Operationalizing the 15-Minute City: An exploration into the “who” and “where” of x-minute cities in the North American context

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Summary:

Achieving the 15- or 30-minute city concept in a North American context is not possible, modifications of such concepts are needed to fit with the travel behaviour and built environment nature in such context.

The Issue:

The **x-minute** city is a planning approach that gained considerable attention over the past 6 years, first since its adoption by some Australian cities in the form of **30-minute city**, second more recently when it was part of the re-election campaign of the mayor of Paris in the form of **15-minute city**. The x-minute city goal aims to ensure that all trips (work, shopping, leisure health etc.) can be made by sustainable transport (walking, cycling, and public transit) in the defined travel time threshold. Politicians around the world found the goal of x-minute city to be attractive due to its ease of communications and have commissioned planners and engineers to explore their implementation in various contexts.

The Research Question:

Is it possible to achieve the 15 or 30-minute city goals in a North American context.

The Approach:

Using Montréal, Quebec, Canada as a case study, this supervised research project explores who is living a local lifestyle (conducting all trips within 15 and/or 30 minutes of travel time by a sustainable mode) from their home and which areas receive the highest number and percentage of trips by sustainable modes within 15 or 30 minutes of travel.

Who is living local?

- 1.8% and 6% of Montréal households are living the 15-minute and 30-minute city lifestyles, respectively.
- Increasing the walkscore of the entire Montréal region to 100 (the highest level) will increase the number of households living the 15- minute city by 0.9% and 30-minute city by 2%.
- Altering the 15 and 30-minute city definitions to be contextually-informed makes them more attainable for a greater diversity of people in the North American context.
- Large household sizes and car ownership impact the odds of living a local lifestyle.

Where do people travel local?

- Very few areas in Montréal currently attract the type of trips that align with the 15- and 30-minute city.
- Medium- and high-density residential land use accompanied with a mix of other land uses characterize the parts of Montréal that most closely align with the 15- and 30-minute city.
- In Montréal, the 30-minute city model is more socioeconomically equitable than the 15-minute city.
- A goal of reaching 40% of trips conducted in 30 minutes or less using sustainable modes is an appropriate target in the North American context.

Policy Recommendations

- The 15- and 30-minute city planning paradigms are hardly reachable within the North American context.
- Policy makers interested in the x-minute city framework should look toward the existing land use and transport landscape to inform x-minute city plans and metrics.
- Analyzing actual travel behaviour using the x-minute city framework creates new perspectives into understanding local accessibility.

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CONTRIBUTION OF AUTHORS

Chapter 1 of this project is based on manuscript titled *Who is living a local lifestyle? Towards a better understanding of the 15-Minute-City and 30-Minute-City concepts from a behavioural perspective in Montréal, Canada*, published in the Journal of Urban Mobility in 2023. Secondary authors to this publication include Rodrigo Victoriano-Habit, Meredith Alousi-Jones, Aryana Soliz, and Prof. Ahmed El-Geneidy. Chapter 2 is based on a manuscript that will be submitted for presentation at the Meeting of the Transportation Research Board in 2024 as well as for publication in a peer-reviewed journal. In this study, the secondary author is Prof. Ahmed El-Geneidy.

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Introduction

The x-minute city is a planning approach that has gained considerable attention over the past 6 years, first since its adoption by some Australian cities in the form of 30-minute city, second more recently when it was part of the re-election campaign of the mayor of Paris in the form of 15-minute city. The x-minute city goal aims to ensure that all trips (work, shopping, leisure health etc.) can be made by sustainable transport (walking, cycling, and public transit) in the defined travel time threshold. Politicians around the world found the goal of x-minute city to be attractive due to its ease of communications and have commissioned planners and engineers to explore their implementation in various contexts. Using Montréal, Quebec, Canada as a case study, this supervised research project explores who is living a local lifestyle (conducting all trips within 15 and/or 30 minutes of travel time by a sustainable mode) from their home and which areas receive the highest number and percentage of trips by sustainable modes within 15 or 30 minutes of travel.

Chapter 1: Who is Living a Local Lifestyle?

1.1 Introduction

Local and regional accessibility policies have been gaining momentum in the planning field in recent years, especially the concepts of “15-Minute City” and “30-Minute City.” These concepts aim to enable urban residents to fulfil essential social functions (including living, working, commerce, healthcare, education, and entertainment) within 15 or 30 minutes from their homes by active travel (Moreno, Allam, Chabaud, Gall, & Pratlong, 2021). The cited benefits of implementing this planning framework include reaching sustainable-mobility goals and improving the general wellbeing of urban populations (Allam, Nieuwenhuijsen, Chabaud, & Moreno, 2022). The movement of the 15-minute city has emerged from historically older European regions, which were designed prior to the car-domination era (ibid). These regions have experienced population growth and expansions over the past decades with recent prioritization of car-oriented planning, which imposed large burdens on their population when it comes to travel time to reach desired destinations. As such, the 15-minute city has become a popular vision among some European decision makers, representing a reorientation toward local living. Reflected in various election campaigns, policymakers across the globe are discussing these initiatives, including the possibility of adopting it in North American contexts (Bruemmer, 2021; Gower & Grodach, 2022; TED Conferences, 2021). In regions where the automobile played a structural role in urban planning, the 30-minute city has emerged as an adaptation to the concept, yet these discussions remain largely limited to Australia and New Zealand (Levinson, 2019).

Given the rising interest in adopting the 15- and 30-minute cities in different contexts, what will these planning approaches look like on the ground in a range of urban environments? Is it possible for any city to apply these concepts and see results? While benefits of x-minute cities are widely shared, the concepts have also been challenged for their feasibility within existing built environment, affordability, and socio-cultural constraints (Dunning, Calafiore, & Nurse, 2021; Guzman, Arellana, Oviedo, & Aristizábal, 2021). Moreover, though extensive research has been conducted on what built-environment features could potentially encourage the 15- or 30-minute city (Capasso Da Silva, King, & Lemar, 2019; Gaglione, Gargiulo, Zucaro, & Cottrill, 2022; Moreno et al., 2021), it remains unclear which groups of the population can achieve this lifestyle.

In this article, we test the practicality of the x-minute city goal in the Montréal metropolitan region (Canada). Our aim is to evaluate whether the 15-minute city planning approach championed by Carlos Moreno is an appropriate measure toward improving local accessibility within this context. The definition stipulates that all social functions, including work, food, health, education, culture, and leisure are conducted within a 15-minute travel time radius using walking and cycling modes (TED Conferences, 2021). In this study, we expand the definition to *include public transit* as an alternative mode given that it has been described as a 'quasi-active mode' (Ermagun & Levinson, 2017) and has proven important to promoting active living environments (Winters, Buehler, & Götschi, 2017), especially in North American contexts (Crist et al., 2021; Daley et al., 2022). To accommodate the land use reality of the study area, we further expand Moreno's definition by testing a 30-minute threshold in addition to the 15-minute version, which has been promoted in newer cities.

Using existing travel behaviour data, we identify which groups of households are living a 15- or 30-minute city lifestyle and which built-environment and personal characteristics differentiate these groups from those maintaining longer travel distances. In line with the definition discussed previously, we conceptualize "15- and 30-Minute Households" as those whose trips do not surpass these respective travel-time thresholds and are all completed using active transport modes: walking, cycling, and/or public transit. Using disaggregate mobility data from a sample of 22,040 households from the 2018 Montréal Origin-Destination (O-D) survey, we estimate binary logistic models followed by a sensitivity analysis to assess the built-environment and household factors defining a 15- or 30-minute household using these active modes. Following these analyses, alternate definitions of x-minute city households are explored to test other ways of conceptualizing local accessibility metrics that are based on travel-time thresholds. First, trips to work and school destinations are excluded from the analysis to recognize the regional scale of employment and education. Second, households that conduct 65% or more of their trips with active modes in the travel time threshold are considered 15- and 30-minute households. This two steps analysis shows how far a North American city is from applying a modified 15 minutes and the 30 minutes city concepts, while the statistical models show the factors that can be used to achieve either of these concepts in practice through policy and planning tools.

1.2 Literature review

Sustainable urban mobility is increasingly being recognized as a high priority for policy makers and planners globally. While decades of car-centric policies have improved travel speeds, they have led to rising issues of urban sprawl, traffic congestion, greenhouse gas emissions, as well as air and noise pollution (Hickman & Banister, 2014; Meschik, 2012; Silva & Altieri, 2022). Rather than being the simple result of consumer preferences, research has demonstrated how car dependency has been fuelled through complex structural, political, economic, and socio-cultural dynamics (Doughty & Murray, 2016; Furness, 2010; Gopakumar, 2020; Sheller & Urry, 2000). Thus, efforts to phase-out carbon-intensive transport systems require both broad-based critical thinking as well as careful attention to the particularities of diverse urban, neighbourhood, and household dynamics (Soliz, 2021).

As a part of the movement for sustainable-urban transitions, the notion of the 15-minute city has been gaining traction as a means of creating higher-density, mixed-use neighbourhoods that help to enhance local resiliency and social wellbeing (Caselli, Carra, Rossetti, & Zazzi, 2022; Moreno et al., 2021; Pozoukidou & Chatziyiannaki, 2021). From this perspective, each neighbourhood unit should provide efficient access to quality-of-life amenities and fulfil essential social functions, including living, working, commerce, healthcare, education, and entertainment within a 15 minute travel time threshold by active modes of transport (Hosford, Beairsto, & Winters, 2022; Moreno et al., 2021). By prioritizing active modes—especially cycling and walking—this concept is seen as fostering a paradigm shift in contemporary urban planning, supporting healthier travel patterns and social interactions (Allam et al., 2022). In this sense, the 15-minute city is often regarded as the contemporary manifestation of the classic "human scale," prioritizing neighbourhood liveability along with people's time and collective wellbeing (Abdelfattah, Deponte, & Fossa, 2022; Weng et al., 2019). Although similar paradigms (such as the neighbourhood-unit concept) have been used since the 1920s (Kissfazekas, 2022), the notion of the 15-minute city has gained popularity among policy makers in recent years, with added attention to enhancing positive social, environmental, and public-health outcomes (Allam et al., 2022).

Notwithstanding the promise of planning for the 15-minute city, the concept has recently been subject to critical questioning by various researchers. By prioritizing neighbourhood efficiency, does this model neglect the mobility needs of people with disabilities and those who cannot afford to stay in dense urban areas (Zivarts, 2021)? Is the concept simply a utopian buzzword, or does it have the potential to generate substantive changes to improve urban environments and social wellbeing (Gower & Grodach, 2022; Herbert, 2021)? What are the risks that this movement will spark neighbourhood transformations that lead to gentrification and social displacement, thus exacerbating urban inequalities (Dunning et al., 2021)? Furthermore, given that the concept was adapted primarily from older European cities, to what extent can 15-minute cities be replicated in different global contexts (Guzman et al., 2021)? While examples of 5, 15, 20, and 30-minute cities abound (Di Marino, Tomaz, Henriques, & Chavoshi, 2022; Gaglione et al., 2022; Hosford et al., 2022; Levinson, 2019; Peters, 2019), what thresholds should be used to guide new planning interventions, and how might these targets need to be modified across diverse urban realities? Furthermore, with several urban-mobility scholars calling for an expanded understanding of active travel to include 'quasi-active modes,' notably public transit and other intermodal options (Agyeman & Cheng, 2020; Ermagun & Levinson, 2017; Sagaris & Arora, 2016; Sagaris, Tiznado-Aitken, & Steiniger, 2017), how can x-minute-city research help to integrate these insights into urban-planning frameworks?

