The City of Edmonton

FACTORS AFFECTING TRANSIT RIDERSHIP

Transit Strategy Guiding Perspectives Report

Sustainable Development;Transportation Strategies
7/14/2016

Table of Contents

1. INTRODUCTION

The single largest factor affecting transit use is automobile ownership. When households own no vehicles they are most likely to use transit because the convenience of the private automobile is unavailable. When households own two or more vehicles, their likelihood of using transit diminishes significantly. Auto ownership is fundamental to the discussion on transit ridership as it "has been found to impact almost all aspects of daily travel patterns" (Bhat & Guo, 2007).

Many factors contribute to automobile ownership: land use density and mixture, proximity of the household to the downtown core, lower household income, and availability of high-quality transit service to name a few. While most of these factors are outside the control of ETS and the transit system, most are within the scope of other City branches. The two key factors that ETS does control are the quality of transit service and the provision of targeted pricing schemes, like the U-Pass, to groups who are less likely to own vehicles and more likely to use transit.

With regard to Edmonton's bus network, the most efficient way to boost transit ridership is to provide frequent and reliable transit service to neighbourhoods with lower automobile ownership and provide good frequent transit network coverage especially in areas with latent demand. In Edmonton, the neighbourhoods closest to the downtown core and closest to LRT stations foster the highest transit ridership in the city.

1.1. LINK TO CITY OBJECTIVES

Transportation mode shift is a key transportation goal for the City of Edmonton as identified in Edmonton's transportation master plan (TMP), The Way We Move, and the City's strategic plan, The Way Ahead. The Way Ahead describes the city's transportation goal as follows:

"Enhancing public transit and other alternatives to single-occupant vehicles will provide Edmonton with a well-maintained and integrated transportation network. Increased use of these options will maximize overall transportation system efficiency and support the City's urban planning, livability, financial, economic and environmental sustainability goals."

The TMP states that "public transportation and active transportation modes are the preferred choice for more people, making it possible for the transportation system to move more people more efficiently in fewer vehicles."

Moving toward achieving The Way We Move and The Way Ahead goals of mode shift toward transit, walking and cycling, it is paramount to continue to deliver high-quality transit service to provide residents with a feasible travel alternative to the automobile. This goes hand-in-hand with developing transit-supportive, walkable land use and built form to entice people out of private vehicles.

This paper endeavors to capture the impact of various factors on transit ridership. The majority of the discussion is based on the findings in the literature supplemented with local data, where possible.

2. MODE CAPTIVITY AND DEMOGRAPHICS

Transit captivity is a common term in transportation and transit planning that is typically used to refer to people who have no other choice than to take transit: in other words, a captive market for transit. Captive transit riders typically have no automobile available for their travel. They are often lower income demographics, such as students, under- or unemployed adults, and seniors living off pensions.

A study of US Census data (TCRP, 2004a) shows that, women, minorities, immigrants, non-vehicle owners and those with household incomes lower than $30,000 are most likely to use transit. Households with incomes above $70,000 also tend to have higher than average transit use, pointing to “choice” transit users. Workers under 30 and over 60 years old are also more likely to use transit given that they are outside the typical child-rearing years.

The 2014-2015 Edmonton Transit Service Customer Satisfaction Survey was initiated in October 2014 and provides demographics of local transit users. The highest number of ETS users are in the 15-24 year old grouping at 77%. Users under the age of 35 represent 80% of bus users. Females have a higher propensity to take transit at 52% as compared to 48% of males and are more likely to ride the bus (78% vs 73% of males). Interestingly, the large majority (81%) of riders own or have access at home to a vehicle that could be used for trips made by transit. About one-in five is a captive rider (19%).

As compared to the greater Edmonton population, ETS users have some unique demographic characteristics. These are summarized as follows:

- Younger (24% are 15-24 years old vs. 17% of population)
- Fewer seniors 65+ (10% vs. 14% of population)
- More enrolled students (22% vs. 15% of population)

Individuals can also be captive auto users. These are people who require a vehicle for their jobs, or for travel throughout the day, and are not typically swayed by improvements to transit, walking or bicycling. This group would not be the target market for mode shift in Edmonton.

3. Transit Mode and Right of Way

To begin it is important to describe the different transit modes, and the rights of way in which they operate. In general there is a hierarchy of attractiveness amongst the transit modes based on the capacity, reliability and operating speed. Modes that offer these attributes to a higher standard are preferred over others, which means that they attract higher levels of ridership.

Transit mode and right of way (ROW) characteristics have large impacts on capacity, reliability and operating speed. These are often labeled, “A”, “B” or “C”, where ROW A delivers these attributes to the highest degree, and each of the attributes is compromised as the ROW becomes less separated.

There are three different categories of transit ROWs:

- **ROW A** -- fully separated, rapid transit; typically metro or commuter rail systems with high-capacity trains operating at high frequencies.
- **ROW B** -- partially separated, semi-rapid transit; typically LRT or physically separated busways at grade, often with some interaction with other traffic.
- **ROW C** -- street transit operating in mixed traffic; typically buses, trolleybuses and streetcars or tramways.

The transit right of way is the primary element of a transit system, as it influences the system technology and operational capabilities, which inherently affect the transit level of service. The hierarchy of transit modes was alluded to in the ROW descriptions and is generally as follows:

- **Rapid Transit** -- Metro or Subway, Commuter Rail
- **Semi-rapid Transit** -- Automated Guideway Transit (like Vancouver’s Sky Train), LRT, BRT

- **Street Transit** -- Buses, Trolley Buses, Streetcars, Tramways

In Edmonton the LRT operates in a ROW B except for the underground portions near the University of Alberta and downtown. All ETS buses operate in ROW C.

