WILL CYCLISTS USE IT? APPLYING REGRESSION MODELS FROM NCHRP REPORT 941 TO SCORE CYCLING ROUTES FOR COMFORT, SAFETY, AND WILLINGNESS TO TRY

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1 Introduction

The Covid-19 pandemic has significantly altered they way most people go about their daily lives and their travel behaviour. The pandemic brought out a proliferation in bicycle sales due to a heightened anxiety and reduction in hours of public transportation, as well as a surge in exercise (Cusack, 2021). There have been large increases in cycling on off-road recreational greenways but declines in cycling in and to commercial areas and university campuses (Buehler & Pucher, 2021). Even before the pandemic, many relied on bicycles as their mode of transportation. Smaller cities have had a growing interest in developing their active transportation (AT) networks, but effectively estimating potential user demand remains elusive.

This paper profiles an application of regression models found within NCHRP Report 941 *Bicyclist Facility Preferences and Effects on Increasing Bicycle Trips* to estimate cyclists' perception of comfort, safety, and willingness to try of routes based on an assessment of physical roadway characteristics. Using this method, AT route segments in Saint John, New Brunswick were evaluated in attempt to quantify these three factors and estimate how select infrastructure improvements would impact rider experience.

2 Background

The City of Saint John has been working on developing an active transportation plan for the city. The cycling strategy development in the MoveSJ plan identified areas of high potential for cyclists across the city for both high potential routes and the Trans-Canada Trail route. It was assumed the demand for cycling routes is dependent on the experience level of the cyclists, the purpose of the trip and the cycling infrastructure itself. The issue is that there has not been a study on which cycling infrastructure meets the needs of various user types and what those demands will be.

The current city plan used The Ontario Traffic Manuel (OTM) Book 18 Facility Selection Process to determine the proposed cycling infrastructure (IBI Group, 2019). This pre-selection nomograph was used to determine the minimum desirable facility class for each route in the plan based off the average daily traffic volume and the 85th percentile motor vehicle operating speed (See Figure 1). According to OTM, perceptions of cyclists' safety and comfort are critical factors in motivating and deterring people from cycling. Bicycling facilities were classified into two types: separate and unseparated. It is shown that the higher the speed, the more distance is needed between the cyclist and vehicles, as well, the greater the volume, the greater the chance of collisions.

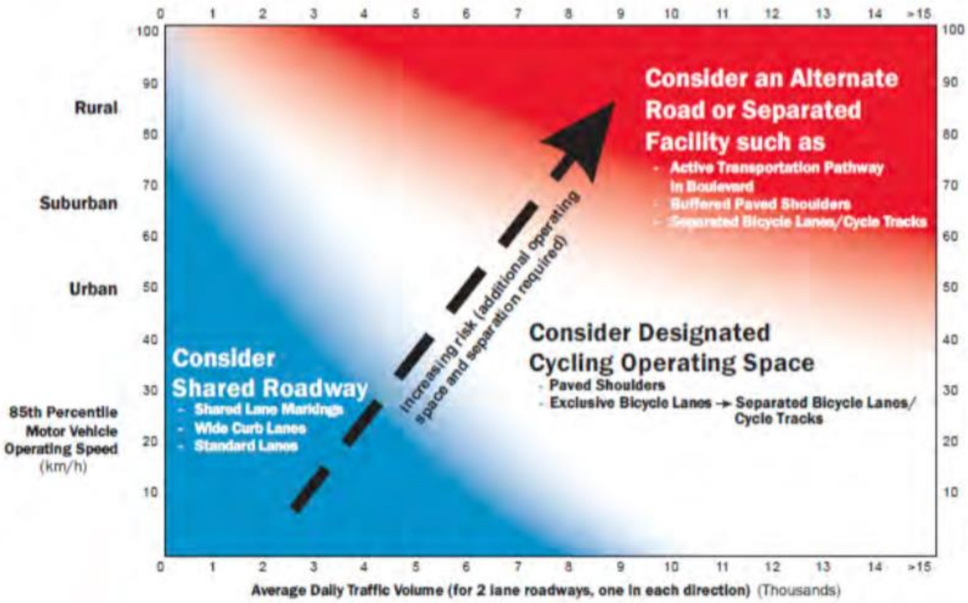

Figure 1: Cycling Facility Nomograph (IBI Group, 2019)

