ADVISORY COMMITTEE REPORT

TO: **Administration & Finance Committee**
FROM: **Saskatoon Environmental Advisory Committee**
DATE: **October 19, 2011**
SUBJECT: **Transit Research Studies**
(1) Impact of Fare Changes on Ridership (SEAC)
(2) Best Practices – Transit Ridership & System Improvement (Transit Administration)
FILE NO.: **CK. 175-9**

RECOMMENDATION: that this report be submitted to City Council as information.

BACKGROUND:

Each year, the Saskatoon Environmental Advisory Committee (SEAC) undertakes a research project in order to fulfill its mandate to "provide advice to Council on policy matters relating to the environmental implications of City undertakings and to identify environmental issues of potential relevance to the City".

In May 2011, your Committee partnered with Transit Administration to obtain research on the impact of Transit Fares on Ridership, in terms of what would increase transit ridership and reduce the use of vehicular traffic. The Administration was interested in research on best practices for Transit Services in terms of what has worked in other cities. A candidate search was initiated and nine applicants were interviewed. The successful applicant – Mr. Lee Smith, a third year University of Saskatchewan student – was hired for a four month term to complete the two research reports. The Environmental Services Branch also assisted by providing in-kind support through the provision of office space and phone access.

REPORT:

Saskatoon is a city with public transportation needs. However it is also a city that, in no small part, is built for the automobile – almost exclusively in some areas. This is the case for most Canadian cities, particularly on the prairies. Its low overall density and sprawling highway-centric development, especially around the outskirts, lends to the private vehicle being the *de facto* standard of intra-urban transportation. A well used public transit system can have a positive impact on a city, such as: reduced overall traffic congestion; positive economic development or re-development of decaying areas; and, most significantly in terms of SEAC's interest, decreased aggregate carbon emissions from reduced vehicle traffic and new bus fuel technologies such as hybrid- or full-electric and compressed natural gas.

The primary objective of this report is to explore the effects that a reduction or complete removal of transit fare would have on Saskatoon Transit ridership. While this discussion, by nature, is primarily economic, it is important to understand that the potential impact on increased transit ridership and the resulting greenhouse gas emission reductions are central to the mandate of SEAC.

The attached study examined the potential impact on transit ridership that results from either an increase or decrease in fares. It demonstrates that previous research on the subject has found public transit to be an inelastic good. This means that ridership generally decreases with an increase in fare and vice-versa, but in terms of percentage, ridership does not change as much as the fare change. Estimates based on the available research suggest that a fare reduction of 10% would result in a ridership increase of between 5 and 9%, while a fare reduction of 90% would lead to a ridership increase of between 30 and 68%.

The attached study also examines the potential impact of a system-wide fare elimination. It should be noted that no North American transit service currently offers a zero-fare system. A review of the currently available research does not support the implementation of a zero-fare system. A zero-fare system can lead to reduced quality and lowered ability to attract commuters, increased cost and loss of revenue, which in turn results in reduced service quality, have been identified as some of the negative consequences. However, it must be acknowledged that a zero-fare program could potentially be successful in a limited or isolated manner, such as within the downtown only or a single line between two major destinations (such as a downtown to University line). Therefore, SEAC does not recommend that Saskatoon Transit consider a zero-fare transit system, especially if the desire is to increase the ridership of commuting adults and attract motorists out of their cars.

There are many factors besides fare that can have a significant impact on ridership. In most cases, these factors are more influential than fare for determining ridership. Some of these factors outlined by past research and observation include service frequency, service coverage, service improvements, availability/convenience, travel time, and general good-quality transit service. The utility and overall cost of automobiles also has a significant impact on ridership, whereby if auto use is subsidized or treated preferentially, it can negatively impact ridership, and if it is priced higher or treated disadvantageously, it can positively impact ridership.

Given these observations, SEAC endorses the findings and recommendations outlined in the Transit Administration report "Best Practices – Transit Ridership & System Improvement". In the opinion of SEAC, a focus on providing better and more reliable transit service to all areas of Saskatoon through the use and implementation of web-based technology, improved customer service, and better transit infrastructure will have a more positive impact on increased ridership then fare reductions or elimination. A successful implementation of the recommendations outlined in the report can lead to an overall reduction in greenhouse gas emissions for the city.

<u>CONCLUDING COMMENTS:</u>

SEAC would like to commend the efforts of Saskatoon Transit and the Environmental Services Branch in working together to produce the attached report.

As always, SEAC is available to assist City Council and City Administration on all matters pertaining to the environment and we look forward to providing our input in the future.

ATTACHMENTS:

1. "Summer 2011 Transit Report – The Effects of a Reduced – or Zero-Fare Structure on Ridership", by Lee Smith.

Written by: **Dr. Sean Shaw, Chair**
Saskatoon Environmental Advisory Committee

Approved**:** **"Sean Shaw"**
Dr. Sean Shaw, Chair
Saskatoon Environmental Advisory Committee
Dated: October 31, 2011

CITY OF SASKATOON

SASKATOON ENVIRONMENTAL ADVISORY COMMITTEE

SUMMER 2011 TRANSIT REPORT

THE EFFECTS OF A REDUCED- OR ZERO-FARE STRUCTURE ON RIDERSHIP

City of Saskatoon

AUGUST 2011

ABOUT THE AUTHOR

The author of this report is Lee T. Smith, an undergrad in the Regional and Urban Planning program at the University of Saskatchewan. He was hired by the Saskatoon Environmental Advisory Committee in April 2011 as a summer student researcher. He can be contacted at: *lt.smith* (at) *usask.ca*.

ACKNOWLEDGEMENTS

This report would not have possible without the support, opportunity, and engaging challenge provided by SEAC. Nor would it have been possible without the generous assistance and cooperation provided by Saskatoon Transit. The support and workspace provided by the Environmental Services Branch at the City of Saskatoon is also greatly appreciated.

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0 EXECUTIVE SUMMARY

This report is a documentation of research done in the summer of 2011 for the City of Saskatoon Environmental Advisory Committee. Its intent is to explore the effects that a reduced fare or a removal of fare would have on Saskatoon's bus transit ridership based on past academic research, economic theory, and historical precedent. A secondary intent of the report is a general investigation of transit fare and ridership (as well as other relevant factors), and how they might affect (or not affect) one another.

0.1 EFFECTS OF FARE CHANGES ON RIDERSHIP

The primary intent of this report is to examine the effects on ridership from a fare reduction and a fare removal. Economic analysis tools and theory are the primary method by which a fare reduction will be analyzed, and previous research and historical precedent will be used to discuss a fare removal.

a. FARE REDUCTION

The economic tool used for analysis of a fare reduction is known as "elasticity" – specifically, "price elasticity of demand" (or "fare elasticity of ridership"). See subsection *1.1.b* of this report for an introduction to this principle. Elasticity is a numerical value that tells us what fraction of a percent ridership will change for every one percent change in fare.

There are a number of models in past research that use various elasticity values. The industry standard (called the Simpson-Curtin rule) is that for every one percent change in fare, ridership changes by a third of a percent in the other direction (Curtin, 1968). In other words, the Simpson-Curtin elasticity value is –⅓. However, there is research that suggests that this value is outdated, and potentially understates actual ridership change. Pham & Linsalata (1991) offer a value of –0.4, as well as a number of other values that vary depending on city size and peak/off-peak hours. Litman (2011) states that Simpson-Curtin and Pham-Linsalata both still understate potential changes, particularly for the long-run, and offers an even wider range of values which vary depending on short/long term as well as other factors.

See Table 2-1, Figure 2-3, and Figure 2-4 on the next two pages (originals on pages 8, 9 and 11 respectively) for an index and two visual summaries of the Saskatoon fare reduction ridership potential according to Simpson-Curtin, Pham-Linsalata, and Litman. The predictions under the Litman model are not single-point values, and so are not indexed or plotted alongside Simpson-Curtin and Pham-Linsalata; they are instead given their own graph (Figure 2-4) depicting the ranges that are the flagship of Litman's research.

		Fare Reduction				
		10%	25%	50%	75%	90%
Simpson-Curtin (-0.333…)	R % Increase	3.333…%	8.333…%	16.666…%	25.000%	30.000%
	New R	11,893,014	12,468,482	13,427,596	14,386,710	14,962,178
	New Rpc	53.02	55.59	59.86	64.14	66.71
Pham-Linsalata (-0.4)	R % Increase	4.000%	10.000%	20.000%	30.000%	36.000%
	New R	11,969,743	12,660,305	13,811,242	14,962,178	15,652,740
	New Rpc	53.36	56.44	61.57	66.71	69.78
Pham-Linsalata (-0.45)	R % Increase	4.500%	11.250%	22.500%	33.750%	40.500%
	New R	12,027,290	12,804,172	14,098,976	15,393,780	16,170,662
	New Rpc	53.62	57.07	62.86	68.63	72.09

Table 2-1: Index of ridership changes influenced by fare reductions under Simpson-Curtin and Pham-Linsalata models (pg. 8)
(R = Ridership; Rpc = Ridership per capita; current ridership = 11,509,368)

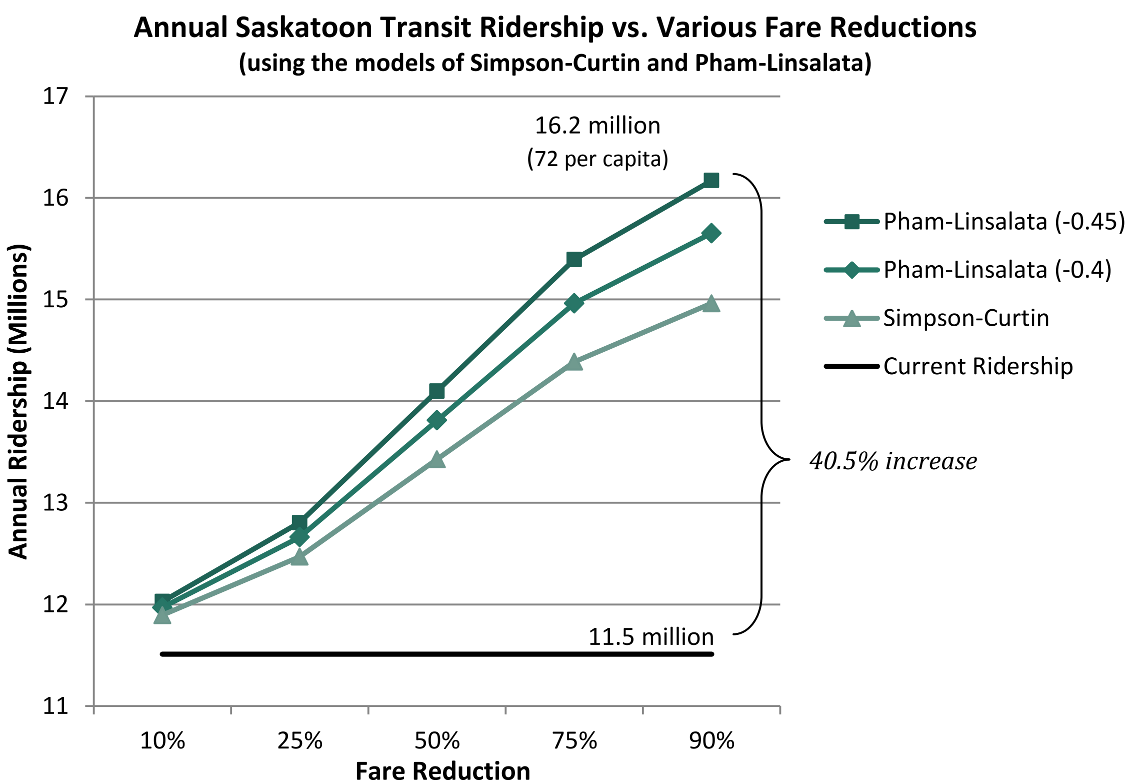

Figure 2-3: Annual ridership vs. fare reduction under Simpson-Curtin and Pham-Linsalata models (pg. 9)

