Bicycling is an increasingly important form of travel for environmental and public health reasons. Although many factors influence bicycling in urban areas, particular attention has been given to the role of built environment attributes and how specific attributes affect bicycle flows. While information about trip origins and destinations can be inferred from trip records, it is more challenging to capture the attributes of the built environment along specific routes. With new algorithms for cycle routing it is now possible to infer bicycling routes between origins and destinations. Therefore, the objective of this study is to investigate the correlates of bicycling in Hamilton, Ontario, a mid-sized city in Canada and part of the Greater Toronto and Hamilton Area. Using bicycle trip records from the Transportation Tomorrow Survey, a spatial interaction model is developed to test the level of bicycling against various built environment attributes. A feature of the analysis is the use of CycleStreets to compare different routes between origins and destinations. The various routes are characterized as being fastest, quietest, or balanced. In addition, network autocorrelation is accounted for in the estimated models. The models suggest that shortest-path quiet routes that allow bicyclists to avoid traffic best explain the pattern of travel by bicycle in Hamilton. This method is useful to better understand the types of routes that bicyclists may seek out and presents opportunities to systematically audit the built environment for attributes that correlate well with bicycling.

1. Introduction

Hamilton is a mid-sized city, located in the Greater Toronto and Hamilton area, which is an urban region in Ontario, Canada. The city has experienced a rise in bicycling in recent years. As of 2018, 12% of all trips in Hamilton are made by bicycle according to the latest Transportation Tomorrow Survey (TTS) of the periodic travel survey in the region [2]. This represents a two-fold increase from the 2011 survey results. To date, there has been no published research that has investigated bicyclist trip trends using the TTS data from Hamilton, so we know relatively little about where Hamiltonians are bicycling to and from or the route they potentially use to reach their destination.

Many studies document the relationship between the built environment and bicycling for transport, and identify various attributes that have been found to influence bicycling levels [3-6]. To understand the level and pattern of bicycle trips and to investigate the spatial distribution of such flows at the meso-level, the level of bicycling flows in Hamilton can be tested against various attributes from the known literature.

This study describes the development of a spatial interaction model to test the level of bicycling against various built environment attributes. A feature of the analysis is the use of an algorithm for cycle routing, i.e., CycleStreets [7], to approximate and compare different routes between origins and destinations. This paper addresses the following two questions: 1) Which built environment attributes influence bicyclist trip flows in Hamilton? and 2) Which type of route best explains the pattern of travel by bicycle in Hamilton?

2. Data Sources

Secondary data was obtained from the following sources:

- University of Toronto Transportation Research Institute: Transportation Tomorrow Survey
- University of Hamilton: 2018 Census
- DMT Spatial Inc. Points of Interest
- Teranet Inc.: Hamilton Parcel/Land Use Data
- City of Hamilton Open Data Program: Hamilton Street Railway (HSR) Transit Stops

3. Methods

Data Preparation

A dataframe containing 284 origin-destination (O-D) pairs that produced bicycle trips within Hamilton was accessed. After cleaning the data, a series of demographic and built environment attributes that may explain bicycle trip patterns were then added to this table. Although the origin and destination of each trip is known, there is no information available about the routes that were taken by bicyclists who made those trips. To overcome this limitation, a novel feature of the analysis is the use of CycleStreets, which can be accessed in R through the package `cyclestreets` to retrieve different routes between origins and destinations that a knowledgeable bicyclist could take [7]. CycleStreets characterizes routes as being fastest, quietest, and balanced and each route can be measured by both distance and time, which serves as a measure of spatial separation. A final expanded origin-destination matrix was created with all associated variables for each O-D pair.

Spatial Interaction Modelling

Transportation trips, the manifestation of which are flows of commuters Will Use Them. The best model reveals that quiet routes that allow bicyclists to avoid traffic best explain the pattern of travel by bicycle in Hamilton. This indicates that environmental and public health reasons. Although many factors influence bicycling in urban areas, particular attention has been given to the role of built environment attributes and how specific attributes affect bicycle flows. While information about trip origins and destinations can be inferred from trip records, it is more challenging to capture the attributes of the built environment along specific routes. With new algorithms for cycle routing it is now possible to infer bicycling routes between origins and destinations. Therefore, the objective of this study is to investigate the correlates of bicycling in Hamilton, Ontario, a mid-sized city in Canada and part of the Greater Toronto and Hamilton Area. Using bicycle trip records from the Transportation Tomorrow Survey, a spatial interaction model is developed to test the level of bicycling against various built environment attributes. A feature of the analysis is the use of CycleStreets to compare different routes between origins and destinations. The various routes are characterized as being fastest, quietest, or balanced. In addition, network autocorrelation is accounted for in the estimated models. The models suggest that shortest-path quiet routes that allow bicyclists to avoid traffic best explain the pattern of travel by bicycle in Hamilton. This method is useful to better understand the types of routes that bicyclists may seek out and presents opportunities to systematically audit the built environment for attributes that correlate well with bicycling.

4. Analysis

Three spatial interaction models were estimated in R Studio. Bicycle trip counts were the dependent variable, the zonal attributes were independent explanatory variables, and the distance or time of approximate cycle routes as a measure of spatial separation. Akaike’s Information Criterion (AIC) was used to compare the estimated models. The relative likelihood was calculated as a final measure of comparison. Model #3 included variables zonal attributes at the origin and destination, topography, and quietest distance as the measure of separation produced the best model. There was no network autocorrelation present.

5. Discussion

The best model reveals that quiet routes that allow bicyclists to avoid traffic while minimizing distance best explain the pattern of travel by bicycle in Hamilton. This indicates that people who travel by bicycle in Hamilton are likely to be seeking out routes that are less busy and potentially more enjoyable. This finding is consistent with a recent study that used GPS data to investigate bicycle route preferences [11]. While we cannot know with complete certainty which routes were travelled, by exploring different types of routes in our study we found a statistically significant preference for quiet routes that minimize distance.

Furthermore, the model reveals that points of interest at the zone of origin have a negative influence on the number of expected bicycle flows. This can create more intervening opportunities that ultimately reduce the need to travel. The model also uncovered a positive relationship between diversity of land use and characterized by mix of uses at zone of destination, and the expected number of trips - which is also consistent with other studies. Topography was found to have a negative relationship with the expected number of bicycle trips, likely because it increases effort to travel.

6. Future Research

The analysis of flows that were over- and under-predicted (Figure 4) presents opportunity to explore the built environment along approximated bicycling routes. We hypothesize that shortest-path quiet routes may have attributes that promote or hinder travel by bicycle, including bicycle facilities or lower speed limits, which leads to more enjoyable, less congested routes. This analysis will be conducted along turbine routes for OD O-D pairs that were under-predicted.

References


[7] Elise M. Desjardins, BSc. and Dr. Antonio Paez, PhD. School of Geography and Earth Sciences, McMaster University, 1280 Main Street West, Hamilton, Ontario, Canada.


