Final Report

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Evaluation of Software Platforms for Transit Service Planning
for Potential Statewide Applications

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SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.400	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.610	kilometers	km
mm	millimeters	0.039	inches	in
m	meters	3.280	feet	ft
m	meters	1.090	yards	yd
km	kilometers	0.621	miles	mi
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		AREA		
in^2	square inches	645.200	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.590	square kilometers	km^2
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.470	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		VOLUME		
fl oz	fluid ounces	29.570	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3

NOTE: volumes greater than 1,000 L shall be shown in m^3.

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Ms. Gabe Matthews, Transit Research, Planning and Commuter Assistance Administrator, served as the Project Manager for this project.

16. Abstract

Transit agencies are increasingly using commercially available software platforms to assist in their service planning. These platforms vary in their applications, functionalities, and capabilities, among others. This project includes three focuses: (1) identifies and evaluates existing software platforms used by transit agencies for transit service planning, (2) identifies and demonstrates transit service planning applications that could be implemented in existing software platforms, and (3) develops a checklist template for use by transit agencies to identify, evaluate, and select software platforms for transit service planning.

A survey of Florida transit agencies was first conducted to learn about their general service planning practices and to identify software platforms being used by the agencies for service planning. This was followed with a series of Web meetings held with ten select transit agencies within and outside Florida to obtain more specific details on the software platforms the agencies used. The efforts identified a total of eight software platforms for potential evaluation. Six of these platforms were evaluated. The evaluation focused on the platform features and capabilities, applications, use of data, user support, and user friendliness.

Based on the evaluation results, four transit service planning applications that have not been included in the software platforms evaluated were identified. As the applications were expected to be data-driven, the project identified and acquired the available data sources, identified the available data attributes, and extracted and prepared the data in the form appropriate for specific applications. The applications were demonstrated on a browser- and cloud-based platform that integrated all the data from different data sources and provided a user interface to perform the applications. The applications were presented via a webinar to transit agencies, allowing them to see the workings of the applications and potentially request to have their software vendors implement these applications in their platforms. Finally, based on the findings from all of the above project efforts, a checklist template that includes essential items of consideration for identifying, evaluating, and selecting appropriate software platforms was developed.

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EXECUTIVE SUMMARY

Project Objectives

Transit agencies regularly make service changes in response to demographic changes, new developments, customer requests, etc. They are increasingly relying on commercially available software platforms to assist them in making these changes. These software platforms vary in their applications, functionalities, and capabilities, among others. This project aims to accomplish the following five objectives:

1. Identify existing commercially available software platforms for transit service planning analysis by conducting a state-of-the-practice survey of Florida's transit agencies and by scanning the literature and the Internet.
2. Meet with transit service planners from transit agencies to learn about their software application experiences and needs.
3. Review and evaluate the software platforms on their system platforms, application objectives, functionalities and capabilities, data requirements, licensing costs and structures, user-friendliness, technical support and training availability, etc.
4. Identify and demonstrate transit service planning applications not included in existing software platforms, and study their feasibility and limitations.
5. Create a checklist template for use by transit agencies to help identify, evaluate, and select software platforms for transit service planning.

Identification of Transit Service Planning Practices and Software Platforms

A survey of Florida transit agencies was first conducted to learn about their general service planning practices and to identify software platforms being used by the agencies for transit service planning. A total of 19 agencies participated in the survey. The survey found that:

- Nearly all agencies had conducted Comprehensive Operations Analysis (COA) or expected to have one done in the coming years, with larger agencies tending to conduct COA studies more frequently.
- All but four agencies (86%) had made at least one type of service changes in response to COVID-19, with a majority of these agencies making multiple types of changes, including reducing the service hours (63%), reducing the service frequency (53%), increasing the number of vehicles to accommodate social distancing (37%), reducing the number of routes due to reduced demands (26%), and increasing the frequency to accommodate social distancing (16%).
- Most agencies (37%) made route change on an as-needed basis, while those on a fixed schedule made their service route changes triannually (21%), semiannually (16%), annually (11%), and quarterly (5%). Similarly, most agencies (26%) made schedule changes on an as-needed basis, while those on a fixed schedule make service schedule changes triannually (32%), semiannually (16%), annually (11%), and quarterly (5%).
- The reasons for making service changes are to improve low-performing routes (74%), service new areas (68%), respond to customer complaints (58%), and better

accommodate high-performing routes (53%), provide better service for people with disabilities (26%), and expand service due to budget increase (26%).

- All agencies had in-house employees help make service changes for their agencies. Three agencies used off-site contracted employees, and one agency used on-site consultants.
- A majority of the agencies (74%) used some software platforms to assist in their service planning. The most commonly used software was Remix (58%). Other software platforms listed by the participants included Optibus, Swiftly, TransLoc, TBEST, Trapeze, HASTUS, ArcGIS, RouteMatch, Clever Devices, and NextBus.
- Of the five agencies (26%) that did not use any software platform, they relied on analyses using local data, including survey and farebox data, input from citizens and vehicle operators, and local knowledge.
- Remix, TBEST, Swiftly, and HASTUS were mentioned by six agencies as software platforms that they would like to have to help with route Title VI analysis and route planning.
- The types of data agencies frequently used to assist in service planning included census data (95%), street maps (89%), on-board survey data (84%), land use data (74%), satellite images (74%), Automatic Vehicle Location (AVL) data (74%), and Automatic Passenger Count (APC) data (63%). Less frequently used data included Automated Fare Collection (AFC) data (37%) and land parcel data (26%). A majority of the agencies (84%) also relied on local knowledge to make service changes.

Interviews with Transit Agencies

To obtain more details and insights on the software platforms transit agencies use, the research team interviewed ten agencies, including six in Florida and four outside Florida. The key findings from the interviews include:

- Transit agencies may use several software platforms because there is no one software platform that addresses all the needs in one platform.
- Transit agencies use these software platforms mainly for fixed-route service planning. Examples of their applications include planning and modifying transit routes; managing detours; calculating changes to operating costs due to service changes; complying with Title VI and improve service equity; responding to customer complaints; and assisting with the monitoring, improving, and reporting of on-time performance (OTP).
- Transit agencies often received requests from different parties for new service or service changes that required a quick response. Use of software platforms helped them address such requests quickly and meet pressing deadlines.
- Before they had the software platforms, one major challenge agencies faced was that they could not estimate costs of proposed services. Software platforms helped agencies estimate the costs of expanding service.
- The agencies interviewed were generally highly satisfied with the software platforms they used in service planning. They regarded these software platforms as user friendly,

and the vendors were responsive to their needs and provided good technical support service.

- The fact that most of the software platforms are Web-based makes it easy for the agencies to receive timely system and data updates. The updates were usually included or negotiated as part of the license agreement.

- Older platforms that were not Web-based could be very slow and also made it difficult for staff that needed to work remotely, especially during the pandemic.

- As most of the software platforms used in service planning are Web-based and the vendors provide technical support, the role of the IT departments has diminished.

- Agencies used data from different sources such as the census, ACS, and General Transit Feed Specification (GTFS) or scheduling data from platforms like Optibus, Trapeze or HASTUS. Agencies also used data from transit ITS systems like AVL, AFC, and APCs from different vendors including Avail, TransLoc, UTA, Clever Devices, or GFI Genfare.

- Because software platforms such as Remix, Optibus, and NetPlan provided census and other data as part of their software licenses, agencies did not need to prepare the data themselves for demographic analysis. The vendors can upload for agencies standardized data such as GTFS into their software platforms quickly.

- Not all agencies would be willing to embrace changes, as the workforce had already been trained in older platforms. Agency leadership and decision makers would need to assess the costs and benefits of implementing more efficient platforms.

- The pricing of the software platforms was generally an annual fee that was based on the number of vehicles and may have some limitations on the maximum number of users. The software license agreement is generally signed for multiple years and covers initial platform setup, training, support, and data updates.

- A statewide license could especially benefit smaller agencies which might not have the financial means to pay for the license fee as well as the staff resources needed to research software platforms and deal with contractual agreements.

- A statewide software license could provide a good economy of scale for the state. It was suggested that this could follow the FDOT program they had with the Center for Transportation Research (CUTR) at the University of South Florida (USF) for the procurement of new transit vehicles and that the same could be done for all transit platforms, including for planning, scheduling, operations, and paratransit software.

- A statewide license could also help with the coordination between agencies because all the agencies would be using similar software, which could be particularly helpful, to planning and scheduling of paratransit riders, who often travel across multiple jurisdictional boundaries.

Evaluation of Existing Transit Service Planning Software Platforms

A total of six software platforms that could help transit agencies perform transit service planning were evaluated. The evaluation focused on the platform features and capabilities, use of data, applications, user support, and user friendliness. Three of these platforms, i.e., Optibus, Remix, and NetPlan, had been designed to perform route planning analysis such as transit accessibility, equity, and service impact analysis. As transit service levels depend on schedules,

these platforms are also integrated with scheduling systems at different levels of sophistication. More specifically:

- Optibus includes features for transit service planning, with particular strengths in scheduling optimization. Optibus can offer transit agencies the convenience and capability to perform a thorough service planning that includes planning and scheduling within a single platform. It is particularly suited for agencies that would like to benefit from a powerful cloud-based platform and desire to have both planning and scheduling functionalities in one integrated platform.
- Remix is the software platform that has been the most widely used in Florida for transit service planning. It includes many user-friendly features that can be used for different transit service impact analyses, such as transit service accessibility, service equity, and service coverage. Currently, Remix provides limited scheduling capabilities. Therefore, agencies using Remix may need to have a separate platform for scheduling. Remix is also a cloud-based platform, and it is particularly suited for agencies that already have a scheduling platform and would like a strong platform for service planning.
- NetPlan is a client-server application that includes many planning features for agencies to conduct comprehensive service planning analysis, especially those that require detailed and accurate service cost estimates. NetPlan is particularly suited for larger agencies or agencies that already have HASTUS as their scheduling platform.

The three other platforms, i.e., Swiftly, Hopthru, and Teralytics, are specialized data platforms that make use of data to provide important information, allowing transit agencies to perform sophisticated planning and scheduling tasks. Unlike the other planning and scheduling platforms, these data platforms do not include direct route, stop, and schedule editing capabilities. Nevertheless, they provide highly specialized and interactive dashboards for selecting and visualizing their specialized data that can be used to improve planning and scheduling. More specifically:

- Swiftly specializes in the application of AVL, scheduling, and operational data to provide live and archived information such as real-time on-time performance monitoring and analysis and review of historical data. The Swiftly dashboard also provides features to analyze vehicle headways and can suggest changes to existing schedules to help improve on-time performance and reduce vehicle bunching, among others. While the Swiftly dashboard already includes many capabilities, it further provides APIs to allow users to retrieve data that can be used for further analysis outside the platform.
- Hopthru mainly focuses on using APC, and also uses stop inventory data, for analyzing ridership at different levels of aggregation and can provide detailed passenger information to help planners and schedulers identify congested segments and develop measures including schedule adjustments and potential route changes. As Hopthru is a relatively new platform, it is expected that additional transit datasets and functionalities be added in the near future.
- Teralytics specializes in general trip data, including trip origins, destinations, and flows, that are constantly extracted and estimated from mobile device signal. Trip origins and

destinations are needed to identify the travel activity levels of different areas and trip flows are needed to understand the travel patterns. The platform provides a highly interactive graphical user interface that allows different ways of visualizing travel patterns.

Other than NetPlan, which is a client-server application, all the other platforms evaluated are browser- and cloud-based. Browser- and cloud-based platforms provide easy platform access, high processing speed, convenient data sharing, and frequent data and platform updates. The high processing speed is especially beneficial to platforms that perform scheduling tasks and optimizations, which can take many hours or even days to complete using personal computers or agency servers. These platforms also minimize the need for IT support within the agencies.

The research team was provided full access to Optibus, Swiftly, Hopthru, and Teralytics, and partial access to Remix. All of these platforms were found to give fast processing speed, with only occasional data-loading problems that appeared to be due to temporary network issues. All user interfaces were also found to be highly user-friendly, feature-rich, modern looking, and highly professional. All platforms provide similar map visualization functions. Optibus uses Google Maps while the other cloud-based platforms use Mapbox together with OpenStreetMap.

Identification and Demonstration of Transit Service Planning Applications

This part of the project attempted to identify and demonstrate multiple data-driven transit service planning applications. The research team first researched and identified potential applications that might be of interest to transit agencies but have either not been included, or not fully so, in existing software platforms. Because the data needed to support the applications must be available, the search for potential applications that were also feasible must consider the data availability. In other words, the identification of potential applications must go hand-in-hand with the data sources available to support specific applications. The efforts resulted in the following four planning applications:

- Prioritizing bus stops for improvements
- Balancing bus stops
- Identifying transit supportive areas
- Estimating transit service coverage level of service.

The available data attributes needed to support these applications were then identified and extracted from their data sources and prepared in the format appropriate for specific applications. Finally, a browser- and cloud-based demonstration platform that integrated all of the data from different data sources was developed to demonstrate each of the four applications. The demonstration platform not only helps illustrate the application concepts, but more importantly, allows potential users to see how each application works, try out different inputs, and visualize the outputs. These applications were presented via a webinar to transit agencies. It was envisioned that agencies interested in these applications could request to have them incorporated by the vendors in their software platform.

Development of Checklist Template for Software Platform Evaluations

Having gathered all the information and knowledge from the above project tasks, the final project task developed a checklist template that included essential items of consideration when preparing and evaluating platforms by an agency. The template included checklist items covering the following aspects of software platforms:

- General vendor information
- Platform system information
- General platform features
- Input data
- Data visualization
- Data applications
- Data export
- Licensing options and fees
- User support and training
- Current Florida client list.

The checklist template was designed as a Microsoft Word form to be given to each candidate vendor to complete and then have the self-assessed results from the vendors be verified by the agencies.

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LIST OF ACRONYMS/ABBREVIATIONS

ACS	American Community Survey
ADA	Americans with Disabilities Act
AFC	Automated Fare Collection
APC	Automatic Passenger Counter
API	Application Programming Interface
ATSIM	Automated Transit Stop Inventory Model
AVL	Automatic Vehicle Location
AWS	Amazon Web Services
BCT	Broward County Transit
BI	Business Intelligence
CAT	Collier County Transit
CATA	Centre Area Transportation Authority
CCT	Citrus County Transit
CIS	Customer Impact Simulator
COA	Comprehensive Operations Analysis
COVID-19	Coronavirus Disease 2019
CTPP	Census Transportation Planning Package
CUTR	Center for Urban Transportation Research
D&B	Dun & Bradstreet
FDOT	Florida Department of Transportation
FGDL	Florida Geographic Data Library
FIU	Florida International University
FTPN	Florida Transit Planning Network
GIS	Geographic Information System
GTFS	General Transit Feed Specification
HART	Hillsborough Area Regional Transit Authority
IT	Information Technology
ITS	Intelligent Transportation System
JTA	Jacksonville Transportation Authority
KPIs	Key Performance Indicators
LACMTA	Los Angeles County Metropolitan Transportation Authority
LOS	Level of Service
LYNX	Central Florida Regional Transportation Authority
MCAT	Manatee County Area Transit
MIA	Miami International Airport
NAICS	North American Industry Classification System
OSM	Open Street Map
OTP	On-Time Performance
Palm Tran	Palm Beach Transit
PCPT	Pasco County Public Transportation
RFP	Request for Proposals
RTS	Regional Transit System

SaaS	Software-as-a-Service
SCAT	Space Coast Area Transit
SPSS	Statistical Package for the Social Sciences
TCQSM	Transit Capacity and Quality of Service Manual
TDPs	Transit Development Plans
TSA	Transit Supportive Area
TTAFT	Transit Technology Assessment Framework Tool
UF	University of Florida
USF	University of South Florida
UTA	Urban Transportation Associates
VPN	Virtual Private Network
WSL	Windows Subsystem for Linux

CHAPTER 1
INTRODUCTION

1.1. Project Background

Transit service changes are especially important for a high-growth state like Florida. Major transit service changes are typically done after a comprehensive operations analysis (COA). However, because COA studies are expensive to conduct, they can only be done once every few years. In between major service changes, transit agencies regularly make service changes in response to demographic changes, new developments, customer complaints, etc. Further, the changing COVID-19 pandemic conditions continue to require agencies to make service adjustments. In making transit service changes, which may include route realignments and adjustments to service frequency and service span, transit agencies need to have two system components at work in order to make effective, data-driven decisions: (1) software platforms capable of performing service planning scenario analysis, and (2) local data to support the analysis.

Various off-the-shelf platforms designed to apply local data for service planning analysis are available commercially today. These platforms vary in their system platforms, application objectives, functionalities and capabilities, data requirements, licensing costs and structures, user-friendliness, technical support and training availability, etc., and it is not often clear to transit agencies which platforms are best suited to meet their needs.

1.2. Project Objectives

This project aims to accomplish the following five objectives:

1. Identify existing commercially available software platforms for transit service planning analysis by conducting a state-of-the-practice survey of Florida's transit agencies and by scanning the literature and the Internet.
2. Meet with transit service planners from transit agencies to learn about their software application experiences and needs.
3. Review and evaluate the software platforms on their system platforms, application objectives, functionalities and capabilities, data requirements, licensing costs and structures, user-friendliness, technical support and training availability, etc.
4. Identify and demonstrate transit service planning applications not included in existing software platforms, and study their feasibility and limitations.
5. Create a checklist template for use by transit agencies to help identify, evaluate, and select software platforms for transit service planning.

1.3. Report Organization

The rest of the report is organized as follows. Chapter 2 summarizes the results from a survey of Florida transit agencies to learn about their general service planning practices and to identify software platforms being used by the agencies for transit service planning. Chapter 3

documents the findings from meetings with ten transit agencies to obtain more specific details on the software platforms the agencies used. Chapter 4 describes the effort to recruit existing software platform vendors for platform evaluation and presents the findings from the evaluation. Chapter 5 identifies and demonstrates four transit service planning applications that had not been included, or not fully so, in the software platforms evaluated in Chapter 4. Based on the information and knowledge gathered from Chapters 2 to 5, Chapter 6 presents a checklist template that includes essential items of consideration for identifying, evaluating, and selecting appropriate software platforms. Finally, Chapter 7 summarizes the key efforts and findings from this project.

CHAPTER 2
IDENTIFICATION OF TRANSIT SERVICE PLANNING PRACTICES AND SOFTWARE PLATFORMS

This chapter documents two initial efforts to identify and inventory software platforms used by Florida transit agencies to perform service planning. The first involved developing the survey questionnaire and conducting an online survey of Florida transit agencies to identify software platforms that the agencies had used or wish to use in the future. The second effort was to scan the literature and the Internet to identify any additional software platforms that were not identified from the survey. Lastly, the results from the above efforts were compared with those documented in the Transit Technology Assessment Framework Tool (TTAFT), which included an inventory of transit technologies and related literature.

2.1. Survey of Florida Transit Agencies

A draft survey instrument including questions that targeted the following areas of interest was first developed and submitted to the FDOT project manager for review and approval:

- Status on conduct of Comprehensive Operations Analysis (COA) studies
- Transit service changes in response to the COVID-19 pandemic
- General practices on transit service changes (outside COAs and COVID-19)
- Existing and desired software platforms for transit service planning
- Use of data in transit service change analysis

It is noted that while the focus of this project was on software platforms, the survey also included questions on agencies' general practices on transit service planning for the purpose of providing some background information to the project. The final survey instrument is given in Appendix A. The survey consisted of a total of 17 mostly fact-based questions. Upon FDOT's approval of the draft survey, the questions were set up in the Qualtrics online survey tool. The survey link was distributed on July 29, 2020 by the FDOT project manager via the Florida Transit Planning Network (FTPN) forum listserv. The FTPN listserv is a message board system that is subscribed by transit planners and other transit professionals from across Florida and the country. Appendix B shows the survey invitation email that was distributed with the listserv. The deadline for responding to the survey was set initially for August 15, 2020. A total of 12 responses were received by the initial deadline.

