Investigate the Engineer's Role in Making Canadian Communities Healthier by Encouraging Active Transportation

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Abstract. There has been a growing interest in Canada and the globe in promoting sustainable communities and active lifestyles. That is why engineers and planners are looking to rebuild and plan for walkable, bikeable communities by implementing infrastructures that promote Active Transportation (AT) use. This paper presents the initial results of the Healthy Canada by Design Coalition Linking Action & Science for Prevention Initiative (CLASP) sponsored, cross-Canada UBC research project to investigate the challenges and barriers that community planners and engineers face when attempting to introduce infrastructure that could facilitate active modes of transportation, but that have never before been used in their particular community. In particular the study wanted to see how we might overcome these challenges and barriers. Several case studies will be presented for projects related to the development of newly active transportation infrastructure throughout Canada.

The study began with a comprehensive literature review of peer-reviewed journal databases with an emphasis on Canadian sources and experiences. International sources were used for comparison with cities that have a similar climate to Canada. 26 one-hour interviews were conducted with key stakeholders across Canada, including: government representatives, land-developers, and advocacy groups. The cities were randomly chosen, with aim to achieve at least three cities (small, medium, large) in each province, and at least one city in each territory. We couldn't cover all provinces in Canada due to lack of response.

Bike lanes and multi-use trails have been implemented broadly cross Canada, but this does not mean that they are the appropriate for most of the Canadian cities. People in each community have a preference of a type of AT infrastructure over another based on risk tolerance and experience level. Discontinuity of AT infrastructure system has been found to be the main barrier in the majority of the nominated cities. This has been caused mainly by the lack of fund available for AT projects.

Literature Review:

A variety of factors, including health and safety are encouraging the federal government in Canada to plan for active walkable and bikeable communities. One factor driving planning is the correlation between Active Transportation (AT) and health. Physical inactivity has massive costs

related to health (VanBlarcom & Janmaat, 2013). Walking and cycling contribute to reducing obesity and chronic diseases (Pucher & Buehler, 2010). Cycling also substantially reduces the risk of cancer, cardiovascular diseases and obesity-related diseases among adults and seniors (Oja et al., 2011). Similarly, a study of active commuting found that it is negatively correlated with obesity, triglyceride levels and higher blood pressure (Gordon-Larsen et al., 2009). Moreover, Active transportation has a multiplicity of environmental advantages such as decreasing Greenhouse gas (GHGs) emissions and energy consumption. The extent to which these factors affect the environment depends on the total length of fossil-fuel-using trips that are substituted with other modes of transportation (Martens, 2004).

In addition, it has been demonstrated that increasing number of AT users has great effects on AT users' safety. "Safer cycling encourages more cycling, and more cycling encourages greater safety." (Pucher, Buehler, & Seinen, 2011). Pucher and Buechler (2005) state that the increase in number of cyclists in Canadian cities was associated with a drop in the number of fatalities. For example, the number of cyclists in Quebec increased by 50% between 1987 and 2000; the number of the cyclist fatalities dropped by 42% during the same period. The benefit of increasing the number of AT users extends to road safety. A study suggested that there is a relationship between cyclist infrastructure and road safety; Increasing cycling infrastructure reduces collisions (Alam, Lovegrove and WEI, 2011).

Despite the advantages of an active life style by promoting cycling and walking, Canadian cities are facing many barriers and challenges. The main barrier facing Canadian communities is the lack of funding. AT needs more financial and political support from the federal, provincial and local governments. The limited funds provided for AT limits the planners and engineers from implementing new AT infrastructure, or even maintaining existing infrastructure. For example, one of the main barriers the municipalities' staffs are facing in Greater Toronto and Hamilton region is the lack of funding provided for AT projects (The Clean Air Partnership, 2008). Also federal government does not have recurring funding to support the different AT facilities across Canada, which causes the fund to rely mainly on the local governments (Pucher et al., 2011).

