59K $	299	18%
	60-89K $	349	21%
	90-119K$	327	19%
	120-149K$	210	12%
	150K+$	284	17%
	Don't Know	140	8%

Gender			
	Man	816	48%
	Woman	861	51%
	Other	21	1%
Disability			
	Prefer not to answer	29	2%
	No	1520	90%
	Yes	149	9%
Household has a baby		245	14%
Household size			
	Min	1	
	1st qu.	2	
	median	2	
	mean	2.681	
	3rd qu.	4	
	Max.	9	
Travel in rush hour		1239	73%
Travel during weekend		130	8%
Has public transport pass		970	57%
REM is good for Montreal			
	Strongly agree	697	41%
	Agree	676	40%
	Neutral	192	11%
	Disagree	70	4%
	Strongly disagree	63	4%
REM is good for my neighborhood			
	Strongly agree	273	16%
	Agree	353	21%
	Neutral	753	44%
	Disagree	171	10%
	Strongly disagree	148	9%
REM is good for the environment			
	Strongly agree	539	32%
	Agree	733	43%
	Neutral	307	18%
	Disagree	74	4%
	Strongly disagree	45	3%

5 Results

This section covers the results of the clustering analysis by presenting the summary statistics of each cluster, the z-score of the variables, and the spatial dispersion of the home and work location of the respondents of each cluster on six distinct maps. It is then followed by bar plots describing the intent to use the REM and the opinion about the REM for each cluster. The section concludes with the presentation of the results of the ordered logit model.

5.1 Cluster analysis

A total of six clusters based on the combined home and work location characteristics were obtained. These clusters are distributed unevenly across the region, have variations in terms of socio-economic characteristics and their reported intention to use the REM varies importantly.

Figure 2 shows the standardized values (z-scores) of the explanatory variables for each cluster, revealing distinct patterns between the clusters. We see that the first cluster (*typical commuter*) is defined by the presence of public transport stations near home and work, high employment density, bus service during rush hour at work and the proximity between the work location and the CBD. The second cluster (*urban car user*) is the only other cluster with a slightly greater presence of a REM station near home, but no other public transport service either at home or work. Individuals in this cluster also have a work location further from the CBD than the average. The third cluster (*suburbanite*) is identified by a much larger distance between the home and work location and the CBD, low density and Walk Score, and limited public transport services. The fourth cluster (*urban commuter*) includes individuals working next to a metro station, but not living close to one. The fifth cluster (*car-free urbanite*) is composed of people who live and work in high-density areas close to a metro station. Finally, the sixth cluster (*atypical commuter*) is composed of people who live next to a metro or a train station but work far from the CBD and from a metro station.

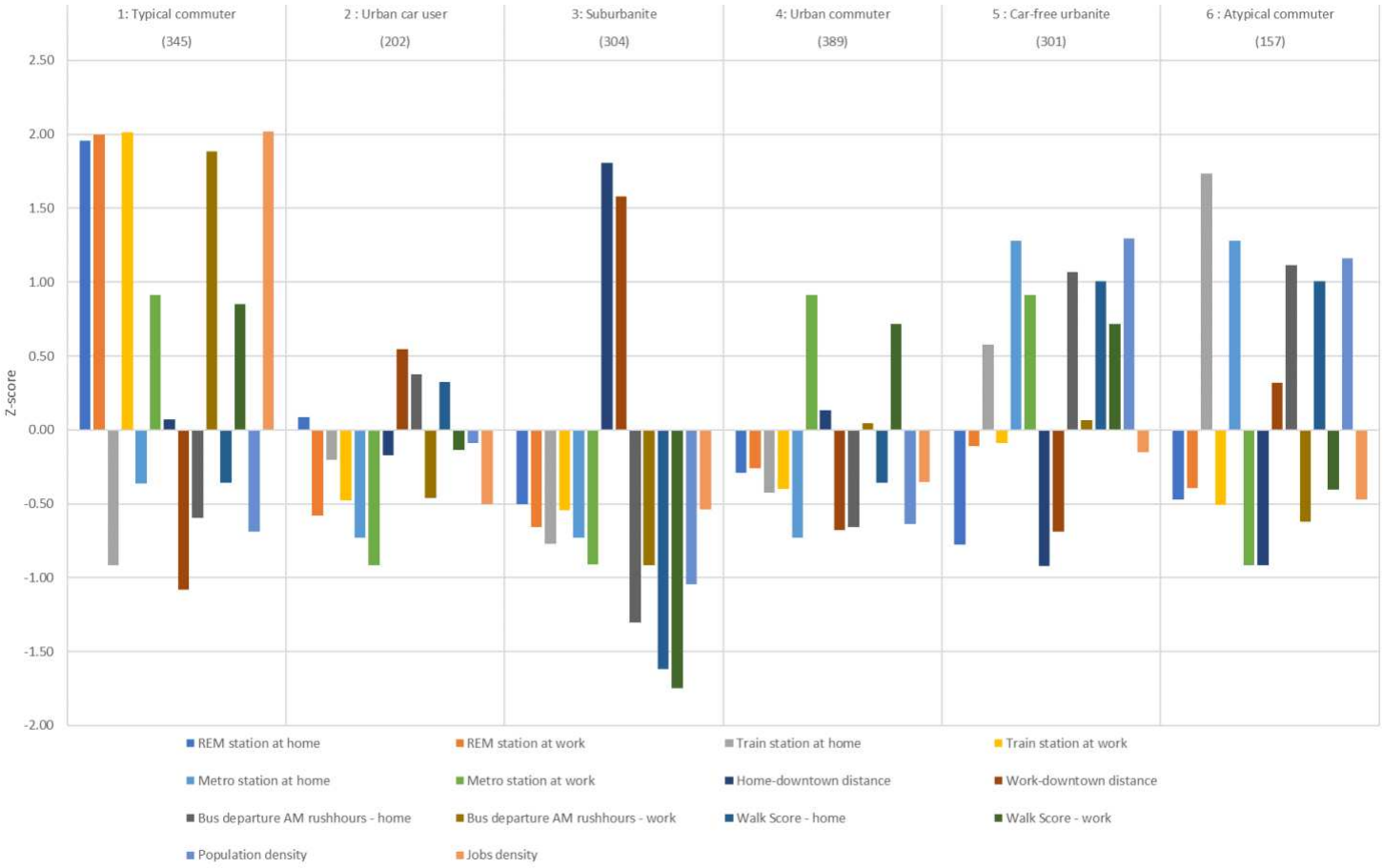


Figure 2. Z-score of the clusters' explanatory variables

To further understand the predominant commute patterns of each cluster, the home and work locations of individuals in each cluster are presented in Figures 3 to 8. These patterns are presented together with the socio-economic characteristics of the clusters (Table 2). Overall, trends are observable in terms of income, education level and main commute mode within each cluster.

