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Residential choice and sustainability
Comparing people and place performances in sprawled city

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RÉSUMÉ

Cette thèse examine la performance de durabilité du comportement des ménages et les compare à leur lieu de résidence. Elle porte sur un sujet novateur et important. Les résultats apportent un éclairage singulier sur la complexité des liens qui unissent comportements résidentiels et des milieux de vie en matière de durabilité. Dans le but d'identifier les variables pour évaluer la durabilité du comportement, elle étudie les preuves scientifiques. Les résultats montrent que les indicateurs utilisés le plus souvent pour évaluer la durabilité des lieux de résidence représentent l'environnement bâti en relation avec sa forme, avec ses fonctions et avec sa densité, ainsi que ses caractéristiques socio-économiques. Pour évaluer la durabilité du comportement, des indicateurs multiples de différentes natures sont utilisés. Ces derniers sont environnementaux, sociaux, économiques et les modes de transport de la mobilité quotidienne, ainsi que l'espace et le temps parcourus. Les liens trouvés entre la performance de durabilité des lieux et les comportements sont décrits comme correspondant ou ayant un manque de congruence. Un cadre d'inventaire est proposé pour aider à étudier la performance du choix résidentiel concernant les trois piliers de la durabilité. Pour ce faire, un groupe de 740 ménages, avec au moins un répondant travaillant à temps plein, est analysé. La base de données est «Demain Québec» : un sondage en ligne réalisé auprès des résidents de la région métropolitaine de Québec, et ce, détaillant leurs profils socioéconomiques, résidences et caractéristiques de mobilité. Pour évaluer la durabilité du comportement, une analyse en composante principale est effectuée sur 20 variables. Six facteurs représentant 74,9% de la variance sont extraits. Ils sont les suivants: 1) la dépendance au véhicule, la distance globale parcourue, et les coûts économiques 2) l'intensité globale d'activité, 3) l'intensité d'activités récréatives et les distances parcourues, 4) l'intensité d'activités de magasinage et les distances parcourues, 5) les distances parcourues dans les transports en commun et les dépenses temporelles et 6) les dépenses de logement et les distances parcourues moyennant le transport actif. Ces facteurs sont soumis à l'analyse Two-step Cluster conduisant à l'identification de sept profils comportementaux: « Immobile Shoppers », « Immobile Recreationist using Public Transport », « Savers-on-Time and Spenders-on-Housing », « Mobile Individuals using Public Transport », « Mobile

Individuals using Active Transport », « Hypermobile Shoppers using Car », and « Recreationist using Car ».

Pour évaluer la performance de durabilité des lieux et pour la comparer aux profils de comportements, nous utilisons le Walk Score. Pour certains profiles, les résultats confirment la correspondance entre la performance des lieux et des ménages, alors que pour d'autres, l'influence de la localisation semble être perturbée par les caractéristiques socio-économiques des ménages. Dans certains groupes, ces indicateurs ne tiennent compte ni de la congruence ni de la discordance entre la durabilité du lieu et de la durabilité du comportement. Ce sont plutôt les activités dominantes des ménages par rapport à l'endroit où elles se déroulent qui jouent un rôle crucial dans la prospérité durable. Dans la dernière étape, la thèse examine la désirabilité de choix résidentiels durables conçue comme satisfaction acquise et aspiration future. Cet examen se base sur les typologies comportementales développées à l'étape précédente. Les résultats montrent que des choix résidentiels à la fois durables et désirables sont possibles. Cependant, les ménages qui font de tels choix sont moins satisfaits de la verdure, de la tranquillité, de l'ambiance, de la sécurité et des caractéristiques des voisins. En outre, les sources d'insatisfaction ne constituent pas nécessairement les intentions de déménagement. Les principales raisons de déménagement sont souvent liées au désir de devenir propriétaire ou d'avoir accès à une résidence plus grande. Pour ce qui est des choix de logements, les ménages tiennent surtout compte des caractéristiques environnementales qui correspondent à leurs besoins et à leurs objectifs à un stade particulier de leur vie et à leurs activités dominantes. Bien que le milieu bâti joue un rôle majeur dans la réalisation de choix durables et désirables, les ménages sont les protagonistes de l'amélioration de la prospérité durable.

Mots-clés : Choix résidentiel, Comportements des ménages, Performance de durabilité, Enquête quantitative, Analyse typologique

ABSTRACT

This thesis examines the sustainability performance of households' behaviors and compares it to their place of living. This thesis deals with an innovative and important subject. The results shed light on the complexity of the links between residential behaviors and the living environment regarding sustainability behaviors. With the aim of identifying variables to evaluate behavioral sustainability, it investigates the scientific evidence. The results show that the indicators frequently used to assess the sustainability of the places depict the built environment regarding its form, functions and density, and its socio-economic features. To evaluate the behavioral sustainability, multiple indicators are used of different natures, that is, environmental, social, economic, and transport modes related to daily mobility, as well as traveled space and time. The links found between sustainability performance of places and behaviors are described as matching or lacking congruity. An inventory framework is proposed to help to study the performance of residential choice concerning the three pillars of sustainability. Applying this framework, a group of 740 households with at least one respondent working full-time is analyzed. The database is « Demain Québec » an Internet survey of residents of the Quebec City metro area detailing their socio-economic profiles, residences and mobility characteristics. To assess the behavioral sustainability, a principal component analysis is performed on 20 variables. Six factors are extracted accounting for 74.9% of the variance. They are as follows: 1) Car dependency, global travel distance, and economic costs, 2) Global activity intensity, 3) Recreational activity intensity and travel distance, 4) Shopping activity intensity and travel distance, 5) Travel distance in public transport and global travel time costs, and 6) Housing expenditures and global active transport distance. These factors are put on to a two-step clustering analysis leading to identification of seven behavioral profiles: « Immobile Shoppers », « Immobile Recreationist using Public Transport », « Savers-on-Time and Spenders-on-Housing », « Mobile Individuals using Public Transport », « Mobile Individuals using Active Transport », « Hypermobile Shoppers using Car », and « Recreationist using Car ».

To assess the sustainability performance of places and to compare it to the profiles of behaviors, we use the neighborhood Walk Score. The results confirm the correspondence between place and people's performance for some profiles, while for the others, the influence

of location seems to be interfered by socio-economic characteristics of households. In some groups, neither these indicators do not account for the fitness or discrepancy between the both. It is rather the households' prevailing activities in relationship with the location in which they go on that plays a crucial role in sustainable prosperity. In the final step, the thesis examines the desirability of sustainable residential choices, understood as satisfaction-with and aspiration for, based on the behavioral typologies developed in the previous step. The results show residential choices that at once sustainable and desirable are possible. However, households who make such choices are less satisfied with the greenery, quietness, and ambiance, security, and characteristics of neighbors. Also, sources of dissatisfaction does not necessarily drive the moving intentions. The main reasons for moving are often connected to the desire to become a homeowner or having access to a larger residence. On their residential choice decisions, households regard mostly the environmental features which are in accordance with their needs and goals at a particular stage in their life's course, as well as their dominant activity. Although the built environment plays a major role in the achievement of desirable sustainable choices, the households are the protagonist in enhancing sustainable prosperity.

Keywords: Residential choice, Household behaviors, Sustainability performance, Quantitative survey, Cluster analysis

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In dedication to my family with love

ACKNOWLEDGMENT

CHAPTER 1
INTRODUCTION

1.1   Research problems and questions

In North America, we observe a trend in residential choice with a steady increase in the size of houses (despite shrinking households) and the expansion of low-density residential neighborhoods away from the city centers (Schor, 2010). The resulting urban sprawl is an acute phenomenon in the Quebec metropolitan area where suburban expansion is ongoing since WWII. Several related sustainability problems have been associated with this territorial expansion at the environmental level (e.g. ecosystem degradation), the social level (e.g. lack of proximity services) and the economic level (e.g. costs of urban infrastructure and local services) (Després, Brais, & Avellan, 2004; Lovejoy, Handy, & Mokhtarian, 2010) . Urban planners and policymakers are proposing and implementing measures to increase public transport services, develop eco-friendly neighborhoods as well as densify existing ones. Among these measures, providing diverse and sustainable housing, taking into account the needs and financial resources of households has become an issue in policy making (Société d'habitation du Québe, 2011). Despite the presumed detrimental role of suburbia in the realization of sustainable development, many households are attracted by the suburban life for different types of reasons. A first one comprises micro-level factors influencing the decision-making process at the scale of households, e.g. the relationship with nature, experiences of past homes, distance to the workplace and the geography of social ties (Fortin & Després, 2009;   Kährik, Leetmaa, & Tammaru, 2012; Vidal & Kley, 2010). A second type corresponds to macro-level structural factors such as the housing market and offer, namely in suburban areas (Kährik et al., 2012). The metropolitanization of cities creates at once concentration and dispersion, polarization and urban diffusion of activity centers, as well as territorial fragmentation (Gaussier, Lacour, & Puissant, 2003). The traditional city/suburb distinction becomes blurry, which makes it more complex to apprehend households' housing choices. The interposition of different factors leads to residential choices with varying levels of sustainability. In such wise, this thesis examines the sustainability performance of residential choices among different households living in different types of settlements in the Quebec metro area.

The sustainability performance of a residential choice is composed of two dimensions (Figure 1.1): first, the objective characteristics of the neighborhood and their compliance with the sustainability criteria; second, how people use their environment outside the home on a daily basis with regard to work, family and consumption (Enaux, Lannoy, & Lord, 2011). In sprawled cities, even though some employment is available in the neighborhood of residence, two spouses in the same household are very likely to work elsewhere. The same holds true for kindergartens and schools, while their children attend them somewhere else, or for groceries they may choose to shop elsewhere on the way home from work. On the other hand, other households in the same neighborhood may take advantage of all these local amenities. Living in the same neighborhood (with the same sustainability performance), these two households would have two different behavioral performances (influenced namely by green gas emissions associated with driving or walking). It is this complexity of residential choices and the contradictions that emerge regarding sustainability that lies at the heart of this thesis.

This thesis aims at answering the following general questions: How sustainable are the residential choices of the many households living and working in a metropolitan area? To what extent the choice of an inner-city neighborhood is more "sustainable" compared to one on the outskirt? How can this be measured? How much is associated with the objective characteristics of the neighborhoods compared to lifestyle choices? In a more specific way, the following questions need to be answered: What types of behavioral profiles co-exist in the Quebec metro area with regard to residential choices? Where are the households belonging to theses profiles located? How congruent are household patterns of behaviors with the characteristics of their residential environment, with respect to sustainability? If a mismatch is observed, how can it be explained?

Recognition of micro and macro level factors of the phenomenon of metropolitanization and of the two aspects of residential choice would evoke the hypothesis that, at the level of household, the contribution of residential choice (involving both place and people's behaviors) may be equal or higher than the place (residential environment), with regard t sustainability achievement.
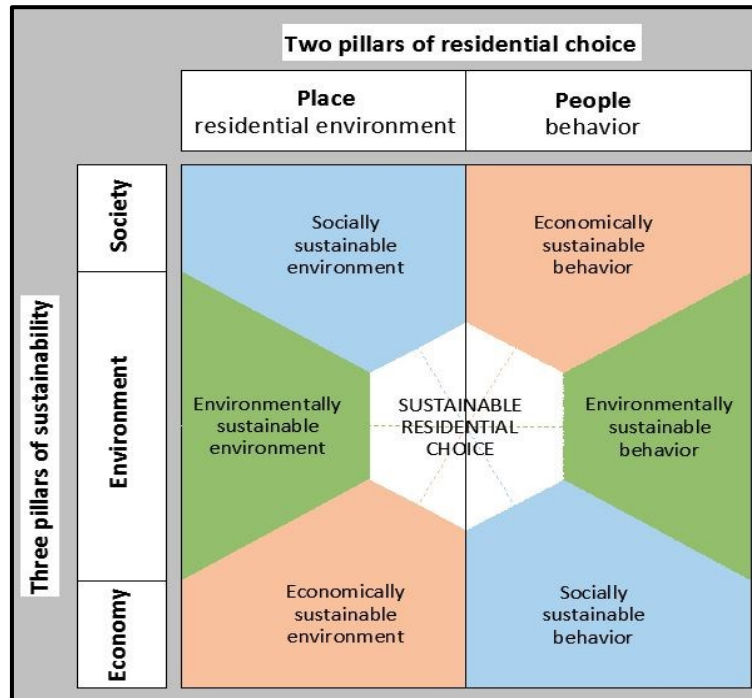
Figure 1.1   Elements of sustainable residential choice

1.2   Research aims and objectives

This study attempts to clarify the degree of congruence between the levels of sustainability of the residential environments where people live and of their out-of-home associated behaviors. Only regular daily activities associated with work, school, and consumption will be considered in the measurement of the ecological footprint (e.g. traveling, energy saving or recycling habits, consumption of organic products will be excluded). Furthermore, residential choice will be considered only at the neighborhood scale even though this concept encompasses the dwelling unit. A range of explanations that may account for the degree of correspondence between the sustainability of people's behaviors and the sustainability of their residential neighborhood will then be examined.

Approaching *sustainability* in the context of residential choice, as Bell & Morse (2008) put, we are "moving toward a measurement of the immeasurable […], a highly complex term open to a wide variety of interpretations and conceptualizations." (p. 127). We define sustainability as the reconciliation of three imperatives: environmental, social and economic. It refers to an accomplishment in which natural environment can thrive and human needs are met

while promoting social equity and economic viability (Coffman & Umemoto, 2009; Dale & Hill, 2001). Sustainability performance refers to the amount of useful outcome accomplished with respect to sustainability. *People performance* is the amount of useful outcome accomplished by household behaviors in their daily life. *Place performance* refers to the extent to which residential neighborhoods contribute to sustainability, more specifically, the degree to which patterns of behaviors stem from the concomitant aspects of an environment. As previous studies (Myers & Gearin, 2001 ; Walker & Li, 2006) demonstrated, there may be congruity or incongruity between the level of performance of a residential location and the level of performance of a concerned household (e.g. using a private car in a single-family low-density neighborhood and using it in inner-city neighborhood adapted to walking and well-serviced in public transport).

The specific objectives of the thesis are:

1. to identify indicators which can be used to evaluate the level of sustainability of people's behaviors as well as that of their residential location;

2. to develop an assessment framework to measure the sustainability performance of residential neighborhoods and household behaviors;

3. to apply the assessment framework (Figure 1.1) to evaluate the sustainability performance of different residential locations and the associated behaviors and determine the level of (in)congruity between the two.

1.3   Research Significance

This study examines the degree of correspondence between the sustainability performances of people's behaviors and of that their residential environment. Its objective is to shed light on the variables linking the two and the gap that need to be bridged in order to achieve more sustainable development. This research will contribute to the knowledge base on residential choice by exploring not only the environmental dimension of their sustainability but also the social and economic aspects. The assessment framework to be developed may help planners and policy makers evaluate the effectiveness of the measures put forward to increase sustainability in residential neighborhoods to improve the sustainability of the people living in

them. Indeed, it is important for decision makers to develop reliable empirical evidence on the potential effectiveness of these measures and on the conditions and mechanisms facilitating or inhibiting their potential effects.

This thesis deals with an innovative and important subject. The results shed light on the complexity of the links between residential behaviors and the living environment regarding sustainability behaviors. The most original part of the research is to verify not only the level of congruity between the level of sustainability of the place of residence and the behaviors associated with mobility out of home but to assess the desirability for households of their residential situation in relation to their future aspirations.

This type of "demonstration" is essential in view of the lack of integration of studies aimed at either objectively measuring the sustainability of the premises or evaluating the sustainability of household or individual behaviors and the scarcity of studies targeting the two simultaneously. Studies that evaluate sustainable behaviors are predominantly conducted by psychologists and those that evaluate the sustainability of the built environment by transportation engineers. This thesis contribute both theoretically and methodologically to combine these two perspectives.

1.4 Outline of thesis

This thesis is organized into six chapters, three of them in scientific article formats to be submitted to peer-reviewed journal.[1] For publication purposes, the thesis is constructed in a way that these chapters are independent. The chapters include a general introduction (chap. 1), a literature review (article 1) to which the conceptual framework of this study is integrated (chap. 2), the research methodology (chap. 3), two chapters on the results of the analyses: a first one comparing place and people's performance (chap. 4, article 2), a second one reporting on the desirability of (un)sustainable residential choice (chap 5, article 3); and finally, a discussion

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[1] The first author of each article is Simin Lotfi, the author of this thesis. She conducted the data analysis and wrote the articles. The two other authors, Sébastien Lord Ph.D and Carole Després, Ph.D. are respectively director and co-director of the thesis.

of the results, followed by the general conclusion (chapter 6). Annexes have been added to this thesis to provide all the necessary additional information that the reader might need to consult to fully understand the research project.

Chapter 1: Introduction. Overview of the study: discussion of the background to the research, research problem, aim and objectives of the research, significance of the research, and the scope of the study.

Chapter 2: Literature review (article 1). The first article aimed at relocating this research in the scientific context. The scientific evidence discussed was identified through a search in multidisciplinary databases from 1994-2016, in addition to recommendations from experts. Their content was classified and analyzed according to how it answered the following questions: 1) *What* aspects of places and people's behaviors are considered to evaluate sustainability?; 2) To *which* pillar of sustainability do these characteristics of places or behaviors refer?; 3) *How* or by which mechanisms are places and people related; and finally, 4) *why* are places and behaviors linked the way they are? This article attempted to clarify the concepts of people's performance and place performance regarding sustainability in the context of residential choice. We discuss how previous researchers have approached the two concepts, the previous works' strengths and weaknesses, and the actual gaps which need to be bridged. We classify the empirical evidences about the relationship between residential neighborhood and people's behaviors. An important outcome of this chapter is the framework developed for the assessment of the sustainability of people's performance.

Chapter 3: Methodology. Discussion of how the research was developed and conducted. The methodology used to address the study objectives is also presented. A thorough understanding of the survey that provided the database is presented, along with the study area, sample, and operational framework and research procedures before advancing analysis.

Chapter 4: Comparing the sustainability levels of people's behaviors and their residential location (Article 2). The article is aimed at studying, with a quantitative and cross-sectional perspective, the profiles of people's behaviors for out-of-home activities and assessing their sustainability performance, and then comparing these with the sustainability performance of their residential location. A group of 740 households with at least one respondent who worked

full-time was analyzed. The database was "Demain Québec", an Internet survey of residents of the Quebec City metro area detailing their household, residence and mobility characteristics. To assess the sustainability performance of people's behaviors, a principal component analysis was performed on the variables, developed in chapter 2 (article 1), based on the available database, which led to six factors. These variables were later applied to a two-step clustering analysis leading to seven profiles of behaviors. To assess the sustainability performance of people's residential location and compare it with behavior profiles, we used the neighborhood Walk Score.

Chapter 5: The desirability of (un)sustainable residential choice (Article 3). This article is aimed at understanding to what extent working households are satisfied with their residential choices with varying levels of sustainability and aspire to continue similar or different choices in their residential projects. This article is based on the sustainability performance of behavioral typologies developed in the latter article.

Chapter 6: Discussion and conclusion. The findings are discussed according to the research objectives presented in chapter 1. The implications of the research include the study's contribution to the body of knowledge and practice. The limitation of the study and recommendation for future research are also outlined. The chapter finally concludes with an overall comment on the study.

CHAPTER 2

DOES "WHERE WE LIVE" REFLECT "WHAT WE DO"?
AN OVERVIEW OF EMPIRICAL EVIDENCE ON PLACE-PEOPLE
CORRESPONDENCE WITH REGARDS TO SUSTAINABILITY

(Article 1)

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2.1   Abstract

Despite substantial effort to uncover the link between people's behaviors and places over the last decade, the findings remain ambiguous. While some research shows a clear relationship between sustainable neighborhoods and behaviors, others fail to do so. This paper presents a critical overview of the empirical evidence on this issue. In the end, an inventory framework is proposed to help the design of studies on the performance of residential choice with regard to the three pillars of sustainability. The scientific evidence discussed was identified through a search in multidisciplinary databases from 1994-2016, in addition to recommendations from experts. A total of 17 papers was retained for the review. Their content was classified and analyzed according to how it answered the following questions: 1) What aspects of places and people's behaviors are considered to evaluate sustainability?; 2) To which pillar of sustainability do these characteristics of places or behaviors refer?; 3) How or by which mechanisms are places

and people related; and finally, 4) why are places and behaviors linked the way they are? In response to the first question, the indicators most often used to evaluate the sustainability of the places describe the built environment in terms of its form, functions and density, as well as its socio-economic characteristics. To evaluate the sustainability of people's behaviors, multiple indicators are used of different natures, that is, environmental, social, economic, and daily mobility-related indicators with regard to transport modes, as well as the traveled space and time. The relationships identified between levels of sustainability of places and behaviors are described as matching (sustainable behaviors in sustainable places or unsustainable behaviors in unsustainable places) or lacking congruity (unsustainable behaviors in sustainable place and sustainable behaviors in unsustainable places). Reasons why places and people are linked in such ways are most often analyzed with regards to factors belonging to different types of variables having to do with life situations, lifestyles, and conveniences. The conclusion underlines the need for researchers to embrace the complexity of residential choice and the associated daily mobility in future research as well as for policymakers to define actions to be taken for unsustainable places to be improved and more sustainable behaviors to be adopted.

2.2   Introduction

With regard to residential choice, it is often assumed that people who choose to live in locations defined as more sustainable will show or adopt more sustainable behaviors at the neighborhood scale (Boarnet, Forsyth, Day, & Oakes, 2011; Van Acker & Witlox, 2010). Because of this expected determinant role of residential neighborhoods on behaviors, it is important for policy-makers, planners, and practitioners to better understand the interaction between "where people live" and "what people do". To investigate the level of congruity between the two, sustainability must be embraced in all its complexity, that is, its environmental, social and economic imperatives. One difficulty in making sense of existing scientific evidence is that the findings commonly stem from the consideration of only one imperative, or two at the most. Another difficulty is that the bulk of the scientific literature investigates the sustainability of either the places where people live or the associated behaviors; examining scientific evidences linking the two is at the heart of the critical overview presented in this paper. The considered behaviors are those related to daily mobility and activities outside the domicile. From

the collected evidence, a conceptual framework was developed to analyze "people-place" correspondence as a transactional unit of analysis, to help elucidate which features make both place and people reach their full potential with regards to sustainability performance.

2.3   Method

2.3.1 Search Strategy

A literature search using keywords Residential choice AND Lifestyle OR Behavior AND Residential neighborhood OR Built environment OR Urban forms AND Sustainability, was performed on databases (e.g. Web of science and SpringerLink). In addition to the web search, 22 references were provided from two experts. A total of 112 papers published after 1992[2] were thus first identified on the basis of their titles. Since this review aims at understanding the mechanisms linking people's behaviors to their places of residence with regard to sustainability, we considered the two following exclusion criteria after reading the abstracts: 1) abstracts focusing exclusively on either places or behaviors were excluded; 2) papers focusing on scenario situations instead of real life situations were also excluded. Of the 112 initial papers, we were left with 32 articles which were read entirely after which half of them were further excluded because of the similarity between their contents.

2.3.2 Corpus Description

The seventeen articles retained for the critical overview were published after 2011 (Table 2.1). Six were written by geographers, five by civil engineers, and one by an environmental psychologist; the five others were led by interdisciplinary teams among which transport and urban planners and only one including architects. The majority of the research was conducted in Western countries, more than half in European countries (3 in the UK, 2 in Belgium, 1 in Austria, 1 in Denmark, 1 in Finland and 1 in Germany); the rest in North America (4 in the US,

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[2] We considered the papers published after 1992 because Action for sustainable development was the key proposal of the first UN Conference on Environment and Development, held in Rio de Janeiro in June 1992, in response to concerns about global environmental problems (United Nations, 1992). Agenda 21 was enacted and, since then, major groups participated in the SD process in a constant manner. Lifestyle, formalized as the patterns of production and consumption, was addressed in Principal 8 of the Rio Declaration for the first time (UN-Rio Declaration, 1992).

1 in Canada); Australia (2); only one was conducted in China (Yu, Zhang, & Fujiwara, 2012). Two main types of strategies are used for evaluating the sustainability of residential choice and the level of congruity between people's place and behaviors. The first type favors the objective measurement of the built environment and socio-economic factors (twelve studies focus strictly on these dimensions). The second favors subjective variables associated with psychological factors (eight studies target solely these dimensions). Finally, eight studies mix both approaches, incorporating objective and subjective variables. Most studies used cross-sectional survey designs (9 quantitative, 1 qualitative and 2 mixed), the others proceeded through cohort observation with quantitative research design: quasi-longitudinal, prospective and retrospective. The sample sizes among studies are highly variable (from n=26 to n=75331). The primary criterion for sample selection is to have respondents residing in different types of places (e.g. suburban vs. urban neighborhoods; transit-oriented development vs. "regular" neighborhood). For cohort studies, another considered criterion is that respondents have experienced relocation.

Table 2.1   Empirical studies on place-people correspondence with a view of sustainability

#	Author/Year	Sample/ country/ design	Place performance/ Unit	People performance	Accord between place and people's performance	Congruity	Incongruity	No association
1	**Aditjandra, Cao & Mulley (2012)**	219 households / UK/ Quasi-longitudinal quantitative	ABCD typology (Marshall, 2005) / LSOA*	Car driving	[+]	• Accessibility to public transport (PT) [decreased] driving	Not applicable (NA)	NA
2	**Barr & Prillwitz (2012)**	1561 individuals/ City of Exeter, Devon, UK/ Cross-sectional qualitative and quantitative	• High-density, Medium-density suburban, Low-density outer-urban, and Commuter settlement • Rural centre /NA	Travel mode along with travel purpose	[+, -, o]	•Urbanization** [decreased] car use • Urbanization [increased] PT-use and walking	•Urbanization [increased] car use •Urbanization [decreased] cycling and walking	•Urbanization [had no effect on] car use, PT-use, and walking
3	**Boussauw & Wiltox (2011)**	7273 individuals/ Flanders, Belgium/ Cross-sectional quantitative	Accessibility, residential and job density, diversity, min. commuting distance, proximity of facilities / 1, 4, and 8 km buffers	Daily kilometrage per person	[+, o]	• Residential density [decreased] travel distance • Population density, diversity and proximity [decreased] travel distance (within a radius of 1 km)	NA	• Accessibility to street net and job density [had no effect on] travel distance
4	**Buys & Miller (2011)**	26 residents from high-density dwellings in inner-city/ Brisbane, Australia/ Cross-	Inner urban higher density precincts (≥30 dwellings/ hectare) located within 6 km of CBD/ precinct	Travel mode along with travel purpose	[+, -]	• CBD [increased] PT-use for CBD work destinations and Walking for some non-work purposes	• CBD [increased] Car-use for non-CBD work and non-work destinations	NA

Table 2.1   Empirical studies on place-people correspondence with a view of sustainability

#	Author/Year	Sample/ country/ design	Place performance/ Unit	People performance	Accord between place and people's performance	Congruity	Incongruity	No association
		sectional qualitative						
5	**De Vos et al. (2012)**	1657 university students and staff members / Flanders, Belgium/ Cross-sectional quantitative	Urban and suburban/ NA	Travel mode	[+, -]	• Urbanization [Increased] AT-use and PT-use -Urbanization [decreased] car use	-Urbanization [decreased] AT-use and PT-use -Urbanization [increased] car use	NA
6	**Delmelle, Haslauer & Prinz (2013)**	8700 individuals/ Vienna, Austria/ Cross-sectional quantitative	Population density, centrality, transportation factors, and dwelling types/ NA	Social satisfaction	[+, -]	• PT services and Population density [increased] social satisfaction	• Residing in apartment complex [decreased] social satisfaction	NA
7	**Fan, Khattak & Rodríguez (2012)**	2886 households/ Triangle area in North Carolina (Orange, Wake, and Durham), US/ Cross-sectional quantitative	Building density, retail accessibility, and street connectivity/ 0.25 miles buffer	Observed, required and excess travel, travel mode, travel purpose, and travel time	[+]	• Connectivity and accessibility to retail stores [decreased] travel distances • Density, mixity, and street connectivity [decreased] required and excess travel	NA	NA
8	**Farber & Lio (2013)**	NA/ 42 metropolitan area, US/ Cross-sectional quantitative	Sprawl indicators (Ewing, Pendall, & Chen,2003): decentralization, big city, fragmentation, low mixing, long	Social Interaction Potential (SIP)	[+]	• Decentralization and fragmentation [increases] mean commuting time • Decentralization and fragmentation [decreases] SIP	NA	NA

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Table 2.1   Empirical studies on place-people correspondence with a view of sustainability

#	Author/Year	Sample/ country/ design	Place performance/ Unit	People performance	Accord between place and people's performance	Congruity	Incongruity	No association
			travel/ Regional scale					
9	**Figueroa, Nielsen & Siren (2014)**	75331 young (18–64 yrs) and older (65–84 yrs) adults (national dataset)/ Denmark/ cross-sectional quantitative	5 D's of Ewing & Cervero, 2010: density, destination accessibility, design, diversity & distance to transit/ NA	On a daily basis: travel distances, non-work travel distances, and car travel distances (driver or passenger)	[+, -, o]	• Population density and accessibility [decreased] car travel distance • Population density [decreased] all travel distance and travel distance for non-work travel distance (stronger for older adults) • Mixity [decreased] non-work travel distance • PT service [decreased] car travel distance	• Accessibility to retails job [increased] car travel distance for non-work purpose	• Density [had no effect on] car travel distance (for older adults)
10	**Jarass & Heinrichsa (2014)**	317 individuals / Berlin, Germany/ Cross-sectional quantitative	New inner city development*** (with low density) and inner city development/ NA	Travels frequency, travel length, and travel mode	[+, -]	• Inner city [increased] PT-use -Inner city [decreased] car use	• New inner city [increased] Distance • New inner city [decreased] non-motorized mode	NA

Table 2.1　　　Empirical studies on place-people correspondence with a view of sustainability

#	Author/Year	Sample/ country/ design	Place performance/ Unit	People performance	Accord between place and people's performance	Congruity	Incongruity	No association
11	**Kamruzzaman et al. (2013)**	3957: 510 TOD residents and 3447 non-TOD residents/ Brisbane, Australia/ Longitudinal quantitative	TOD versus non-TOD : net residential density, land use diversity, intersection density, cul de sac density, and PT accessibility/ 600 m buffer	Travel mode and Travel time	[+, o]	• PT accessibility [increased] propensity of walking in TOD • Cul-de-sac [decreased] PT-use and AT-use in non-TOD • Density [increased] AT and switch to walking in TOD and non-TOD • Intersection density[increased] walking in non-TOD	• Intersection density [decreased] switching to AT-use in TOD	• Diversity [had no effect on] mode choice in TOD and non-TOD • PT accessibility to [had no effect on] propensity of walking, only in non-TOD • Cul-de-sac density [had no effect on] PT-use and AT-use, in TOD
12	**McCunn & Gifford (2014)**	84 individuals/ Canada/ Cross-sectional quantitative	Green Neighborhood Scale (GNS) ****	Sense of place and neighborhood commitment	[+, o]	• Greenness [increased] neighborhood commitment	NA	• Greenness [had no effect on] sense of place
13	**Nahlik & Chester (2014)**	American Housing Survey/ Los Angeles, US/ Prospective quantitative	BAU (business-as-usual) versus TOD/ .8 km buffer around Gold Light Rail Transit (LRT) & Orange Bus Rapid Transit (BRT)	Travel mode, Travel length, Energy use, Greenhouse Gas Emissions, Respiratory Impact potential, and Smog formation potential	[+]	• Mobility options [increased] shift from car to PT-use and AT-use • Closeness to commerce and center [decreased] car travel distance • TOD[decreased] fuel cost and car emissions	NA	NA

Table 2.1   Empirical studies on place-people correspondence with a view of sustainability

#	Author/Year	Sample/ country/ design	Place performance/ Unit	People performance	Accord between place and people's performance	Congruity	Incongruity	No association
14	Susilo et al. (2012)	659 residents of sustainable neighborhoods/ UK/ Cross-sectional	densities, connectivity, bike path, surveillance, PT services and permeability/ NA	Travel mode, frequency, and length, and activity locations	[+, -, o]	• Connections [Increased] cycling	• Density [decreased] cycling	• Mixity [had no influence on] walking
15	Valkila & Saari (2013)	30 individuals/ Finland/ Cross-sectional qualitative and quantitative	Inner city, inner suburb, and outer suburb/ NA	Carbon footprints, travel length along with travel mode, and vehicle occupancy	[+, o]	• Urbanization, PT accessibility [decreased] car travel distance • Centrality [decreased] travel-related carbon footprint • PT accessibility [decreased] carbon footprint	NA	• Urbanization [had no influence on] PT-use
16	Yu, Zhang, Fujiwara (2012)	530 households/ Beijing, China/ Retrospective quantitative	Urbanization degree and access to train / 1.2 km radius buffer	Energy consumption measured by : monetary expenditure	[+, -]	• Recreational facilities and bus lines [decreased] car-related energy consumption	• CBD Residing [Increased] car expenses	NA
17	Zhu et al. (2014)	449 households/ Austin, Texas, US/ Retrospective quantitative	Walk Score/ NA	Travel time, travel mode, social interactions, and cohesion	[+]	• Walk Score [Increased] At-use, social interaction, and cohesion • Walk Score [decreased] travel time by car	NA	NA

* LSOA refers to the lowest administration area used in UK 2001 Census (Aditjandra, Cao, & Mulley, 2012)

** Urbanization: refers to the traditional suburb/urban approach whereas more urbanized structure refers to inner city areas.

***New inner city development refers to new residential neighborhoods within the existing built structure, which has lower density compare to the inner city structures (Jarass & Heinrichs, 2014).

****18 variables derived from the United States Green Building Council, CMHC, & Kellert, Heerwagen, & Mador, 2008, within a radius of half-mil

Legend: (**+**) positive relationship, (**-**) negative relationship, (**o**) no relationship

2.4   Results

2.4.1 Operationalizing the sustainability performance of people-place interaction

Among our corpus of 17 articles, we identified a diversity of indicators of different nature used to evaluate the sustainability performance of people-place interaction (Table 2.1). To evaluate the sustainability of places, the indicators used describe the residential location in terms of its built environment or socio-economic characteristics (e.g. Boussauw & Witlox, 2011; Delmelle et al., 2013; Farber & Li, 2013; Figueroa, Nielsen, & Siren, 2014). With regard to evaluating the sustainability of the built environment, most indicators provide quantifiable measures. Boussauw & Witlox (2011) and Fan et al.(2011) considered the contribution of accessibility, population density, and residential density. In other studies, it is a typology of urban developments that is considered, e.g. transit-oriented development (TOD) versus non-TOD (Kamruzzaman et al., 2013) or inner-city, inner suburb and outer suburb (Valkila & Saari, 2013). Concerning the definition of the territorial unit of measurement, the most common approach is to define a buffer around each respondent's home. Fan et al. (2011), Kamruzzaman et al.(2013) and Yu et al. (2012) respectively uses radiuses of 0.4 km, 0.6 km, and 1.2 km; Boussauw & Witlox, (2011), radiuses of 1 km, 4 km, and 8 km. A variation is to define the buffer zone around a rail or bus rapid transit (Nahlik & Chester, 2014). Another avenue is to use a homogeneous dwelling density, e.g. precincts defined as 30 or more dwellings/hectare (Buys & Miller, 2011) or existing administrative boundaries, e.g. census Lower Super Output Area (LSOA) (Aditjandra et al., 2012). The incorporation of subjective indicators to evaluate the sustainability performance of place is also necessary. Indeed, even a homogeneous socio-economic group living in the same location may differ in terms of individual behaviors (De Vos, Derudder, Van Acker, & Witlox, 2012).