To increase the number of participants, the FDOT project manager followed up with a second email to the FTPN listserv and extended the survey response deadline to August 28, 2020. The research team further reached out directly to individuals from transit agencies that had not responded to the survey to encourage their response. The survey was finally closed with a total of 19 responses. Table 2-1 lists the survey participants and their contact information. This information was provided by the participants in response to the first question of the survey.

Table 2-1. Survey Participants and Contact Information

Participant Agency and Acronym	Participant Name	Participant Job Title	Participant Email and Phone
Broward County Transit (BCT)	Tara Crawford	Senior Planner	tacrawford@broward.org 954-357-8381
Bay County Board of County Commissioners (BTT)	Lamar Hobbs	Transit Operations Coordinator	Lhobbs@baycountyfl.gov 850-248-8167
Collier County (CAT)	Omar Delon	Transit Manager	omar.deleon@colliercountyfl.gov 239-252-4996
Citrus County Transit (CCT)	Lon Frye	Transit Director	lon.frye@citrusbocc.com 352-527-7634
Treasure Coast Connector (CT)	Murriah Dekle	Transit Division Director	Deklem@stlucieco.org 772-462-3065
Hillsborough Area Regional Transit Authority (HART)	Christopher Cochran	Director of Service Planning	cochranc@gohart.org 813-384-6553
Jacksonville Transportation Authority (JTA)	Michael Epstein	Acting Director of Transit Planning	mepstein@jtafla.com 904-632-3806
Lee County Transit (LeeTran)	Arnold Valdez	Transit Planner	avaldez@leegov.com 239-533-0393
Central Florida Regional Transportation Authority (LYNX)	Myles O'keefe	Manager of Strategic Planning	mokeefe@golynx.com 407-254-6076
Manatee County Area Transit (MCAT)	Susan Montgomery	Transit Planner	susan.montgomery@mymanatee.org 941-747-8621
Miami Dade County - Dept. of Transportation and Public Works (MDT)	Franchesca Taylor	Senior Planner	franchesca.taylor@miamidade.gov 786-469-5098
Palm Beach County (PalmTran)	Yash Nagal	Transit Planning Manager	ynagal@pbcgov.org 561-841-4238
Pasco County Public Transportation (PCPT)	Kurt Scheible	Director	kscheible@ridepcpt.com 727-834-3200
Regional Transit System	Jesus Gomez	Transit Director	gomezjm@cityofgainesville.org 352-393-7860
Space Coast Area Transit (SCAT)*	Terry Jordan	Planner	terry.jordan@brevardfl.gov 321-635-7815
City of Tallahassee (StarMetro)	Andrea Rosser	Transit Planning Manager	andrea.rosser@talgov.com 850-891-5196
City of Ocala (SunTran)	Steven Neal	Transportation Manager	sneal@ocalafl.org 352-629-8286
Hernando County Transit (TheBus)	Jannina Stampfli	Transit Coordinator	jstampfli@hernandocounty.us 352-540-6567
County of Volusia (Votran)	Elizabeth Suchsland	Assistant General Manager	Esuchsland@volusia.org 386-763-3727

* In the rest of this document, SCAT is listed as "Space Coast" to avoid confusion with Sarasota County Area Transit.

2.1.1. Status on Comprehensive Operations Analysis (COA) Studies

Two survey questions were included to obtain information on the status of Florida transit agencies on conducting comprehensive operations analysis (COA) studies. The first question asked the participants to specify the year the last time their agency conducted a COA study. The participants were also given the choices to indicate "Not sure" and "No COA has been

conducted". The second question asked the participants to indicate when their agencies anticipate conducting the next COA study. The participants were given the following choices:

- Within 1-2 years
- Within 3-4 years
- Within 5-6 years
- Within 7-8 years
- Within 9-10 years
- None anticipated at this time
- Not sure
- Other (*specify*)

Table 2-2 summarizes the results from both questions. The results show that all but one agency had either conducted a COA in the past and/or expected to have one done in the coming years. Four agencies (labeled with an "*") indicated that their agencies were working on a COA study that was either underway or in the paperwork process. From the participants who provided specific years for both questions, it was estimated that the agencies conducted COA studies at a frequency ranging from 3 to 15 years, with an average of about 8 years. Also, most larger agencies (e.g., MDT, PalmTran, and JTA) tended to conduct COA studies more frequently.

Table 2-2. Agency Status on Conducting Comprehensive Operations Analysis (COA) Studies

Agency	Q2. When was the last time your agency conducted a Comprehensive Operations Analysis (COA)?	Q3. When do you anticipate that your agency will conduct the next COA?	Approximate Years between COAs
BCT	2009	Within 1-2 years	12 years
BTT*	2020	Currently underway	-
CAT	2010	Within 1-2 years	11 years
CCT	Not sure	Within 3-4 years	
CT*	No COA has been conducted	Scope of services will be issued by the St. Lucie TPO this calendar year, with an expected completion date of Summer 2021	-
HART	2020	Not sure	
JTA	2019	Within 1-2 years	3 years
LeeTran	2020	Within 9-10 years	10 years
LYNX	2017	None anticipated at this time	-
MCAT	2016	None anticipated at this time	-
MDT	2020	Within 3-4 years	4 years
PalmTran	2018	Within 1-2 years	4 years
PCPT*	No COA has been conducted	Starts 10/4/2020	-
RTS	2015	Within 3-4 years	9 years
Space Coast	No COA has been conducted	Within 1-2 years	-
StarMetro*	2005	We have an RFP on the street now for a COA	15 years
SunTran	2018	Within 3-4 years	6 years
TheBus	Not sure	None anticipated at this time	-
Votran	Not sure	Within 1-2 years	-

* At the time of the survey, the agency had a COA study underway or in the paperwork process.

2.1.2. Service Changes in Response to COVID-19

Participants were asked about what changes their agencies had made to transit services in response to COVID-19. The participants were given the following choices:

- No service changes due to COVID-19 have been made
- Reduced number of routes due to reduced demands
- Reduced service frequency due to reduced demands
- Reduced service hours due to reduced demands
- Increased service frequency to accommodate social distancing
- Increased number of vehicles to accommodate social distancing
- Others (indicate)

As shown in Table 2-3, at the time of the survey, only three agencies (16%) had not made any changes in response to COVID-19, while the other agencies had made at least one type of changes, with a majority of these agencies making multiple types of changes.

Table 2-3. Types of Service Changes Made by Florida Agencies in Response to COVID-19

Agency	Q4. What transit service changes have your agency made so far that were due to COVID-19 (*check all that apply*)?						
	No service changes due to COVID-19 have been made	Reduced number of routes due to reduced demands	Reduced service frequency due to reduced demands	Reduced service hours due to reduced demands	Increased service frequency to accommodate social distancing	Increased number of vehicles to accommodate social distancing	Other
BCT			☑	☑	☑	☑	Add daily trippers as needed
BTT						☑	Assisting with meal delivery
CAT						☑	
CCT							Went totally paratransit
CT	☑						
HART		☑	☑	☑			
JTA			☑	☑			
LeeTran		☑	☑	☑			
LYNX		☑	☑	☑			
MCAT			☑	☑		☑	
MDT		☑	☑	☑			
PalmTran			☑	☑	☑	☑	Paratransit vehicle follows fixed route to pick anyone that was passed up high demand routes
PCPT							Free fares
RTS		☑	☑	☑	☑	☑	
Space Coast			☑	☑		☑	
StarMetro				☑			
SunTran	☑						
TheBus				☑			Did not collect fares
Votran							Suspended one low ridership fixed route
Total	**2 (11%)**	**5 (26%)**	**10 (53%)**	**12 (63%)**	**3 (16%)**	**7 (37%)**	**7 (37%)**

Figure 2-1 shows the frequency distribution of the different types of service changes made by the 19 agencies in response to COVID-19. The most frequent changes made was reducing the service hours (63%), followed by reducing the service frequency (53%). A significant number of agencies had also increased the number of vehicles in order to accommodate social distancing (37%), and reduced the number of routes due to reduced demands (26%). The least frequent type of changes made was to increase the frequency to accommodate social distancing (16%). Other changes (totaling 37%) noted by participants included two agencies that provided free fares, one smaller agency that was able to convert to 100% paratransit, and one agency that provided paratransit vehicles to pick up customers that were passed up (to accommodate social distancing) by fixed route vehicles.
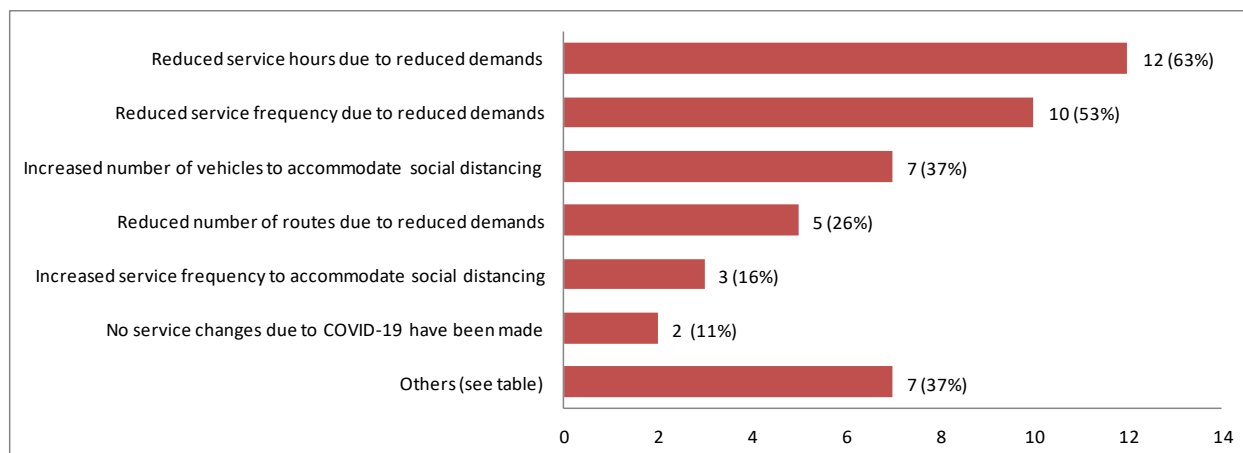
Figure 2-1. Frequency Distribution of Service Change Types Made in Response to COVID-19

2.1.3. General Practices on Transit Service Changes (Outside COAs and COVID-19)

A total of five questions were included in the survey to obtain information on the general practices of agencies on making transit service changes. They included one question on each of the following practice areas:

1. Frequency of transit agencies in performing service route changes
2. Frequency of transit agencies in performing service schedule changes
3. Reasons for performing service changes
4. Main reasons for performing service changes
5. Type of employees performing service changes

For the two survey questions on how frequent agencies made transit service changes, participants were given the following choices:

- Quarterly
- Triannually
- Semiannually
- Annually
- On as needed basis
- Other (*specify*)

7

Table 2-4 lists the responses to both questions from each agency. The table shows that a majority of the agencies performed both service route and schedule changes at least three times a year or on as needed basis.

Table 2-4. Frequency of Florida Transit Agencies Making Transit Service Changes

Agency	Q5. Outside COA and COVID-19, which of the following best represents how often your agency review and make changes to your transit service routes?	Q6. Outside COA and COVID-19, which of the following best represents how often your agency review and make changes to your transit service schedules?
BCT	Other: By pick basis, which is typically every 3 months, or so	Other: As needed, but pretty much by pick; as we have experience seasonality in service
BTT	On as needed basis	On as needed basis
CAT	Semiannually	Semiannually
CCT	On as needed basis	On as needed basis
CT	On as needed basis	On as needed basis
HART	Other: At least 3 times a year	Other: At least 3 times a year
JTA	Triannually	Triannually
LeeTran	On as needed basis	Triannually
LYNX	Triannually	Triannually
MCAT	Semiannually	Semiannually
MDT	Annually	Annually
PalmTran	Triannually	Triannually
PCPT	On as needed basis	On as needed basis
RTS	Quarterly	Quarterly
Space Coast	Semiannually	Semiannually
StarMetro	On as needed basis	On as needed basis
SunTran	Triannually	Triannually
TheBus	On as needed basis	Annually [a]
Votran	Annually	Triannually [b]

a. Changes usually take place with the new fiscal year.
b. Three times a year as required.

Figure 2-2 shows that most agencies (37%) performed service route changes on as needed basis. For agencies with a fixed schedule for making service route changes, most did so triannually (21%), followed by semiannually (16%), annually (11%), and quarterly (5%).

Similarly, Figure 2-3 shows that it was also common (26%) for agencies to make service schedule changes on as needed basis. For agencies with a fixed schedule for making service schedule changes, most did so triannually (32%), semiannually (16%), annually (11%), and quarterly (5%).
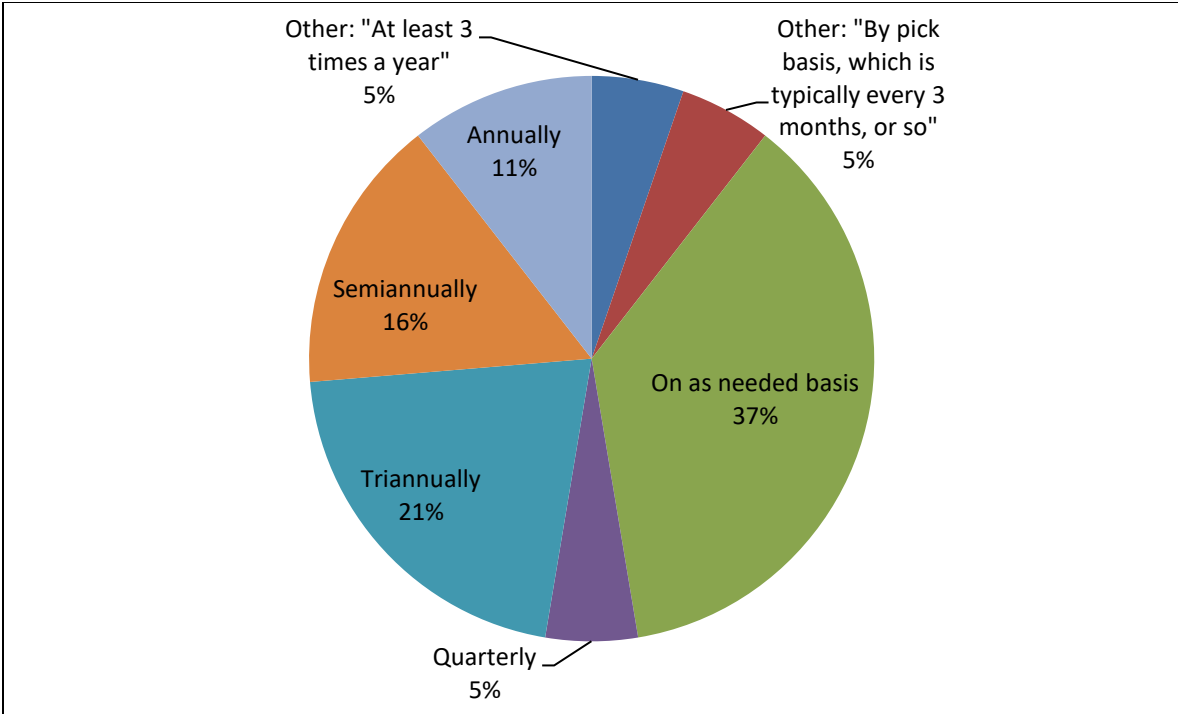
Figure 2-2. Frequency Distribution of Florida Transit Agencies Making Service Route Changes
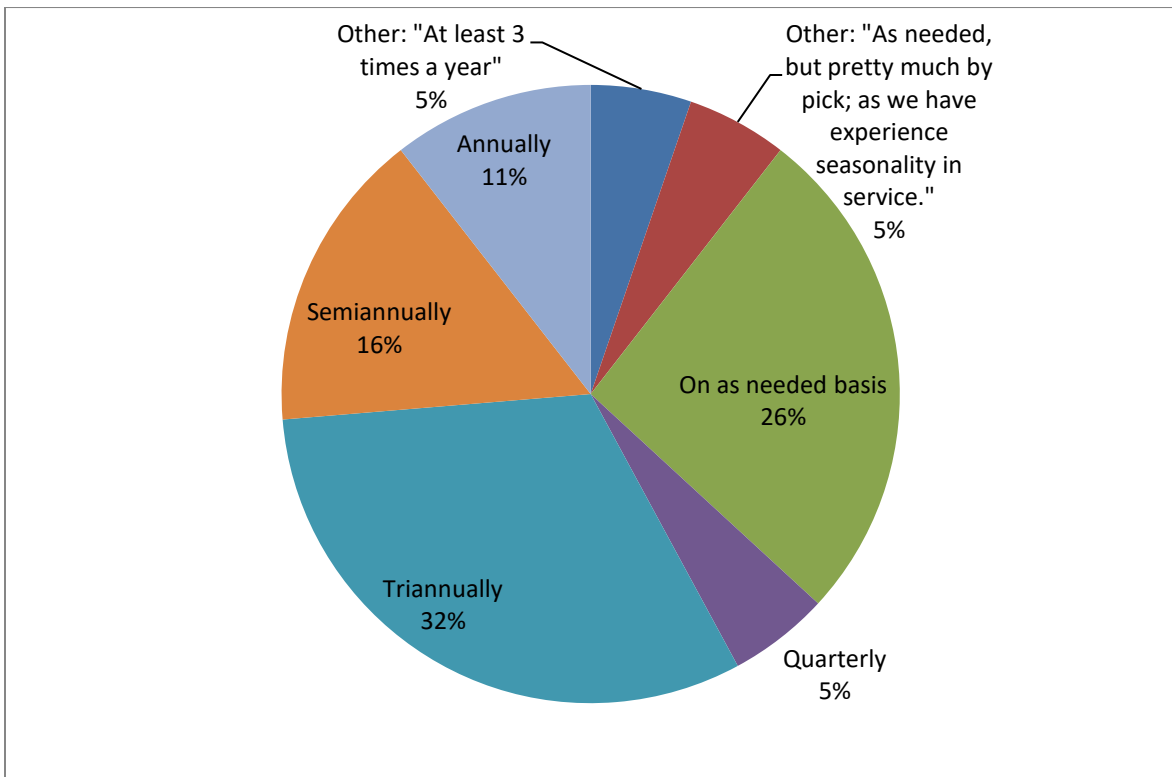
Figure 2-3. Frequency Distribution of Florida Transit Agencies Making Service Schedule Changes

The next question attempted to find out the reasons behind changes agencies made that were not part of a COA or in response to COVID-19. Participants were given the following multiple choices to select from:

- Improve low performing routes
- Better accommodate high performing routes
- Straighten transit routes
- Service new areas
- Improve service equity
- Provide better service for low income population
- Provide better service for older adult population
- Provide better service for people with disabilities
- Respond to customer complaints
- Reduce service due to budget issues
- Expand service due to budget increase
- Others (*specify*)