Table 2. Socio-economic and mobility profile of the six clusters

	Cluster 1 Typical commuter	Cluster 2 Urban car user	Cluster 3 Suburbanite	Cluster 4 Urban commuter	Cluster 5 Car-free urbanite	Cluster 6 Atypical commuter
Number of observations	345	202	304	389	301	157
Income						
Less than 30K	2.5%	10.7%	3.9%	5.7%	8.1%	7.7%
30k to 59k	10.5%	19.3%	17.5%	15.0%	23.2%	35.1%
60k-89k	22.8%	17.1%	21.4%	22.6%	20.2%	20.2%
90k-119k	21.5%	9.6%	18.1%	23.5%	17.5%	16.1%
120k-149k	14.8%	8.3%	15.3%	10.9%	8.4%	7.7%
More than 150k	28.0%	5.8%	13.9%	14.1%	15.1%	13.1%
Education						
Less than high school	0.0%	1.1%	1.1%	0.7%	0.0%	0.0%
High school diploma	5.9%	13.0%	13.1%	7.0%	5.8%	4.0%
Trade or college diploma	22.5%	33.1%	34.5%	24.1%	13.1%	16.0%
Undergraduate degree	41.6%	31.2%	33.1%	38.5%	35.1%	39.4%
Graduate degree	30.1%	21.6%	18.1%	29.7%	46.0%	40.6%
Household Size	2.84	2.59	3.05	2.81	2.25	2.18
% of household with young children	23.14%	19.05%	27.22%	23.23%	11.14%	15.82%
Cars per driver (Median)	0.67	0.67	0.67	0.67	1	1
% of women	47.90%	53.8%	53.9%	54.7%	53.6%	55.7%
Mode choice						
Bicycle	3.6%	4.4%	0.8%	4.8%	7.2%	3.4%
Public transport	76.9%	29.3%	12.2%	56.7%	63.9%	51.4%
Car	10.2%	53.5%	83.1%	29.8%	10.2%	31.6%
Walk	8.3%	11.7%	3.3%	7.7%	18.1%	12.4%
Other	1.1%	1.1%	0.6%	0.9%	0.6%	1.1%

Cluster 1: The typical commuter

The *typical commuter* cluster consists of those who commute to the CBD. Figure 3 shows that all individuals work downtown, but their home location is scattered across the region. As indicated previously, many of them reside near a REM station. Table 2 shows that this cluster is characterized by individuals with a high income and education, typically living in larger households with children and already using public transport to go to work.

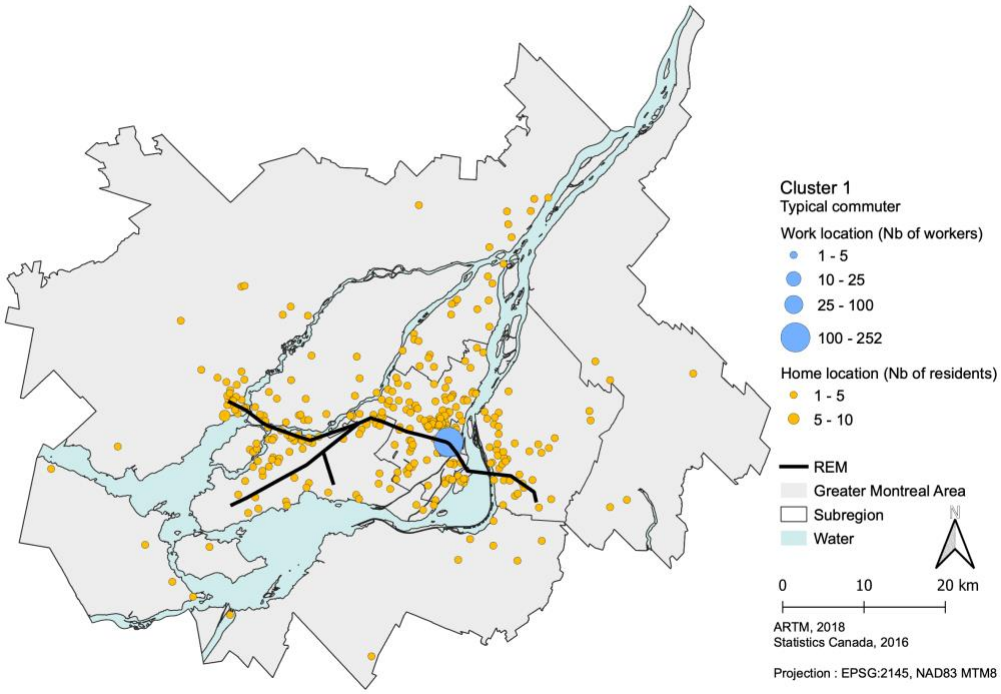


Figure 3. Geographical distribution of the *typical commuter* cluster

Cluster 2: The urban car user

The second cluster mostly consists of people who live and work on the Montreal Island, mainly in the center, and in dense neighborhoods on the South Shore (Figure 4). However, they do not work nor live close to a metro station. While the *typical commuters*' workplaces are concentrated downtown, the *urban car users'* work locations are dispersed across central and pericentral neighborhoods, with employment clusters outside the CBD. Their home locations are characterized by a higher Walk Score and higher bus services than their work locations. Table 2 shows that this cluster have middle-class income and trades or college diplomas and usually travel by car for their daily commute.

