Transit Planning Recommendations

NYSAMPO Shared-Use Transit Software Project

June 2023

AVAIL transpogroup Sam Schwartz mca Marlene Connor Associates LLC

Table of Contents

Executive Summary

The Shared-Use Transit Software project was launched to assess the transportation software landscape, perform a market analysis, and identify software viable for statewide deployment in a shared-use program for Metropolitan Planning Organizations and Transit Authorities. These agencies were surveyed about their needs for transit planning software and about their important agency objectives. Agency needs were considered when referring to the technological environment necessary to operate a software and the difficulty of designing an analysis within it. Each software was then assessed through the lens of how they could perform analyses in support of specific transit planning functions.

The Research Team solicited applications for four pilot projects to test different transit planning software tools. Rochester's Regional Transit Service, Westchester County's Bee-Line Bus System, Central New York Regional Transportation Authority (CENTRO), and the Capital District Transportation Authority (CDTA) applied to the research program with case study project concepts. The Research Team reviewed both proprietary vendor software that meet transit planning feature needs and budgetary considerations, and a variety of available open-source modules to determine which software could be utilized for each pilot. **Remix, TBEST, Conveyal, Replica**, and **STOPS** were all selected for the pilots. Several other software packages were evaluated, but not used, and additional software were utilized in the pilots in support of the transit planning software.

The selected software for each pilot were assessed during the study for their shared use potential and for the following subjective measures:

- user Interface/experience,
- flexibility, ease of setup/use,
- staff requirement, and
- output quality.

This paper makes a case for technological recommendations for five transit planning softwares, and institutional recommendations for how to ensure the success of any software investment. The Research Team evaluates the appropriateness of each chosen software to meet the pilot project's needs and makes recommendations for how to deploy each software in a statewide shared use program. Recommendations are also made on how to continue to build upon the momentum of this research project to assist in deepening the partnership between New York State Department of Transportation, Transit Agencies and New York State's Metropolitan Planning Organizations. The Research Team recommends three methods to effectively and efficiently increase the use of software tools in transit planning and analysis. These include provision of assistance in designing and running technical analyses, establishment of an interagency cooperative community of practice that supports transit planning in New York State, and a playbook of previously completed analyses for future reference.

Transit Planning Market Analysis and Software Selection

Introduction

This paper serves to outline software and shared-use recommendations for transit planning in New York State (NYS) after testing several software in pilot projects across the state. These recommendations are based on the compatibility of available tools with the needs and goals of the Metropolitan Planning Organizations (MPO) and Transit Authorities (TA) that were surveyed about their use for transit planning software, as well as their immediate and long term agency needs.

The Research Team solicited applications for four pilot projects to test different transit planning software tools. Rochester's Regional Transit Service, Westchester County's Bee-Line Bus System, Central New York Regional Transportation Authority (CENTRO), and the Capital District Transportation Authority (CDTA) applied to the research program with case study project concepts. The Research Team reviewed a variety of software, both proprietary vendor software and available open-source modules, to determine which could be utilized for each pilot, with specific consideration for replicability of the pilot projects. **Remix, TBEST, Conveyal, Replica**, and **STOPS** were all selected for the pilots. Each of the software were evaluated during the case studies for their potential in a statewide shared-use program, and for agency-specific use. Several other software packages were evaluated, but not used, and additional software were utilized in the pilots in support of the transit planning software.

This paper will summarize key takeaways, document how the tools may be used by MPOs or transit providers, and identify necessary hardware, software, education, and staffing needs for successful use of the recommended tools. Additionally, the paper recommends the establishment of an interagency cooperative community of practice that supports transit planning in New York State and provides recommendation for shared-use of transit planning software statewide.

Software Uses and Needs Survey

The Research Team developed a Market Research Survey Questionnaire to better understand transit planning software usage by MPOs and TAs, as well as the challenges agencies face in using such software. Twelve MPOs and eight TAs were surveyed about their transit planning software needs and their agency's priorities over the next five years. MPOs were categorized based on their population size: small (total population < 140k), medium (140k-200k), and large (>250k). The responses by both MPOs and TAs helped to inform the software selection for the study. The survey assessment targeted the following objectives:

- Assessing the goals and objectives of each organization as it relates to their utilization of transit planning tools.

- Identifying and ranking the features of these tools that are most useful to the organizations.
- Understanding the technological challenges in transit planning technology, both in current projects and in future endeavors.

The Research Team and the survey respondents identified twenty-five transit planning analysis types, of which the following software needs were identified as most important:

Immediate Needs:
MPOs and TAs:

- Ridership analysis;
- Last-mile connection analysis.

MPOs:

- Accessibility analysis;
- Changes to transit networks;
- Equity analysis;
- Reliability analysis;
- Travel time analysis;
- Ridership analysis;
- Last-mile connection analysis.

TAs:

- Changes to transit networks;
- Ridership analysis;
- Last-mile connection analysis.

When asked to describe their important agency priorities for the next five years, MPOs identified increasing transit ridership, better serving disadvantaged groups, better serving choice riders, and improving access to employment as key out of possible eighteen choices. TAs responses indicated that better serving disadvantaged groups, increasing transit ridership, and improving access to employment were the priorities. Both MPOs and TAs shared increasing transit ridership, better serving disadvantaged groups, improving access to employment, reducing journey times for transit riders, improving access to social services, and improving sustainability as important agency objectives over the next five years.

Software Market Analysis

For the transit planning software market assessment, the Research Team reviewed both proprietary vendor software and available free or open-source modules that met the following transit planning needs:

- Proximity of transit services to jobs, population, medical facilities, education institutions, and other services
- Ridership demand forecasting and revenue projections

- Operational scenario planning:
  - Routing , frequency, and transfer analysis
  - Stop consolidation and relocation
  - Detour impact analysis
- On-time performance analysis
- Park and ride and transit center/ mobility hub market analysis
- First and Last mile connection analysis
- Title VI analysis

Software Reviewed by the Research Team			
Open-Source / Free		**Commercial**	
Conveyal-Analysis	Route Trends	Conveyal (Commercial)	TransCAD
Conveyal-r5	STOPS	ESRI Public Transit Tools	Trapeze
Conveyal-Taui	TBEST	Hastus	TripSpark Transit
GTFS Editor	TNExT	Remix	
GTFS-R	Transitland	OptiBus	
OneBusAway	Transitr	RideConnect	
RidePilot		Spare Realize	

Table 1 – Software Reviewed by the Research Team

Due to their availability and the set of features offered by each software, TBEST, STOPS, Conveyal, Remix, Replica, and the ESRI Public Transit Network Analyst Tools were analyzed in-depth. TBEST was shown to be an extraordinarily versatile planning tool with valuable outputs but required extensive data configuration prior to use. STOPS specialized in forecast modeling and its functionality was limited beyond this. Conveyal was excellent for isochronal mapping and had a web-based user interface, but its functionality and features were limited. The ESRI Public Transit Network Analyst Tools appear valuable for planning and operations functionality, but the steep learning curve may be a deterrent to many users. Remix and Replica were added to the case studies where some agencies had access to them and requested incorporation.

ESRI Public Transit Tools and OpenTripPlanner were both assessed during the case study scoping processes and were dropped from further consideration due to their intense labor requirements and analysis limitations. The following software tools were selected as most appropriate for transit planning

case study analyses due to their capabilities in performing required analyses, ease of setup/use, and potential for statewide shared-use.

Software can either be open-source, freely available, or commercial. Open-source software is software which makes its code repositories available, allowing for end-users to modify them freely. Free software is freely available as-is, but cannot be modified by the end-user. Commercial software is obtained through a paid license or subscription.

Software	License Type
TBEST	Free (requires ArcGIS license)
STOPS	Free (requires of ArcGIS/TransCAD license)
Conveyal	Open-Source
Remix	Commercial License
Replica	Commercial License, (Statewide Availability at the Time of Analysis)

Table 2 – Selected Software by License Types

Each software has strengths and weaknesses in regards to its features and functions. Some are designed to perform very specific tasks and others are designed to perform a variety of tasks. The table below highlights some of the specializations of selected software:

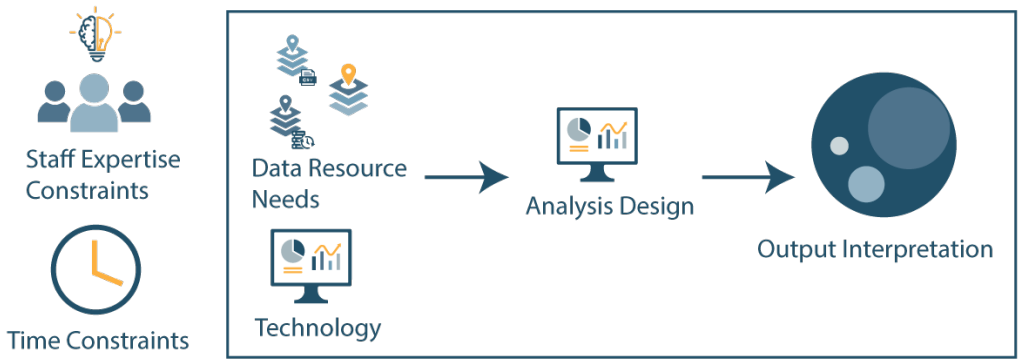
Software	Specializations
TBEST	• Ridership Modeling • Scenario Comparison • Scheduling • Census/Land Use Data Integration • Market Demographics • Equity Analysis • Accessibility Analysis
STOPS	• Ridership Modeling • Scenario Comparison
Conveyal	• Accessibility Isochrones • Origin/Destination (O-D) Travel Times • Travel time matrices
Remix	• Ridership Modeling • Scenario Comparison • Scheduling

