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Transit market research using structural equation modeling and attitudinal market segmentation

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ABSTRACT

This paper presents a comprehensive approach for identifying potential transit markets and for developing strategies to increase public transport ridership. The approach uses structural equation modeling (SEM) to identify simultaneously travelers' attitudes, travel behavior, and the causal relationships between a traveler's socioeconomic profile and his/her attitude toward travel. Travel attitudes are also used to identify distinct market segments and to develop plans that best serve the needs of each segment and increase transit ridership. The approach is demonstrated with a case study from the Utah Transit Authority.

1. Introduction

This paper presents a comprehensive approach for identifying potential transit markets and for developing strategies to increase public transport ridership. The approach uses structural equation modeling (SEM) to identify simultaneously travelers' attitudes, travel behavior, and the causal relationship between a traveler's socioeconomic profile and this traveler's attitudes toward travel. Attitudes toward travel are used to identify distinct market segments in order to best serve the needs of each segment and to develop plans to increase transit ridership.

The market segments traditionally used in transportation planning are most often based, contrary to the most sophisticated market research used in the private sector, on general socio-economic characteristics, such as income, gender, or automobile ownership. To better understand the reasons that different travelers have for choosing their everyday travel mode, there is a need to break away from these traditional segmentations and, instead, to determine the attitudes that drive each segment's mode choice (see, for example, Anable, 2005). These attitudes often cut across social and economic groupings.

This paper demonstrates the proposed approach with a case study from the Utah Transit Authority (UTA). The study was initiated by UTA looking for assistance in identifying potential markets and adopting the best strategies to increase transit ridership in the Salt Lake City region. This case study was chosen for this paper to show the application of this approach to a city that has little use of transit and limited premium transit service and demonstrate how this approach can be used to explore strategies of bus service improvement.

2. Literature review

The importance of market segmentation when investigating travel behavior is well documented (for example, Badoe and Miller, 1998; Button and Hensher, 2001; Paez, 2006), and analyzing travel demand by market segment has become common practice (Brand et al., 1994; Roberts and Vougioukas, 1993). Segmentation by trip purpose, geographical location, time, and several other trip characteristics is common in travel demand–choice models as shown, for example, by Mandel (1998), Cascetta (1991), and Lythgoe (2002). Other segmentations have included the division of auto users into car drivers and car passengers (Elgar and Bekhor, 2004) and socio-demographic or life cycle features (Ryley, 2006).

Market segmentation has been advocated as a means of increasing transit ridership. TRB, in fact, has published a handbook on the topic that provides transit managers, marketing professionals, and planners with steps and procedures for implementing market-segmentation strategies to increase transit ridership (Elmore, 1998). Guiliano and Hayden (2005) describe the wide array of existing marketing strategies for increasing public transport patronage, including segmentation strategies to better serve various submarkets.

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Recently there has been growing interests in segmentation by attitude as shown, for example, in early work by Koppelman and Hauser (1978) and, more recently, by Proussaloglou and Koppelman (1989), Golob and Hensher (1998), Cambridge Systematics (2001), Lieberman et al. (2001), Golob (2001), and Outwater et al. (2003). Anable (2005) showed that attitude-based market segments were very useful in identifying potential 'mode switchers,' whereas socio-demographic factors had little bearing on the travel profiles of the segments; this suggests that attitudes largely cut across personal characteristics. This is supported by significant work on understanding motivational and affective factors, as well as their effect and relative importance on mode choice comparing to instrumental variables (Steg et al., 2001a, b; Steg, 2005; Gardner and Abraham, 2007; Anable and Gatersleben, 2005). The studies show that these types of variables are significant and important in mode choice, sometimes even more than instrumental variables.

Some advances in the area of segmentation for travel-behavior analysis were made by Badoe and Miller (1998), who developed an analytical procedure that automatically identified segments by dealing simultaneously with level of service and socioeconomic and spatial factors to determine the relative role that each plays in determining travel behavior. Bhat (1997) used an endogenous segmentation approach to model mode choice that jointly determined the number of market segments in the travel population, assigning individuals probabilistically to each segment and developing a distinct modal choice model for each group.

SEM, a flexible linear-in-parameters multivariate statistical modeling technique that best fits this type of analysis, has been used for various travel-behavior studies since the 1980s. An early example is Allaman et al. (1982), who used it to determine attitudes toward travel, as well as travel behavior. Recent applications include Axhausen et al. (2001), who tested a hypothesis linking car ownership, transit season-ticket ownership, and modal usage; Simma and Axhausen (2003), who investigated the interactions among travel behavior, accessibility, and personal characteristics; Choo and Mokhtarian (2007), who studied the relationships between telecommunications and travel; and Fujii and Kitamura (2000), who used it to represent the effects of transportation-control measures on commuters' daily activity patterns after working hours.

Examples of SEM to study the relationships between attitudes and travel include Golob and Hensher (1998), who developed models in which changes in travel times, attitudes toward carpooling, mode choice, and the use of an exclusive freeway lane for carpools were examined; and Gärling et al. (2001), who tested the link between attitude toward driving and frequency of choice of choosing whether to drive. See Golob (2003) for a good review of the method, as well as more recent applications in the field of travel demand,

3. Methodology

The results in this paper are based on 522 records from a UTA household survey that involved three types of questions. The first part asked respondents about their travel habits for both work and non-work purposes. The last part included some socio-demographic questions. The second and main part of the survey inquired about 38 attitudinal variables that were used to measure respondents' sensitivity to a broad range of experiences that they might encounter during a trip, as well as characteristics of the different travel modes that they might consider for their journey. 37 out of these 38 attitudinal statements are shown in Table 1 (these are the statements that are included in the confirmatory factor analysis (CFA). Each survey respondent was asked to provide his or her rating level of agreement or disagreement with each statement, using a scale from 0, meaning strong disagreement, to 10, meaning strong agreement, while 5 meant a neutral attitude. The choice of the various attitudinal questions was based on the literature review and experience from previous studies conducted by the authors, as well as inputs from the local planning agency.