Physical environment is an important factor in encouraging people to be more physically active. The main characteristic of the physical environment is to be continuous with no gaps in the system and also to provide convenient facilities for cyclists at their end location, i.e. providing safe parking areas (Arvidson, 2012). Transportation infrastructure is strongly correlated with physical activities (Sallis, Frank, Saelens, & Kraft, 2004). This relationship between the type of the infrastructure and the users has been investigated by many researchers. Cyclists will ride on a road with better infrastructure rather than using the shortest route; also, cyclists prefer using off - street paths and lower-volume roads (Winters, Teschke, Grant, Setton, & Brauer, 2010). Likewise, El-Geneidy and Larsen (2010) find that cyclists would prefer a longer route if it is on an off-street facility as well as a separate lane as compared to a delineated lane. In addition, they find that the availability of cycling facilities within 400 m of the home and the destination increases the probability of using the facility by 129%. Cyclists who prefer using trails are

willing to extend their travel distance by 67% in order to use a trail as part of their trip (Krizek, El-Geneidy, & Thompson, 2007). By contrast, a study of Guelph found that the majority of cyclists prefer using on-road facilities rather than using off-road paths (Aultman-Hall, Hall and Baetz, 1997). The classification of the road where the AT facility is located also affects AT users as well as vehicles drivers. Audirac (2007) shows that drivers would be annoyed the most from sharing the road with cyclists on an arterial road (83%), then Highways (80%) and local collectors (58%). Although not related to the creation of AT infrastructure, parking cost near the workplace is a factor related to physical environment for commuters; High parking cost encourages more cyclists.

Another important factor that has to be taken into consideration when planning for AT is the gender-based factors that affect cycling use. It is important specially when knowing that women in Canada accounted for 47.9 % of the labour force in 2009 (Turcotte, 2011) .Women have preference to use routes that are separated from road traffic like off-road paths (Garrard, Rose, & Lo, 2008). This preference can be explained by the sensitivity of women toward safety, regardless the experience level (Emond, Tang, & Handy, 2009).

Another barrier found to be common in Canadian cities is the low density. This barrier minimizes the efficiency of Active Transportation by stretching the lengths of trips (The Clean Air Partnership, 2008; J Pucher & Buehler, 2007). This barrier can be overcome if the transit systems tie in well with the AT efforts. A survey conducted by the clear Air Partnership (2008) to study Greater Toronto, Hamilton and beyond reported that public transit is a barrier for active transportation because of the law service and having an appropriate integration between walking, biking and transit. Cycling and public transport complement each other, cycling increase catchment area of public transit facilities. And public transit facilities that support AT (i.e. Bike lockers) encourage cycling (Pucher et al., 2011). The combination of biking and public transport which is known as bike and ride, minimize the total trip time of public transport users trip (Martens, 2007). Bike and ride can also be as good alternative as cars. Although data have shown that having a car has a significant negative effect on selecting bike and ride, but at the same time, availability of car doesn't eliminate the other option (Martens, 2004).

All these efforts might be useless if the cold weather in Canada has a great negative effect on cycling. There has been a debate regarding the effect of cold weather on cycling and walking. Cycling in Canada is generally three times higher than in the USA, which means that the cold weather in Canada does not affect the mode split of cyclists (Pucher and Buehler, 2007). Also, cyclists account for 2.6% of the total commuters in the Yukon territories which is considered to be one of the coldest areas in Canada (Pucher et al., 2011). These facts suggest that cold weather does not seem to be a significant barrier for cycling. A study conducted in Stockholm, Sweden to examine cycling in winter, only few participants replied that low temperature prevents them from cycling in winter (Sundquist, Eriksson, & Kawakami, 2011). On the other hand, other studies have found that cold weather will effect AT use. A study of Halifax shows that there is a positive significant relationship between higher average temperatures and walking, and negative

relationship with perception (Clark, Scott, & Yiannakoulias, 2013). These relationships indicate that promoting walking in communities where average annual temperature is very cold and rainy day might be difficult.

Methodology

The study began with a comprehensive literature review of peer-reviewed journal databases with an emphasis on Canadian sources and experiences. International sources were used for comparison with cities that have a similar climate to Canada.

26 one-hour interviews were conducted with key stakeholders across Canada, including: government representatives, land-developers, and advocacy groups. The cities were randomly chosen, consisting of at least three cities (small, medium, large) in each province, and at least one city in each territory. Invitations were sent to the selected cities via email (33 cities); the contact information for the key informants were obtained from database from previous research on the safety of Vulnerable Road Users (VRU) by Dr. Gordon Lovegrove (2012). The response rate was approximately 50%, but not covering all provinces in Canada as shown in table 1.

