Effects of Bicycle Facility Characteristics and the Built Environment on Bicycle Use: Case Study of Fargo-Moorhead — Executive Summary

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SURCOM RESEARCH SUMMARY

Abstract

This study developed a level of traffic stress (LTS) map for Fargo-Moorhead (ND-MN) and used crowdsourced bicycle use data from Strava to show relationships between the built environment and bicycle use. The LTS map is useful for showing how friendly and encouraging areas are toward bicycle use, as well as for showing the connectivity of low-stress pathways. The bicycle ridership model shows how the development of bicycle facilities and other changes to the built environment are associated with bicycle use, as measured using Strava count data. The results of the bicycle use model show that the existence of bicycle facilities is positively associated with bicycle use

Introduction

In recent years, cities across the country have been designing new bicycle facilities, or making improvements to existing ones, to provide additional transportation options to residents and encourage increased bicycling. While providing new bicycle facilities may encourage increased bicycling, design characteristics of the street and the built environment are also important.

To measure how bicycle facility and street design characteristics affect bicycle users, previous studies have developed the level of traffic stress (LTS) ratings, which is a 1-4 rating given to a road segment or crossing indicating the level of stress it imposes on bicyclists.

The LTS rating is a theoretical model for predicting bicycling. The factors used to calculate LTS may be important for predicting bicycle use, but other factors may also be important, such as population density, employment density, land use mix, proximity to destinations, connectivity, and demographics. The objective of this research is to study how each of these factors are associated with bicycle use. The research also examines if bicyclists are using roadway design features that are meant to accommodate them.

One of the limitations for conducting this type of research is a lack of data on bicycle use. Recently, studies have begun using crowdsourced GPS data on bicycle use to gain a better understanding of bicycle ridership patterns. One popular source of such data is Strava Metro. This study takes advantage of bicycle count data available from Strava Metro and analyzes bicycle use in the Fargo-Moorhead metropolitan area.

Specific research objectives are as follows:

- Review the literature on bicycle LTS and other measures of bicycle level of service or suitability, the determinants of bicycle use, and the use of crowdsourced data for bicycle use.
- Develop an LTS map for Fargo-Moorhead
- Estimate the relationship between bicycle facility characteristics and bicycle usage.
- Identify the importance of street design characteristics on bicycle usage.
- Determine the importance of other built-environment or land-use characteristics on bicycle usage.

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Level of Traffic Stress

Following methods developed in previous studies, a level of traffic stress (LTS) map was developed for the Fargo-Moorhead metropolitan area. Road segments and bicycle facilities were categorized based on traffic features such as road width, traffic speed, annual average daily traffic volume, functional class, and the presence of or lack of on-street parking, and whether bikes are in mixed traffic, bike lanes, or on segregated routes. Road segments and bike facilities are classified as LTS 1, LTS 2, LTS 3, and LTS 4. LTS 1 roads and bikeways are the least stressful, with low traffic levels and speed restrictions, whereas LTS 4 roadways and bikeways are the most stressful, with high traffic volumes and speed limitations.

Figure 1 shows the constructed LTS map for Fargo-Moorhead. Low-volume residential streets with speed limits of 25 or lower are generally rated as LTS 1, and they account for a large share of the street network. As a result, 56% of the Fargo-Moorhead segments and pathways are classified as LTS 1, while 17% are LTS 2, 3% are LTS 3, and 24% are LTS 4 (higher speed arterials).

