ITRE Triangle Regional Model Service Bureau

Using the TRM to Evaluate Non-Motorized Projects

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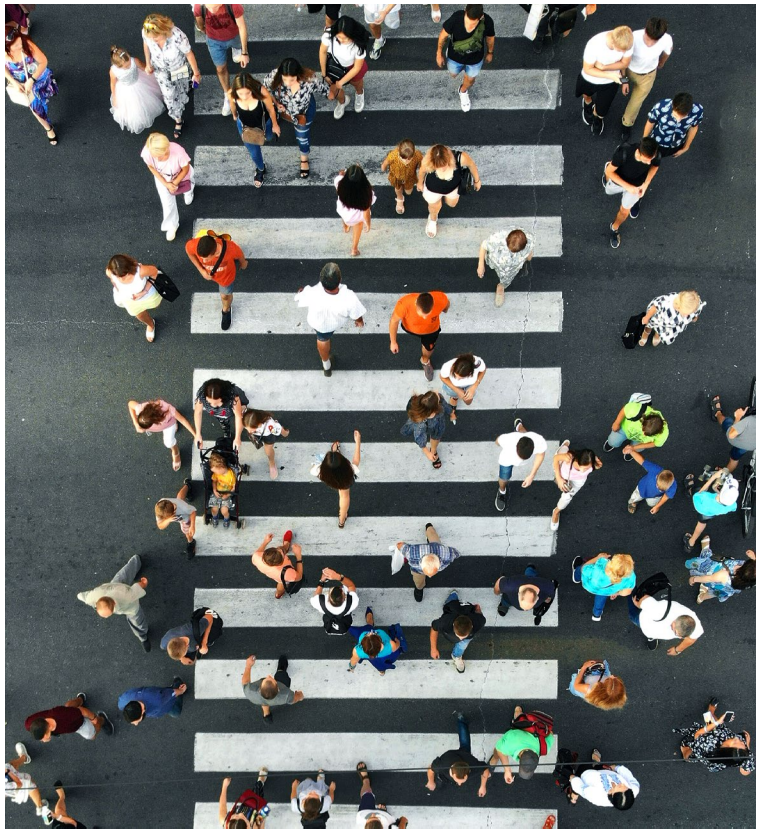

Introduction 1

As walking and cycling gain more popularity in the community, there is an emerging need from the Triangle stakeholders for more responsive tools to evaluate non-motorized (NM) projects.

In this analysis, the current best practice for modeling non-motorized trips in travel demand models was reviewed in order to identify potential ways to enhance the representation of non-motorized travel at a project level in TRMG2.

While regional travel demand models are not the most effective tool for evaluating individual non-motorized projects, the investigation documented in this report recommends the implementation of a model enhancement that will support the evaluation of non-motorized projects with TRMG2.

Literature Review

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Overview

Five (5) papers on the topic of modeling non-motorized trips were reviewed. Three discussed various methods of estimating non-motorized trips within a traditional regional model framework. The other two recommended alternative methods for modeling non-motorized trips. The most useful paper supporting this investigation is summarized in this section.

Pedestrians in Regional Travel Demand Forecasting Models: State-of-the-Practice

The authors of this paper reviewed 48 MPOs models.

- 30 of the 48 models include a non-motorized component
- 14 of the 30 distinguished between walk and bike trips

The authors categorized the models with a non-motorized component into 5 different frameworks, from simple to complex and captured the following:

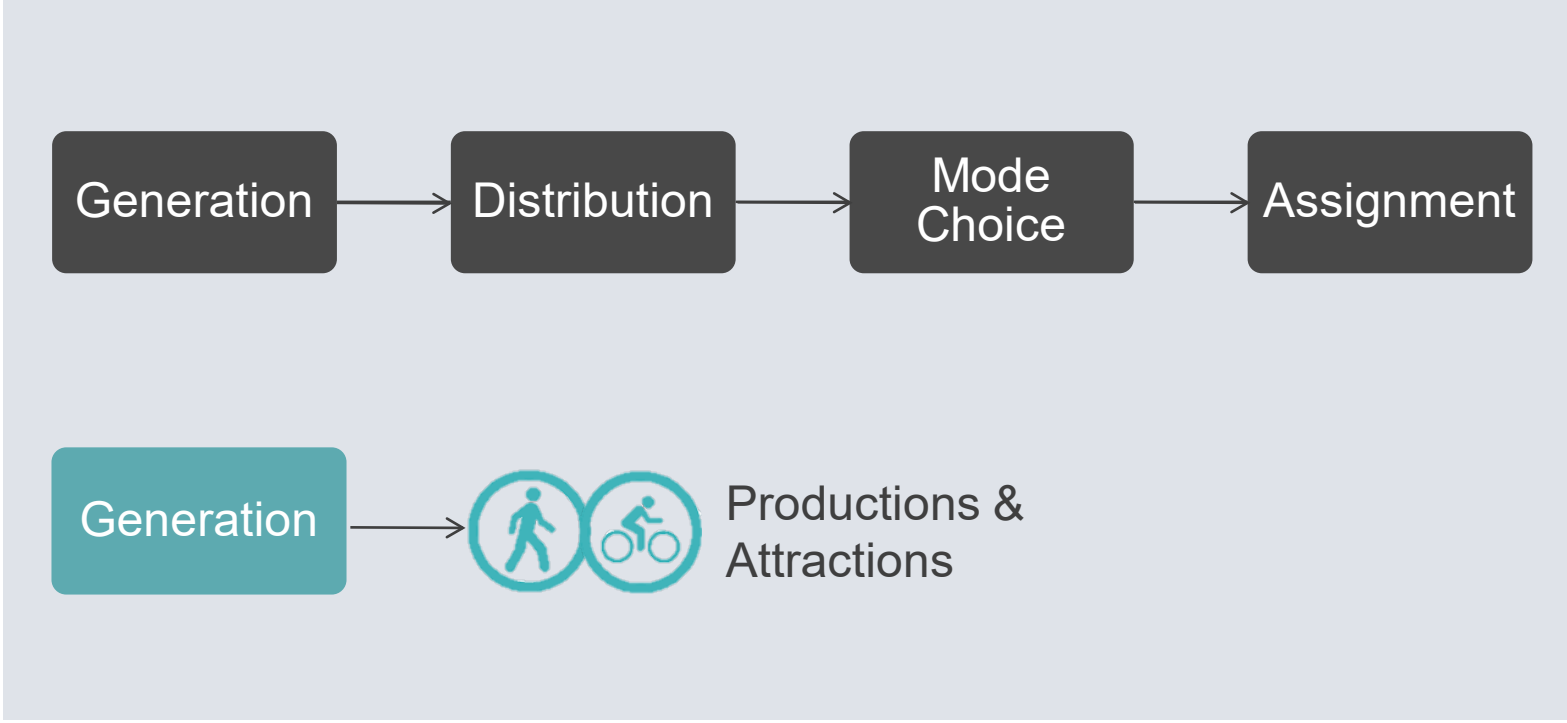
- Common model structure and variables
- Tradeoffs between the frameworks

The results of this review are summarized on the following pages.

Singleton, 2022

1: Separate Trip Generation Process

Non-motorized trips are generated independent of motorized trips. (2 of 30 models reviewed)



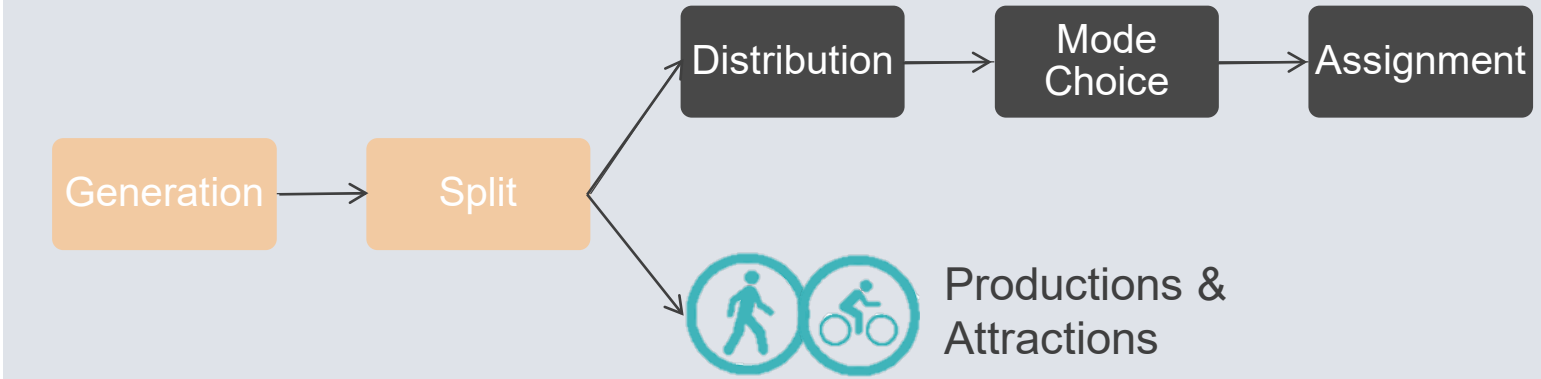
Model Structure: Usually implemented as a cross-classification model, similar to a traditional trip production model.
Common Variables: Household size, vehicle availability, area type, and trip purpose.
Tradeoff: This is a relatively simple add-on to an existing model and does not require recalibrating the existing model. However, it's not sensitive to changes within the regional model.