Indeed, there is compelling evidence that the concept of the 15-30-minute city requires greater attention to residents' actual needs, lived experiences, neighbourhood characteristics, and socio-economic conditions (Calafiore, Dunning, Nurse, & Singleton, 2022; Guzman et al., 2021; Logan et al., 2022; Olsen et al., 2022). As Richard Dunning and colleagues propose, working towards x-minute cities will require "planning for the possible in the context of the existing" (2021, p. 157). This process should not preclude the goals of creating more sustainable, mixed-use, and higher-density cities, but rather requires moving beyond tokenistic discourse about x-minute cities, towards greater engagement with unique urban and neighbourhood contexts (ibid.).

While critical and socially engaged thinking on x-minute cities is on the rise, surprisingly little attention has been given to actual household dynamics and travel behaviour in these discussions. Thus, this paper builds on the literature attending to the relationship between household characteristics and transport planning (Chidambaram & Scheiner, 2020; Habib, 2014; Hawkins, Weiss, & Habib, 2021) to better nuance analyses and planning interventions aimed at fostering the x-minute city. Studies on travel behaviour have long commented on the need to account for the unique social, economic, and demographic trends that result in changing household dynamics and travel patterns (Clark, Huang, & Withers, 2003; Surprenant-Legault, Patterson, & El-Geneidy, 2013; White, 1988). For example, research on walkability measures and their relationship to actual observed travel patterns has found that walkability indexes do not have the same correlation with travel behaviour for all individuals and households (Manaugh & El-Geneidy, 2011). By bringing together this literature on the relationship between household characteristics and transport planning with recent theorizing on 15-30-minute cities, we hope to help move the conversation beyond utopian thinking about urban sustainability, towards more contextualized strategies grounded in people's actual travel experiences, neighbourhood characteristics, and household realities.

1.3 Data and Methods

In this paper we define households who are living the 15- or 30-minute city lifestyle as those households who are conducting all their travel to their desired daily destinations within a 15- or 30-minute travel-time radius from their home and are using active modes of transport (walking, cycling, and/or public transport) to reach them. To do so, we use the 2018 Montréal Origin-Destination (O-D) survey. The O-D survey is administered every 5 years by the regional public transport planning authority in the Montréal metropolitan region, collecting a travel diary record from a 5% random sample of Montréal-area households covering the most recent weekday. Each observation in the O-D survey represents a trip made by an individual on the survey day from a specific household. All trips made by the entire household on the same day are recorded and coded to enable aggregation to the person or household level.

1.3.1 Data cleaning

We restricted our analysis to households whose trips consisted of O-D pairs within Montréal's metropolitan area boundary. Trips with missing O-D information or those that reported modes other than walking, cycling, public transit, and/or car (driving or passenger) were removed since accurate travel times could not be estimated except for these modes. Travel times for each trip were measured between the respondent's home location and the trip destination, based on the mode used to reach the destination. This approach helps correct for potential trip chaining, wherein the trip origin and destination are far from the home location, to capture a true travel time radius of all destinations from the home location.

Network routing for each home-destination pair were calculated using the r5r package in R, supported by OpenStreetMap (OSM) utilizing its sidewalk, cycling, and roadway networks. A speed of 4.5 km/h was used to estimate walking travel time and 16 km/h for cycling (Bastos Silva, Cunha, & Silva, 2014; El-Geneidy, Krizek, & Iacono, 2007). We assembled General Transit Feed Specification (GTFS) data for all public transport agencies providing service in the study area, with feeds downloaded from OpenMobilityData we calculated travel times by public transport trips using the r5r routing tool (Pereira, Saraiva, Herszenhut, Braga, & Conway, 2021). Since the public transport routing procedure relies on schedules from the GTFS, r5r was programmed to measure travel time based on the departure time reported for each trip. The OSM network and GTFS files were downloaded from 2019 and public transport trips were simulated on a typical weekday schedule of April 23rd, 2019. To our knowledge no significant road network changes or public transport service adjustments occurred between the time of the survey and the date the travel time routing data was sourced. It is important to note that congested car travel time was not calculated for this analysis since the goal of the study is to identify households living the 15- or 30-minute lifestyle while exclusively using active modes of transport. For this reason, households with car users were not considered to be living the 15- or 30-minute lifestyle.

With relevant travel times calculated, all trips in the sample (n = 147,274) were then aggregated to the household level for further analysis (n = 50,904). The maximum travel time recorded for each household and the modes used for all trips were utilized to determine whether the household classifies as a 15-minute household or a 30-minute household. To capture daily travel behaviour consisting of a range of trip types, a household was excluded from the sample if it had less than two trips recorded in the survey, and/or if school and work were the only destinations visited by all members of the household. Households were also removed from the sample if their survey results were missing key demographic information such as income that are needed for the analysis. The final cleaned sample consisted of 87,328 trips reported by 22,040 households.

1.3.2 Statistical models and variables

As a central aim of our research is to learn the personal and neighbourhood factors contributing to a household living the 15- or 30-minute city lifestyle based on all of their trips, we used a binary logistic regression to unravel the characteristics that differentiate these households from those with longer travel times. A multilevel binary logistic model was also tested with census tracts as the higher level of analysis. However, when comparing the multilevel model to the binary logistic model, the LR test ($p=0.31$) indicated that it is not needed. For the purposes of this analysis, a 15- or 30-minute household is defined as one whose daily trips (a) do not surpass the respective travel-time threshold and (b) are completed using only active modes (walking, cycling, and/or public transit).

Two groups of explanatory variables, household characteristics and built-environment factors, were included in the models. For the former, sociodemographic information by household was pulled from the O-D survey. Variables included per capita annual income, a binary indicator of household vehicle access, and household size by age and occupation status. For the purposes of modelling, the household composition is indicated by seven variables that count mutually exclusive categories of individuals which comprise households: children (age <5), students (age 5-12), students (age 13-18), students (age 19+), full-time workers, retirees, and other. This disaggregated representation of household size allowed us to pinpoint the influence that household members in varying life stages may have on the ability to meet daily needs within 15- and 30-minute travel-time thresholds.

The built-environment factors included two measures of local and regional accessibility, the ease of reaching destinations, around each household (Handy, 2020; Manaugh & El-Geneidy, 2012). The first is WalkScore, a popular measure of local accessibility by active modes that has been proven reliable in predicting walking behaviour in the Montréal context (Manaugh & El-Geneidy, 2011). This measure reflects neighbourhood-level walkability as an index produced through a gravity-based assessment of amenities within 1-mile of each location. In our analysis, household home locations were spatially joined to postal code-level WalkScore values. To capture the varying impact of WalkScore, four dummy variables were generated in line with the official WalkScore groupings: car dependent (score 0-49), somewhat walkable (score 50-69), very walkable (score 70-89), and walker's paradise (90-100) (Walk Score, 2022).

A public transport gravity-based accessibility measure is the second built-environment metric, defined as the quantity of jobs reachable within the region's from a location and weighted by a gaussian-fit decay function derived from the Census 2016 commuting flows (Palacios & El-geneidy, 2022). Travel time calculations for job accessibility by public transport were produced using the r5r package in R for every minute between 8:00 am and 9:00 am then averaged to account for variation in scheduling and waiting time (Pereira et al., 2021). Job location data was obtained from Statistics Canada (Statistics Canada, 2018). To highlight the policy relevance of this study, a sensitivity analysis was developed after discussing the statistical models showing the odds of different household structures in achieving the 15- or 30-minutes city lifestyle while varying the local accessibility levels.

1.3.3 Samples for alternate 15- and 30-minute city definitions

Two additional samples were prepared to reclassify the same households based on definitions of 15- and 30-minute cities that are less rigid compared to the expectation that all household travel is conducted within the travel time radius. The first sample excludes all work and school trips to evaluate x-minute household status based on each household's non-education and employment destinations. It is understood that work and school destinations tend to assume a more regional scale relative to home locations as individuals seek opportunities that best align with their needs. Moreover, travel for work and school purposes is often more inflexible than other purposes, as their destinations cannot easily be changed (Schwanen & Dijst, 2003). As such, these destinations often span beyond the neighbourhood vicinity and may conflict with our evaluation of local accessibility to other destinations such as leisure, shopping, health, etc. For this sample, work and school trips were filtered out based on the trip type variable included in the Montréal O-D survey. The resulting sample included 55,642 non-work and non-school trips reported among 22,040 households.

The second alternative sample defines 15- or 30-minute city households as such if 65% or more of the household's trips are completed using active modes within the travel time threshold. Under the assumption that household members may choose to travel to longer-distance destinations despite closer options being available, it may be an unreasonable expectation to measure local accessibility based on an exclusive travel time radius. The 65% benchmark was selected because it reflects a household's trip majority for those that have as few as three total trips recorded. This sample includes the same number of households (n=22,040) and trips (n=87,328) as the original sample.

1.4 Results

1.4.1 Descriptive statistics

Our preliminary analysis shows that a minority of households in Montréal are living the 15- and 30-minute city lifestyles (Table 1). Among the 22,040 Montréal households analysed, 1.8% conduct all their daily activities within 15 minutes from their home using active transport (walking, cycling, and/or public transport), and 6% within 30 minutes. Households living a 15- and 30-minute city lifestyle tend to have fewer people than those who are not. This distinction is slightly more pronounced when comparing households within and outside of the 15-minute travel-time threshold to the 30-minute one.

For the built-environment variables, WalkScore and public transport accessibility to jobs are higher for 15- and 30-min households (Figure 1), with a bigger change in WalkScore observed between households within and outside of the 30-minute city compared to the 15-minute ones. These preliminary findings suggest that the 15-minute city lifestyle is more related to household composition, whereas the 30-minute city lifestyle is more closely linked to the built environment.

Table 1. Descriptive statistics of independent variables grouped by 15- and 30-minute households

Variable		Variable Description	Mean (Std. Dev.)			
			15-min households	*Non-15-min households*	*30-min households*	*Non-30-min households*
Household Characteristics						
Income (per capita)	*[$10,000/year]*	Respondent's annual household income, divided by household size	3.38 (2.52)	3.78 (2.62)	3.56 (2.68)	3.78 (2.62)
Household vehicle access	*[1 = yes]*	Access to a household vehicle	0.4 (0.49)	0.91 (0.29)	0.37 (0.48)	0.93 (0.25)
Household Composition						
Children (age <5)	*[count]*	Number of children under the age of 5	0.06 (0.25)	0.15 (0.44)	0.09 (0.35)	0.15 (0.44)
Students (age 5-12)	*[count]*	Number of students between the ages of 6 and 12, inclusive	0.16 (0.52)	0.34 (0.71)	0.18 (0.54)	0.34 (0.71)
Students (age 13-18)	*[count]*	Number of students between the ages of 13 and 18, inclusive	0.04 (0.25)	0.19 (0.51)	0.06 (0.29)	0.2 (0.52)
Students (19+)	*[count]*	Number of students ages 19 or older	0.08 (0.32)	0.15 (0.42)	0.12 (0.39)	0.15 (0.42)
Full-time workers	*[count]*	Number of full-time workers	0.4 (0.63)	1.08 (0.88)	0.61 (0.74)	1.09 (0.88)
Retirees	*[count]*	Number of retired individuals	0.69 (0.74)	0.52 (0.76)	0.55 (0.72)	0.52 (0.77)
Other household members	*[count]*	Number of other household members	0.3 (0.58)	0.26 (0.51)	0.28 (0.53)	0.26 (0.5)
Built Environment						
WalkScore	*[1-100]*	WalkScore of home location	84.9 (18.5)	59.6 (27.3)	87.2 (15)	58.3 (27)
Transit accessibility to jobs	*[1 = 10,000 jobs]*	Gravity-based accessibility to jobs	42.5 (18.7)	21 (19.4)	45.4 (16.4)	19.9 (18.8)
Percent of Sample			1.8%	98.2%	6.0%	94.0%