The overall methodology of the attitude-based market analysis involved four main steps:

Step 1: *Factor analysis to identify traveler attitudes*. This initial step made use of exploratory factor analysis (EFA) and CFA to classify attitudinal variables in such a way as to reduce the number of these variables and to detect structural relationships among them, while retaining the explanatory power of each manifest attitudinal statement. This process groups the various attitudinal questions into a series of traveler factors.

Step 2: *SEM to link traveler attitudes to demographic characteristics*. This step employed SEM, simultaneously estimating the relationships between the demographic and socioeconomic data and the attitudinal factors, between the attitudinal statements and the attitudinal factors, and between various attitudinal factors. SEM enables testing of a set of linear models to identify the structural attitudes of travel behaviors and quantification of the causal relationships between travelers' socioeconomic status or demographic profile and their attitudes. Both manifest and latent variables are used in the SEM. There are two main groups of manifest variables: (1) the attitudinal variables, which are the ratings that travelers give to their attitude toward various travel statements and (2) socioeconomic and demographic variables, such as household size, household income, and vehicle ownership. There are also two groups of latent variables: (1) the attitudinal factors representing the most important attitudinal dimensions for traveler behavior and (2) error terms associated with each variable involved in the SEM model.

The structure of the SEM estimated is shown in Fig. 1. The SEM is constructed in AMOS, which uses path diagrams to represent relationships among manifest and latent variables. Ovals or circles represent latent variables, while rectangles or squares represent manifest variables as shown in Fig. 1. Single-headed arrows in the path diagram represent causal effects.

The SEM process results in a final set of traveler factors, which are estimated by these three sets of equations simultaneously. Using the estimated SEM, attitudinal factor scores can be calculated using the estimated coefficients for functions between attitudinal factors and socioeconomic–demographic variables. The factor scores are then used as inputs to a cluster analysis of market segmentation.

Step 3: *Cluster analysis to segment the traveler market*. This step identifies distinct market segments based on people's attitudes toward travel. The core concept of market segmentation is to view a market as distinct segments rather than one homogeneous group. People within the same segment share similar attitudes toward travel behavior, while people in other segments hold different views. Using exploratory and confirmatory cluster analysis based on the attitudinal factor score (from the SEM), the entire sample of households and riders is grouped into distinct market segments that share the same set of attitudes toward their travel experience.

Step 4: *Applying SEM and market segmentation model to the general population*. The survey-based models are applied to the general population in study areas to estimate the distribution of population in different market segments at the geographic level. This is done by using the socioeconomic variables, which provide a vital link to the census data, enabling the determination of concentration of each market segment in each census block group.

Table 1
Confirmatory factor analysis results

Attitudinal-variable statements	Coefficient	Std. error	*t*-Stat.
Factor 1: desire to help improve air quality			
People who drive alone should pay more to help improve air quality	1		
I would be willing to pay more when I travel if it would help improve air quality	0.99	0.16	6.07
I would switch to a different form of transportation if it would reduce air pollution	0.75	0.13	5.77
Use of public transportation can help improve air quality	0.31	0.09	3.57
Factor 2: desire for productivity and reliability			
I would much rather do something else with the time that I spend traveling	1		
I would like to make productive use of my time when I travel	0.95	0.17	5.61
I prefer a travel option that has predictable travel time from day to day	0.82	0.16	5.20
When traveling, I like to keep as close as possible to my departure and arrival schedules	0.56	0.13	4.50
If my travel options are delayed, I want to know the cause and length of the delay	0.47	0.13	3.59
Factor 3: sensitivity to time			
I would change my form of travel if it would save me some time	1		
I am usually in a hurry when I make a trip	0.77	0.11	6.76
I use the fastest form of transportation regardless of cost	0.44	0.10	4.45
Driving is usually the fastest way to get where I need to go	0.19	0.06	3.14
Factor 4: sensitivity to safety and privacy			
I don't mind traveling with strangers	1		
I feel safe using public transportation	0.79	0.11	7.13
I feel safe walking both near my home and near my destination	0.69	0.11	6.18
When traveling, I like to talk and visit with other people	0.26	0.09	2.77
I prefer driving because I like to be alone while I travel	−0.19	0.09	−2.24
I worry about getting in an accident when I travel	−0.28	0.09	−2.91
Having my privacy is important to me when I travel	−0.38	0.08	−4.35
I avoid traveling through certain areas because they are unsafe	−0.51	0.11	−4.49
Factor 5: need for fixed schedules			
I need to make trips according to a fixed schedule	1		
I need to travel mostly during rush hours	0.88	0.15	6.02
I need to make trips to a wide variety of locations every day	0.72	0.16	4.60
It's important to be able to change my travel plans at a moment's notice	0.35	0.11	3.27
Factor 6: sensitivity to stress and comfort			
Having a stress-free trip is more important than reaching my destination quickly	1		
I don't mind delays as long as I am comfortable	0.60	0.12	4.87
It is important to have comfortable seats when I travel	0.21	0.07	2.81
I avoid traveling at certain times because it is too stressful	0.20	0.10	1.91
A clean vehicle is important to me	0.18	0.06	2.74
Factor 7: willingness to use transit			
I wouldn't mind walking a few minutes to get to and from a bus or a TRAX stop	1		
I would ride transit if services were available to my destination when I need to travel	0.95	0.15	6.43
When I travel with others, I prefer to be the driver	0.36	0.14	2.47
I know how to reach my destination using public transportation	0.32	0.16	2.06
I use the form of transportation that is simple and easy to use, regardless of cost	0.28	0.12	2.32
If I rode public transportation, I wouldn't mind changing between buses or between bus and TRAX	0.28	0.12	2.24
I would use public transportation more often if it were cheaper to ride	0.16	0.13	1.19

