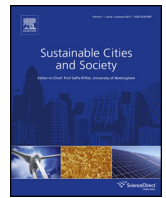




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Cycling characteristics in cities with cold weather

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ABSTRACT

Transportation is one of the major contributors to the global warming due to vehicle fossil fuel consumption. Research has shown that changing travel behavior is one of the most effective methods in reducing the Greenhouse Gas (GHG) emissions in transportation. Cycling in particular, is gaining more attention as a non-automobile alternative mode of transportation. A number of studies have been conducted that examined the impact of various factors such as demographic characteristics on cycling behavior. However, cycling behavior is perceived to be dependent on weather conditions as well. This study focuses on cycling in cold weather and aims to develop an understanding of characteristics of cyclists and their cycling behavior in cold temperatures. An intercept survey is conducted among cyclist on a newly implemented bike lane under close-to-freezing temperatures in Calgary, Canada. The results of the survey provide a baseline for understanding the characteristics of winter cycling. Cross-tabulated analysis of the data identified a number of statistically significant relationships between different variables. The result of this study can help with future planning and policy making in regions with cold climate or long and cold winters.

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1. Introduction

The most recent statistics on Greenhouse Gas (GHG) emissions continue to demonstrate a global increasing trend since the pre-industrial era. Between 1900 and 2008 alone, the global carbon dioxide (CO₂) emissions from fossil fuels – the main cause of global warming – have increased over 16 times (EEA, 2013; EPA, 2013; IPCC, 2007). For example Fig. 1 shows the total GHG emissions trend in Canada (1990–2010). These increasing trends led to the establishment of different policies and practices by governments to stabilize global GHG emission levels and prevent further increases (EU, 2012; Env.Canada, 2012a,b; CACPOA, 2009; OECD, 2003; PIRS, 2008; WI, 2005). However, studies show that without additional policies and a strict supervision on their implementation, it would be very difficult to meet the established targets (Hofman & Li, 2009; Hughes & Scott, 1997; IPCC, 2007; Liimatainen & Pollanen, 2010; Morrow, Sims Gallagher, Collantes, & Lee, 2010; Yang, McCollum, McCarthy, & Leighhty, 2009).

Transportation is considered one of the major contributors to the increasing trend of GHG emissions (Env.Canada, 2012a,b; Norman, MacLean, & Kennedy, 2006; Yang et al., 2009). For example in Canada, distribution of the GHG emissions by economic sector in 2010 shows that the transportation was responsible for 166 Mt

of the total 692 Mt of CO₂ equivalent (CO₂ eq). This accounts for 24% of total GHG emissions in 2010. The importance of the transportation sector in stabilizing the level of GHG emissions indicates the need to increase the sustainability in this sector (Norman et al., 2006; Yang et al., 2009).

Findings from transportation studies show that changes in travel behaviors are the most effective methods for decreasing GHGs emissions in the transportation sector (Yang et al., 2009; Morrow et al., 2010). One way to achieve such changes is to reduce the role of automobiles as a primary mode of transportation and to shift toward other modes of transportation, such as cycling. Studies show that encouraging cycling, as a non-automobile alternative, can be an effective method in reducing GHG emissions, provided sufficient facilities are in place (Kim & Ulfarsson, 2008; Nazelle, Morton, Jerrett, & Crawford-Brown, 2010; Noland & Kunreuther, 1995).

As a result of such studies, cycling is receiving more attention from governments as a sustainable mode of transportation in recent years (e.g. ECF, 2013; EUT, 2012; HTD, 2004; IPSOS, 2010; NY, 2007; UBC, 2013). However, in cities with cold weather, there are still speculations and concerns on the rate of usage for cycling facilities during long winter seasons. The objective of this study is to establish a baseline for the characteristics of cyclists and cycling behavior in a typical North American city with cold weather. This baseline can be helpful in decision making regarding investing on and planning for cycling facilities in cities with cold temperatures and long winters.

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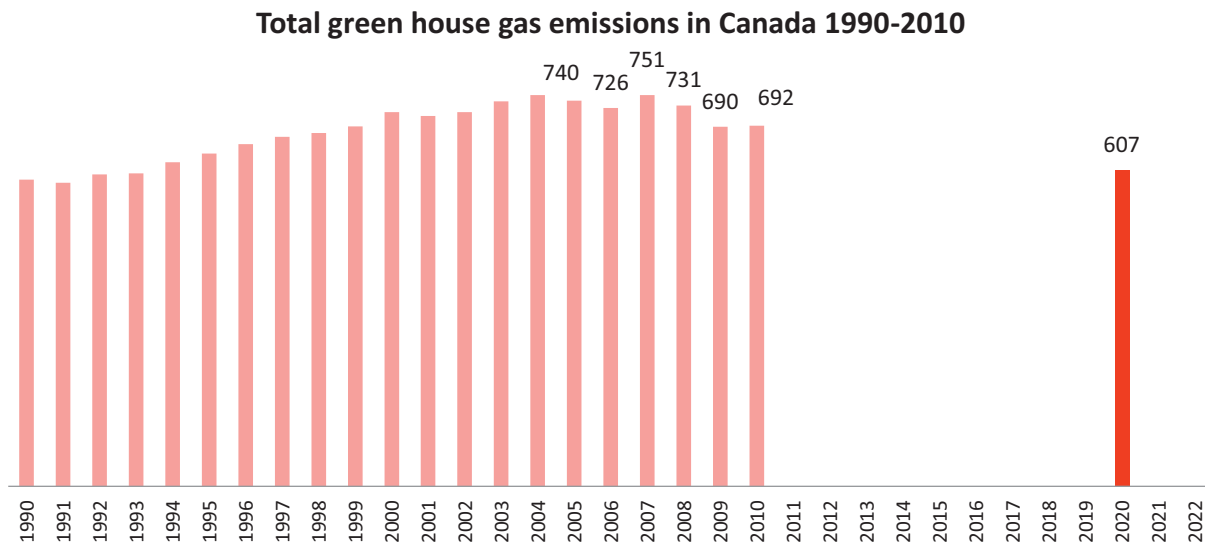