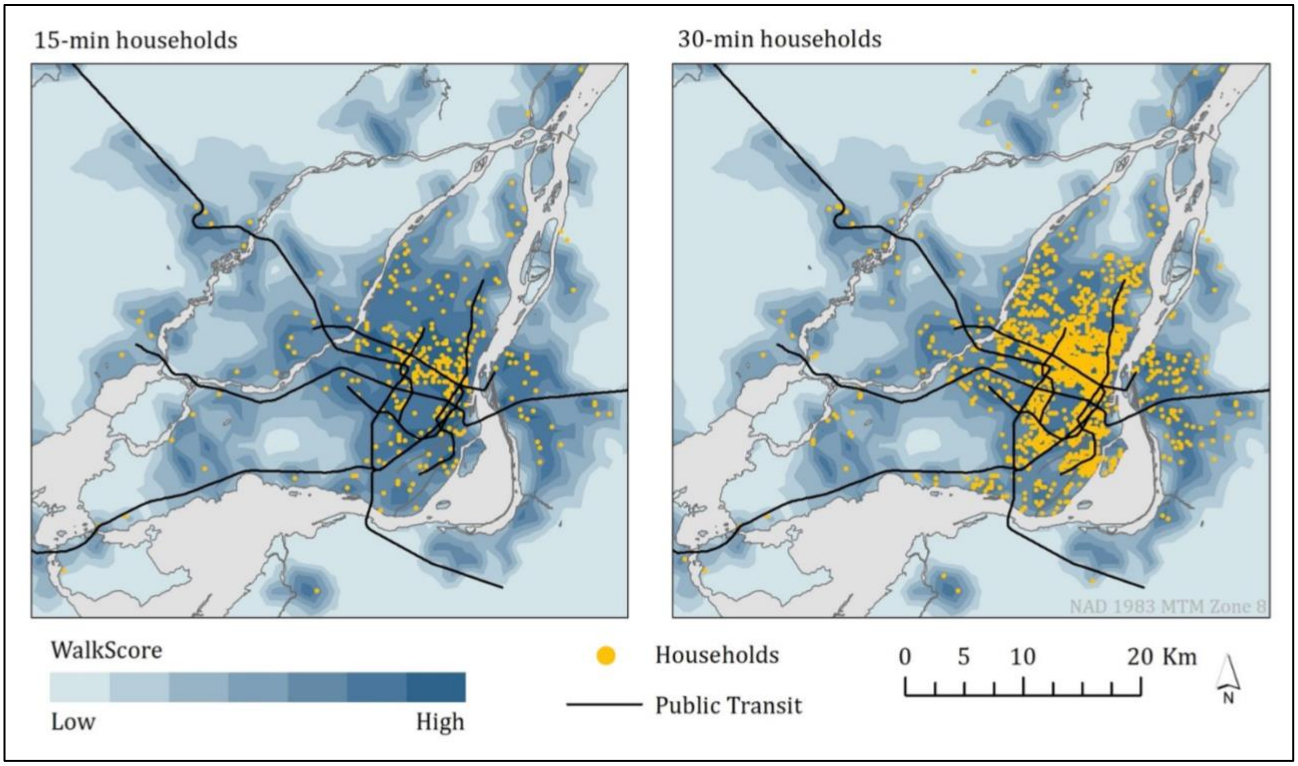


Figure 1. 15- and 30-min household home locations and neighbourhood WalkScore

1.4.2 Model results

Our binary logistic model results allow us to assess the impact of household and built environment characteristics on the probability that all household's trips will fall within a 15-minute or a 30-minute travel-time threshold and using active modes of transport (cycling, walking, and/or public transport). The odds ratios presented in Table 2 for both models reflect the relative importance of each variable on this probability. First, in terms of income, the models indicate that an increase of $10,000 in a household's per capita income results in an 8% decrease in the probability of being a 15-minute household, and a 6% decrease in the probability of being a 30-minute household, while keeping all other variables constant at their mean value. Thus, while the effect of income is significant, and lower income households are more likely to belong to these local accessibility groups, the effect is also relatively small. On the other hand, vehicle ownership has a considerably higher effect. A household that owns one or more vehicles is 78% less likely to be a 15-minute household, and 87% less likely to be a 30-minute household, while keeping all other variables constant at their mean.

Table 2. Model results for 15-minute and 30-minute households

	15-min households		**30-min households**	
Predictors	*Odds Ratio*	*CI*	*Odds Ratio*	*CI*
Intercept	0.05 ***	0.03 – 0.09	0.08 ***	0.06 – 0.13
Household Characteristics				
Income (per capita)	0.92 **	0.88 – 0.97	0.94 ***	0.91 – 0.96
Household vehicle access	0.22 ***	0.17 – 0.29	0.13 ***	0.11 – 0.15
Household Composition				
Children (age <5)	0.71	0.46 – 1.03	0.92	0.76 – 1.11
Students (age 5-12)	1.14	0.91 – 1.40	1.05	0.92 – 1.19
Students (age 13-18)	0.52 **	0.32 – 0.77	0.60 ***	0.48 – 0.75
Students (19+)	0.39 ***	0.26 – 0.56	0.59 ***	0.49 – 0.71
Full-time workers	0.34 ***	0.26 – 0.42	0.54 ***	0.47 – 0.61
Retirees	0.78 *	0.62 – 0.98	0.90	0.78 – 1.04
Other household members	0.74 *	0.57 – 0.96	0.80 **	0.68 – 0.94
Built Environment				
WalkScore (50-69)	1.77 *	1.02 – 3.16	1.71 **	1.17 – 2.54
WalkScore (70-89)	2.38 **	1.40 – 4.19	2.34 ***	1.63 – 3.44
WalkScore (90-100)	4.33 ***	2.34 – 8.26	4.24 ***	2.81 – 6.50
Transit accessibility to jobs	1.02 ***	1.01 – 1.03	1.04 ***	1.03 – 1.04
Observations	22,040		22,040	
R^2 (McFadden)	0.25		0.36	
AIC:	3050.73		6442.21	
BIC:	3162.74		6554.22	

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

Both models also attempt to explain the impact of household composition on the probability of staying within the 15- and 30-minute travel-time thresholds while only using active modes of transport. To simplify the interpretation of individual characteristics in the model, Figure 2 presents the varying effects of the number of individuals with certain characteristics on the probability of a household being characterized as a 15- or 30-minute household. Each additional household member which has a statistically significant effect, negatively affects the probability of being a 15- or 30-minute household. This effect varies based on the age and status of this additional household member. Thus, larger households are less likely to stay within the assessed thresholds regardless of their specific composition, especially for 15-minute households, if all other variables are kept constant.

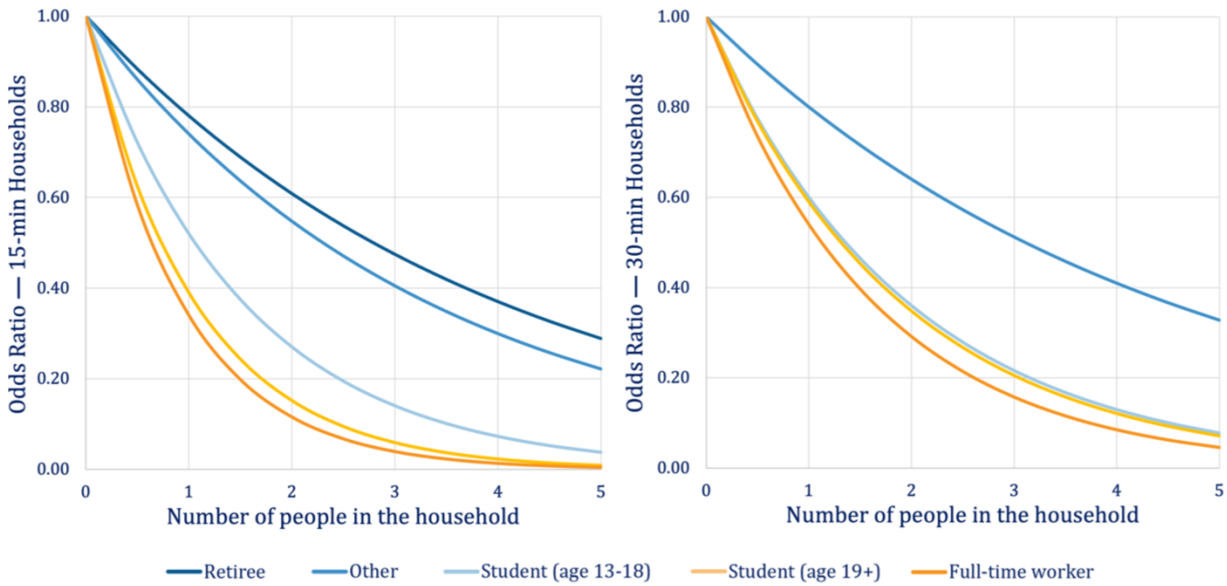


Figure 2. Odds ratios for 15-minute and 30-minute households by number of household members

Retirees have the smallest effect on the probability of being a 15-minute household, meaning that a household comprised of only one retiree would be the most likely to have a 15-minute travel radius while only using active modes of transport. This is followed by the "other household member" category (non-employed and non-students) and students of 13 to 18 years of age. Finally, students over 18 years old and full-time workers have the largest effect, meaning that they are the least likely to stay within a 15-minute threshold. For the probability of being a 30-minute household, "other household members" have a relatively small effect, followed by students over the age of 13. Similar to the 15-minute households, full-time workers have the largest effect, suggesting that work-related responsibilities interfere with the ability to live within a 30-minute travel-time threshold while only using active modes of transport.

Children under 5 years of age and students from 5 to 12 years of age have no statistically significant effect on the probability of a household having a 15-minute or 30-minute travel-time threshold. This means that a household belonging to one of these two travel-time categories is more related to the presence of adults and students over 13 years of age in the household, as younger children show no additional effect.

The models also shed light on the relevance of the built environment on the likelihood that a household will belong to one of the 15- or 30-minute household categories. In this context, the household location's WalkScore has a strong and statistically significant effect on the odds of a household being a 15- or 30-minute one. Compared to households located in areas with the lowest WalkScore values, of 0 to 49, households located in areas with a WalkScore of 50 to 69 are 1.77 times more likely to be a 15-minute household and 1.71 times more likely to be a 30-minute household while keeping all other variables constant at their mean. Households living in neighbourhoods with a WalkScore between 70 to 89 are 2.38 times more likely to be a 15-minute household and 2.34 times more likely to be a 30-minute household when compared to households residing in neighbourhoods with the lowest WalkScore. Finally, households living in areas with the highest WalkScore, with scores of 90 to 100, are 4.33 times more likely to be a 15-minute household and 4.24 times more likely to be a 30-minute household compared to those households residing within the lowest values, while keeping all other values constant at their means.

The probability of being a 15-minute household increases by 2% for every additional 10,000 jobs (weighted based on the gravity decay function) that can be reached by public transit in the region's mean commute time from the household location, while keeping all other variables constant at their mean. On the other hand, the probability of being a 30-minute household increases by 3% for every additional 10,000 jobs that can be reached. These results show that not only local accessibility is relevant for households to live a 15- or 30-minute city lifestyle, but public transit accessibility as well.

1.4.3 Sensitivity analysis

To better understand the implications of the all-trips model results, we propose a sensitivity analysis based on 8 household profiles:

- 1 adult ("other household member": non-employed and non-student), with no car
- 1 student, with no car
- 1 worker and 1 student (13-18), with no car

- 2 adults, with a car
- 1 worker, with a car
- 1 worker, 1 student (19+), 1 student (13-18), with a car
- 1 worker and 1 student (13-18), with a car
- 2 workers and 1 student (13-18), with a car

These 8 household profiles with varying compositions and car ownership only include household members that showed statistically significant effects on both models presented in Table 2. For the sensitivity analysis, we predict the probability that each of these household profiles will be a 15- or a 30-minute household for varying WalkScore levels, while fixing per capita income and public transport accessibility levels at their respective mean values. This analysis allows for evaluation of which household structures are more likely to lead to 15- and 30-minute households, as well as to assess the relevance of varying local accessibility levels for these profiles, a strategy that is being heavily promoted in the 15-minute city literature (Allam et al., 2022; Moreno et al., 2021). Further, we calculate this likelihood for all Montréal households in the sample while varying WalkScore levels. Figure 3 presents the results of the sensitivity analyses. The percentages for each household profile can be interpreted either as the probability that each profile would be a 15- or 30-minute household, or as the share of each household profile that only makes trips within the assessed travel-time thresholds using active modes of transport.

