National Center for Sustainable Transportation

RESEARCH BRIEF

BikewaySim and Complete Paths Networks are Expected to Improve Modeling of Bicycle Activity and Route Choice

Reid Passmore, Kari E. Watkins, and Randall Guensler
Georgia Institute of Technology

February 2022

Research Question

Many cities are focused on increasing bicycle use through development of infrastructure such as bicycle lanes and multi-use paths. Traditionally, travel demand models (TDMs) are used to evaluate the demand for (and impact of) proposed transportation projects. However, the vast majority of TDMs cannot be used to evaluate the impact of bicycle projects, for two main reasons. First, most TDM networks only include a street network comprised of freeways and major arterials, leaving out minor arterials, local roads, and multi-use trails commonly used by bicycles. Second, traditional route assignment is based almost entirely on travel time. Research shows that cyclists will deviate from the lowest travel time route to avoid roads without dedicated bicycle facilities, with high traffic levels, or with steep uphill grades. Improved TDMs are needed to help estimate the impacts of new bicycle projects on cycling activity and prioritize the construction of the most beneficial bicycle projects with limited transportation department resources.

To more accurately model bicycle travel, preference-based route assignments are needed. Such route assignments would account for cyclists' preferences for roadway characteristics such as the presence of dedicated bike lanes, low traffic volumes, and absence of large trucks. Preference-based bicycle trip route assignment requires a much denser transportation network with extensive and detailed information on roadway characteristics. Researchers at the Georgia Institute of Technology created a semi-automated process for developing an all-streets network to be used in TDM applications. The researchers combined detailed roadway characteristic information from three different transportation networks in GIS shapefile format and used BikewaySim, Georgia Tech's newly developed shortest-path calculator for cycling trips, to compare shortest-path routing on the newly created all-streets network versus the simplified TDM network for a 12-square-mile study area in Atlanta. The methods employed in this research are designed to be transferrable to other regions.

Key Findings

The researchers implemented a semi-automated network reconciliation process to construct the all-streets network. This semi-automated process employs Python scripts and is publicly available for use by other researchers and practitioners. These scripts reduce the time required to construct an all-streets network and ensure that all available network characteristic data (e.g., road classification, number of travel lanes, bicycle facility presence) from every source are included. The resulting network still requires a quality assurance/quality control verification process. These network reconciliation scripts are documented and structured in a way that allows them to be used with any network with only slight modifications to the scripts.

Multiple data sources must be reconciled to generate a network that contains the most useful information for modeling bike activity in TDMs. The researchers reconciled the Atlanta Regional Commission's activity-based model network, the proprietary HERE map data network, and the OpenStreetMap network to create an all-streets network for the study area. While the total length of public roads between the OpenStreetMap and HERE networks was similar, OpenStreetMap contained more off-street bicycle paths and service roads. However, the HERE data has more complete attribute data than the OpenStreetMap data. The differences between these networks make it clear that using any single existing network to model bicycle travel is unlikely to be sufficient. The all-streets network developed through reconciliation is a more complex and realistic network for bicycle travel than the simplified network used in current TDMs (Figure 1). The final all-streets network excludes parking lot roads and driveways currently present in OpenStreetMap and HERE, as more research is needed to identify which path types may be critical for bike routing.

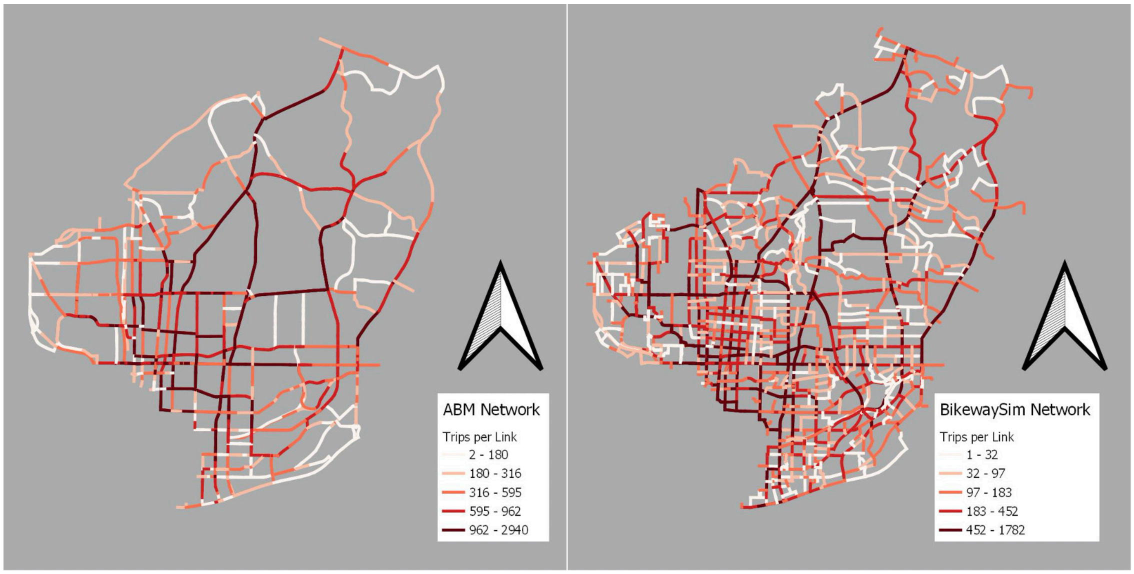

Figure 1. Simplified activity-based TDM network (left) and the all-streets BikewaySim network (right) for the 12-square mile study area in Atlanta

BikewaySim confirms that the all-streets network generates more realistic bicycle routes than would be predicted by TDMs with simplified road networks. The researchers found that modeled trip distances in the study area were slightly shorter using the all-streets network, because the complete pathways network added many alternative network routes. In switching from the traditional network to the all-streets network, 30% of the trip-miles shifted to the added pathways. Hence, the all-streets network includes links that provide shorter routes for bicycles and could be employed in future TDMs to more accurately model bicycle activity.

Using an all-streets network may increase TDM run times. The shortest-path computation time took twice as long with the all-streets network as with the simplified network. This result was expected, given the increase in links and nodes from the TDM network to the all-streets network. This time difference would be more significant when modeling automobile travel where the model is run iteratively to account for congestion. Hence, integrating enhanced all-streets networks into TDMs will need to be balanced against increased processing time, and TDMs might use subsets of the all-streets network to improve run times.

More Information

This research brief is drawn from "BikewaySim Technology Transfer: City of Atlanta, Georgia" a report from the National Center for Sustainable Transportation, authored by Reid Passmore, Kari E. Watkins, and Randall Guensler of the Georgia Institute of Technology. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/bikewaysim-technology-transfercity-atlanta-georgia.

For more information about the findings presented in this brief, contact Reid Passmore at tpassmore6@gatech.edu.

DOI: 10.7922/G2DZ06M7