Singleton, 2022

Legend Motorized | Non-motorized | All Modes

2:
Post-Trip Generation, Pre-Trip Distribution/ Mode Split

Non-motorized trips are estimated following the trip production model and do not carry forward to trip distribution. (5 of 30 models reviewed)

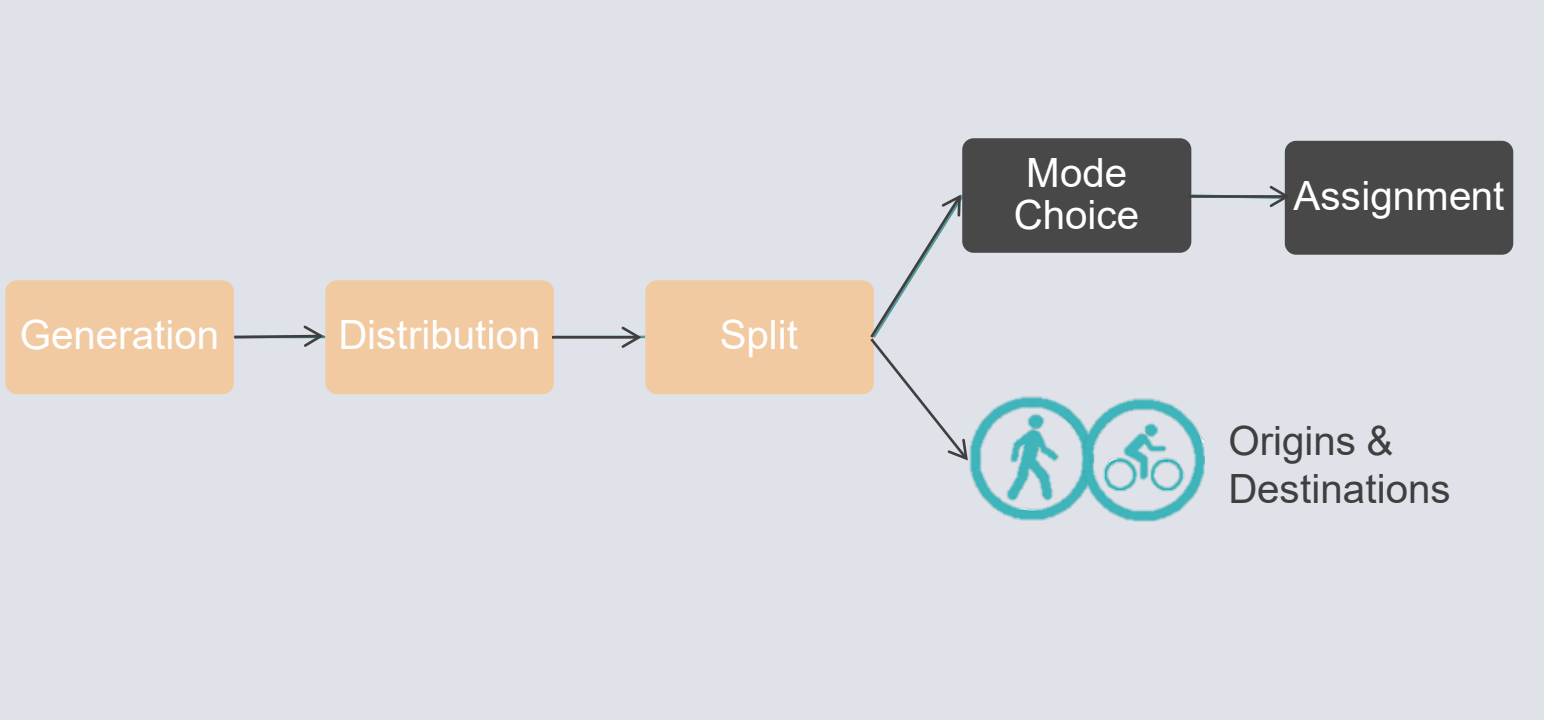


Model structure: Implemented as either a binary logit model, multiple regression, or a simple percent share.
Common variables: Area type, vehicle sufficiency, street block density, population to employment ratio, intersection density, network connectivity, and accessibility.
Tradeoff: Good option for MPOs unable to estimate non-motorized network skims.

Singleton, 2022

3: Post-Trip Distribution, Pre-Mode Choice Split

This approach applies a binary choice model after trip distribution, but prior to mode choice. (5 of 30 models reviewed)



Model structure: Implemented as a binary logit model.

Common variables:

Level of Service (LOS) variables: trip distance, travel time, non-motorized density of attractions (e.g. destination choice logsum).