To evaluate the sustainability of people's behaviors, indicators of different natures were used. All but four studies used objective spatiotemporal indicators related to daily mobility are commonly considered. They measure traveled space and time, trip frequency, or specify travel purpose or transport modes. Researchers use these variables in combination [e.g. travel mode

and travel purpose (Barr & Prillwitz, 2012; Buys & Miller, 2011), travel mode and travel distance (Figueroa et al., 2014), or travel length and travel mode (Valkila & Saari, 2013)]. Some also manipulate variables through mathematical formulations to carve out their area of interest. For instance, Fan et al. (2011) combine a set of variables to define the indicators required travel, and excess travel. Required travel is "a function of the relative distances among daily activity locations", while excess travel is a function of "the relative distances between the actual residential location and the daily activity locations" (p.1242). A lower level of required travel means to have smaller geographical areas and less dispersed activity locations; a lower level of excess travel means to have a better coordination between home and activity locations and vice versa, which may encourage or promote sustainability. Buys & Miller (2011) incorporate four variables to qualify daily mobility, bringing forward the concept of convenience. It is defined as the intersection of utilitarian and psycho-social elements and is identified as a determinant factor of transportation choice. It is the outcome of four objective measures: time-efficiency, seamless journey[3], distance to destination and purpose of the journey.

The social imperatives of sustainability were considered in six studies. The subjective indicators measured alternately the satisfaction with the social composition of the neighborhood or the perception of its social cohesion, the sense place or commitment with the neighborhood, the social interaction with the neighbors, and the satisfaction with current domicile and residential preferences. Some studies refer to two useful concepts. The first one is the residential dissonance[4] which refers to the mismatch between actual and preferred residential neighborhood (De Vos et al., 2012; Kamruzzaman, Baker, Washington, & Turrell, 2013). The second is residential self-selection which refers to the "an individual's inclination to choose a particular neighbourhood according to their travel abilities, needs, and preferences" (Aditjandra et al., 2012; Yu et al., 2012; Kamruzzaman et al., 2013).

Four studies evaluated the sustainability of people's behaviors from an environmental standpoint from three indicators: energy use, carbon footprint and vehicle occupancy(Figueroa et al., 2014; Jarass & Heinrichs, 2014; Valkila & Saari, 2013; Yu et al., 2012). Finally, the

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[3] According to Buys & Miller (2011), " Seamless journey is critically related to the concept of unbroken travel and avoidance of using more than a single mode " (p.296).
[4] This concept is defined in Kamruzzaman et al., 2013.

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economic aspect of behaviors were only considered in one study (Yu et al., 2012). Table 2 2 summarizes the variables used to measure people's behaviors identified in the literature.

Table 2.2   Category of variables used in the 17 reviewed studies to measure people's behaviors

Category of indicators	Indicators	Paper reference Number (see Table 2 1)	Number of studies
SPATIOTEMPORAL			
Transport mode	Car driving Travel mode	[1, 2, 4, 5, 7, 9, 11, 13, 14, 15, 17]	11
Traveled distance	Daily mileage per person Travel distances Observed travel Required travel Excess travel	[3, 7, 9, 13, 14, 15]	6
Trip frequency	Travels frequency	[9,10,14]	3
Travel purpose	Travel purpose	[2, 4, 9]	3
Travel time	Travel time	[7, 11, 17]	3
SOCIAL	Social satisfaction w/ neighborhood Social Interaction w/ neighbors Sense of place Commitment to neighborhood Perception of neighborhood cohesion Satisfaction with current domicile Residential preferences	[6, 8, 12, 17; 4; 7]	6
ENVIRONMENTAL	Energy use Carbon footprints Vehicle occupancy	[9, 13, 15, 16]	4
ECONOMIC	Monetary expenditure on electricity, gas & gasoline	[16]	1

2.4.2 Which imperative of sustainability is evaluated in the studies?

It is well-known and accepted that sustainability encompasses at least three imperatives of environmental, social and economic natures. *Environmental sustainability* deals with the impact of the development process on biodiversity of habitats and the utilization of natural resources (Deakin, Curwell, & Lombardi, 2001). *Social sustainability* refers to the strong of sociocultural life, social involvement, access to services, safety and security and overall human well-being both mentally and physically (Bacon, Douglas, Woodcraft, & Brown, 2012; Deakin et al., 2001; Woodcraft, 2012). Regarding *economic sustainability*, we endorse the definition of Markandya & Pearce (1988) who define it as "the use of resources today should not reduce real incomes in the future" (p. 5) and agree with Moldan, Janoušková, & Hák (2012) that in view of

recent economic and financial crises, economic issues should be addressed "on their own merits, with no apparent connection to the environmental aspects" (p. 4).

A first group of variables are unidimensional in that they measure only one dimension of sustainability. For instance, energy use, carbon footprints, or vehicle occupancy relate to environmental sustainability. Social satisfaction, sense of place or neighborhood commitment rather pertains to social sustainability. A second group of variables could be labeled multidimensional in that they relate to more than one dimension of sustainability. For instance, with regard to transport mode, the use of public transit may contribute to environmental sustainability, but have a negative impact on social sustainability by increasing travel time which may reduce time for social interactions with family or neighbors. Similarly, walking may contribute at once to environmental, social, and economic sustainability by diminishing traffic, pollution, improving health and social relations, and diminishing car-associated monetary expenditures. Finally, a last group of variables allows for to a better understanding of people's behaviors without being necessarily associated to a particular dimension of sustainability (e.g. travel purpose).

2.4.3 How congruent are place and people's sustainability performance?

The reviewed scientific evidence provides mixed findings regarding the correspondence between people and place performances in terms of sustainability (see Table 2.1 in section 2.3.2). The relationships identified between places and behaviors are described as matching or congruent (sustainable behaviors in sustainable places or unsustainable behaviors in unsustainable places) in 17 studies, or lacking congruity (unsustainable behaviors in a sustainable place and sustainable behaviors in an unsustainable place) in eight studies, or else, as showing no significant relationship in seven studies. These relationships are illustrated in Figure 2.1.
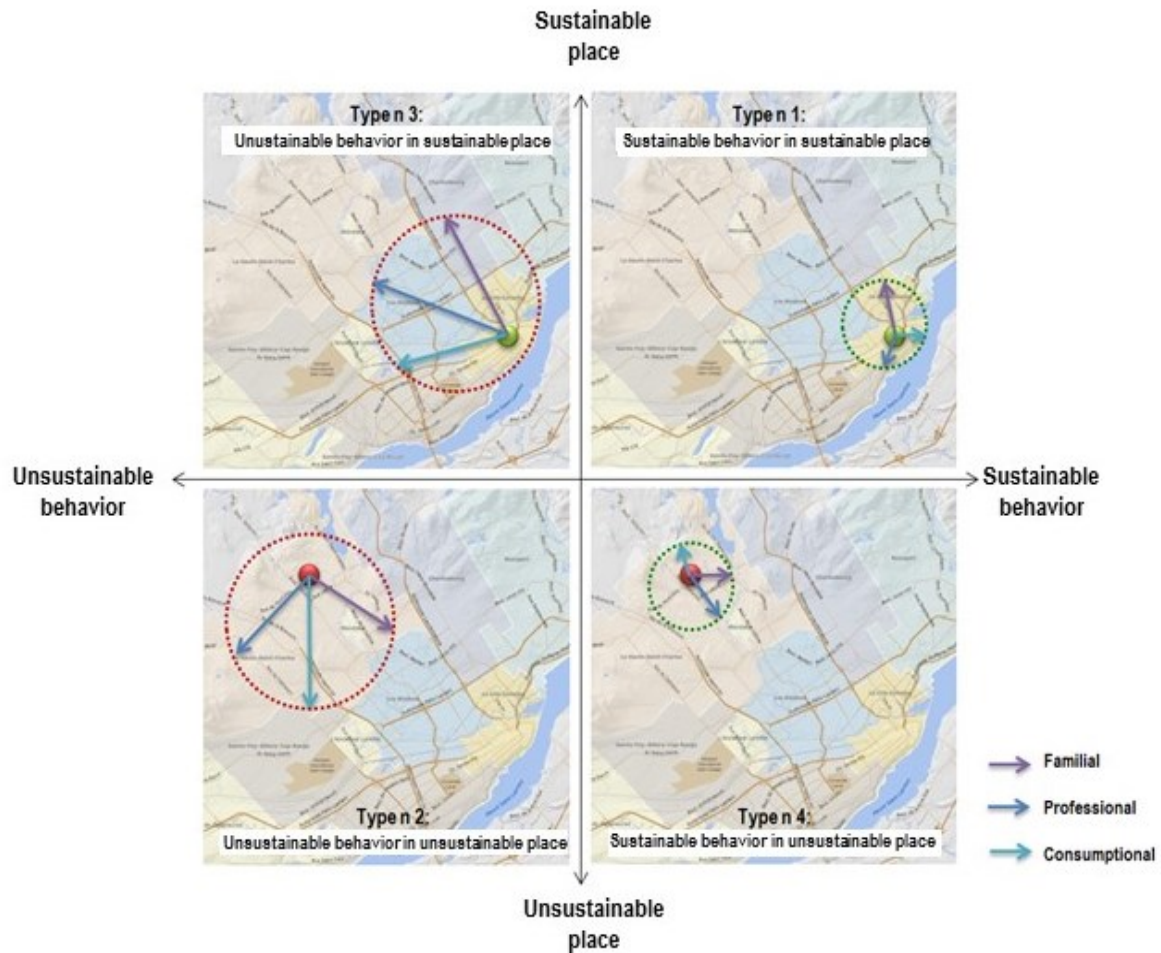
Figure 2.1   Four types of relationship between people and place performance
with regard to their residential location

2.4.4 Why are the sustainability performance of place and behaviors related in such ways?

An overview of the papers revealed several factors influencing the degree of congruence between the sustainability level of people's behaviors and of their residential location. Three main sets of factors contribute to shedding light on the relationship between the two: life situation, lifestyle, and convenience. Alternately, they may influence the direction and force of the relationship between place and related behaviors as well as the level of sustainability.

2.4.4.1 Life situation

Life situation refers to socio-economic and demographic characteristics (Aditjandra et al., 2012). Twelve studies investigated the influence of life situation on place-people correspondence. These variables may change the gravity or direction of the relation between people and place with regard to sustainability. Nine categories of variables were contemplated: age, gender, household-related factors (size, structure, number of children, age of children), income, job-related factors (number of workers, status of job, type of job, retirement), education, mobility resources (car ownership, bike ownership, driver's license), health, home-ownership. *Age* was found to influence the mode of transport. The middle-age group tend to favor car, older adults public transit and younger people walking (e.g. Barr & Prillwitz, 2012; Boussauw & Witlox, 2011). Out of the four papers on social aspects, only Delmelle et al. (2013) found no significant evidence that age was linked to social satisfaction. *Gender* also accounted for some kind of influence. Men used car most frequently than women, who tended to rely more on public transportation (Barr & Prillwitz, 2012; Kamruzzaman et al., 2013). Women also tend to walk more than men (Kamruzzaman et al., 2013). This being said, even when walking was their primary transport mode, it was affected by the perceived safety (Buys & Miller, 2011). According to Fan et al. (2011), the ***presence of children*** in households increased daily mobility. Longer travel distances were related to families with children. Indeed, school quality and location were strong influences on residential choice, and reduce households' opportunities to concentrate their daily trips on smaller geographical areas. The ***number of children*** had no significant effect on excess travel (Fan et al., 2011) although larger households and families with children were found to rely more on car (Aditjandra et al., 2012; Susilo, Williams, Lindsay, & Dair, 2012), which may be used as a to conciliate parental, familial, professional obligations. This being said, larger households were also found to use public transport because of limited access to cars for all members. It is not clear whether ***income*** influences travel mode choice through increasing car ownership and whether it has a direct effect on mobility (Aditjandra et al., 2012; Fan et al., 2011; Figueroa et al., 2014). As for the impact of ***education*** and employment, highly educated professional workers tend to depend less on car and walk more compared to other socio-economic groups (Kamruzzaman et al., 2013; Yu et al., 2012). ***Bike ownership*** incites biking (Barr & Prillwitz, 2012; Jarass & Heinrichs, 2014) and ***car ownership***

encourages driving (Aditjandra et al., 2012; Barr & Prillwitz, 2012; Delmelle et al., 2013; Kamruzzaman et al., 2013). This latter is also the only significant factor pertaining to life situation that influences social satisfaction (Delmelle et al., 2013). Interestingly, the same factor has a negative impact on environmental sustainability.

2.4.4.2 Lifestyle

Variables related to lifestyle refer to preferences and attitudes (Aditjandra et al., 2012). A total of eight papers out of 17 investigated the influence of lifestyle factors on the congruity between the level of sustainability of people's behaviors and their places of residence. Barr & Prillwitz (2012) identified four behavioral profiles with regard to transport: «Addicted Car Users», who used the car most frequently and lived in low-density places did not show pro-environmental attitudes. « Aspiring Green Travellers», who still relied on the car, but used other transport modes, especially active transport, and had strong environmental attitudes. «Reluctant Public Transport Users» used public transport as their primary transport mode, but had relatively negative environmental attitudes. Finally, «Committed Green Travellers», whose attitudes matched their behaviors. These individuals relied on walking and had strong pro-environmental attitudes. With no surprise people favoring public and active transport drove less, and those who preferred easy access to shopping facilities drove more (Aditjandra et al., 2012).

Residential consonance or dissonance refers to the match or mismatch between actual and preferred residential neighborhood. It was studied by De Vos et al. (2012) and Kamruzzaman et al. (2013). Both studies found that the residential consonance or dissonance had a significant influence on travel mode choice, especially on public and active transport. On the other hand, built environment had a stronger impact on car use compared to the other modes of transport. Namely, urban consonants and rural dissonant were more likely to use AT and PT and urban dissonant and rural consonants were more likely to use car, with a lower degree of association compared to the previous group because car use is more influenced by built environment. Consideration for School quality considerations were positively associated with required travel and negatively related to excess travel (Fan et al., 2011). People who considered schools quality in their residential choice had fewer opportunities to concentrate their other daily activities (Fan et al., 2011). According to (Fan et al., 2011), smaller excess travel may

result from the fact that this group of people faced more temporal constraints and tried to create more spatially coordination between residences and daily destinations. Consideration for neighborhood security was negatively associated with excess travel and had no influence on required travel, which may be explained by the fact that people with security concerns had limited housing options which may keep them from residing in the neighborhoods that can minimize their daily travel.

As we have above observed, even though the lifestyle factors were important in the determination of sustainable travel behaviors, they were not always reflected in people's behaviors. People did not or could not always act on their attitudes and preferences because of their life situation, the built environment where they live, or simply for convenience.

2.4.4.3 Convenience

Convenience corresponds to the intersection between utilitarian and psychosocial dimensions. It is considered as a determinant factor of transportation choice and developed used by Buys & Miller, (2011). They define it through three key elements: time-efficiency, seamless journey, as well as distance to and purpose of the journey. Perceived time-efficiency of transport modes[5] was found to be a major influence for modal choice. The authors identified walking as the most time-efficient option for nearby services, especially recreational facilities, restaurants and smaller shops, although traffic jam, low quality and narrow sidewalk may create the feeling of unsafety and hamper walking. Public transport was considered the most efficient option (quick, easy, less stressful) for travel into the city for the well-serviced areas with three impediments being waiting time, unreliable services, and unavailability of seats at peak commuting time. The use of private car was the most efficient option (quick) for travel outside of the local area although in inner-city workplaces, parking is costly and commuting in traffic is stressful. The possibility of a seamless journey is another important factor of influence that may prevent the choice of more sustainable modal choices. Combining multiple trips and modes

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[5]According to Buys & Miller (2011), perceived time-efficiency of transport modes refers to the time-considerations influence the transport choice. "Transport choices were frequently determined by what was perceived—and experienced —as the quickest and easiest option for reaching a destination, while taking into account destination and time of day " (Buys & Miller, 2011, p. 293).

is a time-consuming and uncomfortable experience in the context of poor public transport connections and difficult climate conditions compared to a seamless journey in car. The distance to and purpose of the journey also influence travel mode choice for their relative convenience. For instance, inner-city residents preferred walking to local services and routine destinations and use of public transport for the commute to work. Car is considered more convenient to access suburban areas, leisure activities, as well as visiting family and friends, and for shopping because of the ease of carrying groceries. This being said, the authors found considerable overlap between practical reasons and psychosocial factors in terms of modal choice. Resident definitions of what is a practical or suitable, and thus convenient travel mode was bound up in a range of other considerations or factors, "some of which appear to be attitudinal, symbolic and affective rather than simply functional or utilitarian. For example, one participant explained "although buses were convenient where she lived, she loved her car and just would not consider public transportation" (Buys & Miller, 2011, p. 295).

2.5   Discussion: Learning outcomes

This paper reviewed 17 articles (Table 2.1) investigating the degree of congruity between the sustainability of people's behaviors and those of residential locations. The scientific review (Table 2.2) inventoried several indicators grouped under economic, environmental, social and spatiotemporal dimensions. Each indicator corresponds to some type of objective or subjective measurement (Table 2.2). Despite substantial efforts to uncover the link between people's behaviors and places over the last decade, the findings remain ambiguous. While some research shows a clear relationship between neighborhoods and behaviors, others fail to do so. We identified four types of relationships between place and people (Figure 2.1). Our knowledge synthesis show that if place-related features influence the level of sustainability of people's behaviors, individuals' life situation, lifestyle and convenience are also major influences. In figure 2.2, we bring all these elements together, reflecting the complexity of measuring place-people level of congruity in terms sustainability issues.
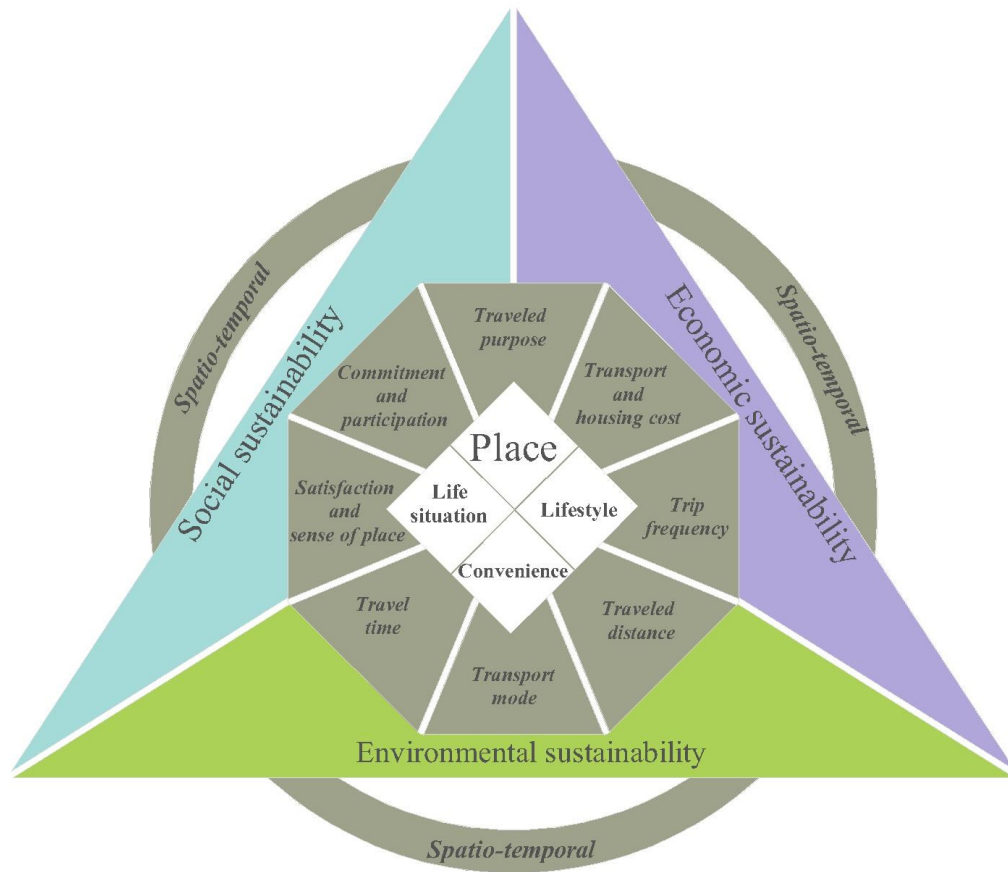
Figure 2.2   Portraying the performance of people's behaviors in terms of sustainability

2.5.1 Sustainability is the results of a complex interplay of factors

The literature review shows that the sustainability of behaviors are influenced to a certain extent by the characteristics of residential location itself, but also by people's life situation, lifestyle and perception of convenience. Thus, sustainability development will be hard to achieve unless these sets of factors are considered as acting together. Indeed, place-related features may not change people's behaviors unless micro-level conditions are provided. Consequently, to promote sustainable behaviors nothing should be considered unimportant. Unfortunately, only one paper considered simultaneously life situation, lifestyle, and convenience and four did not even consider one of them. The influence of place on people's behaviors does not simply involve the effect of its material features but is the result of a complex interplay of factors. For example, spending more time commuting for greater environmental

sustainability may infringe the time spent with family members or for community involvement, associated with dimensions of social sustainability.

2.5.2 Sustainability performance is hard to evaluate

We found no evidence of any particular thresholds used to determine whether places or people's behaviors are sustainable or not. Different geographical boundaries have different spatial structures and planning providing distinct choices of domiciles, as well as destinations and associated daily mobility (Aditjandra et al., 2012) which makes it hardly possible to define universal gauges. This problem is even more acute considering the environmental, economic and social imperatives of sustainability. For example, in context A, the household income is high, and the house price is also high. In context B, the household income is low, and the house price is high. Therefore, the portion of income spent on dwelling is different and incomparable in the two contexts, when it comes to evaluating economic sustainability. Hence, the results may not be transferable from one context to another.

Because of the multidimensionality and cultural specificity of place and behaviors with regards to measuring sustainability, appropriate analytical methods embracing this complexity must be privileged. In such wise, cluster analysis will be a powerful tool since it allows the identification of people's profile segmentation. It was applied in 5 out of 17 reviewed papers (Barr & Prillwitz, 2012; Farber & Li, 2013; Kamruzzaman et al., 2013; Susilo et al., 2012; Yu et al., 2012). The approach is helpful to inform policies targeted to promote behavioral change, soft policy (Barr & Prillwitz, 2012).

2.6   Conclusion

This article provides interesting insights into the complexity of measuring people-places performances in terms of sustainability, as well as interpreting the congruity of performances. As our results show, "where we live" might not necessarily reflect "what we do" and vice-versa. This being said, this critical overview does not purport to represent all disciplinary fields, neither distinguish approaches with regards to place performance or describe the involved dimensions in sufficient detail because of space limitations. Nevertheless, this paper provides a conceptual umbrella embracing elements of the utmost importance, which can be used to orient future

studies and feed further discussions. It could be expanded with additional dimensions (e.g. desirability and upstream impact) and developed into a theoretical model to explain degrees of congruity between places and behaviors. This paper also suggests that for the development and implementation of solutions to move forward to a more sustainable society, individual behaviors must be understood and considered as part of the solution. There is also much work to be done to go beyond mobility-associated behaviors and this calls for interdisciplinary approaches to be developed.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the methodology implemented in this study to accomplish the research goals. This study aims to determine the environmental, social and economic indicators for measuring the level of sustainability of people's behaviors and apply this assessment framework to evaluate performance of households in Quebec Census Metropolitan Area (QCMA). In addition, we seek to examine the degree of correspondence between people's behaviors and residential environment in terms of sustainability and to elaborate the desirability of sustainable residential choice of households, through examination of satisfaction-with and aspiration-for sustainable residential choice. The chapter is structured in six main parts. Following introduction, the second section provides the research strategy, and rationalization for its implementation. The third section explains the research design for the study and outlines the procedure for analyzing the data to answer each research objectives. The fourth and the fifth sections respectively describe the « Demain Quebec » survey and study area. The sixth section outlines the sample selection procedure among the 3000 households who participated in the « Demain Quebec » survey.

3.2 Research strategy

The purpose of the research strategy is to determine the path that we take to conduct our research study. This research intends to develop a framework for measuring the level of sustainability of people's behaviors and later to apply it to evaluate people's performance in QCMA. To answer research questions three common approaches exist: quantitative, qualitative, and mixed methods (Williams, 2007). The quantitative approach contemplates that "research itself is independent of the researcher" (p. 66) and implicates a numeric or statistical methodology to objectively measure reality (Williams, 2007). Quantitative research employs survey, experiments, or an explanatory study to find answers to the research questions (Creswell, 2009).

The qualitative research strategy replaces the figures in data collection and analysis with the power of words (Bryman, 2006). The other distinct difference between quantitative and qualitative research designs is the diversity of methods used for conducting a qualitative research. Leedy & Ormrod (2010) mentions the following five methodologies: case studies, grounded theory, ethnography, content analysis, and phenomenological. Each methodology takes a different path. Case studies and the grounded theory study processes, activities, and events while ethnography inspect the behaviors of an intact cultural group in a natural setting and case studies and phenomenology can be applied to study individuals (Williams, 2007). Unlike the quantitative method that uses only figures as data, the applied data in qualitative methodology is divers (e.g. visual images, interview and records of people statements, and documentation of real events).

Although the mixed methods approach to research emerged after 1950 (Tashakkori & Teddlie, 1998), it has gained much attention from researchers in recent years (Creswell, 2009; John W Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2009). The goal of applying this method is to bring the forts and minimize the drawbacks of the quantitative and qualitative research methodologies (Johnson & Onwuegbuzie, 2004). Mixed methods approach incorporates methods of data collection and analysis from the quantitative methodology (e.g. numerical data) and qualitative methodology (e.g. narrative data) in a single research study (Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998). Mixed methods approach enables researchers to employ deductive and inductive analysis in the same research study that "answers questions about both the complex nature of phenomenon from the participants point of view and the relationship between measurable variables" (Williams, 2007, p. 70)

Although the quantitative approach enables the researcher to measure the reality objectively and qualitative approach enables the researcher to explore the complexity of a phenomenon (Williams, 2007), each of these approaches has strengths and weaknesses (Figure 3.1). Following defining the problem and establishing research objectives, the question researchers must ask themselves is: What kind of research design will suit their purposes? Creswell, (2009) urges research strategy to be fit for the research purpose and needs in order to get research outcomes with social and practical values. We should consider several other aspects

in strategy selection: the available temporal limitations, financial resources, researcher skills in quantitative and qualitative (Creswell, 2009).

Taking into account these considerations, we found the quantitative research strategy as the most suitable option for achieving the research objectives in this study. To complete our framework, further quantitative data was extracted from spatial analysis and inserted into the assessment framework. "Sustainability" is the central subject of study in this research and quantitative measurement is the only applicable approach. In addition, because of the crucial role of society performance in sustainability achievement, the ultimate goal of this research is to provide the data and evidence to be easily communicative with various decision makers (e.g. household & policy makers) to help monitor and understand the existing situation (Bullock, Mountford, & Stanley, 2001). The information provided through a quantitative approach may facilitate such communication, and provide a ground to merge the broader of social and societal performers. This research employs the survey method that allows us to uncover multitudinous segmentation of sustainability profiles, both environmentally and behaviorally and provides us the ability to classify these profiles. Following section elaborates upon the research design that we have chosen for this study.
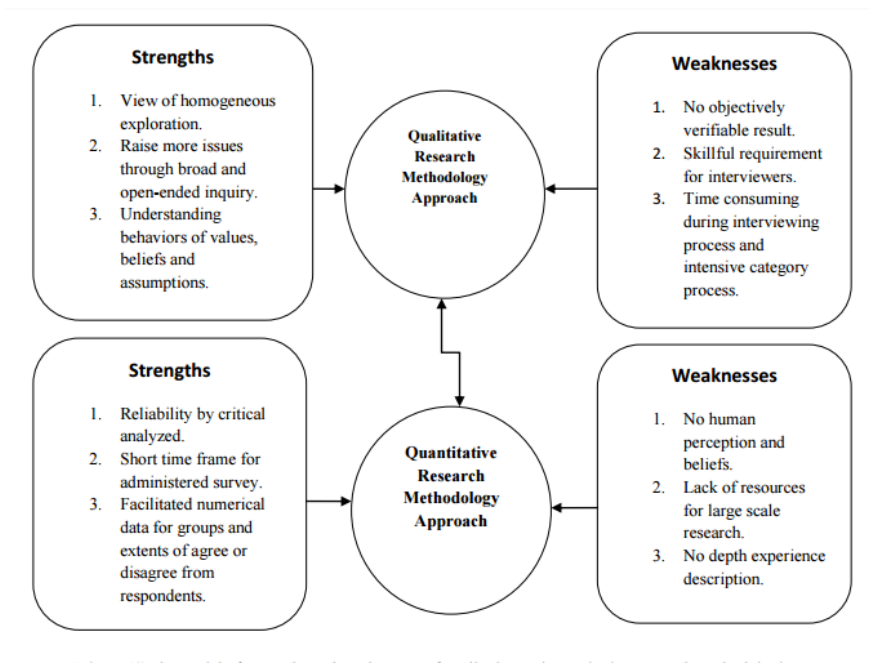
Figure 3.1 The model of strengths and weaknesses of qualitative and quantitative research methodologies (Choy, 2014, p. 101)

3.3   Research design

Research design actually defines the structure of a study. According to De Vaus (2001), the purpose of the research design is to make sure we are acquiring evidences that enable us to answer the research questions as "unambiguously as possible" (p. 9). Besides, the research design should allow us to answer research questions with the most proper and feasible methods (Sproull, 2002). In fact, Research design "deals with a logical problem and not a logistical problem" (Yin, 2013, p. 29). A research design aims to contribute to the clarification of the logic of the research and prevent any discrepancy between the empirical evidence and research questions (Teriman, 2012). This can be obtained by elaborating the manner research data is collected, analyzed, interpreted and reported (De Vaus, 2001). Consequently, establishing a solid research design that articulates all of the components in a research project is a crucial stage to achieve the finest outcomes (Teriman, 2012). Figure 3.2 illustrates the research design implemented in this research.

The research design for the study outlines research procedures, demonstrating the research aims and objectives, the methods and sources of data collection, the types of analysis applied for achieving each research objectives or answering each research question. The principal aim of this study is to measure the level of sustainability of the people's behaviors concentrating on their residential choice. It requires an investigation of empirical evidences on place-people correspondence focusing on residential choice in the view of sustainability issues to identify pertinent and essential indicators for use in this measurement, developing the assessment framework and applying the indicator based framework to people's behaviors. In order to achieve the research's aim and objectives, this study implemented a quantitative research design, and employed two types of data analysis: survey analysis and spatial analysis.

In this study, we worked with already collected data. After identification of environmental, social and economic indicators that can be used to evaluate the level of sustainability of people's performance, we use ArcGIS and spatial analysis to create variables to be included into our framework. In fact, the five research objectives structure the three thesis papers.

Research aims
To develop a framework for measuring the level of sustainability of people's behaviors and to apply it to evaluate people's performance in Quebec Census Metropolitan Area.

Research objectives

1. To identify environmental, social and economic indicators which can be used to evaluate the level of sustainability of people's performance.
2. To determine the behavioral profile of households.
3. To evaluate people's performance based on the identified indicators.
4. To examine the socioeconomic characteristics and spatial features in each profile.
5. To elaborate the desirability of sustainable residential choice

Quantitative research design

To identify sustainability indicators: an overview of empirical evidences on place-people correspondence with a view of sustainability issues.

Spatial data:
spatial analysis provides complimentary data

Survey data: survey can provide data allowing us to measure sustainable behavior (e.g. daily activity)

To determine the behavioral profile of households:
application of Principal Component Analysis to get a manageable number of variables.

To evaluate people's performance:
Application of Quartile analysis to compare the people's

To examine socioeconomic characteristics:
Application of frequency distribution

To evaluate place's performance: Weighted Urban Proliferation (WUP) at Macro-Level and Walk Score at Micro-Level

To elaborate the desirability of sustainable options

To examine satisfaction with residential choice:
Examination of the general satisfaction and the satisfaction with various aspects of the neighborhood

To examine the residential aspirations of households:
Examination of the intention to move, reason(s) to move, desired dwelling and neighborhood type

Discussion and final conclusion, implications

Figure 3.2   Research design

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Objective 1 has been expanded in the first Article: "Does 'where we live' reflect 'what we do'? An overview of empirical evidence on place-people correspondence with regards to sustainability performance." The 2nd, 3rd, and 4th research objectives have been developed in the second article: "Residential choice and sustainability: comparing the performance of people's place with their out-of-home behaviors in sprawled city". Finally, the last objective has been investigated in the third paper: "Are sustainable residential choices also desirable? a study of household satisfaction and aspirations with regard to current and future residential location". So, we will discuss them in detail (e.g. research methodology and analysis) in the relevant papers. The following three sections present description of the survey, study area and sample selection.

The first research aim was to identify the sustainability indicators. To achieve this aim, we reviewed the relevant literature and we identified the variables that can be used to evaluate sustainability performance of people and places. Then, we categorized the variables related to assessment of behaviors into the following four groups: spatiotemporal, social, environmental and economic. The second research aim was to identify the behavioral profiles of households. To achieve this aim, we performed a principal component analysis on 20 variables and six factors were extracted. These factors were put on to a two-step clustering analysis leading to identification of seven behavioral profiles. The third research aim was to evaluate people's performance. To achieve this aim, we used quartile analysis to compare the households' behavior with regards to eighteen variables that can be ranked with regards to sustainability. . The next research aim was to identify the factors accounting for clusters' intensity, diversity and sustainability of behavior. To do so, we used the frequency distribution analysis on socio-economic and spatial characteristics of the households. The next research aim was to assess the sustainability performance of places and to compare it to the profiles of behaviors. We used the neighborhood Walk Score. Finally, the final last research aim was to examine the desirability of sustainable residential choices. To achieve this aim, we again used the frequency distribution analysis and examined the satisfaction of the households with their actual residential choice and their residential aspiration.

3.4   Description of the survey

The data used for this research is drawn from the « Demain Quebec » Survey database. This survey, posted on-line in May 2011, by the Interdisciplinary Research Group on suburbs (GIRBa) under the supervision of Carole Després, focused on the residents of the Quebec Metropolitan Community. GIRBa is an affiliated research group to the CRAD (Centre de Recherche en Aménagement et Développement) at Laval university, Quebec, Canada. This survey is a part of the project "Quebec 2020: Vers un projet collectif d'aménagement durable". It was lunched at the time when several major projects (e.g. eco-quartiers) was been carried out. All these projects may influence housing markets, public services and transport.

The survey aimed to define different profiles of residents in the metropolitan area of Quebec, along with their residential trajectories and aspirations, and to understand the logic embedded in their daily mobility. The questionnaire consists of 130 questions which can be regrouped under three key matters: 1) household profiles, lifestyle and the use of information and communications technology; 2) residential choice and biographies; 3) daily activities and transport mode use. Respondents had a one-month period between May 12 and June 15, 2011, to complete the questionnaire which in total required 60 to 90 minutes, depending on the number of persons in their household, they had to answer several additional questions. The vast majority completed the questionnaire within the first two weeks of the on-line survey, over one or two days. A total of 3338 respondents participated in the survey out of which 2,500 completed the three parts of the questionnaire.