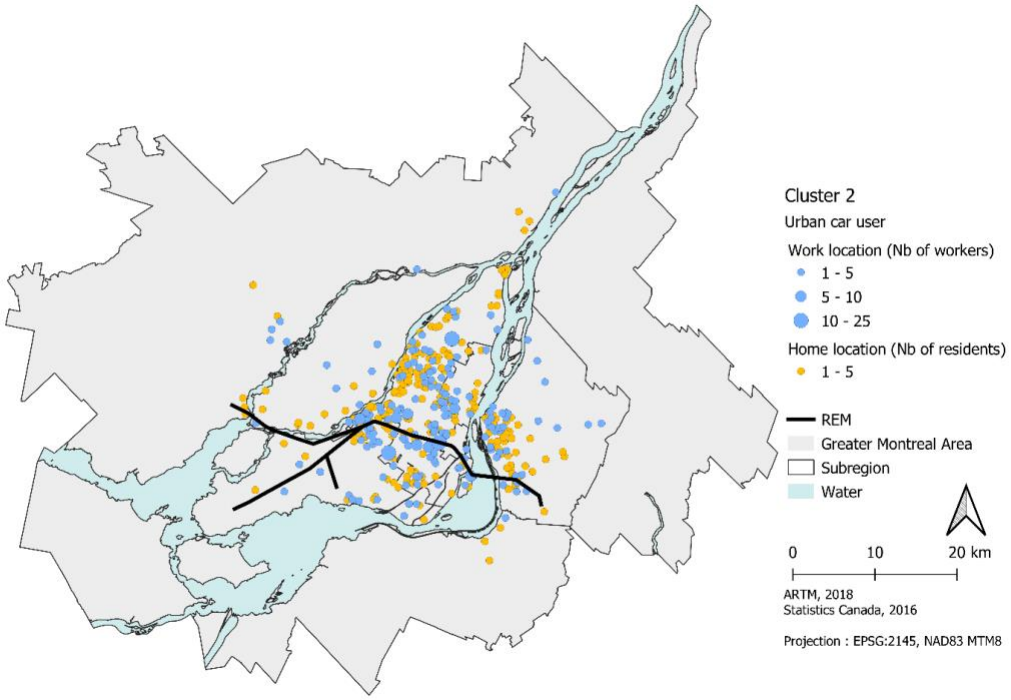


Figure 4. Geographical distribution of the *urban car user* cluster

Cluster 3: The suburbanite

The *suburbanite* cluster is formed of people who live in the suburbs (mainly around the western branches of the REM) and generally also work in a suburban location (Figure 5). The most popular work locations are the Montreal industrial zone and around the airport (both in Montreal – west), where REM stations are projected. Even if many of them live relatively close to the REM, they are less likely to use it. They have upper-middle-class income, but they are the least educated cluster in the sample. They live in the largest households with the most children. The car represents over 83% of the commute mode share.

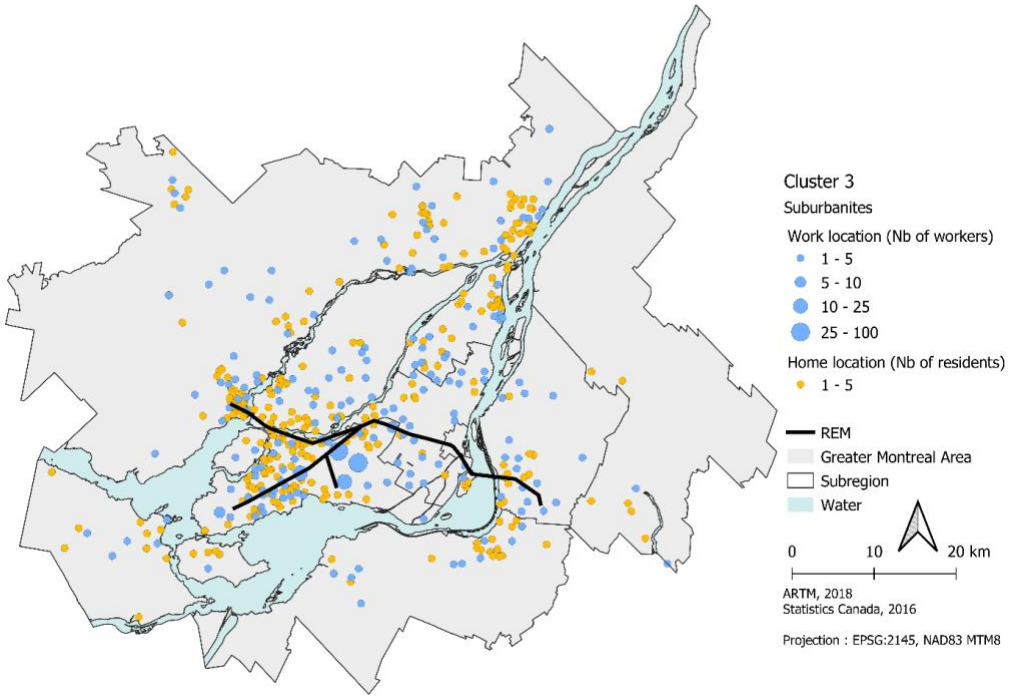


Figure 5. Geographical distribution of the *suburbanite* cluster

Cluster 4: The urban commuter

As shown in Figure 6, this cluster is largely dominated by individuals working near a metro station. Their home locations, however, are distributed across the region (mainly on Montreal Island). Although this cluster's work locations are spread over a large part of downtown, it excludes the very middle of the CBD which is part of cluster 1 (*typical commuter*). This cluster has a middle-class income, a high education, and live in households with children. They travel mainly by motorized modes such as public transport or car.

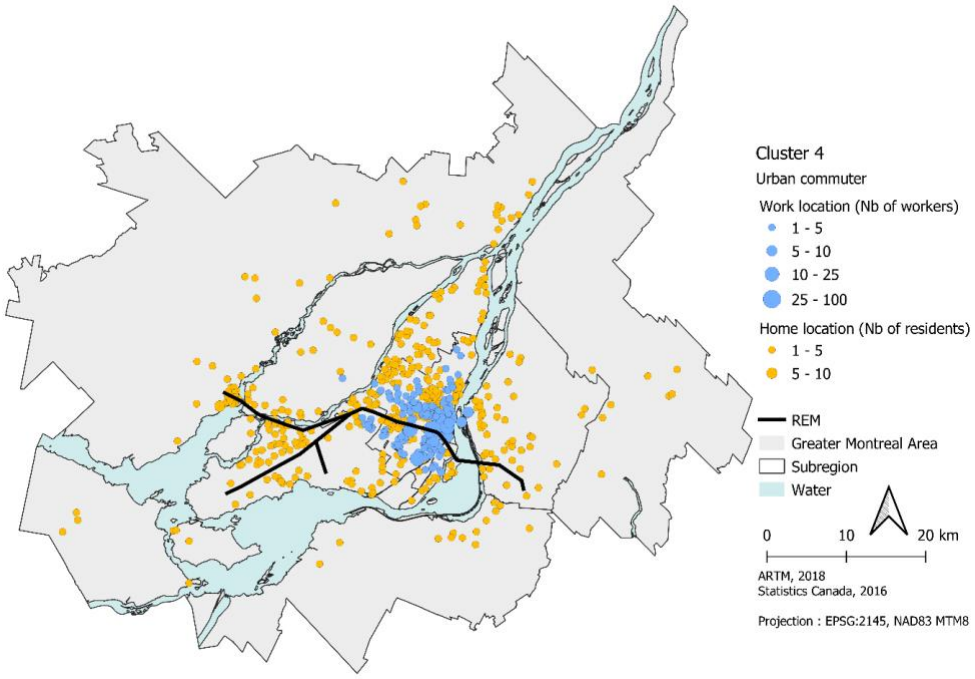


Figure 6. Geographical distribution of the *urban commuter* cluster

Cluster 5: The car-free urbanite

This cluster is made up of people who live and work exclusively around a metro station (Figure 7). Table 2 shows that they have lower household incomes than the average, but with higher levels of education. They usually travel by public transport, bicycle or walk and live in small households without children. Their profile closely matches the one of young professionals.

