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TRANSPORT FINDINGS

Projecting Reductions in Vehicle Kilometers Traveled from New Bicycle Facilities

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Transport Findings

This paper presents a simple method for projecting the impact of new bicycle facilities on vehicle kilometers traveled. Our method starts with existing short-duration bicycle counts on or near the facility corridor, then applies six adjustment factors to project reductions in vehicle kilometers traveled. We examine the feasibility of measuring each factor and the range of their potential values.

RESEARCH QUESTION AND HYPOTHESIS

To what degree will new bicycle facilities reduce driving? We present a simple method for projecting the impact of new bicycle facilities on vehicle kilometers traveled (VKT).

METHODS AND DATA

We developed an equation for projecting VKT reductions resulting from new bicycle facilities using existing short-duration bicycle counts on or near the facility corridor. We then reviewed the English-language literature related to the variables in our equation to gauge the feasibility of measuring each and the range of their potential values. We focus on Class I bicycle paths (separated right-of-way for exclusive bicycle use), Class II bicycle lanes (on-street lanes designated for bicycle use), and Class IV cycle tracks (on-street lanes protected from vehicular traffic by barriers like posts).

FINDINGS

Our method starts from the premise that bicycle "ridership change can be predicted reasonably reliably by volumes observed before facility installation" (Matute et al. 2016). Our equation takes an hourly (or daily) pre-installation bicycle count on or near the corridor of the proposed facility, then applies six adjustment factors to project annual VKT reductions induced by adding the facility (see Figure 1).

The pre-facility-installation bicycle count, F, will vary by project. Best practices for collecting bicycle counts are well established (e.g., Ryus et al. 2014).

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Figure 1: VKT Reduction Equation

Annual Auto VKT Reduced=$F*S*G*T*A*C*L$

Where:

F = bicycle flows on the street to be improved with the bicycle facility or, in the case of a facility not on an existing street, a parallel street (measured as average hourly or daily bicycle counts);

S = seasonal adjustment factor (adjusts the short-duration bicycle count to annual average bicycle trips, accounting for temporal and seasonal variation);

G = growth factor (expected rate of increase in the bicycle count, e.g., 1.0 for a 100% increase in trips on the route; can vary by facility type and length, where sufficient data exists);

T = trip type factor (decrements the increased bicycle count projection by the average percentage of bicycle trips made for recreation; include for more conservative projections);

A = automobile substitution rate (expected rate at which cyclists who did not bicycle on the same route prior to bicycle facility installation switched from driving—or being driven in—an automobile to cycling);

C = carpool factor (reciprocal of the average occupancy for personal automobiles; adjusts for the fact that not all motorists switching to bicycling would have driven alone); and

L = bicycle trip length (produces bicycle kilometers traveled).

The seasonal adjustment factor, S, has a dual purpose of converting the short-term bicycle counts to yearly count estimates and adjusting for the substantial temporal and seasonal variation found in bicycling counts (Jones et al. 2010; Nordback and Sellinger 2014; Skov-Petersen et al. 2017). A year's worth of continuous bicycle count data from even a single counter can be enough to calculate local seasonal adjustment factors (Nordback and Sellinger 2014). Researchers have also attempted to develop more generally applicable seasonal adjustment factors for use in areas without sufficient local bicycle counts (e.g., National Bicycle and Pedestrian Documentation Project. 2009).

The growth factor, G, represents the expected rate of increase in bicycle usage after facility installation. Multiplying the seasonally-adjusted pre-installation bicycle count by the growth factor yields an estimate of the additional annual bicycle trips on the route. Table 1 shows the range of growth factor values from studies that reported facility-level ridership changes after bicycle facility additions.

Table 1: Ridership Change Findings by Facility Type

Facility Type	Ridership Change (Facility Number)	Sources	Notes
Class I: Bicycle Paths	Mean = 86% (see notes)	Matute et al. (2016)	This was the only study we found reporting route usage changes after bicycle path installation that distinguished between bicyclists and pedestrians; however, the results for just Class I facilities are not clear because the study combined counts for two bicycle paths with counts for two bicycle boulevards and six cycle tracks.
	Median = 48%		
Class II: Bicycle Lanes	Mean = 119% (n = 37)	Goodno et al. (2013); Gudz, Fang, & Handy (2016); Matute et al. (2016); Sallaberry (2000)	Mean of reported percentage changes in route usage.
	Median = 73% (n = 34)	Matute et al. (2016)	Median of reported percentage changes in route usage.
	Range = see notes	City of Toronto (2001); Goodno et al. (2013); Gudz, Fang, & Handy (2016); Matute et al. (2016); Sallaberry (2000)	Facility-specific ridership changes (versus mean and median percentage changes) were only reported for three of the facilities in the studies we reviewed.
Class IV: Cycle Tracks	Mean = 119% (n = 10)	Goodno et al. (2013); McClain & Peterson (2016); Monsere et al. (2014)	The mean, median, and range are of reported percentage changes in route usage. This excludes the ridership change data for the six Class IV facilities studied in Matute et al. (2016) because those counts were only presented as combined with counts for two bicycle paths and two bicycle boulevards.
	Median = 67% (n = 10)		
	Range = 21% – >500% (n = 10)		

The low number of new facilities with reported before and after counts specific for bicycling makes it difficult to discern how the growth factor changes by facility type, length, or connectivity. While this presents an obvious need for future research, the results do indicate that ridership increases close to 100% ($G = 1.0$) are not uncommon along the routes of new Class I, Class II, and Class IV facilities.