4. Transit Operations

Transit operations factors covered in this section include scheduling, frequency, reliability, and routing and coverage. The most common transportation system changes undertaken by transit operators to enhance transit service are scheduling and frequency modifications (TCRP, 2004). Routing and coverage are more difficult attributes to change and often require significant planning studies and capital investments.

In this section we refer to elasticity, which is the measure of how sensitive demand is to changes in an attribute. Often demand elasticity is measured using local survey data, however the literature reports generalized elasticities for transit operation attributes which are simpler to isolate, like frequency. Elasticity, in this case, is the measure of how sensitive transit demand is to changes in frequency. Elasticities of zero mean that demand does not respond to frequency changes, elasticities of 1.0 indicate that percentage change in demand is equal to the percentage change in frequency.

4.1. Scheduling and Service Hour Changes

Scheduling changes can be made based on a number of different objectives, outlined as follows.

Minimizing passenger wait times. Providing easy to remember schedules that are easily available has been linked to ridership gains. Best practice suggests scheduling buses to arrive at consistent “clockface” timings each hour, such as 15 minutes, 30 minutes and 45 minutes after each hour (TCRP, 2004).

Minimizing transfer times. Transfer times are reduced through transfer centres and timed-transfer systems. Timed-transfer transit bus routes connect to trunk transit lines, like Edmonton’s LRT, at key transit centers facilitates seamless transfers from the trunk line to the feeder line. Minimizing transfer times is seen as a benefit to existing transit riders. Study findings vary as to the correlation between timed-transfer networks and new ridership. (TCRP, 2004)

Enhancing service hours. Expanding the hours in which transit service is provided has a positive impact on transit ridership. For commuter peak-period routes, care must be taken to ensure demand exists for the extension of the service. In some cases, for new riders to be attracted to the service they need to know that transit service hours will accommodate flexibility in their workday schedules. (TCRP, 2004)

4.2. Frequency

Frequency of bus services is a measure of the number of buses passing a bus stop in an hour. Increases in bus frequency on a route will increase ridership on that route. Average transit demand elasticities for frequency increases are +0.5. Elasticity, in this case, is the measure of how sensitive transit demand is to changes in frequency. Elasticities of zero mean that demand does not respond to frequency changes, elasticities of 1.0 indicate that percentage change in demand is equal to the percentage change in frequency. For example, 0.5 transit demand elasticity for frequency on a bus route means that increasing from 2 buses per hour to 4 buses per hour would increase passenger demand from 100 to 150 passengers per hour.

4.3. RELIABILITY

Schedule adherence is fundamental to any transit schedule enhancements. Reliability is seen by riders to be second only to “arriving without accident” or arriving safely. Studies show that unreliable service has more of a detrimental impact on ridership than planned service cuts (TCRP, 2004). Thus, while reliability does not attract new customers, it is key to retaining existing transit users.

4.4. BUS ROUTING AND COVERAGE

It is nearly impossible to quantify the increase in ridership due to bus routing changes alone, due to all of the confounding factors in local development patterns, complimentary transportation services, and existing travel patterns, for example. Different transit coverage schemes serve different types of travel demand, and so it is important to understand demand patterns and provide a network of transit routes accordingly. Some common transit coverage schemes are outlined as follows.

Radial Lines. These lines connect suburbs to the city centre. This is a basic method of providing transit coverage to new or underserved areas and many cities utilize this transit network scheme. Typically the largest travel demands in urban areas are in radial directions between suburban centres and the urban core; however, ridership on radial routes diminishes with distance from the urban core and is very peaked during commuting hours. Radial transit networks have a primary disadvantage: they provided limited opportunity for circulation in the urban core without transferring to a new line. (Vuchic 2005) In Edmonton the LRT and bus routes such as 1, 4, 9 and 15 are examples of radial transit lines.

Tangential or Crosstown Lines. These routes operate tangential to a city centre, and are most common in cities with gridded street networks. They see less demand than radial routes but their demand is more consistent throughout the day -- it is less peaked in the commuting hours. A good example is the planned Eglinton Crosstown LRT line in Toronto, which will extend suburb to suburb along the Eglinton corridor, running in the east/west direction north of Toronto’s downtown. (Vuchic 2005) In Edmonton, routes such as 6, 23, 33, and 137 are examples of crosstown lines.

Circumferential Lines. These lines circle a city centre and intersect with radial lines running out of the city centre to provide transfer opportunities off of the radial routes. These lines offer direct connections from higher density areas outside of the city centre, they distribute passengers off of the radial lines, and they enable suburb-to-suburb travel by transit without forcing passengers to travel downtown or transfer through the downtown area. Typically ridership on circle lines is high as they provide service to a variety of different activity areas in a city. Demand on these lines is more stable throughout the day than on radial lines. (Vuchic, 2005) In Edmonton we do not have circumferential transit lines.

5. TRIP TYPE

Trip type is a critical element to consider when evaluating factors that affect transit use as trips best served by transit are those with regular patterns, concentrated in both time and space. This is why commute trips have the highest transit mode share, followed by school trips, then shopping trips, and finally social, recreational and other trips. This section provides a snapshot of main categories of trip types, with example studies of particular trip types and the strong degree of interaction with other factors to follow.