The « Demain Quebec » survey is a non-random sample. Not only households participated on a voluntary basis, they were recruited through several routs: 1) emails to mainstream employers in the Quebec Metropolitan Community (Ministries, Quebec Metro High Tech Park, hospitals, CEFRIO (Centre francophone d'informatisation des organisations), RTC (Réseau de transport de la Capitale, municipalities, etc.) and to higher education institutions on the territory of the Quebec Metropolitan Community (colleges and universities), inviting them to disseminate the link to the questionnaire to their employees and users; 2) distribution of the bookmarks at the public transport stops, neighborhood activities, shopping centers entrances; 3)

posters in public libraries and community centers; 4) advertisements in newspapers and blogs; and finally 5) interviews on television, radio and printed press.

This survey provides complete data about the major daily activities of the respondents, their location, attendance rate, mode of transport, allowing us to measure sustainable behavior. Furthermore, accessing to such an extensive, rich and unique database of the households of Quebec Metropolitan Community allows us to uncover multitudinous segmentation of sustainability profiles, both environmentally and behaviorally.

3.5   Study area

This research focuses on Quebec census metropolitan areas (QCMA), Canada and compares the people's behaviors and place performance on its sprawl territory. The study of Razin & Rosentraub (2000) on the link between municipal fragmentation and suburban sprawl showed that Quebec City, along with Montreal, is the most municipally fragmented metropolitan areas in Canada. Their study compared 96 cities in North America. In Quebec City, the degree of urban sprawl measured by Weighted Urban proliferation(WUP)[6] increased 9-fold from 2.41 UPU[7]/m2 in 1971 to 21.02 UPU/m2 in 2011 (Nazarnia, Schwick, & Jaeger, 2016)..

3.6   Sample selection

We obtained our analytic sample by excluding the respondents who did not meet our inclusion criteria. The first criterion was to select the households with at least one working respondents. We considered this criterion because working respondents may have higher decision-making capacity (e.g. financial, stability) for their residential choice. Furthermore, the inclusion of households with working respondents enables us to examine people's behavior with a higher level of complexity (e.g. including professional, familial and consumption activities). The second criterion was the occupation type. We considered the households in which at least one person had a full-time job. The inclusion of these criteria enables us to allocate frequency

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[6] "WUP is a combination of urban permeation (UP), urban dispersion (DIS), and utilization density […]"(Nazarnia et al., 2016, p.1231)

[7] UPU stands for urban permeation unit per square metre of built-up area   (Jaeger, Bertiller, Schwick, Cavens & Kienast, 2010).

more precisely and to have a clear image of their commuting behavior. We eliminate cases which lack substantial values in order to keep the cases that enable us to have a precise action space (e.g. a lot of activity with long distance, but no frequency). A total of 746 respondents met our inclusion criteria, and we analyzed their 7589 activities.

The following chapters present the research results (articles 2 and 3) and the discussion and conclusion of the thesis.

CHAPTER 4

RESIDENTIAL CHOICE AND SUSTAINABILITY:
COMPARING THE PERFORMANCE OF PEOPLE'S PLACE WITH
THEIR OUT-OF-HOME BEHAVIORS IN SPRAWLED CITY (Article 2)

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4.1 Abstract

It is often assumed that the sustainability performance of the place where people live goes hand in hand with the sustainability of their behaviors (Boarnet et al., 2011; Van Acker & Witlox, 2010). However, people's lifestyle and life situation, as well as experienced transport convenience were all found to influence the degree of fitness between the two. For this reason, the study reported here profiled people's behaviors for out-of-home activities and assessed their sustainability performance, and then compared these with the sustainability performance of their residential location, as measured by a bundle of sustainability indicators. The databases used, were on the one hand, « Demain Quebec », an Internet survey of residents of the Quebec City metro area detailing their household, residence and mobility characteristics, and, on the other hand, Quebec metropolitan area Census data. To assess the sustainability level of people's behaviors, a principal component analysis was performed on 20 variables which led to six factors accounting for 74.9% of the variance: 1) Car dependency, global travel distance and economic costs, 2) Global activity intensity, 3) Recreational activity intensity and travel distance, 4) Shopping activity intensity and travel distance, 5) Travel distance in public transport and global travel time costs, and 6) Housing expenditures and global active transport distance.

These variables were later applied to a two-step clustering analysis leading to seven profiles of behaviors. To assess the sustainability performance of people's residential location and compare it to the profiles of behaviors, we used the neighborhood Walk Score. The results confirm the correspondence between place performance and people's performance for some profiles, while for others the influence of location seems to be strengthened, weakened, eliminated or reversed by interfering factors such as households' socio-economic characteristics. In some profiles, neither of these indicators accounted for the fitness or discrepancy between the place and behavior sustainability. It was rather the households' prevailing activities in relationship with the location in which they take place that played a crucial role in sustainable prosperity. This being said, residing in a sustainable place that can accommodate daily activities for a household does not guarantee that these behaviors will be sustainable in terms of their environmental, economic or social impacts, because the decision is often taken beyond the realm of strictly rational factors. In such wise, it is crucial to raise awareness among households and decision-makers with the residential offer about what this choice implies in terms of the residential location and modalities of daily activities and sustainability.

4.2 Introduction

Urban sprawl has been widely criticized for its detrimental role in the realization of sustainable behaviors (Karol & Brunner, 2009; Lovejoy, Handy, & Mokhtarian, 2010). Nevertheless, many households are attracted by the suburban life for different reasons. Two categories of factors influence the ongoing suburbanization. The first group comprises of micro-level factors affecting the decision-making process at the scale of households. The relationship with nature and the residential biography (Fortin & Després, 2009), the distance from the workplace (Vidal & Kley, 2010), and the geography of social ties (Kährik, Leetmaa, & Tammaru, 2012), are among the important factors that push-pull households in or out of suburbia. Macro-level factors, such as housing market and housing policies were also found to be of influence (e.g. ongoing construction of residential neighborhoods in suburban areas) so is the process of metropolization which induces multiple and selective concentrations of activity centers (Gaussier et al., 2003). Several municipalities are acting to either densify existing

neighborhoods, redevelop brownfields, or else develop more compact suburbs, namely TOD (Handy, Cao, & Mokhtarian, 2005).

This being said, the question of whether living in denser and more central locations induces more sustainable lifestyles and that, on the other hand, living in low-density sprawled neighborhoods implied non-sustainable lifestyles is a complex one, and so is the answer. To account for the sustainability performance of residential choices, both settlements and behaviors need to be examined at once before pinning a more sustainable choice over another.

Our review identified 17 studies attempting to measure the degree of fitness between place and residential performances with regard to sustainability,[8] with results showing alternately congruity, incongruity or no significant relationship between place and behaviors in terms of sustainability (Lotfi, Després, & Lord, 2017a). Some researchers found that variables such as public transport services, residential and population densities, mixity of functions, centrality, proximity to a desired facility, and accessibility encouraged sustainable behaviors, namely decreasing car use and increasing public and active transport use (Aditjandra et al., 2012; Jarass & Heinrichs, 2014; Kamruzzaman et al., 2013; Nahlik & Chester, 2014; Susilo et al., 2012), decreasing distance travel (e.g. Boussauw & Witlox, 2011; Fan et al., 2011; Figueroa et al., 2014; Valkila & Saari, 2013), commuting time (Farber & Li, 2013; Zhu et al., 2014) or energy use (Yu et al., 2012), increasing social satisfaction (Delmelle et al., 2013) or neighborhood commitment (McCunn & Gifford, 2014). Some other researchers found that despite the existence of more compact spatial structures, people conducted unsustainable behaviors such as increasing car use or decreasing use of public and active transport (Buys &

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[8] Eight came from Western countries, most specifically the US (Barr & Prillwitz, 2012; Fan, Khattak, & Rodriguez, 2011; Farber & Li, 2013), the UK (Aditjandra, Cao, & Mulley, 2012; Susilo, Williams, Lindsay, & Dair, 2012), and Belgium (Boussauw & Witlox, 2011; De Vos, Derudder, Van Acker, & Witlox, 2012), one additional from China (Yu, Zhang, & Fujiwara, 2012). Researchers are from various disciplines, namely three from geography (Barr & Prillwitz, 2012; Boussauw & Witlox, 2011; De Vos, Derudder, Van Acker, & Witlox, 2012), three more from civil engineering (Aditjandra, Cao, & Mulley, 2012; Nahlik & Chester, 2014; Valkila & Saari, 2013), and one from environmental psychology (McCunn & Gifford, 2014). Most researchers applied cross-sectional observation with either quantitative research design (Boussauw & Witlox, 2011; De Vos et al., 2012; Delmelle et al., 2013), a qualitative one (Buys & Miller, 2011), or mixed ones (Barr & Prillwitz, 2012; Valkila & Saari, 2013). Some research are the results of cohort observation within quantitative research design: (quasi) longitudinal (Aditjandra et al., 2012; Kamruzzaman, Baker, Washington, & Turrell, 2013), prospective (Nahlik & Chester, 2014) or retrospective (Yu et al., 2012). The dominance of quantitative research design fits the nature of the investigation subject, sustainability, which should be measured quantitatively.

Miller, 2011; De Vos et al., 2012; Susilo et al., 2012), increasing distance traveled (Figueroa et al., 2014; Jarass & Heinrichs, 2014), increasing in energy use (Yu et al., 2012), or money expenditure on car (Yu et al., 2012), or decreasing social satisfaction (Delmelle et al., 2013). Finally, some researchers found no influence of variables related to more compact spatial structures on decreasing car use or increasing public and active transport use (Barr & Prillwitz, 2012; Kamruzzaman et al., 2013; Susilo et al., 2012; McCunn & Gifford, 2014).

The research presented compares people and place performances in different residential locations, endorsing a holistic approach to sustainability (Böhringer & Jochem, 2007). It considers all relevant environmental, social and economic variables concurrently and coequal (Hacking & Guthrie, 2008), "moving away from analyses of isolated risks and toward a broader understanding" (Steinemann, 2000, p. 640), and approaching this complicated subject in all its complexity (Bell & Morse, 2008, p. 110). Sustainability is understood as the reconciliation of three imperatives: environmental, social and economic. It refers to an accomplishment in which natural environment can thrive, and human needs are met, while promoting social equity and economic viability (Dale & Hill, 2001; Coffman & Umemoto, 2009). Sustainability performance refers to the amount of useful outcome achieved by people or the place they live in.

This study is an attempt to assess the sustainability performance of people's behavior, compare it to their residential location and to elucidate the underlying factors accounting for various degrees of fitness between the two. The objective is to provide reliable indicators and sound empirical evidence on the sustainability of different residential locations and outlooks to inform social, environmental and economic policies, as well as the mechanisms facilitating or restraining the potential impacts (Bamberg, 2006).

4.3   Study area, database and sample

4.3.1 The study area

The reported study compares the sustainability performance of people's behaviors and that of their places of residence in the Quebec metro area of Canada. It is an especially interesting territory due to the extent of urban sprawl and fragmentation of this territory for a

limited population. Indeed, comparing 96 cities in North America, Razin & Rosentraub (2000) showed that Quebec, with the Montreal, were the most fragmented metropolitan areas in Canada. The degree of urban sprawl of the Quebec Census Metropolitan Areas (CMAs) was measured by Nazarnia et al. (2016), and was found to have increased 9-fold between 1971 and 2011[9] (Figure 4.1)
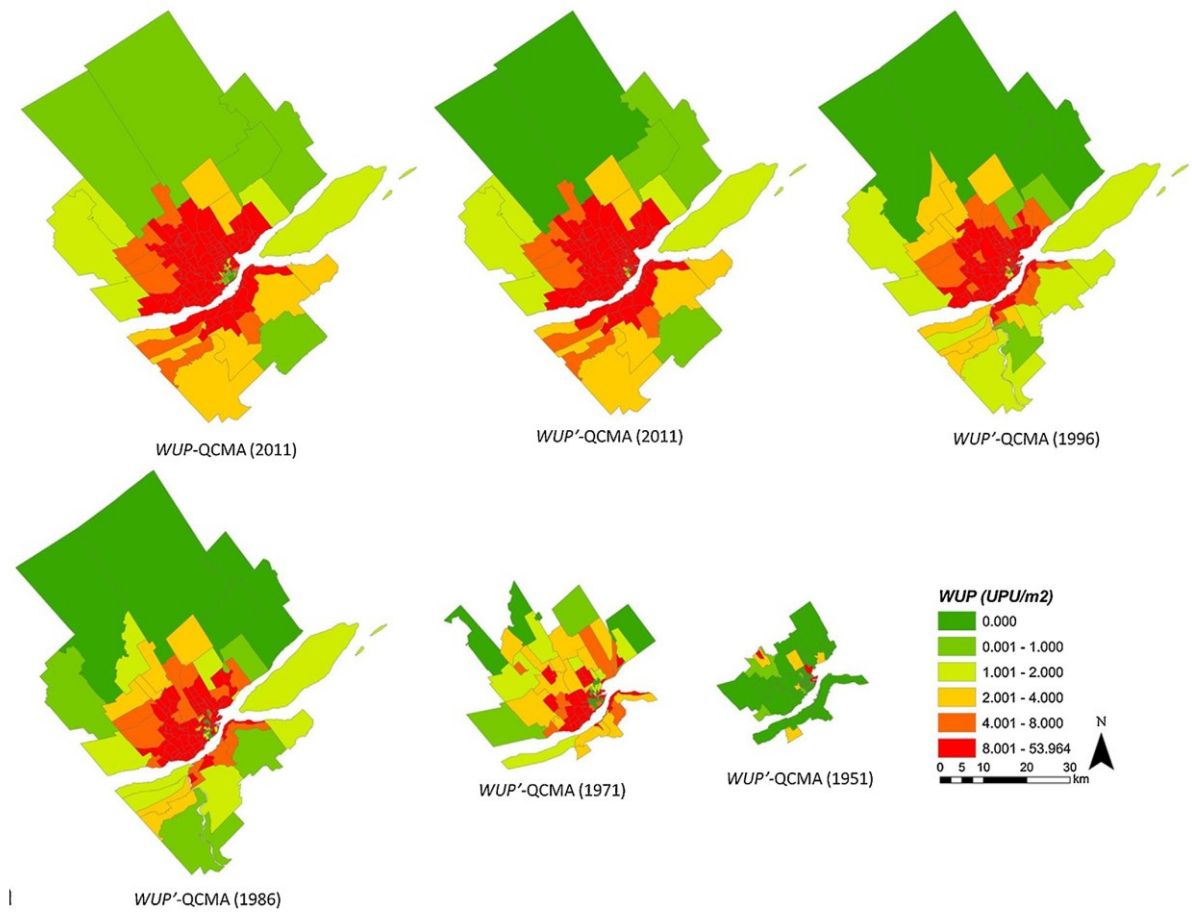
Figure 4.1   Urban sprawl (WUP) at the census tract level in the Quebec CMA from 1951 to 2011[10].

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[9] As measured by "urban permeation units" per m^2 of settlement area, going more specifically from 2.41 UPU/m2 in 1971 to 21.02 UPU/m2 in 2011.

[10] WUP_indicates the value of urban sprawl in accordance with UD' (UD'= inhabitants/settlement area). (Nazarnia et al., 2016, p.1242)

The environmental, social and economic costs of urban sprawl are regularly reported, namely the ecosystem degradation, increased greenhouse gas emissions, lack of accessibility of services, spatial segregation, cost of municipal infrastructure and services (Carole Després et al., 2004). Municipalities are reacting by increasing public transport, proposing eco-neighborhoods or densifying existing ones. These struggles, however, pose significant challenges for urban planners and policy makers: providing diverse, adequate and sustainable housing, as well as taking into account the needs and financial resources of the household have become important in policy making in Quebec agglomeration (Société d'habitation du Québe, 2011).

4.3.2 Database and Sample

To measure people's performance, the database « Demain Québec » was used. It is the result of an Internet survey carried out by the Interdisciplinary Research Group on Suburbs (GIRBa) at Laval University (Canada) in May 2011.[11] This survey, addressed to the 765,706 residents of the Quebec metro area, aimed at identifying the various co-existing profiles of households, but also of residential situations and daily mobility patterns. A non-probabilistic sample of 2500 respondents filled out the three modules of the questionnaires (for a total of 130 items)[12]. A subsample of 746 cases was kept after applying the following inclusion criteria: 1) at least one respondent in the household worked full-time, which enabled us to examine complex daily schedules (including daily commuting, familial obligations and consumption activities) and excluded students or retired people who might have less financial stability and control over

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[11] This survey was part of the project " Québec 2020: Vers un projet collectif d'aménagement durable " directed by Carole Després. It was launched among residents of the Quebec CMA when major projects (e.g. tramways and eco-quartiers) were under consideration with the potential of influencing housing markets and public services.

[12] When compared with the population surveyed in the 2011 Canadian Census (the same year as our survey), being from a non-probabilistic survey, the sample does not represent the true diversity of the population of the Quebec metropolitan community and therefore cannot be used to generalize the results to the entire population. It also includes a significant over-representation of young, highly educated individuals and professional workers in relation to the population of the Quebec Metropolitan community. Table 4.1 shows the sociodemographic characteristics of the final subsample.

their choice of residence; 2) cases with no missing information on activity locations and frequencies.

Table 4.1   Socio-economic characteristics of the sub-sample of 746 respondents applied to this study

Sociodemographic characteristics	Categories	# of respondents	%
Gender	Females	405	54.3
	Males	334	44.8
	Missing	7	0.9
Age of respondent	18–24	51	6.8
	25–34	294	39.4
	35–44	161	21.6
	45–54	172	23.1
	55 and over	62	8.3
	Missing	6	0.8
Number of income	1	226	30.3
	2	517	69.3
	Missing	3	0.4
Household annual income	Less than 30 000$	23	3.1
	30 000- 50 000$	103	13.8
	50 000-75 000$	116	15.5
	75 000-100 000$	122	16.4
	100 000-125 000$	107	14.3
	125 000-150 000$	109	14.6
	150 000$ and more	104	13.9
	Missing	62	8.3
Type of Job	Public Administration	232	31.1
	Professional, scientific, technical services	165	22.1
	Education services	123	16.5
	Health care and social assistance	80	10.7
	Finance, insurance, real estate and leasing	33	4.4
	Information, culture and recreation	19	2.5
	Other	94	12.7
Education	Secondary-College	197	26.4
	Bachelor	256	34.3
	Master	210	28.2
	Doctorate	44	5.9
	Missing	39	5.2
Household size	1	159	21.3
	2	259	34.7
	3	130	17.4
	4	138	18.5
	5+	60	8.0
Household structure	People living alone	159	21.3
	Couples without dependent children	223	29.9
	Single parents	39	5.2
	Couples with dependent children	289	38.7
	Other	36	3.8

Table 4.1   Socio-economic characteristics of the sub-sample of 746 respondents applied to this study

Sociodemographic characteristics	Categories	# of respondents	%
Number of children	0	413	55.4
	1	125	16.8
	2	146	19.6
	3+	62	8.3
Age of youngest dependent child	No children living at home	413	55.4
	Youngest child under the age of 5	125	16.8
	Youngest child aged 6 to 11	70	9.4
	Youngest child age 12 to 16	55	7.4
	Youngest child over the age of 16	83	11.1
Home ownership	Owners	509	68.2
	Tenants	237	31.8
Home ownership and Home type	Owners-detached house	324	43.4
	Owners-semi-detached house	81	10.9
	Owners-apartment condominium	99	13.3
	Tenants-detached house	5	0.7
	Tenants-semi-detached house	9	1.2
	Tenant-apartment small building	166	22.3
	Tenant- apartment large building	48	6.4
	Missing	14	1.9
Car ownership	0	124	16.6
	1	324	43.4
	2	260	34.9
	3+	38	5.1

4.4 Methods and results

4.4.1 Measuring the people's performances

People's performance is considered as the amount of useful outcome accomplished by individuals in their daily mobility behaviors. Twenty-seven items from the « Demain Quebec » questionnaire were initially selected to evaluate these behaviors in terms of their sustainability, as assorted to eight categories of indicators identified in the literature review (Lotfi et al., 2017a), accounting for the economic, environmental, social and temporal dimensions of behaviors. Since the database had been collected for more general purposes than those of our study, the best available proxies were selected to operationalize some variables. The final set of 25 variables is described on Table 4.2.

Table 4.2   Descriptive statistics of the variables used to evaluate people's performance

#	Variable	Description	Frequency	Mean/Mode*	Std. dev.	Min.	Max.
1	DSTCFRQ_Work_Wkly.	Distance traveled to work per week (m)	746	95475	66442	38	396567
2	DSTCFRQ_L&R_Wkly.	Distance traveled for recreation per week (m)	746	23517	33440	0	345994
3	DSTCFRQ_CONS_Wkly.	Distance traveled for shopping per week(m)	746	46024	47080	0	41615
4	DSTCFRQ_Car_Wkly.	Distance traveled by car per week (m)	746	149904	162072	0	1210049
5	DSTCFRQ_PT_Wkly.	Distance traveled by public transport per week(m)	746	51668	72796	0	560128
6	DSTCFRQ_AT_Wkly.	Distance traveled by active transport per week(m)	746	24601	39673	0	294271
7	Time_TRSP-Work_Wkly.	Time spent on transport for work purpose per week(min)	746	311	161	10	1000
8	TRSPCost	Expenditure on transport ($)	746	537	392	21	2458
9	Hcost	Expenditure on housing	746	633	449	9	3600
10	FuelCONS	Household fuel consumption**	746	155	148	0	1000
11	Area_SD_Ellipse	Area of action space**	742	35844356	45245103	13703	566288000
12	Distance_DWLG_EllipseCenter	Distance between dwelling and center of action space***	744	5725	5659	133	32325
13	NofPLACES	Number of visited places	746	9.68	3.5073	3	20
14	NofPLACE_Wkly.	Number of frequented places per week	746	5.839	2.5353	1	15
15	NofPLACE_CONS	Number of visited places for shopping	746	5.975	2.6011	0	13
16	NofPLACES_LR	Number of visited places for recreation	746	0.835	0.5684	0	5
17	DSTC_LR	Distance to recreation center (s)	746	6588	7902	0	56386
18	DSTC_CONS	Distances to shopping center(s)	746	40279	33498	0	367602
19	Proportion_Place_CONS	Proportion of visited places for shopping	746	60.77	14.91	0	90.91
20	Proportion_Place_LR	Proportion of visited places for recreation	746	9.16	7.05	0	40.0
21	DSTC-FRQ_SCH_Wkly.	Distance traveled for education per week (m)	243	91549	94547	1781	560128
22	TRSPCost_Income	Percentage of income to spend on transport	684	7.645	6.463	0	91
23	HCost_Income	percentage of income to spend on housing	689	10.377	8.217	0	77
24	SenseofSecuity	Satisfaction with the security of neighborhood	742	3.56/4	0.625	1	4
25	SocialCohesion	Satisfaction with characteristics of neighbors ****	734	3.22/3	0.739	1	4

* We applied **mode** for categorical variables.

** **Household fuel consumption:** we applied the same methodology of Yu, Zhang, & Fujiwara (2012), using fuel cost to reflect energy consumption.

*** **Action space**: We used ArcGIS to calculate standard deviational ellipse that represents action spaces of households (Buliung & Kanaroglou, 2004)

**** **Satisfaction with characteristics of neighbors**: This variable is used to measure neighborhood social cohesion.

In total, 25 indicators were considered to evaluate the sustainability of out-of-home behaviors. To identify the underlying structure of these behaviors, a Principal Component Analysis (PCA) was performed. For this analysis, five additional indicators had to be excluded. Three of them had important numbers of missing values (distance traveled to school per week, because 413 households did not have children at home; percentages of income spent on housing and on transport, because 62 respondents didn't answer the question about their earnings). Two others had been measured on a four-point scale which did not fit the statistical requirement[13] for PCA analysis: the neighborhood perceived sense of security and social cohesion.[14] A final set of 20 variables was used for the PCA.

We applied a Principal Component Analysis (PCA) to a set of 20 variables based on items initially selected from « Demain Quebec » to evaluate the out-of-home behaviors. This set of variables encompasses four very large and different aspects of behaviors as follow: economic, environmental, social and temporal dimensions. The PCA reduced dimensionality of the set of 18 indicators into six components, explaining 74.9% of the variance were identified (Table 4.3 and 4.4). The two key elements that affect component differentiation are frequency and intensity of activity and mode of transport.

The first factor (F1) was labeled « Car dependency, global travel distance and economic costs » relates highly to questions about car use, commuting distance, action space and distance between dwelling and center of action space. The second factor (F2) was labeled « Global activity intensity » concerns frequency and intensity of activities in general. The third factor (F3) was labeled « Recreational activity intensity and travel distance » involves items related to recreational activities including frequency, distance and intensity. The fourth factor (F4) was labeled « Shopping activity intensity and travel distance » has high loading for questions related to shopping activities including frequency, distance and intensity. The fifth factor (F5) was labeled « Travel distance in public transport and global travel time cost » contains the variables

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13 If we need to perform PCA on categorical and dichotomous variables special considerations are required (Gie Yong & Pearce, 2013).

14 Although excluded from the PCA analysis, they were reintroduced for the interpretation of the results.

of distance travelled by public transport per week and time spent on transport for work purpose per week. The last factor (F6) was labeled «Housing expenditure and global active transport distance » contains the variables of expenditure on housing and Distance traveled by active transport per week.

Table.4.3   Statistical validity measures of the conducted Principal Component Analysis

Measure	Aiming for	Results
Communalities	Mean communalities ≥.6 for over 250 observation (Stevens, 1986)	0.749197
Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy	Value over 0.5 (Gie Yong & Pearce, 2013)	0.625
Bartlett's Test of Sphericity	Significant level of $p < .05$ (Gie Yong & Pearce, 2013)	0.000
Total variance explained (cumulative)	At least 70 (Gorsuch, 1983)	74.897
Percentage of non-redundant residuals with absolute values greater than 0.05	Less than 50 of the non-redundant residuals with absolute higher than .05 (Gie Yong & Pearce, 2013)	36

Table 4.4   Factors extracted from Principal component analysis of behavioral

Factor	Item(s) with highest factor loading and items with negative factors loading	Highest loading eigenvalue	Percentage of contribution to solution
Factor 1: Car dependency, global travel distance and economic costs	Distance travelled by car per week	.875	21.397%
	Household fuel consumption	.825	
	Expenditure on transport	.757	
	Distance travelled to work per week	.739	
	Distance between dwelling and center of action space	.636	
	Area of action space	.630	
Factor 2: Global activity intensity	Number of visited places	.934	14.325%
	Number of frequented places per week	.910	
Factor 3: Recreational activity intensity and travel distance	Distance to recreation center (s)	.793	13.729%
	Number of visited places for recreation purpose	.793	
	Proportion of visited places for recreation purpose	.782	
	Distance travelled for recreation purpose per week	.760	
Factor 4: Shopping activity intensity and travel distance	Proportion of visited places for shopping purpose	.838	11.159%
	Distances to shopping center(s)	.598	
	Number of visited places for shopping purpose	.571	
	Distance travelled for shopping purpose per week	.428	
Factor 5: Travel distance in public transport and global travel time cost	Distance travelled by public transport per week	.831	8.701%
	Time spent on transport for work purpose per week	.797	
Factor 6: Housing expenditure and global active transport distance	Expenditure on housing	.776	5.586%
	Distance traveled by active transport per week	-.596	
Total explained variance			**74.920 %**

4.4.2 Defining people's performance profiles

The next step is to use the six factors identified in the PCA to define profiles of households in terms of sustainability performance for out-of-home behaviors. These profiles are most useful to help planners target policies promoting behavioral change (Barr & Prillwitz, 2012), different ones addressing subsets of the population. Since cluster analysis is a powerful tool for identification of patterns of behaviors, we used the six derived factors listed in Table 4.4 to conduct a hierarchical analysis. The resulting dendogram led to the natural grouping of households with similar behavioral profiles. We got nine solutions by cutting the dendrogram and then performed a two-step cluster analysis which led to a statistically acceptable (*Fair*) seven-cluster solution where all factors contributed and the resulting groups were with relatively even in size [we looked for *Ratio of Size* (Largest Cluster to Smallest Cluster) of less than 3.] (Figure 4.2). Table 4.5 compares the scores of the six factors used to define the seven clusters while Table 4.6 compares the five removed variables from the PCA, which we then placed into the Evaluation Fields in the two-step cluster analysis. These results are discussed in the presentation of each cluster that follows.
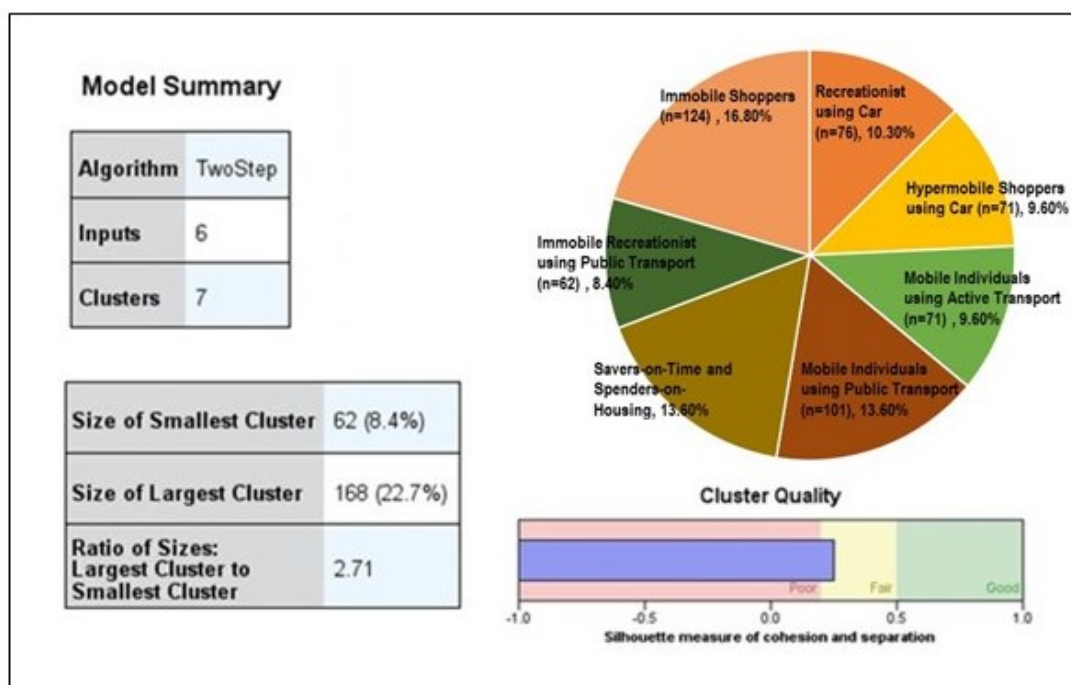
Figure 4.2   Cluster analysis to derive behavioral clusters in Quebec CMAs

Table 4.5   Comparison of the scores of six factors within the seven clusters of people's behavior

Factor	Mobile Individuals using Active Transport (n=168; 22.7%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Shoppers (n=124; 16.8%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)
Car dependency, global travel distance and economic costs	-0.69	-0.16	-0.13	-0.3	0.77	1.64	0.16
Global activity intensity	0.7	0.01	-0.97	0.15	-0.23	0.73	-0.78
Recreational activity intensity and travel distance	0	0.17	-1.24	0.13	1.8	-0.6	0.35
Shopping activity intensity and travel distance	0.01	-0.03	0.5	0.07	0.68	-0.18	-1.7
Travel distance in public transport and global travel time cost	-0.32	-0.6	-0.2	1.73	-0.25	-0.1	0.19
Housing expenditure and global active transport distance	-0.53	0.84	-0.14	0.25	-0.42	0.25	-0.33

Table 4.6   Comparison of the scores of five variables situated in the Evaluation Fields within the seven clusters

Variable	Measure	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)
Distance traveled for education purpose per week (m) (Mean) Std.Deviation=94547	Mean	30934	100961	11974	39213	17322	46352	12020
% of income to spend on transport (Mean) Std. Deviation=6.46	Mean	7.04	10.55	3.57	4.84	7.12	9.95	5.46
% of income to spend on housing (Mean) Std. Deviation=8.21	Mean	6.16	8.11	9.32	9.79	12.26	6.68	6.96
Sense of Security (Satisfaction with the security of neighborhood)*	Mean	3.72	3.50	3.50	3.58	3.52	3.69	3.52
	Mode	4 70.3%	4 54.2%	4 54.2%	4 63.4%	4 58.7%	4 75.8%	4 60.5%
Social Cohesion (Satisfaction with characteristics of neighbors)*	Mean	3.30	3.21	3.21	3.24	3.21	3.26	3.29
	Mode	3 55.4%	3 47.3%	3 47.3%	3 49.5%	3 49.3%	4 45.9%	3 54.1%

*1. Not at all satisfied; 2. Not very satisfied; 3. Somewhat satisfied; 4. Very satisfied

The Recreationist using car (n=76; 10.3%) are characterized by the highest intensity of recreational activities and shopping. They are relatively car-dependent with extended action spaces and a considerable distance between its center of gravity and the residence. The share of their income spent on housing expenditure is similar to the one on transport (6.16% compared to 7.04%). They were the most satisfied with the sense of security and the social composition of their residential areas. One tenth of the sample is part of this cluster.

The Hypermobile shoppers using car (n=71; 9.6%) are very mobile and highly car-dependent. Their daily activities are located far from their dwelling and dispersed on the largest action spaces, although few have to do with out-of-home recreational purposes. The average percentage of their income spent on transport (10.55%) is higher than the one spent on housing (8.11%). Compared to the other groups, they are relatively satisfied with the sense of security of their neighborhood but less so with its social composition. One tenth of the sample is part of this cluster.

The Mobile individuals using active transport (n=168; 22.7%) are very mobile with a limited action space. They work, shop and entertain close to their residence. They show a low level of car use but also no tendency to use public transport; active transport being part of their daily lives. Hence, they spent little of their time in transport. They are also the ones spending the smallest share of their income on transport (an average of 3.57 %) but more than average on housing (9.32%). Compared to the other profiles, they are the least satisfied with the sense of security and social composition of their neighborhood. This group makes up for almost a quarter of the sample.

The Mobile individuals using public transport (n=101; 13.6%) show the highest public transport use and commuting time, despite activities relatively concentrated around their dwelling. The average percentage of their income spent on housing (9.79%) is almost twice the one spent on transport (4.84%). They are relatively satisfied with the sense of security and social composition of their neighborhood. One out of every eight households is part of this cluster.

The Savers-on-Time and Spenders-on-Housing (n=138; 18.6%) travel for work, recreation and shopping but less frequently than the first group. They are those walking the most, with the shortest commuting time, and using the least public transport. They are those

spending the highest percentage of their income on housing (an average of 12.26%). As for the *Hyperactive Locals*, they are among the least satisfied with the sense of security and social composition of their neighborhood. This group is the second largest group with one-fifth of the sample.

The Immobile recreationist using public transport (n=62; 8.4%) show the less intense level of out-of-home activities and associated mobility, compared to the other groups except the Domocentered Locals. They have the lowest level of shopping activity, with a tendency for recreational activities. Despite a low general mobility, they spent a high proportion of their income on transport (9.95%) compared to housing (6.68%). The global score for sense of security in the neighborhood (75.8%) was the highest for this group, although it was the lowest for social composition (45.9%).

The Immobile shoppers (n=124; 16.8%) are those traveling the least frequently and the closest to their home. They show the lowest intensity of recreation activity, mostly related to shopping. Hence, they do not spend much time on traveling, or on public transport. They are the one spending among the least percentage of their income on housing (6.96%) and on transport (5.46%).