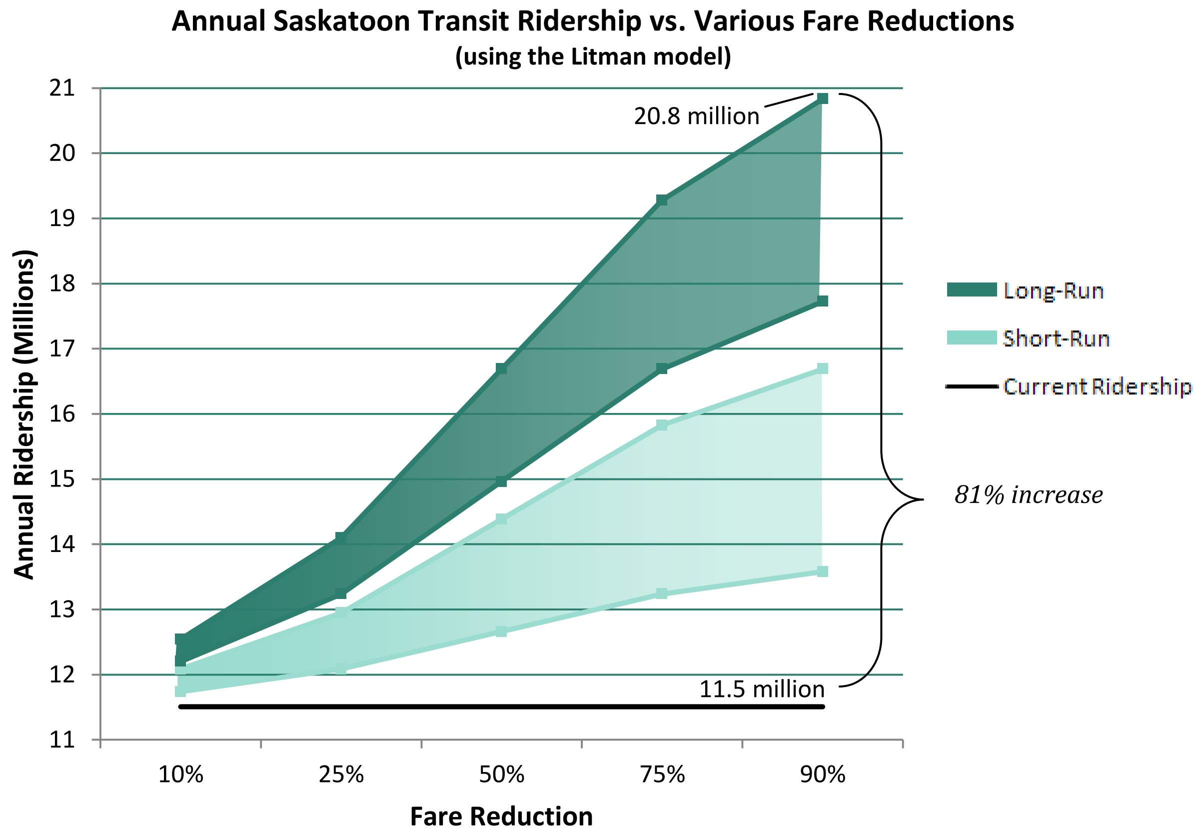

Figure 2-4: Annual ridership vs. fare reduction under the Litman model (pg. 11)

b. ZERO-FARE

An absence of fare is much different from any fare value, even the smallest fraction of a dollar. For this reason, the economic tools used above will not be used to analyze a zero-fare scenario, as it would not appear very useful, and would merely be an extrapolation of the above data. We will investigate previous literature on the subject instead, which discusses the real-world implications and actual consequences of a zero-fare transit system.

Researchers have almost unanimously dismissed a system-wide zero-fare policy (Cervero, 1990; Perone, 2002; Vobora, 2008). A zero-fare system does in fact increase ridership – by a substantial amount typically – but it is not so-called "choice" ridership. To quote Perone (2002, p. 4-5):

> *In the fare-free demonstrations … most of the new riders generated were not the choice riders they were seeking to lure out of automobiles … [They] suffered dramatic rates of vandalism, graffiti, and rowdiness due to younger passengers who could ride the system for free, causing numerous negative consequences. Vehicle maintenance and security costs escalated due to the need for repairs … The greater presence of vagrants on board buses also discouraged choice riders and caused increased complaints from long-time passengers. Furthermore … the transit systems became overcrowded and uncomfortable for riders … [which] discouraged many long-time riders from using the system as frequently as they did prior.*

Cervero (1990) came to virtually the same conclusions in his own research and review of past research up to that time. Vobora (2008) investigated the feasibility of the implementation a zero-fare system in Lane Transit District, Oregon, USA, and advocated against it mainly due to significant cost implications (associated both with the general loss of revenue and with increased maintenance) and the decreased service quality that would inevitably arise as a result of these costs.

However, another important conclusion of Cervero (1990) is that zero-fare transit systems have seen moderate success when they are geographically limited to a certain area, such as a downtown, as just a small part of a larger, fare-charging transit system. This is supported by the success of a limited zero-fare service in Durham, North Carolina, USA which has a single line – that carries nearly 2,000 rides per day – running between Duke University and downtown Durham alongside their standard fare-taking transit system (Interview, Durham Area Transit Authority, 2011).

Global zero-fare systems are not recommended – especially if the desire is to attract daily commuters or to get motorists out of their cars – based on the past consequences of transit systems who have attempted their implementation in the past. There are no benefits to a global zero-fare system other than an increased number of patrons, which research has shown is not necessarily a good thing. However, limited-scope zero-fare systems as discussed in the paragraph above could be considered as a minor part of an overall standard system.

0.2 OTHER SIGNIFICANT IMPACTS ON RIDERSHIP

Transit fare is not the only thing that can have a significant impact on ridership. In fact, some research suggests that there are many other things that are in fact ***more*** potent than fare for influencing ridership. These factors can either be internal (a policy initiative of the transit agency) or external (out of the control of the transit agency). Among the internal factors that can influence ridership, there are two categories: quantitative, and qualitative.

Quantitative factors are things such as service coverage and service frequency. Several independent researchers have found that the measures of service coverage and frequency (referring primarily to geographical extent of routes, and headways, respectively) are more important for explaining ridership fluctuations than fare (Perone, 2002; Taylor & Fink, 2003; Thompson & Brown, 2006; Taylor et. al., 2008). *Qualitative* factors refer to things such as availability, convenience, travel time, and ease-of-use. Research has shown that these qualitative factors, including general overall ***service quality***, are more important for explaining ridership than fare – and in some cases, are more important than even the quantitative factors discussed above (Cervero, 1990; Perone, 2002; Taylor & Fink, 2003; Swimmer & Klein, 2010).

The private automobile has also been evidenced to have a notable impact on ridership levels, both in terms of its competitive utility and convenience (in a negatively-impacting relationship) and in terms of its costs (in a positively-impacting relationship) (Cervero, 1990; Taylor & Fink, 2003; Litman, 2011). There is also some research that suggests that good weather (or extremely bad weather) can increase ridership, and bad weather can decrease it (Guo et. al., 2007).

0.3 CONCLUSIONS

Fare changes can have a varying level of influence over transit ridership. This variation depends upon many factors, but ultimately it hinges on which model is used to predict the influence. This report has used a range of common prediction models using economic theory and has developed a set of possible ridership changes for various fare changes. Ridership gains can range from 2% to 5% following a 10% fare reduction; from 10% to 25% following a 50% fare reduction; and from 18% to 45% following a 90% fare reduction. The fare changes investigated in this report were strictly reductions, but in theory the models could be reversed, with fare *increases* having the exact opposite impact upon ridership. The models employed have been exhibited plainly and reworked into a set of equations for future use with custom variables (see Appendix 4).

The concept of a fare removal was discussed, not using the same economic models, but using past research and historical precedent. Ultimately, it was found that a zero-fare transit system is not effective for overall system improvement, despite the fact that it does tend to increase ridership. There are many other negative consequences of a zero-fare system that trump its one positive consequence of increased patronage; the biggest negative consequence is in fact the nature of this increased patronage.

It was also evidenced in this report that transit fare is not the most important factor that can influence ridership, and in fact might even be quite unimportant, when compared to other things such as service quality, service quantity, and externalities like the private automobile. These factors must be considered when investigating effects on ridership, as research suggests that they are much more potent – especially for the ridership of discretionary riders and daily commuters. Some of the biggest things that impact ridership are: availability and convenience of use, service frequency (headways), service coverage (extent of routes), and travel time.

Finally, it was noted that any future research in this area with *applied* intentions (rather than *academic* intentions) ought to further investigate the other important factors discussed above in addition to transit fare, as they are all potentially significant elements for deciding transit ridership.

A few general recommendations for Saskatoon Transit were formulated. Briefly, they are as follows:

- Dismiss considerations of a system-wide zero-fare program. Research has plainly shown that they are unsuccessful and detrimental to the overall quality of a transit system.
    - However, do not outright dismiss the eventual possibility of a ***limited*** zero-fare program, such as within the downtown core, or between the University and the downtown.
- Consider fare reductions seriously and carefully in the interest of an increased ridership.
- Do not rely on fare increases in the interest of long-term revenue gains.
- Keep in mind that general quality of service, convenience, and availability all trump any consideration of fare – especially for the ridership of discretionary riders and commuters.
    - i.e. A better value for money is much more important than the money itself.

1 INTRODUCTION

Saskatoon is a city with public transportation needs. However it is also a city that, in no small part, is built for the automobile – almost exclusively in some areas. This is the case for most Canadian cities, particularly on the prairies. Its low overall density and sprawling highway-centric development, especially around the outskirts, lends to the private vehicle being the *de facto* standard of intra-urban transportation. The utility, speed, and convenience of the private vehicle is unmatched by any other transport mode in the city – indeed, most cities. However, the fact remains that the private vehicle is just that – a private good purchased from a private retailer, most often used by private citizens on public roads; and it comes with many costs, both internal and external. In North America we often forget that the use of an automobile is a privilege, and more importantly, a choice, made by those who have the means to afford it.