The objective of the NCHRP 941 report is to understand how current and potential cyclists respond to different types of cycling facilities in attempt to get a better understanding and quantification of demand. Data were collected to outline how current and potential cyclists perceive different types of cycling facilities. Previous research focused on areas where bicycling is more prevalent and this report focuses on areas where cycling for transportation is relatively low, comparably to Saint John. Focus groups were chosen from six different communities and the participants had a variety of demographics, cycling experience, and rider frequency range of "never" to "frequent". This survey measured preferences for facility types regarding comfort, safety, and willingness to try. Images were shown to participants using one common roadway setting as a base image to control for urban environment, weather, and other contextual variables. Variations were based on different types of bicycles facilities, the presence or absence of on street parking, and the number of automobile lanes. Each image displayed cycling and automobile interaction. Four different versions of cycling facility images were prepared and include shared lanes, bike lanes, buffered bike lanes, barrier- protected bike lanes, and multiuse paths.

For each image, respondents were given a prompt: "Bicycling on a road (trail) like this is…" with the sentence being completed in each of three ways: "comfortable", "safe" and "something I'd try". For each perception, they were asked to choose the most appropriate response on a 5-point scale (completely disagree, disagree, neutral, agree and completely agree, with 1 being "completely disagree" and 5 being "completely agree"). The distribution of the responses demonstrates that the degree of agreement increases with each degree of separation from traffic and decreases with addition of on-street parking. Comfort, safety, and willingness to try all improved for each increased degree of separation provided by the bicycle facility types, indicating a positive benefit associated with separation from moving and parked cars. Parking and traffic lane characteristics were influential in shaping perceptions of the layouts.

Linear regression models were built using the multiple responses for comfort, safety, and willingness to try (See Table 1). Dummy variables for each infrastructure type, along with the presence of on-street parking and additional lanes of traffic were included in the models. An issue that resulted from the design was the emergence of framing effects. Each version of the survey had a logical sequence of four images based on a common lane configuration, along with two out of sequence images. Each image received different responses based on the sequence of the images shown. This introduced the framing effects. Most images when compared to the preceding images, changed by only one variable (facility type, parking, and number of automobile lanes), but some were changed by two variables (such as change in facility type and addition of parking). The framing effects show sensitivity to the comparative removal of a perceived negative aspect (parking or an additional travel lane) that is not explained by the variables indicating the absence of that aspect alone. The roadway characteristics (parking and four lanes) variables represented the effects of roadway characteristics.

Table 1: Linear Regression for Expressed Comfort, Safety and Willingness to Try (NCHRP Report 941, 2020)

Variable	Comfort			Safety			Willingness to Try		
	Coefficient		P	Coefficient		P	Coefficient		P
Constant	2.90	***	<0.001	2.62	***	<0.001	2.82	***	<0.001
Bicycle Facility Types									
Bike Lane (BL)	0.37	***	<0.001	0.45	***	<0.001	0.30	***	<0.001
Buffered BL (BBL)	0.73	***	<0.001	0.89	***	<0.001	0.57	***	<0.001
One-way Protected	1.34	***	<0.001	1.68	***	<0.001	1.12	***	<0.001
Two-way Protected	1.16	***	<0.001	1.45	***	<0.001	0.96	***	<0.001
Multi Use	1.24	***	<0.001	1.53	***	<0.001	1.12	***	<0.001
Roadway Characteristics									
Parking	-0.27	***	<0.001	-0.26	***	<0.001	-0.17	***	<0.001
Four Lanes	0.02		0.477	0.05		0.103	-0.02		0.500
Framing Effects									
BL – No Parking	0.42	***	<0.001	0.50	***	<0.001	0.41	***	<0.001
BBL – No Parking	0.22	***	<0.001	0.33	***	<0.001	0.22	**	0.002
BL – Two Lanes	0.28	***	<0.001	0.35	***	<0.001	0.22	*	0.015
# Of Responses	6743			6723			6664		
R^2	0.175			0.232			0.093		

*P<0.05, **P<0.01, ***P<0.001

While R^2 of each model is low with respect to typical transportation models (meaning there are likely other factors that influence the models that are not infrastructure only), most of the coefficients have a high degree of significance and the overall sample size is high.

3 Methodology

The AT routes and segments identified in the draft Cycling Strategy MoveSJ plan were evaluated by applying the regression model from Table 1 to the assessment of the characteristics of the route segments and the route as a whole. The routes were broken up into shorter distances where the bicycle facility types, and roadway characteristics remained constant. The regression model returned a score between 1 and 5 for each segment for comfort, safety, and willingness to try. Areas with a high dwelling and employment count were identified and the AT routes connecting these areas are labelled as major routes. The length of each route was determined, and an overall weighted average score for comfort, safety, and willingness to try was calculated for five major routes:

1. West side to Uptown,
2. Millidgeville to Uptown,
3. West side to Millidgeville,
4. East side to Uptown, and
5. Millidgeville to East side.

