POLICIES TO PROMOTE SUSTAINABLE TRANSPORTATION IN CALGARY

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Abstract
This paper uses structural equation modeling (SEM) to link attitudinal variables (latent variables) and respondents' characteristics to mode choice among. The effects on mode choice of changes in eleven variables (both latent and exogenous variables) were considered: transit fare, fuel price, transit travel time, walking and cycling distance, bus stop distance, modal knowledge, transit frequency satisfaction, comfort satisfaction, safety characteristics, cycling preferences, and carpooling characteristics. The SEM identified six important policy variable or groups of manifest variables: (1) travelers attitude towards fare increase; (2) travelers attitude towards gas price increase; (3) travelers attitude towards travel time increase; (4) travelers attitude towards distance increase; (5) travelers attitude towards bus stop distance increase; and (6) travelers attitude towards transit arrival frequency.

Keywords: Keywords: Mode Choice, Policy Variables, Structural Equation Modeling, Sustainable Transportation.

INTRODUCTION

An efficient transport system is indispensable for the society with continued economic development and social welfare. Thus, it has become a necessary and integral part of our modem life. Vehicular transport is highly appreciated because of its benefits. A major portion of our population spends large amounts of their income on vehicular purchase. This has resulted in a sharp increase of vehicles on our roads and the same trend is forecasted in the future.

The growth in transportation energy demand is closely linked to economic development. Increase in gross domestic product (GDP) per capita also increases the distance that people are able to travel, as they use their income to switch from slower to faster and more expensive modes of transportation (Schafer and Victor, 1997). As economic growth occurs in developing countries, demand for petroleum increases and people change their modes from walking and bicycles in favour of motorbikes and automobiles. In developed countries, on the other hand, travelers are more likely to adopt transition from automobiles to high-speed rail and aircraft.

Each of these developments will increase the total energy demand for transportation, since the faster modes of transport require increasing amounts of energy to reach the higher speeds. The transition to faster modes of transportation is also likely to impact the level of urban sprawl around cities, since the commuting distance can increase without a proportional increase in a person's travel time.

The widespread use of road transportation is responsible for many negative externalities such as serious health and environmental problems and depletion of finite fossil fuels resources. The increase in environmental externalities has been accelerated by the regular trend of modal shift in favour of the private car, which is the most damaging form of motorized transport (Rienstra et al., 1996).

One of the most widely recognized effects of road transportation is air pollution worldwide. Air pollution problem has drastically aggravated in the last few decades, especially increase in the traffic emissions of sulphur dioxide, carbon dioxide, carbon monoxide, oxides of nitrogen, volatile organic carbons, polycyclic aromatic hydrocarbons, particulate matter, ozone and other gases. Air pollution caused by these gases is the result of the combustion of sulphur-containing fossil fuels such as coal for domestic, vehicular and industrial purposes.

The major threat to clean air is now posed by traffic emissions which have an increasing impact on urban air quality both indoors and outdoors. The quality of the air is closely related to morbidity and mortality from respiratory and cardiovascular diseases. Worldwide increase in the use of vehicular traffic within the urban centers has brought the problems of congestion and air pollution that not only impair human health but also have an impact on the economy, global warming, noise pollution and water pollution.

The nature and extent of these problems were summarized in a Blueprint for Quality Public Transport (Transport 2000 Trust, 1997). Some of these costs include road casualties, pollution, noise, congestion, social isolation, damage to wildlife and the countryside, and resource depletion. Hence, the argument for a sustainable transport policy has gained force and urgency as evidence of environmental damage and of people's concern has mounted (Transport 2000 Trust, 1997).

While technology plays a significant role in reducing the levels of pollution at the source, the benefits that technological improvements can offer are likely to be over-shadowed by the predicted worldwide growth in transportation (WBCSD, 2001). In addition, the increasing noise and land use impacts of transportation combined with growing numbers of accidents and congestion represent a significant burden on society and adversely affect sustainable development.

One of the major issues surrounding sustainable development is the development of sustainable urban transportation systems. A sustainable transport system is one that meets the needs of the present without compromising the ability of future generations to meet their own transport needs (Cahill, 2007).