For this purpose, socioeconomic data from the 2000 Census Data (STF3A) at the block group level were used to calculate the percentage of population in each socioeconomic category for each block group. Thus, the factor scores for each socioeconomic characteristic combination could be calculated using the estimated parameters from the SEM. Based on these factor scores, the segment of each such combination was determined using the market segmentation model. By summing up the percentages of population of each market segment, the percentage of each market segment was calculated for each block group.

A similar procedure was applied to the 1990 public use micro data sample (PUMS). These data have an advantage over the STF3A, because they contain individual- and household-level information. This is an important attribute, because the market segmentation model is estimated using individual-level survey, so it could be applied to each individual in the PUMS data, to determine what segment the individual belongs to. However, PUMS data have a disadvantage of having only a subsample (5%) of the population enumerated in the census, and for lacking geographic details. The individual-level segmentation results were therefore aggregated to the PUMS geographic level and by comparing the results of the two methods, adjustment factor for each market segment were calculated within each PUMS area.

4. Identifying traveler attitudes using factor analysis

Based on preliminary EFA, three sets of factors, using six, seven, and eight factors, were tested by CFA to determine the right group of factors that explained all the attitudinal questions. The Cattell Scree plot method was used to decide on the number of factors and a set of seven factors that were significant and all of whose loadings had the correct sign was chosen. These seven factors are shown in Table 1, which includes the loading of each variable in each factor, its standard error, and *t*-statistics. Factor one, for example, includes four variables related to *desire to help improve air quality*. It reflects respondents' willingness to help improve the

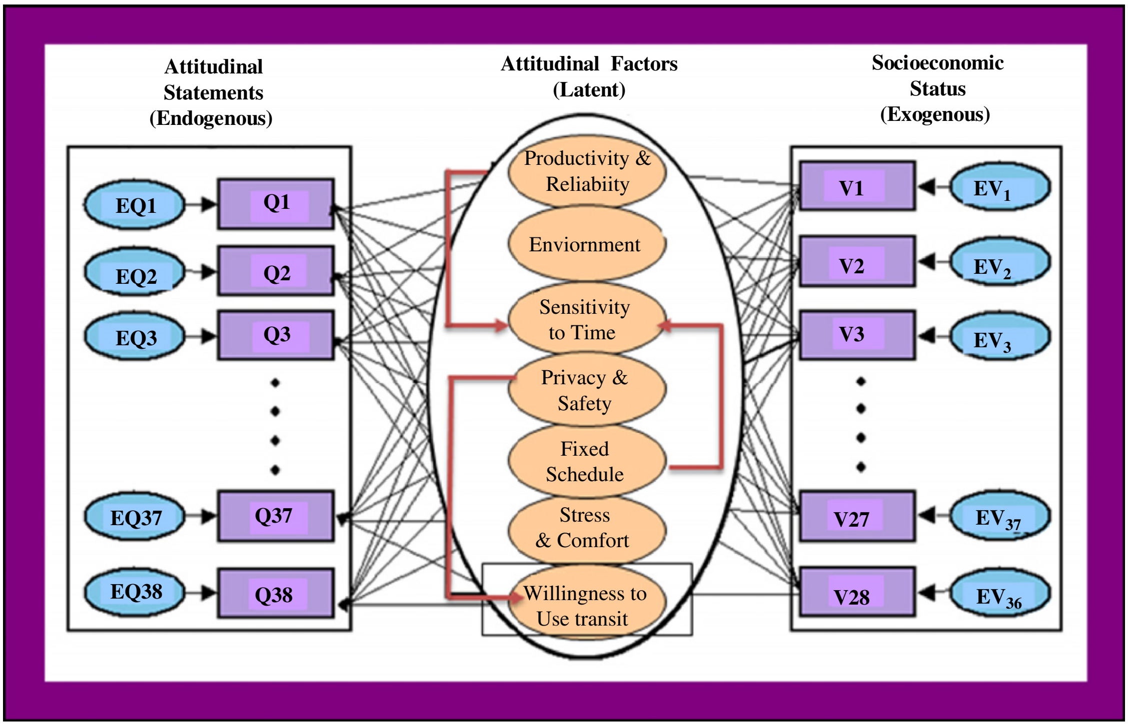

Fig. 1. SEM model structure.

environment by paying more (second variable) or changing their travel mode (third variable). People in this group also believe that using transit can help improve the environment (fourth variable), and hence desire to penalize commuters who drive alone (first variable). Other factors can be interpreted in a similar way; 37 out of the 38 attitudinal questions were used in the CFA. One question (I am usually anxious and unsettled when traveling) did not fit into any of the seven factors, therefore was dropped from the factor analysis.

The various factors account for 3.8% to 11% of the total variance in the data, while the total variance explained by the EFA is 40.2%. The goodness of fit index (GFI) of the CFA was 0.86, indicating that 86% of the co-variation in the data can be reproduced by the given model. Thus, the CFA supports the seven-dimension attitudinal construct.

5. Identifying traveler attitudes using structural equation modeling (SEM)

As described in the section on methodology, three types of functions were estimated in the SEM. The main results of each type of function are presented here.