Table 2-5 summarizes the choices selected by each agency. The table shows that a majority of the agencies made service changes for multiple reasons. Figure 2-4 shows that the most common reason for making service changes was to improve low performing routes (74%), followed by servicing new areas (68%), responding to customer complaints (58%), and better accommodating high performing routes (53%). Less frequently done were to provide better service for people with disabilities (26%) and expand service due to budget increase (26%). One special note was the changes made as part of recently approved 30-year surtax plan in Broward County. Another participant noted changes in response to elected officials. In retrospect, this should have been included but omitted as one of the choices in this survey question.
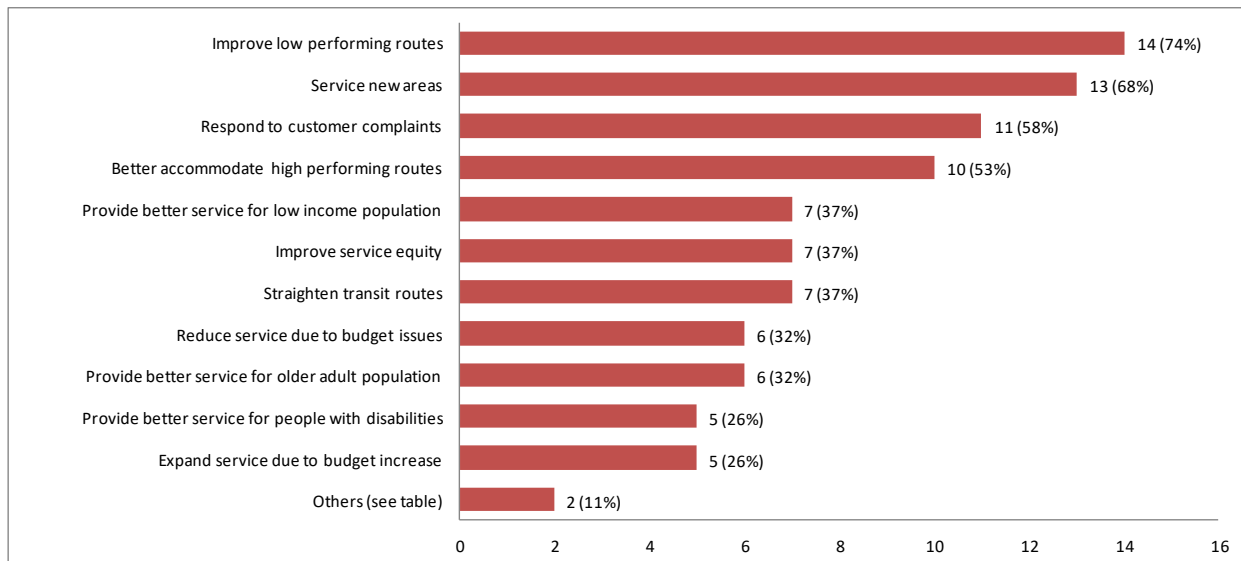
Figure 2-4. Frequency Distribution of Reasons Florida Transit Agencies Made Service Changes (Outside COAs and COVID-19)

10

Table 2-5. Reasons Florida Transit Agencies Made Service Changes (Outside COAs and COVID-19)

Agency	Q7. Outside COA and COVID-19, what have been the reasons for which your agency made transit service changes (check all that apply)?											
	Improve low performing routes	Better accommodate high performing routes	Straighten transit routes	Service new areas	Improve service equity	Provide better service for low income population	Provide better service for older adult population	Provide better service for people with disabilities	Respond to customer complaints	Reduce service due to budget issues	Expand service due to budget increase	Other
BCT	☑	☑		☑	☑	☑	☑	☑	☑	☑	☑	a
BTT	☑	☑		☑	☑						☑	
CAT	☑											
CCT	☑				☑	☑	☑	☑	☑			
CT				☑								b
HART	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		
JTA	☑								☑		☑	
LeeTran	☑		☑						☑			
LYNX	☑	☑		☑					☑	☑		
MCAT	☑	☑	☑					☑				
MDT	☑			☑					☑	☑		
PalmTran	☑		☑	☑	☑	☑	☑		☑			
PCPT		☑		☑								
RTS	☑	☑	☑	☑		☑	☑		☑	☑	☑	
Space Coast				☑	☑	☑						
StarMetro	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		
SunTran		☑	☑						☑			
TheBus				☑							☑	
Votran	☑	☑		☑								
Total	**14 (74%)**	**10 (53%)**	**7 (37%)**	**13 (68%)**	**7 (37%)**	**7 (37%)**	**6 (32%)**	**5 (26%)**	**11 (58%)**	**6 (32%)**	**5 (26%)**	**2 (11%)**

a. 30-year surtax plan
b. Public input and requests from elected officials

As a continuation to the previous question, the next question asked participants to list the top three reasons for making service changes. Table 2-6 lists the reasons provided by each agency in their original text descriptions. Among the different reasons listed by the participants, the three that were mentioned most often were responding to requests from stakeholders that included citizens and elected officials' requests (highlighted in blue), serving new areas (highlighted in green), and increasing or improving service to meet demand (highlighted in yellow).

Table 2-6. Top Three Reasons Florida Transit Agencies Made Service Changes

Agency	Q8. Please list up to three most common reasons for which your agency made transit service changes.		
	Most common	*Second most common*	*Third most common*
BCT	30-year surtax plan	Safety-related	Better meet needs of our riders
BTT	Improve service	Increased funding for new routes	Service new areas
CAT	Request for service	To manage schedule	
CCT	Low ridership		
CT	New funding	TDP	Requests from the public
HART	Funding	Ongoing detour issues/realignment	Service equity
JTA	Increase service	Better match existing population	Better match commercial development
LeeTran	On time performance issues	External requests	Increase UPT
LYNX	Balance resources (from low-performing routes to higher-performing routes)	Service requests (public and/or funding partner)	Service new areas
MCAT	Improve low performing routes	Adjust route to new construction (roads and buildings)	Increase frequency on high performing routes
MDT	Commissioner Request	Budget consideration	Citizen request
PalmTran	To increase access	To enhance service reliability	To enhance rider experience
PCPT	Requests from stakeholders	Service new areas	Increase service on popular routes
RTS	Meet demand	Seasonal adjustments	Service modifications
Space Coast	Provide service to previously unserved areas	Increased frequency to accommodate demand	Planned/Identified service needs
StarMetro	To increase on time performance	To serve unserved areas	Reallocation of buses to underserved areas
SunTran	Demand	Route timing	Alignment
TheBus	Improve service headways	Service new area	
Votran	Direction of County Council	New areas	Improve ridership

The final question on agencies' general practices on making service changes inquired about their staffing practice, i.e., whether they had in-house and/or contracted employees making their service changes. In the case of contracted employees, the question also differentiated between working on-site at the agencies or off-site. Accordingly, the participants were given the following choices for the question:

- In-house agency employees
- Off-site consultants
- On-site consultants
- Other (*specify*)

Table 2-7 shows that all agencies had in-house employees that made service changes for their agencies. Three agencies used both in-house employees and off-site consultants. Only one agency used both in-house employees and on-site consultants.

Table 2-7. Florida Transit Agency Staffing Options for Making Service Changes

Agency	Q9. Who reviews and makes transit service changes for your agency?			
	In-house agency employees	*Off-site consultants*	*On-site consultants*	*Other*
BCT	☑			
BTT	☑	☑		
CAT	☑			
CCT	☑			
CT	☑			
HART	☑			
JTA	☑			
LeeTran	☑			
LYNX	☑			
MCAT	☑		☑	
MDT	☑	☑		
PalmTran	☑			
PCPT	☑			
RTS	☑			
Space Coast	☑			
StarMetro	☑			
SunTran	☑	☑		
TheBus	☑			TDP
Votran	☑			With Approval by County Staff

2.1.4. Existing and Desired Software Platforms for Transit Service Planning

A series of five survey questions were included to learn about the existing software platforms Florida transit agencies used and wished to use. The five questions are listed below:

- Q10: Does your agency use commercially-available software platforms (e.g., Remix) to assist in making transit service changes?
- Q11: If you answered No to Question 10, please describe the general approaches your agency use to make decisions on transit service changes.
- Q12: If you answered Yes to Question 10, please provide the information below on the commercial software platforms (up to 3) your agency have used to assist in making transit service changes (*starting with the one that is used the most often*).
- Q13: Are there software platforms for transit service planning that you are aware of and would like to have access for your agency?

- Q14: If you answered Yes to Question 13, please list the names of the software platforms and describe how you think they could be helpful to your agency.

Tables 2-8 and 2-9 summarize the results from all five questions. Specifically, Table 2-8 lists the responses to four questions (i.e., Q10, Q11, Q12, and Q14) from all agencies, and Table 2-9 lists the specific software platforms being used by the 14 agencies that answered "Yes" to Q12.

From the responses shown in Table 2-8, the agencies can be categorized into the following four groups:

1. Agencies (11 of 19, 58%) that used at least one software platform and were satisfied with what they already had
2. Agencies (3 of 19, 16%) that used at least one software platform and would like to use more of them
3. Agencies (3 of 19, 16%) that did not use any software platform, but would like to use them
4. Agencies (2 of 19, 11%) that did not use any software platform and did not see a need for any.

For the 14 agencies (74%) in groups 1 and 2 which used software platforms to assist in their service planning, the participants were asked to identify and provide information for up to three software platforms. The information included the name of each platform, the year it was acquired, and the applications performed using the platform. Table 2-9 lists the responses from the agencies. The results show that 11 agencies (58%) had used Remix, some from as early as 2015. Other software platforms listed by the participants included Optibus, TransLoc, TBEST, Trapeze, HASTUS, ArcGIS, RouteMatch, Clever Devices, and NextBus. Among these software platforms, Trapeze and HASTUS were used by agencies mainly for scheduling, although these platforms also included components that could be used for other service planning. In addition, the participants also listed automated passenger counter (APC) systems, including those from Avail Technology and Urban Transportation Associates (UTA), which served to provide passenger count data used in service planning.

For the five agencies in groups 3 and 4 that did not use any software platform, the participants were asked to describe the general approaches their agencies used (without the use of a software platform) to make decisions on service changes. Of the four responses received, as listed in Table 2-8, the general approaches included relying on analysis using local data including survey and farebox data, input from citizens and vehicle operators, and local knowledge. One agency indicated that its outside consultants might have used a software platform to help recommend route changes.

Finally, from the six participants in groups 2 and 3 who answered "Yes" to Q13, the participants indicated Remix, TBEST, Swiftly, and HASTUS as the software platforms they would like to have, notably, to help with Title VI route analysis and route planning. Remix, in particular, was indicated in three of the responses.

Table 2-8. Software Platforms and General Approaches Used by Florida Transit Agencies

Group	Agency	Q10. Does your agency use commercially-available software platforms (e.g., Remix) to assist in making transit service changes?	Q11. If you answered No to Question 10, please describe the general approaches your agency use to make decisions on transit service changes.	Q13. Are there software platforms for transit service planning that you are aware of and would like to have access for your agency?*	Q14. If you answered Yes to Question 13, please list the names of the software platforms and describe how you think they could be helpful to your agency?
1	BCT	Yes	N/A	No	N/A
	CAT	Yes	N/A	No	N/A
	CCT	Yes	N/A	No	N/A
	CT	Yes	N/A	No	N/A
	LeeTran	Yes	N/A	No	N/A
	LYNX	Yes	N/A	No	N/A
	PalmTran	Yes	N/A	No	N/A
	RTS	Yes	N/A	No	N/A
	Space Coast	Yes	N/A	No	N/A
	SunTran	Yes	N/A	No	N/A
	Votran	Yes	N/A	No	N/A
2	HART	Yes	N/A	Yes	Too many to list
	JTA	Yes	N/A	Yes	Swiftly - improve on time performance, route planning
	MDT	Yes	N/A	Yes	No specific platform name at this time.
3	BTT	No	Typically, we conduct surveys and review farebox detail to make determinations on routes. We also rely on outside consultants to utilize available software that assist with recommending route changes.	Yes	Remix and TBEST
	PCPT	No	Makes the best decision we can	Yes	Remix /HASTUS
	StarMetro	No	Data analysis, operator and citizen input, and local knowledge	Yes	Remix would assist us in performing our Title VI analysis and look at potential ridership through census data.
4	MCAT	No	Routes changes are evaluated using GIS and comments from public outreach. Efforts are made to reallocate revenue service hours to high performing routes whenever possible rather than making new operational investments.	No	
	TheBus	No	-	No	

* The full description for the No choice is "No, we already have everything we need."

Table 2-9. List of Software Platforms Used by Florida Transit Agencies to Assist in Making Transit Service Changes

Agency	Software Platform #1			Software Platform #2			Software Platform #3		
	Q12. If you answered Yes to Question 10, please provide the information below on the commercial software platforms (up to 3) your agency have used to assist in making transit service changes (*starting with the one that is used the most often*).								
	Platform Name	*Year Acquired*	*Applications Performed Using the Platform*	*Platform Name*	*Year Acquired*	*Applications Performed Using the Platform*	*Platform Name*	*Year Acquired*	*Applications Performed Using the Platform*
BCT	Remix	Not sure	Pretty much use it for everything service-planning related						
CAT	Remix	2017	Planning	Avail Technology	2010	Passenger Counters			
CCT	RouteMatch	2010	NTD data						
CT	Remix	2018	Bus stop location analysis and projected ridership generation						
HART	Remix	2018	Basic planning	Trapeze	Many years ago	Scheduling			
JTA	Giro		HASTUS - Scheduling software	UTA APC		Automatic passenger counter data	NextBus		Bus location, on time performance
LeeTran	HASTUS	2020	Scheduling	Clever Devices	2016	Data collection, reporting, performance monitoring	ArcGIS Pro	2019	Geographic and Network Analysis
LYNX	Remix	2017	Route design; preliminary schedule development	TBEST	Unknown	Ridership estimation; Demographics	Trapeze	Unknown	Schedule development; GTFS generation
MDT	Remix	2015	A preliminary test of new routes						
PalmTran	Remix	2015	Service expansion/ evaluations/changes/proposals	Optibus	2020	Runcutting and scheduling	ArcGIS	Not sure	Mapping and analysis
RTS	Remix	2019	Route Planning	HASTUS	2017	Route Operations	TransLoc	2010	AVL System for planning and operations
Space Coast	Remix	2016	Service Planning for route design and schedule building	Trapeze	Unknown	Demand response trip planner/ customer database			
SunTran	Avail	2013		Remix	2020				
Votran	Remix	Not sure							

2.1.5. Use of Data in Transit Service Change Analysis

The participants were asked the types of data they had used to assist them in making transit service changes. They were given the following choices:

- Census data
- Land use data
- Land parcel data
- One-board survey data
- Street maps
- Satellite images
- Automatic Vehicle Location (AVL) data
- Automatic Passenger Counter (APC) data
- Automatic Fare Collection (AFC) data
- Local knowledge
- Others (*specify*)

Table 2-10 lists all the choices selected by each participant for their agency. Figure 2-5 shows the number of agencies that used each type of data. Among the most frequently used data were census data (95%), street maps (89%), on-board survey data (84%), land use data (74%), satellite images (74%), AVL data (74%), and APC data (63%). Less frequently used data included AFC data (37%) and land parcel data (26%). A majority of the participants (84%) also indicated that they relied on local knowledge to make service changes. Several participants also indicated some other data and/or information, with the most common being from the customers, including through *SeeClickFix*, which was an app that allowed citizens to quickly report non-emergency neighborhood issues they encountered to local government bodies.
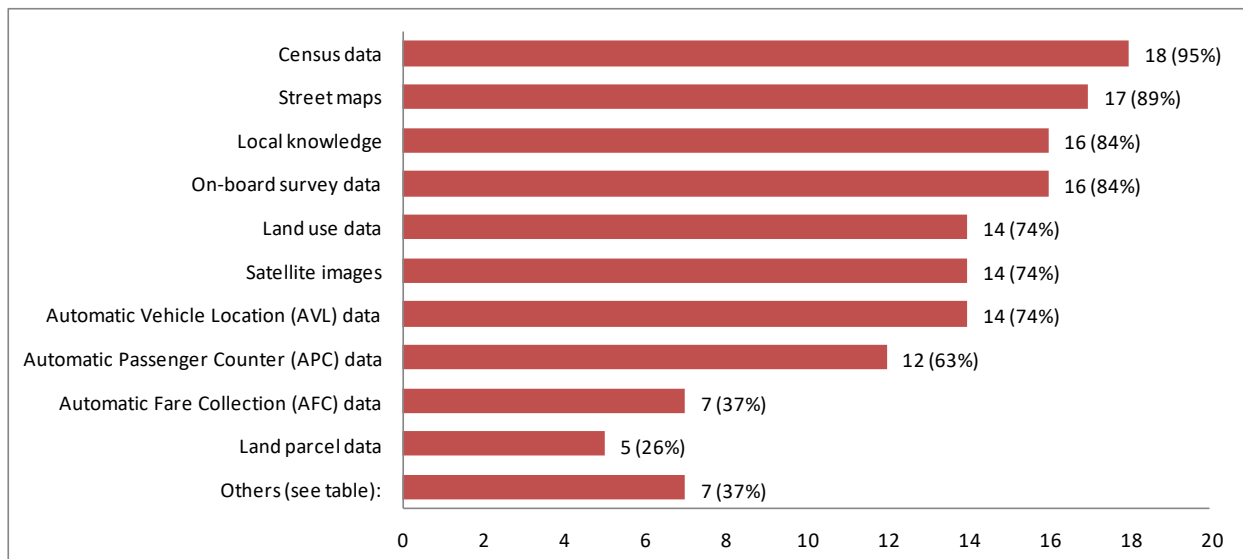
Figure 2-5. Frequency Distribution of Data Sources Used by Florida Transit Agencies

Table 2-10. List of Data Sources Used by Florida Transit Agencies

Agency	Q15. What data have your agency used to assist in making transit service changes (*check all that apply*)?										
	Census data	Land use data	Land parcel data	On-board survey data	Street maps	Satellite images	Automatic Vehicle Location (AVL) data	Automatic Passenger Counter (APC) data	Automatic Fare Collection (AFC) data	Local know-ledge	Other
BCT	☑	☑	☑	☑	☑	☑			☑	☑	
BTT	☑			☑	☑	☑	☑		☑	☑	a
CAT	☑						☑	☑	☑		
CCT	☑			☑	☑					☑	
CT	☑	☑	☑	☑	☑	☑				☑	b
HART	☑	☑			☑	☑	☑	☑	☑	☑	c
JTA		☑		☑	☑	☑	☑	☑		☑	
LeeTran	☑			☑	☑	☑	☑	☑		☑	
LYNX	☑	☑		☑	☑	☑	☑	☑		☑	d
MCAT	☑	☑	☑	☑	☑	☑	☑	☑		☑	e
MDT	☑	☑		☑	☑	☑	☑	☑	☑	☑	
PalmTran	☑	☑		☑	☑	☑	☑	☑	☑	☑	f
PCPT	☑	☑	☑	☑	☑	☑	☑			☑	
RTS	☑	☑		☑	☑	☑	☑	☑		☑	
Space Coast	☑				☑					☑	g
StarMetro	☑	☑	☑	☑	☑		☑			☑	
SunTran	☑	☑		☑	☑	☑	☑	☑	☑		
TheBus	☑	☑		☑				☑			
Votran	☑	☑		☑	☑	☑	☑	☑		☑	
Total	**18 (95%)**	**14 (74%)**	**5 (11%)**	**16 (84%)**	**17 (89%)**	**14 (74%)**	**14 (74%)**	**12 (63%)**	**7 (37%)**	**16 (84%)**	**7 (37%)**

a. Driver input
b. RouteMatch boarding and ridership data
c. SeeClickFix customer recommendations
d. Mobile device tracking data (cell phone location data)
e. Public outreach
f. Customer complaints
g. TDP and local boards, elected officials & service requests from general public

2.1.6. Others

One of the last questions asked if the participants would be willing to hold a web meeting with the research team to share more information about their service planning practices, use of software platforms, and needs for support that could potentially be provided by FDOT. Table 2-11 lists the responses, which included 8 participants who gave a definite "Yes", 9 participants who indicated "May be", and 2 who indicated "No".

Table 2-11. Willingness of Participants to Meet with FIU Project Team

Agency	Q16. Will you be willing to meet with the FIU project team via a web meeting to share more information about your agency's transit service planning practices, use of software platforms, and needs for support that could potentially be provided by FDOT?		
	Yes	May be	No
BCT			☑
BTT	☑		
CAT	☑		
CCT		☑	
CT	☑		
HART	☑		
JTA		☑	
LeeTran		☑	
LYNX		☑	
MCAT	☑		
MDT			☑
PalmTran	☑		
PCPT		☑	
RTS		☑	
Space Coast	☑		
StarMetro	☑		
SunTran		☑	
TheBus		☑	
Votran		☑	
Total	**8 (42%)**	**9 (47%)**	**2 (11%)**

The survey ended by asking the participants to provide any additional feedback they wished to share. Table 2-12 lists the response from five participants. One notable response came from MCAT who reiterated that it was sufficient for the agency to make use of their ample CAD/AVL and APC data to evaluate service changes without investing in a software platform.