METHODOLOGY

Structural equation modeling (SEM) is a statistical methodology used by sociologists and psychologists as well as transportation engineers, biologists, economists and medical researchers. There are many reasons to use SEM for various research purposes. One of the reasons is the ease of handling and measuring unobservable or latent variables and observable variables, which are also called exogenous and endogenous variables in econometric analysis to provide researchers with a comprehensive method for the quantification and testing of substantive theories. It also take into account measurement error that is ever-present in most disciplines, and typically contain hidden variables which is one of the major characteristics of structural equation models (Tenko Raykov, 2006)

In general, the overall structure of SEM can be expressed by the following equation:

$$\eta = B\eta + \Gamma\xi + \zeta \qquad (1)$$

where η is a vector for endogenous variables
ξ is a vector for exogenous variables
B and Γ are coefficient matrices
ζ is a vector that expresses latent errors in the equations.

Note that η and ξ are, in fact, variables that are not measured but are related to the measured variables y (observed indicators of η) and x (observed indicators of ξ) by the following equations:

$$Y = \Lambda\,\eta + \epsilon \qquad (2)$$
$$x = \Lambda\,\xi + \delta \qquad (3)$$

where Λ is the coefficient vector relating y to η or x to ξ and ϵ and δ are error terms associated with the observed x or y variables.

These equations are multivariate regression equations associated with variables that are easily observed, and with latent variables that are not observed (Hair et al., 2006). B and Γ in Eq. (1) represent the coefficient matrix for η and ξ respectively. Also, Λ in Eq. (2) is the coefficient relating y to η whereas Λ in Eq. (3) is the coefficient relating x to ξ. Therefore, B is a matrix consisting of Λ_y, and Γ is a matrix consisting of Λ_x, which can be expressed in the following equation:

$$z = \begin{bmatrix} \Lambda y & 0 \\ 0 & \Lambda x \end{bmatrix} \begin{bmatrix} \eta \\ \xi \end{bmatrix} + \begin{bmatrix} \varepsilon \\ \delta \end{bmatrix} \quad (4)$$

where Z = observed polychotomous vector
Λ_y = coefficient rating y to η
Λ_x = coefficient rating x to ξ

SEM differs from other types of multivariate analysis models not in terms of how it analyzes variance but in terms of the covariance analysis method it uses. Consequently, SEM deals with the covariance among the measured variables or observed sample covariance matrices. Although the use of a covariance matrix or a correlation matrix among the variants measured with SEM is not always clear, SEM programs can use one of these two matrices as their input (Hair et al., 2006).

DATA

In this study, self-completion questionnaire survey technique is chosen because it is the most widely used technique in transportation studies. Self-administered surveys are defined as those in which the respondent completes a questionnaire without the assistance of the interviewer. Several types of basic survey format can be described, depending on the methods used for collection and distribution of the questionnaire forms. These include:

- Mail out / mail back surveys;
- Delivered to respondent / mail back;
- Delivered to respondent / collected from respondent.

Due to the higher response rates (Stopher et al, 1992), the latter two methods are chosen in this study for data collection.

The survey conducted in this study was approved by the Conjoint Research Ethics Board of the University of Calgary. A self administered questionnaire, consisting of 69 questions, was developed in collaboration with City of Calgary Transportation Demand Management (TMD) section. The survey will be administered door-to-door in three community areas selected in consultation with the City of Calgary. The data collected will be analyzed using the standard descriptive statistical analyses and then applied to more advanced statistical methods like discrete choice models and structural equation models.

RESULTS AND DISCUSSION

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

1 Relationship between public transport fare increase and mode choice.

As shown in Table 1, public transport fare increase with respect to the structural components does not influence ‘‘mode choice” to work except Car which is positively influenced (coefficient = 0.11, *t=2.28*). Coefficients for other modes (walk, cycle, BRT, bus, bus+train, train and train+car) are negatively influenced and are all insignificant most probably because the mode shift from car is distributed among various modes because of fare increase or decrease. The opposite of fare increase or a decrease will fare will also result in the decrease of car use. A study conducted by Dissanayake et al, 2002 involving the Bangkok metropolitan region as a case study showed that fare reduction in public transportation can be used as an efficient tool in congestion-reduction policy in the central business district.

