LINK21

CONNECT NORTHERN CALIFORNIA

INITIAL TDLU TOOL DOCUMENTATION REPORT

DRAFT FINAL EXECUTIVE SUMMARY

February 2024

Prepared By:
Link21 Program Management Consultants (PMC)

BART

CAPITOL CORRIDOR

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Issue and Revision Record

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Acronyms and Abbreviations

ACRONYM/ABBREVIATION	DEFINITION
BART	San Francisco Bay Area Rapid Transit District
CCJPA	Capitol Corridor Joint Powers Authority
HBO	home-based other
MPO	metropolitan planning organization
RDM	Regional Dynamic Model
TDLU	Travel Demand and Land Use
TTW	travel to work
VoT	Value of Time

Link21 Program Team Names

TEAM NAME	TEAM MEMBERS
Program Management Consultants (PMC)	The HNTB Team
Program Management Team (PMT)	BART/CCJPA + PMC
Consultants	Consultants supporting program identification/project selection
Link21 Team	PMT + Consultants

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The material contained herein includes main findings and summaries of the Report and Outputs, and it should not be used as a single source of information about the Initial Tool performance or results. Detailed information regarding these findings is included in the Report.

Executive Summary

Introduction

The *Initial Travel Demand and Land Use (TDLU) Tool Documentation Report* (TDLU Report) describes the approach to develop and validate the Initial TDLU Tool that supports the Project Identification phase of the Link21 Program (Link21). This is a summary document and more details can be found in the main body which is available upon request.

The Link21 Team[1] has developed tools to assist with evaluating concepts. These include:

- *Initial TDLU Tool:* a zone-based simulation that is designed as a sketch planning tool for screening large numbers of concepts quickly in order to assess relative performance and to identify representative concepts for further evaluation.[2]
- *Refined TDLU Tool:* an activity-based travel demand forecasting model with a detailed representation of land use, which (from mid-2023) is being used to evaluate the representative concepts in further detail and to conduct an uncertainty analysis on the results.[3]

This TDLU Report summarizes the Initial TDLU Tool approach, and it describes the following:

- Modeling framework
- Modeling approach (inputs, calibration, validation)
- Quality assurance and control approach
- Conclusions and next steps

Model outputs can be found in the Validation section and Appendix G of the main body of this report.

[1] San Francisco Bay Area Rapid Transit District (BART), Capitol Corridor Joint Powers Authority (CCJPA), Program Management Consultants (PMC), and Consultants supporting program identification/project selection (Consultants)

[2] In conjunction with the Initial TDLU Tool, a post-processing tool (the Regional Dynamic Model Adapted Tool [RDMAT]) was developed for the estimation of business case metrics using outputs from the Initial TDLU Tool.

[3] The Refined TDLU Tool, developed by Cambridge Systematics, is now operational as of July 2023.

Modeling Framework

The Initial TDLU Tool was developed using an established modeling framework, the Regional Dynamic Model (RDM), which is a zone-based simulation of how transportation, people, employers, and land use interact over long periods of time (decades). The RDM was adapted to meet Link21's specific objectives. This involved some new developments and some simplifications of the standard model framework.

The most notable changes were the:

- Model was adjusted to be an AM peak[4] period model.
- Land use dynamics were simplified to focus the model functionality on transport, in particular rail.

The focus of the Initial TDLU Tool was on the outbound journey. As such, mode choice was determined based on the outbound leg. Returning trips in the AM peak period were represented in the model but in less detail.

The Initial TDLU Tool had a base year it started from (2015), then it simulated each year beyond that to a final year (2050).

The base year was calibrated to a set of trip tables (based on previous market analysis work) and then validated to the observed data. The behavior beyond the base year was driven by information provided to the model about how data and parameters were forecast to change over time.