5.1. COMMUTING

Journey to work is easily the most discussed trip type in transportation planning literature. Extensive research is done in the area of commuting, including a report on Commuting in America published regularly by TRB and AASHTO. The primary data source for this work is the generally long form census / national household survey / American Community Survey, which provides details of place of work and journey to work mode, thereby allowing an intersecting analysis of demographics and travel patterns. The figure below (AASHTO, 2015) shows that 39% of all transit trips are commute trips. Typically commute trips represent only 20% of daily trips and so the share of transit trips made by commuters is disproportionately high.

TABLE 1: TRANSIT TRIP PURPOSE

Public Transit Travel 2009	
Household Travel	**Percent of Total Annual Transit PMT**
Commuting	39.0%
Work-Related/Business Travel	4.5%
Other Purpose Household and Tourist/Visitor Travel	56.5%
Total	**100.0%**

5.2. TRAVEL TO SCHOOL

Journey to school is similar to journey to work in that they are predictable and concentrated in both time and space. School travel is also often tied to transit captivity, as students under the age of 16 are non-auto drivers, and post-secondary students often have lower incomes, leading them to choose more cost-effective transportation options.

In Edmonton, travel to school is a significant portion of transit trips in two important ways. First, many secondary schools are served by specialized 'school specials' that adjust the timing and routing to optimize trips to and from high schools. Some high schools also have customized routes to enhance the opportunity of school children to travel by transit and prevent overloads on other routes in the area.

Secondly, Edmonton has a significant post-secondary student rider segment. An increase in post-secondary transit ridership has been seen in recent years through the implementation of the Universal Transit Pass, or U-Pass, and significant transit service being directed at Edmonton's post-secondary institutions. The U-Pass, prescribed to students at the University of Alberta, Grant MacEwan and NAIT, is a transit pass paid for automatically through student enrollment fees at these institutions. It is estimated that U-Pass holders account for approximately 25% of all trips made on ETS in 2015. More information about Edmonton's U-Pass and its impacts on transit ridership locally are provided in the Section 9. The positive effects of the U-Pass on encouraging student transit use have been proven in other jurisdictions (Zhou, 2012).

5.3. SHOPPING, SOCIAL, RECREATIONAL AND OTHER TRIPS

Travel for shopping, recreation, appointments, socializing and other discretionary activities are typically not well-served by transit. Unfortunately transit is most suited for when travel is concentrated in time and space, and this category of trips outside of work and school are difficult to isolate to one area in a city or a consistent time period. Thus, they often require flexibility that is not easily provided by transit services outside of densely built urban environments. It has been shown that in the United States, automobile use is lower for these discretionary trip purposes than for commuting, but that people more often choose to walk for these purposes and not use transit (USEPA, 2013).

6. Land Use and the Built Environment

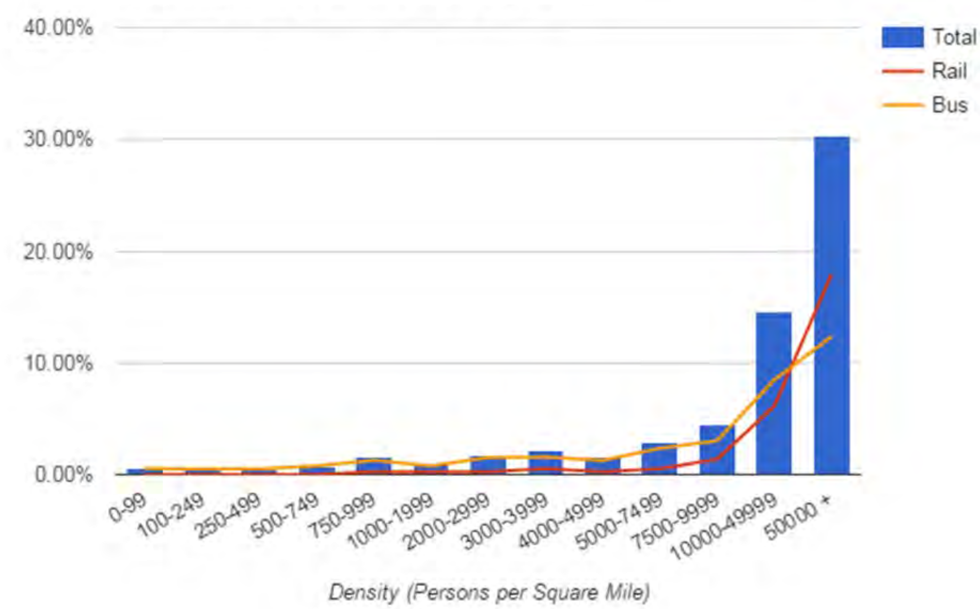
Land use and the built environment have measurable effects on transit ridership but these effects are confounded by the relationship between land use and auto ownership, and the relationship between auto ownership and transit use. It has been found that auto ownership is, in fact, the largest predictor of transit use. The built environment and land use may have a larger effect on trip distances, private vehicle use and non-motorized travel. The land use and built environment characteristics outlined below may not directly influence transit use, but they do promote the transit ridership conditions that support enhanced transit service quality and thereby lower vehicle ownership rates.

Transit supportive land use and built environment are often characterized by Transit Oriented Development (TOD). This section addresses the various aspects of TOD as outlined in Chapters 15 and 17 of the TCRP-95 (TCRP, 2003; TCRP, 2007).