Public transport fare increase with respect to the structural components does not influence ‘‘mode choice” to school, though coefficients demonstrate to be negatively influenced but all of them are statistically insignificant. Bus passes at uniform rate for university students and school buses for school going children makes different modes of transportation independent of fare increase that is why we do not see any significant changes in mode of transportation to school.

It can also be seen in Table 1 that fare affects non-work trips more negatively than work trips and results are statistically significant; Bus+Train (coefficient = -0.14, *t=2.07*) and Train (coefficient = -0.15, *t=1.99*), whereas we do not see any significant changes in car for non-work trips. It can be argued that increase in car for work trips may be used for non-work trips on the return trips from works on the same day. This result can be incorporated successfully if flexible fare rates are adopted at different

Table 1: Estimates of relationship between fare increase and mode choice

	Structural Component								Measurement component		
Work Mode											
Exogenous Variable	Public Transport Fare Increase								Public Transport Fare Increase		
Endogenous variable	Walk	Cycle	BRT	Bus	Bus+ Train	Train	Train+Car	Car			
Observed variable									X7	X8	X9
Standard coefficient	-0.13	-0.06	-0.10	-0.04	-0.07	-0.06	0.04	0.11	1.10	1.28	1.22
Standard error	0.08	0.07	0.11	0.08	0.12	0.15	0.09	0.05	0.06	0.05	1.05
t-value	1.57	0.84	0.95	0.49	0.63	0.41	0.51	2.28	19.51	26.01	25.41
School Mode											
Standard coefficient	-0.05	-0.02	-0.02	-0.08	-0.02	-0.07	-0.08	-0.11	1.10	1.28	1.22
Standard error	0.06	0.06	0.07	0.07	0.09	0.10	0.06	0.06	0.06	0.05	0.05
t-value	0.81	0.28	0.33	1.1	0.20	0.70	1.35	1.88	19.51	26.05	25.36
Other Mode											
Standard coefficient	-0.05	-0.06	-0.13	-0.10	-0.14	-0.15	0.04	0.02	1.10	1.28	1.22
Standard error	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.05	0.06	0.05	0.05
t-value	0.68	0.90	1.74	1.6	2.07	1.99	0.65	0.39	19.50	26.05	25.36

$t \geq 2.58 \approx$ 99% significance
$t \geq 1.96 \approx$ 95% significance
$t < 1.96 \approx$ not significant

2 Relationship between gas price increase and mode choice.

As shown in Table 2, gas price increase has no statistically significant effect on any of the mode choices available to a traveler. Gasoline prices have risen substantially over the last three years worldwide. Many transit agencies have pointed to fuel price growth as a major impetus to increased transit ridership. Haire et al (2007) conducted a research st based on previous research conducted in 2006 by the same research team, which found high correlation between fuel price and transit ridership in several historically auto-based US metropolises. This comparative research sought to discern whether a similar pattern of fuel cost-driven mode choice could be observed in Canadian cities. Three Canadian cities, Calgary, Ottawa, and Vancouver, were selected based on their relative levels of auto-orientation and the extent and variety of transit services offered. This study found that although ridership and fuel prices grew in all three cities, the rates of growth do not correspond and correlation is unlikely which corroborates with the results of this study.