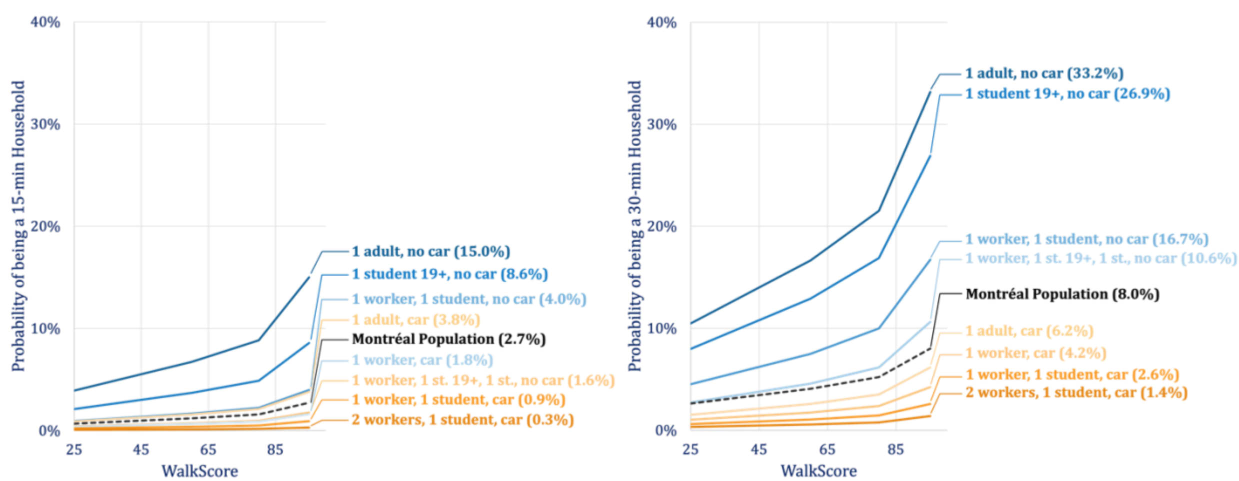


Figure 3. Sensitivity analysis results

The household structure with the highest share of 15-minute households is composed of 1 non-employed, non-student adult with no private vehicle. For this household structure, the share of 15-minute households would be 15% when located in a neighbourhood with a WalkScore of 90 or above. However, all other profiles have shares of under 10% meeting the 15-minute household status, and all profiles with more than one person in the household have shares of under 5%. These results illustrate how having to perform work activities and having larger households strongly restricts the possibility of staying within a 15-minute threshold. Improving the local accessibility levels for all areas in the Greater Montréal Metropolitan region to the highest WalkScore levels (90 to 100) would lead to only 2.7% of all households attaining a 15-minute travel-time radius that relies on active modes of transport only. This represents an increase of only 0.9% in the number of households relative to the existing 1.8% 15-minute households currently experiencing this lifestyle.

Compared to 15-minute households, the share of households that would stay within the 30-minute travel-time threshold is higher for all profiles. In this case, the profile with the highest probability is also 1 non-employed, non-student adult with no car, for which the share would be 33.2% when located in a neighbourhood with a WalkScore of 90 or more. This is followed by other profiles without a private vehicle, all of which have a share of over 10% when located in the highest WalkScore level. On the other hand, all profiles with at least one car have shares of less than 7% of 30-minute households. Finally, for the current Montréal population, 8.0% of households would be categorized as a 30-minute household if local accessibility was improved to WalkScore levels of 90 or more. This represents an increase in 2.0% of households compared to the existing 6.0% 30-minute households in the Greater Montréal Area.

These sensitivity analysis results provide insights into the feasibility of the 15-minute and 30-minute city planning approaches in the North American context, as well as into the potential planning measures that can be taken to move toward these goals. First, we can conclude that the expectation that households will be able to perform all their trips in 15 minutes or less while only using active modes of transport is unrealistic for most existing household structures, even if local accessibility was considerably increased. More specifically, households with employed members are much more likely to perform trips with a duration of more than 15 minutes, which shows the current incompatibility of the 15-minute city paradigm with the distribution of working activities. Additionally, households with more than one person are also highly unlikely to remain within the 15-minute threshold, meaning that more complex household structures tend to be less compatible with a 15-minute-city lifestyle. The 15-minute city planning approach, as defined by maintaining all trips within 15 minutes of the home, does not only provide a difficult goal to reach for North American cities, but it is more related to household-structure characteristics, which are not within the scope of planning and policy interventions and less with the built environment.

On the other hand, while the 30-minute city lifestyle is also strongly related to household structure, the probability of being a 30-minute household is higher for a variety of household profiles. This includes households with workers and a larger number of members, meaning that the expectation that all of a household's trips could be performed in 30 minutes or less by active modes is not contradicting the necessity of commuting for work or the needs of more complex household structures as much as the 15-minute travel time threshold. Our findings also show that the goal of encouraging the 30-minute city lifestyle can be achieved through planning policy interventions, such as increasing local and regional accessibility around households. While this is in line with previous studies (Boisjoly, Wasfi, & El-Geneidy, 2018; Manaugh & El-Geneidy, 2015), we have also found that households that own one or more cars are considerably less likely to live the 30-minute-city lifestyle. This means that to aim for the 30-minute-city and encourage more local and active lifestyles, built-environment interventions should be accompanied by travel-demand management policies aiming to reduce car ownership.

1.4.4 Alternate 15- and 30-minute city definitions

Both the 15- and 30-minute city lifestyles in which all trips are conducted using active modes within the given travel time threshold are not achievable by most people in Montréal. With only a 0.9% increase in the number of households meeting the 15-minute standard when WalkScore is increased to the highest levels across the Greater Montréal area, and a 2% increase for the 30-minute standard, the metric used to determine x-minute city eligibility is far too strict. Furthermore, this definition of local accessibility does not account for natural variations in travel behaviour that include trips to destinations in different neighbourhoods of a city. Conducting all travel within a certain travel time may not be realistic or desirable and may instead reflect a constrained mobility experience.

These results point to a need for more contextually appropriate parameters for the x-minute city that can lead to benefits for a greater proportion of people. In this study, Moreno's 15-mincute city definition was already expanded from its original conceptualization to include public transit as an acceptable mode and allow for a larger travel time radius of 30 minutes, even with such expansion the number of households living these lifestyles were limited and the planning interventions that can be applied on the ground are also limited to a large extent. Two further expansions are explored below.

In the first of the two alternative definitions, 15- and 30-minute households were reclassified using only non-work and non-school trips. This analysis provides another perspective into travel-time trends while recognizing the regional nature of employment and education opportunities. For the second alternative definition, households meet the 15- and 30-minute city status as long as a minimum of 65% of their trips were conducted within the travel time and using active modes. Table 3 shows that when these modifications are applied, a higher proportion of households meet the standard. Excluding trips to work and school destinations leads to 11.1% of households conducting their trips using active modes within a 30-minute travel time radius of their home. Around 10.4% of households meet the 30-minute city status when only 65% of trips need to occur within the 30 minutes of the home. These alternate definitions provide examples of some methods for creating x-minute city parameters that reflect more local travel behaviour.

Table 3. Percent of households that meet different versions of x-minute city concepts

	Percent of Montréal households			
Trips that conform to the x-minute city definition	*15-min households*	*Non-15-min households*	*30-min households*	*Non-30-min households*
100% of trips	1.8%	98.2%	6.0%	94.0%
Non-work and non-school trips	5.9%	94.1%	11.1%	88.9%
65% of trips	4.3%	95.7%	10.4%	89.6%

1.4.5 Modeling alternative definitions of x-minute city

For the first alternative definition the 15- and 30-minute households were reclassified and modeled using only non-work and non-school trips among the same 22,518 households (Table 4). This analysis provides another perspective into travel-time trends while recognizing the regional nature of employment and education opportunities. Findings from this analysis reflect similar results compared to the model that included all trips, with a few distinctions.

Firstly, the number of full-time workers became non-significant and weak toward influencing households' travel-time thresholds when trips to work were excluded. This is a notable difference compared to the models accounting for all trips, yet it has a consistent implication that trips to employment destinations generally take longer than 15 and 30 minutes. The impact of other household members remained relatively consistent, with the exception of students 5-12 years of age positively impacting 15-minute households, and students over the age of 19 positively impacting 30-minute households. This supports our earlier inclination that university students are likely to live in households that maintain a travel-time radius between 15- and 30-minutes.

In terms of built environment factors, the effect of WalkScore follows the same pattern between both sets of models with a higher magnitude influence when work and school trips are excluded. Transit accessibility to jobs remains significant and positive toward predicting 30-minute households, while for the 15-minute threshold this variable becomes slightly less significant. This definition provide transport professionals with more evidence that achieving the 15-minute and 30-minute city is more reachable if you exclude work and that changes in the built environment will have a stronger effect.

Table 4. Model results for 15-minute and 30-minute households for non-work and school trips

	15-min households		**30-min households**	
Predictors	*Odds Ratio*	*CI*	*Odds Ratio*	*CI*
Intercept	0.04 ***	0.03 – 0.06	0.13 ***	0.10 – 0.16
Household Characteristics				
Income (per capita)	0.95 ***	0.92 – 0.97	0.94 ***	0.92 – 0.96
Household vehicle access	0.31 ***	0.27 – 0.36	0.15 ***	0.13 – 0.17
Household Composition				
Children (age <5)	1.02	0.88 – 1.17	0.92	0.82 – 1.04
Students (age 5-12)	1.18 ***	1.08 – 1.29	1.07	0.99 – 1.16
Students (age 13-18)	0.82 **	0.70 – 0.95	0.84 **	0.75 – 0.95
Students (age 19+)	0.86	0.74 – 1.00	0.94	0.83 – 1.06
Full-time workers	1.04	0.93 – 1.15	1.01	0.92 – 1.10
Retirees	0.74 ***	0.64 – 0.85	0.81 ***	0.72 – 0.90
Other household members	0.90	0.78 – 1.04	0.97	0.87 – 1.09
Built Environment				
WalkScore (50-69)	1.66 ***	1.24 – 2.24	1.79 ***	1.41 – 2.27
WalkScore (70-89)	2.92 ***	2.20 – 3.90	2.66 ***	2.11 – 3.37
WalkScore (90-100)	5.18 ***	3.70 – 7.29	4.61 ***	3.51 – 6.09
Transit accessibility to jobs	1.02 ***	1.02 – 1.03	1.03 ***	1.03 – 1.04
Observations	22,040		22,040	
R^2 (McFadden)	0.19		0.30	
AIC:	8,036.86		10,812.88	
BIC:	8,148.87		10,924.89	

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

The second alternative is to set a threshold of the number of trips to be under 15 minutes and 30 minutes, the current alternative definition sets it at 65% of all trips. This alternative was modeled using the same sample of 22,518 households (Table 5). The model is generally consistent with the previous models, except for the highest WalkScore showing a much stronger impact of the built environment compared to previous models. In other words, providing an alternative definition that expands the 15 minutes or 30 minutes constraints to partially include the majority of trips, 65% and above in this case, provides professionals with more tools to reach these goals compared to the original 15-minute or 30-minute definitions.