	• Census/Land Use Data Integration • Market Demographics • Equity Analysis • Accessibility Analysis
Replica	• O-D information with Demographic Information (e.g., Transit Propensity)

Table 3 – Selected Software Specializations

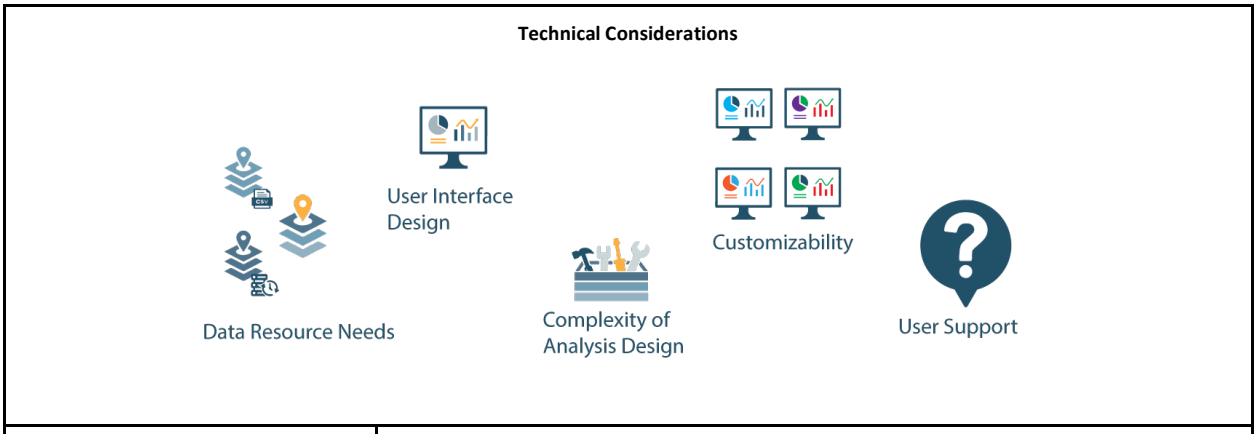
In addition to these functionalities, the software packages were assessed by a number of other measures that may impact MPOs or TAs and organized into two primary categories: institutional and technical considerations:

Institutional Considerations



Time Constraints	Quantities of time required to set up/configure software and to run processes/analyses.
Staff Expertise Constraints	The limitations that an agency has regarding their staff availability and capability to learn, set up, and/or operate software.
Data Resource Needs	The expertise and time requirements of an agency in gathering and configuring the data resource inputs.
Technology Environment	The technological hardware and software that an agency is required to utilize in order to run a given software, as well as time and expertise required to set up the software.
Analysis Design	The process of developing and configuring an analysis to generate a desired type of output.
Results Interpretation	The effort behind interpreting the software outputs to determine accuracy, viability, and an understanding of the results.

Table 4 – Institutional Considerations



Data Resources Needs	The quantity, complexity, and variety of data resource inputs the software requires to generate outputs. This may also include optional data components a software would use to enable additional features.
User Interface Navigation	The software's graphical user interface (UI), its complexity, and how intuitive that UI is to navigate effectively.
Complexity of Analysis Process	The level of effort required to perform a designed analysis within the tools (i.e., how many settings must be adjusted/buttons pressed to run an analysis).
Customizability	The degree of which users (or power users) could tweak/edit/configure a software to run additional analysis or processes that the software was not originally designed for.
Support	The amount of third-party support available specific to the software. This may include one-on-one meetings, tutorials/training offered, and software documentation.

Table 5 – Technical Considerations

The Market Research Survey Questionnaire responses indicated that staff expertise and time constraints played a critical role in measuring the efficacy of implementing a new software within their organization. These agency needs were considered when referring to the technological environment necessary to operate a software and the difficulty of designing an analysis within it. Each software was then assessed through the lens of how each software could perform analysis in support of specific transit planning functions. Table 5 depicts the selected software and their associated features.

Software Features					
	Conveyal	Replica	Remix	STOPS	TBEST
New Route	X		X	X	X
New Stop	X		X		X
Consolidate Stops	X		X		X
Consolidate Services	X		X		X
Frequency	X		X		X
Costs					X
Equity/Title VI Reporting			X		X
Accessibility Analysis	X		X		X
Equity Analysis		X	X		X
Land Use Market Analysis		X	X		X
O-D Travel Time Estimates	X		X		X
Reliability Analysis			X		
Travel Time Analysis	X	X	X		
Transfer Analysis	X	X	X		X
On-time performance analysis			X		X
Detour Analysis					X
Last Mile Connection Analysis					
Evacuation Analysis					
Current Ridership Analysis		X	X	X	X
Modeled Ridership Analysis			X	X	X
Transit Demand Analysis			X	X	X
Park and ride and transit center/ mobility hub market analysis	X				

Table 6 – Selected Software Features

Finally, each software was assessed by its range of transit planning analyses including what transit planning questions the specific software can answer. The following table lists the various software and the transit planning questions each software is designed to answer.

Transit Planning Questions and Software	
Software	**Questions that can be answered**
Conveyal	• How long will it take to travel from an origin to a destination with a variety of specific travel parameters? • What destinations can be reached from a specific origin with a variety of specific travel parameters?
Remix	• What are the estimated ridership values for my transit system? • What is the difference in ridership between multiple transit system scenarios? • What are the demographics of my transit system's estimated and potential ridership? • What land uses are located near the transit network's routes?
Replica	• Where are demographics with high transit propensity originating? • Where do demographics with high transit propensity travel for work?
STOPS	• What is the difference in ridership between multiple transit system scenarios?
TBEST	• What are the estimated ridership values for my transit system? • What is the difference in ridership between multiple transit system scenarios? • What are the demographics of my transit system's estimated and potential ridership? • What land uses are located near the transit network's routes?

Table 7 – Selected Software Questions Answered

Pilot Applications

Each application posed a question or questions that each sought to answer with a software solution. These were reviewed by the Research Team and changes to the proposed questions were made based

on the software features that would be necessary to perform the desired analyses (see figures below). The refined questions were used for the pilot projects.

RTS - Rochester: Increasing Employment Access through Increase Fixed-Route Frequency

Rochester's Regional Transit Service (RTS) sought to determine which fixed routes they could increase the frequency of to provide the greatest increase in employment access for low- and moderate-income communities. The analysis would provide a list of priority routes on which increasing frequency would have the greatest impact on the target metric.

The types of analyses that would need to be performed to answer RTS' question were matched to the available software. Based on the needs (see figure below), Remix was selected. Analysis would be performed for a pre-selected grouping of Routes of Interest (ROI) to determine how increases in frequency would increase access to employment for the target community types. Remix provided per-route demographic and job data readily for analysis, which was exported to Excel for processing.

TBEST was also capable of performing all of the required analyses for this pilot and there was an opportunity to utilize both software to compare their outputs. Once the primary objectives of the pilot were complete using Remix, the Research Team replicated the process using TBEST and compared the results side-by-side.

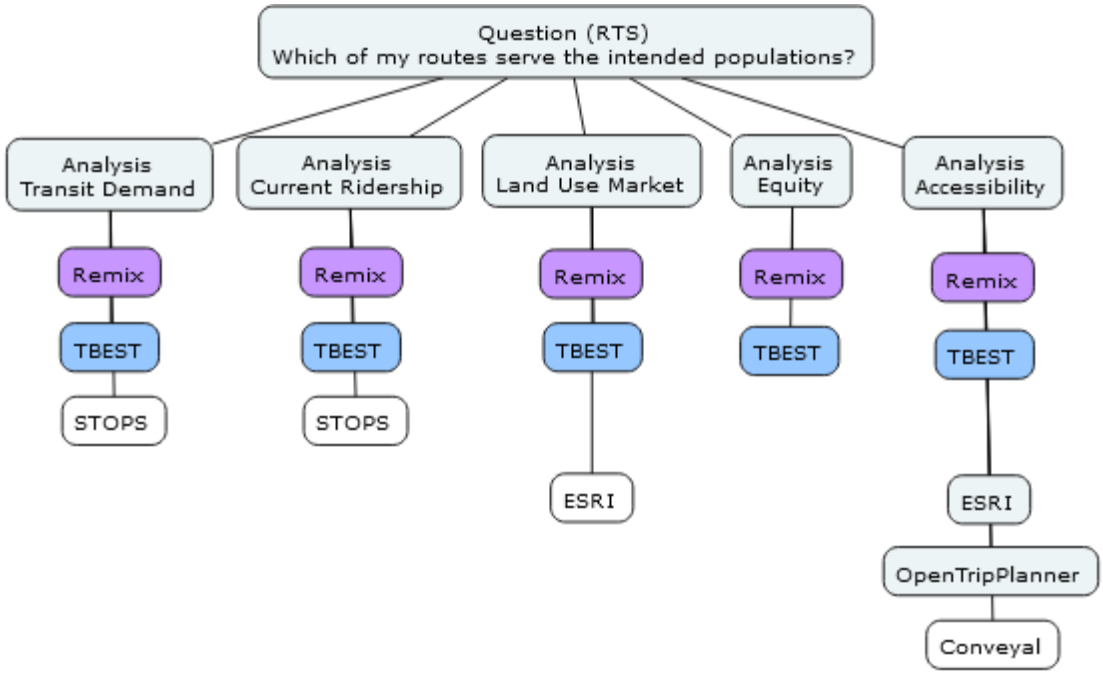


Figure 1 - RTS Question Map

Software: *Remix* and *TBEST*
Replicability: This project could be replicated easily by anyone with access to Remix. Replicating it with TBEST is somewhat more complicated due to the setup requirements associated with TBEST.