Table 1: Interviewed cities by province

Province/Territory	city
Alberta	Calgary, Edmonton, Red Deer, Canmore,
British Columbia	Kelowna, Kimberly, Whistler, TransLink (Greater Vancouver), Chilliwack
Manitoba	Pinawa, Provincial Government
New Brunswick	Moncton, Fredericton
Newfoundland and Labrador	No respondents
Northwest Territories	No respondents
Nova Scotia	Halifax, Cape Breton
Nunavut Territory	No respondents
Ontario	Thunder Bay, Ottawa, Niagara Falls, Toronto, Guelph
Prince Edward Island	No respondents
Quebec	Montreal
Saskatchewan	No respondents
Yukon Territory	Whitehorse

The survey was divided into five sections. The first section contained general information on the community status of AT such as the type of the facilities implemented in the community and the policies and standards community is using for designing facilities. The second section was about communities profile such as the percentage of AT users, accidents statistics and the classification cyclists. The third section was regarding public attitudes toward AT in general and AT

infrastructures. The forth section documented AT Infrastructure case studies, how it helped promote AT in the community and the public perception regarding the infrastructure. All the responses were preserved on a secure server at UBC-Okanagan.

Results and Discussion

In order to prepare adequate infrastructure for waking and cycling, it is important to include these modes of transportation in planning priorities. In some communities, Public demand for AT pushes municipalities to be more AT oriented, whereas in other cities, city councilor and mayor support AT, which most likely will drive public demand later. Nominated communities were asked if they prioritize in planning for different mode of transportation; out of nine communities, only four communities reported that pedestrians and cyclist are the first priority. Some communities they still do not have a clear policy to prioritize planning are hoping to establish this priority by introducing a new transportation master plan for the city. A third group, which does not have a clear AT priority, shifts their priorities for pedestrians and cyclists at a particular location if a specific project is part of the city AT plan. Table 2 shows the different priorities for the Nominated cities.

Table 2: Cities planning priority

City	Priority
Calgary	Pedestrian & cyclists
Canmore	Pedestrian & cyclists
Cape Breton	Automobile
Fredericton	Automobile
Guelph	No policies
Halifax	No policies
Kelowna	Pedestrian & cyclists
Kimberly	No policies
Moncton	Pedestrian?
Montréal	All modes have the same priority
Ottawa	No policies, but transit oriented
Pinawa	No policies
Red Deer	No policies
Thunder Bay	Automobile (if the project is in AT plan, then pedestrian & cyclists)
Whitehorse	Automobile

Snow Removal:

As discussed earlier in the literature review, many studies suggest that cold weather might not be a significant barrier for AT. However, cold weather is not the only factor that affects AT during winter in Canada. An important factor that influences AT use is the condition of the facilities during winter. Canada is known as a country that receives large amount of snow each year. The amount of snow varies from city to city, which makes it a big challenge to maintain AT infrastructure that is clear from snow for cities that receive large amounts of snow. Nominated Canadian cities reported different practices regarding snow removal.

Some communities reported that the city plan states that the snow should be removed from bike lanes and shared lanes within 24 to 48 hours after the end of snowfall, according to the priority of the street where the facility is located. However, because roads are not cleared well from edge to edge, the reality is not well suited to the needs to cyclists. In other group of cities there are no policies related to snow removal from bike lanes. The snow is plowed away from the road to the bike lanes, which makes bike lanes temporally as snow storage. In some communities the lack of fund is the reason behind not maintaining AT facilities, where in other communities lack of demand doesn't encourage municipalities to plow the snow as the case for Whistler. On the other hand, other cities who don't have policies yet, like Whitehorse, are interested in encouraging winter biking and already starts to study accommodating bike lanes during winter through a pilot project in downtown core.