For many people in Saskatoon and around the world, a private vehicle is an unobtainable luxury, and so public transportation is a crucial daily need. Transit is often the only option for many people – and not just those without the means to obtain a vehicle – to get to work, to shop, and to otherwise move around the city. An inadequate transit system, for them, can mean complete isolation from goods and services they may need to survive, support their families, and be productive members of society. However, necessity is only one explanation for the use of transit – there is much variety in the reasons why people take transit, and even more variety among the people who do.

Public transit is also beneficial to a city in many ways besides providing its citizens and visitors with a means to move around it. Weyrich & Lind (2009) point out a number of universal benefits that good public transit can have on a city, such as: reduced overall traffic congestion; positive economic development or re-development of decaying areas; encouragement of pedestrians, "whose presence is vital to the life of cities" (Weyrich & Lind, 2009, p. 1); and a general re-focus of regions onto their urban cores, minimizing car-oriented, polycentric urban form and sprawling suburbs. Not to mention one of the most significant benefits of transit – decreased aggregate carbon emissions from reduced vehicle traffic and new bus fuel technologies such as hybrid- or full-electric and compressed natural gas.

The primary objective of this report is to explore the effects that a reduction or complete removal of transit fare would have on Saskatoon Transit ridership. While this discussion, by nature, is primarily economic, it is important to understand that there are a number of things that can have an effect on transit ridership. Thus, it could be said that a secondary objective of this report revolves around a general investigation of transit efficiency, fare in particular, and how ridership might be affected by a variety of things.

The current state of Saskatoon Transit will first be introduced. A literature review of academic research on ridership affected by fare change will then follow, and the tools used by researchers will be employed on Saskatoon Transit. Finally, a discussion of other important things that can impact ridership will conclude the report.

1.1 METHODOLOGY

In effort to assess the effects of fare change on Saskatoon Transit ridership, this report will use established principles of public transportation economics, peer-reviewed professional research, and examples of other transit agencies who have conducted similar changes in the past. Empiricism and objectivity will be exploited as best they can be within the social sciences, and predictions and estimations will be made conservatively. Appendix 1 provides a basic introduction to the principle of economic elasticity, and may be dismissed if such an introduction is not necessary. However, it is recommended that the reader consult this appendix if elasticity is not a familiar concept, as it will be used extensively in this report.

a. PREVIOUS RESEARCH

A literature review of journal articles and academic reports on public transit ridership and fare will be employed as part of this report, with the intent to both familiarize the reader with the current state of affairs in urban transportation studies and to give context to Saskatoon Transit. Peer-reviewed research from such publications as *Journal of Public Transportation, Transportation Research Record,* and both the *American Public Transportation Association (APTA)* and *Canadian Urban Transit Association (CUTA)* will be featured, as well as many others, in order to provide a detailed evaluation of the effects on transit ridership from fare changes. See the References section at the end of this report for a list of all works cited.

1.2 CURRENT STATE OF SASKATOON TRANSIT

This subsection is intended to give a background understanding of the current information regarding Saskatoon Transit to give context to the analysis in this report. While exploring this report further, the reader may wish to refer back to this subsection to make comparisons.

Ridership for Saskatoon Transit (ST) has grown over the past five years by approximately 27% (Saskatoon Transit, 2010). ST correlates this growth with strategic service improvements in 2006 including the Direct Access Rapid Transit (DART) system, which is a series of bus routes designed to offer more quick and efficient service between popular nodes (downtown, University, etc) and outer suburban areas by utilizing arterial “trunks” and minimizing core-area stops. Annual ridership on ST in 2010 was over 11.5 million rides (Saskatoon Transit, 2010) – or approximately **51.3 annual rides per capita** – with a 2010 civic estimated population of 224,300 (City of Saskatoon, 2011). Annual rides per capita can be thought of as an approximation of the number of times the average citizen of the corresponding city took transit that year. In this regard, ST is significantly above the national average for cities in the 100,000–400,000 population range, which is only **38.7 annual rides per capita** (Canadian Urban Transit Association, 2010). There are 23 Canadian cities within this population window that have transit agencies registered with the Canadian Urban Transit Association (CUTA). See Figure 1-1 below for a graph comparing the annual ridership per capita of each of these cities.

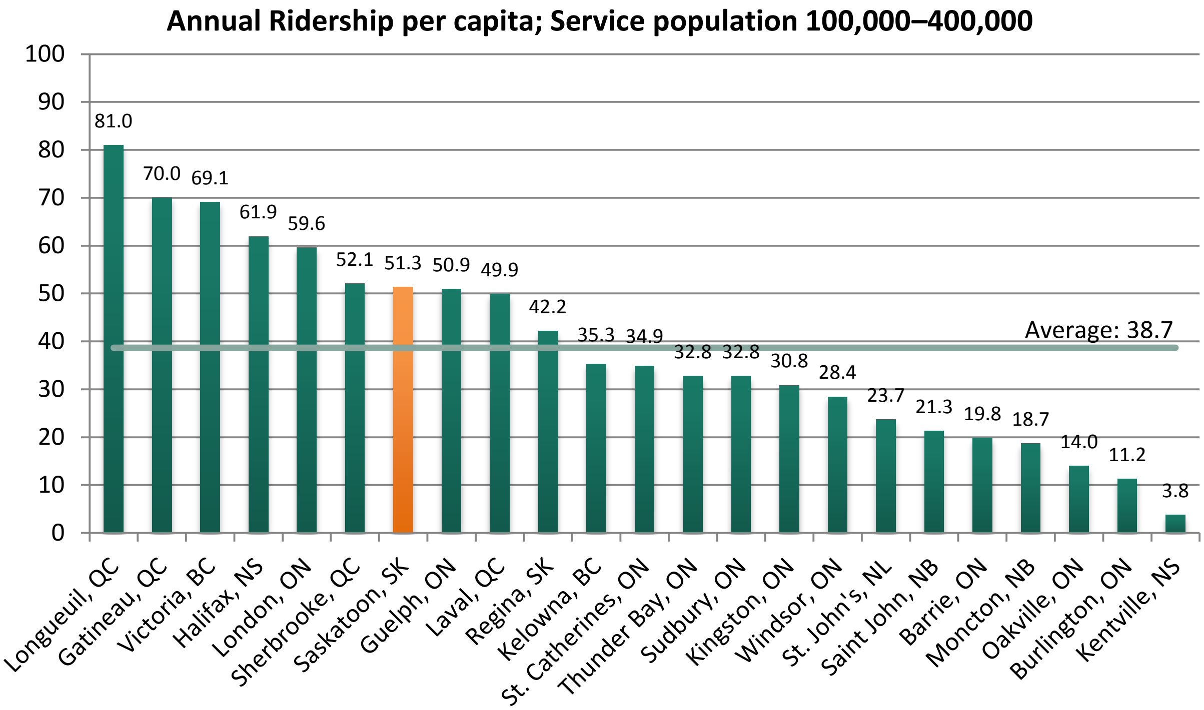

Figure 1-1: Annual ridership per capita of Canadian cities, population 100,000–400,000
Data source: (Canadian Urban Transit Association, 2010)

In terms of transit fare in 2010, the adult cash fare on ST was \$2.75, the adult ticket price was \$2.10, the adult monthly pass was \$71.00, and the senior monthly pass was \$21.00 (2010 data and dollars). ST is approximately average in all categories except for senior monthly pass, in which it is by far the cheapest out of all 23 cities, and the only one under \$30, the second-cheapest being Gatineau, QC at \$34.50.

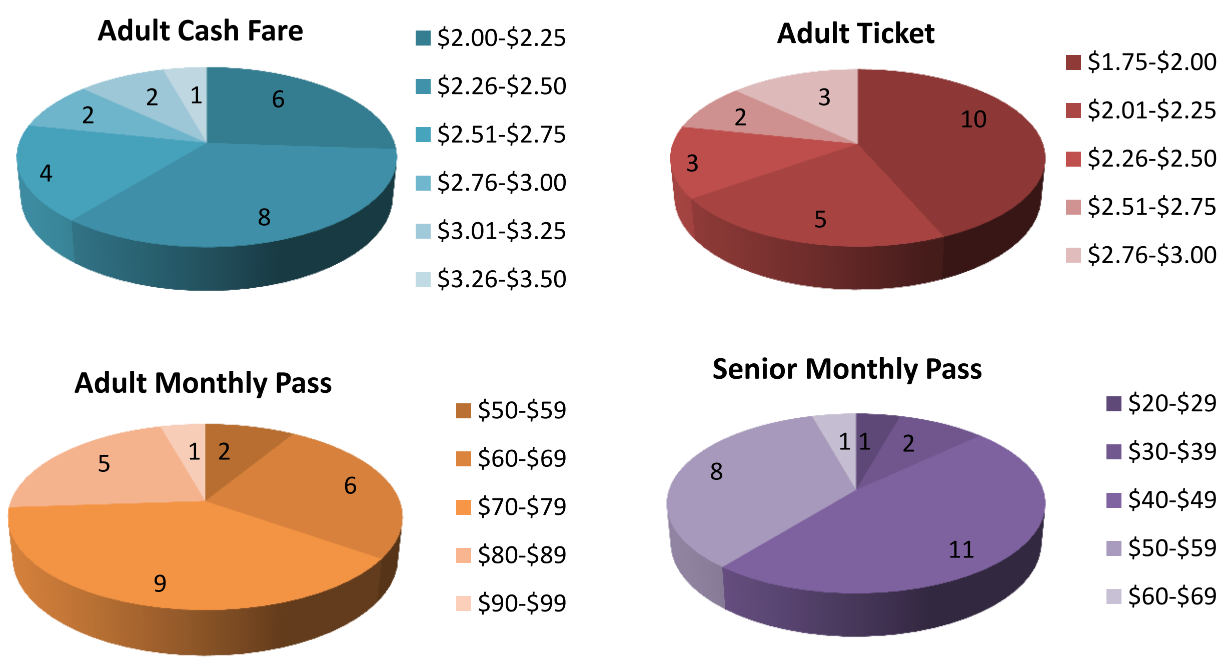

Figure 1-2: Comparison of fare media by number of cities in price range
Data source: (Canadian Urban Transit Association, 2010)