The Bee-Line - Westchester: Analysis of Proposed Route Elimination

Westchester County's Bee-LIne Bus System sought to determine the impact of the potential elimination of the BxM4C bus route between White Plains and Midtown Manhattan as part of a County Mobility and Bus Redesign Study. Declining ridership, long travel times, and the use of a custom size coach buses contributed to higher than average operating costs. The analysis would assess the impacts of elimination for both riders and for the County.

The types of analyses that would need to be performed to answer Westchester's question were matched to the available software. Based on the needs (see image below), Conveyal was selected, although the Research Team also tested the use of OpenTripPlanner. The Research Team designed an analysis to assess alternative modes, new travel costs, and equity analysis. Conveyal had recently developed a travel-time matrix feature which automated an otherwise repetitive process. OpenTripPlanner was capable of returning the similar results but would have required excessive staff time to either run manually or to create a script to automate the process. Conveyal also provided a csv export which could be opened in Excel for post-processing. It was determined that OpenTripPlanner's potential for statewide shared use was limited. It will not be discussed as a recommendation in this paper.

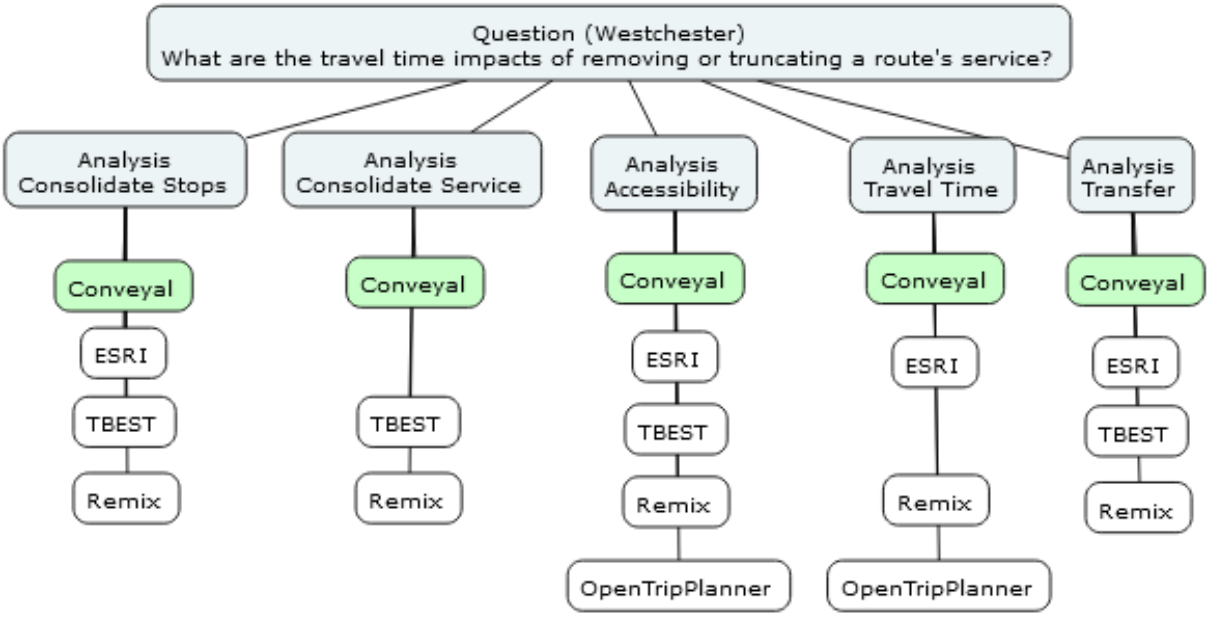


Figure 2 - Westchester Question Map

Software: *Conveyal*
Replicability: Replicating this project would require third party support due to the complexity of software setup, configuration, and data post-processing steps.

Centro - Oswego: Service Alignment Study

Central New York Regional Transportation Authority ("Centro") operates bus services in and around the City of Oswego. They proposed a project to assess whether overall efficiency gains can be delivered by reorganizing the Oswego system without changes in staffing or revenue-vehicle resources.

The types of analyses that would need to be performed to answer Centro's question were matched to the available software. Based on the needs (see figure below), STOPS was selected. STOPS is a tool that provides features for meeting federal Title VI reporting requirements, supporting future service improvements, and assessing the impact of transit investments. STOPS requires a model to identify origin and destination information about potential transit ridership, but Oswego is not in an area that has an MPO model. The Research Team circumvented this software limitation by using Replica, which was recently made available to NYSDOT and the state's MPOs via a statewide contract, was utilized to determine where transit riders live and work. This statewide data availability provided the Research Team with a critical component for utilizing STOPS in a region without a model.

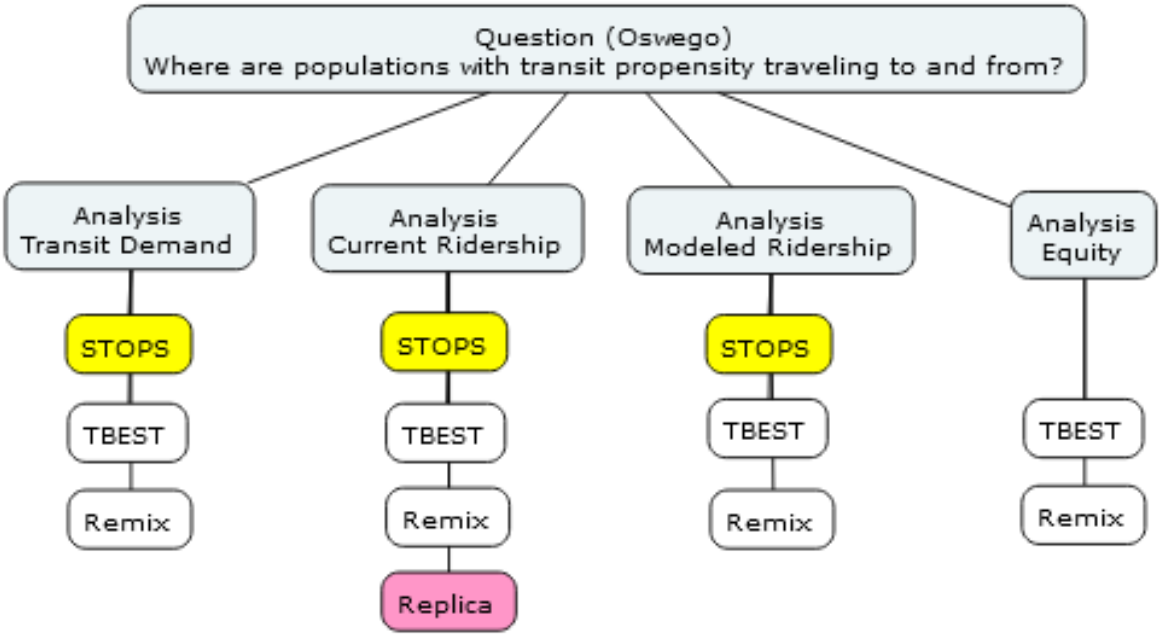


Figure 3 - Oswego Question Map

Software: *STOPS* and *Replica*

Replicability: This project is replicable due to the statewide Replica license and the availability of STOPS, but STOPS has a steep learning curve and third party support might be essential to replication.

CDTA - Capital District Transportation Authority: Route Restructuring

The Capital District Transportation Authority (CDTA) sought support for a full-system route restructuring. Software that would be able to analyze the current transit system and model potential changes to ridership based on service changes was required. To scale the project down to a viable pilot, the analysis area was restricted to the City of Troy and how well transit service met demand for the routes serving the city.

Transit demand analysis, current ridership analysis, potential ridership modeling, and equity analysis were all central to answering CDTA's question. TBEST was selected based on the types of analysis needed to be performed. In order to streamline the process, CDTA's current GTFS data was exported from Remix and imported into TBEST to assess potential impacts to ridership.

The Research Team conducted a gap analysis to identify latent ridership, along with a CTPP O-D analysis to identify the main travel patterns in and around Troy, which was the basis for several different route modifications. The ridership of these new routes was modeled using TBEST, with the differences in ridership visualized using ESRI ArcGIS.

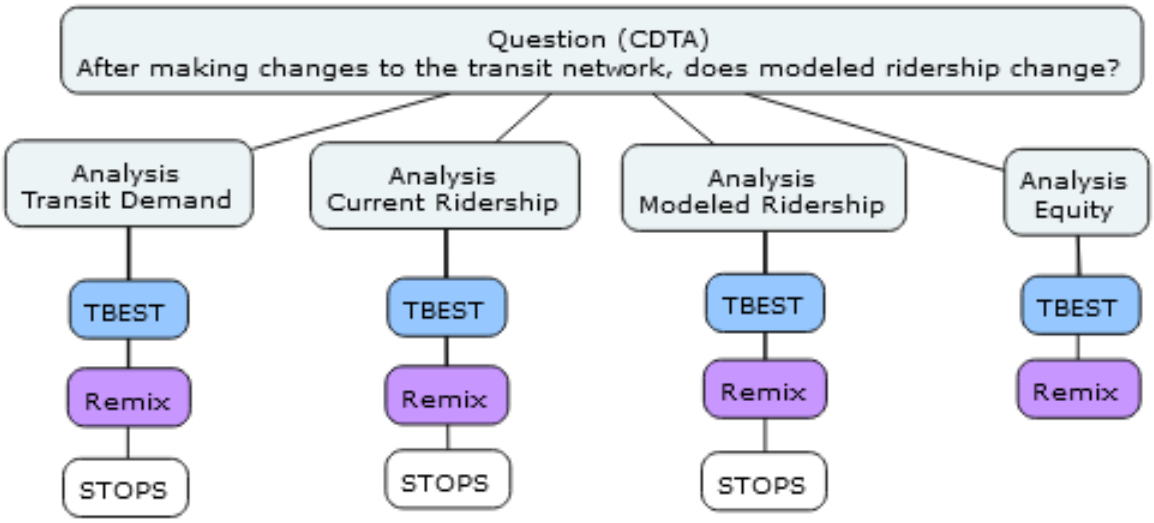


Figure 4 - CDTA Question Map

Software: *TBEST*, *Remix*, and *ESRI ArcGIS*
Replicability: This project is replicable in regions that have access to TBEST and its underlying socioeconomic data. CDTA was trained on how to replicate this project and appears able to do so.