4.4.3 Accounting for clusters' intensity, diversity and sustainability of behaviors

4.4.3.1 The influence of households' socio-economic characteristics

To interpret these seven clusters, it is important to compare the socio-economic outlook of their members. Since the clusters were established on the basis of households' daily mobility intensity and characteristics, it is interesting to find out that the three variables accounting for the differences between the clusters are the tenure status, the number of cars and the number of incomes in the households (Table 4.7).We can already expect a link with the characteristics of the residence in terms of housing type, cost and location; we will come back to this in the next section.

Table 4.7 Socio-economic characteristics of the clusters by decreasing levels of association

Variable (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	All n=740 100%	p-value/ Cramer's V
Tenure Status‡‡								n=740	.000***/.301
Owners	89.5	93.0	50.0	71.3	66.7	77.4	62.1	68.5	
Tenants	10.5	7.0	50.0	28.7	33.3	22.6	37.9	31.5	
Car ownership‡‡								n=740	.000***/.297
0	6.6	0.0	37.5	19.8	5.1	8.1	16.9	16.4	
1	40.8	14.1	47.6	58.4	50.7	32.3	41.9	43.5	
2	43.4	67.6	13.7	20.8	41.3	50.0	37.1	35.0	
3+	9.2	18.3	1.2	1.0	2.9	9.7	4.0	5.1	
# income‡‡								n=740	.000***/.261
1	21.1	4.2	47.6	32.7	27.5	30.6	29.8	30.5	
2	78.9	95.8	52.4	67.3	72.5	69.4	70.2	69.5	
Household structure‡‡								n=705	.000***/.219
People living alone	14.9	1.4	41.0	23.7	20.0	15.3	19.1	22.4	
Couples w/o dependent children	40.5	17.4	31.1	24.7	36.9	20.3	37.4	31.1	
Single-Par	4.1	2.9	5.6	6.2	3.8	11.9	6.1	5.5	
Couples w/ dependent children	40.5	78.3	22.4	45.4	39.2	52.5	37.4	41.0	

Table 4.7   Socio-economic characteristics of the clusters by decreasing levels of association

Variable (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	All n=740 100%	p-value/ Cramer's V
# of children‡‡								n=740	.000***/.207
0	55.3	21.1	72.6	50.5	58.0	38.7	58.9	55.0	
1	19.7	18.3	9.5	22.8	15.9	19.4	19.4	16.9	
2	19.7	31.0	13.7	21.8	19.6	29.0	15.3	19.7	
3+	5.3	29.6	4.2	5.0	6.5	12.9	6.5	8.4	
Household size‡‡								n=740	.000***/.207
1	14.5	1.4	39.3	22.8	18.8	14.5	17.7	21.4	
2	44.7	19.7	32.7	24.8	40.6	27.4	42.7	34.3	
3	15.8	18.3	11.3	26.7	15.9	21.0	19.4	17.6	
4	19.7	31.0	13.1	19.8	18.1	24.2	15.3	18.6	
5+	5.3	29.6	3.6	5.9	6.5	12.9	4.8	8.1	
Age of youngest dependent child‡								n=740	.000***/.178
No children at home	55.3	21.1	72.6	50.5	58.0	38.7	58.9	55.0	
Youngest child over 16	11.8	12.7	7.7	11.9	13.8	21.0	6.5	11.2	
Youngest child 12 to 16	3.9	11.3	4.2	14.9	2.9	11.3	8.9	7.4	
Youngest child 6 to 11	9.2	15.5	6.5	8.9	7.2	16.1	9.7	9.5	
Youngest child < 5	19.7	39.4	8.9	13.9	18.1	12.9	16.1	16.9	

Table 4.7　　　Socio-economic characteristics of the clusters by decreasing levels of association

Variable (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	All n=740 100%	p-value/ Cramer's V
Household annual income‡								n=678	.000***/.155
Less than 30 000$	0.0	0.0	7.7	2.2	1.5	10.2	0.9	3.4	
30–50000$	13.2	1.5	20.0	17.8	15.4	6.8	19.4	15.0	
50–75000$	16.2	10.3	23.9	20.0	12.3	16.9	13.0	16.7	
75–100000$	17.6	14.7	16.8	17.8	15.4	13.6	26.9	17.8	
100-125000$	19.1	19.1	9.7	15.6	19.2	16.9	15.7	15.8	
12–150000$	20.6	23.5	11.6	21.1	13.8	11.9	14.8	15.9	
+ 150 000$	13.2	30.9	10.3	5.6	22.3	23.7	9.3	15.3	
Generation‡								n=729	.007**/.137
Y (1972–1992)	45.9	40.8	51.8	39.6	54.0	28.3	50.8	46.8	
X (1966–1972)	29.7	45.1	29.3	46.5	27.7	50.0	30.3	34.8	
Baby boomers (1946–1965)	24.3	14.1	18.9	13.9	18.2	21.7	18.9	18.4	
Education‡								n=701	.007**/.131
Second./Col	38.9	23.9	17.8	34.0	22.8	35.7	32.8	27.7	
Bachelor	30.6	49.3	32.5	35.1	38.2	39.3	34.5	36.2	
Master	26.4	23.9	39.5	28.7	30.9	19.6	26.9	29.8	
Doctorate	4.2	3.0	10.2	2.1	8.1	5.4	5.9	6.3	
Gender N-S								n=734	.255/na
Male	40.8	42.3	47.6	40.6	54.1	37.7	44.7	45.3	

Table 4.7   Socio-economic characteristics of the clusters by decreasing levels of association

Variable (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	All n=740 100%	p-value/ Cramer's V
Female	59.2	57.7	52.4	59.4	45.9	62.3	55.3	54.7	
Age N-S								n=734	.130/na
18-24	4.0	2.8	7.8	5.0	10.1	8.3	7.3	6.9	
25-34	41.3	38.0	43.4	34.7	43.5	20.0	43.1	39.5	
35-44	16.0	31.0	19.3	27.7	19.6	26.7	19.5	21.9	
45-54	28.0	23.9	18.7	25.7	21.0	33.3	21.1	23.2	
55 and over	10.7	4.2	10.8	6.9	5.8	11.7	8.9	8.4	

***p < 0.001

a Chi-Square statistics were used to compute most test results.

b This Chi-Square test is reported significant but the test is invalid due to more than 20 of expected values being under 5.0.

c Reference: https://www12.statcan.gc.ca/census-recensement/2011/as-sa/98-311-x/98-311-x2011003_2-eng.cfm

Legend: Cramer's V: ‡ Weak relationship (0.1-.0.2), ‡‡ Moderate relationship (0.2-0.4), and ‡‡‡ Strong relationship (0.4-0.8)

Three other variables were found to be moderately associated with the defined clusters, all related to the household composition, that is, the number of dependent children, the household size, and household structure. Four additional variables were weakly associated with the typology of clusters; by decreasing order, they are the age of the youngest dependent child, the household annual income, the generation type, and the education level. No significant relationship was found between the clusters in terms of respondents' gender or age.

The « Hypermobile Shoppers using Car » and « Recreationist using Car » are made up almost systematically of two-income households, homeowners, the majority of a detached-house, and those who owned at least one car but more likely two or more. What distinguishes the first from the second cluster is that there are dominantly no dependent children living at home or under 16 in the former, while it is the opposite for the latter. With no surprises, there are more baby boomers in the first group and more of the generation X in the second. The second group is also wealthier and show a higher level of instruction. We can hypothesize that the second group has less time for all type of activities, but spend more time on recreational activities, most probably children related.

The three groups of « Mobile Individuals using Active Transport », « Savers-on-Time and Spenders-on-Housing », and « Immobile Shoppers » comprise the highest share of renters. Unlike this cluster who are made up people living alone and with one income, the « Savers-on-Time and Spenders-on-Housing », and « Immobile Shoppers » are mostly composed of couples, either with or without children, with two-income. What distinguishes the « Mobile Individuals using Active Transport » from all the other six clusters is the low level of car ownership and the high levels of education. Despite the high similarity between « Savers-on-Time and Spenders-on-Housing » and « Immobile Shoppers », the members of first group are wealthier.

The two last clusters of « Mobile individuals using public transport » and « Immobile recreationist using public transport » are composed mostly of two-income households and homeowners. One fifth of the « Mobile individuals using public transport » didn't own a car and majority of the « Immobile recreationist using public transport » owned two or more cars. While almost more than half of the « Mobile individuals using public transport » don't have children, nearly half of the « Immobile recreationist using public transport » have two or more children.

There are more baby boomers in the second group, with a relatively high percentage of households with a low income.

4.4.3.2 The influence of the objectively measured behaviors

We found no particular thresholds used to evaluate the performance of households in terms of the sustainability of their out-of-the-home mobility (Lotfi et al., 2017a). Different geographical boundaries have different spatial structures and planning providing distinct choices of domiciles, as well as destinations and associated daily mobility (Aditjandra et al., 2012) Consequently, it is hardly possible to define a universal gauge. An alternative is to objectively assess these different sets of opportunities and observe people's choice within them. For this purpose, we compare the seven clusters on the 18 spatial, economic, temporal and social indicators of sustainability identified in the literature review (Table 2.2), using a Quartile analysis and ranking their performance from most sustainable (Q1) to most unsustainable (Q4) (Table 4.8).[15]

Interestingly, the two most powerful indicators to account for the different levels of sustainability performance among the clusters are related to recreation and not to employment, on which a considerable number of studies focus. There are the distance to recreation purposes and the distance traveled per week for recreation. The next most powerful variable was the global distance traveled weekly per car. Weekly distance and travel time to work only came out as the 4th and 5th variables accounting for the differences in the clusters' sustainability performance. The next most significance set of indicators has to do with the distance between the dwelling and the gravity center of households' activity space, as well as with their monthly fuel and transport consumption. Interestingly, all these indicators explain more than the most powerful socio-economic indicators discussed in the previous section, that is, the tenure status, the number of cars and the number of incomes in the households (Cramer tests > 0,320 compared to 0,301).

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[15] Except for sense of security and social cohesion for which we use the original four-point Likert scale.

Table 4.8   Clusters' Sustainability Performance by decreasing strength of indicators

Objectively Measured Sustainability Indicators (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	p-value/ Cra-mer's V
Distance to recreation center (s) ‡‡‡								.000/ .560
Q1: Most sustainable	1.3	36.6	9.5	6.9	5.1	3.2	100.0	
Q2: Sustainable	0.0	21.1	40.5	21.8	40.6	38.7	0.0	
Q3: Unsustainable	9.3	15.5	39.9	34.7	36.2	25.8	0.0	
Q4: Most unsustainable	89.3	26.8	10.1	36.6	18.1	32.3	0.0	
Distance traveled for recreation purpose per week (m) ‡‡‡								.000/ .559
Q1: Most sustainable	1.3	35.2	10.7	5.9	4.3	3.2	100.0	
Q2: Sustainable	1.3	22.5	41.7	30.7	37.7	25.8	0.0	
Q3: Unsustainable	5.3	16.9	31.5	34.7	39.1	46.8	0.0	
Q4: Most unsustainable	92.1	25.4	16.1	28.7	18.8	24.2	0.0	
Distance traveled by car per week (m) ‡‡								.000/ .388
Q1: Most sustainable	9.2	1.4	41.7	33.7	10.1	17.7	35.5	
Q2: Sustainable	2.6	2.8	33.9	40.6	26.8	29.0	24.2	
Q3: Unsustainable	17.1	15.5	20.8	18.8	37.0	29.0	31.5	
Q4: Most unsustainable	71.1	80.3	3.6	6.9	26.1	24.2	8.9	

Table 4.8   Clusters' Sustainability Performance by decreasing strength of indicators

Objectively Measured Sustainability Indicators (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	p-value/ Cra-mer's V
Distance traveled to work per week (m) ‡‡								.000/ .358
Q1: Most sustainable	6.6	8.5	54.2	1.0	31.9	12.9	22.6	
Q2: Sustainable	11.8	8.5	32.7	22.8	27.5	21.0	33.9	
Q3: Unsustainable	23.7	19.7	11.3	46.5	27.5	37.1	21.8	
Q4: Most unsustainable	57.9	63.4	1.8	29.7	13.0	29.0	21.8	
Time spent on transport for work purpose per week ‡‡								.000/ .356
Q1: Most sustainable	21.1	19.7	47.6	0.0	54.3	33.9	40.3	
Q2: Sustainable	31.6	26.8	26.2	0.0	28.3	27.4	26.6	
Q3: Unsustainable	25.0	19.7	17.9	18.8	14.5	12.9	11.3	
Q4: Most unsustainable	22.4	33.8	8.3	81.2	2.9	25.8	21.8	
Distance between dwelling and center of action space‡‡								.000/ .327
Q1: Most sustainable	6.6	7.0	53.6	6.9	27.5	16.1	24.2	
Q2: Sustainable	11.8	18.3	31.0	20.8	30.4	25.8	25.8	
Q3:Unsustainable	18.4	29.6	13.1	32.7	34.1	33.9	21.8	

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Table 4.8   Clusters' Sustainability Performance by decreasing strength of indicators

Objectively Measured Sustainability Indicators (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	p-value/ Cra-mer's V
Q4: Most unsustainable	63.2	45.1	2.4	39.6	8.0	24.2	28.2	
Fuel consumption per month ($)‡‡								.000/ .323
Q1: Most sustainable	14.5	0.0	42.3	28.7	6.5	16.1	21.0	
Q2: Sustainable	7.9	0.0	32.7	29.7	30.4	16.1	24.2	
Q3: Unsustainable	32.9	22.5	20.8	25.7	34.8	27.4	33.1	
Q4: Most unsustainable	44.7	77.5	4.2	15.8	28.3	40.3	21.8	
Expenditure on transport/month ($)‡‡								.000/ .320
Q1: Most sustainable	18.4	0.0	48.2	29.7	13.0	14.5	26.6	
Q2: Sustainable	22.4	11.3	35.1	33.7	23.9	11.3	19.4	
Q3: Unsustainable	22.4	16.9	14.3	25.7	37.0	30.6	31.5	
Q4: Most unsustainable	36.8	71.8	2.4	10.9	26.1	43.5	22.6	
Distance to shopping center(s) ‡‡								.000/ .306
Q1: Most sustainable	6.6	4.2	24.4	13.9	26.1	62.9	34.7	
Q2: Sustainable	14.5	4.2	38.7	17.8	26.8	27.4	28.2	
Q3: Unsustainable	22.4	33.8	22.6	33.7	27.5	9.7	24.2	
Q4: Most unsustainable	56.6	57.7	14.3	34.7	19.6	0.0	12.9	

Table 4.8　　　Clusters' Sustainability Performance by decreasing strength of indicators

Objectively Measured Sustainability Indicators (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	p-value/ Cra-mer's V
Distance traveled for shopping purpose per week(m) ‡‡								.000/ .298
Q1: Most sustainable	6.6	7.0	23.8	13.9	24.6	67.7	33.9	
Q2: Sustainable	17.1	8.5	31.5	24.8	28.3	22.6	29.0	
Q3: Unsustainable	21.1	25.4	23.8	30.7	36.2	8.1	21.0	
Q4: Most unsustainable	55.3	59.2	20.8	30.7	10.9	1.6	16.1	
Action space area ‡‡								.000/.295
Q1: Most sustainable	14.5	1.4	38.1	6.9	21.7	29.0	41.5	
Q2: Sustainable	18.4	9.9	31.0	29.7	29.0	17.7	26.0	
Q3: Unsustainable	13.2	22.5	21.4	29.7	33.3	30.6	23.6	
Q4: Most unsustainable	53.9	66.2	9.5	33.7	15.9	22.6	8.9	
Monthly housing expenditure ($)‡‡								.000/ .271
Q1: Most sustainable	38.2	21.1	29.8	18.8	1.4	51.6	33.1	
Q2: Sustainable	18.4	12.7	41.1	32.7	13.8	19.4	24.2	
Q3: Unsustainable	19.7	32.4	22.0	24.8	35.5	22.6	25.0	
Q4: Most unsustainable	23.7	33.8	7.1	23.8	49.3	6.5	17.7	
Distance traveled by AT per week (m)ᵃ ‡‡								.000/ .270

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Table 4.8   Clusters' Sustainability Performance by decreasing strength of indicators

Objectively Measured Sustainability Indicators (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	p-value/ Cra-mer's V
Q1: Most sustainable	36.8	43.7	5.4	27.7	38.4	48.4	40.3	
Q2: Sustainable	19.7	23.9	9.5	20.8	26.1	16.1	23.4	
Q3: Unsustainable	9.2	18.3	32.7	27.7	26.8	24.2	21.8	
Q4: Most unsustainable	34.2	14.1	52.4	23.8	8.7	11.3	14.5	
Distance traveled for education/week (m)‡‡								.000/ .270
Q 1: Most sustainable	5.3	16.7	36.6	20.0	31.7	21.9	37.0	
Q2: Sustainable	21.1	14.6	31.7	28.6	26.8	25.0	29.6	
Q3: Unsustainable	26.3	14.6	29.3	22.9	34.1	28.1	22.2	
Q4: Most unsustainable	47.4	54.2	2.4	28.6	7.3	25.0	11.1	
% of income to spend on transport ‡‡								.000/ .248
Q1: Most sustainable	13.2	2.9	45.2	28.9	21.5	15.3	24.1	
Q2: Sustainable	25.0	13.2	35.5	33.3	25.4	25.4	26.9	
Q3: Unsustainable	25.0	32.4	12.3	25.6	30.8	23.7	27.8	
Q4: Most unsustainable	36.8	51.5	7.1	12.2	22.3	35.6	21.3	
% income to spend on housing ‡								.000/ .171

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Table 4.8   Clusters' Sustainability Performance by decreasing strength of indicators

Objectively Measured Sustainability Indicators (%)	Recreationist using Car (n=76; 10.3%)	Hypermobile Shoppers using Car (n=71; 9.6%)	Mobile Individuals using Active Transport (n=168; 22.7%)	Mobile Individuals using Public Transport (n=101; 13.6%)	Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	Immobile Recreationist using Public Transport (n=62; 8.4%)	Immobile Shoppers (n=124; 16.8%)	p-value/ Cra-mer's V
Q1: Most sustainable	40.9	34.3	32.0	25.5	13.0	50.0	29.9	
Q2: Sustainable	21.2	30.0	19.0	26.5	29.7	11.5	18.7	
Q3: Unsustainable	16.7	27.1	22.2	26.5	25.4	11.5	35.5	
Q4: Most unsustainable	21.2	8.6	26.8	21.4	31.9	26.9	15.9	
Neighborhood security N-S								.138/ NA
Very satisfied	70.3	67.6	54.2	63.4	58.7	75.8	60.5	
Somewhat satisfied	28.4	22.5	39.8	31.7	36.2	19.4	33.1	
Not very satisfied	1.4	8.5	6.0	5.0	3.6	3.2	4.8	
Not at all satisfied	0.0	1.4	0.0	0.0	1.4	1.6	1.6	
characteristics of neighbors N-S								.717/NA
Very satisfied	36.5	42.3	36.4	36.4	36.8	45.9	36.9	
Somewhat satisfied	55.4	46.5	47.3	49.5	49.3	36.1	54.1	
Not very satisfied	5.4	8.5	13.9	12.1	9.6	13.1	7.4	
1: Not at all satisfied	2.7	2.8	2.4	2.0	4.4	4.9	1.6	

a For active transport, higher distance means more sustainable because of the positive influence of active transport on well-being that is an important dimension of social sustainability (Bacon et al., 2012; Deakin et al., 2001; Woodcraft, 2012).

b This Chi-Square test is reported significant but the test is invalid due to more than 20% of expected values being under 5.0.

Legend: Cramer's V : ‡ Weak relationship (0.1-0.2), ‡‡ Moderate relationship (0.2-0.4), and ‡‡‡ Strong relationship (0.4-0.8)

The Recreationist using car were very unsustainable for most variables (Figure 4.3), except for expenditure on transport and housing. Most households were relatively active compared to the other groups, walking and cycling a lot. Most of them traveled long-distance with a resulting high fuel consumption and also long distance for recreation purpose. However, most of them spent less time travelling to work as a result of high car use.

The Hypermobile Shoppers using Car, unlike members of the first group, most members of this group were very sustainable, with regard to their recreation activities (Figure 4.4). On the contrary, almost 85% of these members were unsustainable with regard to the distances traveled for shopping purpose. Interestingly, more than half were economically (so) unsustainable spending too much on housing of their income. Like the first group, they didn't spend much of their time traveling to their high frequency of car use.
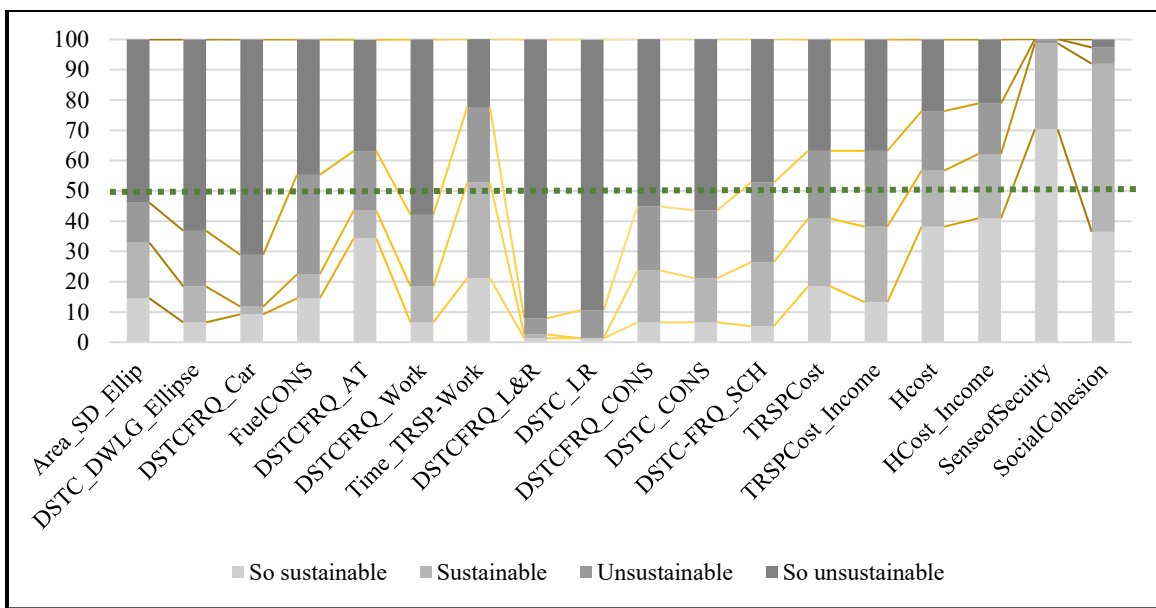

Figure 4.3   Sustainability performance assessment (SPA) of the Recreationist using car
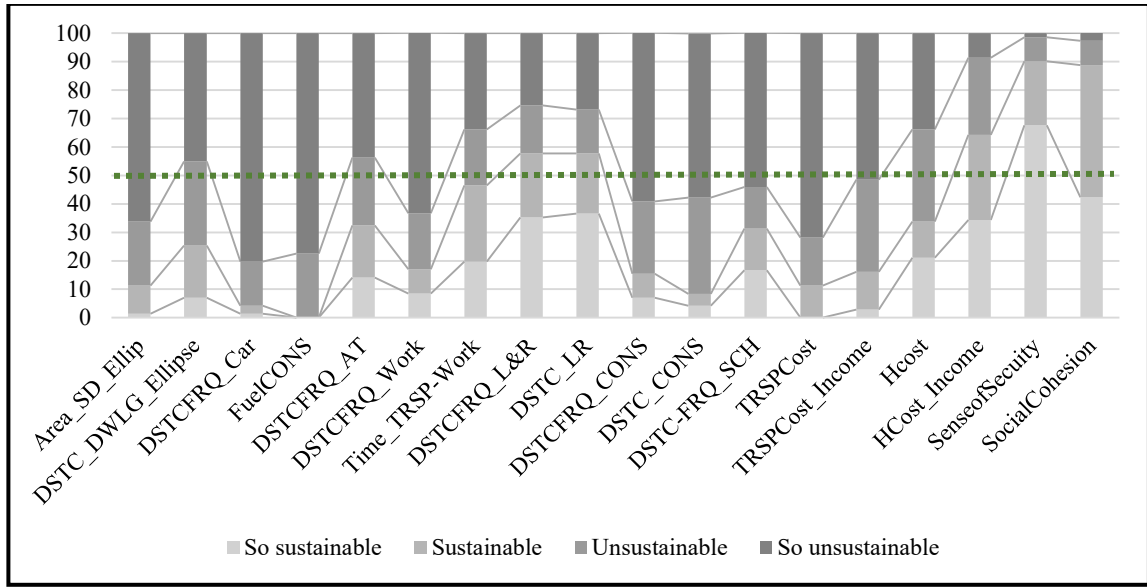
Figure 4.4   Sustainability performance assessment (SPA) of the Hypermobile Shoppers using Car

The Mobile Individuals using Active Transport, the largest group, (n=168; 22.7%) were (so) sustainable on all 18 variables (Figure 4.5), more so on shopping-related distance compared to recreation-related traveled ones. These households were more sustainable in their expenditure on transport than on housing. There were so sustainable (41.7%) and sustainable (33.9%) in car use leading to the very high level of sustainability in terms of fuel consumption. The highest rate of households were not very satisfied with the social cohesion of their neighborhood (13.9%).

The Mobile individuals using public transport were very unsustainable in terms of their commuting time (Figure 4.6) linked to the long distance traveled to work. Despite extended space and long distance between their dwelling and the center of their action space, these households were relatively sustainable in car use and fuel consumption.
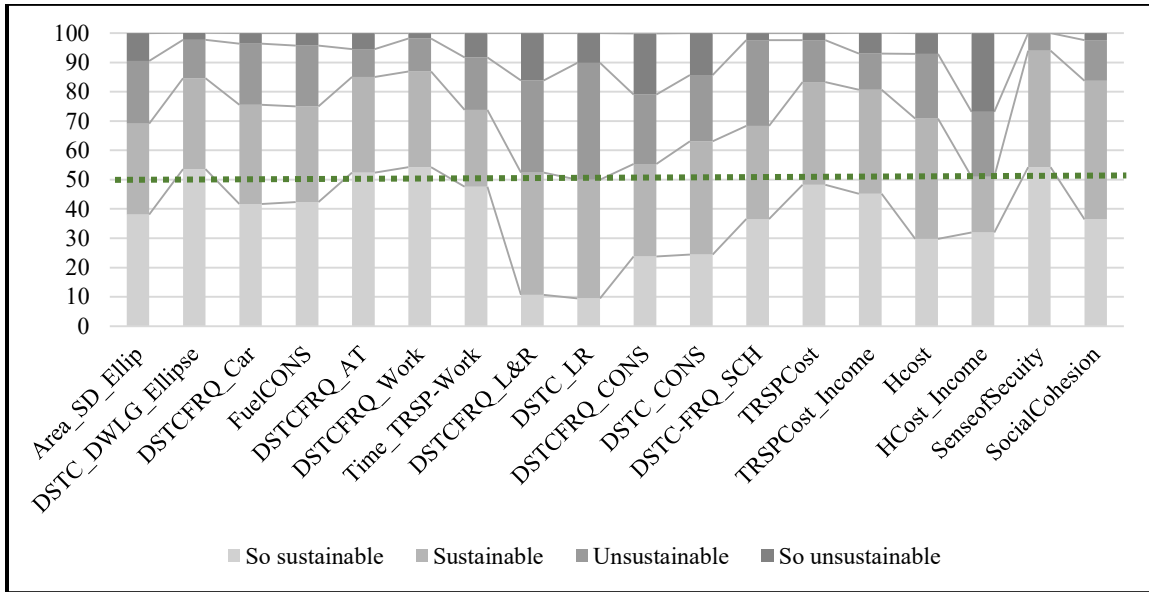
Figure 4.5   Sustainability performance assessment (SPA) of the Mobile Individuals using Active Transport
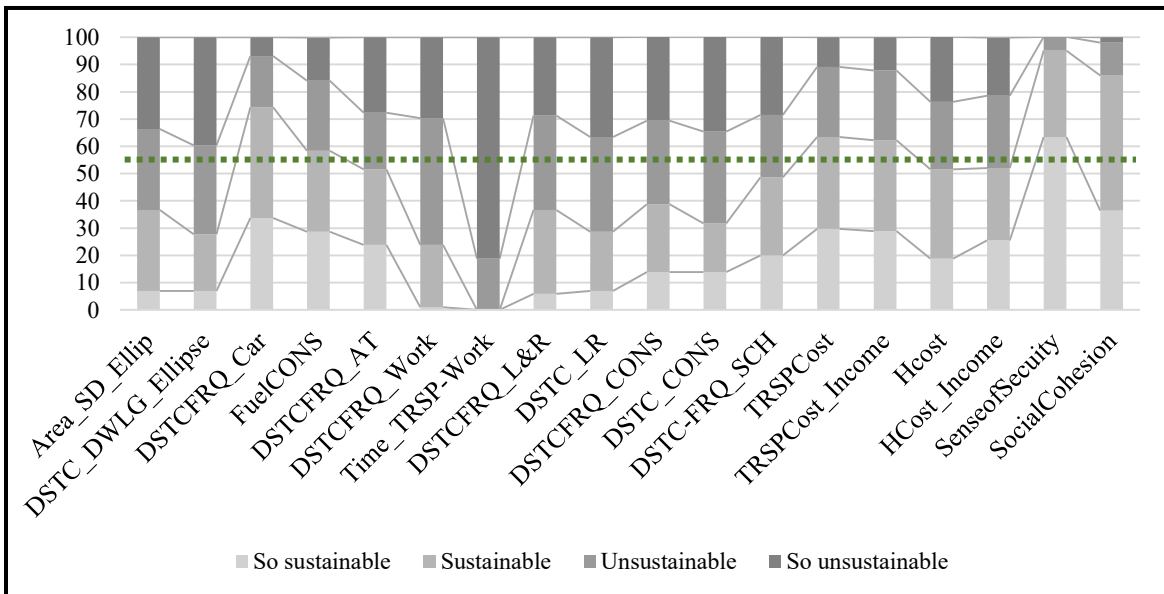

Figure 4.6   Sustainability performance assessment (SPA) of the Mobile Individuals using Public Transport

The Savers-on-Time and Spenders-on-Housing were the most sustainable households in terms of the time spent on transport for go to work. Therefore, this cluster had the highest number of households who were so unsustainable in terms of both expenditures on housing (49.3%) and proportion of income spent on housing (31.9%). For most of the 18 variables, this group had almost the equal share of households who were sustainable and unsustainable.

The Immobile Recreationist using Public Transport were very unsustainable on almost all variables except for housing cost, shopping-related distance, and satisfaction with neighborhood (Figure 4.8). More than 90% of them were unsustainable or very unsustainable in their shopping-related distance. Despite a high level of sustainability associated with housing cost, they spent more in transport cost.

The Immobile shoppers were somewhat sustainable for most variables (Figure 4.9). Although around 70% of them had the limited action space, less than 50% had limited distance between their dwelling and the center of their action space, suggesting lack of co-ordination between their dwelling location and their action space. All members were very sustainable in terms of the distance travelled to their recreation activities.
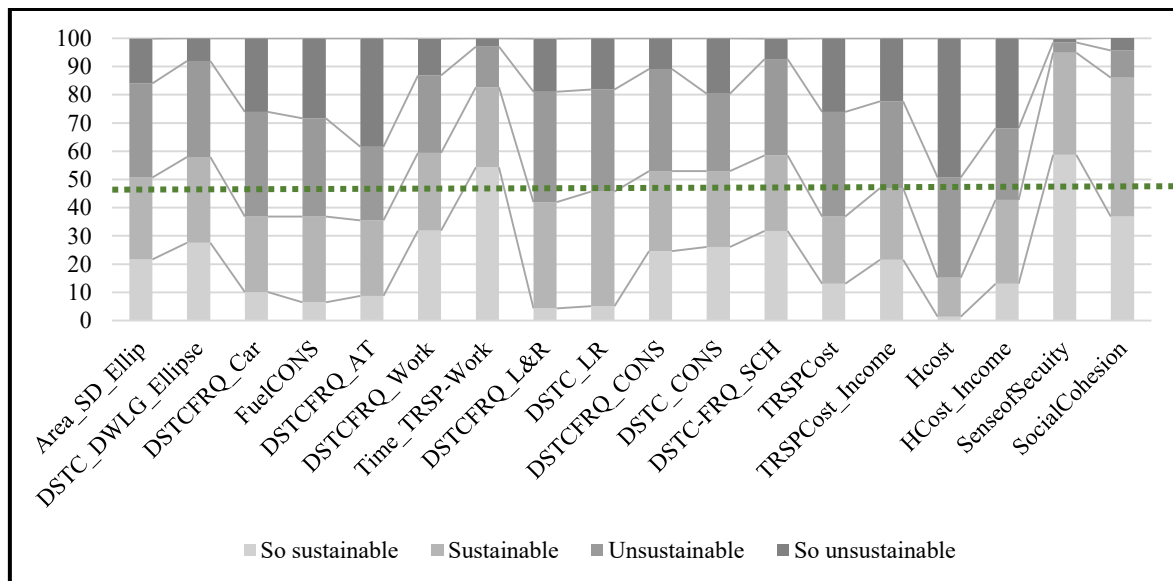

Figure 4.7   Sustainability performance assessment (SPA) of the Savers-on-Time and Spenders-on-Housing
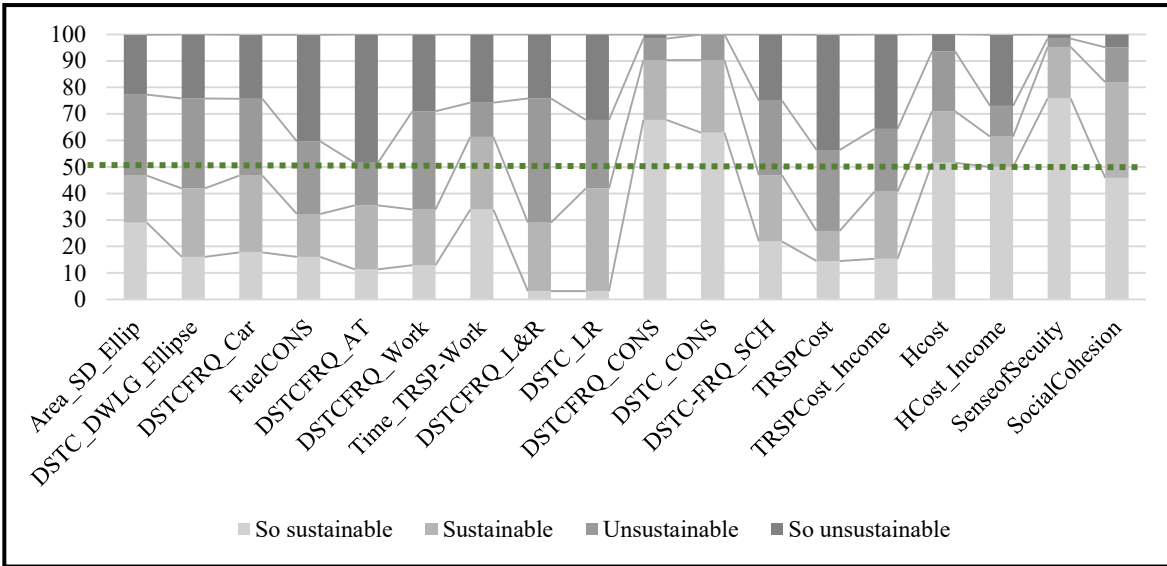
Figure 4.8   Sustainability performance assessment (SPA) of the Immobile Recreationist using Public Transport
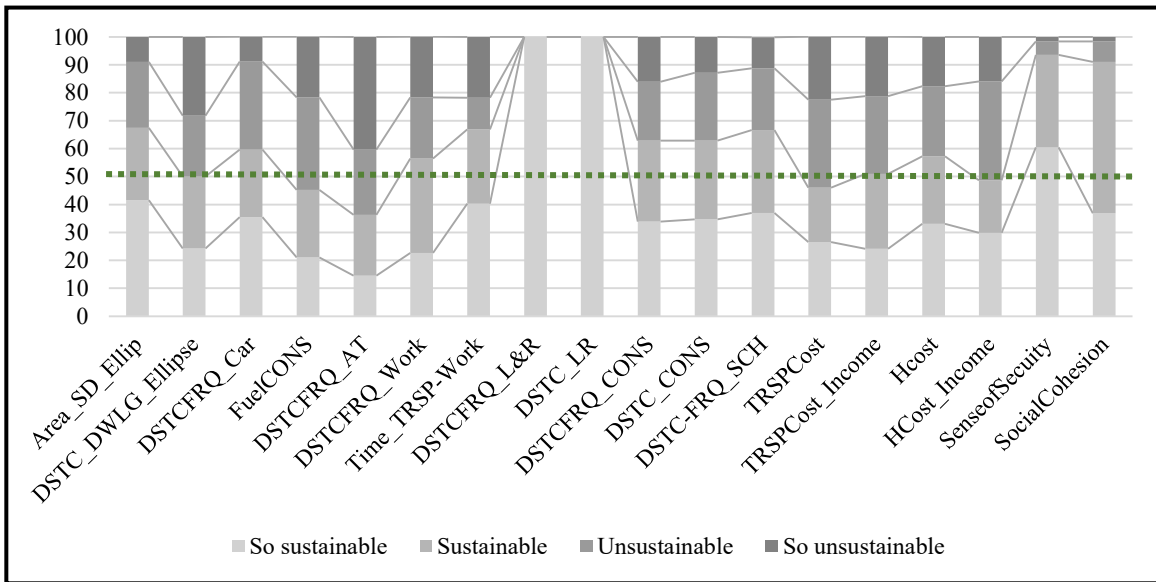

Figure 4.9   Sustainability performance assessment (SPA) of the Immobile shoppers

4.4.3.3 Description of spatial characteristics of the clusters

Regarding the spatial characteristics of groups, we observed that our clusters differed significantly in terms of their residential location, type of urbanization, and Walk Score at a p-value of .001 (Table 4.9). The two car-dependent clusters (Hypermobile Shoppers using Car and Recreationist using Car) and the Immobile Recreationist using Public Transport are also mostly residing in single-family detached houses. Although the « Savers-on-Time and Spenders-on-Housing » and « Immobile Shoppers » are mainly residing in different types of single-family houses, the apartment building is a common dwelling type among these three groups. « Mobile Individuals using Active Transport » is the only cluster in which the proportion of households residing in apartment buildings is higher that of the single-family houses.