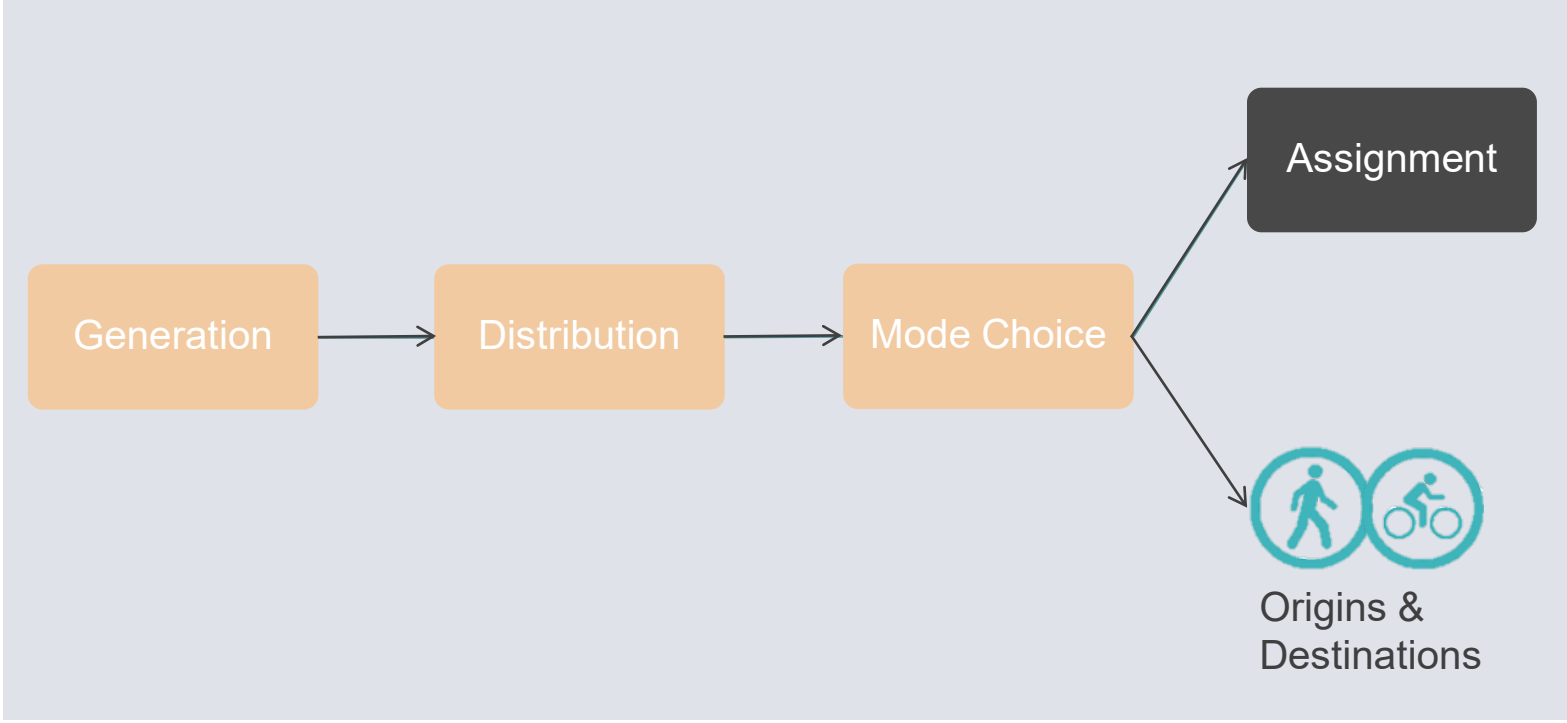
Built environment variables: NM friendly index, ease of crossing, area type, NM path density, block size.

Tradeoff: The model is more complex, but the use of LOS variables support a better estimate of non-motorized trip destinations.

Singleton, 2022

4: Mode Choice Model

This approach is implemented as a separate nest in the mode choice model. The nest can represent all non-motorized trips, or consider walk and bike trips separately. (18 of 30 models reviewed)



Model structure: Implemented as a multinomial or nested discrete choice model. The nesting structure reflects how the different non-motorized modes are modeled.

Common variables:

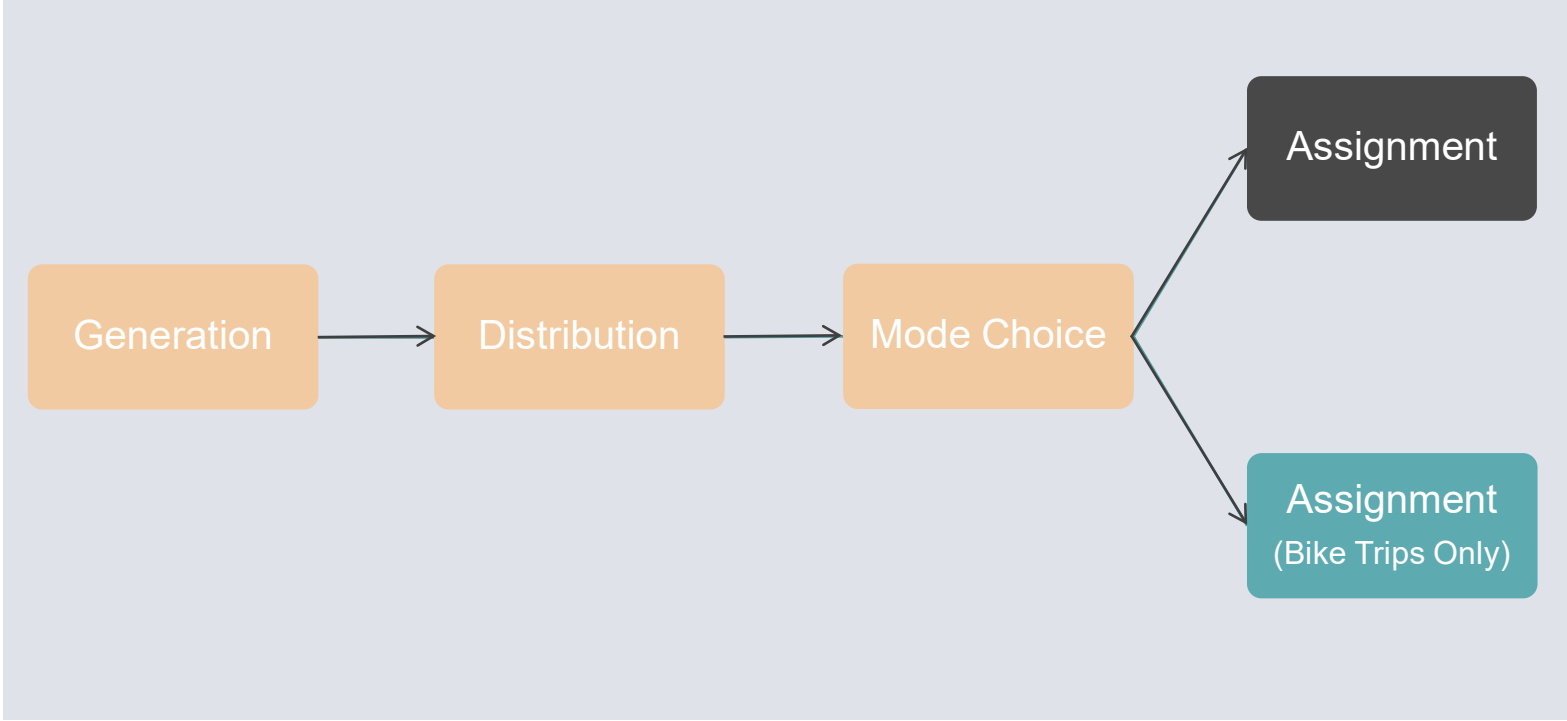
LOS variables: trip distance, non-motorized mode generalized cost.

Built environment variables: land use diversity mix, density, area type.

Tradeoff: Implementing this approach is often impeded by limited non-motorized survey observations making model estimation a challenge.

Singleton, 2022

5: Non-motorized Trip Assignment



This approach follows the same structure as #4, but an additional step is implemented that assigns the bike trip tables from mode choice a bike network. (2 of 30 models reviewed)

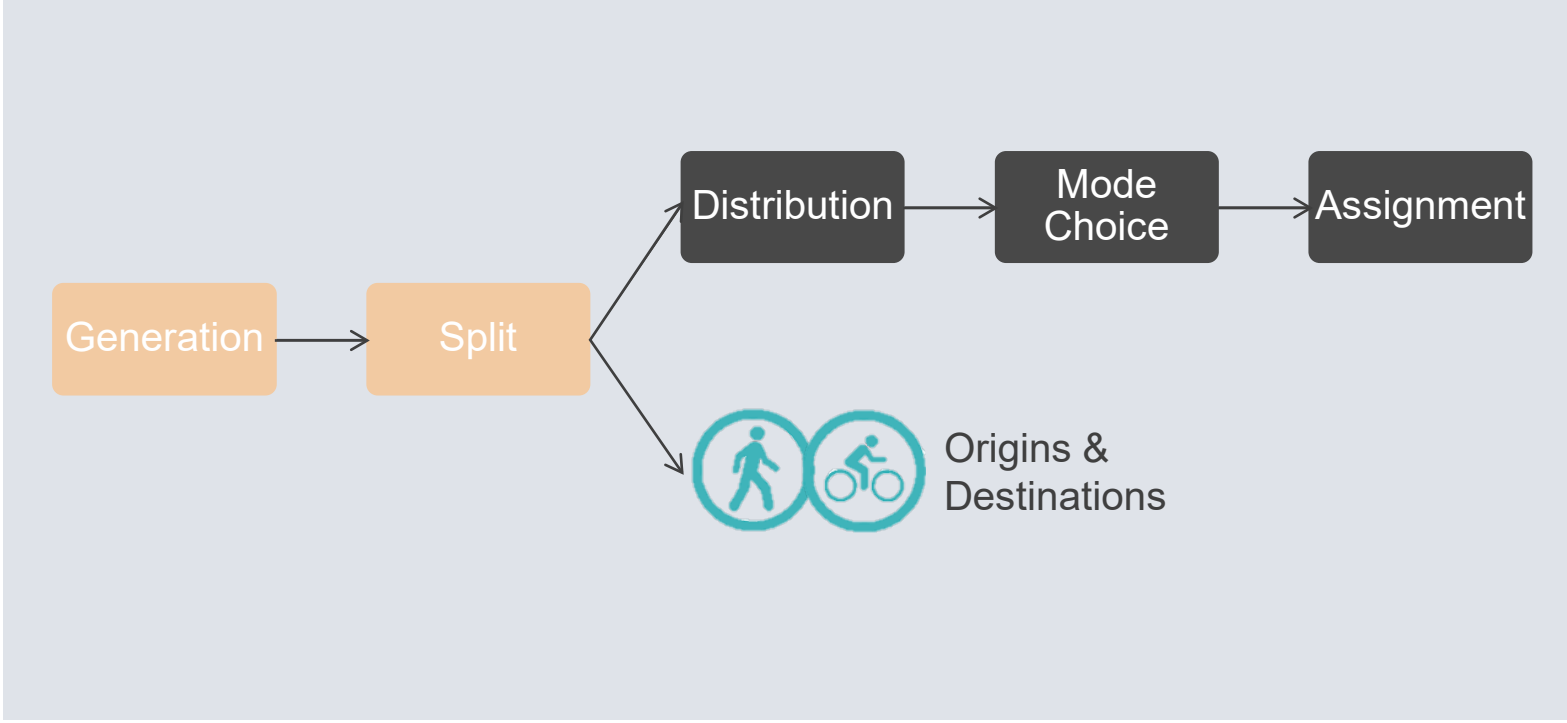
Model structure: Discrete choice model with trip assignment.
Common variables:
Bike nest: trip distance, travel time, total employment accessed within ½ mile, if production zone in bike user preference area, route attractiveness, number of stops.
Walk nest: travel time, pedestrian environment factor, retail employment accessed within ½ mile, number of stops.
Tradeoff: Requires sufficient bike and pedestrian observed counts to support model validation.