Table 2-12. Additional Feedback from Participants

Agency	Q17. If you have any additional feedback, comments, or clarifications, please use the text box below.
CT	Thank you FDOT!!
MCAT	For an agency our size (peak pullout =22), it just isn't worth it to invest is specific purpose built service planning software platforms. We have access to a great deal of data through CAD/AVL and APC's and find that is more than sufficient to evaluate service changes.
MDT	Eric Zahn, DTPW may be a better contact for this survey.
PCPT	The reason that surveys may be delayed is that we are busy
Votran	Votran has an opening for a Transit Planner.

2.2. Commercially-Available Software Platforms for Service Route Planning

The survey results identified the following six commercially available software platforms that some Florida transit agencies had used or wished to use:

1. Remix
2. Optibus
3. Swiftly
4. TransLoc
5. HASTUS
6. Trapeze

All six platforms were documented in the Transit Technology Assessment Framework Tool (TTAFT). Other than HASTUS, which was listed in TTAFT under its *Literature Review* section, the rest of platforms were listed under its *Vendors* section. The survey results, as summarized in the previous section, show that the agencies did not necessarily use some of these platforms specifically for service route planning. For example, Optibus, HASTUS, and Trapeze were listed by agencies for applications on scheduling and General Transit Feed Specification (GTFS) file generation. However, these platforms also included a planning module for service route planning. The six platforms are briefly introduced below.

2.2.1. Remix

The agency survey above shows that Remix had been widely used agencies in Florida. As described in TTAFT (see Figure 2-6), the platform allows transit agencies to design and test different service route alternatives and quickly see the service cost and demographic impacts of the alternatives. Remix was also known for its user-friendly mapping interface and transit agencies were known to use the platform to create route maps. Remix is a cloud-based software-as-a-service (SaaS) platform, which allows the developer to update the platform based on customer feedback and push the updates to the cloud quickly. The developer website claimed to have customers from over 340 cities worldwide. Remix's U.S. office is located in San Francisco. (Ref: https://www.remix.com/solutions/transit)

Figure 2-6. TTAFT Information on Remix

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2.2.2. Optibus

Among the agencies surveyed, Palm Tran was the only agency that used Optibus for runcutting and scheduling. Like Remix, Optibus also uses the SaaS platform, relieving agencies from the burden of meeting the IT support while receiving continuous and timely system improvements. The TTAFT information included for Optibus is shown in Figure 2-7. It lists two key Optibus modules, i.e., Optibus OnSchedule and Optibus OnTime. The platform had since added a planning module that included routing planning. It allowed the users to import data and perform route planning or modifications with an integrated timetable. Optibus is headquartered in Tel Aviv, Israel, with local offices located across the U.S. (Ref: https://www.optibus.com/product/planning/)

Figure 2-7. TTAFT Information on Optibus

2.2.3. Swiftly

This particular software platform was on the wish list of JTA which would like to use it for on-time performance monitoring and route planning. Swiftly integrates multiple functions including scheduling, operations, planning, and customer service. It is also a SaaS-based platform marketed by Swiftly, Inc., headquartered in San Francisco. The company website claimed to have customers from over 70 cities. Figure 2-8 shows the information included in TTAFT for Swiftly. (Ref: https://www.goswift.ly/solution-planning)

Figure 2-8. TTAFT Information on Swiftly

2.2.4. TransLoc

TransLoc was known for its real-time vehicle location passenger information system. What was less known, but of interest to this project, was a product called Microtransit Simulator. The simulator allows the planners to see how a microtransit service would run under various demand and service scenarios before actual deployment. The simulator takes ride requests and service parameters and dynamically assigns rides to vehicles based on an algorithmic optimization. It then outputs a schedule of pickups and drop-offs for each vehicle and ride, from which performance metrics can be derived. The platform was designed to help address questions such as on the rider experience be (such as wait and ride times) with a service, the number of rides that could be served with a given number of vehicles, the number of vehicles needed to be added to serve the demand while maintaining service quality, and the relationship between service quality and service cost. Figure 2-9 shows the TransLoc information in TTAFT describing the other TransLoc modules and their functions. TransLoc is headquartered in Durham, North Carolina (Ref: https://transloc.com/ondemand-microtransit-simulator/)
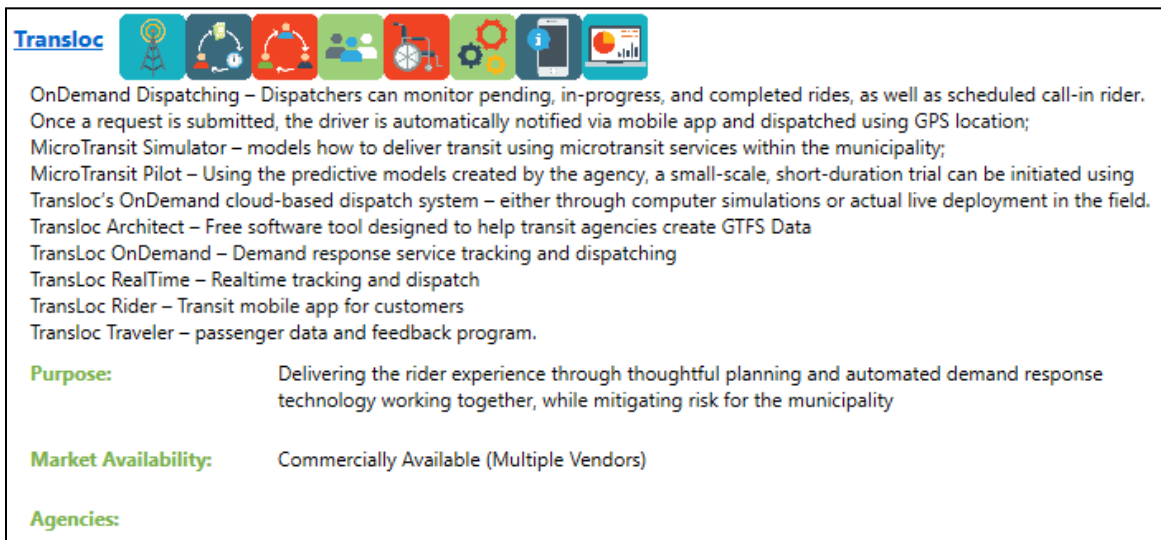
Figure 2-9. TTAFT Information on TransLoc

2.2.5. HASTUS

As noted earlier, HASTUS from Giro, Inc. of Montréal, Canada, was known for route scheduling and operations. However, HASTUS provides a comprehensive platform that includes a planning module for evaluating how well service meets demand and compare scenarios to redesign service network. Its network-design tools allow planners to create or modify routes, which are obtained directly from scheduling data. Unlike the four platforms above, HASTUS is a client server application. Figure 2-10 shows information in TTAFT for HASTUS. (Ref: https://www.giro.ca/en-ca/our-solutions/hastus-software/hastus-for-planners/)

Figure 2-10. TTAFT Information on HASTUS

2.2.6. Trapeze

Like HASTUS, Trapeze is also based in Canada and is also known for route scheduling. Trapeze offered a comprehensive platform serving a variety of transit functions, one of which was its Mobility Planning module. The module allows the users to use spatial and operational data to estimate the impacts of coverage and service change scenarios as part of route planning and network redesign. Again, like HASTUS, the platform is integrated with its scheduling data. The TTAFT information included for Trapeze is given in Figure 2-11. (Ref: https://www.trapezegroup.com/mobility-planning)

Figure 2-11. TTAFT Information on Trapeze

2.3. Selection of Florida Transit Agencies for Interviews

This chapter summarized the results from a survey of Florida transit agencies to learn about their general service planning practices and to identify software platforms being used by the agencies for transit service planning. The survey results also provided information needed to identify transit agencies to participate in the next project task, which was to interview select transit agencies via web meetings to gain more information and insights on their use of software platforms. Table 2-13 lists the all the survey participating agencies and the associated

information their willingness to participate, the software platforms used and wish to use, their geographic location in the state, and the size of urban area size they serve. Based on this information, six agencies, as indicated in the last column of the table, were tentatively selected for interviews with the research team. Together, they covered all areas of the state and the FDOT districts (except D6) as well as urban areas of different sizes.

Table 2-13. Florida Transit Agencies Selected for Interviews

Agency	Willingness to Meet? (from Q16)	Use Software Platforms? (from Q10)	Software Platforms in Use (from Q12)	Wish to Use (more) Software Platforms? (from Q14)	FDOT District	Urban Area Size	Selected for Web Meeting Invitation
BCT	No	Yes	Remix	No	4	Large	
BTT	Yes	No	N/A	Yes	3	Small	
CAT	Yes	Yes	Remix	No	1	Small	☑
CCT	May be	Yes	RouteMatch	No	7	Small	
CT	Yes	Yes	Remix	No	4	Small	
HART	Yes	Yes	Remix, Trapeze	Yes	7	Large	
JTA	May be	Yes	HASTUS	Yes	2	Large	☑
LeeTran	May be	Yes	HASTUS, ArcGIS	No	1	Medium	
LYNX	May be	Yes	Remix, TBEST, Trapeze	No	5	Large	
MCAT	Yes	No	N/A	No	7	Medium	☑
MDT	No	Yes	Remix	Yes	6	Large	
PalmTran	Yes	Yes	Remix, Optibus, ArcGIS	No	4	Large	☑
PCPT	May be	No	N/A	Yes	7	Large	
RTS	May be	Yes	Remix, HASTUS, TRANSLOC	No	2	Medium	
Space Coast	Yes	Yes	Remix, Trapeze	No	4	Medium	
StarMetro	Yes	No	N/A	Yes	3	Medium	☑
SunTran	May be	Yes	Remix, Avail	No	5	Small	
TheBus	May be	No	N/A	No	7	Small	
Votran	May be	Yes	Remix	No	5	Medium	☑

CHAPTER 3
INTERVIEWS WITH TRANSIT AGENCIES

This chapter summarizes the findings from interviews with select transit agencies via Web meetings to obtain additional details and insights on the software platforms the agencies used. The efforts involved arranging, conducting, and summarizing a series of Web meetings with ten transit agencies, including six in Florida and four outside of Florida.

3.1. Web Meeting Organization and Administration

Based on the survey results described in the previous chapter, the research team identified and selected six transit agencies from Florida for the Web meetings. Invitations were first extended to the six agencies selected, as described in Section 2.3. However, some agencies were not responsive. Up to three follow-up emails were sent to the agency contacts that did not respond to the initial invitations for meeting. Overall, a total of nine transit agencies in Florida were contacted, of which six agencies eventually agreed to participate in the Web meetings. In addition, with some assistance from software platform vendors, the research team contacted a total of five agencies outside of Florida, four of which agreed to meet with the research team, for a total of ten transit agencies interviewed for this project. These agencies and the participant information are listed in Table 3-1. Appendix C shows the letter template that was used to prepare the emails sent to the Florida agencies. A similar email was sent to the out-of-state agencies.

The Web meetings were conducted over the period of October 2020–February 2021. Each meeting was scheduled for one hour. Prior to the Web meetings, the FIU team researched the individual transit agencies and compiled a checklist of information that would be discussed at these meetings. At the beginning of each meeting, the research team thanked the participants and asked if they would permit the meetings to be video-recorded for the purposes of review and reporting by the research team and not to be shared publicly. All participants graciously provided their permission.

The research team then proceeded to reiterate the purposes of the project and the objectives of the meetings. While the focus of the meetings was on aspects related the specific software platforms the agencies used in service planning, other software platforms, systems, datasets and related issues were also discussed. When possible, agencies also demonstrated the use of the software platforms they used for transit service planning. It is important to note that, as the out-of-state agencies were identified with assistance from software platform vendors (i.e., CATA was identified through Optibus, Pierce Transit through Swiftly, GoTriangle through Remix, and LA Metro through NetPlan), the Web meetings were focused mainly on the specific software platforms from these vendors. In general, all meetings were conducted in a casual and conversational manner to allow an open discussion.

Table 3-1. Web Meeting Participants and Contact Information

Transit Agency	Participant Name and Title	Key Contacts
Palm Beach Transit (PalmTran), Palm Beach County, FL	Yash Nagal, Transit Planning Manager	ynagal@pbcgov.org (561) 841-4238
Collier County Transit (CAT), Collier County, FL	Omar Delon, Transit Manager; Karto Zachary, Senior Planner; and Tamarin Kirby, Planning Technician	omar.deleon@colliercountyfl.gov (239) 252-4996
County of Volusia (Votran), Daytona Beach, FL	Elizabeth Suchsland, Assistant General Manager	Esuchsland@volusia.org (386) 763-3727
Space Coast Area Transit (SCAT), Brevard County, FL	Terry Jordan, Planner	terry.jordan@brevardfl.gov (321) 635-7815
Regional Transit System (RTS), Gainesville, FL	Jesus Gomez, Transit Director; and Ricky Walker, Transit Planner	gomezjm@cityofgainesville.org (352) 393-7860
StarMetro, Tallahassee, FL	Andrea Rosser, Transit Planning Manager; Ronnie Shelly, Planner I	andrea.rosser@talgov.com (850) 891-5196
Centre Area Transportation Authority (CATA), State College, PA	Christopher Jordan, Director of Service Planning and Community Engagement	cjordan@catabus.com (814) 238-2282 x5153
Pierce County Public Transportation Benefit Area Corporation (Pierce Transit), Tacoma, WA	Ryan Wheaton, Planning and Community Development Executive Director	rwheaton@piercetransit.org (253) 983-3399
Triangle Transit Research Triangle Park (GoTriangle), NC	John Tallmadge, Director of Regional Services Development (formerly)	jdtall@email.unc.edu
Los Angeles County Metropolitan Transportation Authority (LACMTA), Los Angeles, CA	Wayne Wassel, Senior Transportation Planning Manager	wassellw@metro.net (213) 922-6979

3.2 Summary of Web Meetings

This section summarizes the discussions and findings from the Web meetings with the ten participating agencies. The summary is structured based on the key subject areas of questions asked to the agencies during the meetings.

3.2.1. Software Platforms Used

Based on conversations with the transit agencies, the following were the main software platforms used in service planning:

- Remix: This software platform is the most used system in Florida. Remix is user friendly and includes many features that can be used in service planning. Transit agencies seemed highly satisfied with the features it provided.
- Optibus: This software platform includes user-friendly features for service planning, with

particular strengths in scheduling. It offers innovative features and powerful optimization algorithms especially for scheduling.

- NetPlan: This software platform includes many planning features that allow agencies to conduct a detailed analysis and cost estimates, in particular if the agency has HASTUS as their scheduling platform.
- Swiftly: This software platform specializes in the application of AVL data for tracking transit vehicles and operators, analyzing and improving on-time performance, and calculating segment speeds.

There were also additional software that agencies were considering, including Hopthru and Teralytics, which present innovative approaches on the use and analysis of real-time big data. Hopthru focuses on using APC data for analyzing ridership at different levels of aggregation and can provide detailed information such as average daily boardings and average vehicle load. It provides maps and charts that allow for a more sophisticated data analysis. As this was a relatively new platform, it was expected that other transit datasets and additional functionalities would be added in the future.

Teralytics, on the other hand, focuses on big data and uses data from mobile devices that could be very helpful for understanding human mobility and for identifying origins and destinations of travelers. The platform provides an interface that allows the visualization of travel patterns and summary of travel data.

It is worth mentioning that while transit agencies use several software platforms, each platform addresses a particular area. Further, the transit landscape is very vast and collect lots of data and information from different transit ITS systems. Therefore, at least in the near term, transit agencies have to use several software platforms because there is no one software platform that addresses all the needs in one platform. In the service planning area, software platforms like Remix, Optibus, or NetPlan seem to be sufficient. However, if the agency is interested in improving on-time performance, a platform like Swiftly can be very helpful.

In Florida, the most utilized software platform in service planning was Remix. Five of the six Florida agencies interviewed use Remix and the other one is considering the use of Remix. This was also evident in the surveys, where the agencies that currently use at least one software platform also mentioned using Remix. Some of the agencies interviewed have been using Remix for quite some time. For instance, Palm Tran has been using Remix since 2015 and Space Coast since 2016. Remix was founded in 2014 and agencies like GoTriangle and Palm Tran were early adopters of the platform. During the meetings, some agencies provided a quick demonstration of Remix and it was clear the agencies had good knowledge of the platform and the planning applications the platforms could serve. In addition, Palm Tran also demonstrated their use of Optibus.

Besides the tools provided by the different software vendors, transit agencies mostly used Microsoft Excel and ArcGIS for data analysis. Nevertheless, some agencies reported using Crystal Reports, SPSS, and Microsoft Power BI as part of their planning activities.

3.2.2. Software Platform Applications

Transit agencies use different software platforms for different purposes. As most agencies tried to improve efficiencies, they had to continuously make service changes to deliver a better service to their customers. It was reported that limited funding and resources continued to be problematic, so they had to be creative to address their inefficiencies. The different software platforms could assist the transit service planners achieve these goals.

During the interviews, the transit agencies mentioned that they often received requests and suggestions for new service or service changes that required a quick response. They usually receive these requests and feedback from different groups such as direct requests from commissioners, requests from individuals and organizations, and suggestions and recommendations from operators and staff. With this input, along with other considerations, agencies could quickly use the software platforms to help decide how to improve existing transit service or where to put transit service for new developments and new destinations. In addition, transit agencies were always under pressure from customer complaints that they needed to address within a certain deadline. If these complaints were not addressed timeline, they could escalate the issues, which is not desirable.

A majority of the agencies interviewed used Remix to design routes, to comply with Title VI, and to identify potential ridership using census data. For Title VI, they used block group census data to figure out what portions of the route serve minority and low income areas and measured the distance that each route went through these areas. Agencies that did not have Remix conducted the Title VI analysis by hand with the assistance of GIS software. Both Remix and Optibus provided Census demographic data as part of the license with the agencies. In addition, they also provided scheduling features that allowed planners to visualize the impacts of route modifications, calculate the cost of these changes, and better prepare service planning in general.

There were clearly many applications of the software platforms in service planning and the main use had been for fixed-route service planning. The following were the main areas where software platforms were being used in service planning, as reported by the agencies interviewed:

- Plan and modify transit routes.
- Manage detours.
- Calculate operational costs due to service changes.
- Comply with Title VI and improve service equity.
- Respond to customer complaints.
- Assess the whole system, specific routes, or segments of a route using demographic information mainly from the Census and the American Community Survey (ACS).
- Assist with transit planning analysis such as identifying dense locations to attract more people into mass transit.
- Help estimate operating budgets based on costs per hour and hours of operation.

- Link demographic information to the transit routes.
- Help visualize the areas where agencies provide service and the population they serve. For instance, minority or low income segments of the population can be identified.
- Provide a convenient mapping tool that can generate reports and service changes graphics for customer service.
- Export dataset such as shapefiles for use in other platforms like ArcGIS.
- Useful to determine the overall impacts of routes and service changes.
- Assist with the monitoring, improving, and reporting of On-Time Performance (OTP).
- Assist with system restructuring.

In general, agencies used software platforms in-house for most transit planning tasks. However, they hired consultants for Transit Development Plans (TDPs) and Comprehensive Operations Analysis (COA). All related tasks to the TDPs and COAs were usually performed by consultants. The consultants helped transit strategies by taking a comprehensive look at the transit systems and provided recommendations to improve efficiencies.