The results also indicate that the magnitude of the percentage increases may remain relatively stable regardless of the bicycle counts before facility installation, therefore indicating that pre-facility-installation bicycle counts can be a reasonably reliable predictor of counts made after installation (Matute et al. 2016; Goodno et al. 2013). The growth factor will vary depending on context and is likely to vary more for facilities in areas with very high or very low existing bicycling levels. The before-and-after studies available for areas with high existing bicycling levels generally found growth rates comparable to the others; for example, there was a 119% increase in Davis, California (Gudz, Fang, and Handy 2016) and an 87% increase in Oakland, California (McClain and Peterson 2016). Conversely, studies in areas with very low base bicycling rates showed minimal to no increases in bicycling following infrastructure improvement (Brown et al. 2016; Burbidge and Goulias 2009; Evenson, Herring, and Huston 2005). However, it would take a rate much higher than 1.0 to appreciably change VKT reduction estimates in those areas.

The trip type factor, T, decrements the post-facility-installation bicycle count projection by the average percentage of bicycle trips made for recreation (e.g., as derived from a household travel survey). But the adjustment may lead to a conservative projection. At least one study indicates that bicycle facilities influence an individual's choice to bicycle instead of drive for utilitarian *and* recreational purposes (Matute et al. 2016). Furthermore, the studies from which we gleaned the auto–bicycle substitution rates calculated the rates from all surveyed cyclists, not just utilitarian cyclists (Matute et al. 2016; Monsere et al. 2014; Thakuriah et al. 2012).

The auto substitution factor, A, and carpool factor, C, convert the projected additional bicycle trips into avoided automobile trips. Auto substitution represents the percentage of additional bicycle trips that would have otherwise been made by automobile. The rate is generally much lower than the existing auto mode share in the corridor because most of the "new" cyclists would have also cycled before installation of the new infrastructure, just on a different route. The available data indicate an auto substitution rate of about 0.1, mostly based on data from intercept surveys on Class IV facilities (Matute et al. 2016; Monsere et al. 2014; Thakuriah et al. 2012). The carpool factor corrects for the fact that not all those shifting from auto to bicycle would have driven alone previously and is the reciprocal of the relevant average vehicle occupancy.

The trip length factor, L, converts the projected reduction in automobile trips into avoided VKT. Data on average bicycle trip length (usually 3–5 km) can be used here (e.g., from national, state, or regional household travel surveys).

While data on some variables in our equation remain sparse, it is increasingly possible to project VKT reductions from new bicycle facilities using existing short-duration bicycle counts. Table 2 presents potential default values for the independent variables in our equation, except the site-specific bicycle count and seasonal adjustment factor. We chose California as the example region in setting values for the carpool factor and bicycle trip length.

Table 2: Potential Default Values for Equation Variables (Except *F* and *S*)

Variable	Potential Default Value	Notes and Sources	Specific to California
Growth Factor (*G*)	*1.0*	See Table 1 and proceeding discussion.	No
Trip Type Factor (*T*)	*0.506*	Default is based on the combined share (49.4%) of bicycle trips made for "vacation" (2.1%) or "other social or recreational" (47.3%) purposes, taken from the 2009 National Household Travel Survey in the United States. Default is the percentage of all other trips, calculated as 1–0.494 (= 0.506); however, this article covers why this factor might lead to a conservative projection.	No, but specific to the US
Auto Substitution Factor (*A*)	*0.1*	Matute et al. (2016); Monsere et al. (2014); Thakuriah et al. (2012).	No
Carpool Factor (*L*)	*1/1.15*	Reciprocal of average vehicle occupancy rate (average number of people per auto) used by California Department of Transportation (1.15) (CA Department of Transportation, 2016).	Yes
Trip Length Factor (*L*)	*2.4*	Average bicycle trip length (kilometers) across all trip purposes, as estimated by 2010–2012 California Household Travel Survey (CA Department of Transportation, 2013).	Yes

Table 3 applies the default factors from Table 2 to estimate the annual VKT reduction from the 2014 installation of Class II lanes eastbound and westbound on a 1.3 km section of Fifth Street in Davis, California. The result is an annual VKT reduction of 77,512.

Table 3: Applying VKT Reduction Equation to Fifth Street Road Diet Project (Davis, CA)

Variable	Value	Notes and Sources
Before-installation Bicycle Count (*F*) * Seasonal Adjustment Factor (*S*)	*734,015 (trips/ year)*	Before-installation hourly bicycling counts were reported by Gudz, Fang, & Handy, (2016) and seasonally adjusted to yearly estimates using factors from the method developed in National Bicycle and Pedestrian Documentation Project (2009).
Growth Factor (*G*)	*1.0*	See Tables 1 and 2.
Trip Type Factor (*T*)	*0.506*	See Table 2.
Auto Substitution Factor (*A*)	*0.1*	See Table 2.
Carpool Factor (*L*)	*1/1.15*	See Table 2.
Trip Length Factor (*L*)	*2.4*	See Table 2.
Annual VKT Reduced	77,512	Product of all variable inputs.

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