These routes were determined assuming the shortest measured distance from start to finish was the route taken. The same procedure was done for the Trans-Canada Trail route and an overall weighted average for all three variables was calculated. The scores of these routes were then analysed to see if there are areas of improvement in the cycling routes. Sample calculations of this method are shown below for West side to Uptown.

Table 1: One Segment of Main St W Route Score for Comfort, Safety and Willingness to Try

Name: Main St W from: Manawagonish Rd to Chesley Dr		
Comfort =	2.9 + (0.37x0) +(0.73x1) +(1.34x0) +(1.16x0) +(1.24x0) +(-0.27x1) +(0.02x1) +(0.42x0) +(0.22x0) +(0.28x0)	= 3.4
Safety =	2.62 + (0.45x0) +(0.89x1) +(1.68x0) +(1.45x0) +(1.53x0) + (-0.26x1) +(0.05x1) +(0.50x0) +(0.33x0) +(0.35x0)	= 3.3
Willingness to try =	2.82 + (0.30x0) +(0.57x1) +(1.12x0) +(0.96x0) +(1.12x0) + (-0.17x1) +(-0.02x1) +(0.41x0) +(0.22x0) +(0.22x0)	= 3.2

Table 2: Major Route West Side to Uptown Scores

Name	From	To	Comfort	Safety	Willingness to Try	Distance (km)
Main St	Manawagonish St	Chesley Dr	3.4	3.3	3.2	1.05
Chesley St	Douglas Ave	Bentley St	3.9	3.9	3.6	1.02
Harbour Passage	Bently St	Long Wharf	4.1	4.2	3.9	1.35
Smythe St	Long Wharf	Union St	3.7	3.6	3.5	0.15
Total Distance						3.57 km

Table 3: Weighted Average Score of Comfort, Safety, and Willingness to Try for Major Route West to Uptown

Name:	From:	To:	Comfort	Safety	Willingness to Try
Main St	Manawagonish Rd	Chesley Dr	(3.4x1.05km)/3.57km = 0.99	(3.3x1.05km)/3.57km = 0.97	(3.2x1.05km)/3.57km = 0.94
Chesley Dr	Douglas Ave	Bentley St	1.11	1.20	1.03
Harbour Passage	Bentley St	Long Wharf	1.57	1.82	1.49
Smythe St	Long Wharf	Union St	0.16	0.16	0.15
SUM =			3.8	4.1	3.6

4 Interpretation of Results

Ideally, these scores would translate into some type of metric that could help transportation planners connect the provision of cycling infrastructure to a change in demand for that infrastructure. While it is not possible to do that with these data, one potentially useful interpretation is to associate the 1 to 5 Likert agreement scale with a qualitative assessment of “likelihood” that a cyclist would “feel comfortable on this route”, for example. Given that scores of 3, 4 and 5 correspond with responses of “neutral”, “agree” and “completely agree” with the three factors, respectively, the higher the score, the more it may be expected that users would agree with the statement regarding comfort, safety, or willingness to try. Conversely, routes with lower scores would expect to be seen as less comfortable and safe or a user was less willing to try. The following table associates a score with a subjective interpretation of cyclist likelihood to feel comfortable, safe, and willing to try a route or segment.

Table 4: Interpreting Route/Segment Scores in Terms of User Interpretation

“Bicycling on a road (trail) like this is…” comfortable”, “safe”, “something I’d try””				
1	2	3	4	5
Completely Disagree	Disagree	Neutral	Agree	Completely Agree
Route or segment scores				
< 3.0		3.0	> 3.0	
Route or segment has features that cyclists are increasingly **unlikely** to feel comfortable with, safe or are willing to try			Route or segment has features that cyclists are increasingly **likely** to feel comfortable with, safe or are willing to try	

5 Results & Analysis

The weighted average score for the five major routes can be found below in Table 2. Each segment of the route obtained a different score for comfort, safety, and willingness to try (See Figures 2, 3, and 4).