3.2.3. Satisfactions with Software Platforms

All the agencies interviewed were highly satisfied with the software platforms used in service planning, namely Remix, Optibus, Swiftly, and NetPlan. The transit agencies mentioned that their experience with Remix had been very positive. The agencies thought the platform was user friendly and transit staff could be trained quickly to use it. The learning curve of Remix varies. Some agencies mentioned that it took about a month to fully learn Remix, while others said that it could take up to three months to be proficient with the platform. In terms of performance of the platform, users rated the software very highly. Some considered Remix as "a pretty smooth system" and never seen a crash or glitches. Agencies also reported good communications between the agencies and Remix and they were free to send suggestions for potential future software improvements. Before using Remix, some agencies had to use a combination of manual methods, GIS, and office tools like Microsoft Excel to perform service planning activities.

Besides the use of Remix, Optibus, and Swiftly by the Florida agencies, CATA's fixed-route bus system, Catabus, used Optibus for both planning and scheduling. Pierce Transit also used Remix, but the interview focused on Swiftly which was used by the agency to provide real-time information to customers. They found that the information provided by Swiftly was highly accurate. The meeting with GoTriangle focused on Remix and the feedback received during the interview was similar to the one provided by the Florida agencies. They were highly satisfied with the system.

LA Metro used NetPlan to assist in the preparation of the "NextGen" study for the restructuring of the whole transit system. The agency was also very satisfied with their use of NetPlan. Before NetPlan, they relied on good old fashion sketch planning methods that were a tedious time-consuming manual process. Their decision to go with NetPlan as the main service planning platform for a large agency like LA Metro had to do with the fact that the already had HASTUS

as their scheduling platform. It allowed them to incorporate the scheduling data into the planning software, so that they could perform very accurate cost estimates and create planning strategies that could be used by the scheduling department.

3.2.4. Impacts and Adjustments Due to COVID-19

As this was a relevant topic and an ongoing situation, the research team also asked the Florida agencies about the service adjustments they had to make as a result of COVID-19. Some agencies mentioned that they started early on to address this issue by putting hand sanitizers on the buses, rear-door loading, waving fares, and doing everything they could to ensure enough space between passengers. Agencies also paid attention to recommendations and suggestions throughout the industry.

Agencies made significant changes to the routes and schedules and some were looking back to see if they made the right decision. Going forward, one of the main concerns was the loss of revenue due to the reduced ridership. To address this issue, agencies would probably be tweaking or changing some routes and schedules, putting in alternative forms of delivery, or maybe even eliminating some low performing routes as a result of COVID-19. After bouncing back from the pandemic where, at the worst point, ridership dropped to around 25%. Some agencies reported that by the end of November of 2020, they were operating at around 60%-70% of normal pre-COVID numbers. Agencies reported that they received funding from the CARES Act to keep the operating expenses going. They also mentioned that they lowered the number of employees due to attrition. All this and the fact that they were not using as much fuel helped with the budget issue.

3.2.5. Preparation of Data in Software Platforms

The research team discussed with the agencies about the data they used in service planning, the amount of effort required to prepare the data, and who was responsible for uploading the data into the system.

Agencies used data from different sources such as the Census, ACS, and GTFS or scheduling data from platforms like Optibus, Trapeze or HASTUS. Agencies also used data from transit ITS systems like AVL, AFC, and APCs from different vendors including Avail, TransLoc, UTA, Clever Devices, or GFI Genfare.

In general, agencies used data for different applications as part of their planning process. For instance, they used demographic data for equity analysis to provide a fair and equitable service to different segments of the populations such as low income and minority areas. Agencies could obtain demographic data in two ways: conducting surveys or using the data from the census. For the surveys, agencies might use their own staff, use interns for the data collection efforts, or hire a consultant to do that for them. Another example on the use of data was for analyzing the fare structure and fare elasticities when transit agencies wanted to increase or decrease fares.

Agencies also used ridership data in some of the software platforms. With this information, agencies could show the ridership associated to routes and bus stops or assess the boarding and alighting at a particular station. As mentioned before, the ridership data could come from the fare collection systems. However, for more detailed ridership data at the stop level, data from APC systems could be used. Some agencies mentioned that they had a high percentage of APCs, but the goal was to achieve 100%.

One agency mentioned that they wished that the software platforms had a layer with historical traffic data, so they could look at that when trying to design some of the routes. In addition, they said that it would be great to have a platform that could alert them of road closures and accidents and automatically reroute the buses to avoid those areas.

Because software platforms including Remix, Optibus, and NetPlan provided census and other data as part of their software licenses, agencies did not need to prepare the data themselves for demographic analysis. For uploads of standardized data, such as GTFS, into software platforms, the vendors could quickly help the agencies upload the data. Agencies could also make a request to have vendors upload their local data (e.g., schools, hospitals, landmarks, etc.) or ridership data from APCs or AFC systems. However, these data must be provided in standard file formats such as shapefiles. An example of this type of request was made by a transit agency that, because of COVID, asked the vendor to upload a shapefile with their health facilities to allow the agency to assess the transit service provided to these facilities.

The GTFS datasets were usually generated by the agency's scheduling platforms. The agencies could send the data to the vendors for upload or place the data in a location where the vendor could retrieve the data. It is worth noting that vendors like Optibus also allowed the users to directly upload GTFS and GIS files in the GeoJSON format or copy and paste data from Excel spreadsheets.

For transit ITS datasets, agencies could provide the data outputs like ridership data to be uploaded or they could work with the different vendors to connect to their databases to retrieve the data. The vendors could also help to setup their platforms to automate this process. However, these might involve major efforts that were not included in their software license agreements.

3.2.6. Challenges and Opportunities

Most of the agencies interviewed did not report any major issues with the software platforms used in service planning. In general, they were very satisfied with the software features and capabilities. Even though some mentioned that they found minor glitches, they also said that the vendors were good at addressing these issues and responding to requests for improvements. However, they had some complaints about some transit ITS systems in particular regarding their AVL and APC systems. In addition, some expressed concerns about the software used in other departments. They said that some software platforms were more reliable than others; some had bugs and crashed often while others were very reliable. The

agencies also complained about older systems that were not web-based. They mentioned that these systems did not perform well for remote work and could be very slow. This had been a problem for staff working remotely.

Some agencies mentioned that if software platforms were not performing adequately, they might consider replacing them so they could be more efficient. As the dissatisfaction with some software platforms occurred, agencies tried to find better solutions. In some cases, vendors upgraded their platforms to provide better options and avoided being replaced. Therefore, to be competitive, vendors must provide adequate tools and services. It is also important to note that not all agencies would be willing to embrace changes, as the workforce had already been trained in older systems. Agency leadership and decision makers would need to assess the costs and benefits of implementing more efficient systems.

A challenge reported mainly by smaller agencies was that the software could be very expensive. Because they may have a different organization structure, such as being under a City government, there were many funding barriers. As such, they had to find their own funding to be able to move forward with software acquisitions. If funding was not available, they would be stuck with platforms that might not be the desirable ones. These limitations might not apply to agencies that were independent authorities or larger county systems. Another challenge for smaller agencies was that their personnel was spreading thin because they might be installing or maintaining other transit ITS systems or collaborating with other departments.

Another challenge mentioned by the agencies was the vast amount of data they collected. Some agencies had been collecting data for many years from their transit ITS systems. However, some reported that they did not have the time and resources to manipulate and analyze the data. Even with the help of sophisticated software platforms, agencies might not have the manpower to analyze all the data.

There were many opportunities of using software platforms for meeting the agency needs. For instance, if there was a community service request, they just went into the software and simulate the new service and gave them back the costs for this service in case they wanted to pay for it or at least they could discuss how to go about implementing the service. Another helpful element was that the vendors provided the Census and ACS data. As such, they basically already had all the data for the whole country and the agencies could use the existing data or work with the vendor to customize the system to see the data the agency needs. If there was something that they did not have, agencies could send it to the vendors for them to incorporate the new datasets into their platforms.

Agencies also stated that before they had the software platforms, the biggest challenge they had was that they could not get any approximate cost of the proposed services. With the software platforms it was easy to see the cost of expanding service (e.g., this is the amount of money they need to extend the service). This helped prepare a budget for future improvements listed in their TDPs. This feature was also helpful for community requests. For example, if there was a request for an improvement, planning staff could provide the estimated costs of this

service. This feature was available in the Remix, Optibus, and NetPlan software platforms.

3.2.7. Software Platform Performance and Vendor Support

To the question on how responsive the software providers were to the needs or issues that come up after installation and use, agencies said that the vendors were very responsive and provided good technical support. If there was a dataset that they did not have, they could give it to vendors to let them upload the data within a few days, and could be faster if they requested that they needed to use the data in a hurry. The response time also depended on how complex the requests were. Some agencies also reported that they never had any type of breach or loss of data.

The fact that platforms such as Remix, Optibus, and Swiftly are web-based makes it easy and timely for the agencies to receive system and data updates. The updates were usually included or negotiated as part of the license agreement. In addition, vendors usually let agencies know when there were new updates. Vendors helped agencies walk through the upgrades or the datasets uploaded into the system.

The software platforms were generally regarded by the agencies as user friendly. When an agency identifies any glitches or little things that may need some changes, the technical support would take a look at that. If the issue had been fixed or it needed some training, vendors could show the agencies how to address the issue. The communication with the vendors could be by email, phone, or through bulletin boards or web pages where agencies could post questions. One issue was that some vendors were located in a place with a different time zone, so they had to take this into consideration for meetings or phone calls. As the vendors provided support to many agencies, they usually assigned a person (Customer Success Manager) to handle a specific agency account.

The training of the software platforms was usually done after the license agreement was executed. After that, agency staff could log in and start using the platforms. The training could be scheduled in the following weeks and the vendors would provide the training, where they explained the basics and how to use all the features of a platform. In the past, the training was conducted at the agencies and online. During COVID-19 all the training was moved online. Vendors also offered regular webinars where they could introduce new features or provide additional training.

The time needed to familiarize with a software platform depended on the staff's level of knowledge and their computer skills. For instance, a planner at CAT who used Remix said that it was very intuitive and took him less than a month to fully learn Remix. Another issue with training was that staff might not be able to dedicate exclusively due to other activities. However, agency staff did not have to take too long to learn these software platforms and were able to start using them in a relatively short period of time. Lastly, it should be noted that some agencies might have only one planner using a software platform, while other agencies might have several employees doing the same.

3.2.8. Agency and Vendor IT Support

As most of the software platforms used in service planning are web-based and the vendors provide technical support, the role of the IT departments has diminished. Unlike the extensive role that IT departments played in the past to support all desktop applications, the current role was to support PCs, the agency network, tools like Microsoft Office and older systems, and in some cases assisted with the transit ITS systems. Again, as most of the current software platforms are web-based, the only time agencies might need IT Department's support is when they renew the software license. Further, dedicated IT personnel specifically to transit agencies might be merging with county IT departments to improve efficiencies. In addition, as reported by one agency, independent IT contractors may be hired to maintain their desktops and to be a liaison between the software vendors and the agency to make sure that they provide support if something goes wrong.

3.2.9. Software Platform Pricing and Licensing

The agencies mentioned that the pricing of the software platforms was generally an annual fee that was based on the number of vehicles and may have some limitations on the maximum number of users. For instance, an agency believed that the Remix limitation was 25 per client and was considered unlimited as very few agencies would have more than 25 people that would be using the same platform. In addition, the term of the Remix agreement was three years and the fee covered the initial platform setup, training, support, and data updates. Another agency reported that they signed their Remix agreement for five years. The costs of the different software platforms vary. However, the ultimate price could be negotiated depending on several considerations such as a discounted introductory price or if they were part of a combined procurement.

After the term of the contract, agencies might have to go to the board for renewal. In some cases, the renewal could be for one year until dedicated funding was identified. As technology continues to improve and software platforms provide similar functionalities, agencies may have options selecting the software platforms that best meet their needs and budget. Some agency staff members were in the lookout for opportunities regarding new technology and software that came their way. This had allowed them to know where the current state of things was and decide if they needed to acquire new software platforms.

3.2.10. Statewide Software Procurement

The Florida agencies were further asked about the possibility of FDOT establishing a statewide mechanism for purchasing software. The agencies interviewed reacted positively to this question. They agreed that getting a state license for acquiring software could be beneficial especially for small agencies. These agencies might not have the resources for researching for software platforms or dealing with the contractual agreements. With a statewide software license, agencies would get a good economy of scale that this might be able to bring. It was suggested that this could follow the FDOT program they had with the Center for Urban Transportation Research (CUTR) at the University of South Florida for the purchase of new

transit vehicles. The same could be done for all transit platforms, including for planning, scheduling, operations, and paratransit software. One agency mentioned that a statewide license could help with the coordination between agencies, since all the agencies would be using similar software. Another area that this could help was with the planning, scheduling, and operations of agencies that provided transit service across county lines. This was particularly relevant to the planning and scheduling of paratransit riders who often travel across multiple jurisdictional boundaries.

3.2.11. Other Software Platforms and Systems

The agencies interviewed have used mainly Remix, Optibus, NetPlan, and Swiftly for service planning. However, there were other software platforms and systems that provided data or interacted directly with service planning. These platforms included mainly scheduling systems like Trapeze and HASTUS, and transit ITS systems like AVL, APCs, and AFC from different vendors.

In general, transit agencies used a variety of platforms for different purposes. These could go from transit planning, scheduling, and operations to customer service, paratransit, and maintenance. In addition, transit ITS systems like AVL, APC, and AFC were mentioned as data generators for service planning. They can generate ridership data, provide information for on-time performance, and provide real-time information that can be used by the agencies and users of the transit system. For instance, APC and AFC vendors like UTA and Genfare GFI can generate ridership data for service planning.

Routematch was also mentioned by some transit agencies interviewed, but the use of this software platform was mainly for paratransit. In addition to specialized software platforms, agencies still use Excel for basic calculations and ArcGIS as tools used for service planning. One agency believed that GIS was better for plotting system maps.

In addition, many agencies offer trip planning and real-time information for passengers on their websites through different software platforms such as TransLoc, Avail, and NextBus. This information was also available through different mobile apps from these vendors. In addition to general trip planning, they also included service alerts, SMS notifications, and some included real-time graphical bus tracking to see where the vehicles were located. This is the case of Gainesville where RTS, in collaboration with University of Florida and TransLoc, offered real-time bus tracking that also provided information on bus capacity. This information could be useful for transit agencies and transit riders to maintain social distances during COVID-19. CAT also offered a similar functionality through the Avail Infopoint system.

Some agencies complained about different technologies that did not meet their needs. However, vendors appeared to be listening to the customers and were developing the tools agencies need. This was the case of Avail that developed Business Intelligent (BI) solutions to empower agencies with the use of data. They offered customizable dashboards, real-time information and reporting, and visualization tools that could be used to help transit agencies be

more efficient.

Although an agency mentioned that Trapeze was being used for customer complaints, there were still some agencies that continued using Excel as the main software for different purposes such as managing customer complaints or compliments. Thus, this was an area that could be improved. Having a software platform to be able to efficiently handle customer complaints could improve the efficiency and image of the transit agency. Other systems mentioned were related to asset management, which was functionally more on the maintenance side or as part of a larger county system on asset management.

It is noted that software platforms like Trapeze had many modules for planning, paratransit, scheduling, and operations (FX, Pass, Blockbuster, and OPS) and each module had different pricing. As such, the software cost could be considerable depending on number of modules an agency had. The cost of the software, as viewed by some agencies, competes with funds needed for providing new service.

Agencies are always looking for better platforms. Some agencies mentioned that they were considering getting new CAD/AVL, APC, and Scheduling systems to replace the existing ones. However, to do this, they would have to go through a Request for Proposals (RFP) process to acquire new technology. While the RFP process could take some time, they continued to update their existing platforms.

3.2.12. Other Topic Areas

As the Web meetings were done in a casual and non-rigid manner, some miscellaneous other related topics came up naturally during the conversations. This section summarizes two of these topics: microtransit service and the peculiarity of college towns.

Microtransit services could be operated by either the transit agencies or operated by a contractor. Although it was more common for transit agencies to contract out microtransit services, RTS and LA Metro mentioned that their agencies operated their microtransit services in house. For this purpose, agencies could use software to map the area being served and to identify the characteristics of the underlying population. The current software platforms were just starting to look into microtransit, so new features were being added to assist the planning and operation of this service. During the process of identifying software platforms and out-of-state agencies for Web meetings, the research team learned that TransLoc had a microtransit simulation tool. One of its uses was to help assess the impacts of different microtransit service scenarios. However, the current version of the tool was available for use by only the vendor. As such, to apply the tool, an agency must first provide the input including project scope and data to the vendor. The vendor then performed an analysis using the input together with the tool and provided its analysis result report to the agency.

Although most transit agencies provided service to areas that included universities and colleges, the transit service provided of college towns present certain characteristics that

differentiates them from the rest. This was the case with two of the ten agencies interviewed: RTS in Gainesville, Florida and Catabus in State College, Pennsylvania. These agencies had agreements with local universities and colleges to include the transit fares as part of the student tuitions. It allowed all students to use the transit system for their mobility which also helped to increase transit ridership. In addition, students from these universities could work as interns at the transit agencies. This was also reported by StarMetro that had agreements with Florida A&M University and Florid State University. In general, the dynamic of college towns encourages innovation, as they bring a fresh perspective on the use of technology and software that helps the transformation of transit agencies.

Another characteristic of college towns was that students enjoyed using electric scooters that had to do with micromobility. This transportation mode was used to cover short distances usually by single-person vehicles such as bicycles and scooters. This was a sensitive issue and many cities around the world had prohibited the use of scooters. However, in college towns this was approached from a different perspective and they usually had a micromobility program that regulated the use of scooters. In Gainesville, people with scooters could ride the RTS buses. However, for the safety of all the passengers, according to the RTS policy, only one person with a wheelchair or scooter was allowed. Service could be refused for passengers who did not comply with this policy.

CHAPTER 4
EVALUATION OF EXISTING TRANSIT SERVICE PLANNING SOFTWARE PLATFORMS

This chapter presents the findings from an evaluation of the software platforms identified in the previous two chapters, i.e., conducting a survey of Florida transit agencies to learn about existing software platforms being used by the agencies for service planning, and interviewing transit agencies to obtain more specific details on the software platforms the agencies used. The evaluation focused mainly on the platform features and capabilities, use of data, applications, user support, and user friendliness.

4.1. Vendor Invitation and Participation

Previous efforts described in Chapters 2 and 3 identified a total of eight transit service planning related platforms. Table 4-1 lists these platforms, its vendors, and the contact persons who worked with the research team on this review.