Table 2: Estimates of relationship between fuel price increase and mode choice

	Structural Component								Measurement component			
Work Mode												
Exogenous Variable	Fuel Price Increase								Fuel Price Increase			
Endogenous variable	Walk	Cycle	BRT	Bus	Bus+ Train	Train	Train+C ar	Car				
Observed variable									X10	X11	X12	X13
Standard coefficient	-0.06	-0.05	-0.21	-0.17	-0.25	-0.33	-0.18	0.01	1.27	1.33	1.19	1.17
Standard error	0.09	0.09	0.12	0.10	0.14	0.18	0.10	0.06	0.05	0.06	0.06	0.08
t-value	0.66	0.57	1.66	1.75	1.82	1.87	1.80	0.17	23.61	23.73	19.42	13.78
School Mode												
Standard coefficient	0.02	-0.06	-0.04	-0.02	-0.21	-0.13	-0.05	-0.09	1.27	1.33	1.19	1.17
Standard error	0.07	0.07	0.08	0.08	0.10	0.11	0.07	0.06	0.05	0.06	0.06	0.08
t-value	0.23	0.86	0.48	0.28	2.04	1.16	0.74	1.36	23.65	23.72	19.39	13.77
Other Mode												
Standard coefficient	-0.06	-0.03	-0.07	-0.04	0.01	-0.07	0.02	-0.03	1.27	1.33	1.19	1.18
Standard error	0.08	0.08	0.08	0.07	0.07	0.08	0.07	0.06	0.05	0.06	0.06	0.12
t-value	0.78	0.37	0.89	0.61	0.18	0.89	0.33	0.50	23.66	23.74	19.37	13.74

$t \geq 2.58 \approx$ 99% significance
$t \geq 1.96 \approx$ 95% significance
$t < 1.96 \approx$ not significant

3 Relationship between public travel time increase and mode choice

As shown in Table 3, public transport travel time increase with respect to the structural components negatively influence ‘‘mode choice” to work, school and other trips. Work mode among the three is influenced the most; second school mode and other modes is least influenced by travel time. This result is in conformity with the result of study by Narisra Limtanakool et al (2006), who showed that travellers seem to be more sensitive to the travel time by train than car.

Table 3: Estimates of relationship b/w travel time and mode choice

	Structural Component								Measurement component	
Work Mode										
Exogenous Variable	Travel Time Increase								Travel Time Increase	
Endogenous variable	Walk	Cycle	BRT	Bus	Bus+ Train	Train	Train+C ar	Car		
Observed variable									X14	X15
Standard coefficient	-0.57	-0.47	-0.85	-0.52	-1.02	-1.47	-0.66	-0.25	1.18	1.06
Standard error	0.2	0.18	0.27	0.21	0.29	0.38	0.21	0.12	0.05	0.05
t-value	2.83	2.59	3.21	2.48	3.46	3.86	3.12	2.04	23.16	21.02
School Mode										
Standard coefficient	-0.39	-0.31	-0.59	-0.52	-0.73	-0.95	-0.37	-0.51	1.17	1.08
Standard error	0.13	0.13	0.14	0.15	0.19	0.20	0.13	0.12	0.05	0.05
t-value	2.98	2.45	4.10	3.56	3.88	4.66	2.84	4.28	22.68	21.08
Other Mode										
Standard coefficient	-0.5	-0.57	-0.73	-0.43	-0.53	-0.67	-0.37	-0.13	1.16	1.09
Standard error	0.13	0.13	0.14	0.12	0.12	0.14	0.11	0.09	0.05	0.05
t-value	3.88	4.44	5.39	3.62	4.35	4.84	3.35	1.39	22.28	21.24

$t \geq 2.58$ = 99% significance
$t \geq 1.96$ = 95% significance
$t < 1.96$ = not significant

4 Relationship between destination distance by walking and cycling increase and mode choice.

As shown in Table 4, travelling distance increase (walking and cycling) with respect to the structural components positively influence ‘‘mode choice” to work, school and other trips. These results suggest that an increase in travelling distance for travellers already using sustainable modes of transportation such as walking and cycling will prefer to use other sustainable modes of transportation (Table 4 shows coefficients of walk, cycle, BRT, bus, bus+train, train and train+car that are positive and are statistically significant) because these sustainable modes of transportation somehow involve walking and cycling and will not switch to car especially travellers using these modes for work trips (work mode “car”; coefficient = 0.04, *t=0.31*). However we see some increase in the use of car for school (school mode “car”; coefficient = 0.42, *t=3.55*) and other trips (other mode “car”; coefficient = 0.27, *t=3.11*).

Mokhtarian and Salomon (2001) suggest that travel may have a positive utility of its own which is not necessarily related to reaching a destination. The phenomenon of taking the car out for a spin is one of the best examples of this. Even when travel is related to a destination (i.e., directed travel), people do not necessarily minimise their travel time or always choose the most cost efficient mode or route (in terms of time, money and effort) to travel to certain destinations. Other utility factors (such as health benefits, flexibility and independence) are associated with walking and cycling which make them attractive. However, studies of travel behaviour often concentrate on car travel and limit any comparisons to those between cars and public transport but very few comparisons have been made with walking and cycling.