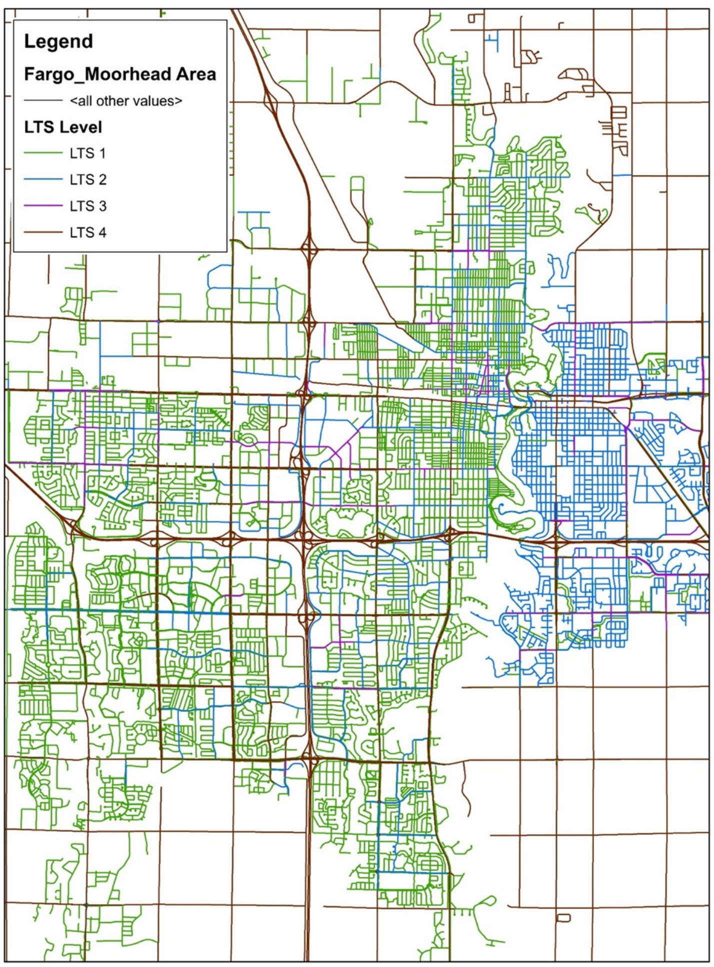

Figure 1. The Level of Traffic Stress Map of Fargo-Moorhead

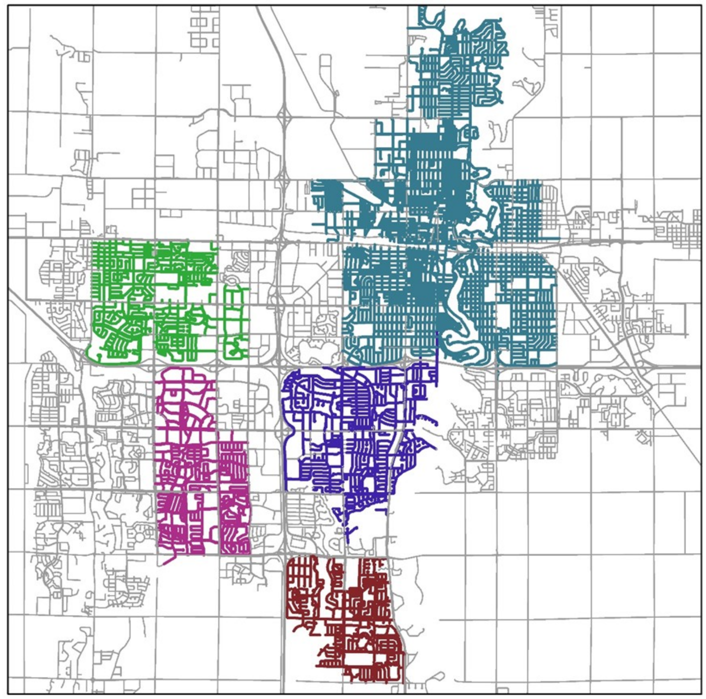

Figure 2. Clusters of LTS 1 and 2 Connectivity

Calculations were made using speed limit data instead of actual vehicle speeds. The use of actual vehicle speeds could provide different results. Low-volume residential streets were classified as LTS 1 if their speed limit was 25 mph. Low-volume residential streets in Moorhead were all classified as LTS 2 because the speed limit is 30 mph. The methodology provides support for speed limits being no higher than 25 mph on these streets, because those lower speeds are necessary to create a network that is more supportive of bicycle use.