Except for the two car-dependent groups (Hypermobile Shoppers using Car and Recreationist using Car), the other groups mostly reside in Quebec. Nearly half of the Car-dependent group resides outside Quebec: Lévis, MRC La Jacques-Cartier and Saint-Augustin-de Desmaures, respectively. These two groups are mostly living in new suburbs and in the periphery where Walk Score are the lowest. Except for the Mobile « Individuals using Active Transport », the other groups are mostly residing in New Suburbs with a higher Walk Score compared to the Car-dependent groups. What distinguishes this cluster is that they are mostly living in the inner-city neighborhoods and older suburbs in very walkable locations.

Table 4.9   Spatial characteristics of the clusters

Variable (%)	Recreationist using Car n=76 10.3%	Hypermobile Shoppers using Car n=71 9.6%	Mobile Individuals using Active Transport n=168 22,7%	Mobile Individuals using Public Transport n=101 13.6%	Savers-on-Time and Spenders-on-Housing n=138 18.6%	Immobile Recreationist using Public Transport n=62 8.4%	Immobile Shoppers n=124 16.8%	All n=740 100%	p-value
Dwelling type								n=702	.000[a]
Single family detached house	77.0	68.6	24.8	43.5	39.4	62.7	43.2	46.2	
Single family semi-detached house	4.1	14.3	5.7	13.0	9.1	5.1	11.0	8.8	
Single family attached house	1.4	1.4	5.7	5.4	4.5	1.7	3.4	3.8	
Apartment (duplex or triplex)	6.8	7.1	18.5	8.7	12.9	10.2	16.1	12.7	
Apartment of 3 stories or less without elevator	8.1	4.3	34.4	19.6	23.5	10.2	16.9	19.7	
Apartment of 4–6 stories with elevator	2.7	4.3	7.0	7.6	6.8	10.2	7.6	6.7	
Apartment building of 6 stories or more	0.0	0.0	3.8	2.2	3.8	0.0	1.7	2.1	
Location								n=740	.000[a]
L'Ancienne-Lorette	0.0	1.4	1.2	1.0	2.2	3.2	4.8	2.0	
Lévis	22.4	25.4	3.6	6.9	5.8	22.6	12.9	11.6	
Quebec	51.3	50.7	94.6	88.1	89.1	71.0	79.0	79.5	
Saint-Augustin-de-Desmaures	7.9	7.0	0.6	3.0	2.2	1.6	1.6	2.8	

Table 4.9   Spatial characteristics of the clusters

Variable (%)	Recreationist using Car n=76 10.3%	Hypermobile Shoppers using Car n=71 9.6%	Mobile Individuals using Active Transport n=168 22,7%	Mobile Individuals using Public Transport n=101 13.6%	Savers-on-Time and Spenders-on-Housing n=138 18.6%	Immobile Recreationist using Public Transport n=62 8.4%	Immobile Shoppers n=124 16.8%	All n=740 100%	p-value
MRC L'Ile-d'Orléans	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
MRC La Côte-de-Beaupré	5.3	4.2	0.0	1.0	0.7	0.0	0.8	1.4	
MRC La Jacques-Cartier	11.8	11.3	0.0	0.0	0.0	1.6	0.8	2.6	
Boroughs of Quebec								n=588	.000[a]
Beauport	12.8	13.9	5.0	19.1	8.9	13.6	15.3	11.4	
Charlesbourg	7.7	25.0	5.7	11.2	13.0	18.2	13.3	11.6	
La Cité-Limoilou	20.5	13.9	62.9	19.1	26.8	15.9	31.6	34.2	
La Haute-Saint-Charles	23.1	27.8	3.1	13.5	4.1	11.4	9.2	9.4	
Sainte-Foy--Sillery--Cap-Rouge	23.1	8.3	17.6	22.5	28.5	22.7	15.3	20.4	
Les Rivières	12.8	11.1	5.7	14.6	18.7	18.2	15.3	13.1	
Boroughs of Lévis								n=86	.014[b]
Desjardins	11.8	38.9	33.3	42.9	12.5	64.3	50.0	37.2	
Chutes-Chaudières-Est	23.5	38.9	66.7	42.9	62.5	21.4	31.3	36.0	
Chutes-Chaudières-Ouest	64.7	22.2	0.0	14.3	25.0	14.3	18.8	26.7	
Type of urbanization								n=740	000[a]
Inner city	2.6	2.8	38.7	5.9	15.2	8.1	16.1	16.4	
Old suburbs	10.5	8.5	32.1	17.8	26.8	12.9	21.0	21.2	

Table 4.9   Spatial characteristics of the clusters

Variable (%)	Recreationist using Car n=76 10.3%	Hypermobile Shoppers using Car n=71 9.6%	Mobile Individuals using Active Transport n=168 22,7%	Mobile Individuals using Public Transport n=101 13.6%	Savers-on-Time and Spenders-on-Housing n=138 18.6%	Immobile Recreationist using Public Transport n=62 8.4%	Immobile Shoppers n=124 16.8%	All n=740 100%	p-value
New suburbs	34.2	40.8	28.6	61.4	52.2	54.8	51.6	45.3	
Periphery	52.6	47.9	0.6	14.9	5.8	24.2	11.3	17.2	
Walk Score								n=465	.000[a]
Mean	32.34	33.84	71.28	48.35	55.15	46.58	55.22	53.48	
	Car-Dependent	Car-Dependent	Very Walkable	Car-Dependent	Somewhat Walkable	Car-Dependent	Somewhat Walkable	Somewhat Walkable	

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

a Chi-Square statistics (for crosstabs) and T-test (for comparing means) were used to compute test results.

b This Chi-Square test is reported significant but the test is invalid due to more than 20 of expected values being under 5.0.

4.4.4 Conformity between people's performance and their place of living

To measure the conformity between people's performance and their place of living ,we performed the analysis of the place based on the Walk Score[16] of the dwelling address, hoping to get a clearer image of the relationship between place and people's behavior (P=.000, Cramer's V=.285) (Table 4.10). Table 4.11 presents the boroughs of dwelling address of respondents. The results of Walk Score analysis implement clarity and ambiguity simultaneously. In the following, we present a consolidated review of people's behavior, their socio-economic features and their residential place in the discussion to get a better understanding of place-people's performance in a sprawl city.

The Recreationist using car (n=76; 10.3%) were characterized by a very high level of recreational activities with a high tendency for shopping. They show large action space with considerable distance between its center and their home. Despite, the fact that they use walking as an important mode of transport and that of their expenditure on housing is relatively small, this cluster is very unsustainable on indicators. The dominant socio-economic profiles in this cluster were female, young, two-worker households, and wealthy with the highest baby-boomer membership. Among the 50% of households residing in Quebec, this group had the highest members from Les Rivières (23.1%). More than 40% of members of this group resides in La Cité-Limoilou (20.5%) and La Haute-Saint-Charles (23.1%). Furthermore, this cluster had a high membership from south shore (22.4%) and a high membership rate from MRC La Jacque-Cartier (11.8%). Around four out five households in this group were living in Car-Dependent locations.

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[16] Reference: https://www.walkscore.com/methodology.shtml

Table 4.10   Analysis of Walk Score of dwelling address of respondents

Walk Score	Recreationist using Car	Hypermobile Shoppers using Car	Mobile Individuals using Active Transport	Mobile Individuals using Public Transport	Savers-on-Time and Spenders-on-Housing	Immobile Recreationist using Public Transport	Immobile Shoppers	Total
0–24 (Car-dependent) Almost all errands require a car.	n=19	n=19	n=3	n=7	n=10	n=9	n=9	n=76
	50.0%	43.2%	2.7%	10.8%	10.6%	22.5%	12.5%	16.3%
25–49 (Car-dependent) Most errands require a car.	n=11	n=16	n=14	n=27	n=27	n=15	n=20	n 130
	28.9%	36.4%	12.5%	41.5%	28.7%	37.5%	27.8%	28.0%
50–69 (Somewhat Walkable) Some errands can be done on foot.	n=1	n=6	n=33	n=21	n=36	n=7	n=22	n 126
	2.6%	13.6%	29.5%	32.3%	38.3%	17.5%	30.6%	27.1%
70–89 (Very Walkable) Most errands can be done on foot.	n=6	n=3	n=32	n=8	n=14	n=8	n=11	n 82
	15.8%	6.8%	28.6%	12.3%	14.9%	20.0%	15.3%	17.6%
90–100 (Walker's Paradise) Daily errands do not require a car.	n=1	n=0	n=30	n=2	n=7	n=1	n=10	n 51
	2.6%	0.0%	26.8%	3.1%	7.4%	2.5%	13.9%	11.0%
Total	n=38	n=44	n=112	n=65	n=94	n=40	n=72	N= 465
	100%	100%	100%	100%	100%	100%	100%	

Table 4.11   Boroughs of dwelling address of respondents

Boroughs	Recreationist using Car	Hypermobile Shoppers using Car	Mobile Individuals using Active Transport	Mobile Individuals using Public Transport	Savers-on-Time and Spenders-on-Housing	Immobile Recreationist using Public Transport	Immobile Shoppers	All n=588
La Cité-Limoilou	20.5%	13.9%	62.9%	19.1%	26.8%	15.9%	31.6%	34.2%
La Haute-Saint-Charles	23.1%	27.8%	3.1%	13.5%	4.1%	11.4%	9.2%	9.4%
Beauport	12.8%	13.9%	5.0%	19.1%	8.9%	13.6%	15.3%	11.4%
Charlesbourg	7.7%	25.0%	5.7%	11.2%	13.0%	18.2%	13.3%	11.6%
Ste-Foy-Sillery Cap-Rouge	23.1%	8.3%	17.6%	22.5%	28.5%	22.7%	15.3%	20.4%
All	43.6%	47.2%	28.3%	52.8%	50.4%	54.5%	43.9%	43.4%
Les Rivières	12.8%	11.1%	5.7%	14.6%	18.7%	18.2%	15.3%	13.1%

Consequently, in this cluster, we observed that place exhibited some degree of influence in this group. The high level of sustainability performance in temporal dimension may result from the high level of car-dependency. The high degree of sustainability performance in economic aspect, particularly housing expenses, may result from living in the districts where the house price are low.

The Hypermobile shoppers using car (n=71; 9.6%) do not spend too much time going to their activities, which are dispersed on vast areas far from dwelling. Despite low levels of recreation activities, they traveled long distance each week for education and shopping purpose. Their expenditure on transport was greater than on housing. Interestingly, they are not mostly unsustainable in their expenditure on housing, but not in the percentage of income spent on housing. This group has the highest rate of two-worker households and composed of affluent households with the highest level of car ownership. Only half of them lived in Quebec. Among the households residing in Quebec, a large proportion lived in La Haut-Saint-Charles, (27.8%) and Charlesbourg (25.0%). Like the « Recreationist using Car », this group had a lot of members from MRC La Jacque-Cartier (11.3%). Most members of this cluster lived in either the new suburbs or the periphery. This cluster had the highest membership from car-dependent locations and lowest membership from more walkable places. Though the places exhibit some degree of influence on the sustainability performance of people's behavior in this group, the socio-economic profiles of these households had a high level of influence (i.e. the low level of recreational activities and related distance may result from having less time for recreation because of the presence of children).

The Mobile Individuals using Active Transport (n=168; 22.7%) are characterized by a very low level of car-use and high level of AT-use, with slight tendency for PT-use. Their expenditure was very low on transport and relatively high on housing. They had the shortest average distance traveled for education purpose. They were the least satisfied households with the sense of security and social cohesion of their neighborhood. They were (so) sustainable for all variables. This very highly educated cluster, mostly comprised of single persons, had the same share of one-worker and two-worker households, and owners and tenants. Car-ownership was very low. Interestingly, our largest cluster with a higher number of households resided in apartment buildings than in single-family houses. Most of them lived in La Cité-Limoilou, 85%

of them lived in walkable places. In this cluster, living in more sustainable places led to more sustainable behavior, particularly environmental sustainability. However, we didn't observe the same level of influence on the other two sustainability pillars. Furthermore, this cluster was mostly composed of single persons who were less involved with associated complexity of parental and familiar aspects of life.

The Mobile individuals using public transport (n=101; 13.6%) were characterized by a relatively low level of car-use and high level of PT-use and commuting time. The mean distance traveled for education purpose was at an average level. The unsustainability in the temporal dimension may result from the PT-use and long distance traveled to work. Interestingly, despite the unsustainable action space and the distance between dwelling and center of action space, they were sustainable in car use and fuel consumption. They are almost equally from diverse socio-economic groups. Most households lived in Quebec and were disseminated in all districts, mostly in the new suburbs. Among the households residing in Quebec, more than 50% of households lived in Beauport (19.2%), Charlesbourg (11.2%), and Saint-Foy-Sillery-Cap-Rouge (22.55). Around 30% of them lived in La Cité-Limoilou (19.1%) and La Haute-Saint-Charles (13.5%), and around 15% of the members of this cluster were living in Les Rivières. They were distributed almost equally in Car-Dependent and walkable locations

The Savers-on-Time and Spenders-on-Housing (n=138; 18.6), the second largest group, were characterized by a very high expenditure on housing. They had little tendency to use both PT and AT. Consequently, they were car-dependent, and their activities were dispersed to a great area far from their dwelling. This cluster had a relatively small average distance traveled for education purposes. They were the most sustainable households in regards with the temporal dimension of behavior and the least sustainable in their expenditure on housing. For most variables, this cluster almost has an equal share of both sustainable and unsustainable households. Compared to the other groups, this cluster had the highest male membership. Most households were couples (with or without children). This cluster had the second-most rates of membership from La Cité-Limoilou (26.8%). Around one-third of the members of this cluster were residing in Sainte-Foy-Sillery-Cap-Rouge. However, relatively a high percentage of households in this cluster were from Les Rivière (18.7%). In this cluster, we had a larger proportion of households who resided in walkable places than car-dependent places.

The Immobile recreationist using public transport (n=62; 8.4%): the smallest cluster, comprised of the immobile household. Though they had the lowest level of shopping activity, they did a fair degree of recreation activities. AT-use was at a reasonable level among the members of this group. The expenditure was low on housing and high on transport. The frequency of very satisfied individuals was at its maximum in the sense of security and social cohesion. This cluster had the highest female members, aged between 45 and 54 and single-parent households. The car ownership was relatively high. Around a quarter of households lived in Lévis and the households in Quebec were disseminated in all districts, mostly lived in the new suburbs and periphery. In this cluster, we had a higher portion of households who resided in car-dependent places than walkable places.

The Immobile shoppers (n=124; 16.8%), the least mobile households, had a higher level of shopping activity compared to recreation. They had a small average distance traveled for education purpose and very low expenditure on transport and housing. Compared to other groups, they were relatively sustainable for most variables, and had a higher level of sustainability for action space compared to the distance between dwelling and center of action space. The dominant income cohort (75 000 and 100 000$) showed that this cluster comes mostly from the middle class, with a high frequency of being a tenant. This group had the second-highest membership from La Cité-Limoilou. Other members of this cluster were distributed in various districts of Quebec. This cluster had the highest members from L'Ancienne-Lorette. The analysis of Walk Score of residential location revealed that the second-highest membership from Walker's Paradise.

4.5   Discussion and Conclusion

The goal of this paper was to elaborate on and clarify the link between place and people's behavior, in the view of sustainability issues, in the Quebec Census Metropolitan Area (QCMA). This objective was achieved by identifying the profiles of people's behavior, assessing their sustainability performance and comparing their performance with the place performance. The findings are not quite clear for all people's profiles. Spatial structures sharply determine the sustainability performance in some clusters. In other clusters, the influence of place is affected by socio-economic characteristics of households. Finally, we have some clusters in which we

are not able to clearly identify neither the influence of the place nor the effect of socio-economic characteristics.

We observed that the influence of the place on the sustainability performance of behavior might differ depending on the pillar of sustainability. For example, a certain type of place may increase the environmental sustainability, but the same place may reduce the social sustainability. Furthermore, the influence of the place might differ depending on the purpose of the activity. For example, living in outer suburbs may decrease the recreation-related distance. But, being far from the shopping centers may increase the shopping-related distance. Consequently, living in outer suburbs may reduce the sustainability performance of people's behavior in the households who prefer shopping activities to recreation activities, overall. Whereas living in the same environment may increase sustainability performance of people's behavior in the households who prefer recreation activities to shopping activities. In such wise, it is crucial that households have an accurate recognition of their needs, preferences, and priorities when deciding on the residential choice to move toward sustainability prosperity.

Previous empirical research in this field suggests that place-related features might have a positive, negative, or no influence on people's behavior. The empirical work in this paper brought the sustainability issues into focus in the study of the place-people relationship and demonstrated that the sustainability performance of people's behavior might/might not be associated with the sustainability performance of places. In this case study, the focus is on out-of-home daily activities. Employing the survey approach, particularly the "Demain Québec" survey, suits the nature of research subject, sustainability, which should be measured quantitatively. In this study, we intended to measure the degree of correspondence between sustainable behavior and sustainable environment. To do so, a quantitative approach was best. This survey also provides almost complete data about the major daily activities of the respondents, their location, attendance rate and mode of transport allowing us to measure sustainable behavior. Furthermore, accessing to such extensive, rich and unique database about the households of CMQ allows us to uncover multitudinous segmentation of sustainability profiles, both environmentally and behaviorally. Also, it provides us the ability to classify, prioritize and weigh these profiles.

Finally, because of the crucial role of society performance in sustainability achievement, the ultimate goal of this research is providing data to be easily communicative with various performers. The information provided through a quantitative approach may facilitate such communication, and provide a ground to merge broader of social and societal performers. The Internet survey of "Demain Québec" was launched in 2011. The research work in this paper was defined in 2012, one year after the Internet survey was launched. The "Demain Québec" survey was not designed to measure sustainability. For this reason, the questions were not designed to measure the sustainability performance. Thus, we selected our variables found in the literature review based on the questions of "Demain Québec", and our analysis could not encompass all the requisite variables to measure the sustainability performance, both behavioral and attitudinal dimensions.

Three clear directions for future empirical work emerge from this study. The first direction for empirical work is to delve into the more sustainability-oriented approaches of measuring the performance of places (e.g. creating an index by the compilation of indicators reflecting the three pillars of sustainability, which each indicator foreshadows a particular behavior.). The second direction is to determine whether we can associate observed people's performance with place performance in a region. For example, it has been argued that Walk Score influence the level of sustainability performance in particular clusters in a Quebec Census Metropolitan area, but we don't yet have sufficient measures to empirically study the relationship between the two of them. To do so, we need to design a questionnaire focusing only on sustainability. The third direction is to investigate not only behavioral and spatial variables, but also the attitudinal variables. Sustainability brings many new ideas and behaviors as well as a fair bit of ambiguity and uncertainty. Most people think positively about sustainability, but they are still uncertain about to the way of implementing it in their everyday lives. We need to give people evidence and social proof in this regard (Manning, 2009). This research aimed to facilitate achieving this goal, and move toward replacing smart cities by smart people, because "There is an unquestioning acceptance that sustainability is a good thing and will generate desirable outcomes for all, all of the time" (Vallance, Perkins, & Dixon, 2011, p. 343).

CHAPTER 5

ARE SUSTAINABLE RESIDENTIAL CHOICE ALSO DESIRABLE? A STUDY OF HOUSEHOL SATISFACTION AND ASPIRATIONS WITH REGARD TO CURRENT AND FUTURE RESIDENTIAL LOCATION

(Article 3)

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5.1   Abstract

The desirability of sustainable residential choices, understood as satisfaction-with and aspiration-for, is a concern for policy makers. Even though sustainable residential choices encompass both the built environment and the associated behaviors, it is mostly studied from the point of view of its material components. This study emphasizes the behavioral component by examining the extent to which working households are satisfied with their residential choices sustainable to different degrees and aspire to make similar or different choices in their residential projects. The results of an on-line quantitative cross-sectional survey, to which 740 households with at least one full-time worker answered, were analyzed. The results showed that it is possible to have residential choices that are at once sustainable and desirable. However, households who had made such choices were less satisfied with the trees and greenery, quietness, and ambiance, security and characteristics of neighbors. Also, sources of dissatisfaction are not necessarily associated with moving intentions, the main reasons for moving are often associated with the desire to become a homeowner or having access to a larger

residence. On their residential choice decisions, households regard mostly the environmental features which are in accordance with their needs and goals at a certain stage in their life and also with their dominant activities. Though the built environment plays an important role in the achievement of desirable sustainable choices, the households are the protagonist in enhancing sustainable prosperity.

5.2 Introduction

There are two overarching views linking sustainability and desirability in housing research. The first one approaches these two concepts as distinct ones (Gordon & Richardson, 1997) while the second considers desirability as an integral part of sustainability (Mayer, 2008; Troell et al., 2005). In this latter view, three principal features define the sustainability of human-environment systems: resilience to disturbances (both natural and anthropogenic), desirability to human societies, and (often implicit) temporal and spatial scale boundaries (Mayer, 2008, p.278). Sustainability is not only the outcome of the resilience of a system, but of the desirability of this system to people (Troell et al., 2005). Desirability and sustainability of residential choices have been correlated both positively (Talen, 2001) and negatively (Audirac, 1999). The study of Talen (2001) showed there is dissatisfaction with the physical planning aspects of suburban development among the affluent households residing in suburbs. The research of revealed households don't desire to hand over the lot size for urban facilities and services (Audirac, 1999). The desirability of residential choices has mostly been estimated from measuring dwellers' satisfaction. If it is useful, it is also not enough since it does not consider the degree of congruence with household' residential aspirations. Knowing about the future demands for residential projects would also provide empirically-based evidence for policy makers to inform the development and implementation of more sustainable residential choices. When investigating the desirability of current and future residential choice with regard to sustainability, two components are at stakes: the sustainable performance of the "place" or built environment where the dwelling is located or should be located, and the sustainable performance of the household behavior associated with these locations in everyday life. In such wise, this paper attempts to answer the following questions: Are sustainable residential choices desirable? How satisfied are people with their (un)sustainable residential choices? What are household's

residential projects? Do households carry on their (un)sustainable choices? Why do they aspire to more/less sustainable residential choices. The next section overviews scientific the literature on the desirability of residential choice with regard to residential satisfaction and aspirations, and present the theoretical framework developed for this research. Section 5.4 describes the data and methods used to answer the research questions. Section 5.5 reports on the residential satisfaction and aspirations of 740 households residing in the Quebec Census Metropolitan Areas (CMAs), Canada. The last section summarizes and discusses the main findings. The concluding section proposes avenues for policy-making and further research.

5.3 Are sustainable residential choices desirable? A theoretical framework

The social desirability of more compact and mixed residential options is a major concern for policy-makers, with regards namely to their potential contribution to generation of more sustainable mobility patterns (Gordon et al., 1997). A residential environment is characterized by its objective material, social and economic characteristics (e.g. location, presence of activity centres, socio-economic level, housing prices) (Audirac, 1999), but also by subjective criteria (e.g. sense of security, attachment) (Dempsey, Brown, & Bramley, 2012; Fan et al., 2011). Its level of desirability can be evaluated by measuring households' satisfaction but also residential aspirations. The two next sub-sections discuss each of these concepts.

5.3.1 Households' Residential Satisfaction

A number of terms are used to refer more or less synonymously with residential satisfaction in the reviewed literature. The first one is *quality of life* which the World Health Organisation (WHO) defines as "an individual's perception of [people's] position in life, in the context of the culture and values in which they live and in relation to their goals, expectations, standards and concerns" (The WHOQOL Group, 1995, p. 17). Jeffres & Dobos (1995) identify three sets of variables influencing the quality of life: life situations (e.g. household composition,

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income, and age), comparison and communication processes[17], and the objective elements of the environment (e.g. access to activity centre and transportation). Residential satisfaction results from a trade-off between these three sets of variables. Subsequently, households with similar traits may appraise their residential neighborhoods in different ways (Adriaanse, 2007). Empirical studies dealing specifically with residential satisfaction report on two aspects of neighborhoods related to sustainability, that is, residential density and land-use mix. Some of them uncovered a positive correlation between these objective characteristics and satisfaction (Breheny, 1996; Wells & Yang, 2008), while other found a negative correlation mostly associated with a preference for low-density suburbs in North American (Audirac, 1999; Delmelle et al., 2013; Dempsey et al., 2012). Delmelle et al., (2013) added temporal dimensions to the study of residential satisfaction. The authors found that a commuting time of 30 min or more engenders lower levels of satisfaction. On their part, Newman & Duncan (2007) found that residential dissatisfaction can predict residential behavior. If people are not satisfied with their neighborhood, they can either cope with it or move (Adriaanse, 2007). Over time, households may adapt to the source of dissatisfaction (Camagni, Gibelli, & Rigamonti, 2002). Neighborhood attachment was identified as facilitating residents' acceptance of unfavourable conditions (Talen, 2001; Taylor, 1996). If people cannot adapt, they generally plan to move according to their financial ability and considerations.

5.3.2 Households' Residential Aspirations

Satisfaction alone is not an accurate measure for revealing the desirability of a residential choice (Matzler, Sauerwein, & Heischmidt, 2003). It has to be considered jointly with residential aspirations since it is found to be an important factor which accounts for moving intentions.(Audirac, 1999) found that if there is no satisfactory supply of preferred housing types in the inner-city districts for suburbanites when thinking about moving, these households will move to parts of the city, districts with lower urban amenities, to satisfy their desire for large lot size. Moving intentions was positively associated with living in multi-occupancy residences,

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[17] Comparison and communication processes refers to how a person learns about his/ her environment through observation and experience (Jeffres & Dobos,1995).

being younger, and with the perception of pollution, but negatively with the satisfaction with the dwelling (Howley et al., 2009). As expected, residential preferences for future demands are diverse (Jarass & Heinrichs, 2014; Myers & Gearin, 2001). The households might have both suburban and urban land use preferences when it comes to either their living environment or travel mode (Jarass & Heinrichs, 2014). Younger generations residential preferences were found to be associated with their parents' residential patterns and travel modes for commuting (Döring, Albrecht, Scheiner, & Holz-Rau, 2014). Among studies examining residential satisfaction in connection with sustainability, only a few take into account the daily mobility-related associated behaviors. Indeed, most studies strictly consider the materiality and spatiality of housing and neighborhoods (e.g. Aditjandra, Cao, & Mulley, 2012; Barr & Prillwitz, 2012; Boussauw & Witlox, 2011; Buys & Miller, 2011; De Vos, Derudder, Van Acker, & Witlox, 2012).

5.4 Data and methods

This article is based on a typology of household behavior developed on the basis of its sustainability performance. Such typologies have been considered in several studies (Aditjandra et al., 2012; Barr & Prillwitz, 2012; Boussauw & Witlox, 2011; Buys & Miller, 2011; De Vos et al., 2012). The database used for this purpose comes from the 2011 on-line quantitative survey *«Demain Québec »*, to which all residents of the Quebec metropolitan area, among the most fragmented census area ones in Canada (Nazarnia et al., 2016), were invited to participate in a variety of recruitment modes.[18] Of the 2338 completed questionnaire, respondents belonging to households in which at least one member worked full-time were considered for the analyses, which made up a total of 746 cases. In the first analysis (Lotfi, Després, & Lord, 2017b), seven clusters of housing- and mobility-related behaviors were identified and assessed in terms of their sustainability performance. These clusters were defined on the basis of six main factors derived from the principal components analysis of 25 behavioral variables retained as indicators of

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[18] The Survey *"Demain Québec"* was carried out by the Interdisciplinary Research Group on Suburbs (GIRBa) at Laval University, Canada, under the supervision of Carole Després. Its goal was to develop a data basis from which it would be possible to identify socio-economic and lifestyle profiles, housing choice, housing aspirations and daily mobility patterns among the 765 706 residents of the Québec CMAs.

sustainability from the literature review (Lotfi et al., 2017a)[19]. The sustainability performance of each of these clusters of behaviors was then evaluated against 18 potential factors of influence, also identified in the literature review (Lotfi et al., 2017a). The sustainability level of each groupings of behaviors was then compared to the one of the places where respondents live, as measured objectively using Walk Score.

The analyses presented in this paper re-examine these clusters with regards to the residential satisfaction and aspirations of the respondents associated with each of them. For this purpose, three sets of questions on residential satisfaction from the online « Demain Québec » survey were analyzed. The first set is comprised of several items, asking respondents to rate their satisfaction with their home on a global and general level, with regard to some specific exterior dimensions (Table 5.2); and finally, with interior dimensions. The answer format is a 4-point Likert scale: not at all satisfied, not very satisfied, somewhat satisfied, and very satisfied. The second set of questions incorporates 16 items to measure satisfaction with the home location with regard to : 1) its proximity of the principal occupation location ; 2) its proximity to shops, services, and public facilities (arena, libraries, etc.); 3) its proximity to childcare centre, elementary and secondary schools, colleges or university attended by child or children; 4) access to the highway, public transport, and layouts of walking and cycling; 5) the satisfaction with trees and greenery, quietness, and ambiance; 6) the satisfaction with security in the neighborhood and with characteristics of neighbours.

The « Demain Québec » questionnaire is also comprised of six sets of questions on residential aspirations. They ask each respondent about their household's: 1) intention to move (no, not yet, yes, between 1 and 5 year, yes, between 6 and 10 years, I don't know); 2) reason(s) for moving (life situation, willingness to change ownership, willingness to change dwelling,

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[19] Distance traveled to work per week (m), Distance traveled for recreation purpose per week (m), Distance traveled for shopping purpose per week(m), Distance traveled by car per week (m), Distance traveled by public transport per week(m), Distance traveled by active transport per week(m), Time spent on transport for work purpose per week(min), Expenditure on transport($),Expenditure on housing, Household fuel consumption, Area of action space, Distance between dwelling and center of action space, Number of visited places, Number of frequented places per week, Number of visited places for shopping purpose, Number of visited places for recreation purpose, Distance to recreation center (s), Distances to shopping center(s), Proportion of visited places for shopping purpose, Proportion of visited places for recreation purpose, Distance traveled for education purpose per week (m), percentage of income to spend on transport, percentage of income to spend on housing, Satisfaction with the security of neighborhood, Satisfaction with characteristics of neighbors

accessibility and proximity concerns, economic concerns, ambiance); 3) desired status of residence; 4) desired dwelling type; 5) desired neighborhood type; 6) desired location.

5.5 Results

5.5.1 Description of clusters

Table 5.1 presents a short description of the behavioral, social and spatial characteristics of the seven groups of behaviors identified in a cluster analysis (Lotfi et al., 2017b), along with the socio-economic profile of the concerned respondents and the main characteristics of their residential locations.

5.5.2 Residential satisfaction

To understand the residential satisfaction among the behavioral profiles, we applied categorical data analysis approaches, Chi-Square test and examination of differences in the distribution of responses, which is recommended for rating items involving four or fewer categories (Harpe, 2015). We examined the frequency of the variables related to satisfaction apropos of six aspects of location, as well as the general satisfaction with the dwelling. Table 5.2 shows the results of the analysis for the statistical measure.

Examination of satisfaction of the seven groups, with regards to the six aspects of the residential neighborhood (Figure 5.1) revealed that more than half of the respondents of all groups, except for « Hypermobile Shoppers using Car » and « Mobile Individuals using Public Transport », are very satisfied with their neighborhood in general. All groups are more satisfied with access to highway than proximity to public transport and layouts of walking and cycling. Also, all groups, except for « Hypermobile Shoppers using Car » and « Savers-on-Time and Spenders-on-Housing », were more satisfied with proximity to shops and services than proximity to public facilities. Finally, all groups, except for « Hypermobile Shoppers using Car » and « Mobile Individuals using Public Transport » , were more satisfied (very satisfied or somewhat satisfied) with the ambiance of their neighborhood than the Trees and greenery and quietness of their neighborhood.