Regions that don't have familiarity with TBEST or lack the resources to set up the data environment are less likely to be able to replicate this project.

Shared-Use Software Technology Recommendations

After conducting an analysis of the software market landscape and based on the case study requests from transit agencies the following software were empirically tested in this project and can be recommended for shared-use in New York State.

- Conveyal
- Remix
- Replica
- STOPS
- TBEST

Overview

Each software used in the case studies was assessed subjectively according to the following key categories:

User Interface/Experience (UI/UX)

- User interfaces (UI) and the user experience (UX) were scored based on their complexity, intuitiveness, and the logic of the software processes required to perform the analyses. Tools that are easier to navigate and analyze often have a shallower learning curve, require less training, and are more likely to be integrated into agency workflows.

Flexibility

- The flexibility metric scales higher with software that are capable of performing a multitude of transit planning tasks and/or extensively modifying analyses. The transportation planning software market analysis identified a critical take-away: there is no ultimate software solution. Rather, each software specializes in specific tasks making them a single tool that can be used in conjunction with other software tools.

Ease of Setup/Use

- This metric assesses software by the complexity of setup and the level effort required for a user to acquire minimum viable proficiency. This includes challenges with desktop application installation, agency permissions, and training required to effectively perform analyses.

Staff Requirement

- Staff Requirement captures the time requirements associated with using the software to design and run analyses, organize and process outputs, and interpret findings. This may also include Information Technology (IT) department involvement in setup, operation, maintenance.

Output Quality

- A critical facet of transportation planning software are the quality and complexity of the outputs. This metric analyzes the outputs for file formats, ease of use, interpretability, post-

processing requirements, results validity, flexibility, visual design for conveying information, and the general shape of the data for use in reporting outcomes.

Using these software assessment categories, the Research Team constructed a table of high-level takeaways in the form of Strengths and Weaknesses.

Software Assessment		
Software	**Strengths**	**Weaknesses**
Conveyal	• Visually Appealing Isochrones • Highly Adjustable Parameters • Cloud Based (No LOCAL User Machine Installation) • Open Source (Free)	• Difficult Setup Process • Unintuitive User Interface and Experience • Cloud Based (Requires Internal IT or Third-Party to Set Up and Host Instance)
Remix	• Cloud Based (No Installation) • Intuitive User Interface and Experience	• Limited Versatility • License Required
Replica	• Cloud Based (No Installation) • Well designed User Interface and Experience • Available to NYSDOT and MPOs via statewide license	• Complicated software • Modeled data, not observed • Not designed specifically for Transit Planning
STOPS	• Comprehensive Outputs • Open Source (Free) • Integrates into ArcGIS	• Difficult Setup Process • Unintuitive Data Outputs (Large Text File)
TBEST	• Curated Reports • Flexible Analyses • Versatile Platform • Comprehensive Outputs • Open Source (Free)	• Difficult Setup Process • Complex User Interface and Experience • Not Open Source • Requires Construction of Socio-Economic Data Package to Operate

Table 8 – Selected Software Assessment

Ease of setup and ease of use are similar metrics that tend toward subjectivity of the assessor. For a more holistic approach, the Research Team collaborated to develop a graph depicting these metrics relative to between the software;

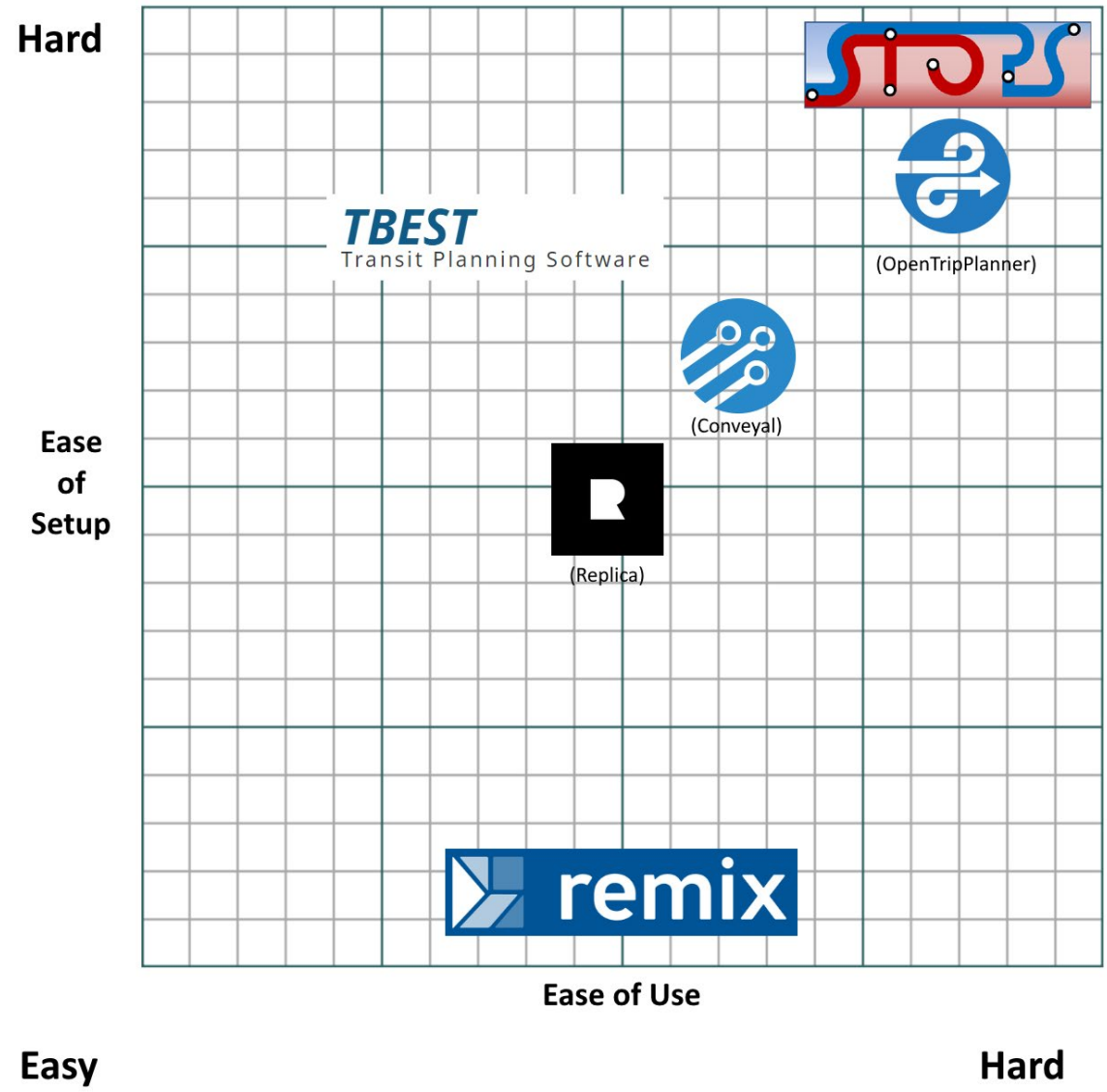


Figure 5 - Ease of Setup/Use Comparison

Using the same tools provides uniformity of access to data and analysis. All software were explicitly assessed for their capacity to be deployed statewide and any relevant features. This analysis identified the strengths and weaknesses each software exhibited with regards to multiple users, collaborative functionality, data sharing, and software ecosystem. The table below summarizes these results:

Statewide Shared-Use		
Software	**Strengths**	**Weaknesses**
TBEST	• Freely available • Data can be compiled and hosted by a third-party for statewide use • Can be a transit planning enterprise software, provides a variety of desired analysis features	• ESRI ArcGIS Dependency • Learning curve may be barrier to adoption, particularly for smaller agencies • Executable file must be installed on a local machine
Remix	• Web-hosted • Data is updated regularly • Very easy to use • Offers a variety of transit planning tools • Can serve both transit planning and operations • License is based on regional population which encourages shared license between TAs and MPOs/NYSDOT	• Requires a license • Limited set of features • Limited output • Requires support in order to setup networks based on different GTFS • Does not provide ridership modeling • Rudimentary transit demand analysis tools
STOPS	• Freely available • Industry standard tool for transit demand modeling	• Difficult to design and run analyses • Requires model data to operate • Limited set of features • Output format is prohibitively difficult to use • Requires GTFS editor to model network change scenarios
Conveyal	• Open-source software, available to be web-hosted by third-party • Provides unique set of features for analyzing transit accessibility • Provides limited GTFS editing tools • Could be used to create statewide data repository for transit accessibility	• Complicated software, may require support for most users • Setting up a hosted instance is complicated for software programmers, might be better served paying Conveyal for license/support. • Setting up the transit network ecosystem required to run analyses is complicated and requires technical data skills
Replica	• Provides useful origin/destination and home/work data	• Modeled data, not observed • Not designed as a transit planning tool,

	● Provides Useful demographic data ● Provides Public Transit Propensity index ● Currently available to NYSDOT and the New York State MPOs via a statewide license ● Supports use of STOPS model	limited transit planning features. ● No transit demand modeling of network change scenarios

Table 9 – Selected Software Shared-Use Potential

TBEST

Overview

TBEST is freely available from ServiceEdge Solutions. The software provides transit planners with tools for analyzing the demographics, accessibility, land-use, and ridership of a transit network system. While the software itself is free, it depends on the presence of a licensed copy of ESRI ArcGIS. The software is packaged as an executable file that is installed and run on the local machine and requires the user to have administrative admissions.[1] As a standalone desktop application the software is limited as a web-hosted shared use software platform.