The results of this study is also consistent with the study conducted by Jillian Anable and Brigitte Gatersleben (2005) that showed how the different journeys are actually experienced or are perceived to perform.

Table 4: Estimates of relationship between destination distance increase and mode choice

	Structural Component								Measurement component	
Work Mode										
Exogenous Variable	Destination Distance Increase								Destination Distance Increase	
Endogenous variable	Walk	Cycle	BRT	Bus	Bus+ Train	Train	Train+C ar	Car		
Observed variable									X16	X17
Standard coefficient	0.77	0.67	1.2	0.86	1.33	1.77	0.89	0.04	0.70	0.54
Standard error	0.19	0.18	0.25	0.20	0.28	0.36	0.20	0.12	0.08	0.06
t-value	3.99	3.76	4.76	4.23	4.75	4.93	4.38	0.31	8.25	8.50
School Mode										
Standard coefficient	0.58	0.51	.68	0.70	1.1	1.16	0.54	0.42	0.85	0.59
Standard error	0.13	0.12	0.14	0.14	0.18	0.19	0.13	0.12	0.09	0.06
t-value	4.52	4.14	4.91	5.02	6.19	6.11	4.31	3.55	9.84	9.10
Other Mode										
Standard coefficient	0.90	0.96	0.85	0.65	0.63	0.92	0.63	0.27	0.88	0.66
Standard error	0.11	0.11	0.11	0.10	0.10	0.12	0.10	0.09	0.08	0.06
t-value	8.36	8.86	7.45	6.29	6.05	7.93	6.57	3.11	10.75	10.83

$t \geq 2.58 \approx$ 99% significance
$t \geq 1.96 \approx$ 95% significance
$t < 1.96 \approx$ not significant

5 Relationship between public transport fare increase and mode choice

As shown in Table 5, increase in transit stop distance has no statistically significant effect on any of the mode choices available to a traveler. As discussed earlier in section 4, travel experiences differed between respondents depending on the travel mode that they used themselves. For example travelers of non-motorised modes when score their modes on high does not mean they only score that mode specifically but they score the utilities associated with that particular mode choice. Most travelers using non –motorized modes of transportation by choice will score walking to the bus stop as a utility associated with that mode and an increase in bus stop distance may not affect choosing that mode, rather increasing bus stop distance may positively influence selecting that mode as is evident from Table 5. Coefficients of BRT, bus and bus+train are all positive although insignificant proves this fact. This fact was also shown by Biggiero et al (1998), who termed bus as a combined mode `pedestrian+bus', because bus users share same preferences towards bus and walking.

Table 5: Estimates of relationship between bus stop distance increase and mode choice

	Structural Component								Measurement component			
Work Mode												
Exogenous Variable	Bus Stop Distance Increase								Bus Stop Distance Increase			
Endogenous variable	Walk	Cycle	BRT	Bus	Bus+ Train	Train	Train +Car	Car				
Observed variable									X20	X21	X22	X23
Standard coefficient	0.03	-0.02	0.03	0.11	0.10	0.03	-0.01	-0.04	0.78	0.48	0.92	0.52
Standard error	0.08	0.08	0.11	0.09	0.12	0.16	0.09	0.05	0.05	0.05	0.05	0.05
t-value	0.36	0.26	0.28	1.24	0.77	0.21	0.14	0.86	16.02	9.43	18.52	9.95
School Mode												
Standard coefficient	-0.02	-0.03	0.04	0.09	0.12	0.12	-0.03	-0.04	0.78	0.48	0.92	0.52
Standard error	0.07	0.07	0.07	0.07	0.10	0.10	0.07	0.06	0.05	0.05	0.05	0.05
t-value	0.25	0.41	0.58	1.21	1.27	1.22	0.52	0.67	16.02	9.23	18.62	9.95
Other Mode												
Standard coefficient	-0.01	0.07	0.07	0.03	0.13	0.06	-0.01	-0.06	0.78	0.48	0.92	0.52
Standard error	0.07	0.07	0.08	0.07	0.07	0.08	0.06	0.06	0.05	0.05	0.05	0.05
t-value	0.08	0.90	0.85	0.37	1.80	0.73	0.21	1.07	16.07	9.27	18.54	9.97