City	Adult Cash	Adult Ticket	Adult Monthly	Senior Monthly	Population	Annual Ridership	AR per capita
Longueuil, QC	$3.00	$2.20	$65.00	$47.00	396,740	32,136,831	81.00225
Gatineau, QC	$3.25	$2.30	$79.00	$34.50	262,391	18,379,477	70.04614
Victoria, BC	$2.25	$2.03	$53.00	$49.00	353,928	24,455,547	69.09752
Halifax, NS	$2.25	$1.80	$79.00	$52.00	312,400	19,346,370	61.92820
London, ON	$2.75	$2.13	$67.00	$57.50	356,100	21,211,000	59.56473
Sherbrooke, QC	$3.10	$2.55	$72.00	$47.00	146,706	7,638,575	52.06723
Saskatoon, SK	$2.75	$2.10	$71.00	$21.00	224,300	11,509,368	51.31239
Guelph, ON	$2.50	$2.31	$70.00	$57.00	120,000	6,111,557	50.92964
Laval, QC	$2.60	$2.00	$68.00	$46.00	391,569	19,520,834	49.85286
Regina, SK	$2.50	$2.00	$60.50	$59.00	179,246	7,558,160	42.16641
Kelowna, BC	$2.00	$2.68	$58.00	$37.00	123,000	4,344,185	35.31858
St. Catherines, ON	$2.50	$1.80	$76.00	$50.00	150,000	5,236,417	34.90945
Thunder Bay, ON	$2.50	$2.35	$65.00	$57.00	109,000	3,577,000	32.81651
Sudbury, ON	$2.45	$2.10	$80.00	$43.00	129,600	4,250,142	32.79431
Kingston, ON	$2.25	$1.90	$70.00	$44.00	108,545	3,348,503	30.84898
Windsor, ON	$2.45	$2.20	$70.00	$40.00	216,473	6,155,650	28.43611
St. John's, NL	$2.25	$3.00	$83.00	$45.00	127,250	3,014,073	23.68623
Saint John, NB	$2.50	$2.00	$71.00	$45.00	122,389	2,609,381	21.32039
Barrie, ON	$2.50	$1.90	$81.00	$49.00	126,000	2,497,761	19.82350
Moncton, NB	$2.00	$2.80	$88.00	$44.00	120,525	2,251,471	18.68053
Oakville, ON	$3.00	$1.80	$82.50	$50.00	177,200	2,479,945	13.99517
Burlington, ON	$2.75	$2.00	$62.00	$54.00	165,435	1,860,825	11.24807
Kentville, NS	$3.50	$3.00	$90.00	$65.00	101,268	380,139	3.75379
AVERAGE	**$2.59**	**$2.22**	**$72.22**	**$47.52**	**196,525**	**9,035,124**	**38.68691**

Table 1-1: Index of Canadian cities within population window, sorted by AR per capita

Data source: (Canadian Urban Transit Association, 2010)

Figure 1-2 shows the distribution of price ranges for four popular fare media among the 23 Canadian cities with a population between 100,000 and 400,000 and a transit agency registered with CUTA. The pie charts show the number of cities out of 23 within each price range for each of the four fare types. Table 1-1 shows the full list of all 23 cities exhibited in Figures 1-1 and 1-2, the values of their various fare types, their population, and their ridership, sorted by annual ridership per capita.

In the 2010 Annual Report, ST divides percentage of ridership by category of user (Saskatoon Transit, 2010, p. 3). The top four ridership categories in 2010 were: *UPass* (27%), *adult monthly pass* (20%), *adult discount pass* (17%), and *high school monthly pass* (14%). Tied in fifth place are *cash* and *adult tickets* (6%). More than four-fifths (81%) of ST riders hold some sort of pre-paid discount/unlimited transit pass – see the shades of green in Figure 1-3 below. All other payment methods are coloured in shades of orange.

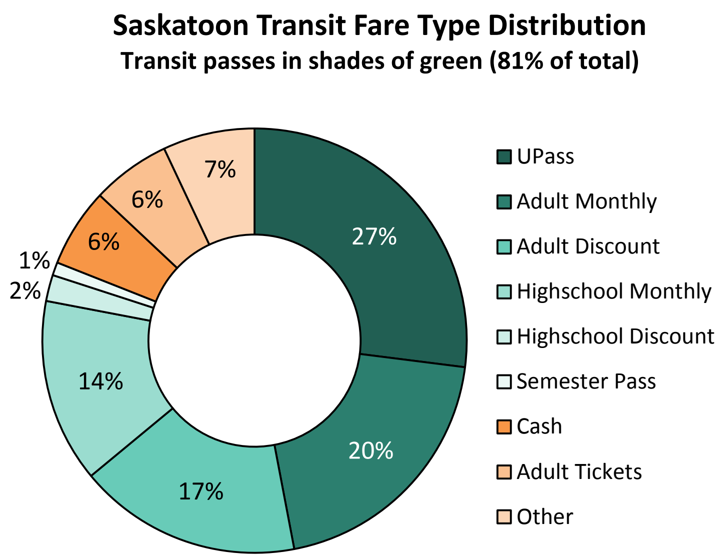

Figure 1-3: Saskatoon Transit fare type distribution; transit passes vs. other methods
Data source: (Saskatoon Transit, 2010)

Thus we can say that, more so than fare media like cash and tickets, which limit the number of rides one can take and are based on a ride-by-ride basis (**restrictive-use**), Saskatoon Transit riders overwhelmingly prefer **unlimited-use** transit passes. These passes allow riders to use transit as many times as they want during the specified time-frame, usually per month or per semester. Another couple of important statistics are that 37% of all riders are pass-holding adults, who therefore make up a very important demographic for Saskatoon Transit; and 27% of all riders are U of S students, who can only use their passes eight months out of the year. Obviously this is an important demographic as well.

With these considerations in mind, we will now investigate the effects that a fare reduction or removal might have on Saskatoon Transit, based on current economic theory, previous research, and case study, beginning in section 2 on the next page.

2 THE EFFECTS OF FARE CHANGES ON RIDERSHIP

This section, the primary one of this report, will explore and discuss the effects that both a fare **reduction** and a fare **removal** would have, or is expected to have, on transit ridership – particularly that of Saskatoon. The basic hypothesis is that a fare decrease has the potential to increase ridership, but the details are impossible to know without analysis, based on both economics and historical precedent.

Appendix 1 introduces the principle of economic elasticity. Most microeconomic theory uses elasticity analysis in the form "price elasticity of demand." We will also use this form, but will refer to it as "fare elasticity of ridership." Fare elasticity of ridership values give us a simple, universal analysis tool for understanding the effects that a fare change would have on the number of people using (or demanding) transit. We will use fare elasticity to investigate the effects of a fare **reduction** only, not a removal. Economic analysis using elasticity falls short in examining effects from a fare removal. The reasons for this are examined in subsection 2.2. For the discussion of a fare **removal**, we will employ academic research, case studies, and historical precedent. See Appendix 2 for an examination of the economic research conducted to date and the basic foundation for our elasticity analysis. Subsection 2.1 below will begin by exploring the effects of a fare reduction.

2.1 FARE REDUCTION

It seems like an easy conclusion to jump to that a fare reduction will increase ridership, but economic prediction using transit fare elasticity can tell us the details. It is the closest method we have to empirical mathematics – but since we are dealing with human behaviour, it of course cannot be perfectly accurate. Nevertheless, it is useful for developing an understanding of basic transit economics. The following discussion will use a variety of different elasticity values employed and developed in previous research within the field to explore the effects of a fare reduction on Saskatoon Transit ridership.

a. SIMPSON-CURTIN

If we take the approach of transit analysts in the mid-late 20th century, we would assume a fare elasticity of ridership of (-⅓), or $-0.\overline{3}$ (Curtin, 1968). This means that any percent change in fare will result in a percent change in ridership that is in the opposite direction and equal to one-third of the original percent change in fare. For example, a transit agency that reduces its fare from $2.50 to $2.00, or by 20%, can expect a ridership increase of 6.667% under the Simpson-Curtin model. See Figure 2-1 below. See Appendix 2 for further explanation.

$$\%\Delta \boldsymbol{F} * \boldsymbol{-0.\overline{3}} = \%\Delta \boldsymbol{R}$$
$$-20\% * -0.\overline{3} = 6.\overline{6}\%$$

Figure 2-1: Simpson-Curtin rule for predicting percent change in ridership

This has been the standard model of predicting ridership change following fare change for many, if not most, (bus) transit agencies for decades. For this reason it has evidently served them well enough. Of course, it is possible that its inaccuracy has gone unnoticed, but it has been used regardless. So, the Simpson-Curtin model will now be employed to explore the effects on Saskatoon Transit ridership from a hypothetical fare decrease.

If we recall subsection 1.2, the current adult cash fare for Saskatoon Transit is $2.75. The model will be applied to a hypothetical reduction of 10% ($0.28), 25% ($0.69), 50% ($1.38), 75% ($2.06), and 90% ($2.48). Of course, these same percentages could also be applied to changes in other fare methods besides cash, such as the adult monthly pass; it is only the percentage that is important. The exact ridership number that will be affected by these changes, as reported by Saskatoon Transit (2010), is 11,509,368 (making Saskatoon's annual ridership per capita 51.31). The population used to determine annual ridership per capita, as estimated by the City of Saskatoon, is 224,300 (City of Saskatoon, 2011).

$-10\% * -0.\overline{3} = 3.\overline{3}\%$
$11{,}509{,}368 + 3.\overline{3}\% = \mathbf{11,893,014}$
53.02 annual rides per capita

$-25\% * -0.\overline{3} = 8.\overline{3}\%$
$11{,}509{,}368 + 8.\overline{3}\% = \mathbf{12,468,482}$
55.59 annual rides per capita

$-50\% * -0.\overline{3} = 16.\overline{6}\%$
$11{,}509{,}368 + 16.\overline{6}\% = \mathbf{13,427,596}$
59.86 annual rides per capita

$-75\% * -0.\overline{3} = 25\%$
$11{,}509{,}368 + 25\% = \mathbf{14,386,710}$
64.14 annual rides per capita

$-90\% * -0.\overline{3} = 30\%$
$11{,}509{,}368 + 30\% = \mathbf{14,962,178}$
66.71 annual rides per capita

Figure 2-2: Simpson-Curtin applied to Saskatoon Transit

The above model is very simplistic, and takes little else into account other than the approximations of transit researchers in the mid-1960s. It has served as a rule of thumb for transit planners and managers for decades, and therefore has likely influenced many major policy decisions (even potentially those of Saskatoon Transit). This is the reason that it is included here.

According to the Simpson-Curtin rule, a reduction in fare ranging from 10% to 90% can generate ridership growth on Saskatoon Transit ranging from 3.333…% to 30%, generating a new total annual ridership of anywhere between **11,893,014** (approximately 53 per capita) and **14,962,178** (approximately 67 per capita). However, according to the more recent findings of both Pham & Linsalata (1991) and Litman (2011), these values are potentially *understating* the impact of a fare change. See Table 2-1 on the next page for the full index of these ridership changes.

b. PHAM & LINSALATA

As stated in Appendix 2, Pham & Linsalata discovered an average fare elasticity of ridership of -0.4, which is 20% higher (in absolute value) than the Simpson-Curtin value. The Pham-Linsalata value can be used to analyze ridership change in Saskatoon in the same way that Simpson-Curtin was used above. For the same fare reductions of 10%, 25%, 50%, 75%, and 90%, Saskatoon Transit would then see ridership growth of 4%, 10%, 20%, 30%, and 36%, respectively, under the Pham-Linsalata model. These percentages would result in new annual ridership levels (and annual rides per capita) of **11,969,743** (53.36), **12,660,305** (56.44), **13,811,242** (61.57), **14,962,178** (66.71), and **15,652,740** (69.78) respectively. See Table 2-1 below for the full index of these numbers.