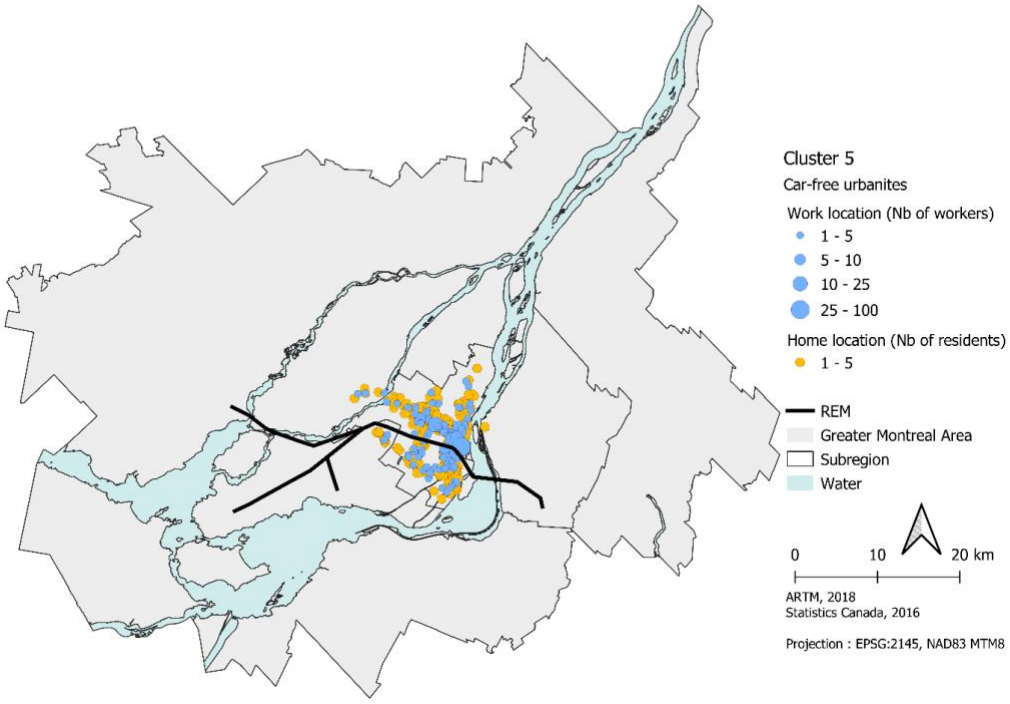


Figure 7. Geographical distribution of the *car-free urbanite* cluster

Cluster 6: The atypical worker

This last cluster is also composed of people who live in central areas close to the metro, but their workplace is further from the CBD and from the metro network (Figure 8). They are typically poorer and more educated than the average cluster and live in small households where women are overrepresented. They usually use public transport or walk to reach their work location.

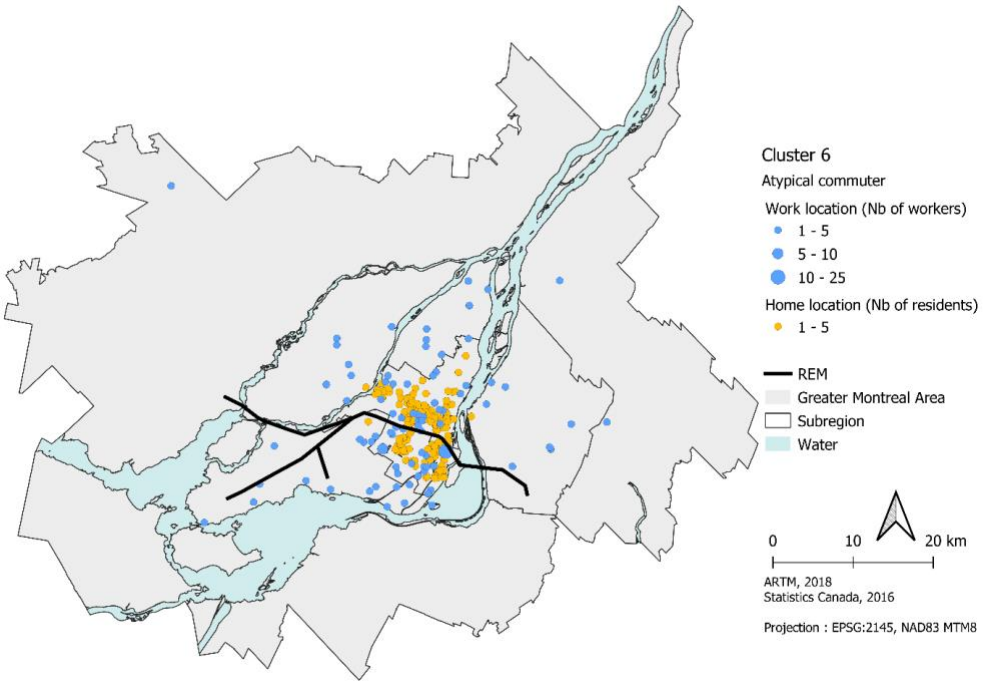


Figure 8. Geographical distribution of the *atypical commuter* cluster

5.2 Intention and perceptions about the REM

Figure 9 shows the proportion of individuals for each level of agreement with the statement *How likely are you to use the REM when it is complete and operational*? for the six clusters. The results show that the *typical commuter* cluster has the highest proportion of respondents who reported being very likely to use the REM (36.8%), while this proportion is around 18% for the other clusters. Interestingly, when combining both individuals who responded that they are *very likely* or *likely* to use the REM, the difference between the *typical commuter* cluster and the other clusters is less pronounced. This suggests that the *typical commuters* (those who commute to the CBD) are more convinced that the REM will serve their commuting needs. The *atypical* and *urban commuters* have the second-highest proportions of respondents that answered *likely* or *very likely*. This could reflect the fact that these commuters perceive that the REM can respond to their needs, but they might have some doubts with respect to the service quality of the REM in the counter peak direction. Finally, the least likely clusters to use the REM are the *urban car users* and the *car-free urbanites*.