$t \geq 2.58 \approx$ 99% significance
$t \geq 1.96 \approx$ 95% significance
$t < 1.96 \approx$ not significant

6 Relationship between public transport frequency satisfaction increase and mode choice.

As shown in Table 6, increase in frequency satisfaction has no statistically significant effect on any of the mode choices available to a traveler. As discussed earlier respondents from the three communities using Bus/BRT/Ctrain as a mode of transportation of expressed their level of satisfaction between good and very good but it is worth mentioning here that traveler is likely to choose a transit mode if a service trip sufficiently compatible with his/her desired arrival time is available rather than for its daily frequency. Further as can be seen, frequency plays its expected positive role but it is much less significant with respect to the travel time and cost attributes (as discussed earlier in section 1 and 3) and partially lose their significance.

Table 6: Estimates of relationship between public transport arrival frequency (Satisfaction) and mode choice

	Structural Component								Measurement component		
Work Mode											
Exogenous Variable	Public Transport Arrival Frequency (Satisfaction)								Public Transport Arrival Frequency (Satisfaction)		
Endogenous variable	Walk	Cycle	BRT	Bus	Bus+ Train	Train	Train+Car	Car			
Observed variable									X30	X31	X32
Standard coefficient	-0.07	-0.02	-0.06	-.12	-0.16	-0.11	-0.17	-0.03	1.17	1.04	0.86
Standard error	0.09	0.08	0.11	0.09	0.13	0.16	0.09	0.05	0.06	0.06	0.06
t-value	0.84	0.27	0.49	1.37	1.29	0.71	1.85	0.48	20.15	16.4	15.12
School Mode											
Standard coefficient	-0.05	0.00	-0.03	0.01	-0.08	-0.05	-0.01	-0.02	1.17	1.04	0.86
Standard error	0.07	0.07	0.07	0.08	0.1	0.1	0.07	0.06	0.06	0.06	0.06
t-value	0.72	0.03	0.45	0.08	0.80	0.45	0.13	0.30	20.04	16.3	15.08
Other Mode											
Standard coefficient	0.09	0.03	-0.1	0.02	-0.08	-0.1	-0.1	0.06	1.17	1.03	0.86
Standard error	0.08	0.08	0.08	0.07	0.07	0.08	0.07	0.06	0.06	0.06	0.06
t-value	1.27	0.37	1.33	0.25	1.11	1.21	1.52	1.04	20.27	16.2	15.11

$t \geq 2.58 \approx$ 99% significance
$t \geq 1.96 \approx$ 95% significance
$t < 1.96 \approx$ not significant

Conclusions

Sustainable modes of transportation must compete be compatible with car to get the market share in much the same way as other products and services compete for customers. In the field of business administration professionals refine their strategies to understand the market trends and customers attitudes and choices towards different products and services in order to attract their potential clients. However, the transportation professionals have for many years studied many transportation related problems and used complex methodologies to dig deep into the traveler's attitudes and their preferences regarding different modes of transportation. This research study is among one of such studies to promote sustainable modes of transportation in the city Calgary. This study demonstrated the use of the SEM approach as a powerful tool to improve the understanding of travel behaviour and to enhance sustainable modes of transportation and restrict as far as possible. Six groups of latent variables representing traveler's behaviour in selecting the preferred mode of transportation and shaping the SEM model were: travel time, fare increase, gas price increase, destination distance by walking and cycling, bus stop distance increase and transit frequency.

Our research found that public transport fare increase has a significant affect in restricting car as a mode of transportation to work but has insignificant affect on other modes of transportation such as walk, cycle, BRT, bus, bus+train, train and train+car. Fare increase affect on mode of transportation to school is insignificant and similarly on non-work trips Bus+Train and Train are significantly affected whereas we do not see any significant changes in car for non-work trips.