5.1. Functions between attitudinal factors and attitudinal variables

Table 2 presents the estimated results of the path coefficients for all the attitudinal variables of each attitudinal factor in the SEM process. Statistics on standard error (std. error) and significance (*t*-stat.) for each variable are also presented in this table. These results are in general similar to the results obtained by the CFA presented in Table 1. Some order of the relative importance of variables within factors have been marginally changed and four more variables have been eliminated, two from Factor 5 and two from Factor 7.

5.2. Functions between attitudinal factors and socioeconomic variables

Table 3 shows the estimation result of the function for the factor 'Need for fixed schedules' as an example of the functions between attitudinal factors and socioeconomic variables. The first column of the table defines the socioeconomic category, while the second column defines its stratification to different variables. These are dummy variables representing different values or ranges of the socioeconomy category. The third column shows the coefficient estimate of the variable, the fourth shows its standard estimate, and the fifth shows the *t*-statistics. These results show that people aged 25–34 have higher need for fixed schedules may be because of the need to take care of small children; one-person household has less need for fixed schedule may be because he or she does not have family constrains. Employed people have a higher need for fixed schedule and people from no-worker household have lower need for fixed schedule. Finally, people from households with no or only one vehicle have higher need for fixed schedule; this may be because people without cars are limited to employment with good transit access or fixed schedules that are more conducive to carpooling.

5.3. Functions between attitudinal factors

Three pairs of causal relationships between attitudinal factors were modeled as shown in Fig. 1: (1) sensitivity to time as a function of a desire for productivity and reliability, (2) sensitivity to time as a function of the need for fixed schedules, and (3) willingness to use transit as a function of sensitivity to safety and privacy. The results of these models are presented in Table 4 and show that people who have high desire for productivity and reliability also have high sensitivity to time, and those with high sensitivity to time also have a high need for fixed schedule. Finally

Table 2
Attitudinal factors and attitudinal variables in SEM

Attitudinal-variable statements	Coefficient	Std. error	*t*-Stat.
Factor 1: desire to help improve air quality			
I would be willing to pay more when I travel if it would help improve air quality	1		
People who drive alone should pay more to help improve air quality	0.89	0.10	8.88
I would switch to a different form of transportation if it would reduce air pollution	0.86	0.09	9.28
Use of public transportation can help improve air quality	0.28	0.06	4.93
Factor 2: desire for productivity and reliability			
I would like to make productive use of my time when I travel	1		
I would much rather do something else with the time that I spend traveling	0.82	0.13	6.26
I prefer a travel option that has predictable travel time from day to day	0.73	0.11	6.36
If my travel option is delayed, I want to know the cause and length of the delay	0.68	0.11	6.08
When traveling, I like to keep as close as possible to my departure and arrival schedules	0.68	0.11	6.43
Factor 3: sensitivity to time			
I am usually in a hurry when I make a trip	1		
I would change my form of travel if it would save me some time	0.93	0.14	6.48
I use the fastest form of transportation regardless of cost	0.85	0.14	6.33
Driving is usually the fastest way to get where I need to go	0.52	0.08	6.18
Factor 4: sensitivity to safety and privacy			
I don't mind traveling with strangers	1		
I feel safe using public transportation	0.85	0.08	10.95
I feel safe walking both near my home and near my destination	0.55	0.07	7.74
When traveling, I like to talk and visit with other people	0.26	0.07	3.64
I worry about getting in an accident when I travel	−0.21	0.07	−2.89
I avoid traveling through certain areas because they are unsafe	−0.51	0.09	−5.76
I prefer driving because I like to be alone while I travel	−0.56	0.08	−7.23
Having my privacy is important to me when I travel	−0.61	0.08	−7.98
Factor 5: need for fixed schedules			
I need to travel mostly during rush hours	1		
I need to make trips according to a fixed schedule	0.89	0.13	7.02
Factor 6: sensitivity to stress and comfort			
Having a stress-free trip is more important than reaching my destination quickly	1		
I avoid traveling at certain times because it is too stressful	0.73	0.12	6.18
I don't mind delays as long as I am comfortable	0.64	0.10	6.36
It is important to have comfortable seats when I travel	0.26	0.07	3.84
A clean vehicle is important to me	0.18	0.06	3.20
Factor 7: willingness to use transit			
I wouldn't mind walking a few minutes to get to and from a bus or a TRAX stop	1		
I would ride transit if services were available to my destination when I need to travel	0.88	0.09	9.67
If I rode public transportation, I wouldn't mind changing between buses or between bus and TRAX	0.78	0.09	8.72
I know how to reach my destination using public transportation	0.64	0.10	6.58
I would use public transportation more often if it were cheaper to ride	0.36	0.08	4.34

people with high willingness to use transit also have high sensitivity to safety and privacy.

5.4. *Analysis of factor scores*

Fig. 2 presents the range of factor scores for the sample as calculated using coefficients estimated from the SEM model. The eight bars shown in the figure show the full variation across each factor for the entire household sample (and the UTA service area population by extension). Note that the first factor, desire to help improve air quality, is skewed to the right. This means that everyone in the sample has a relatively high environmental awareness. Nevertheless, the range from a low score of about −0.4 to a high of about 2.1 shows some variations in the sample. However, the range of desire to help improve air quality is narrower when compared to the very large range in sensitivity to fixed schedule and sensitivity to time.