To run TBEST, the software requires a socio-economic data package that needs to be either collated and meticulously constructed by the user[2], or provided by a third-party for download via hosted-server.[3] This project utilized a socio-economic package constructed by NYSDOT and delivered by SES.

Example Questions Answered by Software
• What are the estimated ridership values for my transit system? • What is the difference in ridership between multiple transit system scenarios? • What are the demographics of my transit system's estimated and potential ridership? • What land uses are located near the transit network's routes?

Specializations	License Type
• Ridership Modeling • Scenario Comparison • Scheduling • Census/Land Use Data Integration	Free (requires ArcGIS license)

[1] Bunner, R., Catala, M., & Mistretta, M. (n.d.). TBEST 4.7 User Guide. *Martin Catala and Mark Mistretta Center for Urban Transportation Research (CUTR)*.

[2] Bunner, R. (2021). *TBEST Socio-Economic Data Configuration*.

[3] *ServiceEdge TBEST Hosting Subscription Add-In – ServiceEdge Solutions*. (n.d.). Retrieved December 29, 2022, from https://ses-transport.com/index.php/serviceedge-tbest-hosting-subscription-add-in/

Software Assessment	
Strengths	**Weaknesses**
• Curated Reports • Flexible Analyses • Versatile Platform • Intuitive (after the learning curve) • Comprehensive Outputs • Free	• Difficult Setup Process • Complex User Interface and Experience • Not Open Source • Requires Construction of Socio-Economic Data Package to Operate

The following scorecard outlines the ratings of each key metric identified in the **Shared-Use Software Recommendations'** *Overview* section. After using and assessing the software, the Research Team scored the metrics negative to positive. TBEST ranked particularly high in flexibility and output quality but lower for its ease of setup and use.

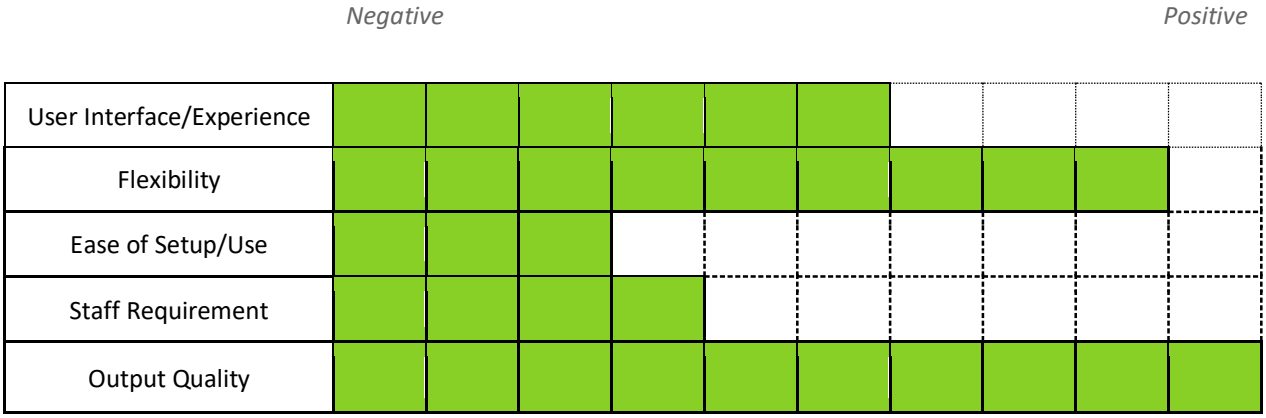


Figure 6 - TBEST Scorecard

The Flexibility rating for TBEST is ranked very high for its wide variety of analyses and ability to create and export custom datasets from the source data.The software can assist transportation planners with an impressive list of out-of-the-box, discrete analyses and report creation. The Query Tool provides a user interface for more advanced users to construct custom query statements to select specific data attributes and export them to Excel.

Ease of Setup/Use was ranked lower due to recurring challenges with installing the software and a steeper learning curve for using it. The Research Team encountered two primary challenges with installation–dependencies and permissions. TBEST has a list of software dependencies that are required and will install ones that the local machine needs. The Research Team was not able to determine the specific dependency that resulted in TBEST being unable to run on one computer, but worked around

the issue by using a Virtual Machine[4] to install the software on. When the Research Team attempted to install the software on a CDTA remote desktop, TBEST encountered read/write file permissions errors when installed on the C: drive. Additionally, the software requires a challenging to configure Socio-Economic data package that presents a recurring maintenance cost.

Output quality scored the highest possible for the extensive quantity of analysis outputs the software is capable of generating, the customizability of those reports, and the unlimited Excel data exporting.

Shared-Use Recommendations

This software is provided as a standalone executable and it is unknown whether a web-hosted, multi-user instance is possible. While this limits the opportunity for shared-use across the state, the framework for downloading transit network systems and socio-economic data is currently available in the software which is an immediate shared-use opportunity.

Statewide Shared-Use	
Strengths	**Weaknesses**
• Freely available • Data can be compiled and hosted by a third-party for statewide use • Can be a transit planning enterprise software, provides a variety of desired analysis features	• ESRI ArcGIS Dependency • Learning curve may be barrier to adoption, particularly for smaller agencies • Executable file must be installed on a local machine

For statewide shared-use, the Research Team provides three tiers of assistive actions that range from providing users with necessities to more advanced options:

[4] A "Virtual Machine" is a digital representation of a computer that can be run on a computer–a computer within a computer. It runs as a movable window on your computer that has its own taskbar, files, and software.

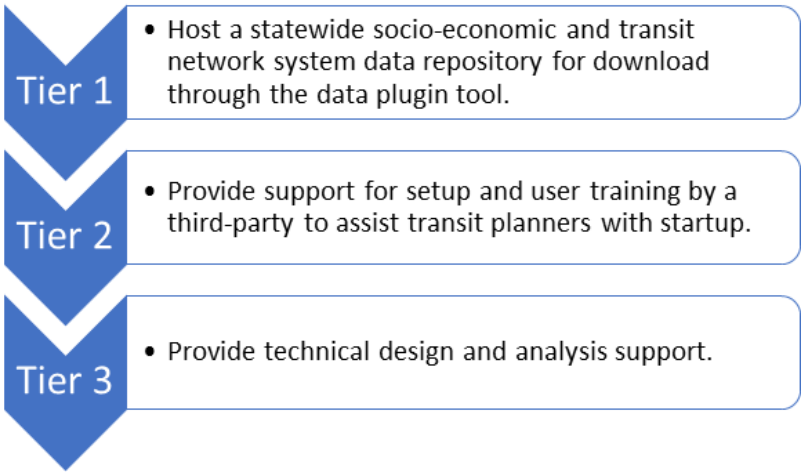


Figure 7 - TBEST Potential Support Tiers

Discussion

TBEST has a wide variety of analysis types and subsequently has a more complex user interface. The Research Team determined that this complexity highlights a limitation in the tiers of shared-use potential outlined above. It is likely that simply providing Tier 1 support would be insufficient for fostering statewide adoption. Tier 1 support should be accompanied with at least Tier 2 support to ensure a viable return on investment.

Remix

Overview

Remix is a proprietary, subscription-based service route planning tool. Users interact via a simple graphical user interface in a web-browser, allowing users with little to no technical knowledge to interact with the tools. Remix provides technical support and data management services with the subscription.[5] Remix charges its subscription fee based on the fleet size and area of population served. Remix is primarily designed to provide agencies with service planning abilities and its data and analytics capabilities are focused on this. The data layers (e.g., ACS or LODES data) are kept up to date by Remix and are available for use by end users.

Example Questions Answered by Software
• What are the estimated ridership values for my transit system? • What is the difference in ridership between multiple transit system scenarios? • What are the demographics of my transit system's estimated and potential ridership? • What land uses are located near the transit network's routes?

Specializations	License Type
• Ridership Modeling • Scenario Comparison • Scheduling • Census/Land Use Data Integration	Commercial License

Software Assessment	
Strengths	**Weaknesses**
• Cloud Based (No Installation) • Intuitive User Interface and Experience	• Limited Versatility • License Required

[5] *Public Transportation Planning Software | Remix*. (n.d.). Retrieved April 20, 2023, from https://www.remix.com/solutions/transit

The following scorecard outlines the ratings of each key metric identified in the **Shared-Use Software Recommendations'** *Overview* section. After using and assessing the software, the Research Team scored the metrics negative to positive. Remix scored well on almost all metrics.

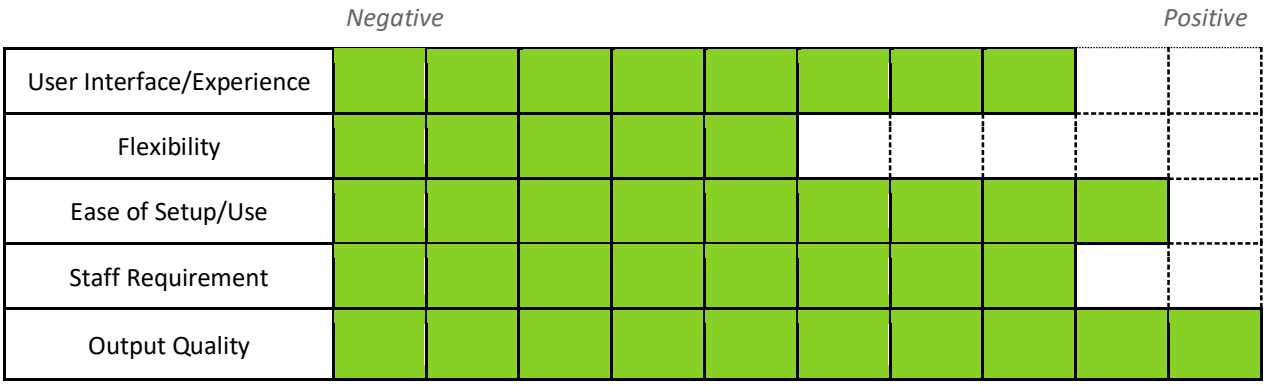


Figure 8 - Remix Scorecard

Remix scores high on many metrics as it provides users with a simple and intuitive interface that makes it easy to navigate and perform tasks efficiently as well as coming with pre-built templates and workflows that enable users to get started quickly. The platform is web-hosted and generates outputs that are visually appealing and easy to understand–reducing Staff Requirements to use it effectively. Remix scores lowest on its Flexibility due to the software's limited variety of discrete analyses. Additionally, the software requires interaction with the company to upload and format additional GTFS files into the platform.