Table 5: Results for Major Routes

Route	From	To	Total Length (km)	Comfort	Safety	Willingness to Try
1. West to Uptown	Main St West	Bottom of Union St	3.6	3.8	4.1	3.6
2. Millidgeville to Uptown	University Ave/Millidge Ave	Bottom of Union St	3.9	3.8	3.6	3.6
3. West to Millidgeville	Main St West	University Ave/Millidge Ave	5.0	3.6	3.5	3.4
4. East to Uptown	McAllister Dr	Top of Union St	4.8	3.9	3.9	3.7
5. Millidgeville to East	University Ave/Millidge Ave	McAllister Dr	9.0	3.9	3.6	3.6

All major routes in the priority network plan scored a neutral or above. The West to Millidgeville (Route 3) route was the only route that scored a 3.4 for Willingness to Try. When looking at the breakdown of this major route, sections such as Douglas Ave and Adelaide St received a score of 3.3, 3.2 and 3.2 for comfort, safety, and willingness to try, respectively. This caused the weighted average score to decrease as all other section of the route were slightly higher. Although this section is small, it may cause a cyclist to avoid the route completely. The West to Uptown route scored the highest for safety (4.1) due to a large section of this route being on Harbour Passage, a multi-use trail. Millidgeville to Uptown, East to Uptown and Millidgeville to East all scored within 3.6 - 3.9 for all three categories. The figures below show the evaluation of segment details, though no segment scored below a 3.2.

