Transportation (2013) 40:625–645
DOI 10.1007/s11116-012-9437-2

Rescuing the captive [mode] user: an alternative approach to transport market segmentation

Cynthia Jacques · Kevin Manaugh · Ahmed M. El-Geneidy

Published online: 17 August 2012

Abstract The prevailing approach to transport market segmentation which identifies two distinct groups, "captive" and "choice" users, has widely been used by professionals and scholars despite the ambiguity associated with these terms. Furthermore, conflicting interpretations from the point of view of decision makers and individuals may result in negative policy implications where the needs of captive users are neglected in favour of attracting new users. This study attempts to address these concerns by proposing an alternative segmentation framework that could be applied to any mode of transport, in any regional context, by users and decision makers alike to better guide the development of transport policies. Using the results of a large-scale transportation survey, a series of clustering techniques are employed to derive this alternative approach for segmenting walkers, cyclists, transit and automobile users. The main factors considered in the final clustering analysis are the level of trip satisfaction and practicality. The analysis yielded four market segments: captivity, utilitarianism, dedication and convenience. Using this theoretical framework to understand the distribution of travellers among market segments is essential in identifying distinct and appropriate policy interventions to improve trip conditions. It is hoped that the segmentation approach and policy framework proposed here will encourage a better balance between pragmatic and idealistic goals in transportation policy.

Keywords Market segmentation · Captive user · Choice user · Mode choice · Travel behaviour · Active transport

C. Jacques · K. Manaugh · A. M. El-Geneidy (✉)
School of Urban Planning, McGill University, Suite 400, 815 Sherbrooke St. W., Montreal, QC H3A 2K6, Canada
e-mail: ahmed.elgeneidy@mcgill.ca

C. Jacques
e-mail: cynthia.jacques@mail.mcgill.ca

K. Manaugh
e-mail: kevin.manaugh@mail.mcgill.ca

Introduction

The prevailing approach to transport market segmentation has defined two types of users: "captive" and "choice". This paradigm has been widely used and accepted as a means of categorizing and understanding travel behaviour for well over 30 years. Despite their widespread use, the meaning of the terms captive and choice as descriptors for travellers is rather ambiguous, and can result in conflicting interpretations, especially from the point of view of an agency or municipality versus an individual. However, the policy implications of these conflicting interests have been largely overlooked and unquestioned, though some scholars have raised valid concerns which deserve further consideration.

In addition, conventional market segmentation approaches have been primarily concerned with whether or not individuals have an alternative choice, but ignore whether these alternatives are more practical or enjoyable than the chosen mode or trip. This could contradict the notion of captivity or choice. For instance, an individual can have limited travel options but enjoy the mode they use, thus rendering the term captive irrelevant or misleading. Prevailing approaches have also focused primarily on public transit and automobile users while ignoring active modes such as walking and cycling, leaving a considerable gap in existing transportation literature and policy.

The purpose of this study is to uncover types of commuters from a large-scale survey, to determine whether an alternative, more holistic approach to transport market segmentation is called for, and what implications this may have. Furthermore, this research will expand the idea of transport market segmentation to include active modes of transportation. It is hypothesized that the practicality of a particular mode or trip could be the most important factor affecting trip satisfaction for some individuals, while others may value their enjoyment of a certain mode regardless of the level of practicality that it offers.

To begin, this study will provide a review of the existing literature related to the definitions of captive and choice mode users, the concerns surrounding this terminology and the resulting implications for transport policy, as well as previous attempts at expansions of the prevailing market segmentation model. Next, using the results of a large-scale survey at McGill University in Montreal, Canada, this study employs a combination of statistical clustering techniques to uncover different market segments that are applicable to four main modes of transportation: walking, cycling, public transit, and private automobile. This is followed by a discussion of how the proposed new market segmentation model can better guide transportation policy to ensure the greatest outcome for all groups of mode users.

Literature review

The prevailing segmentation of the transport market into two broad groups, "captive" and "choice" users, has been the widely accepted paradigm in academic literature and in professional transportation planning circles for many years (Brown 1983; Polzin et al. 2000; Peng et al. 2002; Beimborn et al. 2003; Krizek and El-Geneidy 2007 among others). These terms have been used primarily to describe transit and private motorized vehicle users but rarely so for active modes of transportation; one notable exception is Shmelzer and Taves's (1969) description of elderly people being "captive in pedestrianism" (as cited in Carp 1971). Some variations of the terminology exist; for instance, captive users have also been described as "transit dependent" (Polzin et al. 2000) or "transportation disadvantaged", and choice users are referred to as "discretionary users" (Giuliano 2005).

Of concern, however, is the lack of a precise and consistent definition for captive and choice users of a certain mode (Polzin et al. 2000). Captive mode users have been described as individuals who have no other option available to them. For example, transit captives are those individuals who do not have a driver's license or do not own a car (Beimborn et al. 2003). Automobile captives, on the other hand, are those who feel they have no other option than to use their automobile due to a lack of transit service and connectivity to suit their specific travel needs, or other circumstances such as disabilities or additional responsibilities (Beimborn et al. 2003). Reasons for mode captivity include age, disability, income or other personal circumstances (Beimborn et al. 2003; Garrett and Taylor 2003; Krizek and El-Geneidy 2007). Conversely, choice users have been defined as those who have various options but select a certain mode because they view it as superior to other modes (Beimborn et al. 2003).

The prevailing paradigm was meant to define two different groups of travellers (Fig. 1a); however, there are some groups of individuals that do not fit easily within either of these two categories. For instance, what about individuals who *enjoy* a long, grueling cycling trip for exercise, or individuals who have to take transit because they *choose* not to own a car? This has resulted in an overlap in the use of the terms captive and choice, where some of the literature would describe these individuals as choice, while other would describe them as captive, as illustrated in Fig. 1b.

Conflicting perceptions of this paradigm from an economic versus an equity standpoint present another issue. A transit agency, for example, is concerned with ridership and therefore may perceive captive riders as a mean to generate revenue. As Morison (1982) argued, the term captive implies that individuals will never change modes of transport. This may create a situation where captive users are "taken for granted" by transit agencies since it is assumed that these individuals will always use transit no matter the quality of the service provided (Beimborn et al. 2003). Garrett and Taylor (2003) assert that this attitude results in an inequitable and economically inefficient approach where transit policy that is often driven toward attracting choice riders to increase patronage, at the expense of improving services for existing users. Walker (2008) describes this conflict in terms of "patronage" versus "coverage" goals, where the former refers to an economic approach in which the focus is to increase ridership by attracting choice users, while the latter takes an

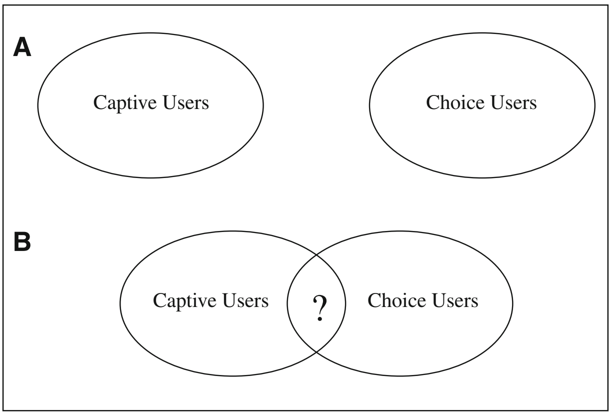

Fig. 1 Illustration of the intended interpretation of the conventional market segmentation model (**a**) and the resulting overlap (**b**)

equitable approach by providing adequate service to existing transit users regardless of the ridership or profitability of the service.