Shared-Use Recommendations

Remix's ability to collaborate between users in an organization, being hosted online, and offering unlimited users through a subscription makes it an ideal tool for agency-wide and inter-agency use for TAs and MPOs. Remix currently charges based on the population of the jurisdictional area of the TA. Therefore, whereTAs are using it, partnership with neighboring MPOs is worth pursuing at a minimal additional cost.

Statewide Shared-Use	
Strengths	**Weaknesses**
• Web-hosted • Data is updated regularly • Very easy to use • Offers a variety of transit planning tools • Can serve both transit planning and operations • Provides useful demographic data • License is based on regional population	• Requires a license • Limited set of features • Limited output • Requires support in order to setup networks based on different GTFS • Does not provide ridership modeling • Rudimentary transit demand analysis tools

which encourages shared license between Transit Agency and MPO/DOT	

Discussion

Remix is primarily designed for transit network planning. It provides demographic data layers that give users access to spatial analysis out of the box. Remix also offers a transit accessibility tool called Jane, a travel-time isochrone, which allows users to visualize transit access in their transit network. Additionally, agencies can send spatial data to Remix for inclusion as data layers. Data can be downloaded from Remix to be post-processed in Excel for additional analysis. Currently, there are some limitations for users as data can only be provided within a radius around a full route. Stop-level and other formats would be helpful for further analysis outside of Remix. Working with multiple GTFS files – for example, if previewing changes to routes – can only be done with the assistance of Remix staff changing the active GTFS on a case by case basis, limiting the ability of users to explore service changes and make comparisons. Remix is being constantly updated, and changes to how data can be accessed by the user would make the tool much more versatile.

STOPS

Overview

STOPS is freely available from FTA via their website.[6] The software provides ridership estimation for build/no-build scenarios and provides a substantial data output. The STOPS software has two primary dependencies;

1. To be linked with a GIS executable (ArcMap or TransCAD)–not technically required to run STOPS but without the linkage, STOPS will prompt the user to manually edit station and district shape files,
2. A Model for input–in rural regions without MPO models, Replica can be utilized in the STOPS process.

There are some notable limitations to the software. Ridership forecasting based on changing GTFS requires a third-party software to alter the GTFS. In terms of staffing resources, STOPS requires extensive training and user guidance. The user interface is simple and intuitive, but the export is in a legacy text format (.PRN) that is difficult to process. Output text files can be hundreds of thousands of lines long and it is not straightforward to copy/paste the data into a third-party software such as Excel for deeper analysis.

Example Questions Answered by Software
• What is the difference in ridership between multiple transit system scenarios?

Specializations	License Type
• Ridership Modeling • Scenario Comparison	Free (soft requirement of ArcGIS/TransCAD license)

Software Assessment	
Strengths	**Weaknesses**
• Comprehensive Outputs • Open Source (Free) • Integrates into ArcGIS	• Difficult Setup Process • Unintuitive Data Outputs (Large Text File)

[6] *STOPS - Documentation and Software | FTA*. (n.d.). Retrieved April 20, 2023, from https://www.transit.dot.gov/funding/grant-programs/capital-investments/stops-documentation-and-software

The following scorecard outlines the ratings of each key metric identified in the **Shared-Use Software Recommendations'** *Overview* section. After using and assessing the software, the Research Team scored the metrics negative to positive, red to green respectively. STOPS score fairly well on Output Quality, but low on Staff Requirement.

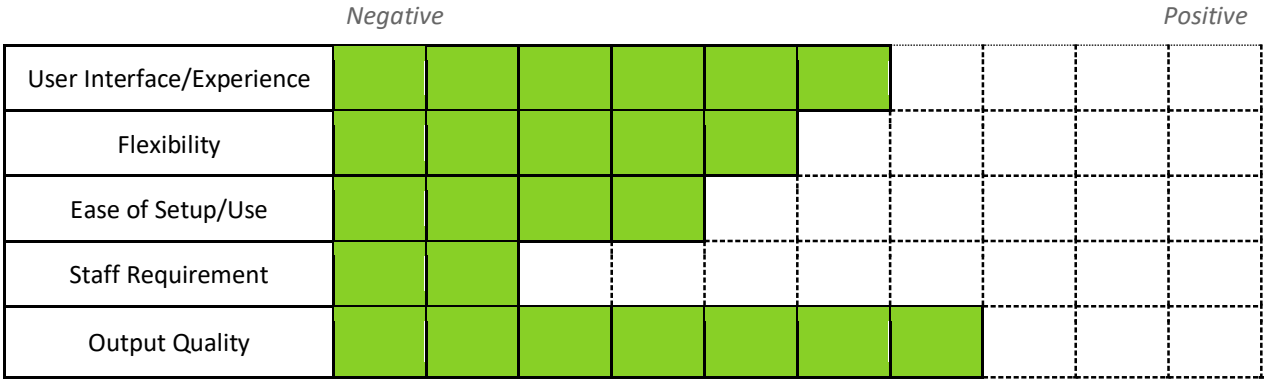


Figure 9 - STOPS Scorecard

STOPS score well on Output Quality due to the extent of information it was capable of providing. Outputs are extraordinarily thorough–to a fault. The score was limited by the unnavigable formatting of that data without a user knowing exactly what they're looking for and where they would locate it within the hundreds of thousands of text lines. The Staff Requirement was scored low for the extent of resources it takes to construct an efficacious analysis and level of effort to identify, compile, and format relevant output data.

Shared-Use Recommendations

STOPS is standalone executable software installed on a local machine, which limits the opportunity for shared-use across the state. It is unknown whether a web-hosted, multi-user instance is possible. Sharing of input and output files is one possible mechanism for shared use whereby a state-level agency provides data inputs statewide and collects outputs into a repository for collective analysis. The software provides useful and replicable outputs but has a high learning curve. STOPS requires technical data skills and time investment. A program for utilizing STOPS statewide would benefit from a community of practice that shares case study analysis design, outcomes, lessons learned, and limitations.

Statewide Shared-Use	
Strengths	**Weaknesses**

• Freely available • Industry standard tool for transit demand modeling	• Difficult to design and run analyses • Requires model data to operate • Limited set of features • Output format is prohibitively difficult to use • Requires GTFS editor to model network change scenarios

Discussion

STOPS needs to improve its report output format. It is currently complicated and almost unworkable. If New York State plans to utilize STOPS statewide for ridership demand modeling they should consider a formal request to FTA to improve the software. The user interface could also use an update but it is currently at least workable. The output format is prohibitively difficult and makes statewide adoption highly unlikely.

Conveyal

Overview

Conveyal is available as an open-source software that must be configured on a server as a web-hosted instance. Setting up a web-hosted instance of Conveyal is a highly technical process requiring software coder and database engineer. In most cases this will require a third-party consultant. Once hosted, the software must be configured with a transit network ecosystem consisting of OpenStreetMap data, GTFS files, and socio-economic data (ACS, LODES).[7] Setup is technically difficult and analysis design and results export are not straightforward processes. The software itself is limited in its scope, which means it performs a number analyses extremely well, but it does not provide a sufficient variety of analyses that would justify the setup time and training costs. It does not provide the full suite of transit planning capabilities.

Example Questions Answered by Software
• How long will it take to travel from an origin to a destination with a variety of specific travel parameters? • What destinations can be reached from a specific origin with a variety of specific travel parameters?

Specializations	License Type
• Isochrones • O-D Travel Times	Free, Open Source

Software Assessment	
Strengths	**Weaknesses**
• Visually Appealing Isochrones • Highly Adjustable Parameters • Cloud Based (No LOCAL User Machine Installation) • Open Source (Free)	• Difficult Setup Process • Unintuitive User Interface and Experience • Cloud Based (Requires Internal IT or Third-Party to Set Up and Host Instance)

[7] *Conveyal—Evaluate changes to your public transportation system*. (n.d.). Retrieved December 23, 2022, from https://conveyal.com/

The following scorecard outlines the ratings of each key metric identified in the **Shared-Use Software Recommendations'** *Overview* section. After using and assessing the software, the Research Team scored the metrics negative to positive, red to green respectively. Conveyal scored moderately well across most metrics, but performed poorly in the Ease of Setup/Use.