Singleton, 2022

TRMG2 Non-Motorized Model

TRMG2 applies a disaggregate choice model for estimating non-motorized trip productions by trip purpose. These trips are then distributed using a gravity model with walk skims from the all streets and greenway layer.

Because the survey data has limited sample size for bike and walk trips, NM trips are estimated as a whole instead of walk and bike separately.



Model structure: Implemented as a disaggregate choice model (productions) and gravity model (distribution).
Variables used: Accessibility in various forms, age, income, number of children, worker status, vehicle ownership and vehicle sufficiency.
Tradeoff: The TRMG2 non-motorized model is a fully disaggregate model and is sensitive to connectivity, accessibility, land use mix, transit accessibility, person characteristics, and household characteristics. The current model specification is not sensitive to the miles of sidewalk or bike lanes.

Commonly Used Variables

This table provides a summary of commonly used variables in non-motorized (NM) models. Variables are grouped by category and subcategory. The final column draws parallels to the variables included in TRMG2. This comparison shows that TRMG2 includes all of the commonly used variables with the exception of the variables for non-motorized facilities.

Category	Subcategory	Variables	TRMG2 Variables
Urban design / Built environment	Diversity	Land use diversity mix	Walkability (approach density, attraction density, GS index) and walk accessibility (SE + walkability)
	Density	Area type, population density, employment density, NM density of attraction	
	Network design	Street block density, block size, intersection density, network connectivity, and network restrictively	
Non-motorized facilities	Ped and bike environment factors	NM friendly index (% streets with sidewalks), ease of crossing (% streets that are easy to cross by pedestrians), NM path density[1]	N/A
Traveler characteristics	Demographic	HH size, HH income, vehicle availability, vehicle sufficiency, life cycle, age, gender	Age, presence of children, vehicles per adult, worker, income
Trip characteristics	Accessibility impedance	Travel distance, travel time distance, NM generalized cost	Accessibility measures (log sums of the gravity model)
	Trip purpose	Tour type, trip purpose	Tour type, trip purpose

[1] *NM path density variable is only used in TRMv6.*

Methodology

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Overview

The findings from the literature review suggest that:

- There is no standard approach to modeling non-motorized trips in travel demand models. The decision of what method to use is largely driven by available data and analysis needs.
- The TRMG2 reflects best practice through the use of accessibility measures and the application of a disaggregate model to estimate non-motorized trips.

Gaps in the existing TRMG2 process:

- TRMG2 does not use variables specifically related to the presence of bike lanes or sidewalks which creates a gap in what the model considers versus what the DCHC MPO wants to evaluate for non-motorized projects.
- Until such time that data can be collected to support the inclusion of this variable, the TRM team evaluated a method for asserting an impedance parameter as an indicator for the presence of a sidewalk and/or bike lane.