Moreover, even captive users potentially have a choice in the long-term if their situation happens to change; for example, if they acquire the resources to purchase an automobile (Beimborn et al. 2003; Morison 1982). If the quality of service offered to captive users is not a priority for the agencies, then these users will have little incentive to continue using the current mode when their situation changes, thus driving them toward alternative modes as they become available to them. The term "choice" user could be criticized as being value-laden, seeming to imply that these people are in some way superior or more deserving of attention than people who simply have no choice, since they take the less desirable mode even though they do not "have" to.

Although the existing examples relate to public transit and automobile use, the paradigm can easily be extended to users of active transportation; for instance, some individuals can be considered captive walkers if they do not own a vehicle and cannot afford transit. In such a case, policies to create safer and more welcoming walking conditions are just as important for existing captive walkers as they are for encouraging more individuals to use walking as a mode of transportation. Perhaps a more useful distinction for active travellers is to understand whether an individual who walks does so because it is a pleasant and practical choice, or simply as a response to financial or other constraints. A person walking in a neighbourhood conducive to such activity is quite different from someone walking in a potentially unsafe environment because they have no other choice.

Some studies have attempted to expand upon the idea of captive and choice users, to further clarify the distinction between the two groups. Wilson et al. (1984) proposed an expansion of the widely accepted paradigm for both transit and automobile users to four market segments: "functional captive mode users", "marginal captive mode users", "marginal choice mode users", and "free choice users". Similarly, Krizek and El-Geneidy (2007) expanded this terminology to examine both transit users and non-users and the regularity of mode use. The authors derived a conceptual diagram depicting eight distinctive market segments of transit users and non-users, playing off of the terms captive and choice. Transit users were classified as irregular and regular captive users, as well as irregular and regular choice users. Non-users were classified as irregular and regular potential transit users, and irregular and regular captive auto users.

While these expanded schemes have contributed to a greater understanding of the types of mode users, they continue to use misleading terminology and retain a strong focus on transit and automobile users. This study attempts to address these key issues through the development of an alternative, value-neutral approach to transport market segmentation, that resolves the conflict between economic and equity perspectives of user types and that can be used to understand travel behaviour for all transportation modes in various geographic contexts. By highlighting nuances among groups and individuals that most current paradigms would place into a "captive" category, this research aims to focus on how policy frameworks should strive to address the specific needs of various groups.

It is worth noting that researchers have classified travellers in ways that go beyond these broad captive and choice categories. Diana and Mokhtarian (2009), for example, clustered travelers by the use of different modes and Objective Mobility, Subjective Mobility, and Relative Desired Mobility. This framework allowed for the examination of how different mode use relates to desired levels of mobility and provides insight into how "mode-specific biases" can be better modelled. Noteworthy recent work has also shown clear evidence of how elements of trip utility or practicality are often secondary to personal elements such as overall well-being, socio-economic, and social life when judging the satisfaction with a particular mode or commute (Abou-Zeid and Ben-Akiva 2011). In addition, they examined how an individual's relationship with a "comparison other" had a strong effect on self-described happiness or satisfaction levels. While somewhat out of the scope of the present research, it is important to note the vast body of research that explores mode choice from a number of theoretical perspectives, as well as how satisfaction with travel choices relate to overall life satisfaction (Anable and Gatersleben 2005; Klockner and Friedrichsmeier 2011; Klockner and Matthies 2004; Duarte et al. 2010). These theories are extremely useful in understanding an individual's propensity to use a given mode; however, this is not the focus of the present study.

Data and methodology

The trip information used to carry out this analysis is based on a commuting trip, which is a trip that individuals make on a regular basis. The data are derived from a large-scale online travel behaviour survey that was conducted in March and April 2011, targeting McGill students, staff, and faculty. The survey included general questions to capture the respondents' primary commuting mode, postal code or nearest intersection to their home, and the location on campus at which they spend most of their time while at McGill. The survey also included a series of guided questions to capture detailed information about each leg of the respondent's last trip to campus, including specific transit routes (when applicable) and the level of satisfaction with the trip (using a likert scale ranging from very satisfied to very unsatisfied). Finally, the survey was designed to capture seasonality in travel choices, allowing individuals that switch modes throughout the year to provide the details of their alternative trip.

Study context

Figure 2 shows the location of the McGill downtown campus. The campus is well-served by transit, cycling and road networks. In total, 29 separate bus lines have stops within 400 m of the campus, 2 subway stations are within roughly 500 m, and a commuter rail station is about 700 m away. Additionally, several cycle paths connect directly to the campus and three BIXI (the local bike-sharing network) stations are easily accessible to campus. Recent campus initiatives have reduced automobile parking on campus and have made efforts to increase the pedestrian realm throughout campus including making most of the campus pedestrian-only. The large area north of campus is the lower slope of Mont-Royal which represents a barrier to most active trips. Transit mode split to campus is relatively high at 55 %; the mode split to the downtown core overall is roughly 43 %. Active modes make up 29 % of trips by McGill students, faculty, and staff and 9 % by all commuters to the downtown area (AMT 2008).

Survey dissemination and data preparation

An invitation to participate in the survey was distributed electronically, providing individuals with a link to the online survey. Email invitations were circulated to all faculty and staff with a McGill email address (8,493). Employees without a McGill email address (200) were sent a postcard inviting them to take the online survey. Invitations could only be sent out to 11,000 students due to concerns of overburdening students with survey requests. To ensure a representative sample of responses from students commuting from