On the other hand, Trails and sidewalks receive better service than bike lanes and shared lanes in most of the communities. In Thunder Bay, the city clears the snow from all sidewalks and hires a private company to plow the snow from trails. Similarly, in Kimberly, trail machines for sidewalks are sent out at the same time as road snowplows go out. In some communities snow plowing for sidewalks is prioritized according to the location of the facility. To illustrate, Halifax municipality set the sidewalks in the main arterials and capital district as a first priority within 12 hours after the snow stops, till removing snow with 48 hours from intersections and bus tops as the last priority. Whereas in other cities, snow is cleared in some of the sidewalks. For instance, Moncton clears snow from 50% of sidewalks because of the limited funding provided.

Public Transit:

Having a transit system that facilitates cycling and walking adds value for AT. The integration between public transit and AT can be accomplished by many ways such as providing bus bike racks, bike parking at terminals and easy accessibility for AT users to transit facilities. Interviewed cities were asked how the transit system ties-in with the active transportation efforts.

Allowing cyclists to bring their bikes with them on transit gives more option for cyclists in cases where they cannot finish their trip due to bad weather, flatten tire or other reasons. It also helps overcome demographic and geographic barriers, like low density and mountainous areas. Most of the interviewed cities have buses equipped with bike racks. Some have their full fleet equipped with bike racks such as Kelowna and Guelph. In Moncton, buses are equipped with

bike racks that have a three bike capacity, versus two bike capacity in the majority of the communities. Allowing bikes on board has the same advantages as bike racks, although it might not be convenient to other transit users. In Calgary, bikes are allowed during the trains except during the rush hours or if the trains is very crowded.

In addition, bike parking at transit facilities enable cyclists to leave their bikes secure till they finish their trip. For example, commuters at rush hours who are not allowed to take their bikes on board will still have an option to bike to the transit facility, keep their bike there, and then collect it at the way back home.

Giving AT's users easy access to public transit facilities has great impact in improving integration between the two modes. Four communities reported that there is a lack of interconnectivity between the two modes such as not having sidewalks on bus routes or bicycle facilities connecting to transit terminals.

A noteworthy program is a pilot project conducted in Seattle, Washington. The 520 evergreen floating bridge does not have bicycling facilities across the bridge. The project provides free ride for the cyclists to and from either ends of the bridge on out of service buses. The disadvantage that might occur is that there are no fixed schedules for the service, which may make it not be very convenient for walking and cycling commuters.

Barriers:

One of the main objectives of this research is to investigate the barriers and challenges that different Canadian communities are facing when trying to promote more AT. As shown in Figure 1, the majority of the interviewed communities reported that people in their communities are facing barriers to increasing their biking and walking. In addition, this study found that there are four major barriers to AT. In order of importance, they are: AT infrastructure discontinuity, length of trips, social and cultural perceptions, and lack of funds. These barriers will be discussed below.