Table 5. Model results for households with 65% or more trips meeting the 15-minute and 30-minute definition

	65% 15-min households		**65% 30-min households**	
Predictors	*Odds Ratio*	*CI*	*Odds Ratio*	*CI*
Intercept	0.03 ***	0.02 – 0.06	0.08 ***	0.06 – 0.10
Household Characteristics				
Income (per capita)	0.93 ***	0.90 – 0.96	0.96 ***	0.94 – 0.98
Household vehicle access	0.28 ***	0.24 – 0.33	0.13 ***	0.12 – 0.15
Household Composition				
Children (age <5)	1.38 ***	1.19 – 1.60	1.18 **	1.04 – 1.33
Students (age 5-12)	1.80 ***	1.64 – 1.98	1.50 ***	1.39 – 1.62
Students (age 13-18)	0.69 ***	0.56 – 0.84	1.02	0.90 – 1.15
Students (19+)	0.60 ***	0.49 – 0.74	0.87	0.76 – 1.00
Full-time workers	0.65 ***	0.57 – 0.74	0.80 ***	0.73 – 0.88
Retirees	0.95	0.81 – 1.11	1.00	0.89 – 1.12
Other household members	1.00	0.85 – 1.18	1.01	0.90 – 1.15
Built Environment				
WalkScore (50-69)	1.54 *	1.07 – 2.24	1.83 ***	1.39 – 2.41
WalkScore (70-89)	3.03 ***	2.16 – 4.30	2.84 ***	2.19 – 3.71
WalkScore (90-100)	5.49 ***	3.67 – 8.28	5.30 ***	3.92 – 7.23
Transit accessibility to jobs	1.02 ***	1.02 – 1.03	1.04 ***	1.03 – 1.04
Observations	22,040		22,040	
R^2 (McFadden)	0.22		0.34	
AIC:	6,159.69		9,779.13	
BIC:	6,271.69		9,891.14	

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

1.5 Conclusion

As political interest in adopting 15-30-minute city concepts gains momentum, policy makers must confront questions of how and for whom will this goal come to fruition. This research responds to this need by evaluating the current reality of local accessibility in Montréal to test the practicality of setting targets based on Carlos Moreno's popular concept of the 15-minute city. This study has shown that even when the 15-minute city planning paradigm is expanded to include public transit and to be defined by a larger travel time radius, the concept provides goals that are hardly reachable in the context of a large North American city. The main reason for this is that maintaining 100% of travel within a 15- or 30-minute travel time radius is not compatible with a wide variety of household structures. In this sense, increasing the number of households that are living the 15- or 30-minute city lifestyle is less related to planning or policymaking and more with varying household structures and their specific needs, which are not possible to modify through transport policy interventions. Therefore, striving for a city in which everyone conducts the entirety of their travel within 15 or 30 minutes from their home is not a useful target. This goal does not accommodate the actual variability of real travel behaviour and is more constricting than it is opportunistic. Cities interested in implementing an x-minute city planning approach must think critically about designing a framework that is both feasible and desirable in the local context.

This study has demonstrated the importance of accounting for household dynamics and travel behaviour in assessing the feasibility of policies aimed at fostering local lifestyles. However, due to the use of O-D survey data, there are some limitations in our analysis. For instance, the identification of 15- and 30-minute households was limited to using a one-day travel diary per household member, which doesn't allow to account for variability in travel between days. Additionally, the analysis was limited to using modelled travel time instead of observed travel time, which may introduce bias into the results. Finally, we could not account for the effect of residential self-selection on households' resulting travel patterns. For these reasons, future research on this topic would need to be conducted by using multiple-day activity-travel data which may be obtained, for instance, through GPS data. While this study used actual travel from an O-D survey, future studies can incorporate data from other sources to account for un-met transport needs to have a more nuanced understanding of the 15-minute or 30-minute city. Additional research can incorporate different measures of accessibility such as accessibility to healthcare by public transit and to retail jobs. Our preliminary analysis has shown these to be highly correlated with accessibility to all jobs by public transit.

Further research is also needed to assess these dynamics across other urban environments to examine the extent to which planning interventions aimed at fostering 15-30-minute cities are within reach, and how to tailor these approaches to best meet the needs of the target populations. Qualitative research is also needed to better understand residents' experiences and perceptions of their local neighbourhoods, including considerations of the comfort and adequacy of facilities for walking, cycling, and public transport, as well as the extent to which local amenities meet residents' needs and wants. Greater research and public engagement are also needed to explore the intersections of x-minute-city frameworks and issues of urban (in)justice, including potential changes to housing prices and affordability as well as the need to better integrate the perspectives of people with disabilities and other underserved groups in urban-policy discussions. By taking local particularities seriously, we hope to help move beyond one-size-fits-all approaches to the x-minute city, towards more contextualized strategies grounded in people's actual needs, lived experiences, and household realities.

Chapter 2: Where do People Travel Local?

2.1 Introduction and Background

The 15-minute city is a popular planning concept that has captured the attention of policy makers and the general public worldwide (TED Conferences, 2021). It's core definition—that everyone can meet their daily needs within 15 minutes of active travel (cycling and walking) from their home—is an easy-to-understand framework that offers an attractive vision for what cities could become (TED Conferences, 2021). For various city leaders around the world looking to combat chronic traffic congestion and overcome urban challenges magnified by the COVID-19 pandemic, the 15-minute city represented a promising path forward. Unlike traditional vehicle-oriented transport planning strategies, this approach prioritizes sustainable and accessible local travel. With an emphasis on walking and cycling, efficiency in transport is redefined to focus on proximity to destinations rather than fast travel speeds. In 2020, Paris became the first major city to incorporate the 15-minute city into its planning policy (Municipalité de Paris, 2022). Mayors around the world have followed suit in hopes of bringing the urban conviviality promised by the 15-minute city to their own cities (Gongadze & Maassen, 2023). In parallel there has been various efforts to apply a similar concept, yet with a much higher travel time threshold 30 minutes, known as the 30-minute City (Levinson, 2019).

While the 15-minute city has resulted in a wave of enthusiasm around improving local accessibility, questions remain unanswered about how this strategy, developed in the Parisian context, could be applied in other cities (Birkenfeld, Victoriano-Habit, Alousi-Jones, Soliz, & El-Geneidy, 2023). The concept of the 15-Minute was conceived in the early 2010s by French researcher Carlos Moreno. Developed in response to increasing automobile dependency, Moreno envisioned a future for cities where all social functions including work, food, health, education, culture, and leisure are conducted within a 15-minute travel time radius using walking and cycling modes (TED Conferences, 2021). What this definition does not make explicit is what it takes to achieve such vision. Most cities look very different than Paris and are characterized by unique built environments, travel patterns, and cultures. That's why Australian cities were advocating for other forms of x-minute city that fits their needs (Levinson, 2019; Stanley & Stanley, 2014). In North America, for example, development is rooted in the separation of land uses, with residential neighborhoods placed in distinct areas away from commercial and business activity (Scott & Storper, 2015). This has cultivated regional commute patterns that lengthen the travel times needed to reach desired destinations (Burd, Burrows, & McKenzie, 2021). It is clear that achieving any x-minute city requires a restructuring of both land use and transport systems. However, the aim of bringing all daily needs within a short walk or bicycle ride for every person in a city, is an impossible goal for many places. If the goal was softened to only strive for certain pockets of a city to achieve this lifestyle, who could afford to live there and who could not? For policy makers attracted to the 15-minute city concept, it is perhaps worth asking whether conducting all trips within a designated travel time is a helpful metric at all toward improving livability for residents, a question that has been raised by some recent research (Birkenfeld et al., 2023) calling for the 30-minute city as a more attainable goal in the North American context.

The purpose of this study is to assess the extent to which land use mix in the North American context aligns with the 15- and 30-minute city goals. This study expands on the work of Birkenfeld et al. (2023) by incorporating existing travel behavior to understand the presence of 15 or 30-minute city in Montréal Canada. Yet this study concentrates on identifying the destinations that meet the x-minute goal. The study identifies which parts of the region are frequented by residents who live nearby by active modes of transport (Cycling, walking, or public transit).

Given the historic separation of land uses that most North American cities are built upon, we are interested to learn what it looks like for neighborhoods to begin to break that mold and evolve toward more locally accessible landscapes. Findings from this study will help to clarify the baseline from which cities outside of Paris are starting from relative to the 15-or 30-minute city vision. It highlights how local accessibility at its best currently exists in a North American context and can help inform whether the 15 or 30-minute city goals are in fact good measures to strive for in the North American context.

2.2 Data and Methods

In this study, x-minute city activity is modeled using travel behavior reported in the Montréal Origin-Destination (OD) survey. The survey is administered every five years by the regional public transport planning authority and our analyses draw from the 2018 edition, which is the most recently available. Data represents a 5% random sample of Montréal households, including a one-day weekday travel diary of every household member. Each observation represents one trip, with origin and destination data provided as latitude and longitude values. The survey collects sociodemographic information at the personal and household level, and a travel-based weighting factor is provided for every trip as an estimated projection of the number of trips it reflects in the region.

The OD data are used to explore the spatial distribution of 15- and 30-minute travel patterns in the Montréal region. For the purposes of this study, an x-minute trip is defined as a trip that was completed using walking, cycling, or public transit modes within the x-minute travel time threshold. First, each trip in the survey is evaluated for its compatibility with the x-minute trip definition. A spatial analysis of trip destinations is then conducted to locate areas that are particularly conducive to travel as defined by the 15- and 30-minute city concepts. Our goal is to identify and compare areas that are cultivating local travel patterns to those that are more regionally serving. Land use, household income, and population density data are analyzed to gain further insight into factors that characterize the most locally accessible areas.

2.2.1 Data Preparation

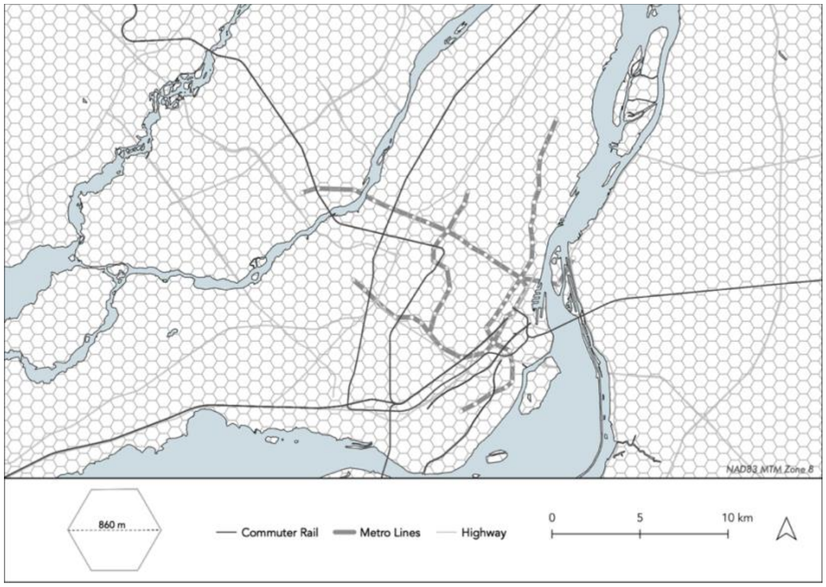
The survey data was first filtered to represent households that conducted all travel within the Montréal metropolitan area boundary. Trips were removed from the sample if the origin and destination locations were identical, trip details were missing, or other variables such as income were not reported. Because our analysis focuses on identifying local and regional destination hot spots, trips were removed if the trip purpose was "return home". Trips indicating modes other than walking, cycling, public transit, or driving were excluded because travel times could not be estimated accurately.