Also important is the connectivity of the low-stress network, because greater connectivity allows users to access a larger portion of the city exclusively on low-stress segments. While much of the Fargo-Moorhead area consists of low-stress facilities, higher-speed and higher-volume roadways often create barriers for the low-stress network. Overcoming these barriers often requires lower-stress options for crossing an LTS 3 or 4 roadway.

To illustrate the connectivity of low-stress networks, Figure 2 shows the largest connected clusters of LTS 1 or 2. Barriers are created by LTS 3 or 4 facilities, or natural

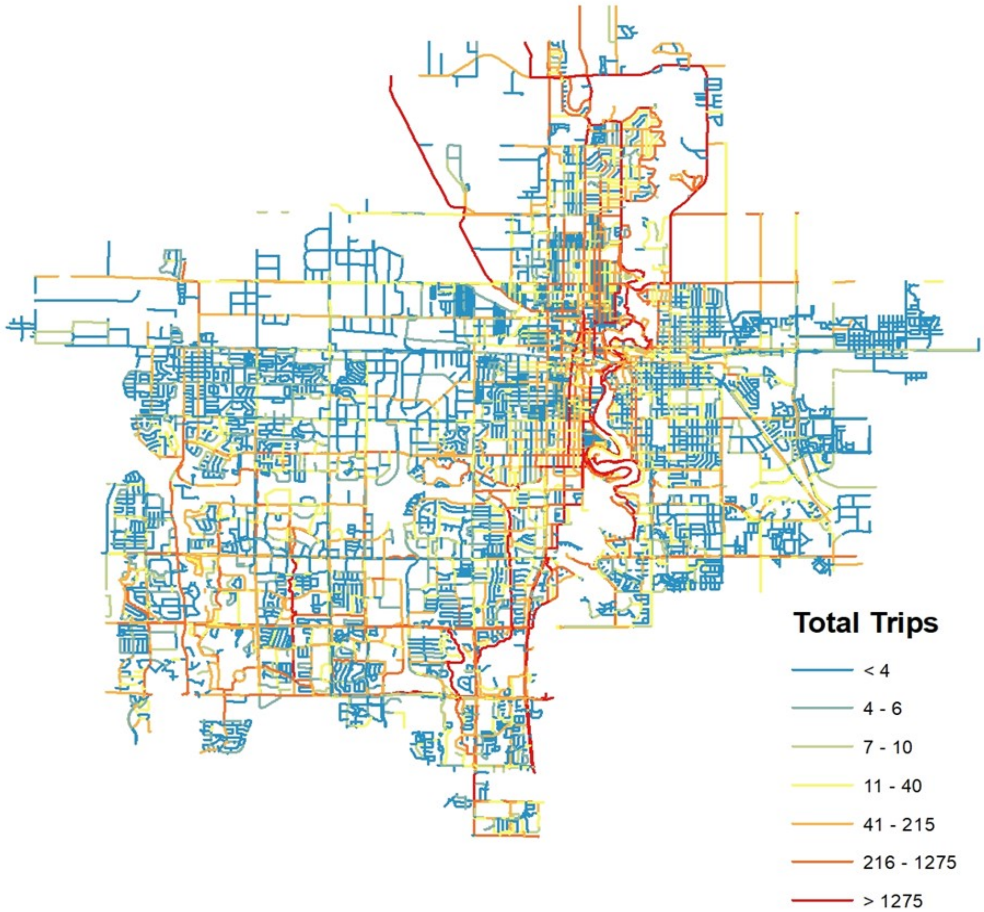

Figure 3. Map of Strava Bicycle Trips for Fargo-Moorhead 2019-2020

barriers such as rivers. The map shows there are some large clusters of low-stress networks, but their utility is limited if they lack low-stress interconnecting links.

Crowdsourced Bicycle Use Data

One of the major challenges to bicycle research and understanding bicycle usage is a lack of bicycle count data. Collecting bicycle count data manually or with automatic counters can be time consuming or expensive, so the number of locations for which bicycle count data are available is limited in most cities. This is especially true in smaller cities.