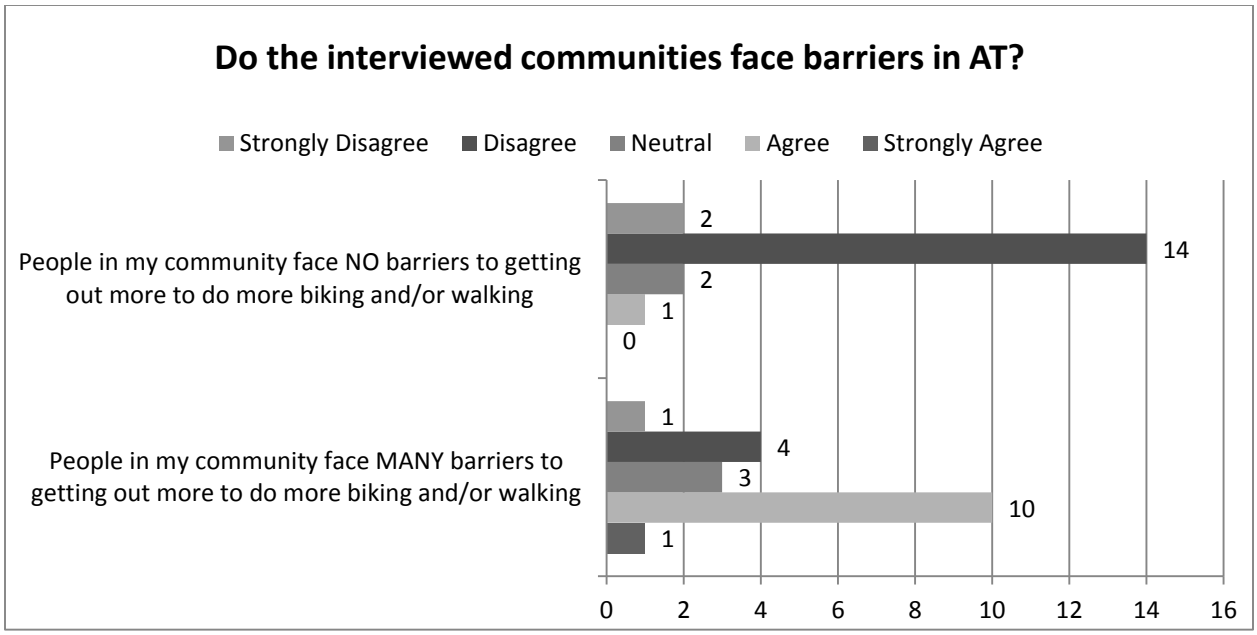

Figure 1: perceptions of barriers faced for AT

12 communities reported barriers related to AT infrastructure. Discontinuity is the main AT infrastructure barrier in these cities. Only three communities reported that this barrier is affecting pedestrians, whereas the majority mentioned that it is related to cycling infrastructure. In some communities, the gap in the AT system is caused by the lack of AT infrastructure. In this case, the users can use the facilities on part of their trips, but in order to reach to their destinations, they also have to share the road with vehicles. This barrier would be more significant in cities with many highways and high volume traffic roads, which will increase the users' perceived risk. Other barriers related to the infrastructure are keeping the infrastructure clear from snow in winter and maintaining the condition of the infrastructure, i.e. the materials used to cover trails (paved vs. unpaved).

The next in importance for the reporting cities are low density and land use related barriers. Four cities mentioned low density as a barrier, and two mentioned land use development. These are both caused by the way the city has been built. Density and uncontrolled land use development increase distances between single-use developments to be greater than the average cycling or walking trips.

Third in importance are the mental barriers faced by the communities, which were reported by three cities. Mental barriers can be caused by social or cultural perceptions of cycling. Besides social factors, there are safety factors that affect AT. Safety factors can be caused by aggressive behavior of drivers toward cyclists, lack of experience for cyclists or a combination of both causes. Having said that, understanding AT users' behavior and what makes them feel comfortable and safe are very important in planning for AT infrastructure. Geller (2006) created four categories to classify cyclists based on the level of comfort when biking on different AT

facilities. These types are: strong and fearless, enthused and confident, interested but concerned, and no way, now how. Interviewees were asked to estimate the percentage of each type of cyclists in their community. For this purpose, the four types were identified for the interviewees in the following ways:

- Strong and fearless: will ride regardless of road condition.
- Enthused and confident: are comfortable riding on road with automobiles, but prefer to improve facilities.
- Interested but concerned: Like to ride, but afraid to do.
- No way, no how: not going to ride a bicycle.

Most of the communities haven't done a study to understand cyclists' behavior, so the percentages obtained for this part was approximate based on the interviewees best guess. Also, some couldn't answer the question. Over 85% of the communities responding to this question reported that the majority of the cyclists are classified as interested but concerned. What is surprising, that some of these communities admitted to implementing cycling infrastructure that is targeted at the braver type of cyclists, such as the Enthused and confident cyclists.

Finally, only two cities reported that lack of funds is a barrier. Most of the communities fund AT infrastructure locally. In addition, as mentioned earlier, only four cities consider walking and cycling as a priority, which might limit local funds as well. This could explain why lack of AT infrastructure is the main barrier in most of the Canadian cities surveyed. Seven communities mentioned that they get funding for AT programs and infrastructure from provincial and/or federal governments. It seems that the federal and some provincial governments have not made AT a major priority, rather, they are still focusing on road networks. Some communities are using Gas Tax Fund from the federal government, which is provided to help local governments to build public infrastructure that will have positive impact on the environment. The Infrastructure Stimulus Fund is also a federal program launched in 2009 after the world economic crisis to enhance Canadian economy. This program, as Gas Tax Fund, is not focusing on AT, but different municipalities across Canada are using these funds to support AT infrastructure.