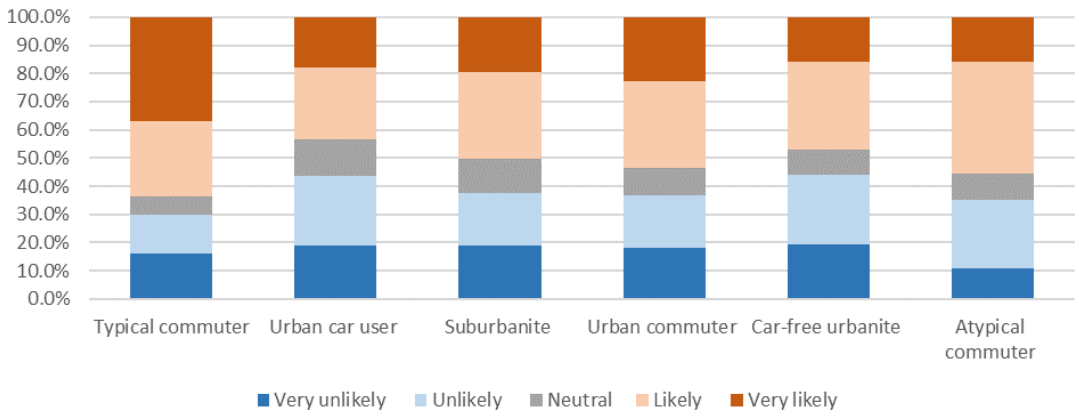


Figure 9. Intention to use the REM by cluster

Figure 10 shows that all clusters generally agree that the REM is a good thing for Montreal. Surprisingly, the individuals that are the least in agreement are the ones that intend to use it the most (*typical commuters*). This could be explained by the fact that part of the main trunk of the REM and one of the branches will replace an existing train line. This implies major service disruption and construction disturbances for several years during the construction of the REM. The *car-free urbanites* and *atypical commuters* have a good opinion of the REM, which could be explained by their familiarity with the metro since they live close to it. Much fewer people agree that the REM will be good for their neighborhood. This is likely explained by the limited spatial coverage of this new system. A notable exception, the *suburbanites*, that are more likely to live close to the REM network, have a generally positive opinion of the REM. Around 70% of each cluster has a positive opinion regarding the environment. The *car-free urbanite*s and the *atypical commuters*, both clusters characterized by individuals living in central neighborhoods, are the clusters who agree the most that the REM is a good thing for the environment.

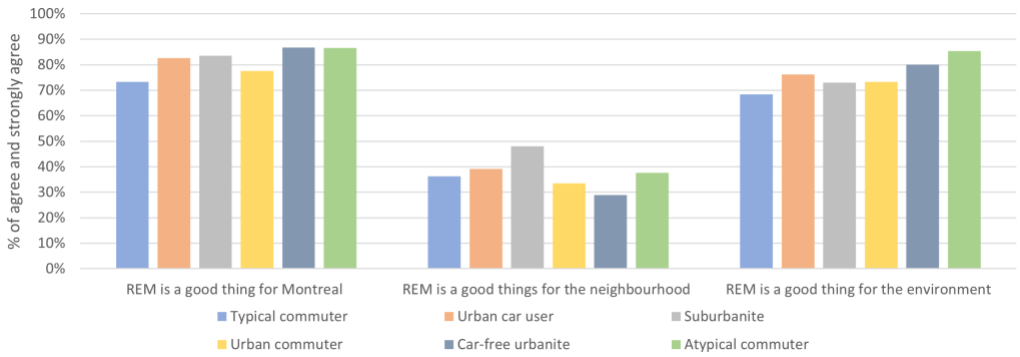


Figure 10. Perceptions on the REM

5.3 Stated intention to use the REM

Results of the ordered logistic model generated to isolate the effect of the home-work clusters are presented in Table 3. The inclusion of the cluster variable in the ordered logit model leads to a significantly higher log likelihood (-2388,9) than for the model with only the socio-demographic and attitudinal characteristics (-2400,7) (p-value < 0,05). All clusters are significatively less likely to use the REM than the *typical commuters* (between 32% and 51% less likely at $p < 0.05$). The *urban commuters* and *atypical workers*, either residing or working near a metro station, are respectively 32% and 34% less likely to intend to use the REM than the *typical commuters* (OR = 0.68, $p < 0.001$ and OR = 0.656, p =0.021 respectively) which is still enough to make them the second and third clusters with the highest odds of using the system in the future. Contrastingly, the *car-free urbanites* are 51% less likely to intend to use the REM (OR = 0.495, $p < 0.001$), making them the last cluster overall.

In term of socio-demographic and socio-economic variables, individuals living in high-income households ($150,000 and more) are 38% more likely to use the REM than people in the middle-income group ($60,000 to $90,000). This likely reflects a more positive perception among these groups given the type of service (perceived as more frequent, faster and more comfortable than the bus) (Allen et al., 2019). Men are also more 27% likely to use the REM compared to women (OR = 1.27, p = 0.009) which is coherent with a recent study on the REM that found gendered differences in intention to use the system (Villafuerte-Diaz et al., 2023). Finally, people owning a public transport pass are 91% more likely to intend to use the REM than those who do not have one (OR = 1.906, $p < 0.001$). While the possession of a public transport pass is likely also influenced by home and work characteristics, it is important to note that model remained stable when including this variable.

For attitudinal statements, people strongly agreeing with the positive impacts of the REM on the Montreal region were 68% more likely to intend to use the REM than those who answered "neutral" to this question (OR = 1.68, p = 0.005). All level of agreement regarding the positive impacts of the REM at the neighborhood level at significant effects compared to neutral responses. Respondents that strongly agreed or agreed with these benefits were respectively 447% and 164% more likely to use the REM than those that answered neutral (OR = 5.472, $p < 0.001$ and OR = 2.641, $p < 0.001$). Contrastingly, respondents that answered disagree or strongly disagree on the question regarding the perceived benefits of the REM for their neighborhood were 34% and 42% less likely to intend to use the system than those who answered neutral (OR = 0.665, p = 0.01 and OR = 0.577, p = 0.007 respectively). Environmental concerns have no significant effect, which is in line with a previous study that found that sustainability was the least important factor when adopting a new automated metro line in Sydney (Fraszczyk & Mulley, 2017).

Lastly, results from the dominance analysis showed that the three more important predictor of intent to use the REM were (1) the perceived benefits of the REM at the neighborhood level, (2) owning a public-transport pass and (3) the cluster variable. The presence of the cluster variable as one of the most important predictors in the model confirms that the combined work and home location characteristics are important to consider alongside other socio-demographic and attitudinal variables when modelling intentions to use a new transport service in the future.

Table 3. Result of the ordered logistic regression modeling how likely respondents are to intend to use the REM when complete and operational