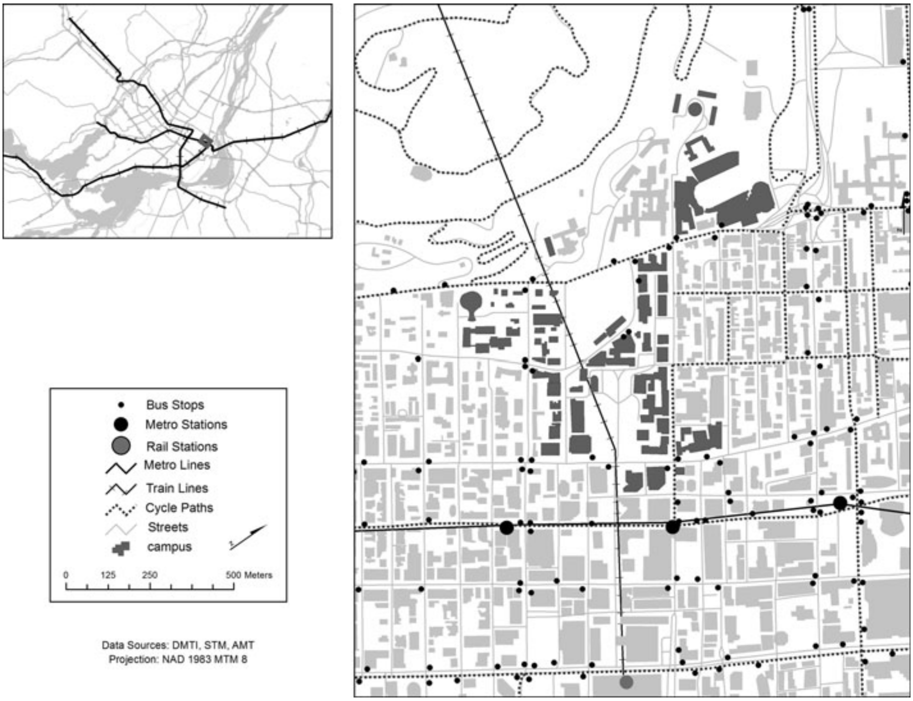

Fig. 2 Transportation connections to the McGill downtown campus

different parts of the Montreal metropolitan region, individual students were randomly selected with the goal of obtaining responses from 5 % of the total McGill student population residing in each borough or municipality in the region. It should be noted that the limitation on invitations to students resulted in an oversampling of employees. The survey remained active for 35 days, during which time 19,693 survey invitations were distributed among the McGill community. A total of 5,016 responses were obtained by the closing date of the survey. This yielded an overall response rate of 25.5 %, which is similar to the rates observed in other comparable studies (Páez and Whalen 2010). Following a series of data cleaning operations, through which incomplete and nonsensical survey responses were removed, a total of 4,697 entries were found to be suitable for use in subsequent analyses of the survey results, giving rise to a sampling error of plus or minus 2 at 99 % confidence.

For the purpose of this study, additional data cleaning was required to remove entries that were missing information relevant to the study or that were not representative of the modes examined. Removed entries include: individuals living outside of the Montreal metropolitan region (such as those commuting from Ottawa, Ontario); individuals identifying themselves as "visitor" and "other"; individuals commuting by motorcycle, scooter, taxi or the McGill intercampus shuttle, as there were far too few individuals to warrant clustering for these modes; and entries for which the age or sex were not indicated.

The modes of transportation examined in this analysis are walking, cycling, public transit (bus, metro and commuter train), and motorized vehicle (drive and carpool). To ensure that trip satisfaction and transit trip details were included for each respondent, their "primary mode" was matched to either of the detailed trips described by the survey respondent (i.e., fall or winter trip). If the indicated primary mode did not match the mode described in either of the detailed trips, the entry was excluded from the analysis. For walkers, additional entries were removed when they were found to have indicated unrealistic walking distances—more than 5 km—or if the respondent lived on campus (as these individuals represent a case that is quite unique to a university setting). This resulted in the dropping of 19 and 21 observations respectively.

Trip distances were measured along the network using geographic information system (GIS) software, linking the home postal code to the campus destination indicated by the survey respondent. It is worthwhile to point out that Canadian postal codes refer to a single block face (i.e., each block in Montreal has 4 unique postal codes); in this way, a postal code is accurate to within 100 m for most of the city. These generated trip distances were then used to derive the travel time for each respondent's trip. Past research has proposed an average speed of 5.47 and 15.94 km/h for walking and cycling trips, respectively (Horning et al. 2007; El-Geneidy et al. 2007). These speeds were used to generate approximate travel times for active modes. Car and carpool travel times were obtained from the Ministry of Transport Quebec (MTQ), using speeds derived from a travel demand model measuring speeds between transportation analysis zones (TAZ). In this analysis we used the travel time matrix for the morning peak period. Every trip origin and destination was assigned to a TAZ to determine the trip speed. This method of travel time derivation was chosen over using the free-flow speeds derived from GIS software to avoid any under estimations in travel time calculations.

A set of transit alternatives was obtained by entering the home postal code and the postal code of the individual's destination (section of the campus) into the Google Maps transit application. For transit users, these alternatives were then matched to the transit trip routes reported by each respondent. This was done by running a java script, which captured all of the pieces associated to the travel time along the different transit modes (bus, metro or commuter train) including in-vehicle time, walking time, and waiting time. Several studies have shown that the out-of-vehicle times have more influence on an individual's decision to use transit than the in-vehicle travel time; therefore, the inclusion of these times better represents the way individuals perceive the overall transit travel time (Beimborn et al. 2003; Morison 1982). Only individuals that walked to transit could be matched to the Google routes, therefore park-and-ride users were excluded from this analysis. For individuals using a mode other than transit as their primary mode, the shortest transit trip option was used to generate the hypothetical transit travel times.

Once the data preparation operations were complete, a total of 3,002 observations were found to be suitable for this analysis, including 1,193 transit users, 254 cyclists, 928 walkers, and 627 automobile users.

Mode-based cluster analysis

A two-step cluster analysis was performed for each of the four modes of transportation examined in this study. The two-step cluster was chosen for these mode-based analyses, as it is a recognized clustering method for dealing with both categorical and continuous variables (Norusis 2010). The goal of these cluster analyses was to identify distinct groups of individuals within each mode category, using several key variables from the survey results. Table 1 provides a list of the variables included in the analysis for each of the four modes examined.

The number of years that an individual has been involved with McGill was used as an indicator of familiarity with the transportation options available to arrive at their destination (i.e., transit routes, cycling lanes and paths). Age was inputted primarily to make the

Table 1 List of variables in the cluster analysis for each mode examined

Variables	Variable type	Data source
Walkers		
Age	Continuous	Survey response
Years actively involved with McGill	Continuous	Survey response
Walking travel time (min)	Continuous	DMTI Inc., Survey response
Practicality (walking versus transit trip)	Continuous	DMTI Inc., Survey response
Year-round	Categorical; 0 = seasonal, 1 = year-round	Survey response
Trip satisfaction dummy	Categorical; 0 = “Neutral”, “unsatisfied” or “Very Unsatisfied”, 1 = “Satisfied” or “Very satisfied”	Survey response
Cyclists		
Age	Continuous	Survey response
Years actively involved with McGill	Continuous	Survey response
Cycling travel time (min)	Continuous	DMTI Inc., Survey response
Practicality (cycling versus transit trip)	Continuous	DMTI Inc., Survey response
Year-round	Categorical; 0 = seasonal, 1 = year-round	Survey response
Trip satisfaction dummy	Categorical; 0 = “Neutral”, “unsatisfied” or “Very Unsatisfied”, 1 = “Satisfied” or “Very satisfied”	Survey response
Transit users[a]		
Age	Continuous	Survey response
Years actively involved with McGill	Continuous	Survey response
Total transit travel time (min)	Continuous	DMTI Inc., Survey response
Practicality (transit versus driving trip)	Continuous	DMTI Inc., Survey response
Number of transfers	Continuous	Google Maps, Survey response
Walking time to transit (min)	Continuous	Google Maps, Survey response
Time in bus (min)	Continuous	Derived from transit schedules