However, Pham & Linsalata did not intend to simply come up with another value to replace Simpson-Curtin in all transit ridership analysis. They acknowledged significant differences between cities and between hours of the day in terms of these elasticity of ridership values. For example, they found that average elasticity is more responsive (greater in absolute value) in cities under one million population (-0.43) than in those over one million (-0.36) (Pham & Linsalata, 1991). This suggests that we may account for the likelihood of further underestimates by even the predictions in the previous paragraph. Furthermore, the researchers also found that elasticity varied widely between peak and off-peak hours: the average value for peak hour ridership was -0.23, while the average value for off-peak ridership was -0.42 (Pham & Linsalata, 1991). These values for cities with a population under one million were -0.27 at peak-hours, and -0.45 at off-peak hours (Pham & Linsalata, 1991). The latter elasticity value will be used in addition to the universal average of -0.4 to analyze changes to Saskatoon ridership in Table 2-1 and Figure 2-3.

The conclusions of Pham & Linsalata are also supported by the research of Lago et. al., who found that, on average, smaller cities have greater fare elasticities than larger ones, and that off-peak elasticity is typically double peak-hour elasticity (Lago, Mayworm, & Mcenroe, 1981). Together, these sources suggest that Saskatoon could potentially have a much more responsive fare elasticity of ridership than the traditional -⅓ employed by many transit professionals for decades – particularly at off-peak service hours.

		Fare Reduction				
		10%	**25%**	**50%**	**75%**	**90%**
Simpson-Curtin (-0.333…)	R % Increase	3.333…%	8.333…%	16.666…%	25.000%	30.000%
	New R	11,893,014	12,468,482	13,427,596	14,386,710	14,962,178
	New Rpc	53.02	55.59	59.86	64.14	66.71
Pham-Linsalata (-0.4)	R % Increase	4.000%	10.000%	20.000%	30.000%	36.000%
	New R	11,969,743	12,660,305	13,811,242	14,962,178	15,652,740
	New Rpc	53.36	56.44	61.57	66.71	69.78
Pham-Linsalata (-0.45)	R % Increase	4.500%	11.250%	22.500%	33.750%	40.500%
	New R	12,027,290	12,804,172	14,098,976	15,393,780	16,170,662
	New Rpc	53.62	57.07	62.86	68.63	72.09

Table 2-1: Index of ridership changes influenced by fare reductions under the Simpson-Curtin and Pham-Linsalata models
(R = Ridership; Rpc = Ridership per capita; current ridership = 11,509,368)

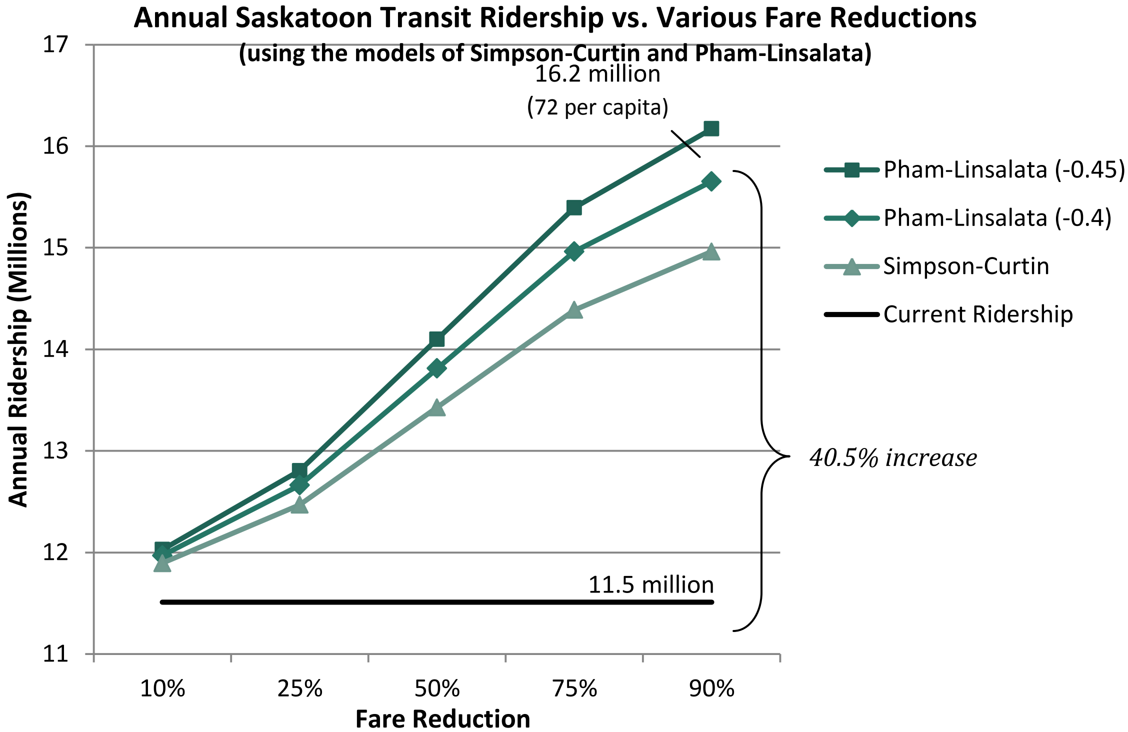

Figure 2-3: Annual ridership vs. fare reduction under Simpson-Curtin and Pham-Linsalata models

Table 2-1 and Figure 2-3 above summarize the ridership predictions made using the models of Simpson-Curtin (fare elasticity of -0.333…) and Pham-Linsalata. Two different Pham-Linsalata models are shown, one being the researchers' universal average fare elasticity (-0.4) and the other being their off-peak average for cities under one million (-0.45). According to these models, Saskatoon Transit could potentially see ridership growth of up to or over 40% following a substantial fare reduction.

However, we must keep in mind that this type of analysis is quite simplistic and assuming, and can in fact convey false accuracy. Single-point elasticity values rarely encompass the entire complexity of urban transit fare and ridership. This was a major finding of Todd Litman, whose conclusions will be discussed in subsection *2.1.c* below.

c. LITMAN

In his research, Litman (2011) found that "commonly-used" elasticity values (referring to both Simpson-Curtin and Pham-Linsalata) tend to understate the actual impact potential of fare changes, as the data used to develop these values is outdated and irrelevant to today's more discretionary riders. Furthermore, he found that single-point values for elasticity were largely inaccurate (i.e. high levels of variability and uncertainty), and that ranges are "preferable" (Litman, 2011, p. 17) for elasticity analysis. Conventional elasticity analysis also primarily "reflect[s] short-run impacts" according to Litman (p. 17), and elasticity values in the long run approach -1.0 (or "unit elasticity" – see Appendix 2, including Figures 6-1 and 6-2).

Litman's conclusions, being based on ranges of elasticity values, are harder to quantify and less quantitatively useful for Saskatoon Transit than the specifics provided by Simpson-Curtin and Pham-Linsalata. However, we can consider his conclusions logically and develop more *qualitative* conclusions of our own. One of his major conclusions is that average universal elasticity of ridership with respect to fare (the value that Simpson-Curtin and Pham-Linsalata calculated as being -0.333… and -0.4 respectively) typically ranges from -0.2 to -0.5 in the short run (one to two years or less), **but in the long run** (five to ten years or more), **this value actually ranges from -0.6 to -0.9, and eventually approaches -1.0** (Litman, 2011), or "unit elasticity," as stated above (see Appendix 2).

Drawing from Litman, we can tentatively conclude a few things:

- Using conventional fare elasticity to predict ridership change is only applicable to the short term, and typically understates actual ridership response in general;
- Long-term policy ought not to be decided based on these short-run conventional models;
- Long-run fare elasticity of ridership approaches unit elasticity, which means that transit fare increases will only increase revenues in the short term, since any change in fare will eventually result in an inversely proportional change in ridership.
  - i.e. 10% increase in fare → 10% decrease in ridership.

Litman summarizes thusly:

> *Transit planners generally assume that transit is price inelastic (elasticity values are less than 1.0), so fare increases and service reductions increase net revenue. This tends to be true in the short-run (less than two years), but long-run elasticities approach 1.0, so financial gains decline over time.*
>
> (Litman, 2011, p. 18)

Litman also comes to one of the same conclusions as Pham & Linsalata and Lago et. al., particularly that elasticity is doubled for off-peak and leisure travel over peak-hour and commuter travel (Litman, 2011). He also finds that elasticity is lower for transit-dependent users, and comments that:

> *In most communities (particularly outside of large cities) transit dependent people are a relatively small portion of the total population, while discretionary riders (people who have the option of driving) are a potentially large but more price sensitive market segment. As a result, increasing transit ridership requires pricing and incentives that attract travelers out of their car.*
>
> (Litman, 2011, p. 17)

Litman's report concludes with a table of recommended elasticity values for varying scenarios. See Table 2-2 on the next page for a partial reproduction of his "Table 15: Recommended Transit Elasticity Values" (2011, p. 18).

	Market Segment	Short Term	Long Term
Transit ridership WRT transit fares	Overall	-0.2 to -0.5	-0.6 to -0.9
Transit ridership WRT transit fares	Peak	-0.15 to -0.3	-0.4 to -0.6
Transit ridership WRT transit fares	Off-peak	-0.3 to -0.6	-0.8 to -1.0
Transit ridership WRT transit fares	Suburban commuters	-0.3 to -0.6	-0.8 to -1.0

Table 2-2: Litman's recommended transit elasticity values

"*This table summarizes recommended values resulting from this study. These values should be modified as appropriate to reflect specific conditions. (WRT= With Respect To)*" (Litman, 2011, p. 18).

Source: "Table 15: Recommended Transit Elasticity Values", Litman 2011, p. 18. (First four rows only)

Figure 2-4 below conveys the ranges of potential ridership growth for various fare reductions in both the long run and the short run under the Litman model (overall market segment). As we can see, Saskatoon annual ridership could potentially reach between 17 and 21 million in the long run following a substantial fare reduction, according to the conclusions made by Litman.