One potential solution to this data problem is the use of crowdsourced data, which researchers have begun using to study various issues relating to bicycle use. Crowdsourced ridership data can be obtained through fitness apps that collect data by using GPS-enabled devices. One of the more popular of these apps is Strava. Strava also provides a data product, called Strava Metro, that has emerged recently as a new data source for analyzing bicycle ridership. Strava users track their bicycle trips with their phone or GPS device and share that data with the Strava app. One potential concern in using crowdsourced data such as Strava is that the data may not be representative and could be biased. This bias could be expected because only a small percentage of bicycle riders use Strava. Bias could occur if certain groups of people are more likely to use Strava or if Strava is more likely to be used for certain types of trips. Research on the degree or seriousness of the bias is mixed, and several studies show that the data can still be useful.

Strava bicycle use data were obtained for Fargo-Moorhead for the two-year period of 2019-2020. Figure 3 shows the total count of bike trips from Strava summed over this period. Areas with the greatest number of trips include the trails near the river, streets in or near downtown, various shared-use paths, and popular routes for recreational cyclists who are riding out of town. The number of trips recorded by Strava is a small sample of the total number of bicycle trips taken.

Model of Bicycle Use

The level of traffic stress is important because it influences how comfortable someone is likely to feel riding a bicycle, which can determine whether they decide to ride their bicycle and influence the overall level of bicycle use in the city. The components of LTS are related to the design of the street and bicycle networks. Along with these design characteristics, other elements of the built environment, including density, diversity, and destination accessibility, as well as demographics, were used as a theoretical framework for modeling bicycle use. Measures of density in the study include population and employment density. Land use mix was used as a measure of diversity. Several design factors were considered. Proximity to downtown and to bodies of water were also considered. A spatial error regression model was developed to analyze the association between these variables and bicycle use in the Fargo-Moorhead area. The crowdsourced data from Strava were used to measure bicycle use.

The results of the bicycle use model provide some expected results and some surprising results. First, the model shows that the existence of bicycle facilities is positively associated with bicycle use. This suggests that bicyclists are using the roadway design features that are meant to accommodate them, and it suggests that investments in these facilities have been useful. Results also show that each type of bicycle facility has had a positive effect, even shared-lane markings, signed-only routes, and shoulders, although the effect is greatest for shared-use paths and bike lanes. Connectivity was also shown to be important. Areas within a larger cluster of connected, low-stress streets or bike paths had higher levels of bicycle use.

Bicycle use was also found to be greater in or near downtown and in areas near the Red River or Sheyenne River. These are popular attractors for bicycle use. The findings, therefore, support the development of bicycle infrastructure in these areas.

Areas with higher traffic volume and speed surprisingly had greater bicycle use, even though these are higher stress areas that would be expected to discourage bicycle use. This result may be because arterials and collector streets with higher speeds and traffic volumes provide better access to destinations and more direct routes for cyclists. It could also be due to bias in the data, as Strava users may be more confident bicyclists who are less deterred by the higher-stress routes. The results do not show specifically that the bicycle traffic is occurring on the streets, but rather it could be on adjacent paths or sidewalks. Some of these streets have separated paths to accommodate bicyclists. The findings suggest that these higher stress streets should have facilities to accommodate bicyclists, particularly separated paths, because there is higher demand for bicycle use.

Conclusions

The research provides information to transportation planners regarding barriers in the bicycle network and the effectiveness of investments and design strategies on encouraging bicycle use. The results show that investments in bicycle infrastructure have been effective in promoting bicycle use, and the study provides insights on where additional investments could be beneficial. The study also shows how emerging crowdsourced data could be used to supplement traditional data sources in understanding bicycle use within a city. The Strava data represent only a small portion of bicycle use, but existing bicycle count data is sparse, and the combination of official count data with crowdsourced data can be useful for mapping bicycle use across the metro area, especially if use of the app continues to increase.

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