Table 1 continued

Variables	Variable type	Data source
Time in metro (min)	Continuous	Derived from transit schedules
Time in train (min)	Continuous	Derived from transit schedules
Walking time in transit (min)	Continuous	Google Maps, Survey response
Walking time from transit (min)	Continuous	Google Maps, Survey response
Total waiting time (min)	Continuous	Google Maps, Survey response
Year-round	Categorical; 0 = seasonal, 1 = year-round	Survey response
Trip satisfaction dummy	Categorical; 0 = “Neutral”, “unsatisfied” or “Very Unsatisfied”, 1 = “Satisfied” or “Very satisfied”	Survey response
Automobile users		
Age	Continuous	Survey response
Years actively involved with McGill	Continuous	Survey response
Automobile travel time (min)	Continuous	DMTI Inc., Survey response
Practicality (automobile versus transit trip)	Continuous	DMTI Inc., Survey response
Carpool	Categorical; 0 = no, 1 = yes	Survey response
Year-round	Categorical; 0 = seasonal, 1 = year-round	Survey response
Trip satisfaction dummy	Categorical; 0 = “Neutral”, “unsatisfied” or “Very Unsatisfied”, 1 = “Satisfied” or “Very satisfied”	Survey response

[a] Park-and-ride users are not included in this analysis; only individuals who walked to transit are included here

important distinction between a young active student who walks or cycles and an older person who is likely to have other options and/or is less likely to engage in physically demanding transportation. Travel time was included to get a sense of the distance individuals travelled between their home and campus; higher than average walking or cycling times could indicate dedication to the particular mode. The year-round variable was used as an indicator for dedication and practicality, an important variable given the region's harsh winters. Trip satisfaction, an important distinction of this dataset, is used in the analysis to show the level of enjoyment an individual derives from their current trip.

Practicality is meant to capture the level of practicality for each trip taken compared to the most realistic alternative for the same trip. For cycling and walking trips, transit was used as the alternative, since it is less likely that an individual using an active mode of transportation would travel by automobile rather than taking transit because they do not own a car, or for environmental, practicality or cost reasons. Similarly, transit was used as the next alternative for automobile trips, since it is unlikely that individuals traveling by automobile would switch to an active mode due to potentially long travel distances. For transit trips, the automobile was used as the next alternative, since some individuals using transit may live too far to realistically commute by active transportation. Several trip practicality variables were tested, and it was found that the selection of transit as the trip alternative yielded a similar output to including other trip practicality variables for every alternative mode. As the relationship between hypothetical walking and cycling times is constant, this value added nothing to the analysis. Accordingly, using transit alternative as the base for measuring trip practicality enabled a reduction in the number of variables included in the cluster analyses.

Trip practicality was calculated as the ratio between the travel time of the alternative trip option and the travel time for the mode actually used for the trip. Values above one indicate that the chosen mode has a higher practicality (is faster) than the alternative mode, whereas values below one indicate that the alternative mode has a higher practicality (is faster) than the mode chosen. For example, a practicality value of 2 indicates that the mode chosen is twice as fast as the next best alternative mode, and a practicality of 0.5 indicates that the chosen mode is half as fast as the alternative mode.

For transit users, a series of additional variables describing the details of their transit trip were included in the cluster analysis, to provide an indication of the complexity or simplicity of the transit trip. For automobile users, a dummy variable indicating whether or not individuals carpool is included in the analysis.

Final cluster analysis

To uncover the types of market segments, a k-means clustering analysis was performed on all 21 mode-based clusters resulting from the two-step cluster analysis. Although there are no defined standards for the minimum sample size for a cluster analysis, other studies have performed cluster analyses on samples with as few as 10 observations (Dolnicar 2002); therefore, our sample of 21 observations (the initial mode clusters) was thought to be appropriate for such analysis. This clustering was based on the mean trip practicality and trip satisfaction for each of the initial clusters, since we hypothesized that the practicality of a mode could be the most important factor affecting mode choice for some individuals, while others may value their enjoyment of a certain mode regardless of the level of practicality that it offers.

Results

Initial mode-based clusters

The two-step clusters yielded distinct groups of individuals for each of the four modes of transportation examined in this study. A total of 21 clusters were defined: five each for walkers, cyclists and automobile users, and six for transit users. The percent variation of the mean cluster values for each of these analyses is presented in Fig. 3. Detailed descriptions of the clusters for each mode are provided below.

Walkers

The cluster analysis for walkers revealed five distinct groups of individuals. The percent variation of the mean cluster values is presented in Fig. 3a. Trip practicality for walkers compares the walking travel time to the hypothetical transit travel time for the same trip. The resulting clusters can be described as follows:

> Cluster W1: young, year-round walkers whose walking trip is slightly longer than taking transit. They do not enjoy this walking trip and it is less practical than taking transit; perhaps they walk to save money on transit fares.
> Cluster W2: young, seasonal walkers who walk out of practicality, but do not enjoy it.
> Cluster W3: older, year-round, satisfied walkers who have a relatively long walk that is longer than taking transit. They walk for enjoyment and other benefits rather than for practicality. They walk year-round even though it is not practical.

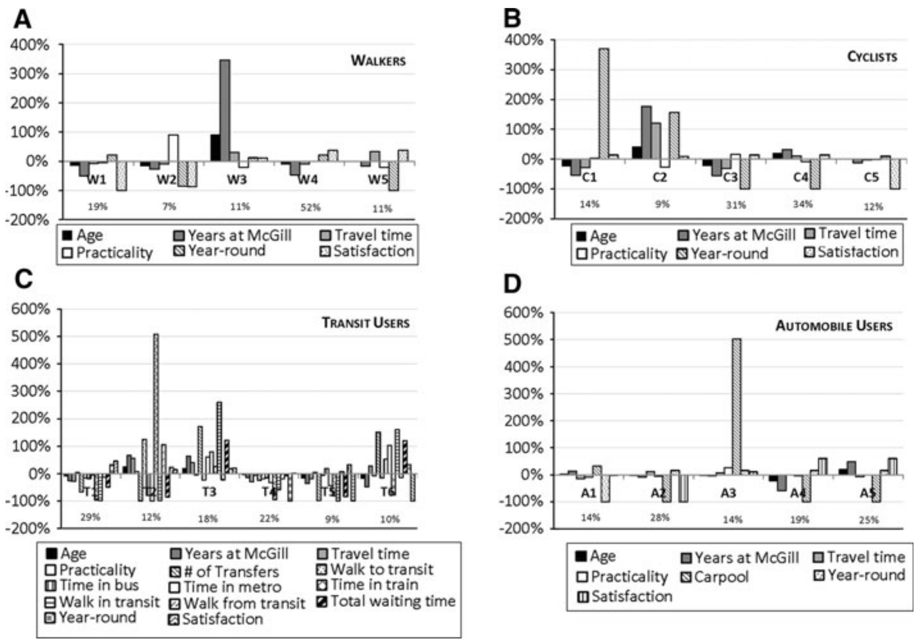

Fig. 3 Percent variation of mean cluster values for **a** walkers, **b** cyclists, **c** transit users, and **d** automobile users

Cluster W4: young, year-round walkers with a short, somewhat practical trip with which they are quite satisfied.
Cluster W5: seasonal, average aged walkers who have a relatively long walking trip that is much longer than taking transit. They likely walk for enjoyment rather than practicality.