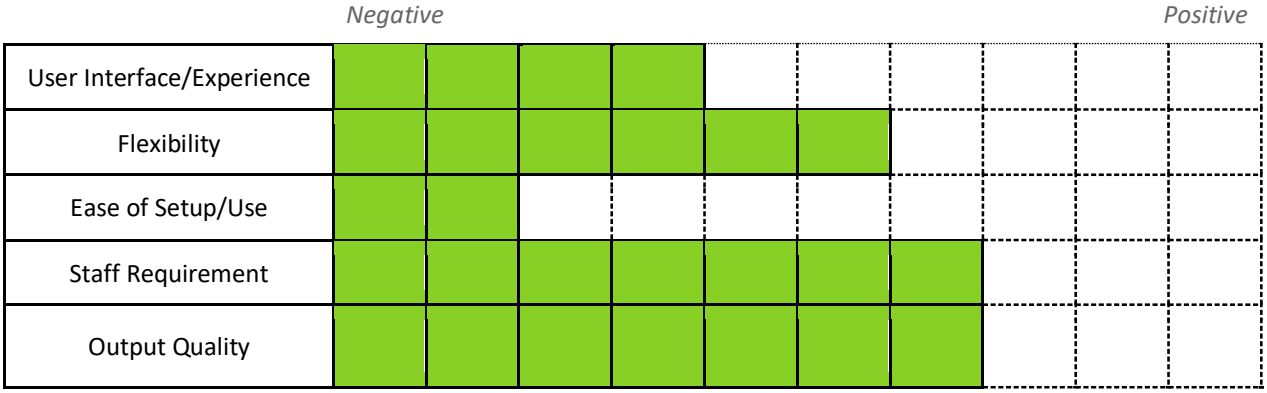


Figure 10 - Conveyal Scorecard

Conveyal's flexibility, staff requirement, and output quality all scored fairly well for the software's fairly extensive analysis customizability, limited training required to perform analyses, and high quality of output data. These scores were limited by, respectively, Conveyal's lack of discrete analysis types, extent of advanced knowledge required to adjust the inputs, and limited types of outputs. The software scored low on Ease of Setup/Use for its extensive process to be deployed as a web-hosted instance. This process requires a software engineer to establish the instance and guide the analyst through the process of building a network bundle to create the transit network ecosystem desired.

Shared-Use Recommendations

Conveyal has a strong framework for shared-use and statewide deployment. The software is technically capable for the tasks that it can perform, which are unique features that no other tools offer. The web-hosting requirement would make it accessible across the state. The software does not have any GIS license dependencies making Conveyal one of the more cost effective solutions for a web-based transit planning software tool – excluding training requirements.

Statewide Shared-Use	
Strengths	**Weaknesses**
• Open-source software, available to be web-hosted by third-party • Provides unique set of features for analyzing transit accessibility • Provides limited GTFS editing tools • Could be used to create statewide data	• Complicated software, may require support for most users • Setting up a hosted instance is complicated for software programmers, might be better served paying Conveyal for license/support. • Setting up the transit network ecosystem

repository for transit accessibility	required to run analyses is complicated and requires technical data skills

Discussion

Conveyal is not an enterprise Transit Planning Software. It is best for analyzing accessibility, service demographics, last mile analyses, and travel time matrices. While Coneyal is available as an open-source software, setup is quite complicated, even for expert software programmers. Additionally, data processing for the setup of Conveyal is complicated but scripts were created during this project that could facilitate a statewide data hosting effort for Conveyal. However, the data processing would still likely require customization by the transit agency network. Hosting a statewide Conveyal software instance with appropriate network data would likely cost as it would to simply purchase the software-as-a-service directly from Conveyal. Purchasing directly from Conveyal would come with the added benefit of direct support and expertise from Conveyal. However, the scope of the support offering from AVAIL is unknown. If Conveyal provides network data packages with up-to-date socioeconomic data, and also provides analysis design and implementation assistance, it would be a no-brainer to work directly with Conveyal.

Replica

Overview

Replica is a proprietary, web-based transportation, land use, and travel behavior data product.[8] Users access Replica via a web-based interface where they can view and download data. Replica is a synthetic dataset assembled from a variety of sources. Users can perform transportation, economic impact, origin-destination, and transit analyses.

Example Questions Answered by Software
● What is the impact of adding or removing transit service on travel patterns and congestion in a given area? ● What are the optimal locations for new transit stations or stops based on existing demand patterns and travel behavior? ● How can transit service be optimized to improve travel times and reduce wait times for passengers? ● How will changes in population growth, land use, and transportation infrastructure affect transit demand and performance in the future? ● How can transit systems be designed to maximize accessibility and equity, particularly for disadvantaged or underserved communities?

Specializations	License Type
● O-D Pairs ● Link Analysis ● Multi-Modal Transportation	Commercial License

Software Assessment	
Strengths	**Weaknesses**
● Continuously Updated Data ● Cloud Based	● License Required

The following scorecard outlines the ratings of each key metric identified in the **Shared-Use Software Recommendations'** *Overview* section. After using and assessing the software, the Research Team scored the metrics negative to positive, red to green respectively:

[8] *Replica: Data to Drive Decisions about the Built Environment*. (n.d.). Retrieved April 20, 2023, from https://www.replicahq.com/

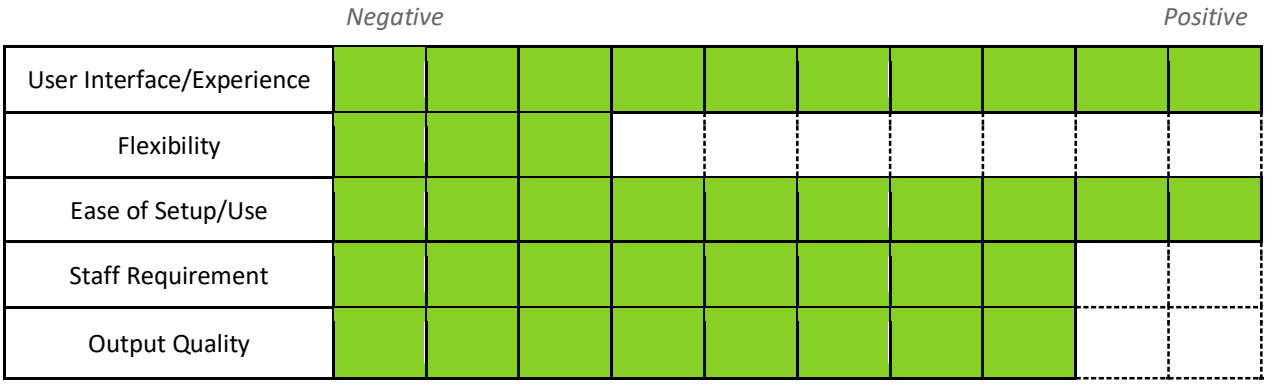


Figure 11 - Replica Scorecard

Replica does not provide a ton of transit planning features. It is mostly a support tool for transit planning. It provides origin and destination by census block group, by a variety of demographics - data that would otherwise require a regional model to obtain. The user interface is excellent, setup and use are easy.

Shared-Use Recommendations

Both the New York Metropolitan Council, via its relationship with New York Metropolitan Transportation Council and New York State Department of Transportation, recently purchased a statewide Replica license for use at DOT Regions and MPOs. Users across the state and at different organizations can access anywhere from their browsers.

Statewide Shared-Use	
Strengths	**Weaknesses**
● Provides useful origin/destination and home/work data ● Provides Useful demographic data ● Provides Public Transit Propensity index ● Currently available to NYSDOT and the New York State MPOs via a statewide license ● Supports use of STOPS model	● Modeled data, not observed ● Not designed as a transit planning tool, limited transit planning features. ● No transit demand modeling of network change scenarios

Discussion

Replica is not designed primarily for transit planning. However, it has the potential to provide supportive contextual information about ridership demographics, home and work locations, and other Origin / Destination information that provides useful context in transit planning. Replica requires users to have a higher degree of familiarity with data analysis before being able to fully make use of the tools.

Institutional Recommendations

The following Institutional Recommendations are designed to ensure the success of any future investment in Transit Planning Software technology. They are, in essence, a formalized program that replicates the best practices of this research project, and builds upon the opportunities identified herein.

The four pilot studies highlighted the varying needs of small and large transit agencies when it comes to technical analyses and software functionality. Transit agencies, such as Centro and Westchester County at the time of study, have limited bandwidth and resources to perform these analyses due to agency size or overburden of workload. This puts them at a disadvantage compared to other agencies, like RTS and CDTA, that have the staffing and capacity to replicate analyses and learn new software.

All participants in the pilot projects were offered training sessions to assist with integration of the software within their organization. Centro and Westchester determined that, despite the software and workflows being valuable, their staff resources were too limited to allocate toward learning additional software. Conversely, RTS and CDTA both had the capacity to engage in training sessions with the Research Team to understand the software. However, both RTS and CDTA could benefit from additional support in order to complete the tech-transfer process by integrating the new software into workflows.

Investing in software is often seen as a solution to improve technical capacity, but the pilot studies suggest that investing in the Transit Planning CoP may be a more effective approach. The institutional constraints identified above each indicate a potential roadblocks against software adoption for an agency acting alone;

- **Time** – Small or strained agencies have limited bandwidth to perform the necessary, and often time-intensive steps for software analyses and processing. On their own, these agencies may lack the resources required to perform the task resulting in stagnating workflows. In a CoP, some data analyses or processing could be performed collaboratively reducing time constraints for all participants.
- **Staff Expertise** – Individually, some agencies lack the technical capabilities and staff availability to learn, set up, and/or operate software. CoPs provide a forum for vastly varied expertise and lessons learned from other agencies that have performed technical tasks before.
- **Data Resource Needs** – The expertise and time requirements of an agency for gathering and configuring the data resource inputs can be substantial and redundant work if multiple agencies perform the same tasks independently. A CoP can provide a repository for data inputs that would substantially reduce the friction of integrating a new software.
- **Technology Environment** – Some software require formidable hardware to efficiently process and analyze data. A CoP has the potential to assist an agency in better understanding their technological environment, limitations associated with it, and software compatibility.