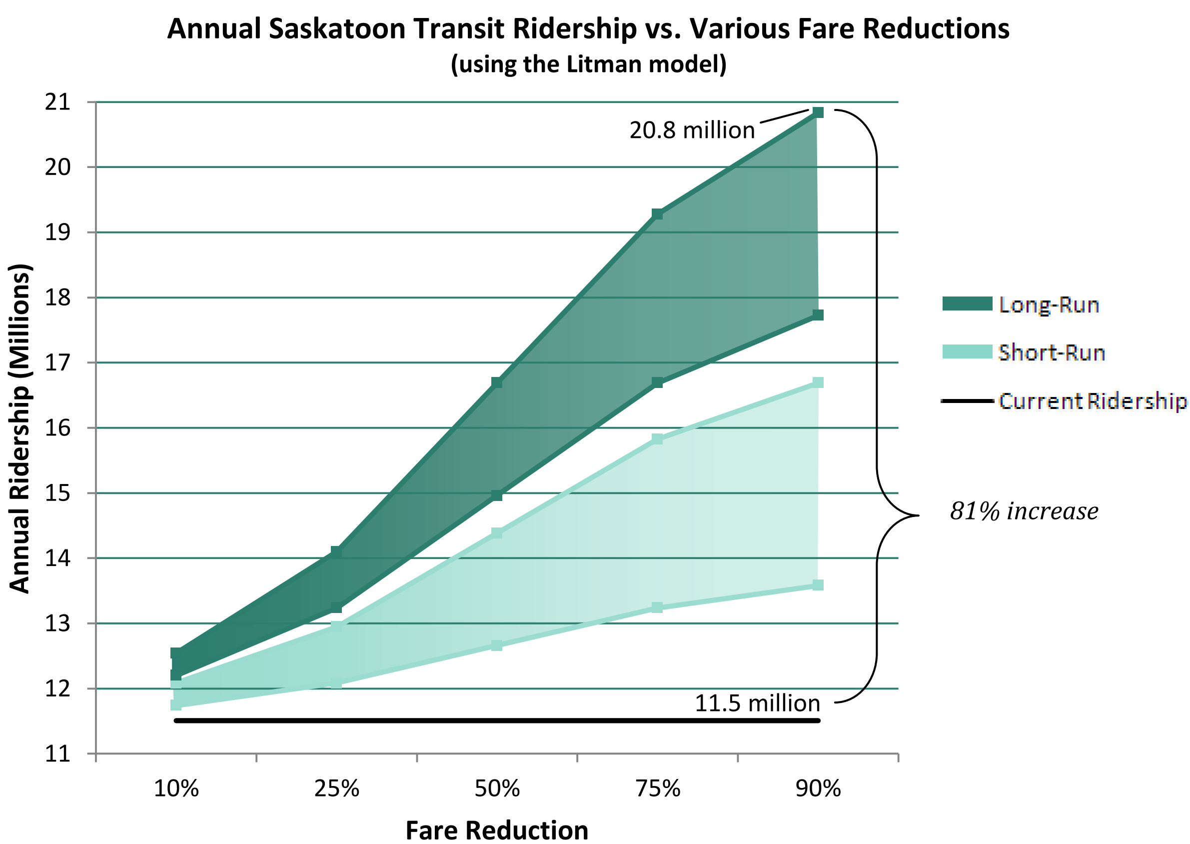

Figure 2-4: Annual ridership vs. fare reduction under the Litman model

2.2 ZERO-FARE

Economic analysis using fare elasticity of ridership is not accurate for discussing a fare-free approach to transit; nor would it be useful. It would simply be an extrapolation of the above data and would not tell us the important considerations of such a policy: namely that an absence of price is different from any price value, even the smallest fraction of a dollar, when dealing with consumer behaviour. Fortunately, we can look back at history and investigate the past research that has been conducted on the subject, as well as the consequences of other transit systems that have experimented with zero-fare.

a. BRUINGO AT UCLA

In a 2003 paper published in *Transportation Research Record*, researchers at the University of California at Los Angeles (UCLA) analyzed the effects of fare-free transit on that school's "BruinGo" transit program (Boyd, Chow, Johnson, & Smith, 2003), which is still in effect today. BruinGo allows students and faculty of UCLA to ride for free by swiping their regular identification card upon boarding the bus. It is not a program paid in advance as a part of regular student fees or by payment deduction like many current post-secondary programs such as Saskatoon's UPass; it is a tab-like system whereby the university is billed – at a discounted rate – for each swipe of a UCLA ID card. Students and faculty who use the system do not personally pay a cent.

Boyd et. al. documented the resulting effects on ridership following BruinGo's implementation and found, among other things, that "providing fare-free transit … did, in fact, increase transit ridership and decrease … reliance on the automobile" (Boyd et. al., 2003, p. 101). The year that BruinGo was implemented, ridership increased by over 50%, and more than 1,000 fewer daily automobile trips to campus were made (Boyd et. al., 2003). Survey respondents also claimed to have "used public transit more often for all facets of their lives including work and personal trips" (Boyd et. al., 2003, p. 108).

The fare-free BruinGo program at UCLA has proven successful for increasing ridership. However, certain discrepancies must be acknowledged that might suggest that this may not be a "true" zero-fare system, particularly that the BruinGo program only applies to UCLA students and faculty, and that the transit system on which BruinGo operates is not providing services for free, as UCLA pays for each trip. The fact remains that this system did get more UCLA members (particularly students) riding transit, but there is no telling whether or not it is because of its fare-free nature, or because of its school-based partnership providing members of the university an incentive to ride. This program might in fact be more closely related to a post-secondary discount pass program (such as the UPass program in Saskatoon) than a strictly zero-fare program, and thus speaks to the success of those programs.

b. DUKE UNIVERSITY–DOWNTOWN ROUTE IN DURHAM, NORTH CAROLINA

The transit agency serving the city of Durham, North Carolina, USA (Durham Area Transit Authority, or DATA) provides a fare-free route between that city's Duke University and the downtown core. (This fact, along with the others providing the basis for the discussion below, was learned through a telephone interview conducted with a manager at said agency in June 2011.)

The fare-free line that DATA provides between Duke University and downtown Durham sees very high ridership – up to 2,000 rides per day (Interview, DATA, 2011). Along the way are many popular activity centres such as movie theatres, performing arts centres, and the like. Duke University recently built offices in downtown Durham, so many members of the university community use the service to travel back and forth between these offices and the main campus. It is, however, open to the general public and is not restricted only to university members, unlike the BruinGo program at UCLA discussed above. It is subsidized by the university and by the City of Durham through a major partnership, and is also supported by an exclusive advertising contract with the businesses of downtown Durham.

This limited zero-fare service has proven to be successful in itself for the city of Durham, with up to 2,000 people on average using it daily. However, despite this not-unsubstantial boost in overall ridership numbers, it remains to be seen whether the zero-fare service actually attracts people to using the standard Durham transit system as well.

c. VOBORA, 2008 (LANE TRANSIT DISTRICT)

In 2008, Andy Vobora, Director of Service Planning, Accessibility, and Marketing at Lane Transit District (Lane County, Oregon, USA) composed a report investigating the feasibility of a zero-fare program on that transit system. He explored the costs associated with the implementation of such a program, as well as the impacts it would have on existing services at Lane Transit District. The report is, of course, specific to the transit system of Lane County, and involves cost predictions specific to their budget. Vobora finds that the cost of implementation would likely range between $4.5 million and $5 million annually (Vobora, 2008, p. 2).

Meanwhile, Vobora predicts that existing services would be negatively impacted, mainly due to the above revenue losses. He claims that bus service hours would have to be reduced by 20 percent, and that a "20 percent reduction of service hours would require a restructuring of how service is delivered, and it is likely that neighborhood coverage would be significantly reduced" (Vobora, 2008, p. 3). This quickly leads to the conclusion that: "considering that current operations would be severely impacted, LTD staff do not recommend the implementation of a fare-free system" (Vobora, 2008, p. 4). However, Vobora points out that "should subsidies become available … the implementation of a fare-free system should be re-examined" (2008, p. 4).

d. PERONE, 2002

Center for Urban Transportation Research graduate research assistant Jennifer Perone explored the *advantages and disadvantages of fare-free transit policy* in a report of the same name for the National Center for Transportation Research in Tampa, Florida in 2002. She studied a multitude of transit systems of varying sizes around the United States with the intent of collecting information and first-hand knowledge of various zero-fare programs. One of her most significant findings is quoted on the next page.

> *A fare-free policy will increase ridership; however, the type of ridership demographic generated is another issue. In the fare-free demonstrations in larger systems reviewed in this paper, most of the new riders generated were not the choice riders they were seeking to lure out of automobiles in order to decrease traffic congestion and air pollution. The larger transit systems that offered free fares suffered dramatic rates of vandalism, graffiti, and rowdiness due to younger passengers who could ride the system for free, causing numerous negative consequences. Vehicle maintenance and security costs escalated due to the need for repairs associated with abuse from passengers. The greater presence of vagrants on board buses also discouraged choice riders and caused increased complaints from long-time passengers. Furthermore, due to inadequate planning and scheduling for the additional ridership, the transit systems became overcrowded and uncomfortable for riders. Additional buses needed to be placed in service to carry the heavier loads that occurred on a number of routes, adding to the agencies' operating costs. However, the crowded and rowdy conditions on too many of the buses discouraged many long-time riders from using the system as frequently as they did prior to the implementation of free-fares.*
>
> (Perone, 2002, p. 4-5)

Through her research, Perone found that, while zero-fare programs do increase ridership by their very nature, as is expected, they also tend to increase levels of rowdiness, vandalism, vagrancy, and overcrowding. These things (which also increase maintenance costs) tend to discourage current and potential users who are discretionary, or otherwise respectable and civil. Judging by Perone's findings, there are no benefits to a fare-free program other than an increased ridership, which evidently is not always guaranteed to be a good thing. On increasing "choice" ridership, Perone comments:

> *Additionally, the results of this research demonstrate that a more effective way to increase choice ridership in larger systems would be to offer incentives such as reduced fares to students and the elderly, all-day passes, or pre-paid employer-provided passes to workers in areas served by transit. All well-informed transit professionals that were contacted for their opinions spoke strongly against the concept of free fares for large systems, suggesting some minimal fare needs to be in place to discourage vagrancy, rowdiness, and a degradation of service. It is also concluded that people are more concerned about issues such as safety, travel time, frequency and reliability of service, availability and ease of schedule and route information, infrastructure at stops, and driver courtesy, than they are about the cost of fares. When fares are eliminated, substantial revenues that help pay for such service characteristics are lost.*
>
> *(Perone, 2002, p. 5)*

e. CERVERO, 1990

In a 1990 journal article published in *Transportation*, Robert Cervero performed a review and synthesis of various transit pricing research up to that time. His research spanned a wide range of transit issues, but included an investigation of zero-fare policy. His conclusions are similar to Perone's discussed above. He concluded that "free fare programs have proven quite costly for each new transit user attracted and have rarely lured motorists to transit" (Cervero, 1990, p. 117). After reviewing the research to date, Cervero comments:

> *Research showed that besides eliminating revenues, free fares resulted in poor schedule adherence (because of less predictable on-off patterns and the emergence of high load points), increased driver-user confrontations, more incidences of rowdyism, and little noticeable effect on regional traffic conditions. … While free systemwide fares might be used on a short-term, selective basis as a promotional tool, researchers concluded that they were a poor way of capturing mass transit's purported social benefits.*
>
> (Cervero, 1990, p. 130-131)

However, Cervero found that among the zero-fare transit systems in his analysis, the ones that are "limited to downtown cores have generally fared better", with "patronage [increasing] by over 300 percent [in one case] following the elimination of … fare for trips made within downtown" (Cervero, 1990, p. 131).

f. SUMMARY

A system-wide fare elimination does not appear to be a wise endeavour for transit agencies (save perhaps for the very small and homogenous) to implement, as per Cervero and Perone (who commented on the reduced quality and lowered ability to attract commuters and motorists that occurs as a result) and Vobora (who commented on the increased cost and loss of revenue, which in turn results in reduced service quality). ***For Saskatoon Transit, a zero-fare system is not recommended, especially if the desire is to increase the ridership of commuting adults and attract motorists out of their cars.*** As will be discussed in section 3, there are many other factors that come into play that can have a significant impact on the average person's transportation decisions.