Table 4-1. Potential Software Platforms and Contact Information

Platform	Vendor, Headquarters	Key Contact Persons
Hopthru	Hopthru, Inc., Seattle, WA https://www.hopthru.com	Stephen Coyner, Co-founder stephen@hopthru.com
MicroTransit Simulator	TransLoc, Inc., Durham, NC https://transloc.com	Joe Melliere, Solutions Engineer joe.melliere@transloc-inc.com Oliver Davis, Customer Success oliver.davis@transloc-inc.com
NetPlan	GIRO, Inc., Montreal, Canada https://www.giro.ca	Mohammed Belbaraka, Account Manager Mohammed.Belbaraka@giro.ca Flavie Gagnon, Product Manager flavie.gagnon@giro.ca
Optibus	Optibus Ltd, Tel Aviv, Israel (local offices in San Francisco, New York, Chicago, Sammamish) https://www.optibus.com	Mike Loeffler, North America Regional Director mike.loeffler@optibus.com Kevin Nguyen, Application Engineer kevin.nguyen@optibus.com
PLAN	Trapeze Software ULC, Mississauga, Canada https://go.trapezegroup.com	NA
Remix	Remix Technologies, LLC, San Francisco, CA https://www.remix.com	Alyssa Overheul, Account Executive alyssa.overheul@remix.com
Swiftly	Swiftly, Inc., San Francisco, CA https://www.goswift.ly	John Eng, Chief Marketing Officer john@goswift.ly Tim Storer, Senior Customer Success Manager tim.s@goswift.ly
Teralytics	Teralytics, Inc., Zurich, Switzerland (local office in New York) https://www.teralytics.net	Matt Bragg, U.S. Country Manager matthew.bragg@teralytics.ch

To recruit the vendors to participate in this review, the research team made various attempts to contact the eight vendors listed in Table 2-1. The initial contacts were made by sending emails to specific known vendor contacts and by making requests for product demonstration via the vendors' websites. While most of the vendors contacted were generally receptive to the invitations to participate in this review, the level of receptiveness varied. Their responses suggested that most vendors, if not all, had not previously participated in a similar evaluation conducted by an external team. This also prolonged the invitation process, as the vendors did not have an existing protocol to handle such a request. The responses and support received from each vendor are summarized below:

- Swiftly was receptive to participating in the review. With the assistance from Swiftly, Mr. Carlos Cruz-Casas, Assistant Director of Miami-Dade County, provided the research team read-only guest access to the Miami-Dade Transit (MDT) data. Swiftly also provided the research team with a product demonstration and a training session, with participation from members of the MDT. In addition, Swiftly continued to provide technical support and answered different questions from the research team.
- Optibus was similarly receptive to participating in this review. With the consent of Palm Beach Transit (Palm Tran), Optibus provided the research team with read-only guest access to the Palm Tran data. Optibus also provided a product demonstration, a hands-on training session, and continued to provide support and answer questions from the research team. Optibus further provided access to an online library that allows users to access its platform information and training materials.
- Teralytics was also receptive to participating in this review and the vendor provided the research team with access to a limited version of its platform. This provided access to trip date from the South Florida tri-county region. As Teralytics is mainly a data platform for accessing and visualizing trip data, the interface was relatively straightforward. The research team also had a quick product demonstration provided by the vendor.
- GIRO, the vendor of NetPlan, was also receptive to participating in this review. The vendor provided an initial product demonstration of the NetPlan platform, followed by a second more detailed demonstration. Unlike the other web-based platforms, NetPlan is a client-server solution that can be integrated with the vendor's HASTUS scheduling system. As guest access to their platform could not be easily provided, this review of NetPlan is limited to information obtained from the demonstrations and the materials the vendor and a manager from Los Angeles (LA) Metro provided.
- Hopthru was receptive to participating in this review. However, as it was a relatively new platform that was still under its early development, the vendor was more cautious with sharing its platform details and required a signed non-disclosure agreement (NDA). The vendor met with the research team twice to introduce and demonstrate its platform.
- Remix provided some demonstrations, but it was less receptive to providing direct access to their platform. Nevertheless, the vendor agreed to allow the research team to review a shared read-only Remix link of Miami-Dade Transit (MDT). The shared link included limited Remix functions. The vendor provided two product demonstrations and offered to answer any questions the research team had on Remix.

The remaining two platforms, i.e., PLAN from Trapeze and Microtransit Simulator from TransLoc, unfortunately, could not be included in this review. The vendor for Trapeze PLAN was not responsive to multiple invitations to participate from the research team. For Microtransit Simulator, after two meetings with the TransLoc team, it was determined that its participation in this review was not feasible because MicroTransit Simulator was designed for use by the vendor only. The process to apply the simulator was such that an agency would first provide its project scenarios and data to TransLoc. The TransLoc team then analyzed the scenarios using the simulator and provided its analysis results and recommendations in a report to the agency.

Consequently, the research team was able to include six platforms in this review and the findings from each platform are summarized in the sections below. The scope of the review was necessarily limited to what the vendors agreed to provide, which may include full or partial platform access, Web meetings, and miscellaneous published materials. As the Web platform allows the vendors to make frequent changes and updates to their software products, the materials presented below must necessarily represent only those at the time of the platform access by the research team for this evaluation.

4.2. OPTIBUS

Optibus is a browser- and cloud-based platform that offers essential tools for both planning and scheduling. More specifically, Optibus can assist transit planners with their work activities such as creating or modifying routes, analyzing demographic data, preparing timetables, and calculating the costs of potential transit service improvements. Figure 4-1 shows the current Optibus modules. The fact that Optibus integrates its planning and scheduling modules makes it easy to combine planning and scheduling information for a complete service planning analysis.
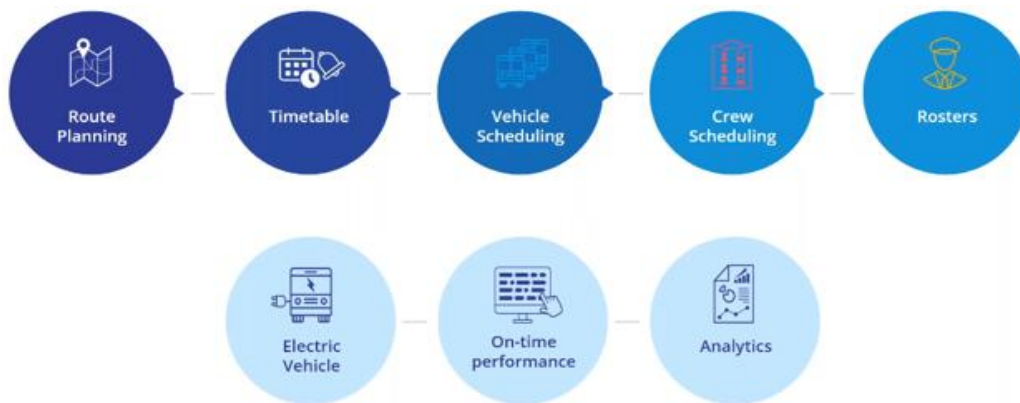
Figure 4-1. Optibus Modules

To prepare the research team for this review, Optibus provided two remote training sessions, one with remote hands-on. In addition, Optibus was available to answer questions from the research team. After the first training session, Optibus created two user accounts for the research team to explore the Optibus sandbox. The research team had access to the following Optibus modules: Planning (Map, Route, Running times, Timetable) and Scheduling (Vehicle schedule, Crew schedule), and user support resources.

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4.2.1. User Support and Training Resources

Optibus offers multiple user support options to familiarize its users with its platform and applications. As part of its license agreement, Optibus provides both on-site and online user support. Optibus emphasized that its user support is unlimited, i.e., it does not have a set limit on the number of support hours they spend with a customer. In addition to personal user support, users also have access to Optibus' online training resources, including the Optibus Academy, the Optibus Support, and the Optibus Guide. Together these resources provide good self-paced user training support through videos, guides, and documents that address a variety of software platform, planning, and scheduling subjects.

The Optibus Academy provides a library of useful videos that include training courses and webinars that can help users master the platform. The research team watched several of these training videos and found them to be very helpful, not only for learning how to use Optibus, but also for performing planning and scheduling tasks. Figure 4-2 shows the Optibus Academy page and some sample contents.
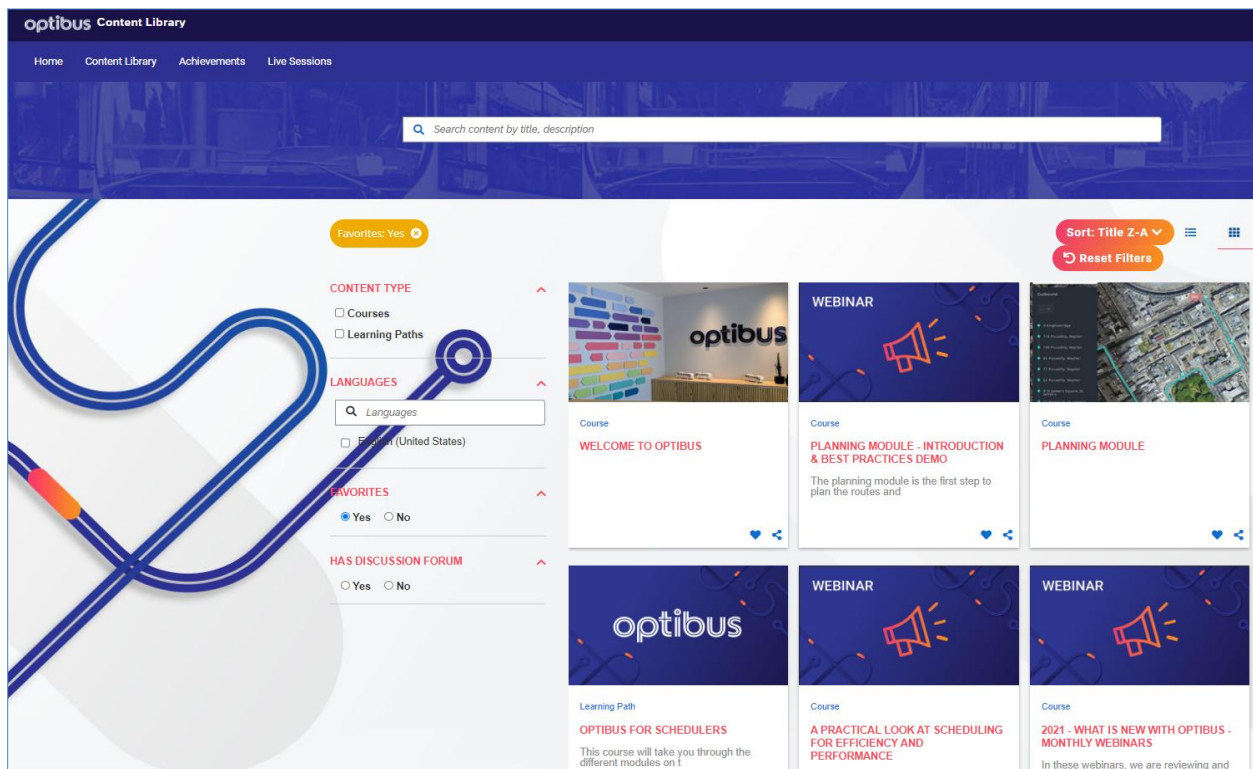
Figure 4-2. Optibus Academy Content Library

The Optibus Support website also provides a great deal of information. As shown in Figure 4-3, the website presents much information on many subjects within planning and scheduling. In addition, it provides information on many topics that can guide users to the different Optibus modules, reports, and related subjects. Through the information in this website, users can contact customer support and keep track of their requests and status. Users can also see the replies to particular requests and access useful articles and news.

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The Optibus Guide provides step-by-step instructions on how to accomplish a specific task in Optibus. The Guide starts with a searchable list of tasks. As shown in Figure 4-4, the list is shortlisted using "route" as the search text. The list includes two types of step-by-step guide. Figure 4-4 shows an example of a workflow style step-by-step guide that effectively walks a user through the steps on actual Optibus screens. The second type is descriptive. As shown in Figure 4-5, it provides instructions on each required step, accompanying by screen snips, some of which with more complex user inputs are demonstrated using animations.
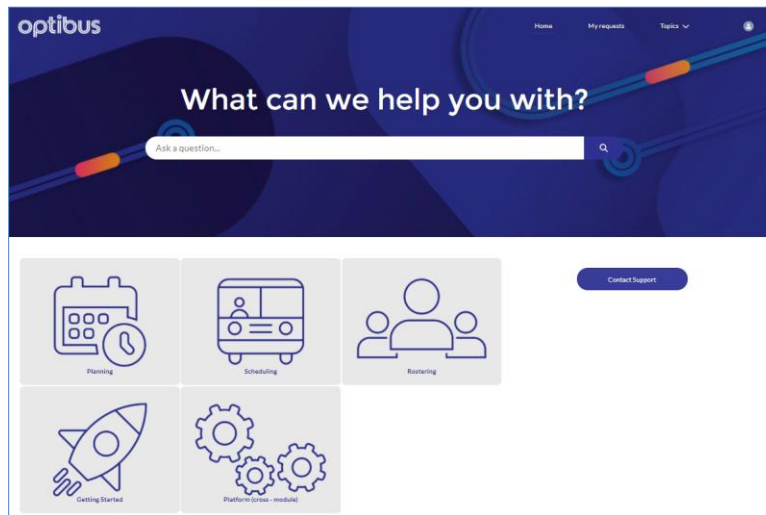
Figure 4-3. Optibus Support Page
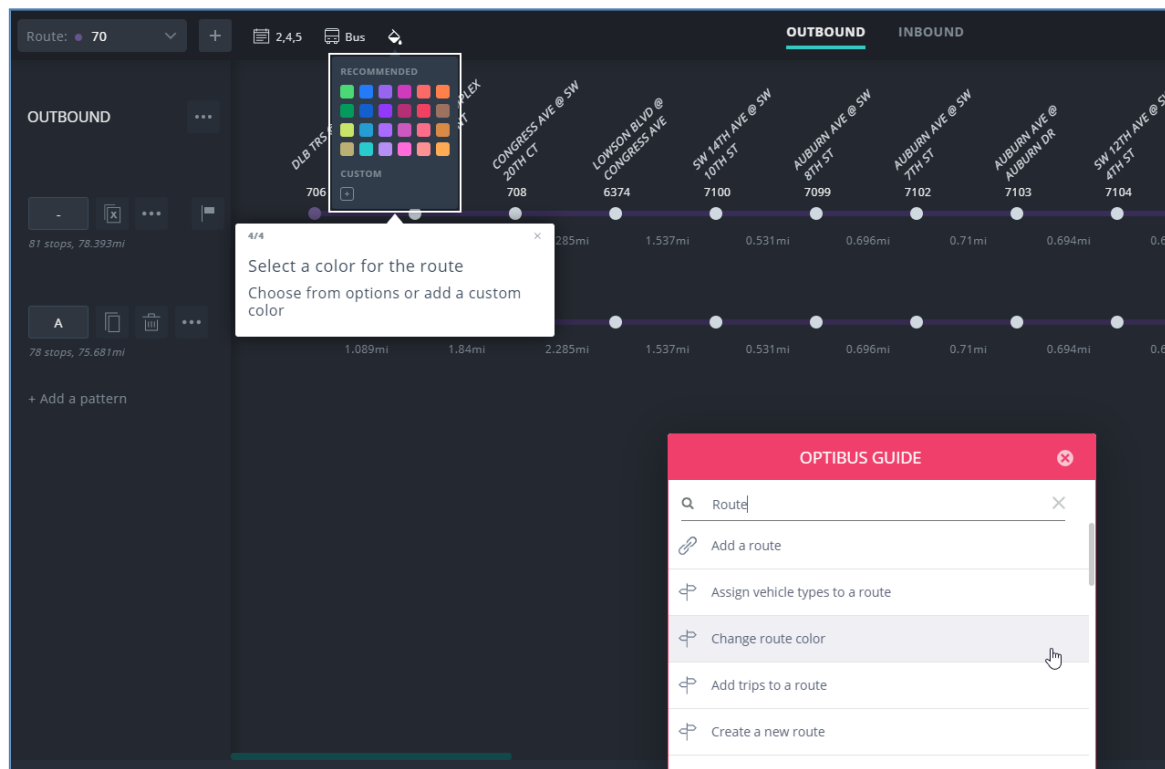
Figure 4-4. Optibus Workflow Step-by-Step Guide

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Add a route

🕐 Aug 13, 2020 · Knowledge

Title ⓘ

Add a route

Description

Your timetable can be based on routes you create from scratch in the platform or on existing stops you import. To create a route:

1. Click on the **route-building** tab in the timeplan module.

2. Click on the **plus sign** in the upper left corner to create a new route.
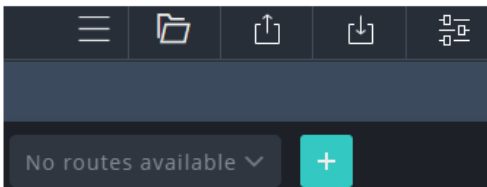
If you are adding an additional route, the plus sign will appear dimmed:

3. Give the route a name and, optionally, a code, header, and note. Add another direction (i.e. inbound or outbound) if needed.
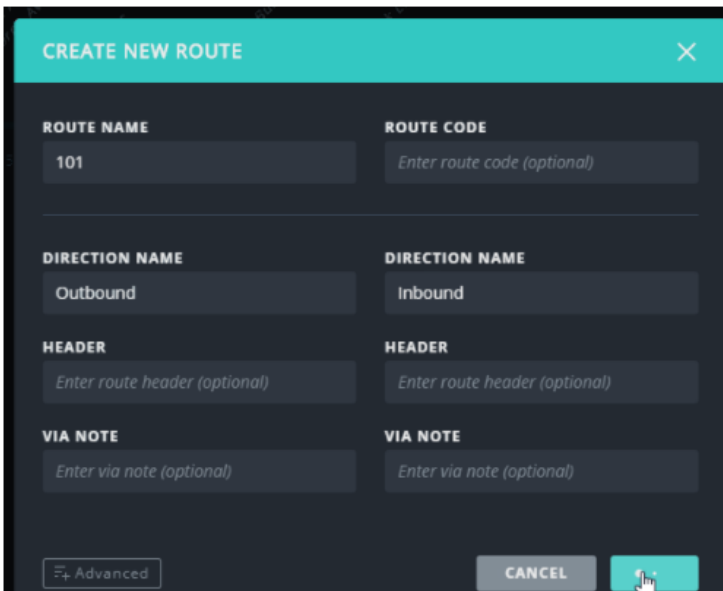
Figure 4-5. Optibus Descriptive Step-by-Step Guide with Animated Snips

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4.2.2. Platform Access and Getting Started

The entry point to the Optibus platform is the *Projects* page where users can create a new project or go to the Planning or Scheduling modules of an existing project. The platform allows users to create different projects that can be used to test different transit planning and scheduling alternatives. The platform also keeps a log of the tasks performed in previous sessions.

Importing the agency GTFS files can be one of the first steps to start populating the Optibus platform with data. GTFS includes data that can be used for both planning and scheduling. Although this saves time, there is still some work that needs to be done to ensure that the data is accurate, missing elements are added, and the platform is setup properly to be fully functional. This is more critical for the scheduling module. For this project, the research team used the GTFS files from Palm Tran. Specifically, the GTFS feed contained the following data files: agency.txt, calendar.txt, calendar_dates.txt, calendar_dates_sunrise.txt, fare_attributes.txt, feed_info.txt, frequencies.txt, gtfs.txt, routes.txt, shapes.txt, stop_times.txt, stop_times_schedule.txt, stops.txt, transfers.txt, and trips.txt.

Figure 4-6 shows the available data in Palm Tran's GTFS feed prior to the data import. It contains the Service IDs (service days: usually three, for weekdays, Saturdays, and Sundays), Routes, and Block IDs (vehicle assignments). By default all data are imported. Specific data categories and items may be excluded using the checkboxes. For example, Figure 4-6 shows that routes 30 and 31 were to be excluded from the import. It is worth mentioning that the import process was very fast and took only a few seconds.
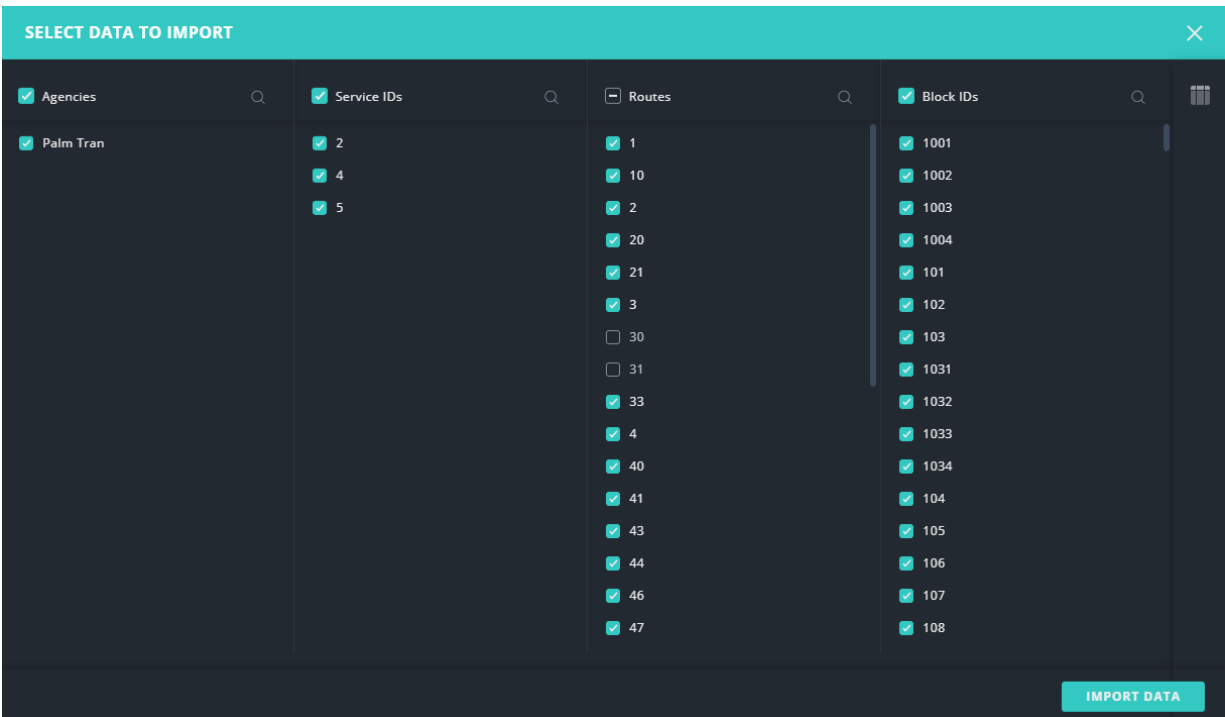
Figure 4-6. Optibus GTFS Import Screen

4.2.3. Optibus Views

The Optibus Planning module organizes its user interface and all of its inputs and outputs within four individual but related views, i.e., Map, Route, Running Times, and Timetable.