	Odds ratio	**Odds change (%)**	**St. Dev.**	**p-value**	
Cluster (Ref: Typical commuter)					
Urban car user	0.513	-49%	-0.175	< 0.001	***
Suburbanite	0.582	-42%	-0.163	0.001	***
Urban commuter	0.68	-32%	-0.143	0.007	**
Car-free urbanite	0.495	-51%	-0.154	< 0.001	***
Atypical commuter	0.656	-34%	-0.183	0.021	*
Income (Ref: 60 K – 89k $)					
Less than 30k $	0.9	-10%	-0.225	0.638	
30-59k $	1.147	15%	-0.146	0.345	
90-119k $	1.148	15%	-0.143	0.334	
120-149k $	1.2	20%	-0.165	0.268	
150k+$	1.38	38%	-0.155	0.038	*
Do not know	1.391	39%	-0.183	0.071	.
Gender (Ref: Woman)					
Man	1.27	27%	-0.091	0.009	**
Other	1.024	2%	-0.42	0.954	
Disability (Ref: No)					
Prefer not to answer	0.829	-17%	-0.36	0.603	
Yes	0.97	-3%	-0.162	0.852	
Household size	1.082	8%	-0.041	0.055	.
Household has a baby	0.897	-10%	-0.09	0.229	
Travels in rush hour	0.969	-3%	-0.116	0.789	
Travels during weekend	1.03	3%	-0.188	0.875	
Owns a public transport pass	1.906	91%	-0.1	< 0.001	***
REM is good for MTL (Ref: neutral)					
Strongly agree	1.68	68%	-0.184	0.005	**
Agree	1.055	5%	-0.16	0.739	
Disagree	0.772	-23%	-0.274	0.344	
Strongly disagree	0.813	-19%	-0.315	0.511	
REM is good for neighborhood (Ref: Neutral)					
Strongly agree	5.472	447%	-0.161	< 0.001	***
Agree	2.641	164%	-0.12	< 0.001	***
Disagree	0.665	-34%	-0.158	0.01	**
Strongly disagree	0.577	-42%	-0.186	0.003	**
REM is good for environment (Ref: Neutral)					
Strongly agree	1.133	13%	-0.164	0.446	
Agree	0.954	-5%	-0.129	0.718	
Disagree	1.242	24%	-0.262	0.409	
Strongly disagree	0.96	-4%	-0.358	0.91	
Observations	1,698				
Log-likelihood	-2388.9				

6 Discussion and conclusion

In this study, we investigated the combined effect of the home and work location characteristics on the intention to use a new LRT system (the REM) for commuting. To do so, we employed data from the Montreal Mobility Survey conducted in fall 2019 in Montreal, Canada, and applied a two-step approach. We first classified every individual in our sample based on their home and work location characteristics resulting in six home-work clusters with distinct commute patterns. We then integrated the clusters in an ordered logistic regression modeling self-reported intention to use the REM, while controlling for individual and attitudinal characteristics.

The results of the logistic regression models highlight that the home-work cluster is a significant determinant of the intention to use the REM, even when controlling for other variables. Indeed, the cluster variable was the third most important predictor of the intention to use the REM, highlighting the importance of considering the built environment both at home and at work when examining intentions to use new public-transit infrastructure for commuting. These findings are in line with previous research that showed that neighborhood land use characteristics, both at the home and work locations, are key determinants of mode choice (Ding et al., 2018; Frank & Pivo, 1994; Lee et al., 2014) and intent to use public transport (Halawani & Rehimi, 2021; Sener et al., 2020). This includes characteristics such as population and employment density (Frank & Pivo, 1994), airline distance from public transit for home based trip to work (Lee et al., 2014) and distance from CBD for home and work location (Ding et al., 2018). Whereas most studies focus solely on the home location, and to a lower extent, work location, this study highlights the relevance of jointly considering the variety of factors that determine future usage as highlighted in previous study (DeWeese et al., 2022; Frank & Pivo, 1994; Larsen et al., 2009). Indeed, as observed through the results of the logistic regression models, characteristics of the home and work location interact with one another: living in a suburban area while working in the CBD (the *typical commuters*) does not have the same implications as living and working in a suburban area (the *suburbanites*). As such, the two-step approach employed in this study and its integration of both home and work location characteristics, provide a novel contribution to the literature. While we have shown its usability when modeling intention to use a new public transport service, it would also be relevant for future research to apply this methodology to actual usage as well to test its applicability.

Another advantage of our two-step methodological approach is that it allows to assess how different groups of individuals are likely to be impacted by new public-transit services based on where they live and work. Indeed, the findings suggest that the effect of the REM will be unequal across different type of commuters. For individuals with typical commutes (mainly toward downtown), the REM has the potential to meet their needs and to provide them with a frequent service at rush hours. Conversely, while the *urban car users* and the *suburbanites* (who are car-dependent) see the REM as a good addition to the Montreal region, they report low intentions to use the REM. This may be explained by the fact that the service is not aligned with their commute needs (between their home and work locations). This was also observed in other studies, where the functionality of a service (e.g., the ability to easily go from your point of origin to your desired destination at the time of your choosing) was identified as a significant determinant of the intent to use a service (Shiwakoti et al., 2019).

The cluster analysis, although not directly capturing travel times or ease of travel, reflects the potential functionality that will be provided by the new service based on the origins and destinations of individuals. As for *car-free urbanites*, they are more likely to commute by walking or cycling and are already well served by the current public

transport network, therefore diminishing the added benefits they may gain from the REM. The proposed methodology can thereby contribute to shed light on the distributional equity of new public-transit projects. When taking into account the fact that residential and work location is linked to socio-demographic and socio-economic characteristics, we see a clear opening for future studies to expand on the proposed methodology by integrating these variables in the segmentation process to further examine social equity.

The observed geographical differences in the usability of the REM for commuting purposes raises questions on the efficiency and equity of pursuing a radial public-transit system aimed at connecting suburban areas to the CBD. The REM remains limited in its ability to cater to a diversity of needs, particularly for individuals who are currently underserved by the network. This reflection is in line with recent research by Tétreault et al. (2018) which demonstrated that projects connecting downtown to the suburbs in the Montreal region will only marginally decrease the travel burden of commuters. This has important policy implications for future investments in public transport in the Greater Montreal. To maximize social benefits, public-transport investments in a mature transit system, like the Montreal region, need to favor corridors that are currently underserved, namely across suburban areas or across the pericentral neighborhoods. This is consistent with what we see in other metropolitan regions. For example, London's investment in the overground, an orbital rail link around inner London, aimed to improve the connectivity of areas that were not served by quality public transport such as the underground (Lagadic, 2019). More recently, the Grand Paris express, connecting several suburbs of the Paris region has gained interest from researchers. For instance, a study stipulates that this project will reduce the inequality regarding employment access for the east and west suburbs (Beaucire & Drevelle, 2013). It is also worth noting that public transport services catering to a greater diversity of needs may increase the resilience of public transport networks, while providing services that are better aligned with post-pandemic behavior. Indeed, it is expected that peak demand and commutes toward CBDs will remain lower (both for public transport and car) than they were before the COVID-19 pandemic (Currie et al., 2021; van Wee & Witlox, 2021). Conversely, more diverse trip patterns which have emerged are likely to persist, including non-work-related trips and trips outside the peak hour (van Wee & Witlox, 2021).