6.1. Density

Density is a measure of population and/or employment in persons or jobs per area. Though there is a positive correlation between density and transit use, studies show that the direct impact of density on transit mode choice tends to be relatively negligible, particularly with respect to residential density. The sheer volume of transit riders that comes from a higher density environment is key to transit success. Data from the 1990 NPTS in the United States shows that as population density increases, daily per capita vehicle miles travelled (VMT) decreases. Person trips made in higher density areas are considerably more likely to be made by auto passenger, transit, taxi or active modes. As shown in Figure 1 below, transit is most effective when density increases beyond 10,000 people per square mile; however there is a small jump in transit use when density increases beyond 5,000 people per square mile, and again at 7,500 people per square mile. (TCRP, 2003)

FIGURE 1: PERCENTAGE OF TRANSIT PERSON TRIPS



On average, Edmonton's population density is 3,090 people per square mile, but this density measure is citywide and accounts for empty park space and undeveloped land. For example, Oliver is Edmonton's densest neighbourhood at 28,800 people per square mile; it has a transit commute mode share of 23%. Malmo Plains neighbourhood has a population density of 9,100 per square mile and a 29% transit commute mode share -- this share is high and due to proximity to the LRT. Gold Bar has a population density of 7,300 and a transit commute share of 12%. (Edmonton, 2014)

The indirect effects of density (walking access to transit, auto parking restrictions, and decrease in auto ownership) have more direct impact on transit mode share than land use density itself, which only creates a more concentrated pool of potential transit customers. With that said, the studies that do isolate density as a contributor to transit ridership show that employment density contributes positively to transit choice, that is density on the non-home end of the trip. For this reason, both land use density and diversity (mixture of population and employment) are important. Walking and bus transit use have been shown to be highest where density and diversity in land uses are highest (TCRP, 2003).

6.2. Diversity

Land use diversity is the mixture of complementary land uses in proximity to each other. Post-war development has emphasized both low-density and separation of land uses, thus vastly reducing the mixture of jobs, housing and amenities. The primary effect of this has been an increase in vehicle kilometers travelled.

While the connection between higher land use diversity and mode choice has more impact on walking and carpooling, studies have shown some slight increases in transit use due to removing people's reliance on private vehicles. Overall the impacts of increased density and diversity are seen through reductions in vehicle kilometers travelled and increases in walking, as density and diversity tend to concentrate origins and destinations to walkable proximities. Transit use has been shown to be positively correlated to land use mix, however the impact is small.

6.3. Design

Design attributes specifically related to transit are:

- Connectivity of streets in a manner supportive of both bus routing without circuitry and easy rider access to stops and stations
- A pedestrian scale of construction with street-oriented buildings
- Alignment of transit stops and major building entrances
- Direct and attractive pedestrian paths
- No requirement for walking across parking lots
- A mixture of appealing uses in a safe environment, all within close reach of transit service

These attributes are shown to have a positive correlation with transit use, but only in the presence of Travel Demand Management programs. Improving the aesthetics of the urban setting had the most influence on transit use, and this was shown to be a positive influence even without supporting TDM measures. As stated above, density is shown above to have an indirect positive effect on transit demand. When density is introduced to models attempting to isolate design variables, density dominates.