- *Map View*: This is the view Optibus first opens to after the GTFS files are imported. As shown in Figure 4-7, it automatically displays the first route on the Route list, which in this case, is Route 1. For each selected route, users can further choose the route direction (outbound or inbound) and the service pattern. Unlike other platforms, Optibus displays only one route at a time and does not provide an option to display the system map with all routes simultaneously. As Figure 4-7 shows, Optibus uses the Google Maps service, which is advantageous, as most users are already familiar with Google Maps, including its Street View, satellite images, and general map operations.
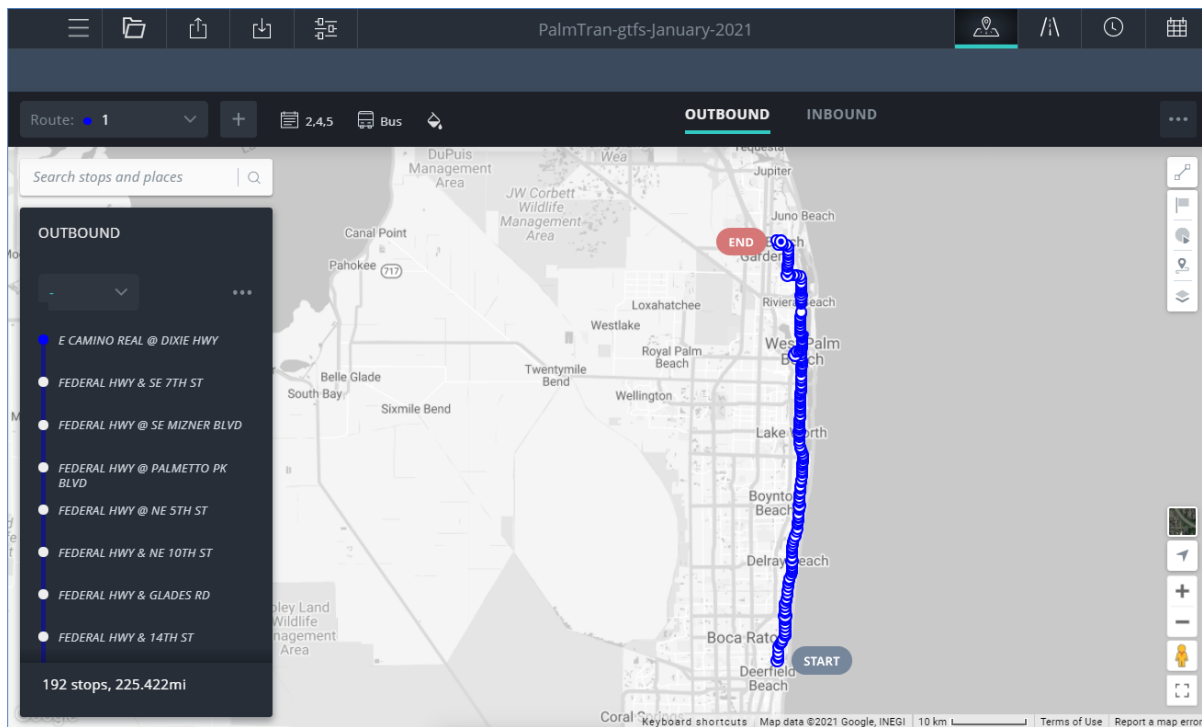
Figure 4-7. Optibus Route Display

As Figure 4-7 also shows, the left panel of the *Map* view lists all the stop locations along the route, as well as the total number of stops and the total miles of the route. Users can further click on a stop location, either on the list or on the map, to display stop information. Figure 4-8 shows the stop information for the "Start" stop, which includes the stop ID, coordinate, and whether it is a timepoint or a relief point. Alternatively, users may use Google Street View to view the physical stop. Figure 4-9 shows the same stop on Street View, which is accurately located. It is noted here that in this *Map* view, users can also create and edit routes and stops, and perform impact analysis. These are further detailed in Sections 4.2.4 and 4.2.5, respectively.
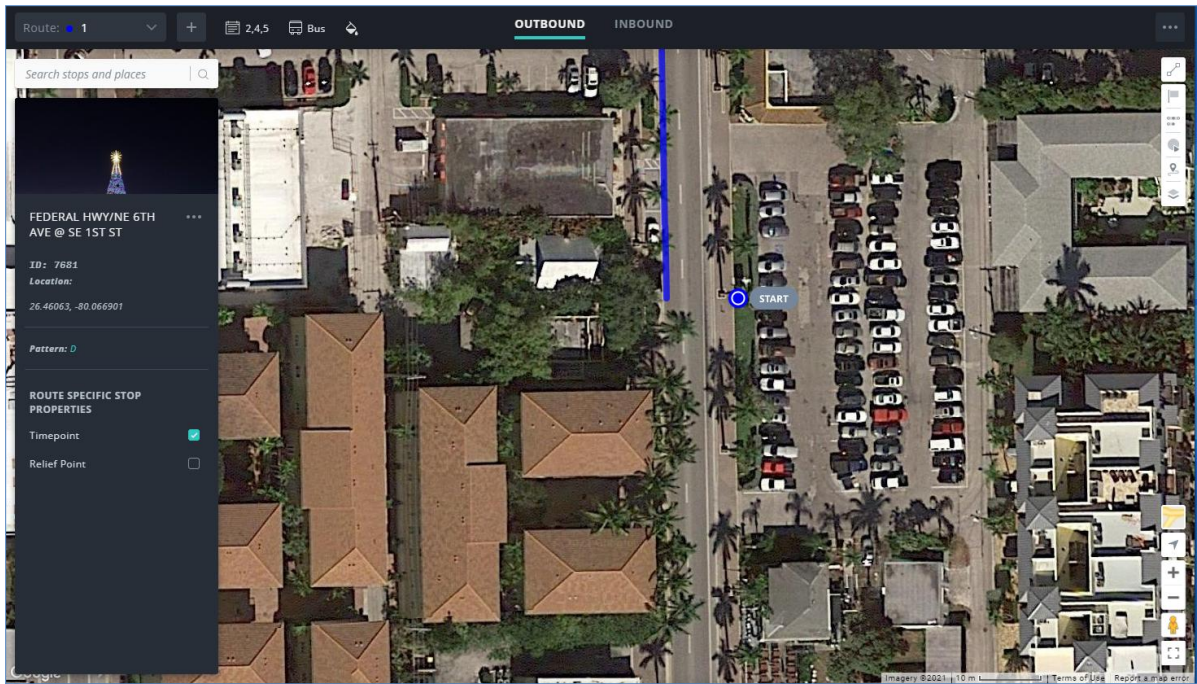
Figure 4-8. Optibus Display of Stop Information
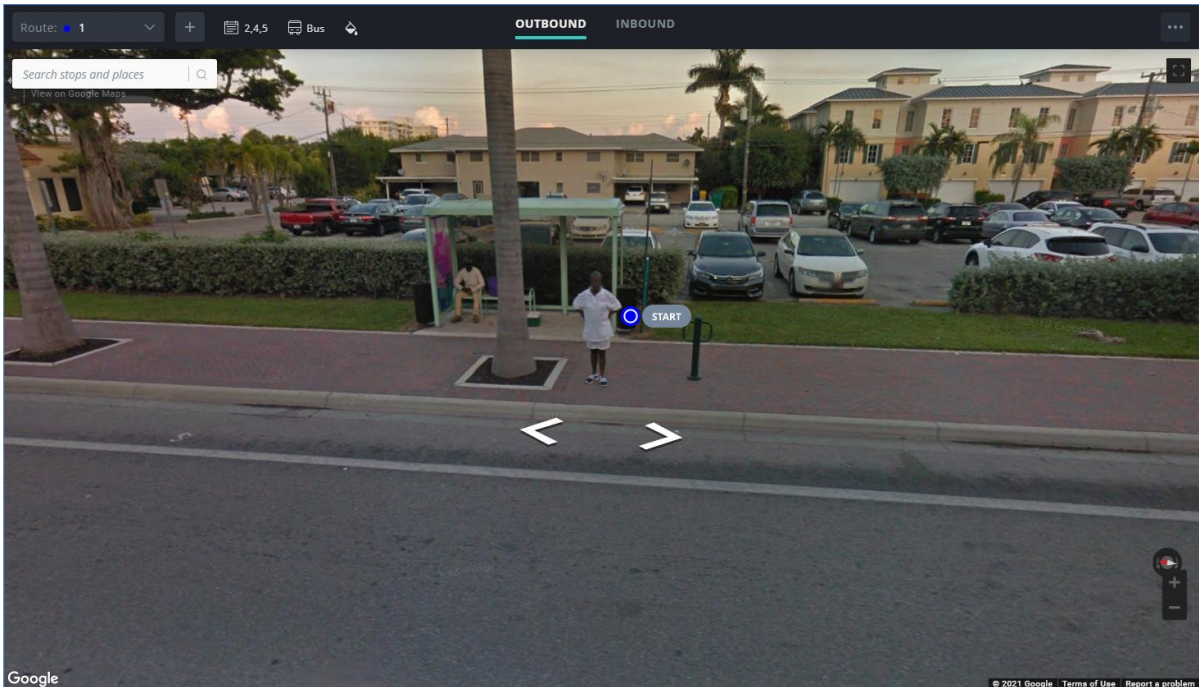
Figure 4-9. Optibus Display of Stop Location in Google Street View

- *Route View*: This view allows users to select and modify routes, patterns, service IDs, vehicle types, etc. As shown in Figure 4-10, the routes and stops of each service pattern are displayed in an easy-to-read ladder format. Besides the user-friendly visual representation

of the routes, Optibus includes many features to prepare the routes and different service patterns. Users can modify the distance between stops, assign times, and copy and paste route stops from Excel. Users can also import route and stop data, or export the data in different formats such as JSON and Excel.
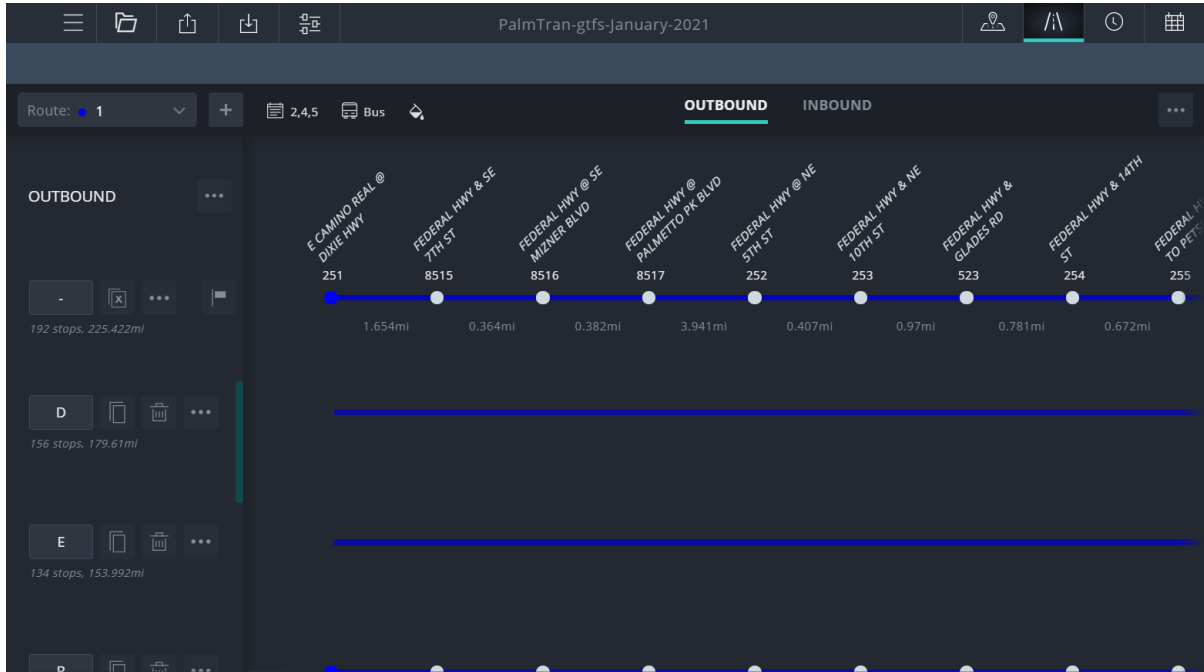
Figure 4-10. Optibus *Route* View

- *Running Times View*: After the routes and service patterns are created, the running times between timepoints and stops can be prepared in this view. Figure 4-11 shows the running times for the main service pattern for Palm Tran Route 1 in the outbound direction during a weekday (Service ID 2) service period. By default only timepoint stops are included, but users may choose to display all stops.

- *Timetable View*: Once the running times are prepared, users can check the timetable in this view. The timetable presents the times along each route. Figure 4-12 presents the timetable of Route 1 in the outbound direction for the weekday service. Users can also choose to include running times and headways in the timetable, as is the case shown in Figure 4-13. Users can further display the vehicle view as Gantt chart display (see Figure 4-14) and Graph chart display (see Figure 4-15). Routes and patterns can be selected by direction and service IDs. Trips can be added, edited, or deleted and times can be modified. This gives transit planners and schedulers enough flexibility to prepare or evaluate different timetables.
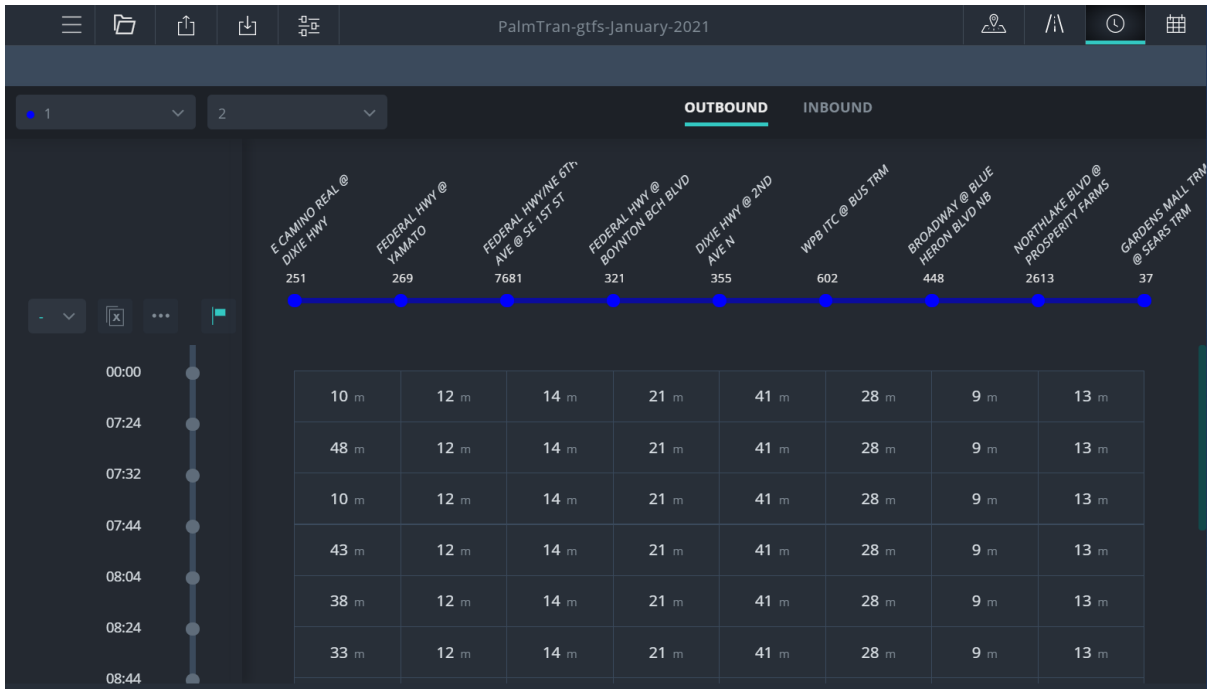
Figure 4-11. Optibus *Running Times* View
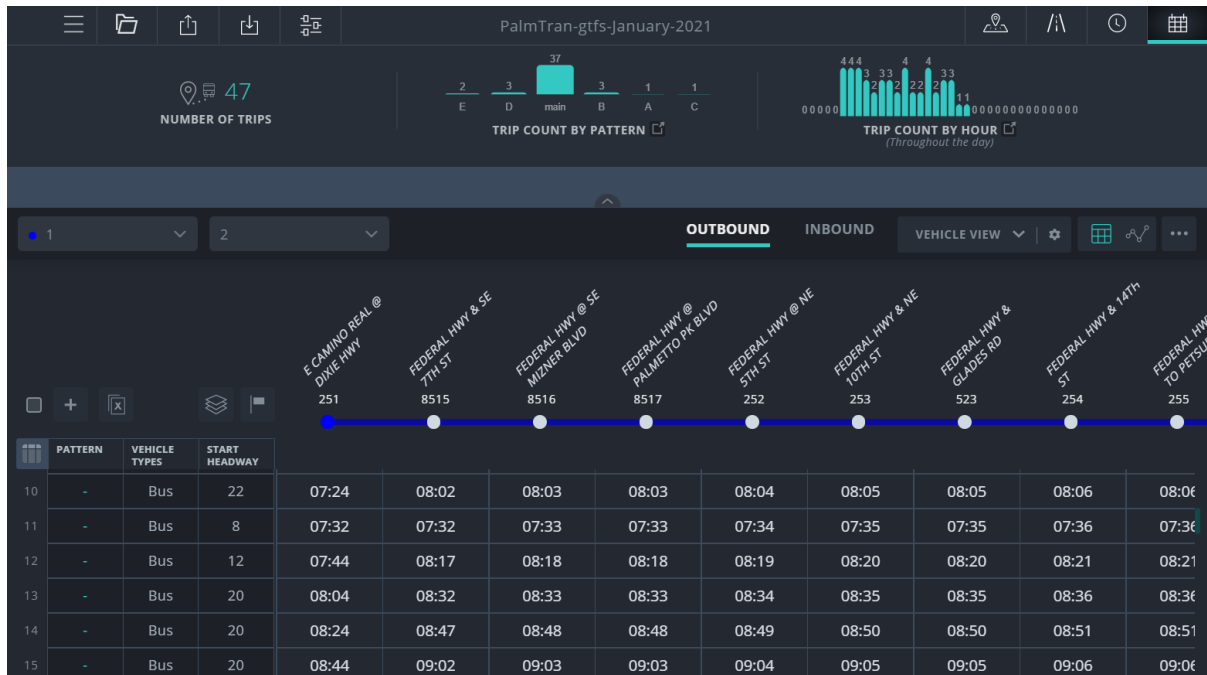
Figure 4-12. Optibus *Timetable* View
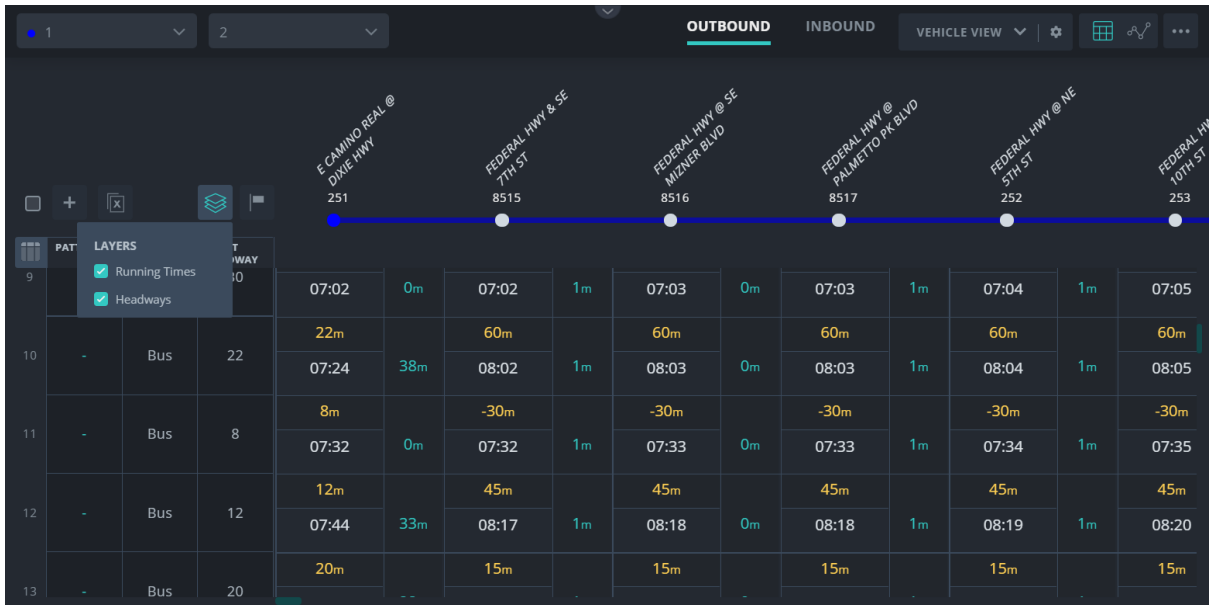
Figure 4-13. Optibus *Timetable* View (with Running Times and Headways)