Cyclists

The cluster analysis for cyclists yielded five distinct groups. The percent variation of the mean cluster values is presented in Fig. 3b. Trip practicality for cyclists compares the cycling travel time to the hypothetical transit travel time for the same trip. It should be noted that all cycling clusters in this analysis resulted in a practicality value of one or more, indicating that the cycling travel time is faster than the transit times for the same trip (although this is not necessarily true for each individual observation). The average practicality for cycling clusters was 1.8; therefore, it is important to consider how the practicality value for each cluster varies from the mean for all cluster groups. The resulting clusters are summarized as follows:

Cluster C1: young, year-round, satisfied cyclists with short travel time and an average practicality, indicating that this group cycles both for practicality and enjoyment.
Cluster C2: slightly older, long cycling trip which some individuals do year-round, high satisfaction with their trip despite the fact that is has a lower than average practicality and long travel time. Although this trip is more practical relative to transit, the fact that it has a long travel time and some individuals do this trip year-round indicates dedication on the part of the cyclist.
Cluster C3: young, seasonal, satisfied cyclists who cycle a relatively short distance and whose cycling trip is much faster than transit (more so than all of the other clusters).
Cluster C4: young, seasonal cyclists whose trip is relatively short and satisfying but not as practical as some of the other groups of cyclists, although it is still faster than taking transit.
Cluster C5: unsatisfied, year-round cyclists with an average travel time and practicality. Given the negative input for years at McGill, they may be unfamiliar with the cycling facilities between their home and destination at McGill, which may contribute to their dissatisfaction.

Transit users

The cluster analysis for transit users yielded six distinct groups. The percent variation of the mean cluster values is presented in Fig. 3c. Practicality for transit users compares the transit travel time to the hypothetical automobile travel time for the same trip. Transit observations have more elaborate findings as additional variables were included in the analysis (waiting time, time in different modes and number of transfers). The clusters are summarized as follows:

Cluster T1: transit users who have a short, simple trip which they take year-round, is nearly as fast as driving, and with which they are satisfied.
Cluster T2: commuter train users with a long walk to and from the station. They are quite satisfied, which could be explained by both the short waiting time and high practicality value.
Cluster T3: transit users who have a complex transit trip with a below average practicality, but nonetheless they are satisfied and take this trip year-round. Their higher

than average age and years of involvement with McGill suggests that they are familiar with their travel options, but remain dedicated transit users.

Cluster T4: somewhat satisfied, seasonal transit users that have a relatively short transit trip with a below average practicality, and they are somewhat satisfied.

Cluster T5: year-round bus users with a relatively simple although not very practical transit trip with which they are not satisfied.

Cluster T6: similar to cluster T3, these transit users have a complex transit trip with a below average practicality, which they take year-round. In contrast, however, these individuals are not satisfied with their commute.

Automobile users

The cluster analysis for automobile users yielded five distinct groups. The percent variation of the mean cluster values is presented in Fig. 3d. Trip practicality for automobile users compares the automobile travel time to the hypothetical transit travel time for the same trip. It should be noted that all automobile clusters resulted in a practicality value which indicated that the automobile travel time is faster than the transit times for the same trip (although this is not necessarily true for each individual observation). The average practicality for automobile clusters was 1.7; accordingly, it is important to consider how the practicality value for each cluster varies from the mean for all cluster groups. The resulting clusters can be summarized as follows:

Cluster A1: seasonal, somewhat satisfied automobile users, some of whom carpool, with a relatively short travel time but below average practicality.

Cluster A2: year-round, unsatisfied drivers, with an average practicality but longest travel time.

Cluster A3: year-round carpoolers, with a slightly higher than average driving time, but the highest practicality (much more time efficient to drive). Despite the high practicality, this group is only somewhat satisfied; this could be due to issues related to carpooling.

Cluster A4: younger, year-round, satisfied automobile users with an average travel time and trip practicality. They drive both because it is preferred and it is more practical than taking transit. They may be unfamiliar with their transit options or may not have found carpool partners since they have been at McGill only a short time.

Cluster A5: older, year-round, satisfied automobile users with an average travel time and trip practicality. They drive both because it is preferred and it is more practical than taking transit.

Final clusters

The final cluster analysis based on the mean trip practicality and satisfaction revealed four groups. Other numbers of clusters were tested, but resulted in clusters with only one observation or difficult-to-interpret outcomes. Four clusters gave the clearest results. Figure 4 provides a visual representation of the final clusters, through a scatter plot of the trip practicality versus the level of satisfaction for each of the 21 initial mode-based clusters. The scatter plot alone illustrates clear trends, as the four resulting clusters are already quite apparent. The k-means cluster analysis further confirms the presence of four clusters, providing empirical evidence for the clusters highlighted by circle outlines in Fig. 4. A description of each of the resulting clusters is provided below.

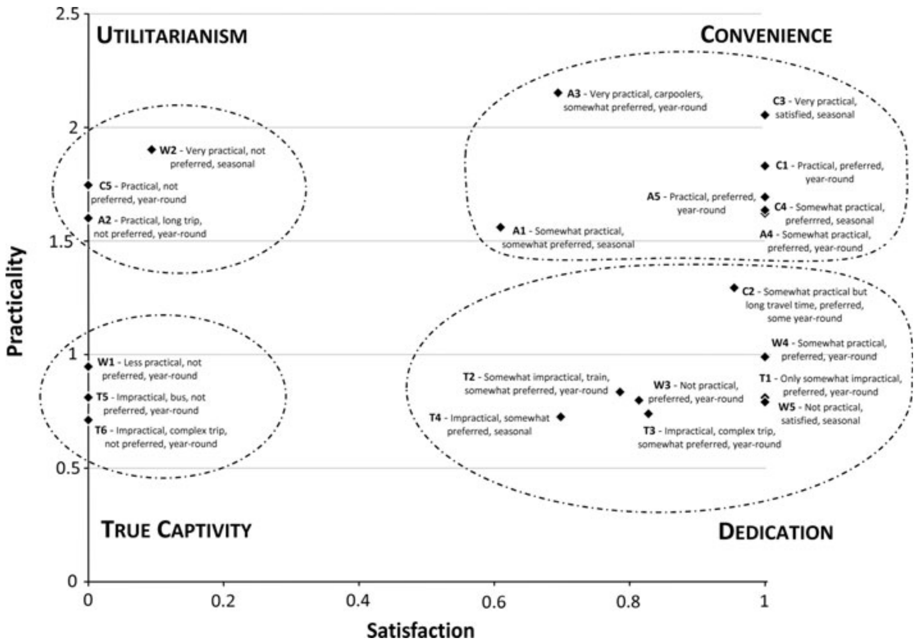

Fig. 4 Visualization of the clusters resulting from the *k*-means cluster for trip satisfaction and practicality