The second variable in our model was price of Fuel increase. Although observed variables significantly influenced the model but its impact on endogenous variables i.e. mode of transportation was insignificant. This finding suggests that although observed variables positively influence the exogenous or attitudinal variables but it is not necessary that this attitude will influence the traveler in selecting a mode.

Transit travel time influences ''mode choice'' to work, school and other trips. Work mode among the three is influenced the most; second school mode and other modes is least influenced by travel time.

Travelling distance increase (walking and cycling) influences ''mode choice'' to work, school and other trips. These results suggest that an increase in travelling distance for travellers already using sustainable modes of transportation such as walking and cycling will prefer to use other sustainable modes of transportation.

Increase in transit stop distance has no statistically significant effect on any of the mode choices available to a traveler. This result suggest that travelers using non –motorized modes of transportation by choice will score walking to the bus stop as a utility associated with that mode and an increase in bus stop distance may not affect choosing that mode, rather increasing bus stop distance may positively influence selecting that mode.

The last variable in our model was an increase in frequency satisfaction that again had no statistically significant effect on any of the mode choices available to a traveler. As discussed earlier respondents from the three communities using Bus/BRT/Ctrain as a mode of transportation of expressed their level of satisfaction between good and very good but it is worth mentioning here that traveler is likely to choose a transit mode if a service trip sufficiently compatible with his/her desired arrival time is available rather than for its daily frequency. Further as can be seen, frequency plays its expected positive role but it is much less significant with respect to the travel time and cost attributes and partially loses their significance in the model.

This approach has significantly increased the ability to answer important questions for better transit planning, such as: what attitudes and preferences acts positively in selecting a mode, what strategies would be the most effective for each policy variable. In order to flourish sustainable modes of transportation in the city of Calgary, newly planned communities must be compact and the three basic problems of inter-city problems congestion, mobility and externalities are addressed.

REFERENCES

Biggiero, L.; Montella, B. (1998) Pedestrian mode in modal choice models Source: International Conference on Urban Transport and the Environment for the 21st Century, p 33-42, 1998

Cahill M, (2007),'Why the U-Turn on Sustainable Transport?' Capitalism nature socialism, volume 18, number 4.

Choo, S., Mokhtarian, P.L., (2007), 'Telecommunications and travel demand and supply: aggregate structural equation models for the US' Transportation Research Part A: 41 (1), 4–18.

Dissanayake, Dilum; Morikawa, Takayuki, (2002), 'Household travel behavior in developing countries': Nested logit model of vehicle ownership, mode choice, and trip chaining, Transportation Research Record, n 1805, p 45-52.

Haire, Ashley R.1; Machemehl, Randy (2007), Comparative analysis of US and Canadian transit ridership response to rising fuel prices', Proceedings, Annual Conference - Canadian Society for Civil Engineering, v 1, p 277-286, 2007.

Jillian Anable a, Birgitta Gatersleben. (2005), 'All work and no play? The role of instrumental and affective factors in work and leisure journeys by different travel modes', Transportation Research, Part A (Policy and Practice), v 39, n 2-3, p 163-81, March, 2005.

Narisra Limtanakool, Martin Dijst, Tim Schwanen (2006),'The influence of socioeconomic characteristics, land use and travel time considerations on mode choice for medium and longer-distance trips', Journal of Transport Geography 14, 327–341

Rienstra, Sytze A., Vleugel, Jaap M. and Nijkamp, Peter, (1996), 'Options for sustainable passenger transport: an assessment of policy choices', p 221-233.

Schafer, A., and Victor, D. (1997) 'The Past and Future of Global Mobility', Scientific American, October 1997.

Stopher PR (1992), 'Use of an Activity-Based Diary to Collect Household Travel Data', Transportation 19 (2) 159-176.

Tenko Raykov, (2006),'A First Course in Structural Equation Modeling', Lawrence Erlbaum Associates, Publishers, London.Second Edition

Transport 2000 Trust, (1997), 'Blueprint For Quality Public Transport', London, Transport 2000.

World Business Council for Sustainable Development (WBCSD) (2001), 'Mobility 2001-World Mobility at the end of the Twentieth Century and its Sustainability', WBCSD, Geneva, Switzerland.