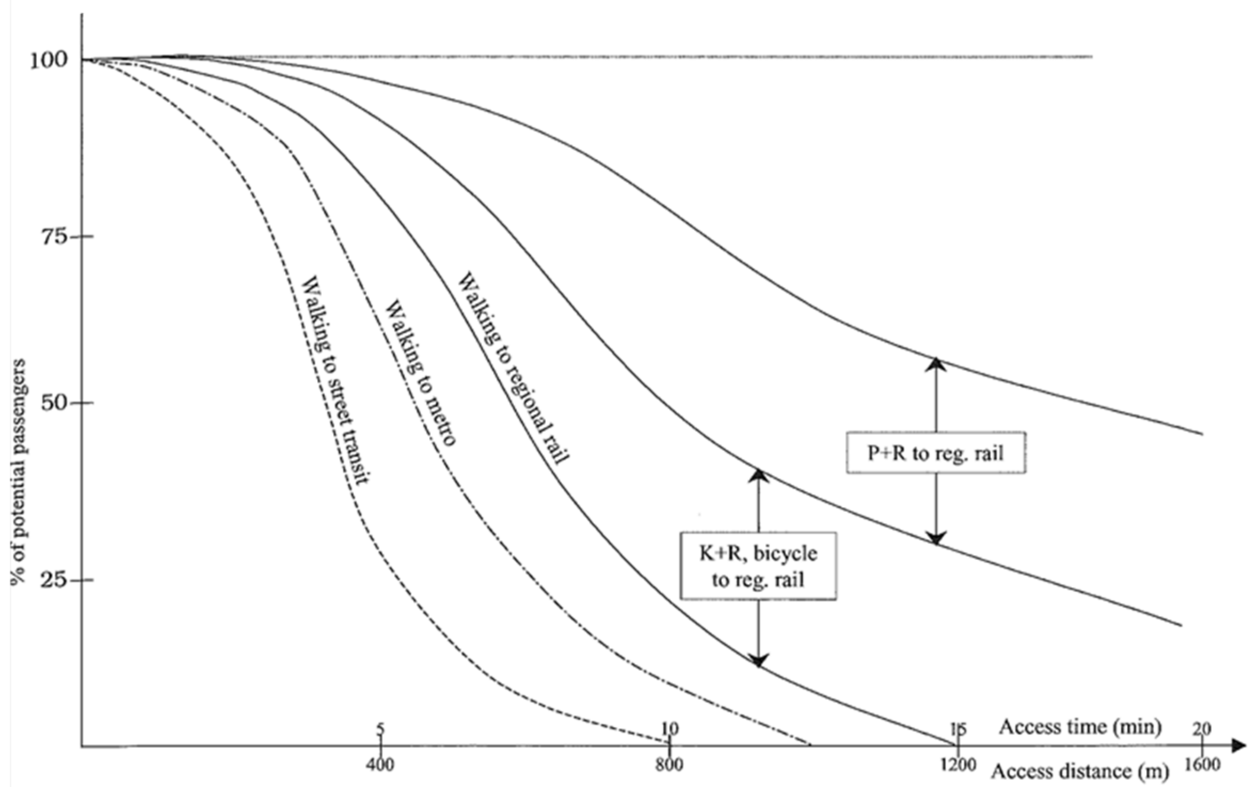
6.4. DISTANCE TO TRANSIT

Proximity to transit is shown to impact transit use. Shorter travel distances to access transit result in higher access and egress walk mode shares and generally higher likelihoods of transit use. Again, this correlation between proximity to transit stations and transit use is affected by vehicle availability -- households living closer to higher order transit exhibit lower levels of vehicle ownership and increased transit use.

A study of the US personal travel survey shows that proximity to a subway (high capacity and high frequency transit) made households six times more likely to be car free, while proximity to lower order transit service had only a small effect on auto ownership (Gardenhire, 1999). A Toronto study (Foth et al, 2013) shows that people who live within 1km from a subway station are more likely to take transit to work, which reinforces the US personal travel survey findings.

Vuchic (2005) provides a model of walking distance to access transit services by mode of transit. Generally, as the quality of the transit mode increases, so does the distance people are willing to walk to access the transit service. The curves suggest that for street transit like Edmonton's bus system, passenger potential is reduced to 25% with a 400m walk from bus stops. For a metro system -- higher speed and capacity than Edmonton's LRT -- passenger potential is approximately 50% within 400m from a station. Figure 2 below illustrates the potential passenger demand by distance to access the transit service. (Vuchic, 2005)

FIGURE 2: WILLINGNESS TO WALK TO TRANSIT (VUCHIC, 2005)



Note: Walking distance curves are approximately scaled; K+R and P+R vary greatly with local conditions

As a rule, propensity for transit use deteriorates with distance from the transit stop or station, regardless of the transit mode and regardless of the access mode (walk, bicycle, park and ride or kiss and ride). Edmonton's LRT would fall between the street transit and metro curves.

7. NATURAL ENVIRONMENT

The effects of temperature and precipitation on bus and rail ridership have been studied to a limited degree. There are conflicting results from varying studies about whether temperature and precipitation have a significant effect on transit ridership and have typically concluded that additional analysis is required.

A Chicago study showed that adverse weather (temperature, precipitation and wind) tended to have a markedly larger effect on bus ridership as compared to rail and on weekend ridership as compared to weekday ridership. Increases in temperature result in increasing bus ridership, and increasing precipitation (rain and snow) results in reduced ridership. (Gou et al, 2007).

8. ATTITUDES, PERCEPTIONS AND CUSTOMER EXPERIENCE

Various attributes of transit service impact the attitudes and perceptions of both transit riders and non-riders and their choice to use transit as a mode of transportation. Generally speaking, transit quality attributes can be grouped into two categories: hard and soft attributes (also referred to as physical and perceived factors). Table 2 below lists the attributes and their definitions (Redman et al, 20120

TABLE 2: PHYSICAL AND PERCIEVED ATTRIBUTES

	Attribute	Definition
Physical	Reliability Frequency Speed Accessibility Price Information provision Ease of transfers/ interchanges Vehicle condition	How closely the actual service matches the route timetable How often the service operates during a given period The time spent travelling between specified points The degree to which public transport is reasonably available to as many people as possible The monetary cost of travel How much information is provided about routes and interchanges How simple transport connections are, including time spent waiting The physical and mechanical condition of vehicles, including frequency of breakdowns
Perceived	Comfort Safety Convenience Aesthetics	How comfortable the journey is regarding access to seat, noise, driver handling, air conditioning How safe from traffic accidents passengers feel during the journey as well as per sonal safety How simple the PT service is to use and how well it adds to one's ease of mobility. Appeal of vehicles, stations and waiting areas to users' senses

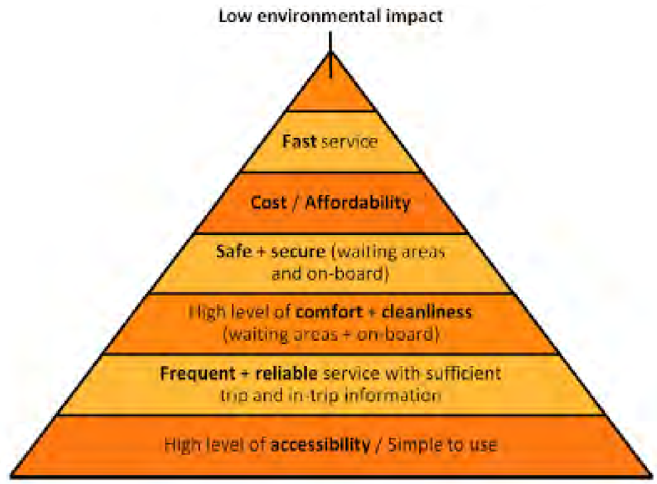
The consensus among the literature reviewed points to hard attributes, in particular reliability and frequency, as being of core importance in determining transit demand and satisfaction levels. Fare price and speed are also key attributes of transit service that affect transit demand. The relative importance of each of the quality attributes in affecting transit demand or mode shift is dependent on user demographics, personal situations and previous experience with transit.