True captivity (lower-left cluster)

Individuals that have a low trip practicality, as well as a low level of preference for their trip, suggesting that these individuals face some level of constraint or captivity related to their trip. This cluster represents 13.6 % of our sample. The term "true captivity" is used to describe this cluster to highlight this negative situation that the individuals in this cluster find themselves in: making an unpleasant, impractical trip. In this sense, the term can be used from the perspective of both a transit agency and an individual in a mutually understood rather than a contradictory way.

Utilitarianism[1] (upper-left cluster)

Individuals that have a low level of preference, but a high level of practicality in their current trip. Therefore, these individuals take a very utilitarian approach to their travel decisions, favouring the level of practicality with a given trip, over their own preference. This cluster represents 9.0 % of our sample.

Dedication (lower-right cluster)

Individuals that have a low level of practicality, but who are satisfied with their trip, suggesting that they base their travel decisions on their level of enjoyment of the trip rather than the practicality. This group therefore demonstrates a certain level of dedication to their trip. This cluster represents 55.7 % of our sample.

[1] The term utilitarianism is used here to imply that a trip choice is functional, pragmatic, and logical.

Convenience (upper-right cluster)

Individuals who have both a high level of practicality and a high level of preference for their trip, thus representing individuals with a convenient trip. This cluster represents 21.7 % of our sample.

A large proportion of our sample is represented in the "dedicated" cluster; this is likely the result of the unique setting at an urban university campus. Although we might expect to see a different distribution of individuals in other samples, the strength of this approach is that it can be universally used to describe people in other contexts and geographic locations.

Discussion

The final clusters resulting from this analysis inspired the development of an alternative approach to transport market segmentation, which considers four different market segments—true captivity, dedication, utilitarianism and convenience—rather than the traditional dichotomy of "choice" and "captive" users. The proposed approach acknowledges that there could be varying levels of preference and practicality within a single market segment, as demonstrated by the distribution of the observations within circles delineating the four individual clusters in Fig. 4. This stresses the importance of recognizing that no two individuals face the exact same circumstances, constraints or resources. These results suggest that such market segments should perhaps be viewed as continuums along which individuals move, rather than static groupings.

Looking at how the proposed model compares to the prevailing paradigm sheds new light on the need for an alternative approach to transport market segmentation. From the viewpoint of the conventional paradigm, the perceived "captive market" would likely include the groups that we have identified as "utilitarianism", "dedication" and "true captivity" in Fig. 4. The prevailing approach is not concerned with *why* these individuals are captive. However, there is a difference between someone who takes transit because they truly have no other trip option, and someone who takes transit because they choose to not own a car. Rather, decisions makers (e.g., agencies, municipalities) using the prevailing approach may be more concerned with the number of individuals that they have in this perceived "captive market"—whether they have enough walkers or cyclists to meet their mode share goals, or more transit users to increase revenue.

Similarly, under the conventional segmentation paradigm, the perceived "choice market" would likely include the groups that we have identified as "utilitarianism", "dedication" and "convenience" in Fig. 4. There may be little concern with *why* these individuals make this particular trip choice. For example, there is a difference between someone who walks because they love the exercise, and someone who walks because it practical even though they do not enjoy it.

By failing to develop consistent definitions for the terms captive and choice, and by ignoring the subtleties that could help to infer the reasons behind the use of a particular trip, the existing paradigm has resulted in an overlap in the groups that end up in the perceived captive and choice markets. The current study suggests that decision-makers *should* be concerned with the various reasons behind one's trip choice, as this could help to clarify some of the ambiguous, overlapping situations that obscure the line between captive and choice users. By considering the level of satisfaction and practicality of the trip, the proposed alternative segmentation model has identified two distinct groups within the

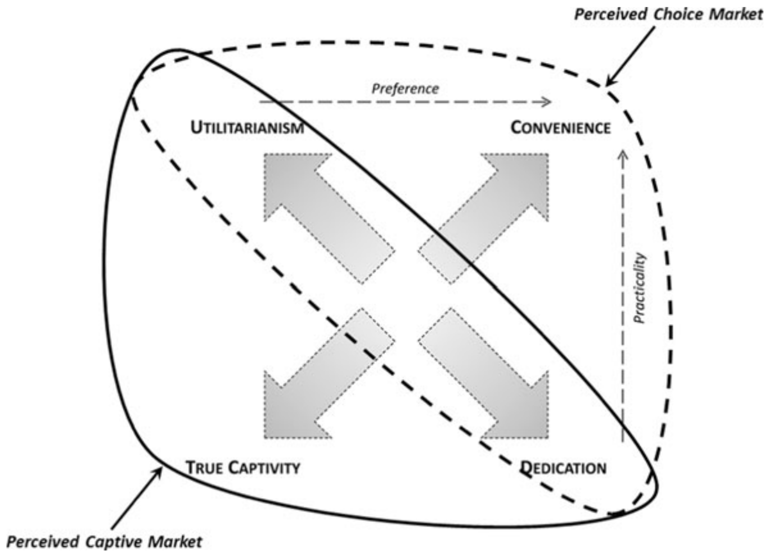

Fig. 5 Illustration of how the proposed market segmentation addresses the issue of overlap in the existing paradigm

traditionally "grey area": *utilitarian and dedicated users*, as illustrated in Fig. 5. With this new framework, an individual who takes transit because they choose not to own a car is considered a dedicated user, while an individual who walks even though they hate it is a utilitarian user. It is hoped the model proposed here will help to clarify the overlap that exists with the use of the existing paradigm.

It is important to note that the market segmentation model proposed here is not so much concerned with whether or not individuals have other trip choices, but rather is focused on addressing issues with their current trip—whether it is pleasant or practical, and how it can be improved. It is for this reason that we have moved away from using the term "choice". In addition, this new approach focuses on the individual's trip rather than their mode, recognizing that an individual's lack of preference for a particular trip does not necessarily imply a lack of preference for a particular mode.

Policy implications

The proposed model illustrates the importance of understanding more distinct groups of travellers, and brings clarity to a traditionally ambiguous overlap between the captive and choice markets. Taking into account the subtleties between market segments is the first step toward ensuring more targeted and equitable policy responses. The results of the current study suggest that transportation policy is not "one size fits all"; distinct markets require distinct policy interventions to improve the quality of an individual's trip.