However, it must be acknowledged that a zero-fare program could potentially be successful in a limited or isolated manner, such as within the downtown only (see Cervero, 1990), or a single line between two major nodes (Durham's Duke University-downtown line). While a global zero-fare system ought to be dismissed outright based on the conclusions discussed above, the potential for a limited and plainly distinct zero-fare system within certain geographic bounds, separate from standard transit operations, could be considered.

3 OTHER SIGNIFICANT IMPACTS ON RIDERSHIP

It seems like a safe assumption that a change in transit fare will have an effect on ridership, and even that a fare reduction will necessarily increase ridership. The economic analysis used in the previous section would support this. However, there are other factors at play in the real world that can have an equally significant impact on ridership. Furthermore, transit fare may not possess the level of influence over ridership one might assume, especially when compared to other factors, some of which are potentially much more influential.

3.1 TRANSIT QUANTITY (SERVICE COVERAGE & FREQUENCY)

Taylor & Fink (2003) define the quantity of transit service to refer to things such as service coverage and service frequency. The authors, following their research to investigate various factors influencing ridership, found these quantity factors of transit "to be even more significant than the fare and pricing variables" (2003, p. 12). In a later article investigating the impacts of external vs. internal factors on transit ridership, the same authors found again that service frequency (an internal, quantitative factor) was a major determinant of ridership (Taylor, Miller, Iseki, & Fink, 2008).

Thompson & Brown (2006) independently found that "service coverage and frequency are the most powerful explanatory variables for variation in ridership change" (p. 172). Their study focused on explaining variations in American ridership in the 1990s. One of their main hypotheses was that "[cities] whose transit agencies had better service coverage (a lower ratio of population to route miles) would enjoy patronage gains", and their models proved this to be true (2006, p. 179). Meanwhile, they also hypothesized that "[cities] whose transit agencies delivered more frequent service on their routes would enjoy patronage gains", and this was also proven to be true (2006, p. 178).

3.2 TRANSIT QUALITY (AVAILABILITY/CONVENIENCE & TRAVEL TIME)

Taylor & Fink (2003) also found that "the ***quality*** of service … is more important in attracting riders than changes in fares ***or*** the quantity of service" (p. 12; emphasis added). "In other words, riders are more attracted by service improvements than fare decreases" (Taylor & Fink, 2003, p. 12).

Swimmer & Klein (2010) define *service availability* as a measure of the convenience of public transit. Through econometric analysis, they came to the very significant conclusion that "availability trumps price as a policy variable" in encouraging transit ridership (2010, p. 45). In fact, they discovered that the "availability coefficient" they developed, when applied to ridership, is approximately 1: "an increase, say, of 10% in availability would be expected to increase ridership by 10%" (2010, p. 45). This "availability coefficient" can be roughly thought of in the same way as the elasticity values employed in this report in section 2, but instead of being "fare elasticity of ridership," it is "availability elasticity of ridership" – and it is a positive value, indicating that growth in availability causes growth in ridership.

Referring back to the multi-faceted transit pricing research of Robert Cervero (1990) as in subsection *2.2.e* above, another one of his major findings was that “people respond more to service improvements than they do to fare discounts” (p. 135). Additionally, Cervero finds that “riders are approximately twice as sensitive to changes in travel time as they are to changes in fares” (1990, p. 117). He purports that agencies should focus less on fare changes and more on offering “premium” quality service, for which some customers “are willing to pay a premium fare” (1990, p. 135).

As quoted in subsection *2.2.d* (page 14 above), Perone (2002) supports both transit quality as well as transit quantity as significant determinants of ridership with the conclusion that “people are more concerned about issues such as safety, travel time, frequency and reliability of service, availability and ease of schedule and route information, infrastructure at stops, and driver courtesy, than they are about the cost of fares” (p. 5).

3.3 PRIVATE AUTOMOBILES

Several independent researchers have come to the conclusion – in support of general intuition – that the competitive edge of the automobile, or the costs associated with it, is a major determinant of transit ridership (Cervero, 1990; Taylor & Fink, 2003; Litman, 2011).

Cervero (1990) investigated the relationship between automobile pricing and costs vs. transit pricing and found that “higher automobile prices would have a significantly greater effect on ridership than lower fares” (p. 117). Additionally, automobile travel is so underpriced relative to its costs (both internal and external), that “transit fares have been ineffective, almost trivial, tools for inducing modal shifts in travel” (Cervero, 1990, p. 136).

Taylor & Fink (2003) found that “the utility of private vehicles and the wide array of public policies in the US which support their use explain more of the variation in public transit patronage than any other family of factors” (p. 13). Some of the public policies that support automobile use and by association discourage transit use, according to Taylor & Fink, are: “extensive arterial and freeway systems, relatively low motor fuel taxes, [and policies] which require parking to be provided to satisfy all demand at a price of zero” (2003, p. 13). The authors also acknowledge that the private automobile has a level of convenience and utility that public transit cannot easily match, particularly “spatial and temporal flexibility” (p. 13); and for these reasons combined, it is a major determinant of ridership.

Litman (2011) also acknowledges the convenience of the automobile as being a major disincentive for transit use. He comments that motorists (who are discretionary transit riders) “may be more responsive to service quality (speed, frequency, and comfort), and higher automobile operating costs through road or parking pricing” than non-discretionary riders (2011, p. 17).

3.4 OTHER EXTERNALITIES

One may begin to wonder if there are other externalities aside from the private automobile that could have an impact on ridership. One hypothesis is that perhaps urban form can play a role; i.e. are those who live far outside of the core urban area, in distant suburbs, less likely to ride? Thompson et. al. (2006) would argue against this with their finding that transit use was in fact growing in expanding and sprawling urban areas in 1990s America.

What of weather or seasonal impacts? Guo et. al. (2007) investigated the impacts that weather and climate can have on transit ridership in Chicago, Illinois and found that “in general, good weather tends to increase ridership, while bad weather tends to reduce it. However, it is still possible that extremely bad weather … may increase ridership because some drivers are likely to switch to transit in these situations” (p. 9).

4 CONCLUSIONS

This report has explored the effects of a reduced- or zero-fare policy on transit ridership in general and on the ridership in Saskatoon. The long-time (and arguably outdated) industry standard for predicting ridership change following fare change (known as the Simpson-Curtin rule) was employed first, followed by more recent and up-to-date methods. Next, the effects and consequences of a complete fare removal were explored, largely based on research and precedent. And finally, it was found that transit fare is not the biggest deciding factor of ridership, especially in terms of attracting discretionary riders.

4.1 FARE REDUCTION

The economic analysis employed in subsection 2.1 has discovered a wide range of possible ridership increases in Saskatoon under various models. For a fare reduction between 10% and 90%, each model predicts the following growths in ridership:

- The **Simpson-Curtin model** predicts a ridership growth of between 8.333% and 30%.
- The **Pham-Linsalata model**, for the universal average elasticity of -0.4, predicts a growth in ridership of between 4% and 36%. For the off-peak elasticity in cities under one million population (-0.45), the Pham-Linsalata model predicts a growth of between 4.5% and 40.5%.
- The **Litman model**, in the short run (1-2 years or less), predicts a ridership growth of between 2%–5% (average of 3.5%) and 18%–45% (average of 31.5%). In the long run (5-10 years or more), the Litman model predicts a growth of between 6%–9% (average of 7.5%) and 54%–81% (average of 67.5%).

For full details of these predictions, see subsection 2.1 above, including Figure 2-2 (page 7), Table 2-1 (page 8), Figure 2-3 (page 9) and Figure 2-4 (page 11). See Appendix 4 for a set of equations that can be used for customized future analysis of ridership change following any percentage fare change, not just the five examples used in this report (10%, 25%, 50%, 75%, and 90%).

4.2 FARE REMOVAL

Research and case studies that have been conducted to date do not recommend a complete system-wide fare removal simply in the interest of ridership (Cervero, 1990; Perone, 2002; Vobora, 2008). A zero-fare transit system does see a significantly increased ridership, but it is often not “choice” ridership, as defined by Perone (2002). Levels of vandalism, rowdiness, vagrancy, and abuse tends to increase sharply following a universal fare removal. Additionally, these increases in negative characteristics also tend to discourage potential and current riders who are otherwise civil and respectable. It comes as no surprise that there are currently no zero-fare transit systems in the United States (Perone, 2002).

However, the occasional success of limited-area transit systems with zero fare must be acknowledged. These limited-area systems are often restricted to just the downtown core (Cervero, 1990), or to a single line running between two popular nodes (Interview, Durham Area Transit Authority, 2011). They are noticeably separate from standard transit operations, have typically had high patronage, and can be subsidized through initiatives like advertising contracts (such as in Durham).

4.3 OTHER CONSIDERATIONS

There are many factors besides fare that can have a significant impact on ridership. In most cases, in fact, these factors are ***more*** influential than fare for determining ridership. Some of these factors outlined by past research and observation include service frequency, service coverage, service improvements, availability/convenience, travel time, and general good-quality transit service. The utility and overall cost of automobiles also has a significant impact on ridership, whereby if auto use is subsidized or treated preferentially, it can negatively impact ridership, and if it is priced higher or treated disadvantageously, it can positively impact ridership. There has also been some research that suggests that unpleasant weather can decrease ridership while good weather can increase it.

4.4 FUTURE RESEARCH & RECOMMENDATIONS

This report has focused primarily on the ridership effects of fare reduction, without going too much into the other factors that were discussed as being equally if not more significant for affecting ridership. Future applied research (meaning not strictly academic research) conducted on various things affecting transit ridership levels ought to consider ***all*** factors with this potential, especially if the research is to lead to actual transit policy consideration.

Fare certainly has an impact on ridership, but it is misguided to consider fare as the ***only*** thing influencing ridership. It is also not unreasonable to claim that fare is actually rather ***insignificant*** in this respect when compared to other factors such as general service quality, convenience, and frequency, things which some research has suggested are much more potent – especially for attracting new riders from out of their cars.

A few general recommendations for Saskatoon Transit can be formulated from the research in this report. Briefly, they are as follows:

- Dismiss considerations of a system-wide zero-fare program. Research has plainly shown that they are unsuccessful and detrimental to the overall quality of a transit system.
    - However, do not outright dismiss the eventual possibility of a ***limited*** zero-fare program, such as within the downtown core, or between the University and the downtown.
- Consider fare reductions seriously and carefully in the interest of an increased ridership.
- Do not rely on fare increases in the interest of long-term revenue gains.
- Keep in mind that general quality of service, convenience, and availability all trump any consideration of fare – especially for the ridership of discretionary riders and commuters.
    - i.e. A better value for money is much more important than the money itself.

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6 APPENDICES

APPENDIX 1: INTRODUCTION TO ECONOMIC ELASTICITY

Fundamental to an analysis of the effects of transit fare change is an economic principle known as *elasticity*. Most broadly, elasticity is a ratio that denotes the reacted change in one economic variable to a change in another, with everything else held constant (O'Sullivan, 2009). In other words, and in the context of this report, it is the percent change in demand resulting from a one percent change in price, all else held constant (Litman, 2011). An elasticity of 1 implies that any change in price will result in a directly proportional change in demand, in terms of percentage; while an elasticity of -1 implies that any change in price will result in an *inversely* proportional change in demand. Price elasticities for almost all goods and services (including transit) are negative, meaning that generally an increase in price will decrease overall demand, and vice versa. Very few goods have positive elasticity values.