In terms of soft attributes, the literature concludes that they help to retain existing passengers but do not attract new riders or induce mode shift. The literature recommends that transit agencies would benefit from understanding the 'user-perceived' attributes when approaching quality improvements. By understanding which quality improvements (hard or soft) are important for the different types of users (i.e. transit user, car users etc), the transit agencies can better target their improvements and achieve the greatest gains in terms of transit mode shift and satisfaction levels.

8.1. HIERARCHY OF ATTRIBUTES

A report published in Travel Behavior and Society (Batty et al, 2014) suggests that a hierarchy of transit service needs, presented in the form of a pyramid (shown in Figure 3 below), provides guidance on the relative importance of transit attributes. The most basic needs are presented at the bottom with more advanced needs (of decreasing relative importance) appear as one proceeds up the pyramid. The hierarchy implies that typically people are less concerned with the environmental benefits of using transit while bigger issues persist in the transit system. The hierarchy provides guidance to transit agencies as they try to establish the priority of attributes to tackle in their services.

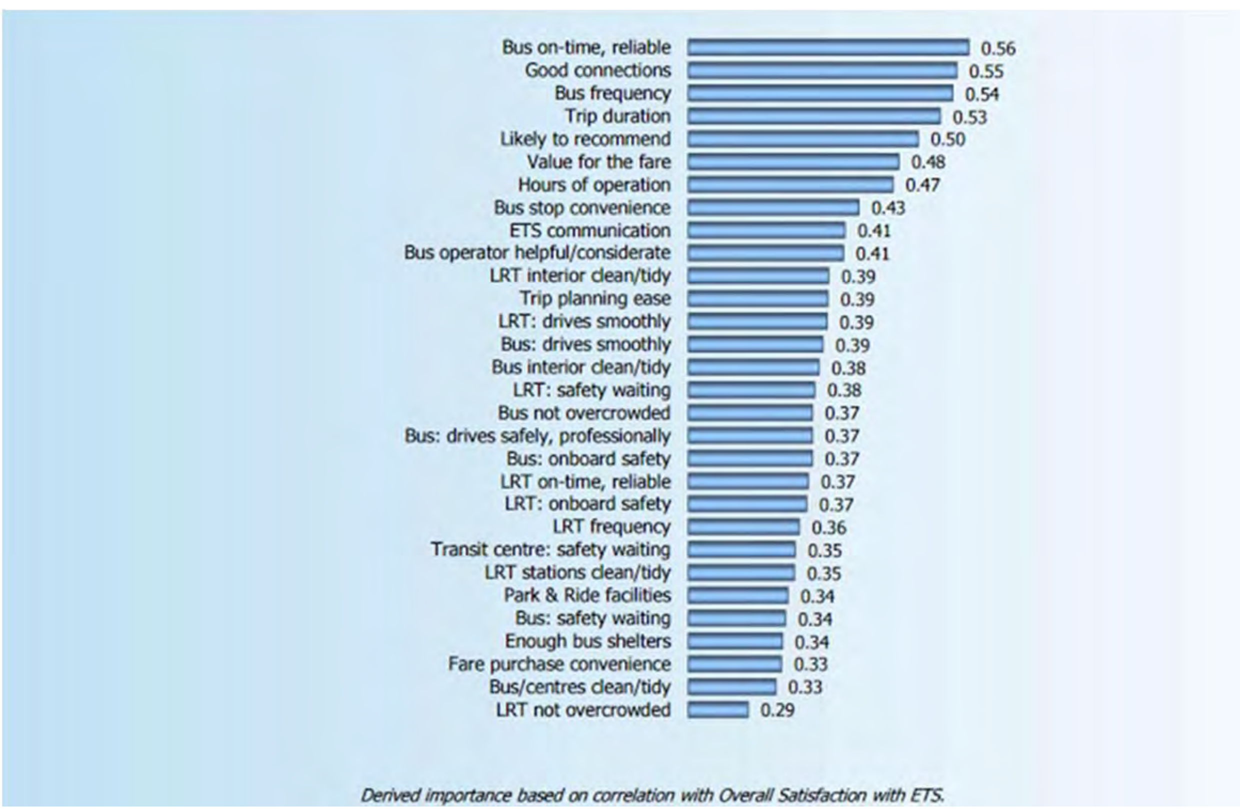
FIGURE 3: PYRAMID OF TRANSIT REQUIREMENTS



8.2. The Edmonton Context: ETS Customer Service Satisfaction

Research conducted by ETS through a continuous survey conducted every quarter in 2015 revealed the importance of transit attributes to riders. To be clear, this survey aims to monitor customer satisfaction and assess the impact of future changes in service delivery. The survey does not sample non-ETS customers and therefore cannot be used as an indicator of the factors that would attract riders to transit. The results are provided in the graph shown in Figure 4 below.