Figure 6 presents the policy implications of the proposed approach to transport market segmentation in a conceptual diagram. There are two key policy areas that could influence an individual's movement along the continuum in Fig. 6 are:

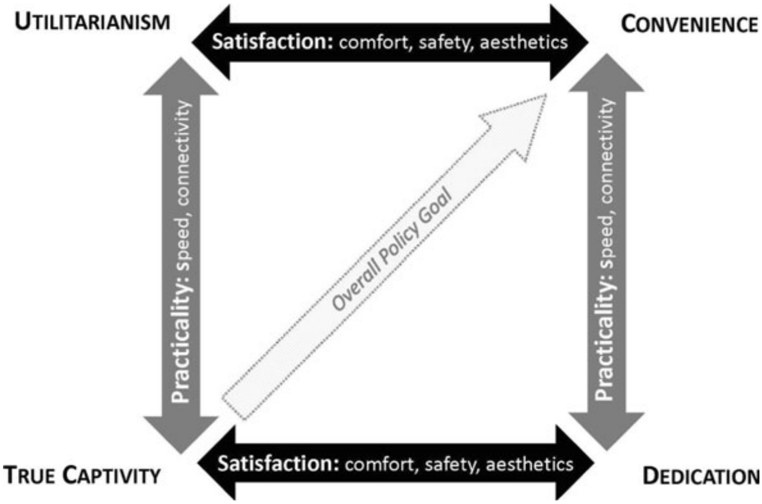

Fig. 6 Conceptualization of the policy implications of the proposed approach to transport market segmentation

(1) Policy interventions that improve trip comfort, the aesthetic quality of the trip route, or increase trip safety (as depicted by the black horizontal arrows in Fig. 6) could lead to increased enjoyment or satisfaction with a given trip. These types of policies would have the greatest effect on *true captives* and *utilitarian* travellers. For example, a walker might enjoy their trip more if improvements were made to their walking route to increase safety and comfort (e.g., wider sidewalks, more trees to provide shade). This might facilitate movement to the right in the conceptual diagram in Fig. 6, moving individuals from "true captivity" toward "dedication" or from "utilitarianism" toward "convenience".

(2) Policy interventions that improve trip speed, efficiency and connectivity (as depicted by the grey vertical arrows in Fig. 6) could improve trip practicality. These policies would have the greatest effect on *true captives* and *dedicated travellers*. For example, the introduction of a new, shortest-route path could shorten the duration of the walking trip, making it a faster, more efficient option. This type of intervention would facilitate movement upward in the conceptual diagram presented in Fig. 6, moving individuals from "true captivity" toward "utilitarianism" or from "dedication" toward "convenience", as their trip becomes more practical.

The double-sided arrows in Fig. 6 acknowledge that policy could have either a negative or a positive effect on the direction that individual's move along the continuum between the various market segments.

Although it may be naïve or idealistic to assume that policy could move all individual travellers toward trip "convenience"—where both trip satisfaction and practicality are maximized—it does not mean that policy should not strive to do so. Many policies are guided by optimistic goals or principles that describe an ideal situation or the "right thing to do". With the overall policy goal of trip convenience for all, it becomes important for decision makers to first distinguish between the various types of individual or groups. Understanding the distribution of individuals amongst the four market segments proposed in this study can help to ensure that the appropriate interventions are implemented. For instance moving individuals from "true captivity" toward "convenience" requires the implementation of both types of policy interventions described above so that the trip becomes both more practical and enjoyable. It is possible, however, that a single policy intervention could improve both the enjoyment and practicality of a given trip at the same time. In either case, if decision makers take the time to understand the distribution of travellers among the market segment, then they could more easily implement targeted policies to improve trip conditions. This is true not only for a transit agency trying to understand its users, but also for a municipality trying to understand who is using their cycling or walking facilities.

In addition to this more idealistic goal, the market segmentation model and policy framework proposed here also has pragmatic implications for decision makers. Although many transportation policies today focus on mode share and increasing the proportion of individuals using sustainable modes, it is equally important to consider those individuals who are already using sustainable modes. There are already many people who are walking or cycling or taking transit but, as noted in the Literature Review, these individuals are sometimes ignored in favour of attracting new users (Garrett and Taylor 2003). This might lead to these individual's switching to other modes.

This ties back to the idea of "coverage" versus "patronage" goals (Walker 2008), and stresses the need to balance the policy interventions targeted at prospective and existing mode users. We would argue that it is in the best interest of decision makers to give more consideration to existing mode users, to ensure that this existing share of sustainable mode users is retained over time. This is particularly important in the case of *true captives* since even these individuals may have a choice in the long run.

The proposed framework shows that travel decisions are not necessarily based on traditional notions of practicality or travel-time minimization (many travellers are satisfied with an objectively impractical trip). This study builds on previous research that seeks to question and expand the way travel behaviour is understood and modelled. Most research equates an observed trip with a "revealed travel preference"; however, by focusing on the satisfaction derived from a trip, this study highlights an important distinction between these two concepts. In other words, for the *"true captives"* identified above, we would argue that their "preferred" travel pattern, in terms of mode or route, is in fact unobserved. This is an important distinction that is often overlooked.

Conclusions

The conventional transport market segmentation of mode users as either "captive" or "choice" has been commonly used by scholars and professionals, despite concerns regarding the ambiguity and overlapping use of these terms, as well as potential negative implications for transport policy. In addition, the conventional paradigm has largely ignored users of active modes of transportation.

This study attempted to address these gaps and concerns using a series of clustering techniques to derive an alternative approach to transport market segmentation that could be applied to any mode, in any regional context, as well as by users and decision makers alike to better guide the development of transport policies. The proposed model identifies four market segments, as presented in Fig. 4: true captivity, dedication, utilitarianism and convenience. In this new approach, the term true captivity is used to purposefully emphasize the dire transport situation of the individuals in this group, urging transport policy to improve their transport options. In this way, the term can be mutually understood by individuals and decision makers to urge policy to improve the trip conditions for these individuals.

A true strength of the approach proposed herein is that it attempts to take into account trip perception, from which one could infer some of the reasons behind an individual's trip choice. Considering these subtleties between individual trip situations, this study has demonstrated the importance of understanding distinct markets. By understanding the distribution of individuals among the four distinct markets, decision makers can employ the policy framework introduced here in Fig. 6 to identify distinct policies to more targeted improvements to trip conditions. It is hoped that the policy framework provided here in Fig. 6 encourages a better balance between pragmatic (e.g., mode share) and idealistic (e.g., trip convenience for all) goals in transportation policy.