Table 5.1   Behavioral, social and spatial characteristics of the seven clusters

Groups	Behavioral characteristics	Social characteristics	Spatial characteristics
Recreationist using Car (n=76; 10.3%)	• Very high level of recreational activities • Car-dependent • Large action space and long distance between their home and the center of action space. • Small expenditure on housing • So unsustainable for most variables, except for economic and temporal dimensions.	• Young age, • Two-worker households, • Wealthy • Highest baby-boomer membership	• 52% in periphery and 34.2% in New suburbs • Four out five lived in the Car-Dependent locations • Only half of them lived in Quebec city
Hypermobile Shoppers using Car (n=71; 9.6%)	• Very car-dependent • Dispersed daily activities were dispersed to far from their dwelling. • Low levels of recreation activities • Highest average distance traveled for education purpose per week. • Higher expenditure on transport than on housing.	• Highest rate of two-worker • Affluent households • More than 60% of them had 2 or more children • Highest level of car ownership	• 40.8% in New suburbs and 47.9% in periphery • Highest membership from Car-Dependent locations (79.6%) and lowest membership from more walkable places. • Only around half of them lived in Quebec
Mobile Individuals using Active Transport (n=168; 22.7%)	• Very low level of car-use • High level of active transport • Low tendency of public transport use • Very mobile • Low expenditure on transport • Relatively high expenditure on housing • Lowest average distance traveled for education purpose • Least satisfied group with sense of security and social cohesion	• Mostly comprised of single persons • Highest rate of renters • Very small rate of car-ownership • Most educated group	• Higher number of households resided in apartment buildings than in single-family houses • 85% of them lived in walkable places, and less than 3% of them lived in the districts with the Walk Score of 0–24. • 38.7% in inner city and 32.1% in old suburbs • Around 90% live in Quebec

Table 5.1   Behavioral, social and spatial characteristics of the seven clusters

Groups	Behavioral characteristics	Social characteristics	Spatial characteristics
Groups	Behavioral characteristics	Social characteristics	Spatial characteristics
Mobile Individuals using Public Transport (n=101; 13.6%)	• Relatively low level of car-use • High level of public transport use • Long commuting time • Large action area and long distance between dwelling and center of action space • Low level of fuel consumption	• From diverse socio-economic groups, almost equally represented • Low level of car ownership	• Almost equally in car-dependent and Walkable locations • Highest membership from New suburbs (61.4%) • High membership from Quebec City (nearly 90%)
Savers-on-Time and Spenders-on-Housing (n=138; 18.6%)	• Very high expenditure on housing. • Little tendency to use both public and active transport • Car-dependent • Low commuting time • Small average distance traveled for education purpose	• Highest male membership • Mostly couples (with or without children) • Highest membership from Generation Y	• Larger proportion of households resided in walkable places than car-dependent places • 15.2% in Inner city, 26.8% in Old suburbs, and 52.2% in New suburbs
Immobile Recreationist using Public Transport (n=62; 8.4%)	• Immobile households • Lowest level of shopping activity, • Fair degree of recreation activities • Reasonable level of active transport use • Low expenditure on housing and high expenditure on transport • High satisfaction in regards to security and social cohesion	• Highest female membership • Age between 45 and 54 years • High membership of the single-parent • Relatively high level of car ownership	• Mostly lived in the new suburbs and periphery • Higher portion of households resided in car-dependent places than walkable places
Immobile Shoppers (n=124; 16.8%)	• Least mobile households • Higher level of shopping activity compared to recreation • Small average distance traveled for education purpose	• Around one-third had the income of 75-100000$ • Mostly couples with or without children	• Second-highest membership from Walker's Paradise • 16.1% reside in inner city, 21.0% in old suburbs, and 51.6% in new suburbs

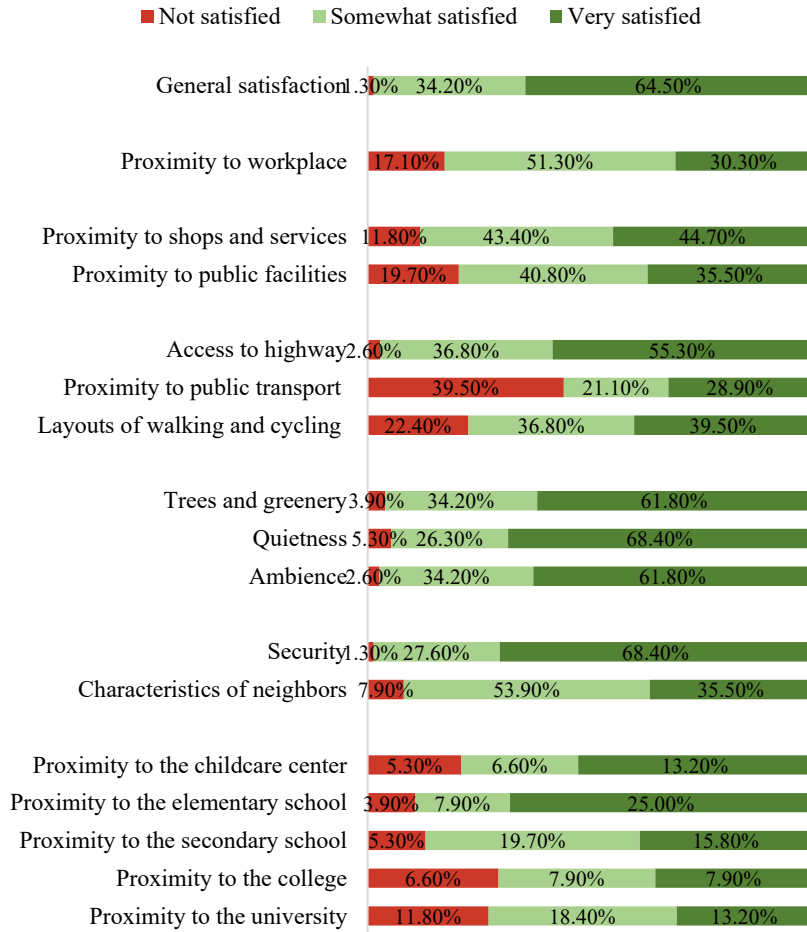Table 5.1   Behavioral, social and spatial characteristics of the seven clusters

Groups	Behavioral characteristics	Social characteristics	Spatial characteristics
	• Very low expenditure both on transport and housing • Relatively sustainable for most variables • Small action space	• *Around 60% no children at home*	

Table 5.2   Qualifying indicators retained for measuring the satisfaction among the seven clusters

Category	Variable	P-value	Cramer's V	% of cells with expected count < 5
General satisfaction	General satisfaction	.410	-	-
Proximity to the place of principal occupation	Proximity to place of work or education	.000	-	25%
Proximity to facilities	Proximity to shops and services	.000***	.165	-
	Proximity to public facilities (arena, libraries, etc.)	.000***	.153	-
Transportation	Access to highway	.065	-	-
	Proximity to public transport	.000***	.209	-
	Layouts of walking and cycling	.947	-	-
Ambience	Trees and greenery	.136	-	-
	Quietness	.053	-	-
	Ambience	.575	-	-
Social aspects	Security	.042*	.115	-
	Characteristics of neighbours	.807	-	-
Proximity to educational institutes	Proximity to the childcare centre	.004**	.130	-
	Proximity to elementary school	.001	-	28.6%
	Proximity to secondary school	.000	-	25%
	Proximity to college	.049*	.114	-
	Proximity to university	.006**	.128	-

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

Recreationist using Car

- Not satisfied
- Somewhat satisfied
- Very satisfied

Category	Not satisfied	Somewhat satisfied	Very satisfied
General satisfaction	1.30%	34.20%	64.50%
Proximity to workplace	17.10%	51.30%	30.30%
Proximity to shops and services	11.80%	43.40%	44.70%
Proximity to public facilities	19.70%	40.80%	35.50%
Access to highway	2.60%	36.80%	55.30%
Proximity to public transport	39.50%	21.10%	28.90%
Layouts of walking and cycling	22.40%	36.80%	39.50%
Trees and greenery	3.90%	34.20%	61.80%
Quietness	5.30%	26.30%	68.40%
Ambience	2.60%	34.20%	61.80%
Security	1.30%	27.60%	68.40%
Characteristics of neighbors	7.90%	53.90%	35.50%
Proximity to the childcare center	5.30%	6.60%	13.20%
Proximity to the elementary school	3.90%	7.90%	25.00%
Proximity to the secondary school	5.30%	19.70%	15.80%
Proximity to the college	6.60%	7.90%	7.90%
Proximity to the university	11.80%	18.40%	13.20%

Hypermobile Shoppers using Car

- Not satisfied
- Somewhat satisfied
- Very satisfied

Category	Not satisfied	Somewhat satisfied	Very satisfied
General satisfaction	4.20%	53.50%	42.30%
Proximity to workplace	32.40%	33.80%	33.80%
Proximity to shops and services	16.90%	36.60%	46.50%
Proximity to public facilities	9.90%	36.60%	50.70%
Access to highway	2.80%	28.20%	69.00%
Proximity to public transport	21.10%	31.00%	36.60%
Layouts of walking and cycling	14.10%	38.00%	46.50%
Trees and greenery	9.90%	32.40%	57.70%
Quietness	5.60%	33.80%	60.60%
Ambience	7.00%	38.00%	54.90%
Security	9.90%	22.50%	67.60%
Characteristics of neighbors	11.30%	46.50%	42.30%
Proximity to the childcare center	8.50%	21.10%	16.90%
Proximity to the elementary school	0.00%	18.30%	35.20%
Proximity to the secondary school	8.50%	15.50%	29.60%
Proximity to the college	9.90%	11.30%	11.30%
Proximity to the university	12.70%	15.50%	11.30%

Figure 5.1   Examination of satisfaction among the seven clusters of people's behavior

Mobile Individuals using Active Transport

Legend: ■ Not satisfied ■ Somewhat satisfied ■ Very satisfied

- General satisfaction: 7.10% | 40.50% | 52.40%
- Proximity to workplace: 4.20% | 26.80% | 69.00%
- Proximity to shops and services: 6.00% | 26.20% | 67.90%
- Proximity to public facilities: 6.00% | 31.50% | 58.90%
- Access to highway: 0.60% | 27.40% | 58.30%
- Proximity to public transport: 4.20% | 23.20% | 71.40%
- Layouts of walking and cycling: 14.30% | 36.90% | 47.00%
- Trees and greenery: 16.10% | 36.30% | 47.60%
- Quietness: 13.70% | 42.90% | 42.90%
- Ambience: 8.90% | 39.30% | 51.20%
- Security: 6.00% | 39.30% | 53.60%
- Characteristics of neighbors: 16.10% | 46.40% | 35.70%
- Proximity to the childcare center: 3.60% | 6.00% | 7.70%
- Proximity to the elementary school: 0.00% | 4.80% | 16.70%
- Proximity to the secondary school: 0.60% | 7.10% | 16.10%
- Proximity to the college: 1.20% | 7.70% | 9.50%
- Proximity to the university: 2.40% | 14.30% | 18.50%

Mobile Individuals using Public Transport

Legend: ■ Not satisfied ■ Somewhat satisfied ■ Very satisfied

- General satisfaction: 6.90% | 44.60% | 48.50%
- Proximity to workplace: 38.60% | 35.60% | 24.80%
- Proximity to shops and services: 2.90% | 23.90% | 73.20%
- Proximity to public facilities: 11.90% | 34.70% | 44.60%
- Access to highway: 2.00% | 30.70% | 59.40%
- Proximity to public transport: 13.90% | 29.70% | 56.40%
- Layouts of walking and cycling: 15.80% | 33.70% | 49.50%
- Trees and greenery: 4.00% | 41.60% | 53.50%
- Quietness: 7.90% | 37.60% | 54.50%
- Ambience: 12.90% | 29.70% | 57.40%
- Security: 5.00% | 31.70% | 63.40%
- Characteristics of neighbors: 13.90% | 48.50% | 35.60%
- Proximity to the childcare center: 4.00% | 5.00% | 6.90%
- Proximity to the elementary school: 2.00% | 5.90% | 19.80%
- Proximity to the secondary school: 3.00% | 16.80% | 19.80%
- Proximity to the college: 4.00% | 6.90% | 13.90%
- Proximity to the university: 11.90% | 6.90% | 12.90%

Figure 5.1   Examination of satisfaction among the seven clusters of people's behavior

Savers-on-Time and Spenders-on-Housing

■ Not satisfied ■ Somewhat satisfied ■ Very satisfied

Category	Not satisfied	Somewhat satisfied	Very satisfied
General satisfaction	3.60%	46.40%	47.10%
Proximity to workplace	6.50%	38.40%	56.50%
Proximity to shops and services	1.40%	37.00%	55.10%
Proximity to public facilities	1.40%	37.00%	55.10%
Access to highway	0.70%	26.10%	68.80%
Proximity to public transport	15.20%	29.00%	52.90%
Layouts of walking and cycling	13.00%	33.30%	52.90%
Trees and greenery	13.80%	44.20%	41.30%
Quietness	13.80%	32.60%	53.60%
Ambience	8.00%	38.40%	53.60%
Security	5.10%	36.20%	58.70%
Characteristics of neighbors	13.80%	48.60%	36.20%
Proximity to the childcare center	1.40%	10.10%	14.50%
Proximity to the elementary school	2.20%	5.10%	19.60%
Proximity to the secondary school	0.00%	12.30%	15.90%
Proximity to the college	2.90%	8.70%	8.00%
Proximity to the university	5.10%	13.80%	16.70%

Immobile recreationist using public transport

■ Not satisfied ■ Somewhat satisfied ■ Very satisfied

Category	Not satisfied	Somewhat satisfied	Very satisfied
General satisfaction	8.10%	41.90%	50.00%
Proximity to workplace	14.50%	41.90%	41.90%
Proximity to shops and services	6.50%	25.80%	67.70%
Proximity to public facilities	6.50%	30.60%	61.30%
Access to highway	1.60%	24.20%	67.70%
Proximity to public transport	12.90%	24.20%	56.50%
Layouts of walking and cycling	14.50%	35.50%	48.40%
Trees and greenery	11.30%	38.70%	50.00%
Quietness	4.80%	35.50%	59.70%
Ambience	6.50%	30.60%	62.90%
Security	4.80%	19.40%	75.80%
Characteristics of neighbors	17.70%	35.50%	45.20%
Proximity to the childcare center	6.50%	11.30%	12.90%
Proximity to the elementary school	1.60%	12.90%	29.00%
Proximity to the secondary school	3.20%	21.00%	25.80%
Proximity to the college	8.10%	17.70%	16.10%
Proximity to the university	6.50%	27.40%	11.30%

Figure 5.1   Examination of satisfaction among the seven clusters of people's behavior

Immobile Shoppers

| | Not satisfied | Somewhat satisfied | Very satisfied |

General satisfaction — 43.50% — 50.80%

Proximity to workplace — 15.30% — 35.00% — 49.10%

Proximity to shops and services 3.20% — 33.90% — 62.90%

Proximity to public facilities 4.00% — 44.40% — 50.80%

Access to highway 2.40% 23.40% — 67.70%

Proximity to public transport — 15.30% — 25.80% — 56.50%

Layouts of walking and cycling 11.30% — 42.70% — 44.40%

Trees and greenery 12.90% — 36.30% — 50.00%

Quietness 5.60% — 40.30% — 54.00%

Ambience 7.30% — 33.10% — 59.70%

Security 6.50% — 33.10% — 60.50%

Characteristics of neighbors 8.90% — 53.20% — 36.30%

Proximity to the childcare center 5.60% — 8.10% — 12.90%

Proximity to the elementary school 2.40% 5.60% — 22.60%

Proximity to the secondary school 4.80% — 10.50% — 20.20%

Proximity to the college 3.20% — 12.10% — 10.50%

Proximity to the university 3.20% — 19.40% — 12.90%

Figure 5.1   Examination of satisfaction among the seven clusters of people's behavior

The first three groups qualify as car-dependent because of their high reliance on the car. The Recreationist using car are the most satisfied with their neighborhood. Like the next two groups, the Hypermobile shoppers using car and the Savers-on-Time and Spenders-on-Housing, only around a third of them are very satisfied with the proximity to their workplace. They are the most dissatisfied group with their proximity to public facilities (20%), to public transport (40%) and with layout of walking and cycling amenities (22%) in their neighborhood. The Hypermobile Shoppers using Car, is the opposite of the previous group, it has the lowest level of respondents (42%) who were very satisfied with their home. They were also the most dissatisfied with their proximity to shops and services (17%). Interestingly, 11% of them were not concerned about the walking and cycling amenities in their neighborhood. They were the most concerned group regarding their proximity to educational institutions and the most satisfied with their proximity to both elementary (35%) and secondary schools (30%).

Three groups were qualified as locals because of their limited actions spaces. The « Mobile Individuals using Active Transport » were the most satisfied among all groups with their proximity to workplaces, but the most dissatisfied with the ambiance of their neighborhood, both in terms of trees and greenery (16%) and quietness (14%). They mostly were not concerned about proximity to the educational institutions. The « Savers-on-Time and Spenders-on-Housing » were also very satisfied with their proximity to the workplace (56%). They were very satisfied with their access to highways (70%). A relatively high percentage of them were not satisfied with both trees and greenery and quietness of their neighborhood (15%). The « Immobile Shoppers » Locals, like most other clusters, were very satisfied generally with their neighborhood. Again, like most other groups, they were more satisfied with their proximity to shops and services compared to public facilities. They were more satisfied with the security of their neighborhood compared to the characteristics of the neighbours.

The next group, the « Mobile Individuals using Public Transport », were 40% dissatisfied with their residential location. They were the most dissatisfied with the proximity to their workplace. Interestingly, a tenth were not concerned about their proximity to public facilities. A relatively high percentage were dissatisfied with the dimensions related to public transport (14%) and active transport (16%) of their neighborhood. This cluster had the highest membership of respondents were not concerned by their proximity to the childcare centre.

Finally, the « Immobile Recreationist using Public Transport » were very satisfied with their proximity to shops and services (68%). They were the most satisfied with their proximity to public facilities (61%). They were also the most satisfied with the security of their neighborhood. Very few were not concerned about their proximity to the educational institutions. Compared to other clusters, their rate of satisfaction was high with regard to the proximity to the childcare centre, elementary and secondary school.

5.5.3 Residential Aspirations

Generally speaking, close to half of all respondents (49%) didn't plan to move either in either a near (1- 5 y) or distant future (6 - 10y); 40% of them expected to move within 1 to 5 years. A similar percentage (4%) didn't know their plan to move[20] (Figure 5.2)
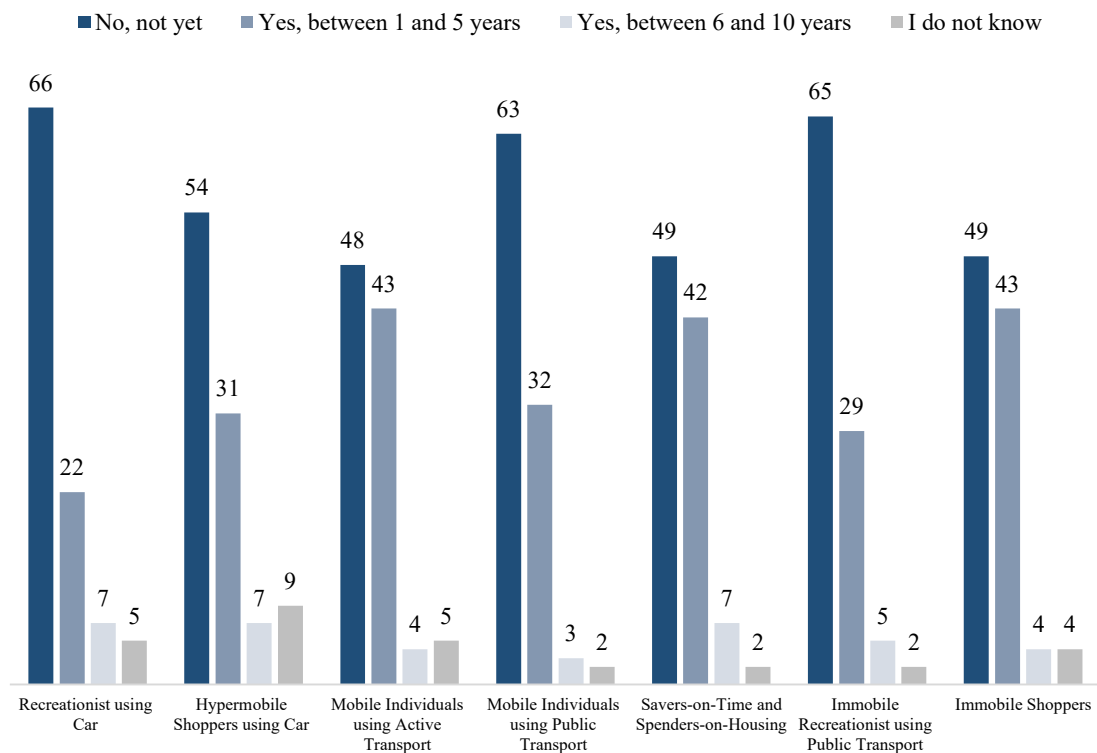
Figure 5.2   Intention to move among the seven groupings of behaviors (%)

[20] Concerning the intention to move, the Chi-Square test was reported significant (p=.047), but the test was invalid due to more than 20% of expected values being under 5. Seven cells (25.0%) have expected count less than 5. The minimum expected count was 2.51.

Among our seven groups, the Recreationist using car had the highest rate of households who didn't plan to move (66%); just over one fifth (22%) planned to move in the near future. As for Hypermobile shoppers using car and Active Locals, 7% of the respondents in this cluster intended to move in a distant future. More than half of the Hypermobile shoppers using car (54%) didn't plan to move either in near or in the distant future. More than one third of them (13%) had the intention to move in the near future. This group had the highest proportion of the respondents who were uncertain about their plan for moving. The intention to move is similar in the three group of « Mobile Individuals using Active Transport », « Savers-on-Time and Spenders-on-Housing », and « Immobile Shoppers ». Less than half of the members of these three groups didn't have the intention to move. Also, more than 40% of the respondents of them had the intention to move within 3 and 5 years. The only notable difference between these three groups is that Savers-on-Time and Spenders-on-Housing had a higher percentage of households (7%) who intended to move in the distant future compared to « Mobile Individuals using Active Transport » and « Immobile Shoppers » (only 4%). Mobile individuals using public transport and Immobile recreationist using public transport were fairly similar in their intention to move. Like « Recreationist using Car », a large proportion of households (more than 60%) in these two group didn't plan to move at all. Around a third of them intended to move between 1 and 5 years. Like « Savers-on-Time and Spenders-on-Housing », only a small share of respondents (2%) were not certain about their plan to move.

Following the intention to move, we examined the desired type of ownership. Among the 302 respondents who intended to move, around four out of five yearn for ownership of a house, a full year habitable chalet or a condo (80.3%, n=236) and around one out of five desired to become the tenant of an apartment or a room (19.7%, n=58). As we can see in figure 5.3 and table 5.3, the Recreationist using car and Savers-on-Time and Spenders-on-Housing were similar in the desired status of residence. A relatively high percentage of households (85% in Recreationist using car and 87% in Active Locals) desired to become an owner. Although the desired type of dwelling for this group, around one out of five respondents in both clusters desired to become the owner of a condo (19% in Recreationist using car and 23% in Savers-on-Time and Spenders-on-Housing). The desire to become an owner was at its maximum (96.4%)

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in the « Hypermobile Shoppers using Car ». Fewer than 4% of the members of this group desired to become a tenant. More than 70% of them desired to become the owner of a house and a quarter of them desired to become the owner of a condo. Interestingly in the « Mobile Individuals using Active Transport », the desire of ownership for a condo was higher than the one for the house (39.5% compared to 35.8%). In contrast to « Hypermobile Shoppers using Car », the desire to become an owner was at its minimum (63.6%) in « Mobile Individuals using Public Transport ». Also, among the households who desired to become an owner, we didn't see much difference in desire for ownership of a house (32.4%) and of a condo (26.5%). Also, Immobile recreationist using public transport and Immobile shoppers were relatively similar in the desired status of residence among their members. More than half of the members of both clusters (58% of Immobile recreationist using public transport and 57% of Immobile Shoppers) desired to own a house. Around one out of five of members of both clusters desired to become the tenant of an apartment.
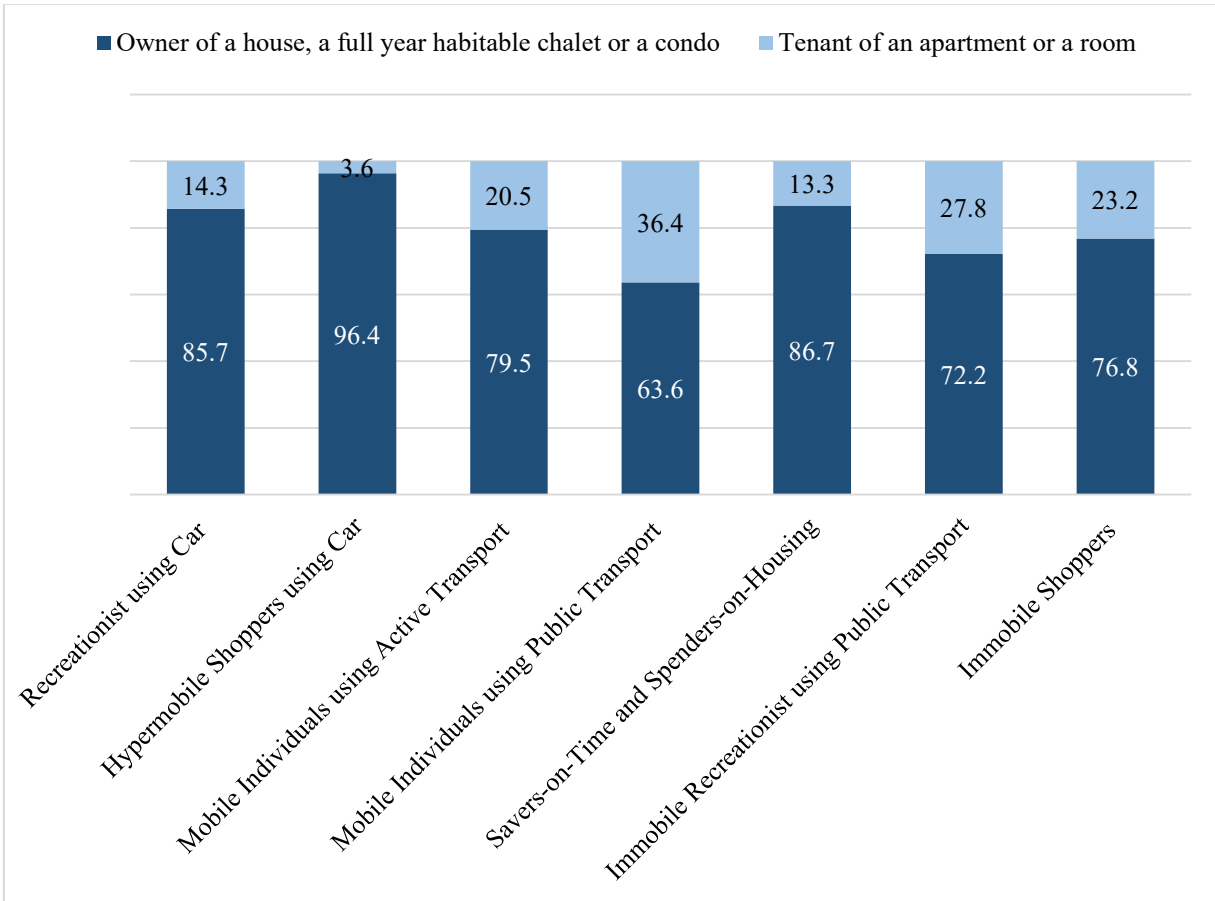
Figure 5.3   Desired status of residence for each grouping o behaviors (%)
(P-Value=.035, Cramer's V=.214).

Table 5.3   Desired status of occupancy for the residence by groupings of behaviors
(Percentage of answer selection in each cluster)

Desired status of residence	Recreationist using Car	Hypermobile Shoppers using Car	Mobile Individuals using Active Transport	Mobile Individuals using Public Transport	Savers-on-Time and Spenders-on-Housing	Immobile Recreationist using Public Transport	Immobile Shoppers	Total
Owner of a house	66.7	71.4	35.8	32.4	62.3	57.9	56.9	51.7
Owner of a full year habitable chalet	0.0	0.0	1.2	2.9	0.0	0.0	0.0	0.7
Owner of a condo	19.0	25.0	39.5	26.5	23.0	10.5	17.2	25.8
Tenant of an apartment	14.3	3.6	19.8	35.3	13.1	21.1	22.4	18.9
Tenant of a room	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.3
Other	0.0	0.0	3.7	2.9	1.6	5.3	3.4	2.6

* P-value=.006, but 24 cells (57.1%) have expected count less than 5.

Following the question of intention to move in the "Demain Québec", a question asked respondents to choose the two main reasons for moving among 20 options (Table 5.4). We classified these 20 options into 7 categories: life situations, health situation, and willingness to change in the ownership, willingness to change in the dwelling, accessibility and proximity concerns, economic concerns and ambiance. None of the respondents selected the options "leaving family home", "health problem", and "to become a tenant". Furthermore, only 3 out of 302 respondents selected the option "Home is too far from my family" from the category of "Accessibility and proximity concerns". Consequently, we deleted these 4 options from our analysis. To inspect the frequency distribution of moving reasons for each group, we ran crosstab with chi-square independence test.

For the « Recreationist using Car », the two main reasons for moving reasons were inadequate dwelling size (33%) and the willingness to become an owner (29%). Furthermore, nearly one out five households planned to move because of the far distance of their dwelling from service (19%). Finally, 14% of them planned to move either because of a new family situation or lack of greenery/nature. Among the « Hypermobile Shoppers using Car », around 40% of households planned to move because of the inadequate dwelling size. 18% of them intended to move because their home required too much maintenance. An equal rate of households (14%) intended to move because of the following reasons: Home is too large, No private courtyard, and Home is too far from the current workplace or study. Willingness to change in the dwelling was the most dominant category of reasons to move among the members of the second cluster. Interestingly, almost half of the « Mobile Individuals using Active Transport » desired to move because of the willingness to become an owner. The desire for a better home was also an important reason to move among them. Around a third of them planned to move because of the desire for a better home. Nearly one fifth of the respondents in the third cluster intended to move because of a new family situation (22%) or Home is not big enough (19%).

The two main moving reasons for « Mobile Individuals using Public Transport » were the far distance of dwelling from the workplace and the desire for a better home. Willingness to become an owner (21%), insufficient dwelling size (21%), and the desire for a better neighborhood (18%) were other important moving reasons. Among the « Savers-on-Time and

Spenders-on-Housing », like most other groups, willingness to become an owner was the main reason to move (39%), followed by inadequate dwelling size (33%). Among the « Immobile Recreationist using Public Transport », the desire for a better home was the principal moving reason (37%). An equal share of respondents (21%) selected the options the willingness to become an owner, the far distance of the workplace from dwelling and the desire for a better neighborhood as the reasons for moving. Finally, among the « Immobile Shoppers », like the « Recreationist using Car » and « Hypermobile Shoppers using Car », the inadequate dwelling size (36%) was the main moving reason. Willingness to become an owner (31%) and the new family situation (28%) were other important moving reasons.

The next element in the investigation of residential projects of households was the desired dwelling type (Figure 5.4). As it was expected, the low-density residences were the most desired option among most groups, except for « Mobile Individuals using Active Transport » and « Savers-on-Time and Spenders-on-Housing ». The « Recreationist using Car » and « Immobile Shoppers » were similar in their desired dwelling type. Relatively high percentage of members of both clusters (71% in Recreationist using car and 66% in Immobile Shoppers) desired for low-density residences (single family detached/semi-detached home and town home). Interestingly, around 40% of the households of both clusters desired for medium-density residences (apartment building of 2 to 6 storeys). A higher percentage of households in Recreationist using car (10%) desired for high density residences compared to the « Immobile shoppers » (only 5%). A high share of members of the « Hypermobile Shoppers using Car », « Savers-on-Time and Spenders-on-Housing », and « Immobile Recreationist using Public Transport » desired for low-density residences. Three-quarter of respondents in these three groups selected the low-density residences as the desired dwelling type. Nearly 30% of members of them desired for medium density residences. The only notable difference between the three clusters was the higher tendency for high density residences among Immobile recreationist using public transport (11%) compared to Hypermobile shoppers using car (7%) and Savers-on-Time and Spenders-on-Housing (3%). Interestingly, the desire for medium density residences was slightly higher than the desire for low-density residences among the members for both the « Mobile Individuals using Active Transport » and « Mobile Individuals using Public Transport ». More than half of the respondents in these two clusters desired for medium density residences.

However, a relatively high percentage of the « Mobile Individuals using Active Transport » (21%) desired for high density residences.

Table 5.4   Reason(s) for moving (Percentage of answer selection in each group)

Item	Reason	Recreationist using Car n=21	Hypermobile Shoppers using Car n=28	Mobile Individuals using Active Transport n=81	Mobile Individuals using Public Transport n=34	Savers-on-Time and Spenders-on-Housing n=61	Immobile Recreationist using Public Transport n=19	Immobile Shoppers n=58	p-value/ Cramer's V
Life situation	New family situation	14	7	22	12	16	11	28	.194/na
	New job	5	0	9	6	7	5	0	.302/na
	Retirement	5	4	0	3	5	5	3	.686/na
Ownership change	Become an owner	29	7	49	21	39	21	31	.001**/.277
Willingness to change in dwelling	Home is small	33	39	19	21	33	5	36	.027**/.217
	Home is large	10	14	1	0	2	5	2	.011[b]/Na
	Home requires too much maintenance	5	18	9	12	3	16	7	.274/na
	No private courtyard	0	14	10	6	10	5	10	.671/na
	A better home	10	11	31	24	23	37	22	.169/na
Accessibility and proximity concerns	Home is too far from centre	5	7	4	12	2	0	2	.196/na
	Too far from the workplace	5	14	0	24	8	21	5	.000[b]/Na
	Home is too far from services	19	7	1	9	2	11	2	.007[b]/Na
Economic concerns	Home is too expensive	5	7	4	0	3	5	2	.769/Na
Ambience	Desire for better neighborhood	5	11	10	18	7	21	10	.442/Na
	Not enough greenery/nature	14	7	5	0	8	0	7	.339/Na

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

a Chi-Square statistics were used to compute most test results.

b This Chi-Square test is reported significant but the test is invalid due to more than 20 of expected values being under 5.0.
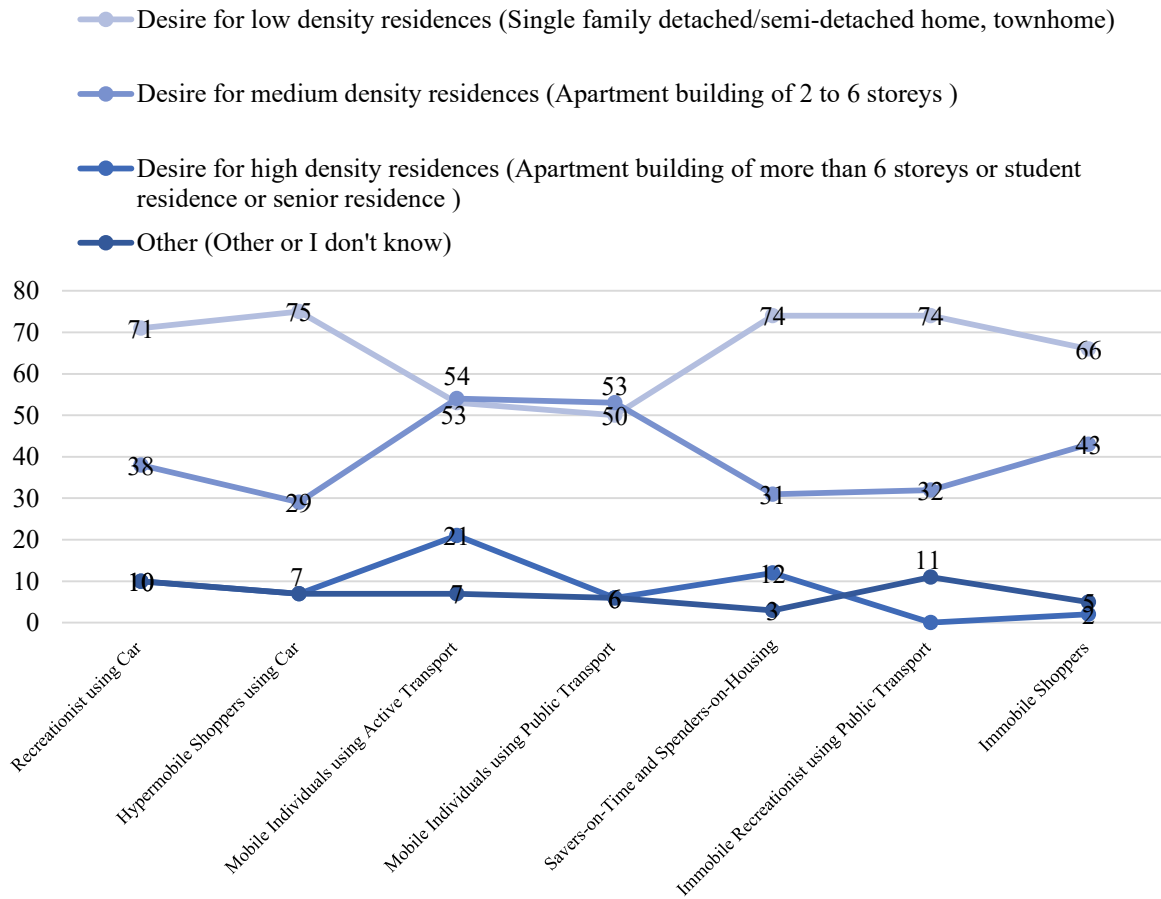
Figure 5.4   Desired dwelling type

The next studied element in regards to the residential aspirations was the desired neighborhood type (Figure 5.5 and Table 5.5.). Interestingly, as we can see in figure 5.5, the respondents of the seven clusters were more flexible about the desired neighborhood type than dwelling type because, though the respondents could choose more than one option for both desired dwelling and neighborhood type, the disparity between the different options was larger for desired dwelling type compared to desired neighborhood type. Furthermore, we observed greater differentiation among the seven clusters with regards to the desired type of neighborhood compared to the desired dwelling type.