Future assumptions on policy, infrastructure, and transport changes were based on the various metropolitan transportation organization (MPO) plans[5], and most notably MTC's *Plan Bay Area 2050*, in particular strategies:

- T4: Reform Regional Transit Fare Policy
- T5: Implement Means-based Per-mile Tolling on Congested Freeways with Transit Alternatives
- T10: Enhance Local Transit Frequency, Capacity, and Reliability

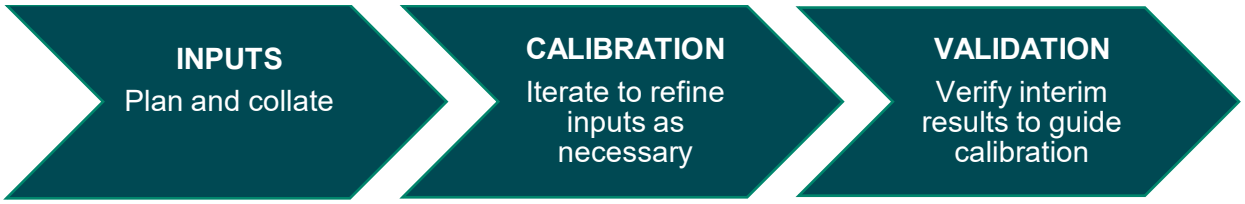
[4] This is the four-hour period from 6 am to 10 am.

[5] MPO plans from the Metropolitan Transportation Commission (MTC), Sacramento Area Council of Governments (SACOG), San Joaquin Council of Governments (SJCOG), Association of Monterey Bay Area Governments (AMBAG), Stanislaus Council of Governments (StanCOG), and Merced County Association of Governments (MCAG) were reviewed.

Modeling Approach

The approach to the Initial TDLU Tool modeling was phased, as illustrated in **Figure 1**.

Figure 1. Initial TDLU Tool Approach Overview



Inputs

The inputs and assumptions used in the Initial TDLU Tool were intended to be consistent with established sources and modeling approaches, and they took into account the differences in modeling frameworks between the Initial TDLU Tool and the various MPO models in the region. Inputs were grouped into three categories, which are discussed in more detail later in this section:

- Global (zoning, segmentations, and Values of Time [VoT])
- Land use (population, employment, etc.)
- Transport (generalized journey times and their components for each modeled mode)

Global

The following global assumptions underpinned the entire modeling effort:

- **Modeling base year**: the first year of observed data that all simulations of the future begin from; this was set as 2015.
- **Modeling time period**: the four-hour AM peak period that is from 6 am to 10 am.
- **Forecasting horizon**: the Initial TDLU Tool produced forecasts for all years between 2015 and 2050, with the focus of future year results on 2050.
- **Price base upon which the modeling was undertaken**: all costs were in real 2015 U.S. dollars ($2015); inflation was not explicitly considered.
- **Zoning**: the geographic segmentation used to disaggregate the study area; there were 314 zones, including 248 zones in the San Francisco Bay Area.
- **Segmentations:** the Initial TDLU Tool modeled outbound travel demand (half tours) by journey purpose (travel to work [TTW], home-based other [HBO], business, and non-home based) and mode; all of which were further split into person types, household types, and business types, as appropriate.
- **VoT:** these were used to convert all cost-related travel inputs into equivalent generalized minutes (refer to the following Transport subsection).

The focus of the modeling effort and the greatest level of detail was on the two largest trip purposes, TTW (about 45% of the AM peak outbound trip demand) and HBO travel (about 53% of the AM peak outbound demand). These two trip purposes were generated using a gravity model, which considered the importance of and distance between potential origins and destinations.

Land use

The Initial TDLU Tool simulated how households and businesses responded to a change in a zone's attractiveness as a result of a change in transportation accessibility. It required inputs related to populations, households, and number of businesses and jobs in each zone for the base year (2015) and future year (2050). The 2050 assumptions were consistent with *Plan Bay Area 2050* and the other MPO plans in the Megaregion.

For model runs, the choice of where a person chose to work was dynamic, and it depended on the available jobs that were predefined in the model. The model generated information on factors of attractiveness for households and businesses, and it simulated movements of people between jobs and in and out of employment.

For households, attractiveness of a location related to the availability and type of housing and employment. For businesses, attractiveness related to access to a workforce and to customers and business premises. The model could distinguish between different types of people, businesses, and buildings.

Equity was accounted for within the land use inputs by the proportion of priority populations[6] in each Initial TDLU Tool zone. Priority populations is a Link21-specific geographic designation that is used to allocate benefits/disbenefits.