A few limitations of this study should be noted. Although the satisfaction variable provides an indication of the respondents overall level of satisfaction with their trip, it does not capture which specific aspect of the trip they are satisfied (i.e., whether they are satisfied with the comfort, level of safety, speed, etc. of their trip). Future research in this area should try to identify some specific aspects that contribute to trip satisfaction. While it would be best to consider the actual best alternative mode for each individual survey respondent, this was not realistic given the large number of respondents included in the analysis (just over 3000); for this reason, the next best alternative mode for each primary mode was selected at an aggregate level (e.g., the same best alternative was used for all transit users). The identification of the next best alternative mode for each individual respondent could be the subject of future research. Moreover, individuals make many different types of trips, each of which have their own defining characteristics. This study acknowledges that individuals will likely have varying levels of satisfaction and practicality with individual trip types. This is why, for the purpose of deriving the different market segments, this research focuses on a single trip type, the commuting trip that individuals make on a regular basis.

It is expected that applying this approach to other data samples would yield similar clusters to those defined here, although we might expect to see a different distribution of individuals among the clusters. Future research in this area would also benefit from further exploring the motivations behind an individual's mode or trip choice. In addition, it would be interesting to expand this research to look at different trip purposes, such as work/school versus recreational, to gain a better understanding of how individuals choose a particular trip for a specific purpose and their level of satisfaction towards these trips. Other aspects of transit service (such as park-and-rides), comfort and mode-specific amenities could also deepen the analysis presented here. In addition, considering the value that some individuals associate with being able to have extra time to read or relax while taking transit or the added stress of driving in traffic, which could affect the perceived practicality of a trip, such factors should be considered further in future research.

Acknowledgments We would like to thank the McGill Office of Sustainability and McGill Campus and Space Planning for their feedback and guidance at various stages of this project. We would also like to thank Daniel Schwartz from IT Customer Services for his assistance in developing the online survey and managing the distribution of the survey to the McGill Community. Thanks to Jacob Mason, Marianne Hatzopoulou and Naveen Eluru for their help throughout the survey design process. Also we would like to thank Guillaume Barreau for modeling the transit trips to McGill in Google Maps, as well as Vincent Chakour for his help with data cleaning and manipulation. We would also like to thank all those in the McGill community who took the time to fill out the survey. Thanks also to Eric Anderson who participated in the lively discussions and provided feedback on the new model and terminology proposed in this study. We express our gratitude to the McGill Sustainability Projects Fund for providing funding for this project. Finally we would like to thank the anonymous reviewers for their valuable feedback.

References

Abou-Zeid, M., Ben-Akiva, M.: The effect of social comparisons on commute well-being. Transp. Res. Part A **45**, 345–361 (2011)

AMT: Fichier de déplacements des personnes dans la région de Montréal Enquête Origine Destination version 02.b période automne (2008)

Anable, J., Gatersleben, B.: All work and no play? The role of instrumental and affective factors in work and leisure journeys by different travel modes. Transp. Res. A **39**, 163–181 (2005)

Beimborn, E., Greenwald, M., Jin, X.: Accessibility, connectivity, and captivity: impacts on transit choice. Transportation Research Record: Journal of the Transportation Research Board **1835**, 1–9 (2003)

Brown, M.: Public Transit Fare and Subsidy Policy in Greater Vancouver, 1970–1983: Efficiency and Equity Implications. School of Community and Regional Planning, University of British Columbia, Vancouver (1983)

Carp, F.: Walking as a means of transportation for retired people. The Gerontologist **11**(2 Part 1), 104 (1971)

Diana, M., Mokhtarian, P.: Desire to change one‘s multimodality and its relationship to the use of different transport means. Transp. Res. Part F **12**, 107–119 (2009)

Dolnicar, S.: A review of unquestioned standards in using cluster analysis for data-driven market segmentation. In: The Australian and New Zealand Marketing Academy Conference 2002 (ANZMAC 2002). Deakin University, Melbourne (2002)

Duarte, A., Garcia, C., Giannarakis, G., Limao, S., Polydoropoulou, A., Litinas, N.: New approaches in transportation planning: happiness and transport economics. Netnomics **11**, 5–32 (2010)

El-Geneidy, A., Krizek, K., Iacono, M.: Predicting bicycle travel speeds along different facilities using GPS data: a proof of concept model. In: Paper read at 86th Annual Meeting of the Transportation Research Board, at Washington DC, USA (2007)

Garrett, M., Taylor, B.: Reconsidering Social Equity in Public Transit, vol. 193. Social Research in Transport (SORT) Clearinghouse (2003)

Giuliano, G.: Low income, public transit, and mobility. Transportation Research Record: Journal of the Transportation Research Board **1927**, 63–70 (2005)

Horning, J., El-Geneidy, A., Krizek, K.: Perceptions of proximity to urban trails and measurement issues. In: The 37th urban affairs annual meeting. Seattle, Washington, USA (2007)

Klockner, C., Friedrichsmeier, T.: A multi-level approach to travel mode choice—how person characteristics and situation specific aspects determine car use in a student sample. Transp. Res. F **14**, 261–277 (2011)

Klockner, C., Matthies, E.: How habits interfere with norm-directed behaviour: a normative decision-making model for travel choice. J. Environ. Pyschol. **24**, 319–327 (2004)

Krizek, K., El-Geneidy, A.: Segmenting preferences and habits of transit users and non-users. J. Public Transp. **10**(3), 71–94 (2007)

Morison, J.: Equilibrium concepts in modal split modelling. Transp. Eng. J. **108**(5), 457–467 (1982)

Norusis, M.: PASW Statistics 18 Guide to Data Analysis. Pearson SPSS Inc, USA (2010)

Páez, A., Whalen, K.: Enjoyment of commute: a comparison of different transportation modes. Transp. Res. Part A **44**, 537–549 (2010)

Peng, Z., Yu, D., Beimborn, E.: Transit user perceptions of the benefits of automatic vehicle location. Transp Res. Rec.: J. Transp. Res. Board **1791**, 127–133 (2002)

Polzin, S., Chu, X., Rey, J.: Density and captivity in public transit success: observations from the 1995 nationwide personal transportation study. Transp Res. Rec.: J. Transp. Res. Board **1735**, 10–18 (2000)

Walker, J.: Purpose-driven public transport: creating a clear conversation about public transport goals. J. Transp. Geogr. **16**(6), 436–442 (2008)

Wilson, F., Stevens, A., Robinson, J.: Identifying mode choice constrained urban travel market segments. Can. J. Civ. Eng. **11**(4), 924–932 (1984)

Author Biographies

Cynthia Jacques is a recent graduate of the Master of Urban Planning program at McGill University. Her research interests include sustainable transportation planning and policy, travel behavior, the impacts of transport on the environment, and the evaluation of plan outcomes.

Kevin Manaugh is a PhD candidate at the McGill University School of Urban Planning. His main research interests include the social equity implications of transportation planning, modeling travel behaviour, GIS applications in urban planning, and the land use-transportation relationship.

Ahmed M. El-Geneidy is Associate Professor of Urban Planning at McGill University. His research interests include land use and transportation planning, transit operations and planning, travel behavior analysis including both motorized (auto and transit) and non-motorized (bicycle and pedestrian) modes of transportation, travel behavior of disadvantaged populations.