Nearly half of the Recreationist using car desired to move to the neighborhoods of single family detached homes. Equal share (around 30%) of them desired for the other 3 types of neighborhoods mentioned in the figure 5.5. Among « Hypermobile Shoppers using Car », the

tendency for the neighborhood of single family detached homes was relatively high (61%). The desire for the other types of neighborhood was similar to the first cluster. The members of the most sustainable cluster, « Mobile Individuals using Active Transport », desired for more sustainable types of neighborhood. It is important to keep in mind that here we only consider one dimension of sustainability of the neighborhood which is the residential density. Around 90% of the members of this cluster desired to move to the neighborhoods with higher residential density. 38% of them desired to move to the neighborhood of town homes, small and large apartment building and 48% of them desired to move to the neighborhoods of semi-detached homes, town homes and small apartment buildings. Compared to the other groups, relatively low percentage of respondents desired for the neighborhood of single family detached homes (35%). Only around one out five respondents desired for the neighborhoods of single family detached/semi-detached homes and town homes.

In regards to the desire for the neighborhood type, the « Mobile Individuals using Public Transport » were similar to the « Mobile Individuals using Active Transport » except for the desire for the neighborhood of semi-detached homes, townhouses and small apartment buildings that was less desirable option. A relatively high percentage of the « Savers-on-Time and Spenders-on-Housing » desired for neighborhoods of single family detached homes. Although the percentage of respondents for the neighborhoods of town home, small and large apartment was at its minimum in this cluster (16%), but the percentage of members of this cluster who desired for the neighborhoods of semi-detached, town homes and small apartment building was almost twice (30%) of the previous type of neighborhood. Among the « Immobile Recreationist using Public Transport », desire for the neighborhoods of single family detached home was at its maximum. The desire for another 3 types of neighborhood was equal (21% for each type of neighborhood) among the members of this cluster. The households in « Immobile Shoppers » were fairly similar to Active Locals, except for the desire for the neighborhood of town homes, small and large apartment buildings. The desire for this type of neighborhood was higher among the members of « Immobile Shoppers » (29%) compared to « Savers-on-Time and Spenders-on-Housing » (16%). Table 5.5 shows the results of the analysis for the statistical measure.

Table 5.5   The results of Chi-Square test for desired neighborhood type

Variable	P-value	Cramer's V	Percentage of cells have expected less than 5
Neighborhood of single family detached hoouse	.002**	.263	-
Desire for medium-density residence	.735	-	-
Desire for high-density residence	.126	-	-
Other (Other or I don't know)	.143	-	-

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

──●── In a neighborhood of Single family detached homes

──●── In a neighborhood of single family detached home, semi-detached homes and townhome

──●── In a neighborhood of semi-detached homes and townhomes, as well as small apartment buildings (less than 4 storeys)

──●── In a neighborhood townhomes, small apartment buildings (less than 4 storeys) and large apartment building à (more than 5 storeys)

Figure 5.5   Desired neighborhood type

In the next step, we examined the desired neighborhood location. As we can see in table 5.6, « Recreationist using Car » had the second-lowest rate of respondents who desired to move

to Quebec. The desire to move to Lévis was as its maximum (19%) compared to the other 6 clusters. Also, relatively a high percentage of respondents (14.3%) desired to move to regional county municipalities. Among the « Hypermobile Shoppers using Car », we observed the highest rate of respondents who wanted to move to Saint-Augustin-de-Desmaures and L'Ancienne-Lorette (7.1%). Regional County Municipality (17.9%). Interestingly among the « Mobile Individuals using Active Transport », we observed the highest percentage of respondents who desired to move to the other countries. Nearly 80% of the « Mobile Individuals using Public Transport » desired to move to Quebec. As we can see in table 5.6, the « Savers-on-Time and Spenders-on-Housing » had the second-highest percentage of respondents who desired to move to Beauce, Charlevoix, Lotbinière, and Portneuf (1.6%), other regions of Quebec (6.6%) and other provinces of Canada (1.6%). The « Immobile Recreationist using Public Transport » had the lowest rate of households who desired to move to Quebec. The choice for desired location to move was diverse among them. The desire to move to other regions of Quebec and the rate of uncertainty was at its maximum (10.5%) among the « Immobile Recreationist using Public Transport ». Also, compared to other groups, relatively high percentage of households in this group desired to move to Lévis (15.8%) and Saint-Augustin-de-Desmaures and L'Ancienne-Lorette (5.3%). Finally, among the « Immobile Shoppers » desire to move to Quebec (81%) and Beauce, Charlevoix, Lotbinière, and Portneuf (3.4%) was at its maximum among the members of this group.

At the final step of analysis of the residential aspirations of the households, we examined the desired borough location. For all the seven clusters, the boroughs of La Cité-Limoilou and Saint-Foy-Sillery-Cap-Rouge were the most popular options and the borough of Haut-Saint-Charles and Beauport were the least popular. The desire to move to La Cité-Limoilou was very high among the « Mobile Individuals using Active Transport » (82%). Although the desire to move to La Cité-Limoilu was at its minimum among the « Immobile Recreationist using Public Transport » (36%), it was still the most popular option among them along with Saint-Foy-Sillery-Cap-Rouge.

Table 5.6   Desirable location for future neighborhood (%)

Location	Recreationist using Car n=21	Hypermobile Shoppers using Car n=28	Mobile Individuals using Active Transport n=81	Mobile Individuals using Public Transport n=34	Savers-on-Time and Spenders-on-Housing n=61	Immobile Recreationist using Public Transport n=19	Immobile Shoppers n=58	All
Quebec	61.9	71.4	76.5	79.4	68.9	57.9	81	74
Lévis	19	3.6	4.9	5.9	6.6	15.8	6.9	7.3
Saint-Augustin-de-Desmaures and L'Ancienne-Lorette	0	7.1	1.2	2.9	4.9	5.3	5.2	3.6
Regional County Municipality Côte-de-Beaupré/Jacques-Cartier/Île-d'Orléans	14.3	17.9	2.5	0	4.9	0	0	4.3
Beauce, Charlevoix, Lotbinière, and Portneuf	0	0	0	0	1.6	0	3.4	1
Other regions of Quebec	0	0	3.7	0	6.6	10.5	1.7	3.3
Other provinces of Canada	0	0	1.2	5.9	1.6	0	0	1.3
Other countries	0	0	3.7	0	0	0	0	1
I don't know	4.8	0	6.2	5.9	4.9	10.5	1.7	4.6

* P-value=.030, but 83 cells (91.2%) have expected count less than 5. The minimum expected count is .06.

Table 5.7　　　　Desirable borough location in Quebec City

Desired boroughborough (borough) of Quebec	n	%	P-Value	Cramer's V
Beauport	32	14.4%	.901	-
Charlesbourg	51	23%	.847	-
Cité-Limoilou	119	53.6%	.000***	.374
Haute-Saint-Charles	24	10.8%	.365	
Sainte-Foy–Sillery–Cap-Rouge	95	42.8%	.779	-
Les Rivières	46	20.7%	.578	-

*p <0.05, **p <0.01, ***p <0.001
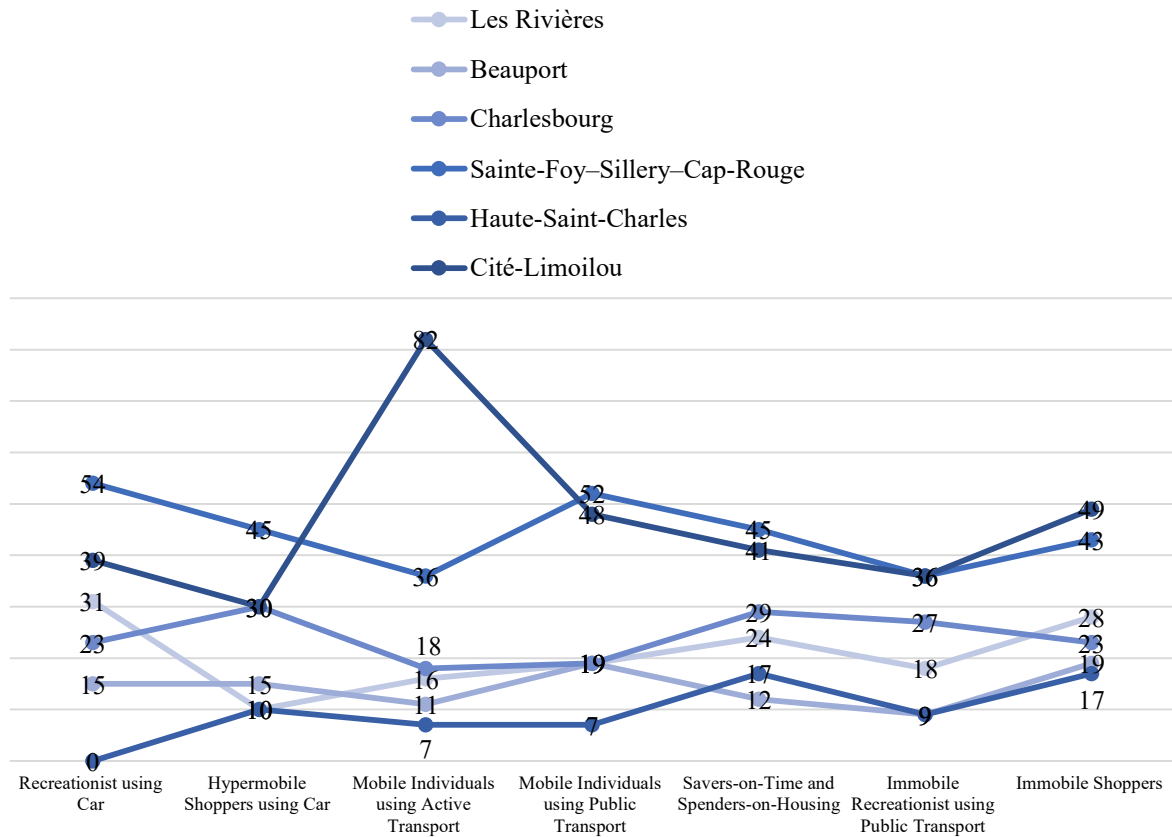
Figure 5.6　　　　Desirable borough of Quebec City (for those intending to move) (%)

5.6 Discussion

The seven studied groups are very different from each other in residential satisfaction and aspirations. The source of dissatisfaction does not mostly lead moving intentions. For example, among « Recreationist using Car », despite dissatisfaction with public and active transit, and public facilities, the intention to move is low among the households of this cluster. Even among the households who intend to move, willingness to become an owner and small size of the house are the main reasons lead moving intention, not the three reasons that were the source of dissatisfaction. Some households, like the « Hypermobile Shoppers using Car », were unsustainable for most variables and the level of dissatisfaction was relatively high among them. However, they did not intend to move in a near future or they were uncertain about their moving intention. It might result from the fact that they are satisfied with one aspect of environment that is important in that certain point of life, here proximity to educational institutions. Although the housing and transport cost were high for the households in this cluster, this did not lead to the intention to move. They would like to move because of the small house size and home requires too much maintenance.

The most sustainable group, the « Mobile Individuals using Active Transport », plan to remain sustainable in their future residential choice. The intention to move is high among this cluster. They were dissatisfied with the ambiance and social aspects of their neighborhood. So, if planners and policymakers implement these aspects in sustainable neighborhoods, we may have households who behave sustainably and are satisfied with their living environment. This will be the best environment-behavior interaction. However, in some group of people (e.g. Mobile Individuals using Public Transport) the source of dissatisfaction leads moving intention and people consider it in their future residences. The members of this cluster are sustainable in car use and fuel consumption and unsustainable in the temporal dimensions, action space, distance between dwelling and their workplace and distance between dwelling and centre of action space. They were very dissatisfied with proximity to the workplace that was also one of the dominant reasons for moving intention. The « Savers-on-Time and Spenders-on-Housing » could be a very interesting target population for planning objectives because they are not sustainable but they intend to move to sustainable residences and neighborhood. Although the proportion of households who reside in walkable neighborhoods is higher than the one who lives

in car-deepened neighborhoods, they were more dependent on the car than active and public transport. The households in the « Immobile Recreationist using Public Transport » are very much interested in recreation activities. They have relatively high tendency for medium and high density. In their moving intention, they have a relatively high tendency for medium and high density residences. So, as they are interested in doing recreational activities, living in a medium and high density residences and neighborhood with adequate recreational activities will be a desirable and sustainable lifestyle. The members of our last cluster are doing a lot of shopping activities. With a relatively high rate of households living in walker paradise, they were sustainable for most variables. They were very satisfied with the proximity to shops and services and they were very sustainable with this aspect along with the other aspect. Satisfyingly, they are sustainable and intend to remain sustainable.

5.7   Conclusion

This article first described residential environmental satisfaction as a global attitude of a resident toward his dwelling, proximity to activities, transportation aspects, ambiance and social aspect of the neighborhood. The article then described the residential projects of the households. We analyzed their intention to move, reason(s) for moving, desired status of residence, residences and neighborhood type and location. All these were analyzed based on the clusters of people's performance. The exploratory results of this research can generate important additional information for policy-making on urban planning. It can offer insight into the degree to which specific neighborhood problems leads to dissatisfaction—and to whom.

Furthermore, in the examination of residential projects in the view of sustainability issues, we observed four categories of behavior: sustainable people who intend to remain sustainable, sustainable people who intend to become unsustainable, unsustainable people who intend to remain unsustainable, unsustainable people who intend to become sustainable. There are two highlights in the results in people's behavior. In some cases, one specific activity may be the source of (un)sustainability. So, if people can choose the neighborhoods in which the amenities and facilities for their preferred activities at a specific point of life is provided, they can still conduct sustainable behavior even when living in more sprawled districts. Also, the source of dissatisfaction does not always drive the moving intention. Even being dissatisfied

with accessibility and the transport aspect of their neighborhood, the dwelling size and willingness to become owner are the dominant factors for moving for many households. So, if the planners and policy maker can facilitate access to these factor in more sustainable neighborhoods (e.g. larger housing size, measure to facilitate home ownership in these areas) they may be able to support sustainable development. A concern for the sustainable households who lived mostly in sustainable districts was dissatisfaction with ambiance and social aspects of their neighborhood. So, it the planner and policy maker can improve these aspects in the sustainable neighborhood, we will have satisfied and sustainable households.

This article shows clearly the advances in knowledge regarding the desirability and prosperity of sustainable residential choice at the household's level, and in a boarder perspective on Behavior-environment interactions. The relevance of exploring desirability and prosperity of sustainable residential experience contributes to knowledge on sustainable prosperity put forward by behavioral patterns analysis. If the experience of these groups of households cannot be generalized for all households, the evaluation of sustainability performance of their residential experience and the desirability and prosperity of such experience nevertheless provides several avenues for discussing the effective measures to increase sustainability performance. More pragmatically, empirical strategy with a micro-level orientation also identify concrete pathways for interventions on living environments. As far as we are aware, this is the first attempt of examination of desirability of sustainable residential choice comprising behavioral performance comprising the three sustainability dimensions of sustainability and behavioral performance.

Studying the desirability of sustainable residential choice at the micro-level of household illustrates the complexity of the residential experience. The importance of targeting particular activities and elements in sustainability achievement are the key issue outlined by the results of this research. The (un)sustainable residential trajectory reinforces the relevance of longitudinal follow ups for understanding residential strategies in the later years. Furthermore, Follow-up research should also consider qualitative and quantitative case studies on a subset of different clusters of people's performance to explore in more depth the differences between successful and problematic lifestyles.

These results convincingly show that it is possible to have sustainable and desirable residential choice which survives. It occurs through the smart choices of households of living environments that matches their lifestyle and life situation. According to Dahl (2012) (un)sustainability is influenced by the individual actions and their choice. In order to have effective national policy, there is a need to public support. So, we should sensitize people to the level of sustainability of their residential choices and let them to know that sustainable residential choices can be desirable and encourage them to make or continue sustainable residential choices by implantation of soft and hard policies.

CHAPTER 6

DISCUSSION AND FINAL CONCLUSION

6.1 Introduction

In Quebec, like most North America cities, the end of the Second World War marked was beginning of a period of economic prosperity and a high birth rate that increased the housing demand. The available dwellings were neither sufficient nor suitable because the new attractive lifestyle for households were to raise the children in the suburbs. This trend lead to urban sprawl that is rooted in individual decisions supported by political decisions, as well as pressure from promoters (Després & Lord, 2002). The effects sought by urban sprawl (e.g. attachment to the automobile, appeal of single-family homes, access to property and proximity to nature), are also lagging behind some of well-known negative effects (e.g. congestion, increase in commuting time, stress, pollution).

The territory of Quebec metropolitan can divided into five types of urbanization: old Center (Composed of the historical center and its immediate surroundings), old suburbs, new suburbs, periphery and rural area. This territorial zoning developed by the Centre de recherche en aménagement et développement (CRAD) at Université Laval based on the period of urbanization (Morin & Fortin, 2008). This territory is characterized by a limited supply of public transport particularly for the suburbs that are further from the center.

Considering the Quebec's urban structure and desirable households' lifestyle, choice of dwelling should not be easy for the Quebec households. The single-family houses built in the central part of city and in the more sustainable neighborhood are expensive and unaffordable. Consequently, households have to choose house in the new residential developments in new suburbs to correspond to their needs. So, when it comes to the performance and people have to choose between sustainability performance and personal performance, they will probably choose personal performance.

Since 2009, with the objective of moving toward the sustainable development, Quebec considered some elements to be integrated into the planning tools on intensification in major projects. Two eco-neighborhoods and tramway are examples of these planning tools (Ville de

Québec - Écoquartier Pointe-aux-Lièvres, n.d.). However, the evidences have brought mixed results about the success of certain types of the planning tools encourage sustainable mobility behavior in Quebec and elsewhere in North America and Europe, notably eco-neighborhoods, Neo-traditional urbanism or Transit Oriented Development (TOD). Boisbriand neighborhood in Montreal (Barbonne, Shearmur, & Coffey, 2008), densification initiatives in Dublin (Howley, Scott, & Redmond, 2009b) are a few examples of partial failure of these tool that calls for considering new approaches such as soft densification of low-density residential neighborhoods and developing decision aid tools especially at the micro-level (individual). For example, our results showed that some households are conducting so many recreational activities. They are living in the neighborhood with low Walk Score. However, they are still relatively sustainable because their neighborhood provides them their favorite and dominant activity, which reduces the need for travelling. So, these households made a right decision regarding their priorities. If we can design decision aid tools that bring such awareness to the households, it may increase the sustainability performance of residential choice of households by decreasing the need to the high costs urban planning solutions.

Considering this context, the aim of this thesis was to better understand the links between residential choices and sustainability. The study was framed around the idea to verify the popular assumption that households living in more central neighborhoods "behave" in more sustainable manners in everyday life than those living in suburbs or in the periphery. The idea was to compare the level of sustainability of different residential locations with that of their residents' behavior in relation to work, school, leisure and consumption, keeping in mind household behaviors can be connected to the built environment in four dominant ways: sustainable behaviors can be performed in sustainable places or unsustainable places, as well as unsustainable behaviors performed in sustainable or unsustainable places. For this purpose, a methodological protocol was developed to assess the sustainability of the places of residence of sample of 740 working households from the Quebec metro area, but also of their daily mobility, housing and travel expenditures, as well and community insertion. The six-step procedures aimed: 1) to identify existing environmental, social and economic indicators to evaluate the sustainability of people's housing choice and daily mobility; 2) to define clusters of behaviors from relevant indicators grouped in dominant factors; 3) to analyze the characteristics that best

define the households in each cluster, as well as their places of residence; 4) to compare the sustainability levels of behaviors in each cluster through a quartile analysis; 5) to evaluate the level of congruity between people's levels of performance in terms of the sustainability of their behaviors and the sustainability of their housing location; and finally, 6) to evaluate the desirability of sustainable housing choices for these respondents, through an examination of their housing satisfaction and aspirations.

This final chapter discusses the main contributions of this thesis, more specifically the bodies of knowledge presented in chapter 4 and 5. In section 6.2, these contributions are examined in a more general manner with regard to knowledge development, methodological challenges, and potential applications. In the concluding section, the limitations of the study are discussed, and directions and recommendations for future research are proposed.

6.2   Discussion of the main findings

Our inventory of indicators used the sustainability of housing choice and mobility-related behaviors revealed that the assessment of the ecological dimensions of sustainability dominates scientific research compared to economic[21] ones and ever more so social ones[22]. We identified four categories of indicators to measure people's performance regarding sustainability: Spatiotemporal (e.g. transport mode, traveled distance, and, trip frequency), social (e.g. social satisfaction, perception of social cohesion, and commitment to neighborhood), environmental (e.g. energy use and vehicle occupancy) and economic (e.g. monetary expenditure on electricity, gas). We could easily identify most sustainability indicators in the "Demain Québec" survey, except for the social indicators. Reasons why place and people are linked in such ways are most often analyzed with regards to factors belonging to different types of variables having to do with life situations, lifestyles, and conveniences. The links recognized between sustainability performances of places and behaviors are described as matching

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[21] Markandya & Pearce (1988) defines economic sustainability as "use of resources today should not reduce real incomes in the future" (p.5).

[22] Social sustainability deals with strong socio-cultural life, involvement, access to services, safety and security and overall human well-being both mental and physical health (Bacon et al., 2012; Deakin et al., 2001; Woodcraft, 2012)

(sustainable behaviors in sustainable places or unsustainable behaviors in unsustainable places) or lacking congruity (unsustainable behaviors in sustainable place and sustainable behaviors in unsustainable places). Different geographical boundaries have different spatial configurations and planning providing distinct choices of dwelling, destinations and associated daily mobility (Aditjandra et al., 2012) which makes it hardly possible to define universal gauges. This problem is even more acute considering the environmental, economic and social imperatives of sustainability.

The available dataset provided measures for 25 variables among the indicators inventoried that were reduced to six factors through a principal component analysis accounting for 74.9% of the variance. According to their contribution to the solution are as follows: 1) car dependency, global travel distance and economic costs (21.397), 2) Global activity intensity (14.325), 3) Recreational activity intensity and travel distance (13.729), 4) Shopping activity intensity and travel distance (11.159), 5) Travel distance in public transport and global travel time costs (8.701), and 6) Housing expenditures and global active transport distance[23] (5.586). These variables were later applied to a two-step clustering analysis leading to seven profiles of behaviors. They are as follows: « Immobile Shoppers », « Immobile Recreationist using Public Transport », « Savers-on-Time and Spenders-on-Housing », « Mobile Individuals using Public Transport », « Mobile Individuals using Active Transport », « Hypermobile Shoppers using Car », and « Recreationist using Car ».

The first factor "*car dependency, global travel distance and economic costs*" has the highest positive score among the two Car-dependent group, « Recreationist using Car » and « Hypermobile Shoppers using Car » and the highest negative score among « Mobile Individuals using Active Transport ». The factors of *"global activity intensity"* has the highest positive scores among « Hypermobile Shoppers using Car » and « Mobile Individuals using Active Transport » and the highest negative scores among « Immobile Recreationist using Public Transport » and « Immobile Shoppers ». The factors of *"recreational activity intensity and*

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[23] The two items with highest loading in this factors are expenditure on housing with a positive loading and distance travelled by active transport per week with a negative loading.

travel distance" has the highest positive score among « Recreationist using Car » and *"shopping activity intensity and travel distance"* has the highest positive score among « Recreationist using Car » and « Immobile Shoppers » and the highest negative score among « Immobile Recreationist using Public Transport ». The factor of *"travel distance in public transport and global travel time costs"* has the highest positive score among the « Mobile Individuals using Public Transport » and the highest negative score among the « Savers-on-Time and Spenders-on-Housing ».

After studying each cluster in association with people socio-economic characteristic, we found the three variables accounting the most for the differences between the clusters are the tenure status, the number of cars and the number of incomes in the households. Three other variables were found to be moderately associated with the defined groups, all linked to the household composition, that is, the number of dependent children, the household size, and household structure. Also, studying each group in association with the spatial features of where they live revealed that spatial structures determines the sustainability performance in various degree of influence among the seven clusters. Spatial structures determine the sustainability performance of some groups sharply. « Mobile Individuals using Active Transport » and « Hypermobile Shoppers using Car » are the examples of such influences. While the first group households mostly live in inner city and suburbs in location with high Walk Scores, the majority of Hypermobile shoppers using car live in new suburbs and peripheries with a low Walk Scores. For some others, though the places exhibit some degree of influence on the sustainability performance of people's behavior in this group, the socio-economic profiles of these households had a high level of influence. In some profiles, neither these indicators did not account for the fitness or discrepancy between the place and behavior sustainability.

Through a quartile analysis, the respondents in each group were split into four groups for each of the 18 indicators of behaviors that could be ranked from most to least sustainable and percentage of members belonging to each quartile calculated. The sustainable performance of the behaviors in each cluster differ depending on which sustainability pillar we insist. For example, the behaviors of households in « Mobile Individuals using Active Transport » globally assessed as environmentally economically sustainable, but not socially. Furthermore, each pillar is composed of different subsets of indicators. Each cluster may be sustainable on one (e.g.

expenditure on housing) not in one other (e.g. expenditure on transport). Consequently, ***insisting too much one dimension, may imbalance other aspects***.

We assessed the levels of congruity between people's performance in terms of the sustainability of their behaviors and the sustainability of the places in which they live, evaluated using the metric of Walk Score. Interpreting the degree of correspondence between people and place sustainability assessments results is not as simple as one might have thought. Built environment seems to influence or inhibits sustainable behaviors much more in some clusters than others. In others, socio-economic traits seem to play a greater role. In some other again, it is impossible to figure out if the place or the people's characteristics play an important role. If the sustainability of a place can support sustainable behaviors, it does not necessarily mean households' prevailing activities will follow this logic. Finally, in some households, one specific type of activity may be the source of a global unsustainable assessment. For instance, if people can choose the neighborhoods in which the amenities and facilities in for their preferred activities at a specific point in their life are provided (ski facilities), they can still adopt sustainable behaviors in a sprawled location.

At the beginning of the thesis, we hypothesized four types of relationships between sustainability of places and behaviors as matching (sustainable behaviors in sustainable places or unsustainable behaviors in unsustainable places) or lacking congruity (unsustainable behaviors in sustainable place and sustainable behaviors in unsustainable places). As we previously explained, our research results revealed that each group may be sustainable on one dimension (not in one other (e.g. expenditure on transport). Consequently, we cannot consider a group sustainable in all the three dimensions of sustainability. However, if we evaluate the link between place and people in regards the factor with the highest percentage of contribution, namely "*car dependency, global travel distance and economic costs*".

At the final step of thesis, we analyzed intention to move, reason(s) for moving, the desired status of residence, residences and neighborhood type and location, based on the seven behavioral profiles. The results show the respondents associated with the seven groups are very different from each other regarding their residential satisfaction and aspirations. « Recreationist using Car » less satisfied with public services, active transport amenities, and public facilities. However, the moving intention was low among them. Interestingly, future movers intended to

move because of their tendency to become a homeowner or owning a large home which does not lead to more sustainability. Households in « Hypermobile Shoppers using Car », despite of their high level of general dissatisfaction with their actual domicile, high costs of housing and transport, do not intent to move in a near future or are uncertain about it. The fact that they live near school facilities might be sufficient at this time of their life course because of the presence of school-age children. The moving intention is high among the households of most sustainable group, « Mobile Individuals using Active Transport » who are being dissatisfied with the social aspects of their neighborhood. However, they would still make sustainable choices for their future residence.

The « Mobile Individuals using Public Transport » are very dissatisfied with the distance to their workplace and several intend to move to get closer, which would diminish their car use and fuel consumption and time spent commuting to work, two sustainable outcomes. If a fair proportion of « Savers-on-Time and Spenders-on-Housing »reside in walkable neighborhoods, they are mostly dependent on driving more than public and active transport. They are very satisfied with the proximity to workplace. They intend to move into more sustainable residences and neighborhoods. The « Immobile Recreationist using Public Transport » live in medium to high-density and are recreation-oriented, with a relatively high tendency to maintain themselves in the same type of neighborhoods with adequate recreational activities, which would support a sustainable lifestyle. They were the most dissatisfied households with the general aspects of their neighborhood, very satisfied with the security of their neighborhood and relatively satisfied with proximity to shops and services and public facilities. They were very concerned about the proximity to the educational institutes and very satisfied with the proximity to the childcare center, elementary and secondary schools. They mostly didn't intend to move. Finally, a relatively high rate of « Immobile Shoppers » who lives in locations with high Walk Scores and have sustainable behaviors for most variables are very satisfied with the proximity to shops and services. They are more satisfied groups with the security of neighborhoods than characteristics of the neighbors. Around half of them doesn't intend to move and relatively high percentage of them (more than forty percent) intends to move between 1 and 5 years mostly desires for low-density residences. Interestingly, a relatively high percentage of them desires for medium-density residences.

Our results revealed the sustainable households were dissatisfied with social climate and ambiance of their living environment and very satisfied with proximity to the workplace. Also, our results showed that the source of dissatisfaction does not always drive the moving intention. Even being dissatisfied with accessibility and transport aspect of their neighborhood, the dwelling size and willingness to become owner are the dominant factors for moving among many households.

6.3 Main contributions

6.3.1 Knowledge Contribution

Previous empirical research suggests that place-related features might have positive, negative, or no influence on people's behavior. Our empirical work confirms that sustainability performance of household behavior might or might not be associated with the sustainability performance of the places where they live. Indeed, our analyses confirms that a sustainable or unsustainable place of residence does not necessarily lead to the corresponding behaviors, with regards to daily mobility. The equation is much more complex and involves different sets of variables. If the setting itself plays a role in supporting or maintaining of (un)sustainable behaviors, it does not determine them. The stage in the life cycle, the inclination towards recreation and shopping, values and attitudes, as well as time and route management for convenience are all part of this equation. Although sustainable neighborhood support sustainable behaviors, if households' prevailing activities are not served by their provided spatial features, it will not lead to sustainable behaviors. In such wise, it is crucial that households have an accurate recognition of their needs and activity preferences during the decision-making to make the most sustainable residential choice.

The influences of places on sustainable behavior might also differ depending on the pillar of sustainability we are referring to. For example, a certain type of residential location may have positive outcomes on environmental sustainability, but less so on social sustainability. Furthermore, its influence might differ depending on the purpose of the activity. For example, while living in an outer suburb may decrease the recreation-related distance, living far from the commercial centers may increase shopping-related travel distance. Consequently, behaviors

might be defined as sustainable or not, depending of which sustainable outcomes are expected. Furthermore, ach pillar is multidimensional and the outcome of several types of behavior. For instance, in terms of economic sustainability, households may be sustainable with regards to housing expenditures but not on transport ones.

The analysis presented in the second article have not produced the expected positive/negative associations. Nevertheless, this lack of results demonstrating a clear link between place and people is still contribute to the advancement of knowledge. It shows that if the theoretical framework of the thesis is very complex, the conclusions are equally so. The results illustrate the complexity of the daily life and the high level of autonomy of households in some decisions (e.g. choice of place of residence, school, grocery store, recreational activities) and much less so in others (e.g. choice of workplace and daycare), in relation to the resources at their disposal (housing and transport supply, income, time management). In an original way, the result highlights the role of attitudes, values and aspirations (often inherited from a long process of enculturation) in household (im)mobility decisions.

Furthermore, the lack of clear link between place and people highlights the importance of considering diverse approaches. By identifying the household's profiles, urban planners can explore on how to increase the sustainability targeting certain indicators. For example, for the neighborhood with the households who their dominant activity is educational activity because of having young age children at home, providing diverse educational institutions can be an excellent solution to decrease the transport for driving children to the school. An example of such neighborhood is Aylmer in Gatineau in Quebec where many bilingual households with young children reside. So, the neighborhood has provided both French and English schools with different programs (e.g. private, international and public) meeting the needs of households with different preferences for their children's education.

6.3.2 Theoretical and Methodological Contribution

First, Literature review of studies looking at one at place and people performance.

Second, our findings revealed that sustainability is a not an absolute but a relative concept. It is multifaceted, with some components overlapping. In both conceptualization and

operationalization, considering the various elements is essential. If one dimension is push too hard, it may imbalance other aspects.

Third, as far as we are aware, our research was the first attempt at investigating the desirability of sustainable residential choice using the concepts of satisfaction and aspiration, thus contributing to body of knowledge inherited from behavioral patterns analysis. Combining the evaluations of the sustainability performance of current residential experience and of the desirability of such experience provides several avenues for discussing effective measures to increase sustainability performance and identifies concrete pathways for interventions on residential environments.

Finally, and not the least, this research proposes an all-embracing framework to study the sustainability of residential choice and applies a holistic approach to measure the sustainability of people's behavior with operational indicators for the three pillars. Two approaches can be used to measure sustainability: reductionism and holism. Reductionism breaks down a complicated natural and anthropogenic human-environment system to simple component parts (Bell & Morse, 2008; Bond & Morrison-Saunders, 2011). In the context of sustainability assessment (SA), this can be exemplified by the approach applied a few selected sustainability variables to signify the sustainability of a whole system (Bond & Morrison-Saunders, 2011). This is also the prevailing approach in the field of residential choice. Unlike the first approach, "Holism understands systems as having complex interactions which can't (currently) be fully understood in terms of the sub-components which make up the full system" (Bond & Morrison-Saunders, 2011a, p. 2). According to the above discussions, assessing a complex human-environment system with a reductionism approach disregards the intrinsic relations between essential variables contributing to system effectiveness, so the holistic research approach is recommended (Bond & Morrison-Saunders, 2011; Cashmore, 2004).