Thus, the position of each bar relative to the scale along the top of Fig. 2 and length of the bar help to understand the advantage and challenges of developing transit services that will attract a significant proportion of the potential market for local travel. For example, this analysis shows that most transit modes are at an intrinsic advantage to private cars when it comes to attracting passengers who have a high desire to help improve air quality. Given that most people are sensitive to this environmental factor, and more than one half of the people show willingness to use transit, there is a high demand for transit services that are more environmentally friendly. On the supply side, knowing that more than one half of the people have high sensitivity to stress and comfort suggests that transit vehicles that maximize comfort and reduce stress should be designed. Alternatively, one may choose to avoid trying to serve the segments that are most sensitive to stress and comfort. In addition, market segments that value other factors where transit can compete, such as reliability and productive use of time, can be targeted. This approach would necessitate using signal pre-emption or putting transit in an exclusive right-of-way, so it can travel faster and avoid the congestion a drive-alone car would get caught in.

6. Market segmentation models

Three of the eight factors, as driven by the data to best assign the household sample to one of eight clusters or segments, were chosen to perform market segmentation. These factors were:

sensitivity to time, need for fixed schedules, and willingness to use public transit. These factors were chosen because they had the highest statistical reliability, as measured by the squared multiple correlations obtained in the SEM. Sensitivity to time had an R-squared of 0.73; willingness to use public transport had an R-squared of 0.49, and need for fixed schedules had an R-squared of 0.36.

Table 3
Structural equation for the need for fixed schedule

Stratification	Estimate	SE	*t*-Stat.
Age			
Age 18–24	0.053	0.327	0.16
Age 25–34	0.467	0.265	1.76
Age 35–64	−0.022	0.214	−0.11
Education			
Low education	−0.134	0.219	−0.61
Auto ownership			
0 Auto	1.770	0.878	2.01
1 Auto	0.520	0.274	1.90
Household size			
1-Person household	−0.722	0.327	−2.20
2-Person household	−0.215	0.229	−0.94
Household income level			
Income <35 K	−0.308	0.241	−1.28
Income 35–50 K	0.275	0.232	1.18
Income 50–100 K	0.114	0.231	0.50
Number of children			
0 Children	−0.343	0.216	−1.59
Gender			
Male	−0.216	0.215	−1.01
Marital status			
Married	−0.197	0.231	−0.85
Employment status			
Employed	1.982	0.261	7.59
Not in labor force	0.728	0.783	0.93
Number of household workers			
0-Worker	−0.915	0.305	−3.00
1-Worker	−0.381	0.237	−1.61

The resulting structure of the confirmatory cluster analysis is presented in Fig. 3. As seen from Fig. 3, the sensitivity of time was used to divide the sample into two groups: one for travelers who have high sensitivity to time and one for those who have low sensitivity to time. Next, each of these two groups was divided into two subgroups, based on their need for fixed schedule. Finally, the factor of willingness to use transit further divided the subgroups into eight market segments. Each market segment is identified with a descriptive name that invokes the primary drivers behind travelers' attitudes in that segment. These names were chosen trying to identify the primary drivers behind the traveler attitudes in that segment. For example, the segment with low sensitivity to time, flexible schedule, and willingness to use transit was named 'green riders' to show that this segment is likely to use transit. A segment with same schedule flexibility and willingness to use transit but with high sensitivity to time was named 'green flyers' to emphasize that they are potentially environmentally friendly but they are sensitive to time. A segment with high sensitivity to stress (anxious) and low sensitivity to time (ambler) was named 'anxious ambler'.

6.1. Characteristics of market segments

This section presents the main characteristics of the various market segments. Although three factors were used to create the eight market segments, each of the latter is best understood when using the information (or the factor scores) of all eight factors. In addition, SEM provides us with significant demographic/socio-economic variables and travel behavior that can be used to provide a complete profile of each segment. The result of this analysis provides the following profiles of each market segment.

Anxious ambler is a segment with low desire to help the environment and very low willingness to use transit. It also has

Table 4
Structural equations between attitudinal factors

Dependent	Independent	Estimate	SE	*t*-Stat.
Factor 2: sensitivity to time	Factor 2: desire for productivity and reliability	0.546	0.113	4.823
Factor 3: sensitivity to time	Factor 5: need for fixed schedules	0.389	0.111	3.485
Factor 7: willingness to use transit	Factor 4: sensitivity to safety and privacy	0.673	0.088	7.633

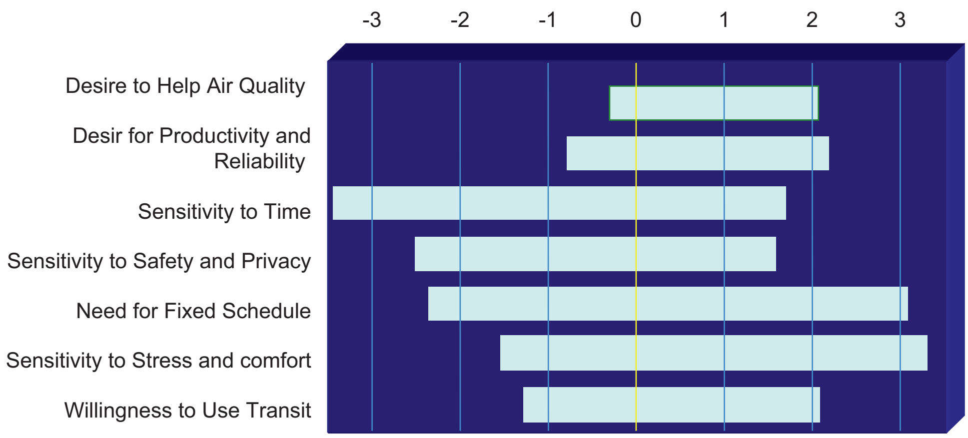

Fig. 2. Average factor scores for the entire service position difference from mean total scores.