Fig. 1. Total green house gas emissions (CO₂ eq) in Canada 1990–2010 (Env.Canada, 2012a,b).

2. Literature review

Several studies have been conducted to examine the effects of different factors that influence cycling behavior and motivation. The main factors examined in literature include particular types of infrastructure (e.g. bicycle path, lane, and shared-used space), safety, gender, age, income, race, marital status and trip distance (Andrade, Jensen, & Harder, 2011; Dill, 2009; Moudon et al., 2005). These studies, along with one study by Kim and Ulfarsson (2008), have unanimously agreed that improved bicycle infrastructures increase the rate of cycling, thus encouraging more people to choose cycling as a transportation mode. Some other studies found that safety was one of the most important reasons that prevented public from cycling, and it was concluded that improving safety in cycling infrastructures can motivate more people in using them (Andrade et al., 2011; Har, 2011; Noland & Kunreuther, 1995; Trans.Canada, 2010). One study indicated that Canadians cycle more than Americans and identified developed cycling infrastructures and safer cycling trips as the main reasons for higher cycling rates in Canada (Pucher & Buehler, 2006).

Cycling was also shown to be dependent on gender and age in a study conducted in Washington State, USA. There were more male (66%) than female (34%) cyclists. Further, middle-aged and young adults (18–44 years old) tended to cycle more than older adults (Moudon et al., 2005). This study also looked into characteristics of cyclists with regards to race, marital status and income and concluded that the majority of cyclists were Caucasian and more likely to be single compared to non-cyclists. The study did not find any significant relation between the rate of income and cycling. This research also identified that the most popular purposes for cycling were recreation and exercise (Moudon et al., 2005). However, statistics in Canada indicate that cycling is also commonly used for transportation, particularly commuting to work (Trans.Canada, 2010).

Trip distance is another factor that can affect cycling motivation. Another survey conducted in Washington State, USA, investigated whether cycling was considered as a non-automobile alternative for trips shorter than 2.25 km. The study found that for trips of this length, there is a preference to walk rather than cycle due to greater safety risks associated with cycling (Kim & Ulfarsson, 2008).

Studies have also shown that cycling demand is highly dependent on weather conditions. One of the most influential factors on cycling demand is the temperature. The number of cyclists

increases with higher temperatures in sunny days. Conversely, days with wind, snow and high humidity are associated with fewer cyclists. Temperature also has negative impact on cycling demand when it rises above 28 °C (Flynn, Dana, Sears, & Aultman-Hall, 2012; Miranda-Moreno & Nosal, 2011; Nankervis, 1999; Thomas, Jaarsma, & Tutert, 2013; Winters, Friesen, Koehoorn, & Teschke, 2007). The aforementioned studies demonstrate the impact of various factors on cycling. The study presented in this paper focuses specifically on cycling in cold weather, and examines the characteristics of cyclists, and factors that affect cycling demand in winter.

3. Study design and hypothesis

In this study, 11 variables of age, gender, frequency of cycling (winter and year-round), safety concerns, temperature comfort, trip purpose, trip distance, trip duration, use of intermodal transportation, and concerns with regards to infrastructure deficiencies were selected to be investigated. These variables were identified using the most important factors associated with cyclists' characteristics and cycling demand in the existing literature.

This study presents an analysis of data collected from cyclists that is related to these eleven variables. In addition, it looks into the possible effects of the first four (4) variables of age, gender and frequency of cycling in winter and year-round on the remaining seven (7) variables of safety concerns, temperature comfort, trip purpose, trip distance, trip duration, use of intermodal transportation and infrastructure concerns. Fig. 2 demonstrates the theoretical model used to examine the hypothesis of this study. For instance, age is speculated to affect all the seven (7) aforementioned variables. All the 28 possible relations between the four (4) independent and the seven (7) dependent variables were considered one by one, and 26 were selected to be examined for statistical analysis. It was not expected that the frequency of cycling, both in winter and year-round, would influence cyclists' concerns about infrastructure deficiencies, and therefore these two relationships were eliminated from the theoretical model.

4. Data collection

An intercept survey was conducted in a newly implemented bike lane at the border of the downtown core in the city of Calgary, Canada, to collect first-hand responses from the participants. A questionnaire was designed to collect data required in order to

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