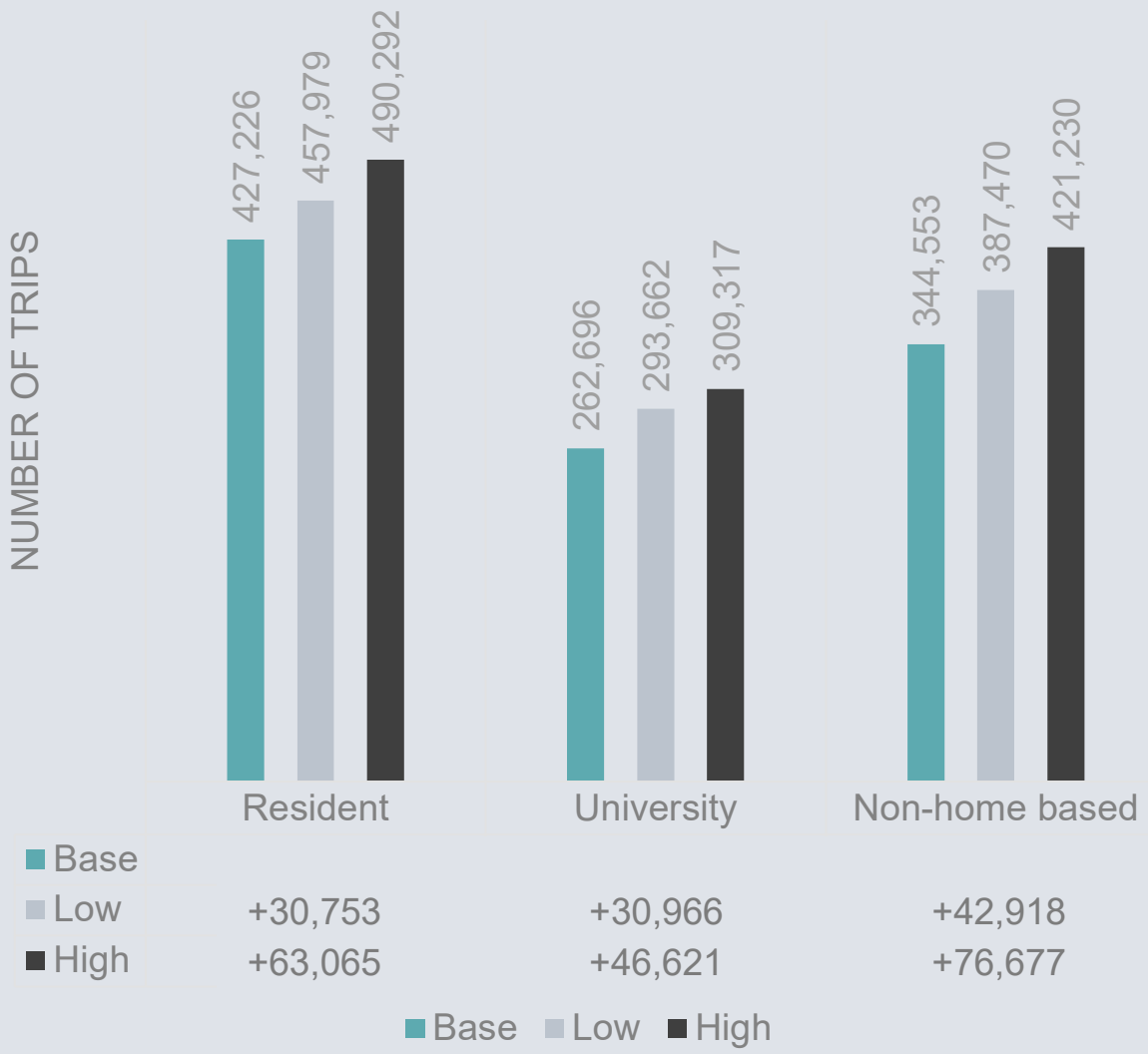
Analysis Approach

- Given the gap in the existing process with respect to the presence of on-road non-motorized facilities, and the challenges associated with collecting and maintaining that data, the analysis focused on applying an indicator variable for roadway links with planned future non-motorized facilities.
- The theory behind this approach captures the concept that bicyclists and pedestrians experience a reduced impedance when using a sidewalk or bike lane. In application, the walk speed can be used as an indicator for reduced impedance on roadway segments with planned sidewalks or bike lanes.
- To evaluate the sensitivity of the non-motorized model to a change in walk speed on a system wide level, scenario testing was used to evaluate the models response to a global change in walk speed. If the model is sensitive to this change, then it supports the application of the approach on a project by project basis.
- Two different scenarios were evaluated and compared to the base case:
  - Base: Walk speed = 3 mph (0% increase)
  - Low: Walk speed = 4 mph (33% increase)
  - High: Walk speed = 5 mph (67% increase)
- The 4 or 5 mph modified speed is not actual speed people can walk at, but rather simulating the decreased impedance associated with adding new walk or bike facilities.

NM Trips by Market

This slide summarizes the scenario results by travel market.

Across all markets, the non-motorized model is sensitive to the increase in non-motorized speed, and results in an increase in non-motorized trips as expected.