Figure 2: Comfort Scores for Major Route Segments

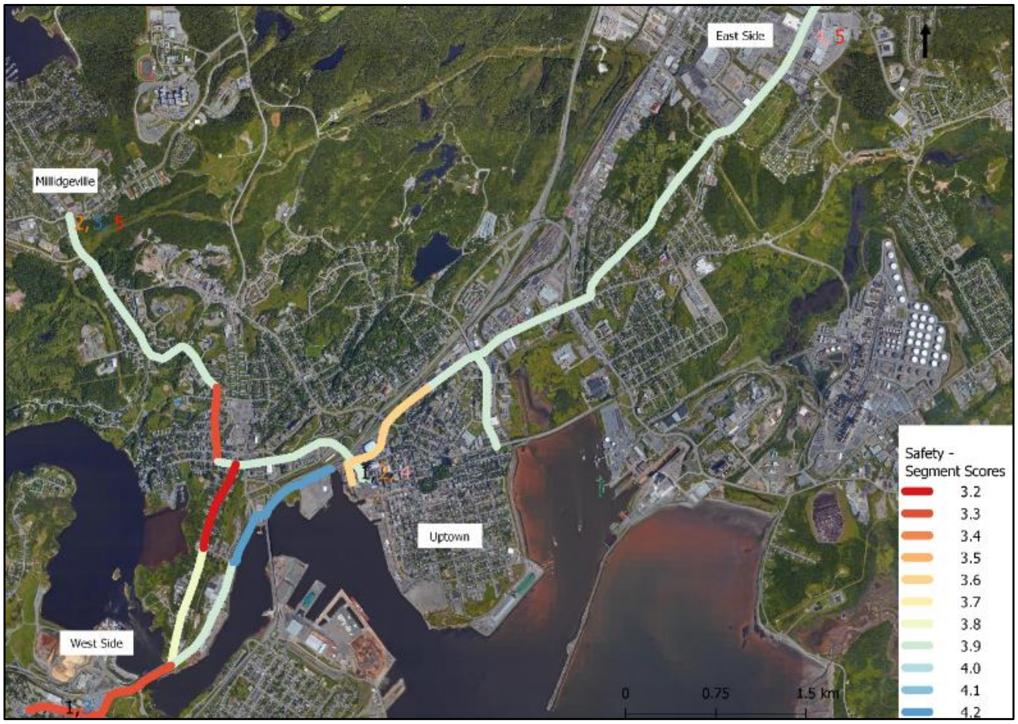

Figure 4: Safety Scores for Major Route Segments

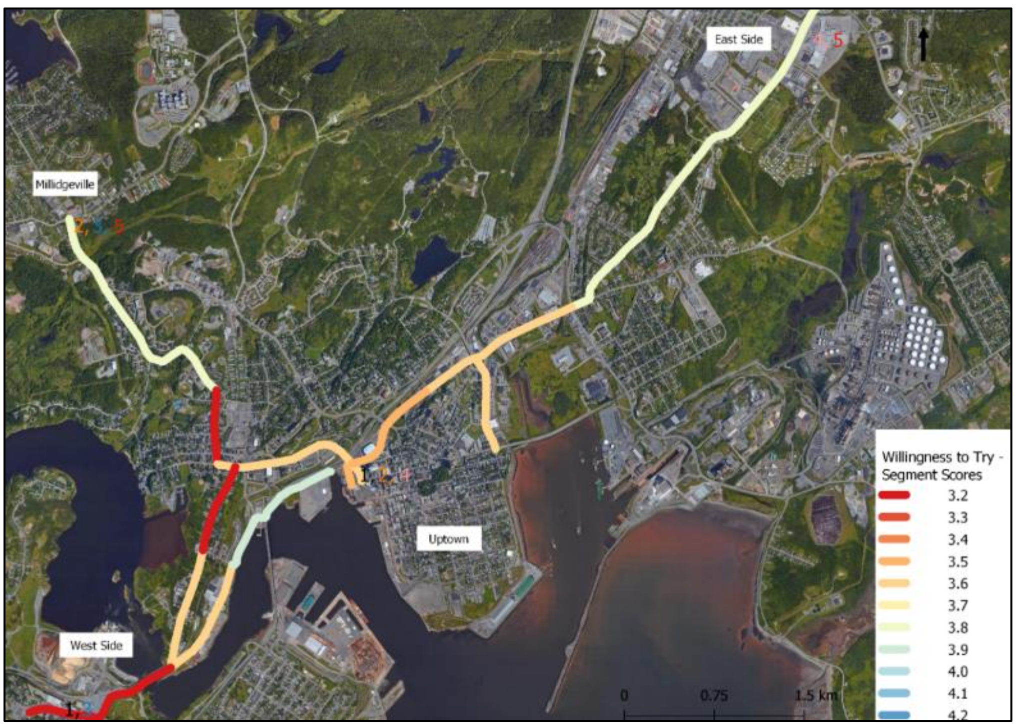

Figure 3: Willingness to Try Scores for Major Route Segments

In addition to the priority routes, the Trans-Canada Trail existing routes in the MoveSJ plan were also given a weighted average score for comfort, safety, and willingness to try for the entire route. The upgraded route was analysed and compared to the existing. The summary of these scores can be found below in Table 3. This analysis assumed that the user took the Chesley Dr route over the Douglas

Ave/Bentley St route due to the steep grade on Bentley St. These results suggest that the improvements envisioned would result in higher scores with the regression model.

When looking at the complete breakdown of the Trans-Canada Trail Route, some sections of the route scored higher than others, but the overall averaged weighted score for comfort, safety, and willingness to try increased from the existing to the upgraded. The upgraded trail received a 3.4, 3.3, 3.2 for comfort, safety, and willingness to try, respectively.

Table 3: Results for Existing and Upgraded Trans-Canada Trail Route

	Comfort		Safety		Willingness to Try	
Length (km)	Existing	Upgraded	Existing	Upgraded	Existing	Upgraded
28.7	3.2	3.4	3.0	3.3	3.0	3.2