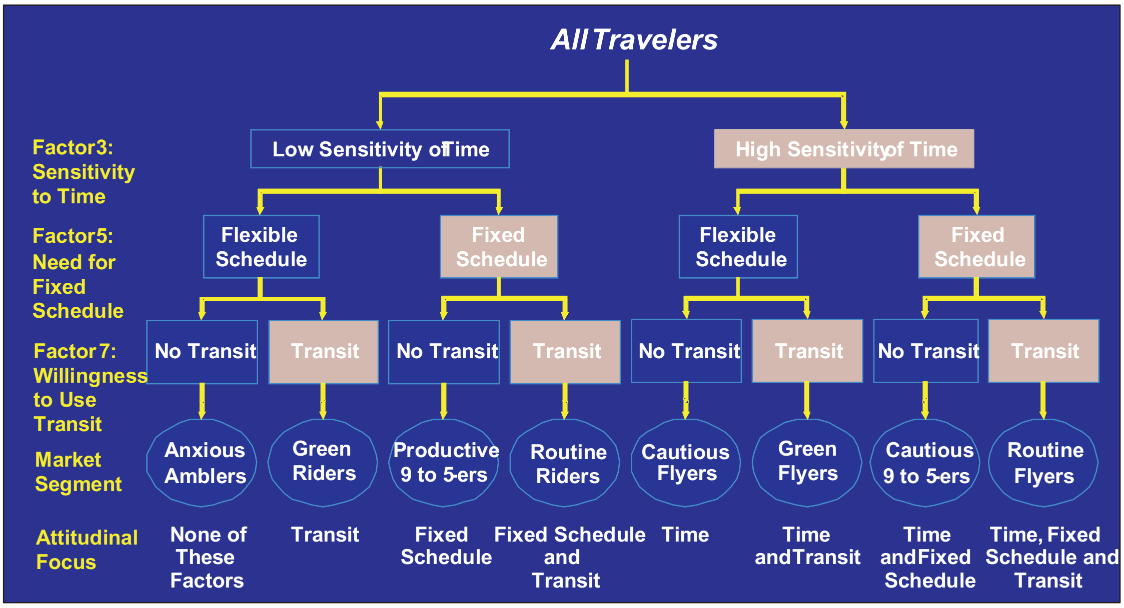

Fig. 3. Market segmentation.

low desire for productivity and reliability, low sensitivity to time, and flexible schedule. But it is highly sensitive to safety and privacy and it is the most sensitive segment to stress and comfort. This segment has high concentration of old retired female population: 70% of its population is retired and 65% are more than 65 years old. Nearly two thirds are female. Their income level tends to be low (less than $50,000) or middle ($50,000 to $100,000). Only 7% of this segment needs to travel more than one-half mile to work and nobody in this segment uses transit as the primary mode to work. Only 4% uses transit for non-work trips.

Green rider is a segment with high desire to improve air quality and the highest willingness to use transit. It has low desire for productivity and reliability, low sensitivity to time, and very flexible schedule. It is the least sensitive segment to safety and privacy, but highly sensitive to stress and comfort. More than half of the population in this segment has no workers in the household; nearly 50% are retired population, and 5% are students. It also has more disabled population than any other segment. All households in this segment own vehicles; most of them have only one vehicle. Only one quarter of this segment need to travel more than one-half mile to work/school; 6% use transit as the primary mode of transportation for work/school trips and 15% use transit for non-work trips.

Productive 9–5*er* is a segment with low desire to help the environment, low willingness to use transit, low sensitivity to time and fixed schedule, low sensitivity to stress and comfort, but very high desire for productivity and reliability, and high sensitivity for safety and privacy. All households in this segment have one or more workers, mostly two workers. All people in this segment are employed either full time or part time. The majority are married with no kids. More than 30% have an annual income of more than $100,000 and nearly one half have three or more vehicles; 91% of the households in this segment need to travel more than one-half mile to work/school; 9% use transit as the primary mode for work/school trips, but nobody uses transit for non-work trips.

Routine rider is a segment with high desire to help improve air quality, high desire for productivity and reliability, and high sensitivity to stress and comfort. Yet it has fixed schedule and low sensitivity to time as well as low sensitivity to safety and privacy. It has very high willingness to use transit. Most people in this segment are males, who are the only workers in their household with several kids; 40% are low-income households. Most own one vehicle, while 2% do not own a vehicle. This segment has the highest transit mode share for work/school trips: 85% needs to travel more than one-half mile to work/school; 13% of them use transit as the primary mode. But only 2% uses transit for non-work trips.

Cautious flyer is a segment with low desire to improve air quality and lowest willingness to use transit. It has high desire for productivity, high sensitivity to safety and privacy, but low sensitivity to stress and comfort. It also has flexible schedule, yet high sensitivity to time. The majority are young married female with kids. Most of them are in one-worker and two-vehicle households. This segment also has most of the homemakers and students, accounting for more than 75% of the population in this segment. Only 35% need to travel more than one-half mile to work. Nobody uses transit as the primary mode for either work or other trips.

Green flyer is the segment with the highest desire to help the environment, and high willingness to use transit. These are people who are highly sensitivity to time, but low desire for productivity and reliability, flexible schedule, low sensitivity to safety and privacy as well as low sensitivity to stress and comfort. Most of people in this segment are young and middle aged. Most of them are employed and their households usually have one worker. More than one half of the households have an annual income below $50,000. Only 44% need to travel more than one-half mile to work/school; 11% of them use transit as the primary commuting model. This is the segment with the highest transit mode share for non-work trips; 22% uses transit for trips other than work.