The x-minute city definition was then used to classify each survey trip as a 15-minute trip, 30-minute trip, or neither (all 15-minute trips were also labeled as 30-minute ones). To meet the definition, a trip must be completed within the given travel time threshold by walking, cycling, or public transit modes. Travel times between each origin-destination pair were produced through network routing using the r5r package in R, supported by sidewalk, bike lane, and roadway data from Open Street Map (OSM). For trips completed by walking or cycling, travel times were estimated using travel speeds of 4.5km/h and 16km/h, respectively (El-Geneidy, Krizek, & Iacono, 2007; Silva, da Cunha, & da Silva, 2014). Public transit trips were routed through a network comprised of the OSM and General Transit Feed Specification (GTFS) data from all public transport agencies providing service in the study area. The r5r tool was used to calculate public transit travel times based on this network and the departure timestamp recorded for the given trip (Pereira, Saraiva, Herszenhut, Braga, & Conway, 2021). The OSM and GTFS files were downloaded from 2019 and public transport trips were simulated for Tuesday April 23rd, 2019. To our knowledge, no significant road network changes or public transport service adjustments occurred between the time of the survey and the date the travel time routing data was sourced. Travel times for car trips were not calculated as these trips were not completed using one of the qualifiable modes defined by the x-minute city framework and were automatically labeled as non-15- and 30-minute trips. Through the travel time calculations procedure, trips were removed from the sample if they had OSM network routing issues. The final cleaned sample totaled 146,556 trips including: 13,379 15-minute trips and 133,177 non-15-minute trips; 24,361 30-minute trips and 122,195 non-30-minute trips.

2.2.2 Spatial analysis

To assess the distribution of trip destinations, a hexagonal grid was produced over the greater Montréal area to represent units of equal geographic size. Each hexagon measured about 860 meters across, or just over half a mile. This size was selected because it represents a reasonable local walking distance.

Figure 4. Montréal region overlaid with hexagonal grid.

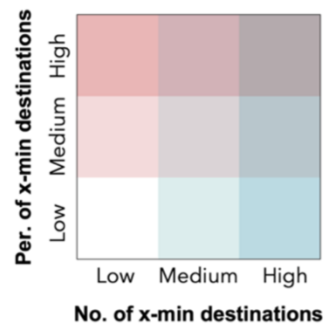


The trip destinations from the cleaned OD data were joined to the grid to count the number of trips ending in each hexagon. The travel-based weighting factors associated with the trips were used to scale each count to a region-wide travel estimate. Hexagons with fewer than 20 trip destinations from the OD survey were removed due to thin data. The number of hexagons with 20 or more sample trips totaled 1,496.

Two metrics of x-minute city behavior were created based on this data. The first represents the number of 15- and 30-minute trips ending within the bounds of each hexagon. The second assigns a percentage based on the proportion of 15- or 30-minute trips ending in each hexagon compared to all trips ending in the hexagon. These variables provide different perspectives into measuring success toward the x-minute city goal; the former evaluating the quantity of local activity and the latter focusing on relative travel behavior. We then combined the two metrics into a bivariate variable to capture the interaction between them. To produce the bivariate variable, each of the two metrics were divided into three bins. Hexagons were labeled with one out of nine categorical values based on the combination between the two sets of low, medium, and high bins.

Figure 5. Bivariate variables

Bin	Number of x-minute trip destinations	Percent of x-minute trip destinations
Low	100 - 500	5% - 15%
Medium	500 - 2,000	15% - 40%
High	2,000 +	40% +



2.2.3 Land use analysis

With the hexagons reclassified based on magnitude and proportion of x-minute city activity, we analyzed the land use distribution across each hexagon type. Land use data were obtained from the Communauté métropolitaine de Montréal (CMM) open data portal (Montréal, 2021). The CMM data are compiled from various public data sources across the region, reflecting land use designations at the most precise geographic area available. The land use designation of each geographic unit corresponds to the primary land use assigned as identified by public records from the given year. It is possible for secondary uses or uses not mentioned in the records to be excluded from the CMM database. For this study, historical land use designations from 2018 were used to align with the 2018 OD survey data.

Analyzing land use against the 15- and 30-minute city metrics helps address our research aim of identifying characteristics of the most locally accessible areas in Montréal through the x-minute city lens. To do so, the land use data were merged with the hexagonal grid and divided by hexagon-type according to the bivariate legend (for both the 15- and 30-minute thresholds). We focused on the hexagon types represented by the four corners of the legend to capture differences among areas with the highest and lowest extents of x-minute activity. For each of the eight hexagon-types (four for each of the 15- and 30-minute analyses), the total land area dedicated to each use was summed and divided by the total land area of all hexagons in the category. The output of this analysis allowed for a look into differences in land use proportions among areas that are the most locally and regionally serving.

2.2.4 Census variables

Census data was used to further investigate the socioeconomic characteristics of these areas. The cancensus package in R was used to draw household median income and population density from the 2021 Canadian Census at the census tract level. The mean values of these variables were calculated for every cell in the hexagonal grid, weighted by the proportional land area of each census tract in the given hexagon. Household median income and population density were then grouped and averaged for each of the hexagon type defined in the bivariate legend.

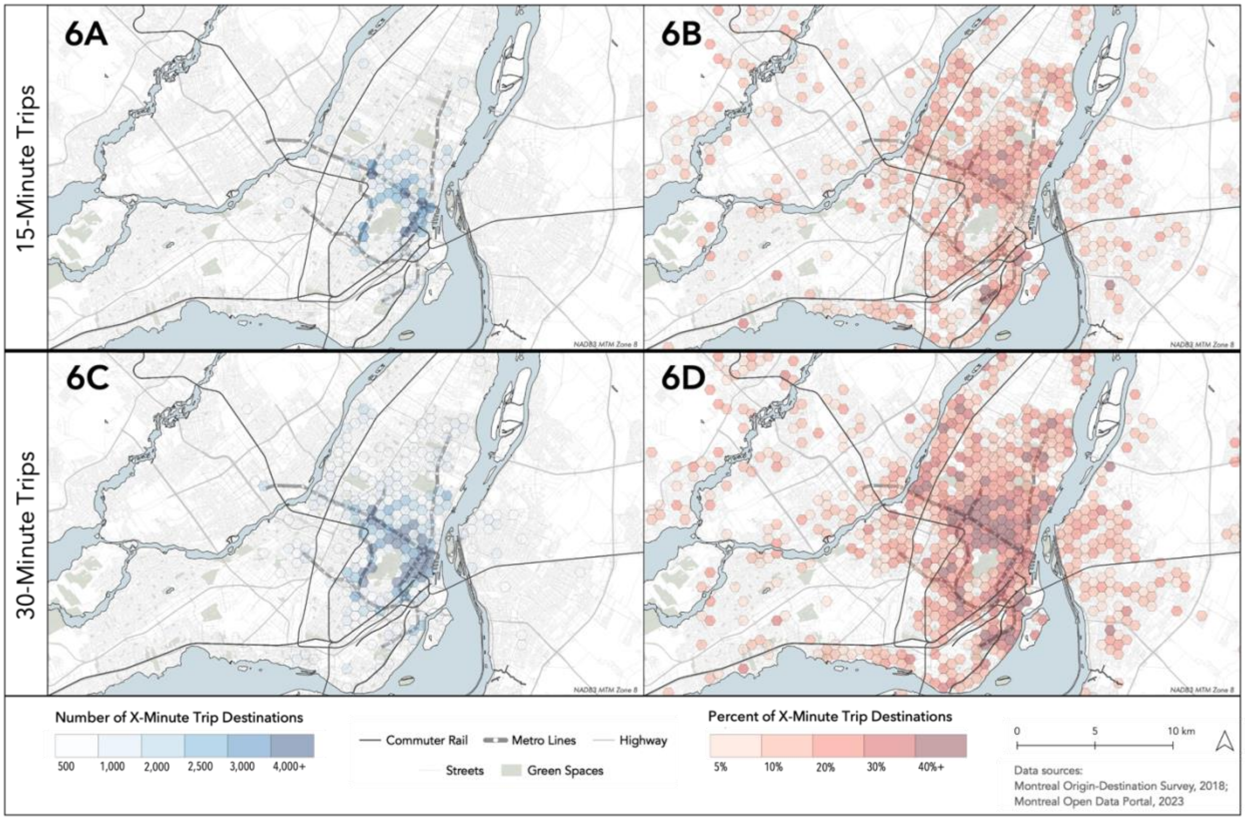
2.3 Results

2.3.1 X-minute city metrics

The results based on the first x-minute city metric reveal high concentrations of 15- and 30-minute trip destinations in areas with frequent public transit. Hexagons shaded in the darkest blue in Figure 6 represent areas that attracted 4,000 or more x-minute trips. Trips that align with the 15-minute city definition occur most frequently in downtown Montréal, dense neighborhoods northwest of downtown, and near metro line junctions (Figure 6A). Trip distribution assessed against the 30-minute threshold follows a similar pattern and reveals more hexagons with high trip counts (Figure 6C).

The second metric, calculated as the percent of x-minute trip destinations compared to all trip destinations, points to very few areas that have high proportions of 15-minute trips (Figure 6B). The darkest red color marks areas where almost 1 out of every 2 trips ending there align with the x-minute trip definition. Downtown, which has some of the highest counts of 15-minute trips, has notably low proportions of local activity. This is to be expected since it is a major job and commercial hub that attracts travel from across the region. The mixed-use neighborhoods to the northwest and south of downtown tend to have at least 10% 15-minute city activity, with a couple hotspots reaching 40% or more. For the 30-minute threshold, consistently high proportions of qualified trips extend along and surrounding the metro lines to the northwest and south of downtown (Figure 6D). Some additional areas with 40% or more 30-minute trips arise to the north and southeast along the metro lines. For both the 15- and 30-minute analyses, local activity is concentrated around the center of the city, while surrounding suburban areas indicate very low proportions.

Figure 6. The number (blue) and proportion (red) of x-minute trip destinations ending in each hexagonal area, based on the 2018 Montréal Origin-Destination one-day weekday travel survey. The top two maps measure against the 15-minute threshold and the bottom two maps use the 30-minute threshold.



2.3.2 Bivariate analysis

Combining the trip count and percentage metrics into a single variable offers a view into the interaction between density and local activity. This bivariate measure differentiates areas based on the x-minute city framework to help us understand what the 15- and 30-minute city looks like in different parts of the city. In Figure 7 (15-minute threshold) and Figure 8 (30-minute threshold), the dark purple color highlights areas that have the highest number and highest percentage of x-minute trips. Hexagons with this classification represent the densest and most locally-serving parts of Montréal. There are 3 hexagonal areas that meet the 15-minute definition of this category and 33 that meet the 30-minute one. The areas in dark red also have high proportions of x-minute trips but they have significantly lower trip counts. These areas most likely represent medium- to low-density residential neighborhoods with a few small commercial establishments that don't attract customers from far away. There are 6 of these hexagons on the 15-minute map and 12 on the 30-minute one.

Since "return to home" trips are removed from the calculations, the results of the bivariate analysis reveal how well destinations in each hexagon serve the local community. As such, even though areas marked in dark red have high proportions of x-minute city activity, the low counts of these trips indicate they are likely not accommodating a diversity of needs. On the contrary, areas marked in dark purple have both high counts and high proportions of x-minute activity, signaling that more trips are being accomplished locally. This positions areas in dark purple to be the parts of Montréal that are the most aligned with the x-minute city concept.

Hexagons depicted in white are the least compatible with x-minute city concept. These areas have low numbers of x-minute trips and low proportions of them. This kind of travel behavior is indicative of locations that attract automobile travel and trips longer than the x-minute travel time. The dark blue shaded hexagons are also characterized by low proportions of x-minute trips, but they attract a high number of them. In the 15-minute bivariate analysis, downtown Montréal is the most prominent hub of this kind of activity. It is an area that attracts travel from across the region while also offering a plethora of destinations that can be reached via a short walk, bike ride, or public transit trip from within.

Figure 7. Bivariate analysis of 15-minute trip destinations ending in each hexagonal area.