FIGURE 4: IMPORTANCE OF ATTRIPBUTES TO ETS CUSTOMERS

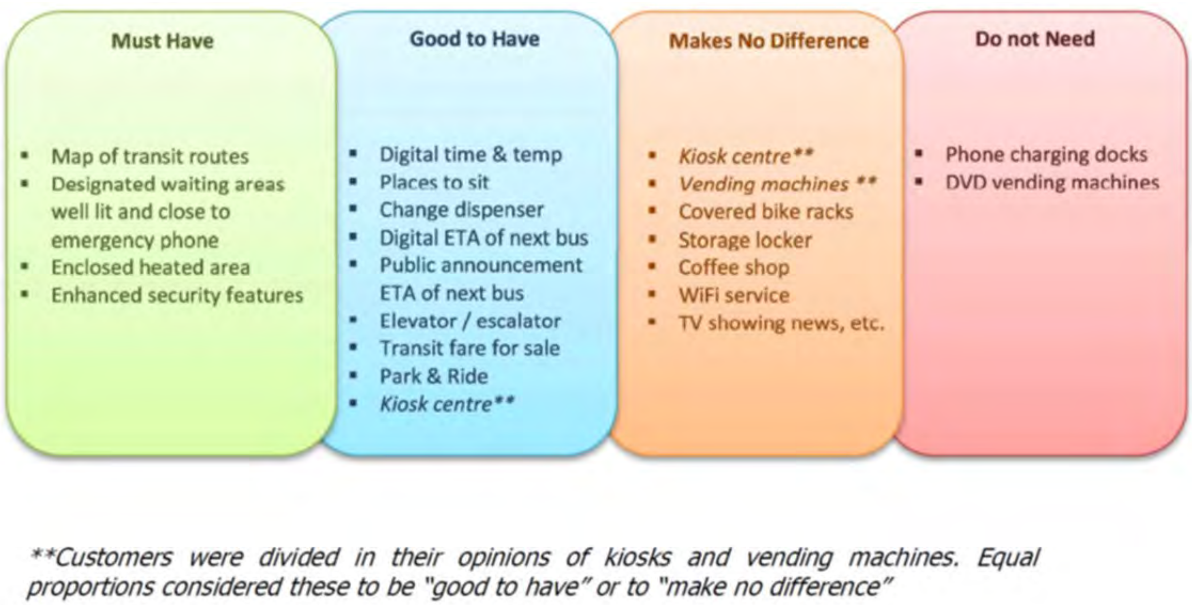


The study also revealed what it refers to as 'Critical Moments of Truth', or moments that have greatest potential to trigger strong positive or negative feelings about the customer experience. These moments were incorporated and aligned with selected service attributes in the tracking study. Three key factors emerged from the Customer Experience Mapping exercise: Access to information, Time and Security.

8.3. Edmonton Context: Expectations of Transit Facility Attributes

In 2011 a study was commissioned by ETS to assess customer needs in their transit facilities. The study found that ETS "customers are open to having additional amenities at their transit facilities. Overall, customers agree that ETS should take steps to make the customer experience as enjoyable as possible and that having a variety of products and services available would make using transit more enjoyable." (Leger, 2011). Figure 5 below provides an overview of how ETS customers categorized the various transit attributes. Many of the features that were identified as "must have" are ones that customers' tend to experience as challenges while waiting for transit. The high emphasis placed on heated and well-lit waiting areas can be explained when considering the Edmonton context of winter climate and shorter daylight hours for periods of the year.

FIGURE 5: CATEGORIES OF ATTRIBUTES BY ETS CUSTOMERS

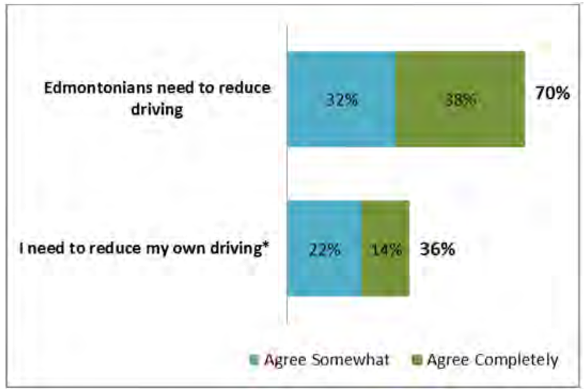


In relation to LRT customers, the study also found that the location and type of transit facility has an impact on the features the customers want. Customers at central LRT stations (e.g., Health Sciences and McKernan) have a stronger desire for the availability of fare products (55% must have), while customers at larger more suburban LRT stations (e.g., Southgate, Belvedere) have a stronger desire for Park & Ride (41% must have). Customers at downtown and large LRT stations also have a stronger preference for enhanced security (41% to 44% must have) compared to those who use the smaller stations (29% must have). [Leger, 2011]

8.4. Edmonton Attitudes on Mode Shift

Results from 2011 research conducted by the City of Edmonton show that Edmontonians are not immune to the emotional and symbolic draw of the person vehicle. The survey showed that that 69% of Edmontonians feel that cars are more than just convenient transportation. While they recognize that driving is not without its stresses, people see their car as a private sanctuary, as a place "where I can be myself". Car ownership is a normal "rite of passage" to personal freedom. However, as shown in Figure 6, Edmontonians recognize the need to reduce driving but they don't take personal responsibility for contributing to the problem or solution.

FIGURE 6: ATTITUDE ON MODE SHIFT



9. PRICING

The cost of transportation and parking affects people's mode choice. Taylor and Fink summarize that policies subsidizing automobile travel are more detrimental to transit ridership than transit supportive policies are beneficial. Improvements to transit service -- frequency, coverage and reliability, for example -- are shown to be more important to ridership than transit fares (Taylor & Fink, 2003). Decreasing transit fares is not recommended as this tactic is shown to only have short term ridership gains (Redman et al, 2013; Batty et al, 2014). Increasing the cost of parking, however, is one of the primary mechanisms to encourage transit use.