There are some limitations to this study. First, this study focused on work trips, thereby neglecting other trip purposes. Yet, non-work-related trips typically display different temporal and spatial patterns, which could result in differences in terms of intention to use the REM. This calls for further studies building on the proposed methodology to investigate how the intention to use a public transport service relates to non-work trip patterns. Future studies could also build on the clustering approach developed in this study to understand the intention to use public transport when considering the whole public transport system. Similarly, the methodology could be applied to analyze mode choice analyses as well as satisfaction with the service. The variable of interest in this study was the reported likelihood to use the REM, but it would be interesting to compare the results of this study with the actual use of the REM once in operation. Another limitation of this study is that while the original sample was adjusted to be representative of the region's population, the 1698 responses selected were not adjusted to be representative of the population (in this case, workers). Nonetheless, individual characteristics are controlled for in the regression analysis, which reduces the biases that could result from the over-representation of some groups. There are also some limitations with respect to the land use variables used in this study. A walking distance of 1 km was set as the threshold to characterize proximity to public transport stations and intensity of bus services. For consistency reasons, the same threshold was used for the bus and metro/train services, which likely leads to an overestimation of access to bus

services. Future studies could examine different thresholds and could also test the inclusion of more complex variables in the cluster analysis, namely entropy and design variables. Lastly, the high correlation observed between some of the variables used in the cluster analysis could have given more weight on certain components of the 5 Ds. As such, future iteration of the method developed in this study should test multiple clustering algorithms.

Notwithstanding those limitations, the proposed approach contributes to the literature through the proposed two-step approach to segment individuals based on a combination of home and work location characteristics. This method is shown to be efficient in contributing to the modelling of intentions to use a new public-transport service. It also revealed distinct patterns and demonstrated how combining home and work location characteristics provides key spatial insights on the potential benefits of public transport investments.

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References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Allen, J., Muñoz, J. C., & Rosell, J. (2019). Effect of a major network reform on bus transit satisfaction. *Transportation Research Part A: Policy and Practice, 124*, 310–333. https://doi.org/10.1016/j.tra.2019.04.002

Autorité Régionale de Transport Métropolitain. (2018). *Réseau Express Métropoliain — Présentation générale de l'entente de fourniture et d'intégration de services du rem*. Retrieved from https://rem.info/sites/default/files/document/2018-04-23-Ententes-REM-ARTM.pdf

Autorité Régionale de Transport Métropolitain. (2021). *Rapport annuel 2020*. Retrieved from https://www.artm.quebec/wp-content/uploads/2021/05/Rapport-annuel_2020.pdf

Autorité régionale de transport métropolitain ARTM. (2019). *Parlon mobilité.* Retrieved from https://www.artm.quebec/wp-content/uploads/2020/12/ARTM_Document_Mobilite_WEB_03-14-2019-1.pdf

Azen, R., & Budescu, D. V. (2006). Comparing predictors in multivariate regression models: An extension of dominance analysis. *Journal of Educational and Behavioral Statistics, 31*(2), 157–180.

Beaucire, F., & Drevelle, M. (2013). Grand Paris Express: A project serving the reduction of inequalities in accessibility between the west and the east of the Paris urban region. *Regional and Urban Economy Review, 201*3(3), 437–460. https://doi.org/10.3917/reru.133.0437

Beltrán, S., & Carlos, A. (2020). Heterogeneous effects of the Bogota's BRT fare increase: Is fare growth fair in Bogota? Retrieved from http://hdl.handle.net/1992/49422

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. https://doi.org/10.1016/S1361-9209(97)00009-6

CMM. (2012). *Plan Métropolitain d'aménagement et de développement* (ISBN 978-2-923013-89-3). Retrieved from https://cmm.qc.ca/wp-content/uploads/2019/03/pmad_plan_metropolitain_amenagement_developpement.pdf

Currie, G., Jain, T., & Aston, L. (2021). Evidence of a post-COVID change in travel behavior – Self-reported expectations of commuting in Melbourne. *Transportation Research Part A: Policy and Practice, 153*, 218–234. https://doi.org/10.1016/j.tra.2021.09.009

De Vos, J., Waygood, E. O. D., & Letarte, L. (2020). Modeling the desire for using public transport. *Travel Behavior and Society, 19,* 90–98. https://doi.org/10.1016/j.tbs.2019.12.005

Dent, N., Hawa, L., DeWeese, J., Wasfi, R., Kestens, Y., & El-Geneidy, A. (2021). *Market-segmentation study of future and potential users of the new Réseau Express Métropolitain light rail in Montreal, Canada*. Retrieved from https://doi.org/10.1177/03611981211014528

DeWeese, J., Santana Palacios, M., Belikow, A., & El-Geneidy, A. (2022). Whose express access? Assessing the equity implications of bus express routes in Montreal, Canada. Journal of Transport and Land Use, 15(1), 35–51. https://doi.org/10.5198/jtlu.2022.1879

Ding, C., Cao, X., & Wang, Y. (2018). Synergistic effects of the built environment and commuting programs on commute mode choice. *Transportation Research Part A, 118*, 104–118. https://doi.org/10.1016/j.tra.2018.08.041

Dirgahayani, P., & Sutanto, H. (2020). The effect of transport demand management policy on the intention to use public transport: A case in Bandung, Indonesia. *Case Studies on Transport Policy, 8*(3), 1062–1072. https://doi.org/10.1016/j.cstp.2020.03.004

Eriksson, L., & Forward, S. E. (2011). Is the intention to travel in a pro-environmental manner and the intention to use the car determined by different factors? *Transportation Research Part D: Transport and Environment, 16*(5), 372–376. https://doi.org/10.1016/j.trd.2011.02.003

Frank, L. D., & Pivo, G. (1994). Impacts of mixed use and density on utilization of three modes of travel: Single-occupant vehicle, transit, and walking. *Transportation Research Record, 1466*, 44–52. https://www.researchgate.net/publication/235358160_Impacts_of_Mixed_Used_and_Density_on_Utilization_of_Three_Modes_of_Travel_Single-Occupant_Vehicle_Transit_Walking

Fraszczyk, A., & Mulley, C. (2017). Public perception of and attitude to driverless train: A case study of Sydney, Australia. *Urban Rail Transit, 3*(2), 100–111. https://doi.org/10.1007/s40864-017-0052-6

Grisé, E., & El-Geneidy, A. (2018). Where is the happy transit rider? Evaluating satisfaction with regional rail service using a spatial segmentation approach. *Transportation Research Part A: Policy and Practice, 114*, 84–96. https://doi.org/10.1016/j.tra.2017.11.005

Guthrie, A., Fan, Y., & Das, K. V. (2017). Accessibility scenario analysis of a hypothetical future transit network: Social equity implications of a general transit feed specification–based sketch planning tool. *Transportation Research Record, 2671*(1), 1–9. https://doi.org/10.3141/2671-01

Halawani, A. T. M., & Rehimi, F. (2021). Evaluation of the intention to shift to public transit in Saudi Arabia. *Transportation Research Part D: Transport and Environment, 94*, 102809. https://doi.org/10.1016/j.trd.2021.102809

Heath, Y., & Gifford, R. (2002). Extending the theory of planned behavior: Predicting the use of public transportation. *Journal of Applied Social Psychology, 32*(10), 2154–2189. https://doi.org/10.1111/j.1559-1816.2002.tb02068.x