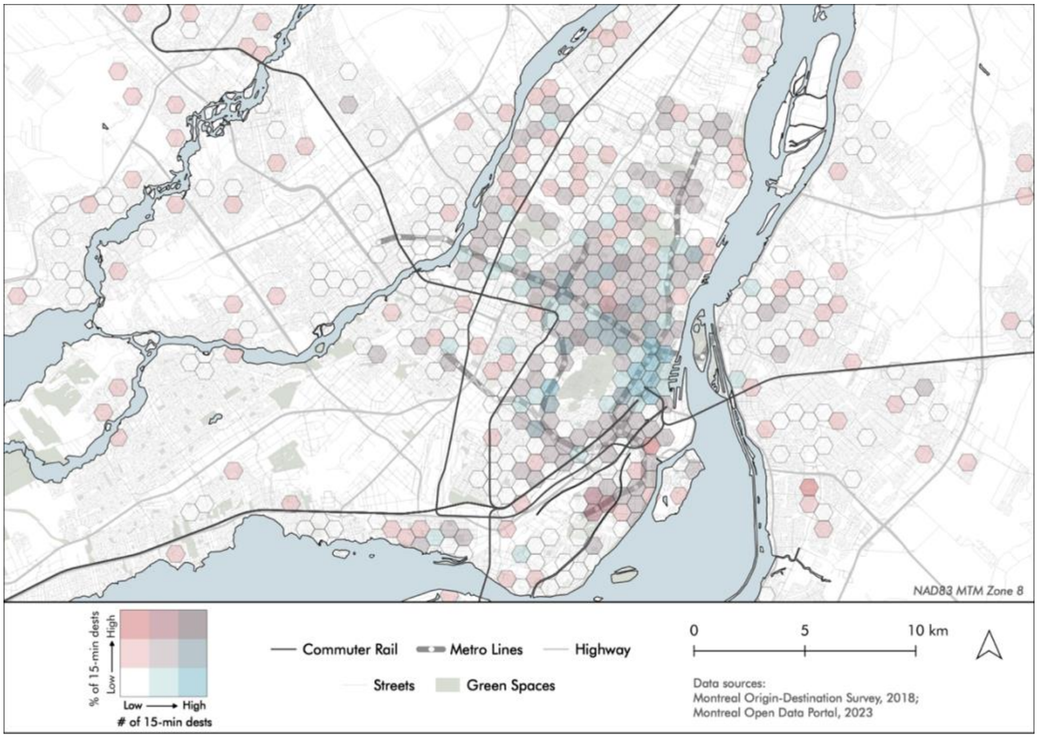
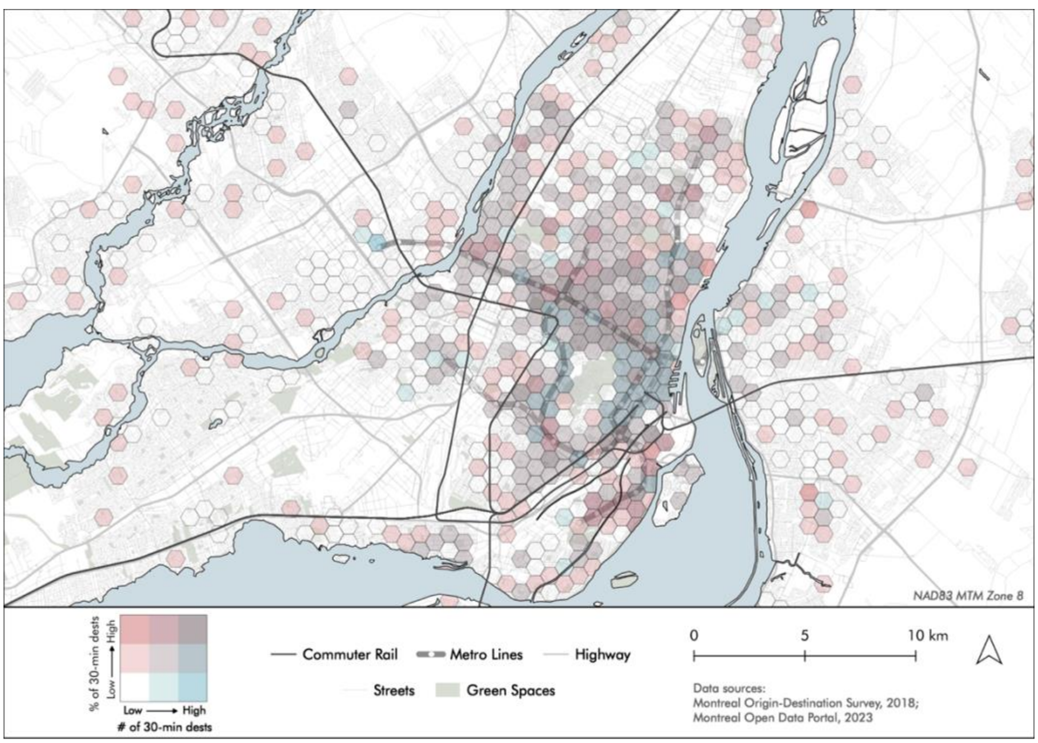


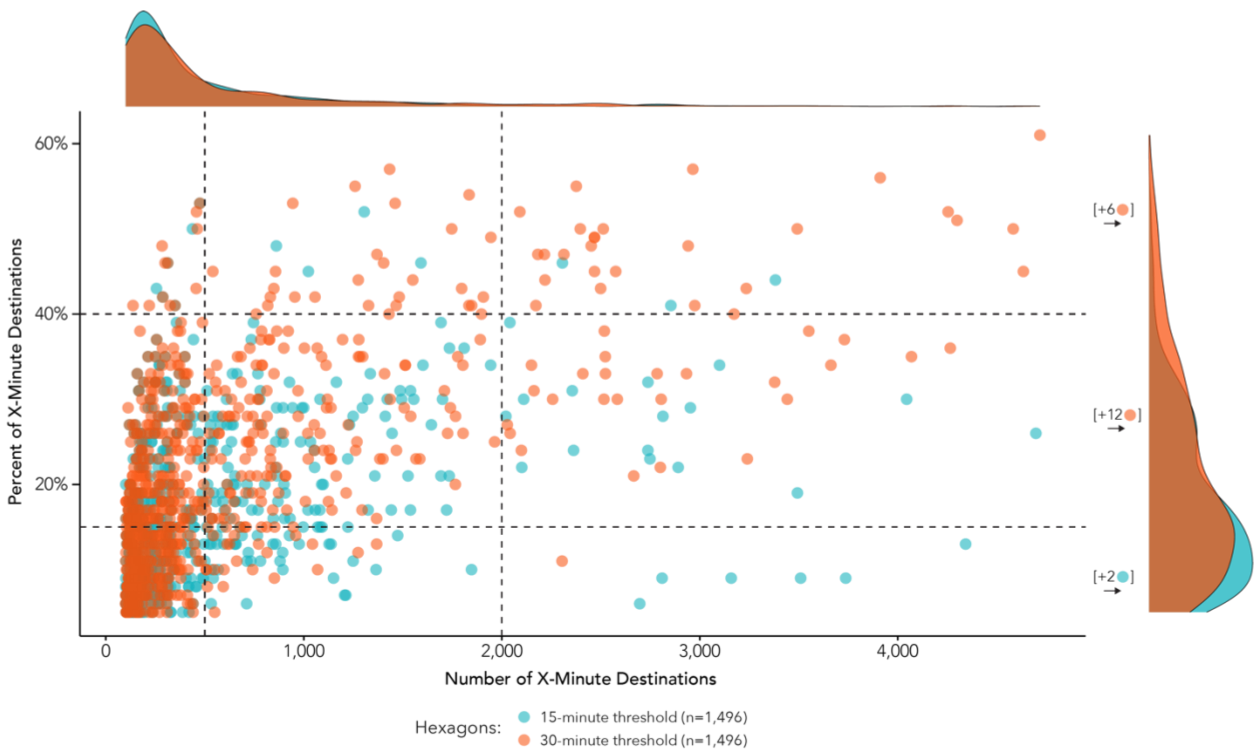
Figure 8. Bivariate analysis of 30-minute trip destinations ending in each hexagonal area.



In addition to the spatial visualization, it is helpful to consider the distribution of hexagonal areas across the two metrics. Figure 9 presents a two-dimensional histogram with the number of x-minute trip destinations on the x-axis and the percent of x-minute trip destinations on the y-axis. Hexagons measured against the 15-minute threshold are displayed in blue and the 30-minute threshold is depicted in red. Dotted lines are drawn to delineate the low, medium, and high bins represented in the bivariate legend. The graph indicates a high concentration of hexagonal areas that have a low number and low percent of x-minute trips, also depicted in white on the bivariate maps. This type of travel behavior reflects common land use and transport patterns in many North American cities, characterized by separated land use and automobile dependency. The points that fall in the eight other sections of the graph represent parts of the city that are challenging this traditional land use and transport arrangement to support smaller scale travel. The points in the top three sections of the graph, also seen in dark reds and purple on the bivariate maps, reflect areas of the city that are cultivating travel patterns that most closely align with x-minute city goals—that is, to provide an environment where residents meet all their daily needs within x-minute travel radius using sustainable modes. However, it is worth noting that none of the hexagonal areas are anywhere close to achieving the 100% x-minute city that aligns with the original definition of the concept. Areas with the highest proportions of local travel reach between 40-50% when measured against the 15-minute threshold and approach 60% against the 30-minute threshold.

These figures beg the question of whether it is feasible or even desirable to aim for the 100% x-minute city target. As cities around the world implement the x-minute city concept, it is important to consider what kind of urban environment this goal represents and how it aligns with the existing land use and transport context in diverse settings. Perhaps in Montréal, a 40% or 50% x-minute city environment represents the most achievable and ideal manifestation of local accessibility. These results point to the value of looking toward current travel behavior to understand what the x-minute city means in different contexts and to create more locally informed x-minute city targets.

Figure 9. Two-dimensional histogram of bivariate metrics.



2.3.3 Land use assessment

Land use policy, which determines the spatial arrangement of people and places, has a major impact on travel behavior and accessibility. A city's ability to plan for better local accessibility relies on strategic zoning decisions that support shorter travel distances. Using the x-minute city categories defined by the bivariate legend, land use data is assessed within each hexagonal area to understand the relationship between land use and travel patterns in Montréal. Figure 10 presents the zoning designations of hexagon samples from each of the four corners of the bivariate legend measured against the 15-minute travel time threshold. Zoning designation samples that align with the 30-minute city bivariate categories are displayed in Figure 11. Areas that attract high counts and percentages of x-minute trips (category B), tend to have smaller land parcels, finer grain zoning designations, and more grid-oriented street networks. Categories A and C, which have the lowest counts of x-minute trips, appear to have larger allocations of low-density housing. While all samples include some office/institutional spaces, categories C and D have particularly sizable areas designated for this use.

Figure 10. Zoning designations of sample hexagonal areas that correspond to the 15-minute city bivariate categories.