9.1. EDMONTON CONTEXT

The University of Alberta's Office of Sustainability reports that the University has implemented a range of incentives and disincentives to deter single occupancy vehicle travel to the university, while promoting sustainable means of transportation. As a component of the Travel Demand Management strategy, parking inventory on campus has been reduced by 10 per cent since 2006. At the same time, parking rates have increased, with the new revenue funding alternative transportation initiatives, such as the U-pass for students. The U-Pass was successfully implemented in September of 2007, and contributed toward increasing Edmonton Transit System's ridership by 12 per cent over the previous year. The students pay for the U-Pass in their enrollment and are then given unlimited access to the Edmonton Transit System, thereby avoiding the variable costs of monthly or single-use transit passes. The University of Alberta is the only North American university with four LRT or subway stops within its campuses: Enterprise Square, University, Health Sciences and South Campus.

10. CONCLUSIONS

- The single largest factor affecting transit use is automobile ownership
- Transit ridership is largely a product of factors outside the control of transit systems
- Improvements to quality of transit service and targeted pricing schemes have shown to be the most effective mechanisms for increasing ridership.
- Increasing the quantity of transit service (frequency and coverage) has been shown to improve ridership in areas where there is latent demand.
- Recent local research shows that ETS riders prioritize improvements in routes and schedules with the heaviest focus on a need for more routes, improved frequency, improved schedule reliability and expanded routes, particularly the LRT. These system characteristics are also key to attracting new transit riders and so an improvement to them could lead to both retention and attraction of users.
- Outside of the transit system, it is important to develop dense land use and built form, transit-supportive community designs, transit supportive and walkable street networks and high quality LRT facilities to entice new transit riders.

11. References

AASHTO (2015) Commuting in America 2013: The National Report on Commuting Patterns and Trends. http://traveltrends.transportation.org/Documents/ES_Executive%20Summary_CAES-4_web.pdf

L. Redman et al. Quality attributes of public transport that attract car users: A research review. Transport Policy 25 (2013)119–127, 2012.

A.Idris et al. Dissecting the Role of Transit Service Attributes in Attracting Commuters: Lessons from a Comprehensive RP-SP Study on Commuting Mode Switching Behaviour in Toronto. 93rd TRB Annual Meeting. October 2013.

P. Batty et al. Challenges and opportunities in developing urban modal shift. Travel BEhaviour Society, 2014.

CR Bhat, JY Guo (2007) A comprehensive analysis of built environment characteristics on household residential choice and auto ownership levels. Transportation Research Part B: Methodological 41 (5), 506-526

City of Edmonton (2014) Municipal Census Results. Retrieved from http://www.edmonton.ca/city_government/facts_figures/municipal-census-results.aspx

Foth, N., Manaugh, K., El-Geneidy, A. (2014) Determinants of Mode Share over Time. Transportation Research Board 93rd Annual Meeting, Washington, DC.

Gardenhire, A. (1999) Economic and Sociodemographic Influences of Autolessness: Are missing variables skewing the results? Transportation Research Record: Journal of the Transportation Research Board. 1670. 13-16

Guo, Z., Wilson, N.H.M., & Rahbee, A. (2007). The impacts of weather on transit ridership in Chicago. *TRB Annual Meeting*.

Pratt, R.H., & Evans, J.E. (2004). Traveler Response to Transportation System Changes Chapter 10 - Bus Routing and Coverage. *Transit Cooperative Research Program Report 95, 10*.

Leger Marketing (2011). Edmonton Transit System Facilities and Amenities: Analysis of Findings.

Mustel Group (2015). Edmonton Transit System Customer Satisfaction Tracking Survey, October 2014 - September 2015 12 Month Report, City of Edmonton.

Kuzmyak, J.R., Pratt, R.H., & Evans, J.E. (2010). Traveler Response to Transportation System Changes Chapter 19- Employer and Institutional TDM Strategies. *Transit Cooperative Research Program Report 95, 19*.

Taylor, B., Fink, C. (2003) Factors Influencing Transit Ridership: A Review and Analysis of the Ridership Literature. UCLA Institute of Transportation Studies. Los Angeles, CA.

TCRP (2003). TCRP Report 95 - Traveler Response to Transportation System Changes: Chapter 15--Land Use and Site Design. Transportation Research Board, Washington, DC.

TCRP (2004) TCRP Report 95 - Traveler Response to Transportation System Changes: Chapter 9--Transit Scheduling and Frequency. Transportation Research Board, Washington, DC.

TCRP (2004a) TCRP Report 95 - Traveler Response to Transportation System Changes: Chapter 10--Bus Routing and Coverage. Transportation Research Board, Washington, DC.

TCRP (2007). TCRP Report 95 - Traveler Response to Transportation System Changes: Chapter 17--Transit Oriented Development. Transportation Research Board, Washington, DC.

USEPA (2013). Our Built and Natural Environments. Retrieved from: https://www.epa.gov/sites/production/files/2014-03/documents/our-built-and-natural-environments.pdf

Vuchic (2005) Urban Transit: Operations, Planning and Economics. John Wiley & Sons, Hoboken, NJ.

Zhou, J. (2012) Sustainable commute in a car-dominant city: Factors affecting alternative mode choices among university students. Transportation Research Part A 46. 1013-1029