In economics, a good or service can be referred to as "elastic" or "inelastic." Elastic goods have an elasticity with an absolute value greater than 1, while inelastic goods have an elasticity with an absolute value lower than 1. Elastic goods – those whose demand levels respond *more* dramatically to a change in price than the price change – tend to be those goods that are readily available, easily supplied, and easily substituted for similar goods, such as food staples and agricultural commodities. There are generally a large number of producers and suppliers dealing with these goods, and monopolistic market dominance is nearly impossible. Inelastic goods, on the other hand, tend to be those goods that are more rare or harder to come by, or have few suppliers. The two extreme ends of the spectrum are *perfectly elastic* and *perfectly inelastic* – absolute elasticity values of *infinity* and *zero*, respectively. The former implies that any change in price whatsoever will cause complete loss of demand, and the latter implies that demand will remain constant regardless of any change in price. Few goods are ever perfectly elastic or inelastic, but many get very close.

Public transportation has been evidenced to be an *inelastic* good (Curtin, 1968; Cervero, 1990; Pham & Linsalata, 1991; Kohn, 2000; Litman, 2011). The elasticity values of ridership with respect to fare ("fare elasticity of ridership") for various public transit agencies in various regions at various times have tended to exist between 0 and -1, meaning that ridership generally decreases with increased fare (as is expected), but proportionally not as much as the fare increase. To provide a hypothetical example, a transit agency with a fare elasticity of ridership of -0.5 will see a decrease of 5% in ridership following a 10% fare increase.

Like many models in microeconomics, this is a very generalized analysis, with all other factors held constant, and usually only considers the short-term. Rarely does the real world accurately follow the models engineered and executed within the vacuum-sealed laboratory of economic theory, even if correct elasticity values are known (which is another story in itself). This type of analysis does, however, help to better illustrate the most basic effects of transit economics.

APPENDIX 2: PREVIOUS RESEARCH – ELASTICITY

Previous research on the subject has found public transit to be an *inelastic* good (Curtin, 1968; Cervero, 1990; Pham & Linsalata, 1991; Kohn, 2000; Litman, 2011), which, as explained in Appendix 1*,* means that demand (ridership) changes by some fraction of a percent and in the opposite direction for every one-percent change in price (fare). Transit agencies tend to have fare elasticity of ridership values between 0 and -1.

a. THE SIMPSON-CURTIN RULE

For decades, the prevailing opinion on fare elasticity of (bus) ridership has been that elasticity, as a rule of thumb, is -0.333… (i.e. a one-percent increase in fare will reduce ridership by a third of a percent); this is referred to as the Simpson-Curtin rule (Curtin, 1968; Cervero, 1990; Pham & Linsalata, 1991; Litman, 2011). While it is generally not used for rail transit as rail elasticity is typically less responsive, especially in larger centres (Litman, 2011), it has been the industry standard for predicting bus ridership change; it is still used today in some modern economic textbooks (O'Sullivan, 2009, p. 286). It has proven to be useful in rough approximations over the decades, and is still used by some transit planners today when predicting ridership change (Personal communication, London Transit Commission, 2011). If this were not the case, it would have been forgotten long ago. As such, its place in transit analysis will not be overlooked in this report, but it has come under rather critical review as of late; and there are many more options, arguably more accurate, for predicting effects on ridership. See Appendix 3 for an index of predicted changes vs. actual changes to historical Saskatoon ridership.

b. EVOLUTION OF THEORY

In 1991, a full two decades following the publishing of the Simpson-Curtin rule, Pham & Linsalata attempted a general approximation of ridership loss following a fare increase to dispute the outdated and inaccurate Simpson-Curtin rule in a paper published by the *American Public Transportation Association*. They concluded that not only does the impact of a fare change vary between cities and between peak and off-peak times, but the average elasticity is higher than previously believed (Pham & Linsalata, 1991). The authors found an average elasticity value, across all city sizes and service hours, of -0.4, 20% higher (in absolute value) than the Simpson-Curtin rule. They also analyzed variances in elasticities and found that, on average, smaller cities tended to be more responsive to fare changes, as did users at off-peak hours. See Appendix 3 for predicted and actual changes to Saskatoon ridership.

However, the work of Pham & Linsalata is also now becoming dated. In a 2004 *Journal of Public Transportation* paper that was updated with new data and re-published in 2011 for the *Victoria Transport Policy Institute*, Todd Litman performed a review and critique of a wide range of transit elasticity research conducted up to that time (Litman, 2011). He commented that "the Simpson-Curtin rule … can be useful for rough analysis but it is too simplistic and outdated for detailed planning and modeling" (Litman, 2011, p. 6). He then goes on to say that Pham and Linsalata's findings were based on data from the late 1980s – "when a larger portion of the population was transit-dependent" (p. 6) –

and that they are based on short-run impacts; because of this, he claims that "[their elasticity] values probably understate the long-run impacts of current price changes" (p. 6).

After extensive research review, Litman concludes that no elasticity value can act as an accurate predictor for all transit agencies in all situations. He acknowledges that there are many factors that can impact responsiveness to fare change, and it is too complex to simplify with a single value. One of his primary concerns is the inaccuracy of using single-point values for elasticities, which are less preferable than ranges. Another of his concerns is that there is a significant difference between short-run and long-run impacts. Based on the evidence he presented, he concluded that elasticities in the short-run (one year or less) can range from -0.2 to -0.5, and in the long run (5-10 years or more), can increase to between -0.6 and -0.9 (Litman, 2011, p. 17). Furthermore, Litman posits that long-run fare elasticities of ridership approach -1 ("unit elasticity," or the critical point at which marginal revenue from an increased price drops to zero), and because of this, it is not generally wise to simply increase fare in hopes of long-term revenue gains (2011, p. 18). See Figures 6-1 and 6-2 below, both in reference to a hypothetical transit agency over the same period of time, for graphical representations of these conclusions. A graph similar to Figure 6-1 can be found as "Figure 2: Dynamic Elasticity" in (Litman, 2011, p. 5).

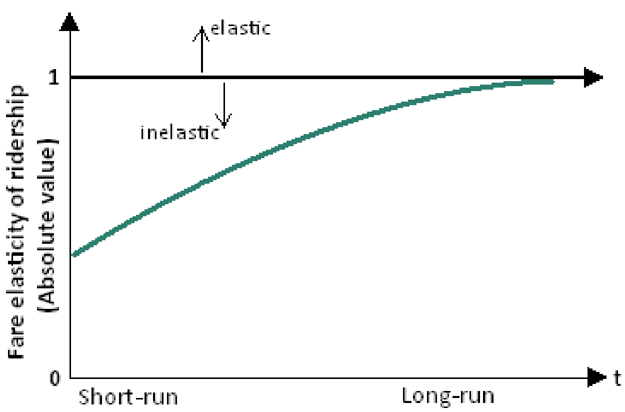

Figure 6-1: Fare elasticity of ridership approaching -1 in the long run

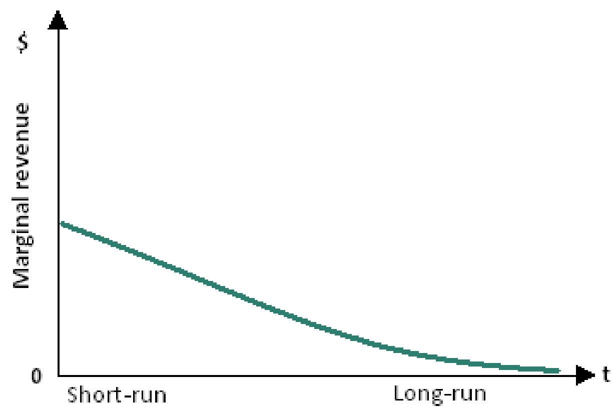

Figure 6-2: Marginal revenue approaching 0 simultaneously

Figures 6-1 and 6-2 based on conclusions in (Litman, 2011)
See similar: "Figure 2: Dynamic Elasticity", Litman 2011, p. 5.

Figures 6-1 and 6-2 above are exaggerated and generalized to illustrate Litman's conclusions, and their measures are not to scale. The important lesson to take away from them is that the fare elasticity for a transit agency approaches unit elasticity in the long-run; and as it does, marginal revenue from fares approaches zero (Litman, 2011).

Litman's work will be taken as the most accurate and up-to-date information in the field thus far. This information will be used to speculate on the effects on ridership from a fare reduction more so than a fare removal, as it is more realistically applicable to the former; case studies and historical data are best for analysis of the latter. The reasons for this are discussed in subsection 2.2.

APPENDIX 3: PREDICTED VS. ACTUAL RIDERSHIP CHANGES IN SASKATOON

The table below indexes historical fare and ridership data for Saskatoon Transit, and uses the models of Simpson-Curtin and Pham-Linsalata to predict hypothetical ridership changes for each fare change. The actual ridership change is provided for each year as a comparison. The inaccuracy between the predicted and actual changes is largely a reflection of other externalities influencing ridership.

				Predicted Ridership Change		Actual R'ship Change
Year	Fare	Ridership	Fare Change	Simpson-Curtin	Pham-Linsalata	
2004	$2.00	8,882,406				
2005	$2.10	8,700,000	5.00%	-1.67%	-2.00%	-2.05%
2006	$2.25	9,046,858	7.14%	-2.38%	-2.86%	3.99%
2007	$2.25	10,598,353	0.00%	0.00%	0.00%	17.15%
2008	$2.50	11,141,672	11.11%	-3.70%	-4.44%	5.13%
2009	$2.50	11,579,606	0.00%	0.00%	0.00%	3.93%
2010	$2.75	11,509,368	10.00%	-3.33%	-4.00%	-0.61%

Table 6-1: Predicted ridership changes vs. actual changes for historical Saskatoon Transit data

Data source: Saskatoon Transit

APPENDIX 4: USING THE MODELS FOR FUTURE ANALYSIS

Customized predictions with various fare changes can be made using the following equations, where R is current ridership, R' is new ridership, $\%\Delta F$ is percent change in fare (in standard percent form, not decimal form), and $\%\Delta R$ is percent change in ridership (again in standard form).

Simpson-Curtin:	$\%\Delta R = -\frac{1}{3} * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Pham-Linsalata (universal average):	$\%\Delta R = -0.4 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Pham-Linsalata (smaller city average):	$\%\Delta R = -0.43 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Pham-Linsalata (smaller city peak-hour):	$\%\Delta R = -0.27 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Pham-Linsalata (smaller city off-peak):	$\%\Delta R = -0.45 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Litman (short-run lower bound):	$\%\Delta R = -0.2 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Litman (short-run average):	$\%\Delta R = -0.35 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Litman (short-run upper bound):	$\%\Delta R = -0.5 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Litman (long-run lower bound):	$\%\Delta R = -0.6 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Litman (long-run average):	$\%\Delta R = -0.75 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$
Litman (long-run upper bound):	$\%\Delta R = -0.9 * \%\Delta F$	$R' = \left(\frac{\%\Delta R}{100} * R\right) + R$