- **Analysis Design** – Analysis design performed independently can be a daunting task that requires dedicated staffing resources and hinges solely on the ingenuity and capacity of the analysts involved. Designing analyses collaboratively in a CoP could expedite the process, yield more thorough results, and have the potential to standardize a methodology for cross-agency comparability.
- **Results Interpretation** – Similarly, the effort behind interpreting the software outputs to determine accuracy, viability, and an understanding of the results requires dedicated staff resources and is limited to the capacity of involved analysts. Incorporation of results interpretation into a CoP forum provides lessons learned and may glean insights beyond the initial interpretation when reviewed by additional practitioners.

Transit Planning Community of Practice

To address the technical capacity gap among transit agencies and MPOs, and to encourage the workflow integration step of tech-transfer, the Research Team recommends the establishment of a Transit Planning Community of Practice (CoP) that fosters collaboration and knowledge sharing along with technical support and documents to facilitate integration such as a transit planning playbook.

A Community of Practice would enable the NYSDOT, TAs, and MPOs to work together to identify their specific technical needs and develop a shared understanding of the most effective tools and methods prior to investing in a specific software–enabling all parties to make more informed decisions about software and other technical solutions tailored to their specific needs and capacity.

The following table outlines a three-part CoP framework wherein a state-level entity can provide varying degrees of assistance tailored to the needs of MPOs and TAs of various sizes and capabilities.

Technical Analysis Support for Small Agencies	The state-level entity could directly perform technical analyses on behalf of smaller transit agencies and MPOs that lack the resources and expertise to conduct them on their own. This would ensure that all MPOs have access to critical technical analyses to inform their planning and decision-making.
Technical Data Processing and Software Support for All Agencies	The state agency could expand the scope of their software support, data processing, and technical skill development to mid-sized and larger agencies to help them integrate new tools into workflows–helping these agencies improve their technical analysis capacity.
Community of Practice Including Agency Needs Assessments,	The state agency could foster a larger-scale CoP where practitioners can engage with each other and develop technical skills. The state agency could solicit technical data and analysis needs from the CoP to better identify and address the most pressing technical challenges facing its members.This would create a

Presentations, and Playbook Development	positive feedback loop where the state agency could tailor its technical analyses to the needs of its members and generate more like-kind analyses for the next round of work.

The Research Team provides the following vision for the establishment of an interagency transit planning cooperative community of practice that supports transit planning in New York State by providing technical analysis support, presentations, and documentation.

The benefits of using any software in a community of practice are extensive. TAs and MPOs can collaborate to identify common goals and prioritize projects that serve the broader transportation network. This will allow them to coordinate their efforts and leverage their resources to achieve a more comprehensive and efficient transportation system.

The Community of Practice and/or its champion(s) would be responsible for the following;

1. Collect technical analysis case studies and best practices into a playbook which would be a living document (catalog of practices and technologies) that is maintained by the champion and/or the community of practice. The playbook would include:
    a. Frequently asked questions, frequently needed analyses,
    b. Analysis methodologies,
    c. Problem identification,
    d. How to assess the value of an analysis, and
    e. Provide crosswalks of problems/questions/analyses to software tools.
2. Support small technical transit planning tasks at MPOs, TAs, and the NYSDOT Public Transit Bureau by soliciting case studies and framing problems for spot analysis.
3. Schedule technical presentations and working sessions for sharing case studies, tech transfer, data analysis training, and planning accreditation credits.
4. Conduct regular research scans and provide literature reviews of best practices.
5. Annually solicit case studies that are meant to enhance the playbook.

Community of Practice Next Steps

Collaboration and Leadership

Prior to expending any additional resources on software or support a lead agency should consider beginning to establish a Community of Practice, by surveying the agencies for their needs, capacities, and interest. This would be the most cost effective next step to advance the findings of this study, and it

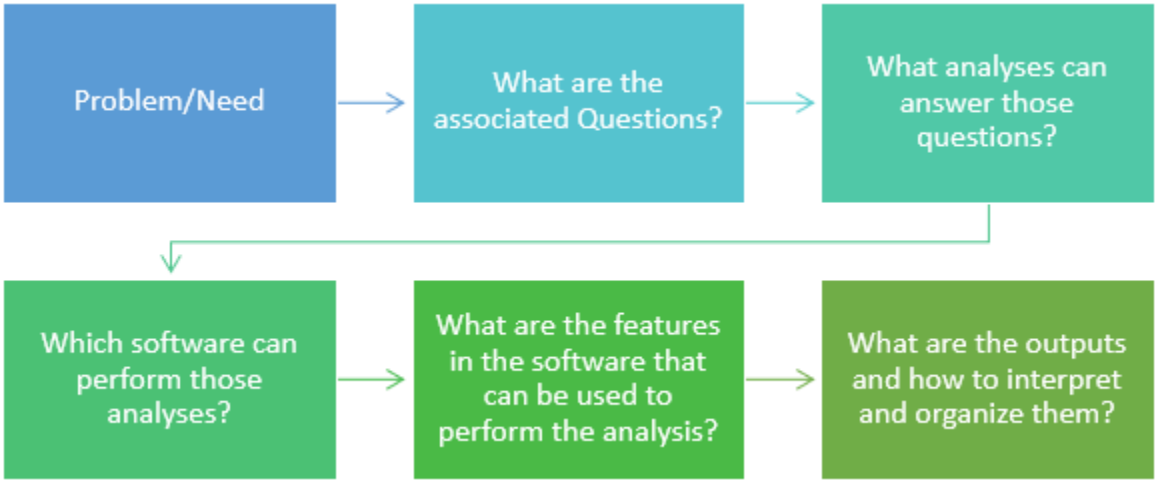
would inform decision making about a statewide program. Potential Community of Practice Champions include:

- NYSDOT
    - NYSDOT's rural transit efforts already provide some of the support outlined in this document to small rural transit agencies. NYSDOT could utilize this existing effort to support a statewide community for technology sharing.
    - NYSDOT's developing mobility policy and support capabilities provide an opportunity for transit planning as a potential organizing effort to implement the recommendations of the Shared-Use Transit Project.
    - With the purchase of a shared Replica license, NYSDOT and NYMTC have demonstrated that a shared purchase for statewide data tools is possible.
- NYSAMPO
    - NYSAMPO's role in a statewide community of practice is as a participant in the technical analyses performed by the MPOs' specific partner transit agencies. The MPOs were active participants in the case studies for this project which demonstrates the viability of a community of practice.
- NYPTA
    - NYPTA could be a partner in organizing the Transit Planning Community of Practice. They might utilize their existing efforts in support of Transit Operations to organize a statewide interagency Transit Planning effort through outreach, advocacy, training, sharing, and assistance in locating funding.

Transit Planning Playbook

To support the establishment of a transit planning Community of Practice, the Research Team recommends developing a product for collecting and sharing best practices for transit planners at all levels. This is best facilitated by the creation of a Transit Planning Playbook that would serve as an institutional starting point for the Community of Practice. The Playbook would be a collaborative effort, collecting and curating institutional knowledge with each iteration. The Playbook would serve the dual role of collecting and disseminating information for the Community of Practice. A champion would regularly update and share the Playbook. The established workflow and any technical documents would be collected for each new update.

Each collected case study added to the Playbook would feature a similar workflow. First, a problem or need would be identified. In order to address this problem or need, the case study would determine which questions need to be asked. From there, an analysis (or analyses) would be constructed to provide answers to the questions. Software would be evaluated to pair appropriate features with the needed analysis. Finally, the outputs, their interpretation and how to organize them would be determined. This process would form the standard for all case studies solicited through the Community of Practice for the Playbook.



How to Update the Playbook

The Community of Practice would need to have a champion regularly interviewing transit planners across the state to learn about their technical planning needs. This champion would be responsible for soliciting case studies for the Playbook and assisting with the design and implementation of analysis as outlined in the transit planning Playbook workflow above. Regular meetings with the Community of Practice would be held by the champion in order to present case studies for feedback, comments, and discussion.

Each case study collected for the Playbook would document the designed workflow in the form of a diagram and a narrative. The Playbook itself could take many forms, including a wiki or a github repository to facilitate sharing and ease of update. The narrative would follow the workflow diagram above. Any technical documents produced for the case study would be included as an appendix in the Playbook. Any technical documents collected this way need to be sure to include the date of the case study and the specific software versions used to perform the analysis. Deprecated analyses would be updated and replaced each time a new and relevant case study was conducted to answer a similar question or need as a previous case study.

References

Bunner, R. (2021). *TBEST Socio-Economic Data Configuration*.

Bunner, R., Catala, M., & Mistretta, M. (n.d.). TBEST 4.7 User Guide. *Martin Catala and Mark Mistretta Center for Urban Transportation Research (CUTR)*.

Conveyal—Evaluate changes to your public transportation system. (n.d.). Retrieved December 23, 2022, from https://conveyal.com/

Deprecated tools | Public Transit in ArcGIS. (n.d.). Retrieved April 20, 2023, from http://esri.github.io/public-transit-tools/DeprecatedTools.html

Home | Public Transit in ArcGIS. (n.d.). Retrieved April 20, 2023, from http://esri.github.io/public-transit-tools/index.html

Public Transportation Planning Software | Remix. (n.d.). Retrieved April 20, 2023, from https://www.remix.com/solutions/transit

Replica: Data to Drive Decisions about the Built Environment. (n.d.). Retrieved April 20, 2023, from https://www.replicahq.com/

ServiceEdge TBEST Hosting Subscription Add-In – ServiceEdge Solutions. (n.d.). Retrieved December 29, 2022, from https://ses-transport.com/index.php/serviceedge-tbest-hosting-subscription-add-in/

STOPS - Documentation and Software | FTA. (n.d.). Retrieved April 20, 2023, from https://www.transit.dot.gov/funding/grant-programs/capital-investments/stops-documentation-and-software