Heinen, E., Panter, J., Mackett, R., & Ogilvie, D. (2015). Changes in mode of travel to work: A natural experimental study of new transport infrastructure. *International Journal of Behavioral Nutrition and Physical Activity, 12*(1), 81. https://doi.org/10.1186/s12966-015-0239-8

Institut de la Statistique du Québec. (2019). Perspective démographique du Québec et des région 2016-2066. Retrieved from https://statistique.quebec.ca/fr/fichier/perspectives-demographiques-du-quebec-et-des-regions-2016-2066-edition-2019.pdf

Irtema, H. I. M., Ismail, A., Borhan, M. N., Das, A. M., & Alshetwi, A. B. Z. (2018). Case study of the behavioral intentions of public transportation passengers in Kuala Lumpur. *Case Studies on Transport Policy, 6*(4), 462–474. https://doi.org/10.1016/j.cstp.2018.05.007

Lachapelle, U., Boisjoly, G., & Vermesch, P. (2020). *Réalisation d'un portrait des besoins et des habitudes de déplacements des personnes vivant en situation de précarité dans la région de Montréal*. Retrieved from https://publications.polymtl.ca/5266/

Lagadic, M. (2019). Along the London overground: Transport improvements, gentrification, and symbolic ownership along London's trendiest line. *City & Community, 18*(3), 1003–1027. https://doi.org/10.1111/cico.12414

Larsen, K., Gilliland, J., Hess, P., Tucker, P., Irwin, J., & He, M. (2009). The Influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. *AJPH, 99*(3), 520–526. https://doi.org/10.2105/ajph.2008.135319

Lee, J., Nam, J., & Lee, S. (2014). Built environment impacts on individual mode choice: An empirical study of the Houston-Galveston metropolitan area. *International Journal of Sustainable Transportation, 8*(6), 447–470. https://doi.org/10.1080/15568318.2012.716142

Long, B., Choocharukul, K., & Nakatsuji, T. (2011). Psychological factors influencing behavioral intention toward future sky train usage in Phnom Penh, Cambodia. *Transportation Research Record, 2217*(1), 63–70. https://doi.org/10.3141/2217-08

Park, K., Farb, A., & Chen, S. (2021). First-/last-mile experience matters: The influence of the built environment on satisfaction and loyalty among public transit riders. *Transport Policy, 112*, 32–42. https://doi.org/10.1016/j.tranpol.2021.08.003

Réseau Express Métropolitain. (2021). Building a network for Greater Montréal. Retrieved from https://rem.info/en

Schikofsky, J., Dannewald, T., & Kowald, M. (2020). Exploring motivational mechanisms behind the intention to adopt mobility as a service (MaaS): Insights from Germany. *Transportation Research Part A, 131*, 296–312. https://doi.org/10.1016/j.tra.2019.09.022

Sener, I. N., Lee, K., Durand, C. P., Oluyomi, A. O., & Kohl, H. W. (2020). Intention to use light-rail transit in Houston, Texas, United States: Findings from the travel-related activity in neighborhoods study. *International Journal of Sustainable Transportation, 14*(12), 944–955. https://doi.org/10.1080/15568318.2019.1663962

Shiwakoti, N., Stasinopoulos, P., Vincec, P., Qian, W., & Hafsar, R. (2019). Exploring how perceptive differences impact the current public transport usage and support for future public transport extension and usage: A case study of Melbourne's tramline extension. *Transport Policy, 84*, 12–23. https://doi.org/10.1016/j.tranpol.2019.10.002

Sottile, E., Piras, F., & Meloni, I. (2019). Could a new mode alternative modify psycho-attitudinal factors and travel behavior? *Transportation Research Record, 2673*(9), 94–106. https://doi.org/10.1177/0361198119843478

Statistics Canada. (2017). Montréal, V [Census subdivision], Quebec and Canada [Country] (table). Census Profile. 2016 Census. *Statistics Canada Catalogue* (no. 98-316-X2016001). Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E

Steer Davies Gleave. (2017). *Réseau électrique métropolitain (REM) CDPQ Infra Inc. Sommaire des prévisions d'achalandage du REM Février 2017*. Retrieved from https://www.cdpqinfra.com/sites/cdpqinfrad8/files/2019-10/summary_rem_forecasting_fr_vf_0.pdf

STM. (2020). *Rapport d'activité 2019*. Retrieved from https://www.stm.info/fr/a-propos/informations-entreprise-et-financieres/rapport-annuel-2019/rapport-dactivite-2019

Tétreault, L.-F., Eluru, N., Hatzopoulou, M., Morency, P., Plante, C., Morency, C., …, & Smargiassi, A. (2018). Estimating the health benefits of planned public transit investments in Montreal. *Environmental Research, 160*, 412–419. https://doi.org/10.1016/j.envres.2017.10.025

van Acker, V., van Wee, B., & Witlox, F. J. T. R. (2010). When transport geography meets social psychology: Toward a conceptual model of travel behavior. *Transport Reviews, 30*(2), 219–240.

van de Coevering, P., Maat, K., Maarten, K., & van Wee, B. (2019). Causal effects of built environment characteristics on travel behavior: A longitudinal approach. *European Journal of Transport and Infrastructure Research, 16*(4), 674–697.

Van, H. T., Choocharukul, K., & Fujii, S. (2014). The effect of attitudes toward cars and public transportation on behavioral intention in commuting mode choice—A comparison across six Asian countries. *Transportation Research Part A: Policy and Practice, 69*, 36–44. https://doi.org/10.1016/j.tra.2014.08.008

van Wee, B., & Witlox, F. (2021). COVID-19 and its long-term effects on activity participation and travel behavior: A multiperspective view. *Journal of Transport Geography, 95*, 103144. https://doi.org/10.1016/j.jtrangeo.2021.103144

Villafuerte-Diaz, J., Victoriano-Habit, R., Soliz, A., & El-Geneidy, A. (2023). Who does light rail serve? Examining gendered mobilities and light-rail transit in Montreal, Canada. *Transportation Research Record*, *2677*(2), 03611981231158318.

Walk Score Professional. (2021). Walk score. Retrieved from https://www.walkscore.com/professional/research.php

Yap, J. B. H., & Goh, S. V. (2017). Determining the potential and requirements of transit-oriented development (TOD). *Property Management, 35*(4), 394–413. https://doi.org/10.1108/PM-06-2016-0030

Zailani, S., Iranmanesh, M., Masron, T. A., & Chan, T.-H. (2016). Is the intention to use public transport for different travel purposes determined by different factors? *Transportation Research Part D: Transport and Environment, 49*, 18–24. https://doi.org/10.1016/j.trd.2016.08.038

Zhou, X., Du, H., Liu, Y., Huang, H., & Ran, B. (2017). Investigating the intention of rural residents to use transit in Cixi, China. *Journal of Urban Planning and Development, 143*(2), 05016017.