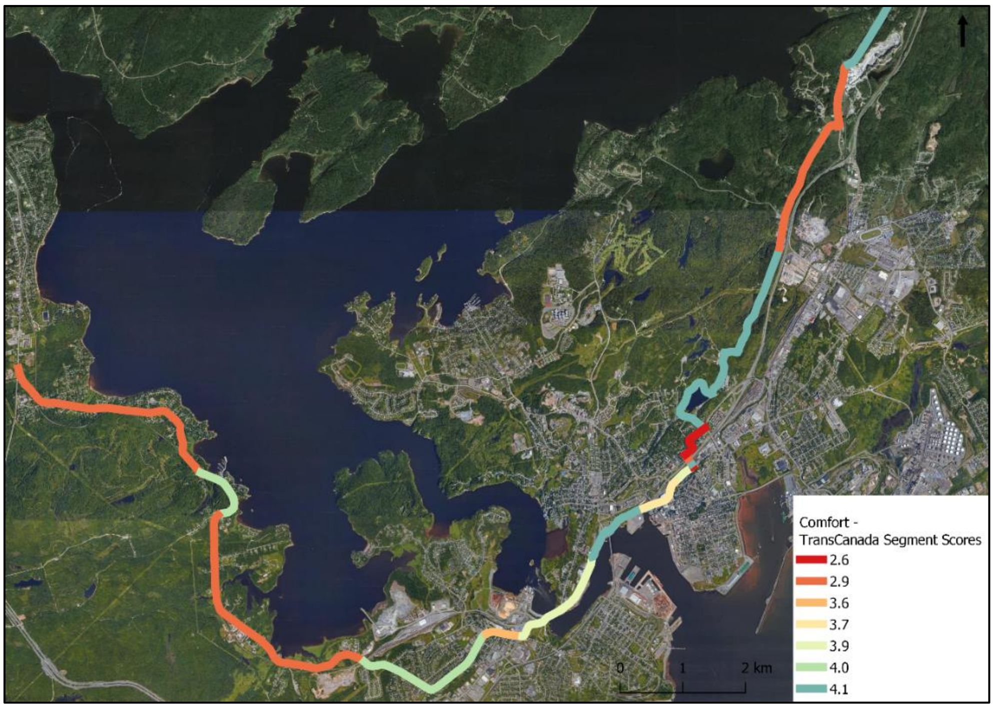

Figure 5: Comfort Scores on Trans-Canada Trail

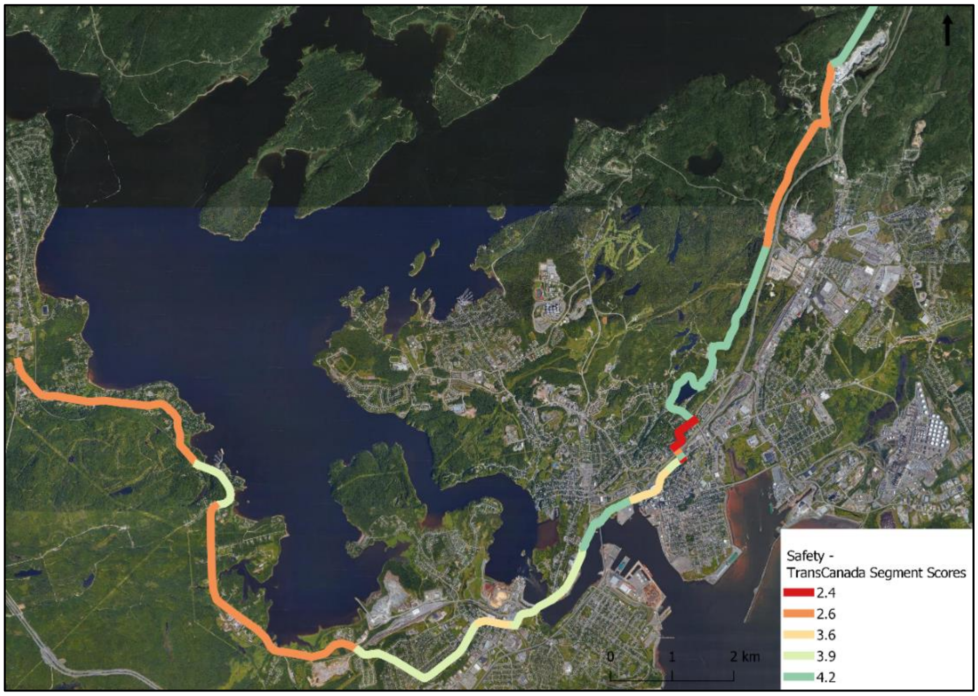

Figure 6: Safety Scores on Trans-Canada Trail

Figure 7: Willingness to Try Scores on Trans-Canada Trail

When looking at the route segments, the shared lanes all scored under 3.0, meaning it may be less likely for cyclists to use this route. If shared lanes are turned into bike lanes, this would increase the comfort score by 0.37, the safety score by 0.45 and the willingness to try score by 0.3, resulting in a score greater than 3. Although small fragments of the routes have a score greater than 3.5, the weighted average score for routes should be looked at because a small section can be a deterrent to cyclists. Unfortunately, these models do not include any climatic factors which could be useful in helping to understand infrastructure use during the winter or other poor weather conditions.

Conclusion

The objective of this report was to attempt to quantify the demand on cycling routes previously developed for the City of Saint John, NB. A study called NCHRP Report 941 *Bicyclist Facility Preferences and Effects on Increasing Bicycle Trips* was used to get a better understanding of cyclists' perceptions for each facility by applying regression models to select routes in Saint John. A score of 1 to 5 was then given for route segments and entire routes in the Priority Network and Trans-Canada Trail routes of the Saint John plan. Although this method does not give demands for each cycling facility, it does give a better idea of whether certain facility improvements are likely to improve how cyclists could perceive each route in terms of safety, comfort, and willingness to try. The regression models showed logical results, though have some limitations especially for the Canadian climate.

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