Transport

The transport component of the Initial TDLU Tool determined for each primary journey purpose:

- Whether people will travel (overall rate of travel).
- How far they will travel (distribution).
- By what mode they will travel (mode choice).

Four modes of travel (all personal) were included in the Initial TDLU Tool:

1. **Auto:** all personal auto travel

[6] The designation of priority populations is given to areas experiencing the greatest number of burdens, including those related to economic, mobility, community, and health and safety. More details can be found in the Priority Populations fact sheet.

2. **Rail:** BART and Regional Rail services (including California High-Speed Rail in 2050)
3. **Other transit:** light rail, buses (express and local), and ferries
4. **Active modes:** walking and cycling

Trips by multiple modes were reclassified as one of these four main modes according to primary movement.

Generalized times for the Initial TDLU Tool were an end-to-end representation of all the component parts that formed a journey, and that were all weighted into equivalent minutes. This included any cost components that were converted using VoT assumptions. Transit crowding was estimated as a time penalty based on the passenger volume to seated capacity.

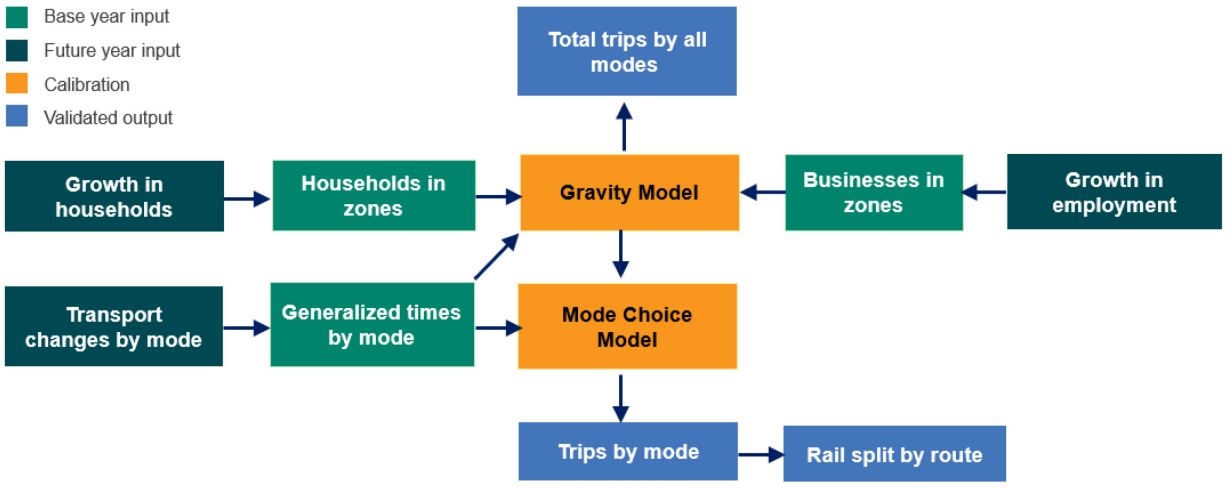
Calibration

As illustrated in **Figure 2**, two individual models within the Initial TDLU Tool simulated the travel choices people made:

1. **Gravity Model:** described whether people travel and how far.
2. **Mode Choice Model:** described which mode they chose.

These models were calibrated to estimate the parameters controlling trip choices. For each origin-destination pair, journey purpose (TTW and HBO), and mode, two inputs were required: synthetic trip tables and generalized times tables (all cost and time components). The process was iterative, with tables of generalized times informing both mode choice and trip distributions.

Figure 2. Gravity and Mode Choice Models within the Broader Framework



Validation

Post calibration of the parameters, outputs from the Initial TDLU Tool were compared against observed sources of information, with the most important checks being:

- **Rail line loads** confirmed the distribution and volume of rail trips were closely aligned to the observed data.
- **Volumes** were the total travel generated by the Initial TDLU Tool by purpose and at key rail and road screenlines.
- **Distributions** were the total travel at the county-to-county level and average distance by all modes, car, and rail.

A series of sensitivity tests were performed to assess how the Initial TDLU Tool responded to changes in transport at an appropriate level. These checks were undertaken through a comparison of implied elasticities to time or cost with those in the literature.