Cautious 9–5*ers* is the segment with the lowest desire to help the environment, and low willingness to use transit. But it has the highest desire for productivity and reliability, fixed schedule, and very high sensitivity to time. It is the most sensitive segment to safety and privacy, but it is not sensitive to stress and comfort. Most of the people in this segment are young and middle aged females who are married and live in households with two or more workers, and two or more vehicles. This segment has the lowest percentage of low-income population: less than 10% come from households with an annual income below $50,000. Ninety percent need to travel more than one-half mile to work/school; but only 1% use transit for work/school trips and for non-work trips.

Routine flyer is a segment with high desire to help the environment, and high willingness to use transit. It also has fixed schedule, high desire for productivity and reliability, and the highest sensitivity to time. But it is not very sensitive to safety and privacy, with very low sensitivity to stress and comfort. Most people in this segment are young and middle aged male who are married with kids. Most households have two or more workers; all households have one or more vehicle, and all people are employed. Eighty-seven percent needs to travel more than one-half mile to work/school. The transit mode share is 6% for work/school trips, and 1% for non-work trips.

6.2. Application of market segments

The results of the model application are the number of population within each market segments for each census block group. Fig. 4 presents the resulting size of the various market segments for the entire UTA service area. The model application results can be mapped at different geographic scales. Fig. 5 shows the spatial distribution of market segments at the PUMA level, census tracts as well as census block group level. The distribution of the market segments, along with the understanding of attitudinal preference and socioeconomic characteristics of each market segment, provides powerful information to transportation planners and transit decision makers to determine the type of service that should be marketed in certain areas.

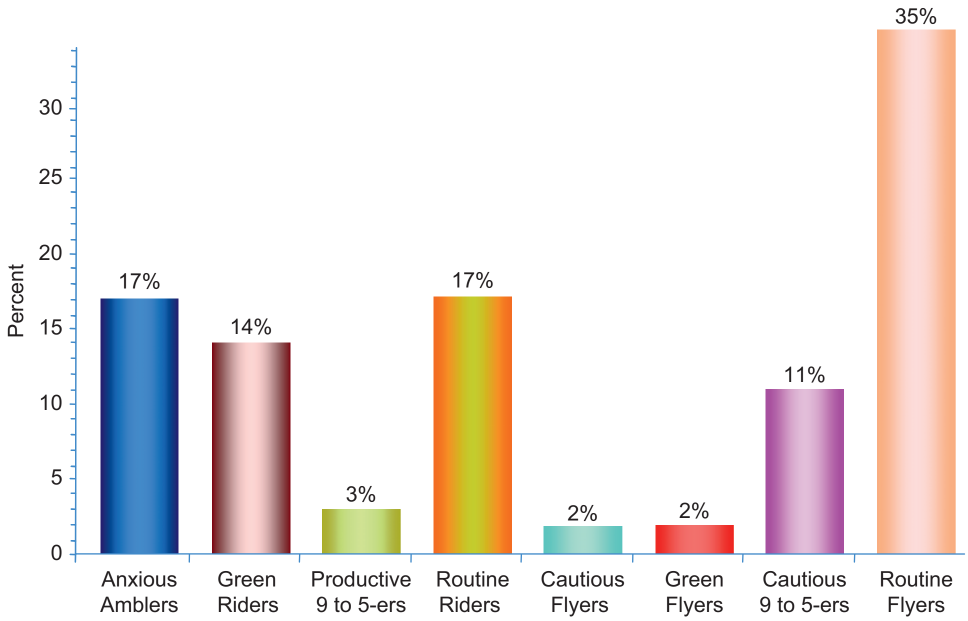

Fig. 4. Size of market segments for all population in Salt Lake and Davis counties.

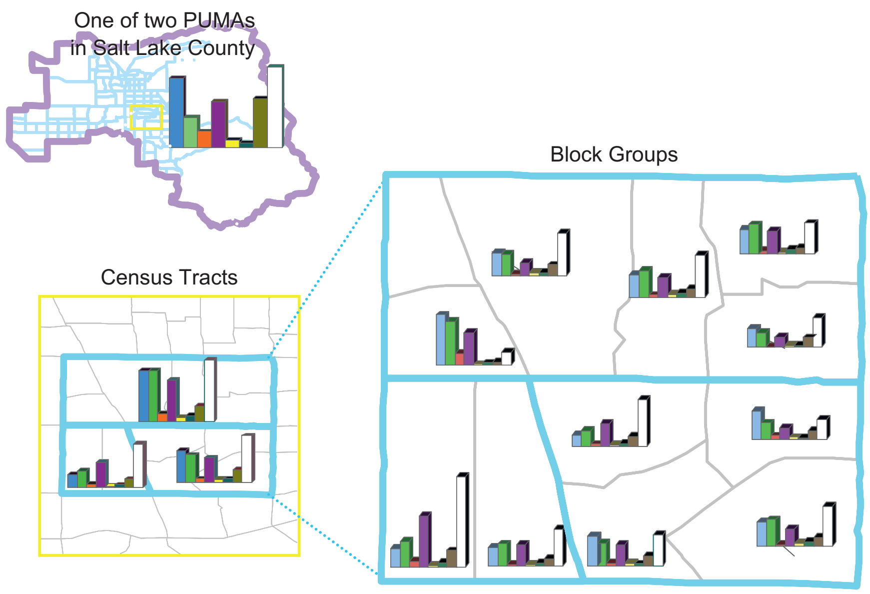

Fig. 5. Spatial distribution of market segment.