Other challenges facing AT are:

- Weather (two cities)
- Lack of road rules education with regard to cyclists.

Overcoming these barriers is extremely important to promote more biking and walking. As showing in Figure 2, in some communities people do not consider walking or cycling to be as important as driving. This indicates that more education programs are needed to increase public awareness regarding Active Transportation. On the other hand, Engineers and planners need to review planning strategies in their communities and attempt to improve the infrastructure system of AT as well as maintain it throughout the year in order be compatible with motorized transportation. For example, Red deer is an example of a very compact city where you can bike from downtown to the city limit within 20 minutes, which allows bikes to be competitive with cars

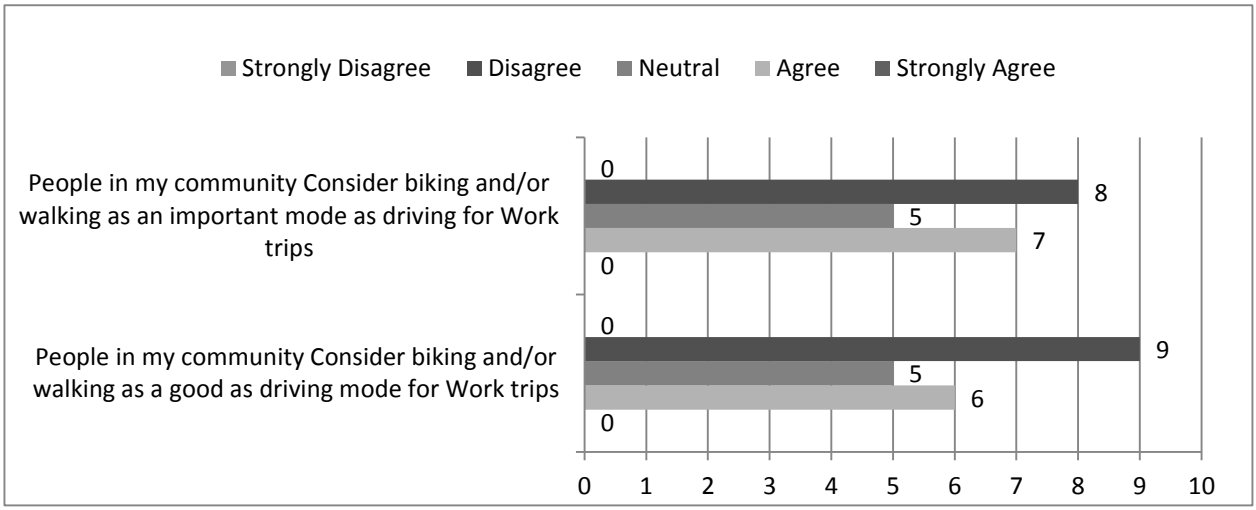

Figure 2: Commuters' perception toward AT

Noteworthy Projects

Thunder Bay

Arundel Street corridor is a road that connects two little communities in Thunder Bay. The road has a side street that connects users to the most popular recreational area in the city (Lyon Boulevard west). The intersection between Arundel Street and Lyon Boulevard west has very high pedestrian use. It was built to be four lane intersection, but the road is just two lanes. There was a huge turning radius that allowed a high turning speed. Pedestrians had a long distance to cross the intersection and vehicles were not stopping because it is on the slope; sight lines were poor. It was fine for automobiles, but cyclists and pedestrians who wanted to reach the recreational facility from the two communities were walking and cycling on a gravel shoulder, so it was not very accessible and comfortable for people. When the road was being reconstructed, the city took the opportunity to put in a 3m wide multi use trail and bike lane on the right side of the road, and paved shoulder on the other side. They also tied up the intersection so it is now a

proper T intersection with good sight lines and proper signage. Later, the city found that drivers are driving inside the bike lane when going around the corner, so next year the city is planning to put a physical barrier, a flexible bollard, to prevent motorists from driving in the bike lanes. (Cost and public perception and that city counted before and after implementing the project + year.)