Validation Findings

The Initial TDLU Model was an appropriate tool for the initial testing and screening of concepts considered in the Project Identification phase. It was developed to support strategic decision-making, such as which markets to serve. Other more detailed tools will consider questions, such as optimal alignment or routing. Within this context, the model sensitivity was reasonable and the level of validation in the core study areas, such as on the San Francisco-Oakland Bay Bridge and across the higher volume BART network, was proportionate to the scope of the tool.

Modeling transit accurately required zones be small enough to appropriately reflect access/egress to transit stations. Therefore, there were a number of considerations that needed to be accounted for that were a direct consequence of the Initial TDLU Tool's strategic network. In general, these were:

- Some zones were too large to accurately model station choice. For reliable results, stations were grouped together when reviewing results.
- Some zones were large, especially in the outer areas. The model was limited when dealing with changes in those areas.
- Average distance of rail trips was shorter than operator figures — between 0.6 and 2.6 miles for BART. This meant the model would be limited in analyzing changes to stations below those thresholds.
- Like most travel demand models, this model was limited when simulating travel on low-volume rail services, like Regional Rail, in some sections.

To address these considerations, post-model trip volume adjustment factors were applied to link-level-ridership outputs. These accounted for the growth projected by the model against the observed 2015 data, and they were used to inform service planning.

Quality Assurance and Control Approach

All the work undertaken in the development of the Initial TDLU Tool was subject to a program of quality assurance (QA) and quality control (QC). Five vehicles were used to achieve this:

1. Internal peer reviews
2. Internal QA/QC reviews by a subject matter expert
3. Consistent reviews and oversight by the Link21 program director
4. Discussions with senior leaders and experts within the broader Link21 Program
5. Socialization of methods, outcomes, and results with two technical panel groups: a Link21 internal panel and an external technical panel, including representatives from Northern California transportation planning and programming agencies

Calibration and validation tasks were intensively reviewed by internal subject matter experts at multiple review gateways, and then socialized with the internal and external technical panel groups for review/comment during September 2022.

A summary of the Initial TDLU Tool technical panels is provided in **Table 1**.

Table 1. Summary of Initial TDLU Tool Technical Panel Meetings

TECHNICAL PANEL	TECHNICAL PANEL 4	TECHNICAL PANEL 5	TECHNICAL PANEL 6
Date	July 2021	December 2021	September 2022
Content	• How the RDM works and how it will be applied to Link21 • Summary of inputs	• RDM calibration and validation process • Key model assumptions	• Recap of inputs • Calibration • Result of calibration and validation

Conclusions and Next Steps

Based on the modeling calibration, validation, and QA/QC approaches, the key findings were that:

- The Initial TDLU Model was an appropriate tool for the initial testing and screening of concepts considered in the Project Identification phase.
- The tool was appropriate for comparing concepts with significant differences (e.g., with changes in station location of more than 2.6 miles, as indicated in the Validation section) that were in support of strategic decisions, such as which markets to serve.
- Results should be considered as relative rather than absolute values to avoid implying more precision than would be appropriate.

- Other more detailed tools would consider questions such as optimal alignment or routing.

Following this work, the Initial TDLU Tool was used to compare broadly different program concepts within the following categories:

- BART technology crossing only
- Regional Rail technology crossing only
- BART technology crossing and a Regional Rail crossing
- Concepts in each of these three categories that might have BART and/or Regional Rail technology components outside the new transbay passenger rail crossing

The results provided input to selected business case metrics related to ridership and accessibility, and they informed the identification of concepts to be analyzed and further evaluated in the later stages of the Project Identification phase.

While the TDLU Report describes the development and validation of the Initial TDLU Tool, the modeling findings can be found in the *Round 1 Evaluation Report*.

The Initial TDLU Tool modeling work for evaluation is now complete. Further evaluation of concepts will be conducted using the Refined TDLU Tool during Round 2 of the Project Identification Phase. The Refined TDLU Tool covers the 9 County region (The MTC area). The Initial TDLU Tool will be used to estimate relative performance of concepts for trips between the Megaregion and the MTC area.