6.3. Policy implications

The information on the seven key attitudes and eight market segments is critical to designing transit services that meet the needs of target market segments. This information is also very useful in showing stakeholders and policy makers, which market segments will be too demanding to provide cost-effective transit services. For example, market segments with a high value of time and a high need for safety and privacy (such as cautious 9–5ers) are more difficult to be served with fixed-route transit systems. But market segments with a low value of time and low need for privacy (green riders) are more likely served by modest improvements to existing UTA services.

Fig. 6 presents the relative position of each segment for two of the three factors. The horizontal axis represents the sensitivity to time ranging from low to high, and the vertical axis represents the need for fixed schedule ranging from low to high. Similar figures can be drawn for other combination of factors. The figure is divided into four quadrants, indicating a few of the challenges and opportunities that the planning agency will have in capturing riders from segments in each quadrant. For example, segments in the lower left quadrant contain travelers who are the least demanding to be served with transit, because their members have low value of time and low schedule constraints. Note that green riders and anxious amblers are positioned in the lower left quadrant, representing markets that are likely to use transit. Green rider is the easiest market segment for UTA transit service as it appears in this quadrant in other combination of factors as well (not shown here). Segments in the upper right quadrant present the toughest challenges. These segments are very demanding travelers with high sensitivity to time and high constraints from schedule. Cautious 9–5ers are positioned in this quadrant, they are also positioned in this quadrant for other combinations of factors, and therefore are probably the most difficult segment to be served by transit. The lower right quadrant contains the cautious flyer segment, which is easier to capture than those in the upper left or upper right, because improving the speed of transit (i.e., satisfying travelers who have a high value of time) may often be easier than providing appropriate transit solutions to travelers with severe schedule constraints.

7. Conclusions

Transit must compete for market share in much the same way as other products and services compete for customers. The first step that most companies take in refining their strategy involves understanding their market according to key attitudes that their potential customers adopt when making a decision as to which product or service to buy. However, the transportation profession has for many years analyzed problems and designed solutions in terms of traveler attributes and levels of service offered by competing modes without revealing the attitudes that drive decision making, much less designing services in a way that these decision makings respond to the need of specific population groups. Categorizing travelers into groups based on demographic and travel behavior is valuable for understanding the transit market, and is one of the reasons why many researches continue to analyze survey data by these dimensions. However, to better understand the reasons why travelers choose different modes for everyday travel, we need an approach that breaks away from these stereotypes and instead determines the attitudes that drive their mode choice.

This study demonstrated the use of the SEM approach as a powerful tool to improve the understanding of travel behavior and to improve transit services. It was found that sensitivity to time, need for fixed schedule, and willingness to use transit are the best attitudinal factors to define market segments in this case study. These market segments help define a transit agency's desired market position and can be used to identify those services and strategies that are critical to achieving that position in the marketplace.

This approach can significantly increase the ability to answer important questions for better transit planning, such as:

- what attitudes and preferences drive each market segment's choice for local travel options?
- what strategies would be the most effective for each market segment?
- where are the 'easy-to-reach' (and 'hard-to-reach') markets?
- what strategies are most likely to be effective at different locations?

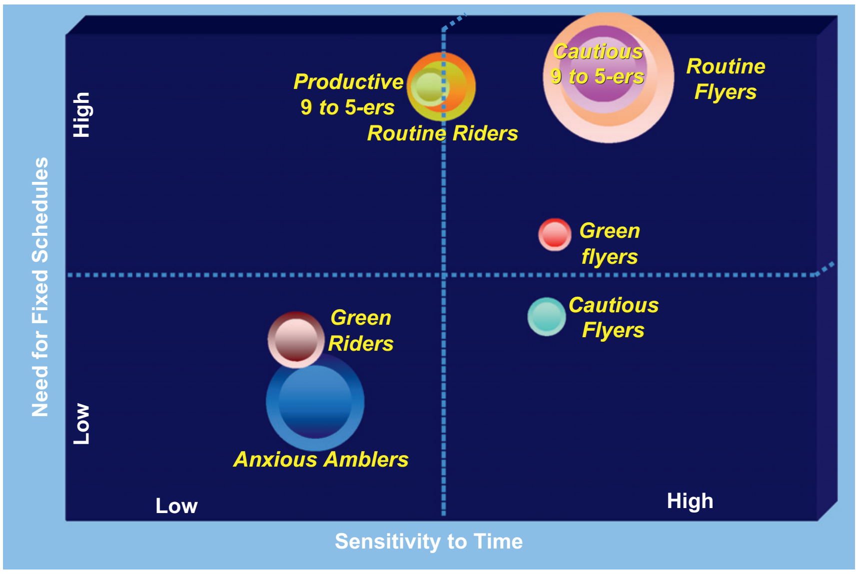

Fig. 6. Relative positions of market segments.

UTA's or any other transit marketplace is composed of multiple geographic submarkets or travel markets, where each travel market is a corridor or origin–destination that has its special conditions and concentrations of different market segments. The special conditions include the amount of free parking, the existence of exclusive right-of-way, access to light rail, occurrence and duration of congestion, density of jobs and housing, and other critical factors that make transit a more or less competitive alternative to driving a car. Transit ability to capture riders depends on how successfully its services can compete against the car in each travel market. This process, known as competitive positioning, involves matching resources (capital and operating funds) and the level of cooperation from local jurisdictions (land use, parking policies, transit priority measures, etc.) to the attitudes and concentrations of one or more targeted market segments. Targeting the right market segment within each travel market will be challenging and may require some iteration, but if successfully implemented, it has great potential to increase ridership and efficiency of the transit system.

Further research, on the choice of attributes to be included in questionnaires, various model structures, the inclusion of travel-behavior variables in the SEM, and the use of SEM for more complex travel-behavior decisions, is required to refine this method.

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