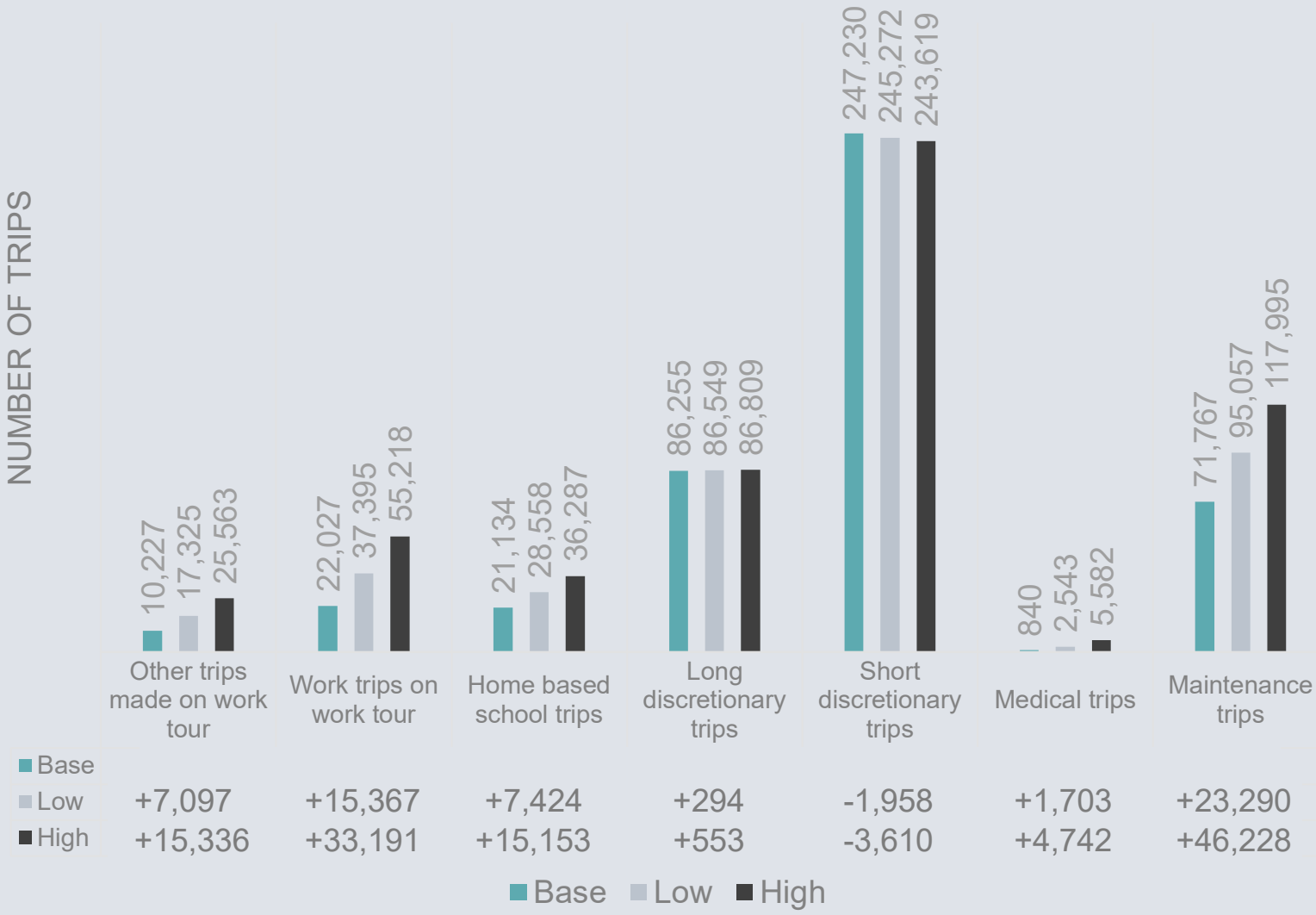


NM Trips by Resident Trip Purpose

This slide summarizes the scenario results by resident trip purpose.

Across most purposes, the non-motorized model is sensitive to the increase in non-motorized speed, and in general results in an increase in home-based non-motorized trips. The exception is the short discretionary trips which show a slight decrease in home-based non-motorized trips with the change in NM speed.

The reason for this result is explained in the next slide.



Short Discretionary Trip Results

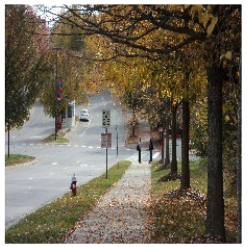
- Short discretionary trips are home-based. TRMG2 has a sophisticated handling of the relationship between home-based (HB) trips and non-home-based (NHB) trips.
- Increasing walk accessibility transfers some home-based trips to non-home-based trips.
- This shift is most notable for short discretionary trips which are quick trips that can be easily chained. The improved walk accessibility leads to an increase in trip chaining, resulting in a decrease in non-motorized home-based trips, but an increase in non-motorized non-home-based trips.
- This result reflects the sensitivity of the TRMG2 non-motorized trip model and the robust accessibility terms in the home-based and non-home-based models.

Total HB trips decreased across the board

NHB auto trips decreased

NHB walk trips increased by 22%
(77k more trips!)

NHB transit trips increased by 78%
(17k more trips!)



Recommendations

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Recommendations

1. For TRMG2v2 implement an enhancement that applies a link level walk speed based on a binary code of 0 or 1. For links with new sidewalk or bike facilities, 1 will be added and have a modified speed of either 4 or 5 mph. Links with 0 will get the base 3 mph speed.

2. The final choice of speed will be based on an additional project level sensitivity analysis once the enhancement is implemented in TRMG2v2.

3. A future enhancement could be the inclusion of a NM path density variable if the MPOs commit to a plan for collecting and maintaining this data for the TRMG2 model region.

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