6.3.3 Knowledge transfer and application

The results of this research generated useful knowledge for decision-makers with two specific highlights. First, one specific activity practiced regularly by households may be the source of unsustainability. So, if people can choose the neighborhoods in which the amenities and facilities for their preferred activities are provided at a specific point in their life, they could

improve the sustainability performance. Second, it can offer insights in the degree to which more sustainable neighborhoods social or physical characteristics may lead to dissatisfaction or be considered not desirable—and for whom. So, if planners and policymakers can work toward improving these aspects, we may have households who are more satisfied or interested by such living environments. Finally, because of the crucial role of society performance in sustainability achievement, the ultimate goal of this research is providing data to be easily communicative with various performers. The information provided through this research may facilitate such communication, and provide a ground to merge broader of social and societal performers. So, our results can be helpful and applicable in designing informative and interactive websites where people can get to define better their needs and identify neighborhoods.

6.4 Limitations and recommendations for future research

The research revealed the value of integrating quantitative and the GIS analysis for producing important sustainability indicators. With the examples given in this research is for assessing the behavioral sustainability, this research shown a path that can be improved and replicated in other SA research, subject to changes to suit local context.

One must acknowledge several methodological limitations of this research and its impact of the generalizability of the findings. First, the "Demain Québec" database is the outcome of a non-probability sample of 3298 of respondents residing in the Quebec Metropolitan Community. So, it does not represent the true diversity of the population of the QCMA and therefore cannot be used to generalize the results to the entire population. It also includes a significant over-representation of young, highly educated individuals and professional workers. These groups are generally those using more mobile technologies with a higher probability to answer an online survey. The non-probability sampling has the drawbacks. The arbitrarily selection process make it impossible to estimate sampling variability and to measure the reliability (Statistics Canada, 2013). Despite these downsides, non-probability sampling methods can be beneficial when descriptive observations and clarifications are desired (Statistics Canada, 2013). Collecting « Demain Quebec » survey data with an internet connection results in the biases of presence of the younger respondents who have internet access. However, this feature of sample, which is often absent from the large surveys, brings originality

to this research. Because of the growing access and subsequent influence of internet, study of samples including internet users can be interesting and useful.

The second limitation is that this research is that the survey "Demain Québec" was not designed to measure sustainability. Thus, from its questionnaire, we selected the variables that could act as the best proxies for the sustainability indicators identified in the literature review. Yet despite the many advantages of this questionnaire, our analysis could not encompass all the indicators inventoried. A third limitation is the cross-sectional data set. As we are all aware, out-of-home behaviors may change over time because of dissonance/consonance, adaptation, and attachment, which a longitudinal survey could account for. Finally, if this large quantitative survey enabled us to classify behavior, assess its sustainably and examine the desirability of housing choice, qualitative data gathered from a sub-sample would have been quite useful to interpret behavior with more depth. It would have helped uncover the mechanisms operating in environment-behavior interactions with regards to sustainability.

This research focuses on working households, while the society is composed of different groups (e.g. retired people and university students). The needs and the behavior of households toward their neighborhood differ and consequently their contribution to sustainability achievement, therefore, it is recommended to the study and analysis of the other groups of households that comprise the society.

In this research, we applied simple analytical methods (descriptive analysis and group comparison) to investigate a complex issue. The methodology developed based on the already conducted « Demain Quebec » survey that was not intended for this research objective. It required the identification of objective indicators to assess the sustainability performance using variables from this questionnaire. Also, we manipulate variables to obtain measures relating to scope of activity (variables of the centrographic analysis), spending behavior, distance traveled, mobility frequency and intensity. This preparation and the manipulation of database required considerable meticulousness and time investment. Thus, it would be highly desirable to add probabilistic models to better understand both behaviors and the belonging to the different groups. This is a step that could be envisaged in the follow-up to the thesis.

Although the descriptive analysis is a useful method for identifying behavioral, but it is inadequate in effectively revealing the strength of the influential factors to sustainability performance. So, we suggest to develop modelling framework to predict the main components of sustainability performance. So, we intend to work on another publication to test the probability of belonging to one cluster or another by developing seven binary logistic regression models and examining the contribution of some key indicators to each of the models. According to the results of this study, the proposed elements for future modeling future are below.

The two most representative indicators of behavioral differences among profiles in terms of sustainability are distance to recreation and total distance traveled for recreation (strong association with V de Cramer> 0.5). These results bring a unique and original light, considering that the commuting mobility dominate research in sustainable mobility. However, the distance traveled per week for work and transport time to work per week are the next indicators to better account for differences between profiles but with less strength (medium association with Cramer's V> 0.35). Twelve socio-economic variables were also tested in their ability to account for the different levels of sustainability between the seven clusters. Home and car ownership (with associations of average strength, Cramer's V between 0.25 and 0.3), had more strength compared to items related to household structure (living alone or in a couple, with children or not, more than Number of children or household size (Cramer's weak V association of 0.2). Finally, we would suggest to develop modelling focusing on action space and distance between dwelling and center of action space because they are comprehensive variables that encompass two key aspects of behavior: distance and frequency.

In this study, we applied the quantitative approach which has a large perspective. It can be descriptive or predictive. In this research, we use the descriptive analysis. However, it is recommended the regression analysis as complementary analysis in further similar research.

6.5   Conclusion

To summarize, the contributions of this thesis are multiple and of different nature. A first an important one is to have developed and operationalized a framework to evaluate the

sustainability of housing choice with environmental, social and economic indicators. It also considers the desirability of sustainable residential choices through the examination of household satisfaction and aspirations. This framework provides necessary guidance to quantify the sustainability of housing-related behaviors. Second, the findings provide insights that can be applied to support responsible decisions of both households and policymakers in mitigating and improving the sustainability of existing behavior (residential choice) and built environment (residential development). It is the compliance of households' prevailing activities with the provided spatial features for those activities in their residential areas that will most support sustainable behavior. It is not necessarily the sources of dissatisfaction that drive the moving intention. Households regards mostly the environmental features which are in accordance with their preferences, needs and goals at a certain point in time of their life situation, as well as in accordance with their prevalence activity.

Our thesis showed that to achieve a high performance in sustainability within its three pillars performance, we need to go beyond transport studies, on the dominance of geographer/ civil engineers. The sustainability research in the context of residential choice calls for truly interdisciplinary teams: economics, environment, environmental psychologist/sociologist, architects and planners.

The results suggest significant discrepancies between household's behavior and the urban characteristics of the living environment in the matter of sustainability. Without denying the contribution of the built environment to the adoption of more sustainable behavior, the thesis highlights the danger of an environmental determinism that underestimates the contribution of socio-spatial representations of the habitat in the individual choices.

It is essential to mention that studying the research hypothesis with the same applied methodology may show different results in other contexts including temporal, spatial and socio-economic context. For example, if we do the research in Quebec metropolitan area in 15 years, the results may be different because the preoccupation of households may be different at that time. In regards to spatial context, we can get different result if we do the research in a city in china because of the traffic congestion many of China's large cities (Ma, Heppenstall, Harland, & Mitchell, 2014). Finally, doing the same research in another Canadian city for example in

Montréal with a heterogeneous population compare to the homogenous population of Quebec may results in different behavioral profiles.

To end this thesis, it should be said that although the built environment plays an important role in the achievement of sustainable desirable residential choice, residing in a sustainable place in agreement with the prevailing activities of a family does not guarantee the accomplishment of the sustainable behavior, within the three pillars of sustainability, because the human being is not an honest broker. However, if we consider the concept of sustainability as a relative not an absolute and do not push hard in a specific aspect, desirable sustainable choices are attainable. We need to nudge the households instead of to push them as the protagonist in enhancing sustainable prosperity.

The prosperity of sustainability demands efforts from the part of both households and urban planners and decision-makers.

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APPENDIX 1

ITEMS FROM THE DEMAIN « QUÉBEC SURVEY » QUESTIONNAIRE USED IN ARTICLE 2

A.1.1 Items from the « Demain Québec » survey questionnaire used to measure people's performance

MODULE 3: VOS ACTIVITÉS

VOS ACTIVITÉS DE LOISIRS

M252

<u>Au cours des derniers 7 jours</u>, quelles activités avez-vous pratiquées <u>en dehors de votre lieu de résidence</u>? Par quel moyen de transport y êtes-vous arrivé(e)?

Vous pouvez mettre plusieurs fois la même activité (par exemple, si vous faites de l'activité physique dans plus d'un seul endroit)

	Type d'activité	Nombre de fois	Lieu (nom, adresse ou intersection, quartier)	Moyen de transport jusqu'au lieu d'activité
1	M252_r1_c1 1. Faire de l'activité physique	M252_r1_c2 1. 1 fois	M252_r1_c3	M252_r1_c4 1. Auto conducteur
2	M252_r2_c1 1. Faire de l'activité physique	M252_r2_c2 1. 1 fois	M252_r2_c3	M252_r2_c4 1. Auto conducteur
3	M252_r3_c1 1. Faire de l'activité physique	M252_r3_c2 1. 1 fois	M252_r3_c3	M252_r3_c4 1. Auto conducteur
4	M252_r4_c1 1. Faire de l'activité physique	M252_r4_c2 1. 1 fois	M252_r4_c3	M252_r4_c4 1. Auto conducteur
5	M252_r5_c1 1. Faire de l'activité physique	M252_r5_c2 1. 1 fois	M252_r5_c3	M252_r5_c4 1. Auto conducteur
6	M252_r6_c1 1. Faire de l'activité physique	M252_r6_c2 1. 1 fois	M252_r6_c3	M252_r6_c4 1. Auto conducteur

M252bis

Autre ou commentaires

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Module 3 complété à 85%

◀ ▶

0% ▭▭▭▭▭ 100%

MODULE 3: VOS ACTIVITÉS

LES COMMERCES FRÉQUENTÉS

M261

Pour chaque catégorie de commerce, indiquez le nom et la localisation du commerce que vous ou votre famille fréquentez le plus régulièrement.

	Fréquence d'utilisation de la catégorie en générale	Lieu 1 Nom ET localisation (ex. IGA LeBourgneuf)	Lieu 2 Nom ET localisation (ex. J.A. Moisan)
Dépanneur	M261_r1_c1 1. Jamais	M261_r1_c2	M261_r1_c3
Rue commerciale de quartier (rue Cartier, rue St-Jean, etc.)	M261_r2_c1 1. Jamais	M261_r2_c2	M261_r2_c3
Halles alimentaires (Halles de Sainte-Foy, etc.)	M261_r3_c1 1. Jamais	M261_r3_c2	M261_r3_c3
Épicerie (IGA, Métro, Provigo, Marché Richelieu, etc.)	M261_r4_c1 1. Jamais	M261_r4_c2	M261_r4_c3
Marché public (en saison)	M261_r5_c1 1. Jamais	M261_r5_c2	M261_r5_c3
Centre commercial (Place Laurier, Galeries Chagnon, etc.)	M261_r6_c1 1. Jamais	M261_r6_c2	M261_r6_c3
Méga-centre et magasins entrepôts (Costco, etc.)	M261_r7_c1 1. Jamais	M261_r7_c2	M261_r7_c3
Alternatives (coopératives alimentaires, banques alimentaires, distribution de panier bio, point de vente chez l'agriculteur)	M261_r8_c1 1. Jamais	M261_r8_c2	M261_r8_c3
Autre, précisez M261_r9_other	M261_r9_c1 1. Jamais	M261_r9_c2	M261_r9_c3

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Module 3 complété à 95%

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MODULE 3: VOS ACTIVITÉS

LES COMMERCES FRÉQUENTÉS

M262a

Pour chacun des commerces fréquentés, précisez les informations suivantes.

	Jour et période de fréquentation	Moyen de transport
[SSI Script]	M262a_r1_c1 1. Surtout en semaine l	M262a_r1_c2 1. Auto personne
[SSI Script]	M262a_r2_c1 1. Surtout en semaine l	M262a_r2_c2 1. Auto personne
[SSI Script]	M262a_r3_c1 1. Surtout en semaine l	M262a_r3_c2 1. Auto personne
[SSI Script]	M262a_r4_c1 1. Surtout en semaine l	M262a_r4_c2 1. Auto personne
[SSI Script]	M262a_r5_c1 1. Surtout en semaine l	M262a_r5_c2 1. Auto personne
[SSI Script]	M262a_r6_c1 1. Surtout en semaine l	M262a_r6_c2 1. Auto personne
[SSI Script]	M262a_r7_c1 1. Surtout en semaine l	M262a_r7_c2 1. Auto personne
[SSI Script]	M262a_r8_c1 1. Surtout en semaine l	M262a_r8_c2 1. Auto personne
[SSI Script]	M262a_r9_c1 1. Surtout en semaine l	M262a_r9_c2 1. Auto personne
[SSI Script]	M262a_r10_c1 1. Surtout en semaine l	M262a_r10_c2 1. Auto personne
[SSI Script]	M262a_r11_c1 1. Surtout en semaine l	M262a_r11_c2 1. Auto personne
[SSI Script]	M262a_r12_c1 1. Surtout en semaine l	M262a_r12_c2 1. Auto personne
[SSI Script]	M262a_r13_c1 1. Surtout en semaine l	M262a_r13_c2 1. Auto personne
[SSI Script]	M262a_r14_c1 1. Surtout en semaine l	M262a_r14_c2 1. Auto personne
[SSI Script]	M262a_r15_c1 1. Surtout en semaine l	M262a_r15_c2 1. Auto personne
[SSI Script]	M262a_r16_c1 1. Surtout en semaine l	M262a_r16_c2 1. Auto personne
[SSI Script]	M262a_r17_c1 1. Surtout en semaine l	M262a_r17_c2 1. Auto personne
[SSI Script]	M262a_r18_c1 1. Surtout en semaine l	M262a_r18_c2 1. Auto personne

M262b

Indiquez ce que vous aimez le PLUS et le MOINS de chaque commerce.

M2Ecran22a

MODULE 3: VOS ACTIVITÉS

VOS DÉPLACEMENTS POUR VOTRE OCCUPATION PRINCIPALE

M221

À L'ALLER: Pour votre occupation principale ([SSI Script]), nommez de 1 à 3 moyens de transport que vous utilisez le plus souvent sur un même trajet pour vous rendre à votre lieu de travail ou lieu d'études? [Incluez la marche de 5 minutes ou plus]

Mode 1	Mode 2	Mode 3
M221_r1_c1	M221_r1_c2	M221_r1_c3
1. Je conduis (seul dans r	1. Aucun	1. Aucun

M222

À ALLER: Quelles sont vos heures de départ et d'arrivée les plus habituelles entre votre domicile et votre lieu de travail ou d'études?

Je quitte mon domicile à...		J'arrive à mon lieu de travail ou d'études à...	
M222_r1_c1	(HH:MM, ex. 07:30)	M222_r1_c2	(HH:MM, ex. 08:30)

M223

AU RETOUR: Pour votre occupation principale ([SSI Script]), nommez de 1 à 3 moyens de transport que vous utilisez le plus souvent sur un même trajet pour revenir de votre lieu de travail ou d'études au domicile. [Incluez la marche de 5 minutes ou plus]

Mode 1	Mode 2	Mode 3
M223_r1_c1	M223_r1_c2	M223_r1_c3
1. Je conduis (seul dans r	1. Aucun	1. Aucun

M224

AU RETOUR: Quelles sont vos heures de départ et d'arrivée les plus habituelles entre votre lieu de travail ou d'études et votre domicile?

Je quitte mon lieu de travail ou d'études à...		J'arrive à mon domicile à...	
M224_r1_c1	(HH:MM, ex. 17:30)	M224_r1_c2	(HH:MM, ex. 18:30)

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Module 3 complété à 15%

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MODULE 1: VOTRE PORTRAIT DE CITOYEN

LES COÛTS POUR VOUS DÉPLACER

M331

À quelle fréquence utilisez-vous les véhicules possédés par vous et ceux qui habitent dans votre domicile; quels sont les frais mensuels liés à chacun? [si plus de 4 véhicules, mentionnez ceux les plus utilisés]

	À quelle fréquence utilisez-vous ce véhicule?	Mensualité de location ou d'achat	Frais d'essence mensuel	Frais de stationnement mensuels	Frais d'assurance mensuels
Véhicule 1	M331_r1_c1 1. Ne s'applique p	M331_r1_c2 1. Voiture dej	M331_r1_c3 1. De 0 à 100	M331_r1_c4 b. Plus de 20	M331_r1_c5 5. Je ne sais
Véhicule 2	M331_r2_c1 1. Ne s'applique p	M331_r2_c2 1. Voiture dej	M331_r2_c3 1. De 0 à 100	M331_r2_c4 b. Plus de 20	M331_r2_c5 5. Je ne sais
Véhicule 3	M331_r3_c1 1. Ne s'applique p	M331_r3_c2 1. Voiture dej	M331_r3_c3 1. De 0 à 100	M331_r3_c4 b. Plus de 20	M331_r3_c5 5. Je ne sais
Véhicule 4	M331_r4_c1 1. Ne s'applique p	M331_r4_c2 1. Voiture dej	M331_r4_c3 1. De 0 à 100	M331_r4_c4 b. Plus de 20	M331_r4_c5 5. Je ne sais

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DEMAIN QUÉBEC
une enquête pour informer l'aménagement de nos villes

UNIVERSITÉ LAVAL

RTC
RÉSEAU DE TRANSPORT DE LA CAPITALE

Communauté métropolitaine de Québec

Faculté d'aménagement, d'architecture et des arts visuels
École d'architecture

M3Ecran32a

MODULE 1: VOTRE PORTRAIT DE CITOYEN
LES COÛTS POUR VOUS LOGER

M321

En tant que locataire, combien déboursez-vous _par mois_ pour vous loger?

	Frais (mensuel)	Je ne sais pas
Loyer	M321_r1_c1 $	M321_r1_c2 □

M322

En tant que locataire, quels autres frais déboursez-vous _par mois_ pour vous loger?

	Frais (mensuel)	Je ne sais pas	Inclus dans le loyer?
Frais d'électricité	M322_r1_c1 $	M322_r1_c2 □	M322_r1_c3 □
Frais de chauffage (autre que l'électricité)	M322_r2_c1 $	M322_r2_c2 □	M322_r2_c3 □
Frais de stationnement	M322_r3_c1 $	M322_r3_c2 □	M322_r3_c3 □

M323

En tant que propriétaire, combien déboursez-vous _par mois_ pour vous loger à votre lieu de résidence principale?

	Frais (mensuel)	Je ne sais pas
Hypothèque	M323_r1_c1 $	M323_r1_c2 □
Frais d'électricité	M323_r2_c1 $	M323_r2_c2 □
Frais de chauffage (si autre que l'électricité)	M323_r3_c1 $	M323_r3_c2 □
Télécommunications (Téléphone, Télévision, Internet, cellulaire)	M323_r4_c1 $	M323_r4_c2 □

M324

En tant que propriétaire, combien d'années vous reste-t-il à payer sur l'hypothèque?

M324_r1_c1 années

M325

En tant que propriétaire, combien déboursez-vous _par mois_ pour ces dépenses additionnelles?

	Frais (mensuel)	Je ne sais pas	Ne s'applique pas
Frais de condo (ou de copropriété)	M325_r1_c1	M325_r1_c2 □	M325_r1_c3 □
Taxes municipales et scolaires	M325_r2_c1 $	M325_r2_c2 □	M325_r2_c3 □
Assurances habitation	M325_r3_c1	M325_r3_c2 □	M325_r3_c3 □

M326

Êtes-vous propriétaire ou locataire d'un domicile secondaire où vous résidez régulièrement?

- M326=1 ▣ Non
- M326=2 ▣ Non, mais mes parents le sont
- M326=3 ▣ Oui, pied-à-terre dans une autre ville
- M326=4 ▣ Oui, chalet
- M326=5 ▣ Oui, condo
- M326=6 ▣ Oui, motorisé/roulotte
- M326=7 ▣ Autre

MODULE 1: VOTRE PORTRAIT DE CITOYEN

VOTRE REVENU ET SCOLARITÉ

M351

Parmi les catégories suivantes, laquelle correspond à votre revenu <u>personnel</u> annuel avant impôt?

1. Je ne sais pas

M352

Parmi les catégories suivantes, laquelle correspond au revenu <u>personnel</u> annuel avant impôt de votre conjoint-e?

1. Je ne sais pas

M353

Quel est votre plus haut niveau de scolarité à ce jour?

M353-1	Études primaires	M353-7	Diplôme universitaire de baccalauréat
M353-2	Études secondaires <u>en cours</u>	M353-8	Maîtrise <u>en cours</u>
M353-3	Diplôme d'études secondaires (DES)	M353-9	Diplôme universitaire de maîtrise
M353-4	Études collégiales en cours	M353-10	Doctorat <u>en cours</u>
M353-5	Diplôme d'études collégiales (DEC)	M353-11	Diplôme universitaire de doctorat
M353-6	Baccalauréat universitaire <u>en cours</u>	M353-12	M353_12_other

Autre (précisez):

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Module 1 **complété à 80%**

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MODULE 2: VOTRE DOMICILE

VOTRE SATISFACTION AVEC VOTRE DOMICILE PRINCIPAL

M131

De manière générale, comment évaluez-vous votre satisfaction avec votre domicile actuel?

Pas du tout satisfait	Peu satisfait	Assez satisfait	Très satisfait
M131_r1=1	M131_r1=2	M131_r1=3	M131_r1=4

M132

En pensant à vos besoins actuels, comment évaluez-vous la localisation de votre domicile en ce qui concerne les aspects suivants:

	Pas du tout satisfait	Peu satisfait	Assez satisfait	Très satisfait	Ne me concerne pas
Proximité des lieux d'emploi ou d'études	M132_r1=1	M132_r1=2	M132_r1=3	M132_r1=4	M132_r1=5
Proximité du CPE (Centre de la petite enfance) fréquenté par mon ou mes enfants	M132_r2=1	M132_r2=2	M132_r2=3	M132_r2=4	M132_r2=5
Proximité de l'école primaire fréquentée par mon ou mes enfants	M132_r3=1	M132_r3=2	M132_r3=3	M132_r3=4	M132_r3=5
Proximité de l'école secondaire	M132_r4=1	M132_r4=2	M132_r4=3	M132_r4=4	M132_r4=5
Proximité des commerces et services	M132_r5=1	M132_r5=2	M132_r5=3	M132_r5=4	M132_r5=5
Proximité des équipements publics (aréna, bibliothèques, etc.)	M132_r6=1	M132_r6=2	M132_r6=3	M132_r6=4	M132_r6=5
Proximité du Cégep fréquenté par ma famille	M132_r7=1	M132_r7=2	M132_r7=3	M132_r7=4	M132_r7=5
Proximité de l'université fréquenté par ma famille	M132_r8=1	M132_r8=2	M132_r8=3	M132_r8=4	M132_r8=5
Arbres et verdure	M132_r9=1	M132_r9=2	M132_r9=3	M132_r9=4	M132_r9=5
Accès autoroutier	M132_r10=1	M132_r10=2	M132_r10=3	M132_r10=4	M132_r10=5
Proximité des transports collectifs	M132_r11=1	M132_r11=2	M132_r11=3	M132_r11=4	M132_r11=5
Aménagement pour la marche et le vélo	M132_r12=1	M132_r12=2	M132_r12=3	M132_r12=4	M132_r12=5
Tranquillité	M132_r13=1	M132_r13=2	M132_r13=3	M132_r13=4	M132_r13=5
Sécurité	M132_r14=1	M132_r14=2	M132_r14=3	M132_r14=4	M132_r14=5
Ambiance	M132_r15=1	M132_r15=2	M132_r15=3	M132_r15=4	M132_r15=5
Caractéristiques des voisins	M132_r16=1	M132_r16=2	M132_r16=3	M132_r16=4	M132_r16=5

M132bis

Autre ou commentaires

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Module 2 complété à 25%

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A.1.2 Items from the « Demain Québec » survey questionnaire used to explore the socio-economic characteristics of clusters

M0Ecran01

INTRODUCTION

UN QUESTIONNAIRE ADAPTÉ À VOTRE SITUATION

Afin de vous assurer que le système informatique vous dirige directement aux questions qui vous concernent, il est important que vous répondiez d'abord à ces 11 questions d'introduction qui permettront de vous associer à un profil général de citoyen.

Intro00

Un membre de votre famille qui habite avec vous a-t-il déjà répondu à cette enquête?

Intro00=1 ◉ Non

Intro00=2 ◉ Oui

Intro00=3 ◉ Je ne sais pas

Intro01

Où est situé votre domicile principal?

[Le mot « domicile » désigne autant une maison, un appartement qu'une chambre louée. Si vous avez plus d'un domicile, considérez celui où vous passez le plus de temps durant la semaine.]

L'Ancienne-Lorette

Intro02

Qu'est ce qui décrit le mieux votre domicile principal?

Intro02=1 ◉ Maison

Intro02=2 ◉ Appartement

Intro02=3 ◉ Chambre

Intro02=4 ◉ Intro02_4_other
Autre ▯

Intro03

Par rapport à votre domicile principal, vous êtes:

Intro03=1 ◉ Propriétaire

Intro03=2 ◉ Locataire

Intro03=3 ◉ Intro03_3_other
Autre (veuillez préciser...) ▯

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M1Ecran11a

MODULE 2: VOTRE DOMICILE

VOTRE DOMICILE PRINCIPAL

M111

Qu'est-ce qui décrit le mieux la maison ou l'immeuble dans lequel vous habitez?

M111=1
Maison unifamiliale détachée

M111=2
Maison unifamiliale semi-détachée ou jumelée

M111=3
Maison unifamiliale en rangée (ou de ville)

M111=4
Maison mobile

M111=5
Immeuble à logements (duplex ou triplex avec escalier d'accès privé pour chaque logement)

M111=6
Immeuble à logements de 3 étages ou moins sans ascenseur (escalier/hall d'entrée partagé)

M111=7
Immeuble à logements de 4 à 6 étages avec ascenseur

M111=8
Immeuble à logements de plus de 6 étages

M111=9
Résidence étudiante

M111=10
Résidence pour personnes âgées

M111=11 M111_11_other
Autre, précisez

M111=12
Je ne sais pas

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INTRODUCTION

UN QUESTIONNAIRE ADAPTÉ À VOTRE SITUATION

Intro08

Durant les 7 derniers jours, quels moyens de transports avez-vous utilisés pour vous déplacer de façon utilitaire (par ex. pour vous rendre à votre travail, pour faire les courses, pour amener les enfants à l'école, etc.)?

Plusieurs réponses sont possibles.

Intro08_1 ☐ Marche

Intro08_2 ☐ Vélo

Intro08_3 ☐ Autobus (RTC, STL, etc.)

Intro08_4 ☐ Traversier

Intro08_5 ☐ Automobile (conducteur ou passager)

Intro08_6 ☐ Aucun

Intro08_7 ☐ Intro08_7_other
Autre (précisez)

Intro09

Combien de véhicules au total possèdent les personnes qui habitent dans votre domicile, en vous incluant?

1.0

Intro10

Utilisez-vous Internet au moins une fois par jour?

Intro10=1 ☐ Non

Intro10=2 ☐ Oui

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A.1.3 Items from the « Demain Québec » survey questionnaire used to explore the spatial characteristics of clusters

MODULE 1: VOTRE PORTRAIT DE CITOYEN

VOTRE LIEU DE RÉSIDENCE ET DE TRAVAIL

Afin de pouvoir faire des liens entre les besoins des résidents qui habitent et fréquentent des portions bien spécifiques de Québec, de Lévis et des MRC avoisinantes, il est important de nous fournir des précisions sur la localisation de vos lieux de résidence, de travail ou d'études. Le code postal, tout au moins ses trois premiers signes, est le meilleur indicateur pour nous permettre de comprendre vos besoins en fonction de votre localisation sur le territoire.

M371

Quel est le code postal de votre domicile principal? Indiquez au minimum les 3 premiers signes.

Code postal

M371_r1_c1 [   ]

M372

Indiquez où se situe votre résidence secondaire.

Municipalité ou nom du lieu
(avec nom de l'édifice ou du pavillon)

M372_r1_c1 [   ]

M373

Indiquez où se situe votre lieu de travail principal.

Nom du lieu ET rue ou intersection

M373_r1_c1 [   ]

M374

Indiquez où se situe votre lieu d'études principal.

Nom du lieu ET rue ou intersection

M374_r1_c1 [   ]

M376

Comment avez-vous entendu parler de l'enquête *Demain Québec*?

M376_1	À la radio	M376_5	Par le bouche à oreille
M376_2	À la télévision	M376_6	M376_6_other
M376_3	Par des signets		Par Internet ou Facebook [précisez le nom du site Web] [ ]
M376_4	Par des affiches	M376_7	M376_7_other
			Par une publicité dans un journal [précisez lequel] [ ]
		M376_8	M376_8_other
			Autre [ ]

M377

Avez-vous des commentaires supplémentaires à ajouter?

[   ]

Module 1 complété à 100%

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APPENDIX 2

ITEMS FROM THE « DEMAIN QUEBEC » SURVEY QUESTIONNAIRE USED IN ARTICLE 3

A.2.1 Items from the « Demain Québec » survey questionnaire used to measure residential satisfaction

A.2.2 Items from the « Demain Québec » survey questionnaire used to explore residential projects

M1Ecran15a

MODULE 2: VOTRE DOMICILE

VOS ASPIRATIONS RÉSIDENTIELLES

M151

Avez-vous l'intention de déménager de votre domicile actuel?

- M151-1 — Non, pas pour le moment
- M151-2 — Oui, c'est prévu pour cette année
- M151-3 — Oui, dans 1 ou 2 ans
- M151-4 — Oui dans 3 à 5 ans
- M151-5 — Oui, dans 6 à 10 ans
- M151-6 — Je ne sais pas

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MODULE 2: VOTRE DOMICILE

VOS ASPIRATIONS RÉSIDENTIELLES

M152

Quelles sont les deux principales raisons pour lesquelles vous voulez déménager?

M152_10	Domicile demande trop d'entretien	M152_2	Nouvelle situation familiale
M152_20	Pas assez de verdure/nature	M152_3	Nouvel emploi
M152_6	Devenir propriétaire	M152_19	Pas de cour privée
M152_13	Me rapprocher de mon lieu d'études	M152_12	Domicile trop loin du lieu de travail ou d'études actuel
M152_18	Domicile trop cher	M152_14	Domicile trop loin de ma famille
M152_4	Départ à la retraite	M152_1	Quitter la résidence familiale
M152_9	Domicile trop grand	M152_7	Devenir locataire
M152_8	Domicile pas assez grand	M152_15	Domicile trop loin des services
M152_17	Désir d'un meilleur logement	M152_16	Désir d'un meilleur voisinage
M152_11	Domicile trop loin du centre	M152_21	M152_21_other
M152_5	Problème de santé		Autre, précisez

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MODULE 2: VOTRE DOMICILE
VOS ASPIRATIONS RÉSIDENTIELLES

M153

À quel statut aspirez-vous lors de ce déménagement?

M153=1	Propriétaire d'une maison	M153=4	Locataire d'un appartement
M153=2	Propriétaire d'un chalet habitable à l'année	M153=5	Locataire d'une chambre
M153=3	Propriétaire d'un condo	M153=0	Autre

M156

Quel(s) type(s) de logement vous intéressent pour votre prochain domicile?

M156_1 0 — Maison unifamiliale détachée

M156_2 0 — Maison unifamiliale semi-détachée ou jumelée

M156_3 0 — Maison unifamiliale en rangée (ou de ville)

M156_4 — Maison mobile

M156_5 0 — Immeuble à logements (duplex ou triplex avec escalier d'accès privé pour chaque logement)

M156_6 0 — Immeuble à logements de 3 étages ou moins sans ascenseur (escalier/hall d'entrée partagé)

M156_7 0 — Immeuble à logements de 4 à 6 étages avec ascenseur

M156_8 0 — Immeuble à logements de plus de 6 étages

M156_9 0 — Résidence étudiante

M156_10 — Résidence pour personnes âgées

M156_11 0 — M156_11_other — Autre, précisez

M156_12 0 — Je ne sais pas

M154

Où aimeriez-vous habiter suite à ce déménagement?

1. Québec

M155

Quel prix seriez-vous prêt à payer pour votre nouveau domicile?

Loyer mensuel tout compris	Prix d'achat d'une propriété	Part du loyer mensuel en colocation
M155_r1_c1	M155_r1_c2	M155_r1_c3

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M1Ecran15d

MODULE 2: VOTRE DOMICILE
VOS ASPIRATIONS RÉSIDENTIELLES

M157

Quel serait le nombre maximum d'étages que vous accepteriez d'avoir dans votre immeuble?

M158

Ce futur domicile aurait combien de chambres à coucher?

M159a

Précisez le ou les secteurs où vous souhaiteriez habiter?

| M159a_0 | Les Rivières | M159a_4 | La Haute-Saint-Charles | M159a_1 | Beauport |
| M159a_3 | La Cité-Limoilou | M159a_5 | Sainte-Foy / Sillery / Cap-Rouge | M159a_2 | Charlesbourg |

M159b

Précisez le ou les secteurs où vous souhaiteriez habiter?

M159b_2	Lévis	M159b_1	Charny	M159b_6	Saint-Jean-Chrysostome
M159b_9	Saint-Romuald	M159b_3	Pintendre	M159b_5	Sainte-Hélène-de-Breakeyville
M159b_4	Saint-Étienne-de-Lauzon	M159b_8	Saint-Rédempteur	M159b_7	Saint-Nicolas

M160

Précisez le ou les types de voisinage où vous aimeriez habiter?

M160_1 Dans un quartier de maisons unifamiliales détachées

M160_2 Dans un quartier de maisons unifamiliales détachées, jumelées et en rangée

M160_3 Dans un quartier de maisons jumelées et en rangée, ainsi que de petits immeubles à logements (moins de 4 étages)

M160_4 Dans un quartier de maisons jumelées et en rangée, ainsi que d'immeubles à logements de moins de 4 étages.

M160_5 Dans un quartier de maisons en rangée, de petits immeubles à logements (moins de 4 étages) et d'immeubles à logements de plus gros gabarits (5 étages ou +)

M160b

Dans quelle mesure l'accessibilité à pied aux services suivants serait importante?

	Pas du tout important	Peu important	Assez important	Très important	Ne s'applique pas
Lieux d'emploi ou d'études	M160b_r1=1	M160b_r1=2	M160b_r1=3	M160b_r1=4	M160b_r1=5
CPE	M160b_r2=1	M160b_r2=2	M160b_r2=3	M160b_r2=4	M160b_r2=5
Écoles primaires	M160b_r3=1	M160b_r3=2	M160b_r3=3	M160b_r3=4	M160b_r3=5
Écoles secondaires ou cégeps ou universités	M160b_r4=1	M160b_r4=2	M160b_r4=3	M160b_r4=4	M160b_r4=5
Commerces essentiels (épicerie, pharmacie, dépanneur)	M160b_r5=1	M160b_r5=2	M160b_r5=3	M160b_r5=4	M160b_r5=5
Équipements publics (aréna, bibliothèques, etc.)	M160b_r6=1	M160b_r6=2	M160b_r6=3	M160b_r6=4	M160b_r6=5

APPENDIX 3

CLUSTERS DISTRIBUTION MAP

Cartography of place of residence of households with at least one respondent working full-time of « Demain Québec » survey in relation to their behavioral sustainability (n=740)

Legend

- Immobile Shoppers (n=124)
- Immobile recreationist using public transport (n=62)
- Savers-on-time and spenders-on-housing (n=138)
- Mobile individuals using public transport (n=101)
- Mobile individuals using active transport (n=168)
- Hypermobile shoppers using car (n=71)
- Recreationist using car (n=76)

Cartography: Simin Lotfi
Projection: NAD 83 (CSRS) / MTM zone 7

Kilometers
0   2.5   5   10   15   20