Moncton

Salisbury Road (5 km), Shediak Road (6 km) and Killam Drive (6 km), all pass through residential areas in Moncton. The design of the streets as well as the low volumes of traffic on these streets allow drivers to exceed the speed limits. As part of the AT plan, the city completed three road diet projects on these drives. In the past, the cross section of Salisbury and Shediak was a four lane road, but after reconfiguring the design, the roads now have 2 lanes with a common center left turn and bike lanes. The increase in the number of cyclists due to this project was impressive: The number increased from 10 cyclists per day to almost 150 cyclists per day. Equally important, the project provides safety for pedestrians by having a dedicated buffer for them. The concept of the project was new to the community; therefore, there was push-back on the project from social. (Cost and public perception + year)

Calgary

7 Street is located in an active area with many business and residential buildings in west downtown Calgary. As a first phase of the city of Calgary's cycle track network, the city built a two way cycle track on the 7 street SW. The construction of the project started in the spring of 2013, and the project went into service in July 2013. At the beginning, the project was proposed to be only a bike lane. The project was targeted for the "Interested but concerned" type of cyclist. The project also included improving signal timing to optimize the movements of cyclists and pedestrians. Moreover, the city ran an educational program to instruct the road users (motorists, cyclists and pedestrians) how to act to the new configuration of the street by distributing a brochure. The cycle track is considered as a first priority in terms of snow removal, and it will be cleared after each snowfall event. The number of trips was 270 per weekday before implementing the project, and it increased dramatically to be 1160 trips per weekday. The cost of the project was 1.2 million, and it was funded through the cycling strategic fund of the province of Alberta.

Red Deer

Recently, Red Deer has completed a Bike Lane Pilot project that consists of 13 km of bike lanes and 5 km of bike routes. The debate in the city is about the need for bike facilities: Is it the right time to implement AT in the city? The project was new to the residents in the community, they claimed that there are not enough cyclists on the road to use the new infrastructure. They also think that the project will increase congestion and it is waste of the tax payers' money. The project cost was funded through the capital budget of the city, but the problem is the lack of

funding for the maintenance cost of the facilities. After implementing the project, the city conducted an online survey to get feedback from residents regarding the project. They have done spot surveys and data counts before and after implementing the project. Building on the survey result, the city kept some of the bike lanes, removed other parts, and converted few to be bike routes. Michael Williston, transportation engineer for Red Deer, said that they have not been directed to remove the entire infrastructure, which shows that they might be heading in the right direction. In 2012, the number of cyclists during the weekdays at four locations was 60 cyclists, whereas, in 2013, they counted at 11 locations, and the number of cyclists was 388 during the weekday peak period.

Conclusion and recommendations

Realizing all the pros of AT, such as health and safety, and how does it affect positively a community has encouraged engineers, planners and researcher to investigate the different practices that can promote AT and change the way these communities are designed. It has been noticed that all the interviewed communities have recognized the advantages of AT, and they are attempting to encourage AT using different practices. Bike lanes have been using widely in different Canadian cities. Bike lanes have a great effect on increasing number of cyclists and reducing collisions. In addition, this research found that the most common barrier in Canadian cities is the discontinuity of AT infrastructure. Some cities have plans to improve AT network, whereas others don't have enough budgets to make progress. In addition, we found that cold weather is not a barrier for AT. Instead, not keeping the facilities clear from snow in winter discourages people to bike or walk.

As has been noted, conducting studies to understand community behaviors and attitude toward active transportation to implement the appropriate AT infrastructure for each city. Some Nominated cities mentioned that their community demand more on-road facilities, however others request off-road facilities. What might be most effective in a city could be useless to another in terms of encouraging more AT.

Furthermore, improving integration between transit and AT is important to overcome low density and land use related barriers in the Canadian cities. Equally important, for public transit to be a complement for AT, it is also required to improve the service of public transit itself, such as frequency.

Acknowledgments

We would like to thank the Healthy Canada by Design Coalition Linking Action & Science for Prevention Initiative (CLASP) and the Canadian Institute of Transportation Engineers (CITE) for

sponsoring the research. Also, we would like to thank the interviewees whom provided us with vulnerable information for the research. And last but not least, the third and fourth student researchers Luis Dias, Teuta Hoti, and Trevor Demerse.

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