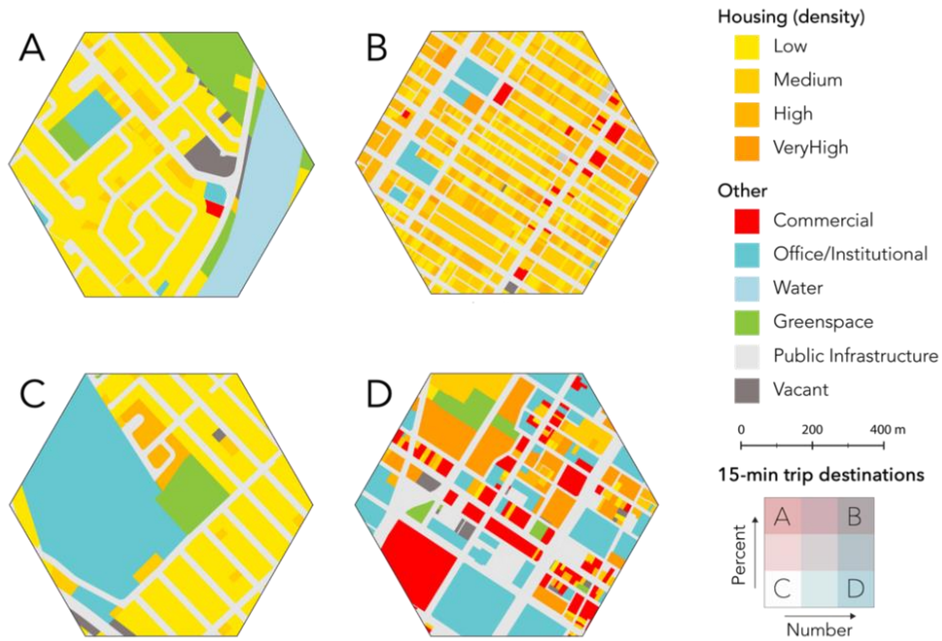


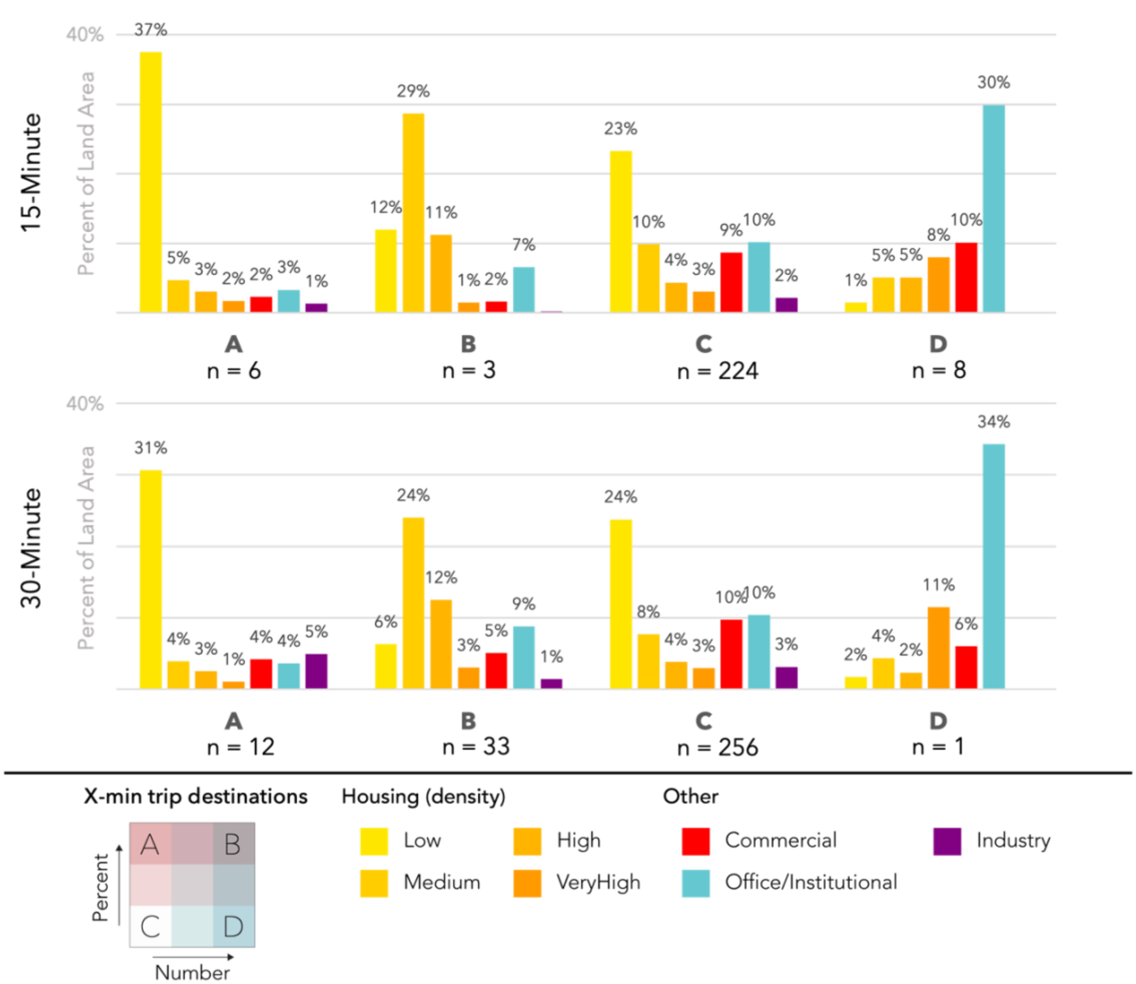
Figure 11. Zoning designations of sample hexagonal areas that correspond to the 30-minute city bivariate categories.

The total land area of all hexagons within each bivariate category were then grouped and analyzed in Figure 12. The “n=” below each graph indicates the total number of hexagonal areas that align with that category of the legend. Note that the land area percentages do not add up to 100% because some zoning designations were removed from the graphs (including public infrastructure, agriculture, golf, greenspace, water, and vacant space) for simplicity.

In this visualization, land use distinctions between areas that are and are not locally accessible become clear. Most notably, hexagonal areas that most closely align with x-minute city goals (category B) have proportions of medium- and high-density housing that are not observed in any other area. This pattern is consistent across both the 15- and 30-minute analyses. Category A hexagons have similarly high proportions of x-minute trips as seen in category B, however, the exceedingly high rates of low-density housing in these areas lead to lower counts of x-minute trips. Category A represents the highest degree of land use separation, with low rates of any use other than low-density housing. Although these areas cultivate local accessibility in terms of percent x-minute trips, they are unable to serve a diversity of needs and they encourage car use.

Category C demonstrates a similar emphasis on low density-housing. However, the larger proportion of land allocated toward commercial and office/institutional uses attracts more travelers who spend greater than x-minutes to get there and/or commute by car. The high number of hexagons that align with category C speaks to the land use reality of separated uses and car dependency that characterizes much of Montréal. Category D hexagons have the highest proportions of very high-density housing and office/institutional. As major job and commercial hubs, these areas attract travelers from around the region while also serving the needs of residents living within.

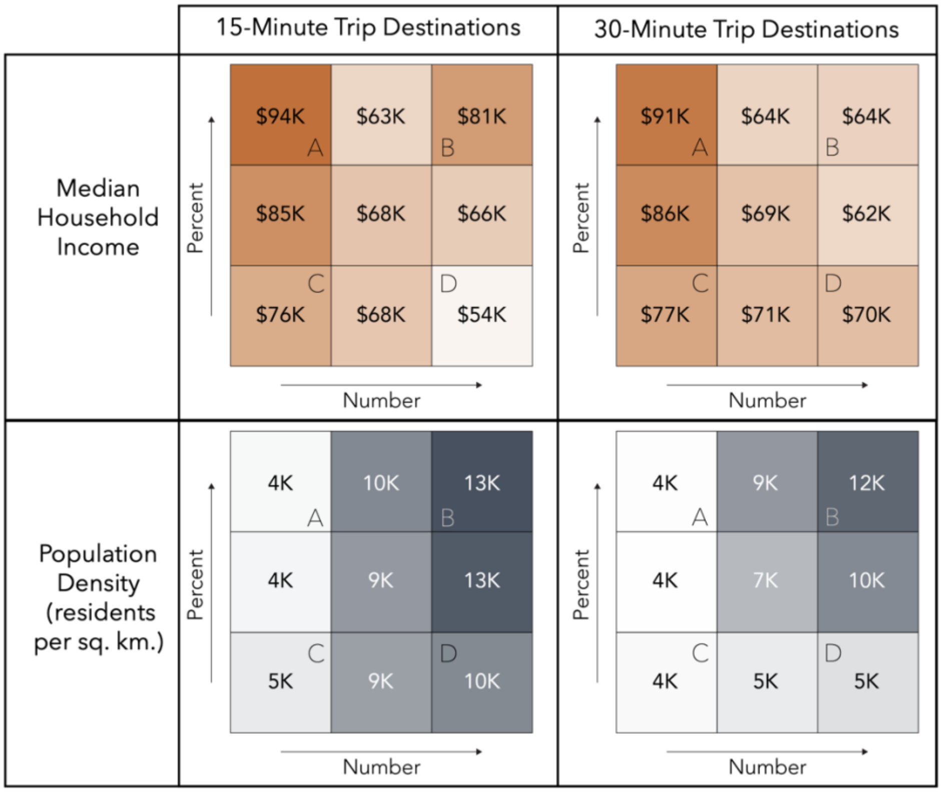
Figure 12. Land use allocations within areas corresponding to each bivariate category.



2.3.4 Income and population density

Despite having some of the lowest rates of very high-density housing, category B areas have the highest population density of all hexagon types (Figure 13). The high rates of medium- and high-density housing in category B paired with destinations and transport systems that cater to nearby residents creates some of the most densely populated and locally-serving environments in the city. Interestingly, 15-minute category B hexagons have a significantly higher median household income compared to 30-minute category B hexagons. This implies that the 15-minute city target in Montréal is more aligned with higher income lifestyles while the most accessible 30-minute areas are enjoyed by a more diverse socioeconomic population. Category A areas are home to some of the highest earning households in Montréal.

Figure 13. Average median household income and population density, by bivariate category



2.4 Conclusion

While the x-minute city concept offers an attractive vision for the future of cities, little is known about what it means to achieve this goal in different global settings. Our study addresses this question by analyzing observed travel behavior and land use data to explore how the x-minute city model can be used to understand local travel patterns in the North American city of Montréal. Our aim was to identify which parts of Montréal are most conducive to x-minute city activity and determine whether this planning framework is a helpful tool to create a more locally accessible city. Findings show that very few areas of Montréal currently attract the type of trips that align with the 15- and 30-minute city. This is largely attributed to the fact that most North American cities were developed with intentionally separated land uses, which lengthen travel times. There are, however, distinct land use patterns that characterize the parts of Montréal that have the most x-minute city activity. These areas have the highest rates of medium- and high-density housing in the city.

Our findings demonstrate the importance of looking toward local travel behavior to create contextually informed x-minute city targets. In the areas that most resemble the x-minute city in Montréal, around 40-60% of all trips ending there were completed in x minutes or less using walking, cycling, or public transit. These rates represent what the highest degree of local accessibility looks like in Montréal and could serve as a feasible goal for other areas of the city. This study also expands the original definition of the 15-minute city to include public transit and assesses the larger travel time threshold of 30 minutes. The 30-minute target proves to be more economically equitable than the 15-minute one, which in Montréal is more aligned with higher income lifestyles. This study is not intended to propose the best x-minute city metrics for Montréal, but to instead challenge the idea that the original concept is universally applicable. Policy makers interested in implementing the x-minute city framework should first gain an understanding of the travel behavior landscape in their region to learn how to cultivate local accessibility and guide x-minute city plans and metrics.

The use of OD data comes with certain limitations in our analysis. The Montréal OD survey samples a one-day weekday travel diary from respondents, meaning our analysis does not account for weekend travel nor for variability in travel over multiple days. Additionally, the analysis was limited to using modelled travel time instead of observed travel time, which may introduce bias into the results. Future research on this topic would benefit from data based on a multi-day activity-based travel diary. There are many opportunities for future research to build on the findings from this study. Using more detailed information about destination types and trip purposes would provide more insight into the specific mix of establishments that characterize the most locally accessible areas. Future work may expand the bivariate metric developed in this study to account for diversity of trip types to capture the ability of different areas to serve a range of needs. Measuring x-minute activity based on the trip origins would add further depth to the destination-based analysis presented here.

Conclusion

The x-minute city, defined by its original parameters, is incompatible with cities in the North American context. The land use development, travel patterns, and spatial income distribution of these areas create distance between the measured goals of the x-minute city and the reality of local accessibility. Policy makers interested in the x-minute city framework should look toward the existing land use and transport landscape to develop contextually informed x-minute city plans and metrics. Travel behaviour data is an effective resource that can be used to understand the how current travel patterns relate to the x-minute city framework and can reveal new perspectives into conceptualizing local accessibility.

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