Figure 4-14. Optibus Gantt Chart Display

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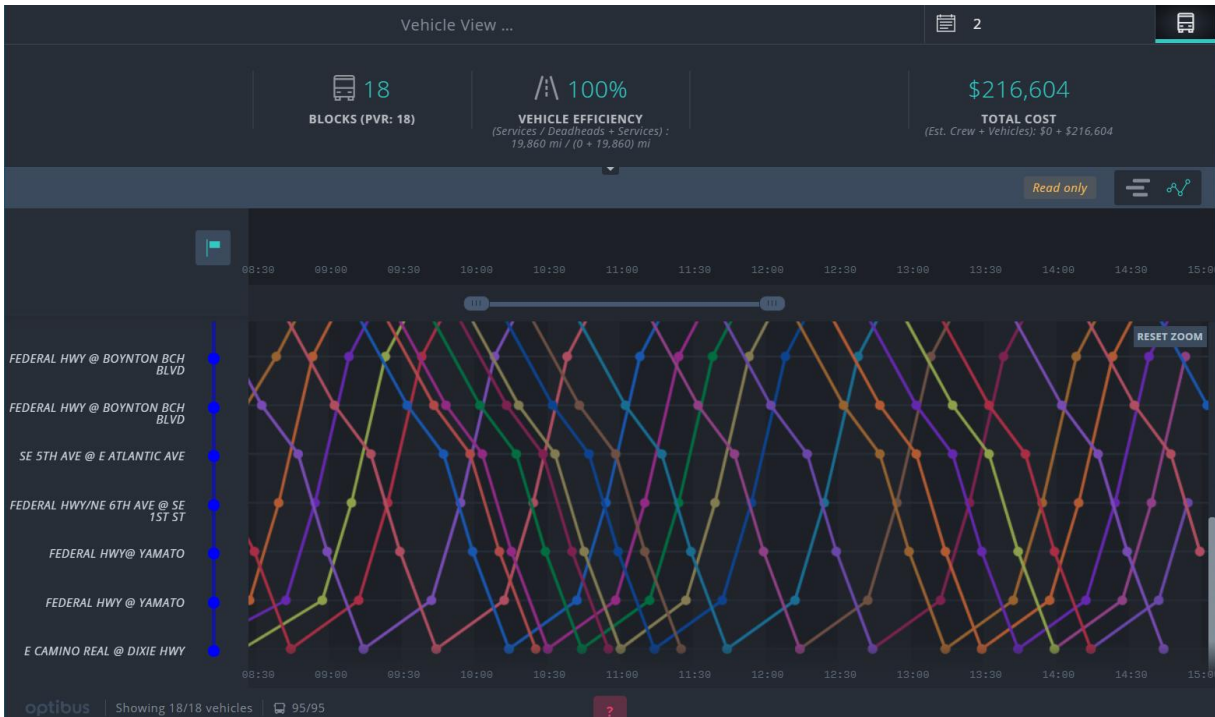
Figure 4-15. Optibus Graph Chart Display

4.2.4. Route and Stop Editing

Optibus' *Map* view provides a complete set of editing tools for creating and modifying routes and stops. However, to be proficient with the tools, some training may be required to figure out how to create routes and place stops along the route. After going through the learning process, the task became natural to the research team.

Figure 4-16 shows a new route that was created by drawing on the map. In the drawing mode, the map displays all existing stop locations. Users can start and extend a route using a combination of existing stops and temporary "checkpoints" (shown in large circles). In the example shown in Figure 4-16, the first half of the new route was created by extending existing stops and the second half of the route did not have existing stops and was created using checkpoints. Checkpoints are also used to guide and change a route path. In Figure 4-16, checkpoints were used to create a diverted route pattern near Yamato Rock and to Highland Beach. Instead of drawing on the map, users can also create a route by selecting stops from a stop list. However, this was found to be difficult to do mainly because the stop list includes all stops instead of the nearby stops only.

Optibus also includes a feature that allows users to easily move stops on either Google Maps or Google Street View. Figure 4-17 shows the stop location (blue circle) on Google Street View before and after it was moved for about 40 feet to the correct location at the stop pole.
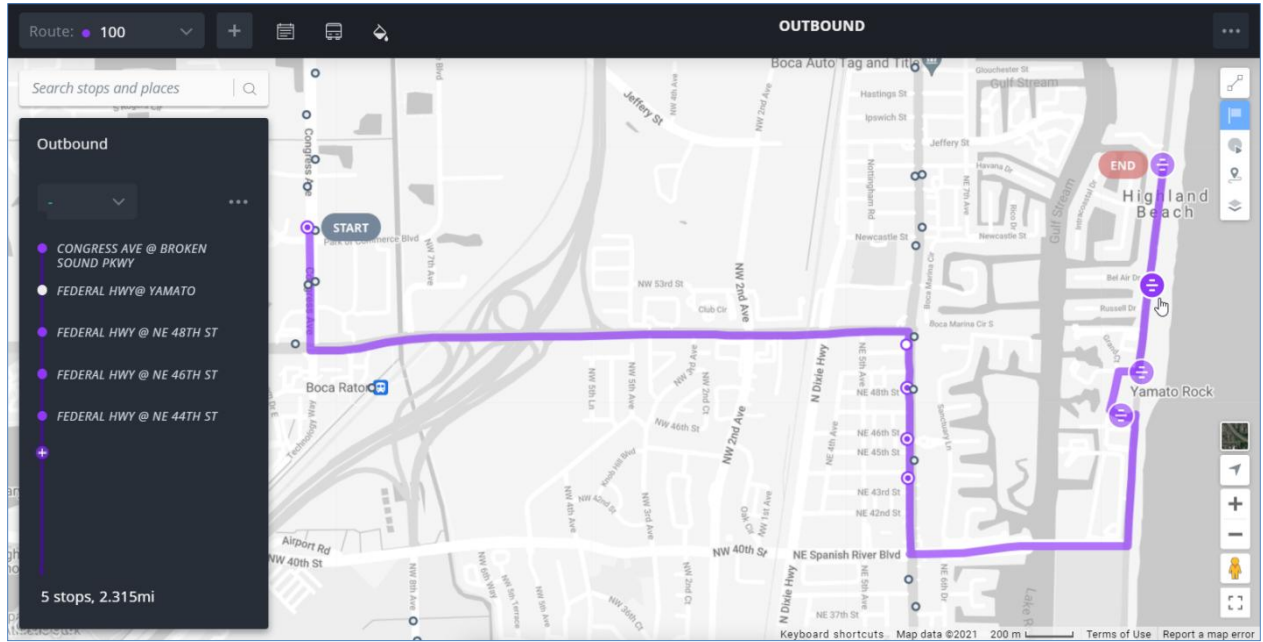
Figure 4-16. Optibus Route Edit
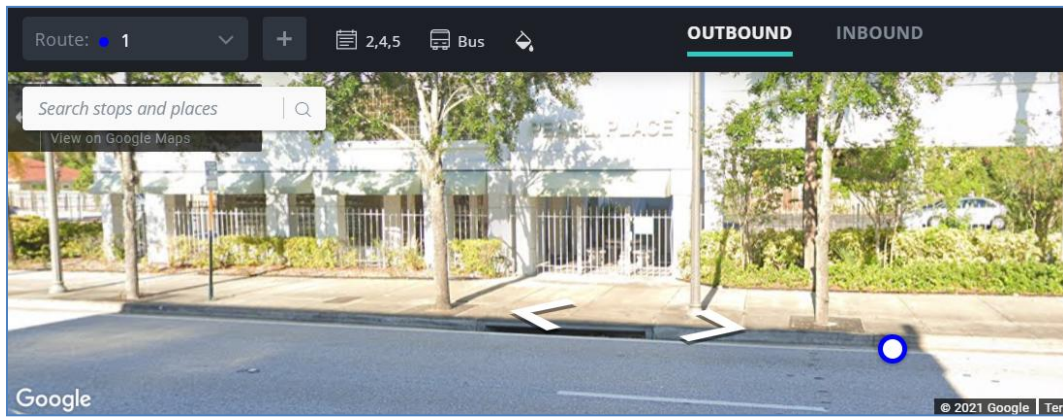
(a) Existing Stop Location
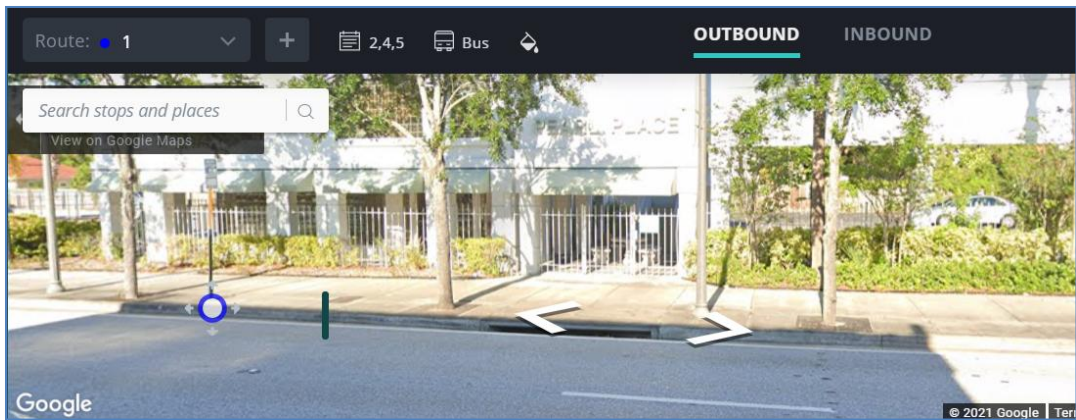
(b) Corrected Stop Location

Figure 4-17. Optibus Stop Location Edit: Before and After Location Correction

4.2.5. Impact Analysis

For its U.S. customers, Optibus provides direct Census API access to the five-year American Community Survey (ACS) data for performing route impact analysis. By default, Optibus includes three demographic variables (referred to in Optibus as "categories"), i.e., total population, minority population, and low-income population. Users can define and add additional variables using the Manage Categories screen shown in Figure 4-18. One of its very useful features is that it allows users to specify formulas using the ACS survey codes to create a variable. For example, in Figure 4-18, minority population is calculated by subtracting the white population (survey code B02001_001E) from the total population (survey code B02001_001E). Figure 4-19 shows the ACS page where users can look up the survey codes.
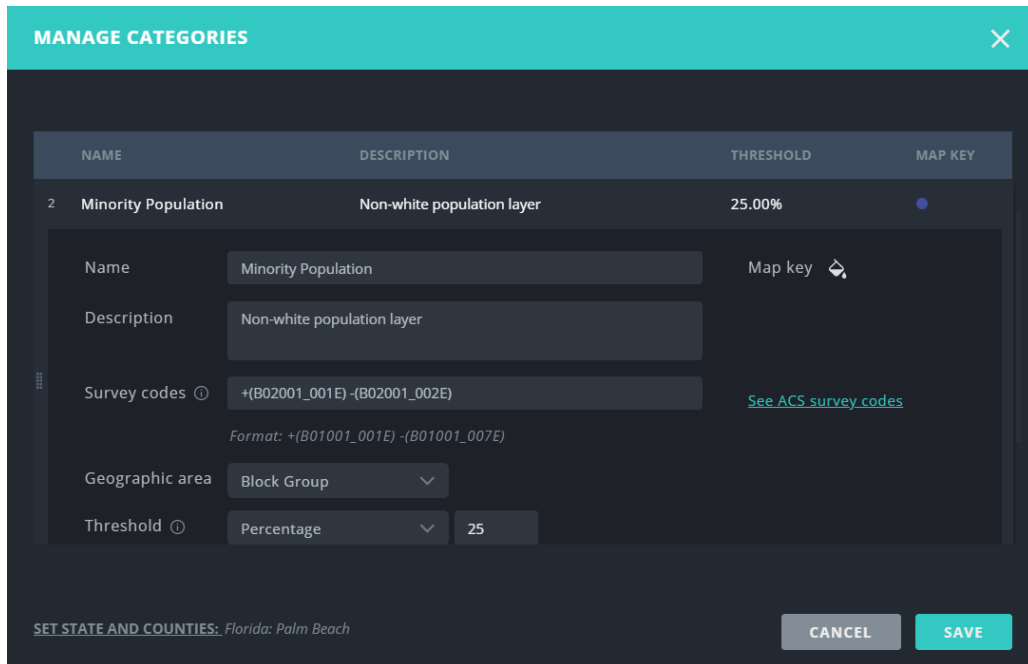
Figure 4-18. Optibus Screen for Defining and Adding Census Demographic Variables

Figure 4-19. Optibus Use of Census ACS Survey Codes Lookup

On Optibus' *Map* view, thematic maps for each variable can be displayed based on the Quantile classification, which divides the target domain into four classes of equal count. Figure 4-20 shows a thematic map of minority population for Palm Tran's Route 64. The legend is shown in the Impact Analysis pop-up window. One minor improvement to the legend would be to expand the window so that all four quantiles are always visible. The same window also displays statistics for the following four standard metrics:

- Route length in shaded block groups
- Percent of total route length in shaded block groups
- Residents in selected category who live near stops on route
- Percent of residents near stops who are in selected category.
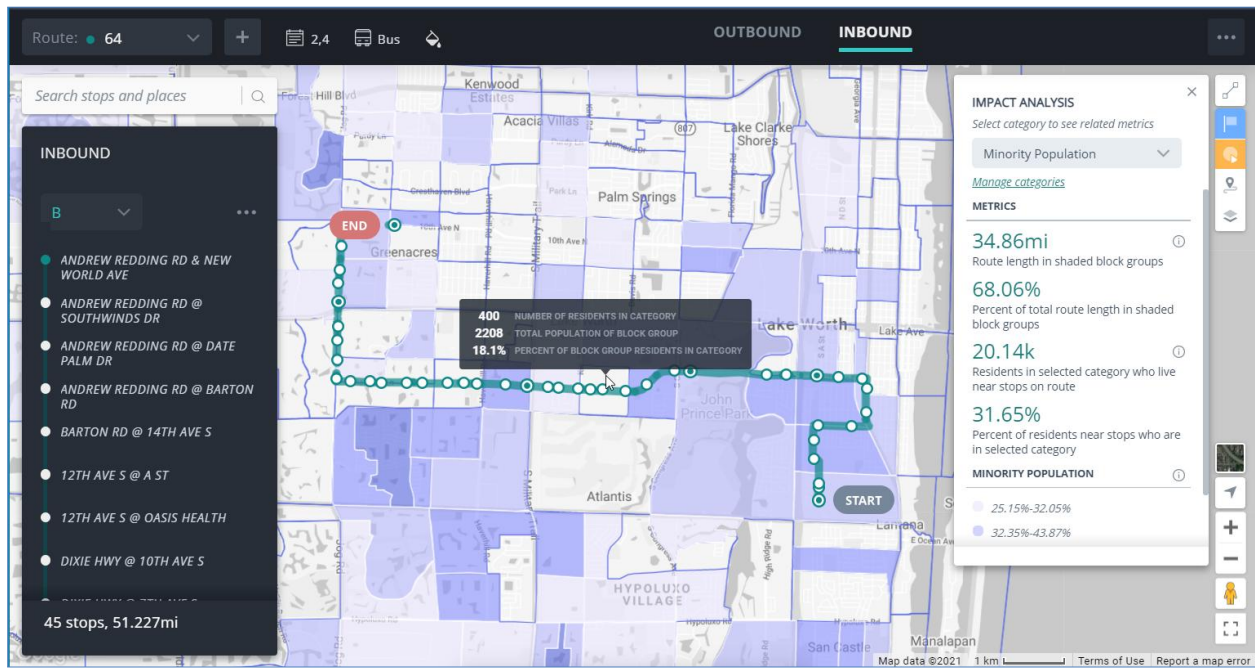
Figure 4-20. Optibus Impact Analysis

The first two metrics are based on "shaded" block groups, which are determined using a user-defined threshold. The threshold allows the two metrics to measure how well a route covers the "shaded" high minority areas. As shown in Figure 4-18, a threshold of 25% for minority population is used. An area can be either a census tract or a census block group. It is shaded only if it meets the threshold target. Accordingly, the block group selected in the middle of Figure 4-20 is not shaded because only 18.1% of its residents are minorities. The impact analysis results show that 68.06% (or 34.86 miles) of the total route length of 51.227 miles run through block groups that have at least 25% of minority residents.

The last two metrics are more commonly used. They measure the amount of a target population having access to a transit service. The accessibility is based on a ¼ straight-distance buffer to the existing stops along the route. To change the buffer distance, users must contact Optibus, as it is an Optibus administrative function. Another related note is that Optibus does

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not display buffers on its map. However, Optibus indicated that these were features they were considering making available to their users.

In addition to Census data, Optibus allows additional GIS layers to be imported. Optibus supports only the GeoJSON file format, which is slightly inconvenient for its U.S. customers, as most local data in the U.S. exist in ArcGIS file formats such as shapefiles or geodatabase files. Therefore, shapefiles need to be converted to GeoJSON format before uploading to Optibus.

4.2.6. Scheduling

This section presents a review of the Optibus scheduling module where additional features were tested, including the vehicle and crew scheduling. In the scheduling module, the vehicles (blocks) can be presented as shown in Figure 4-21. In this area, users can find information about bus numbers, time of day, route numbers, trip numbers, deadheading (pull-outs and pull-ins), etc. After route alignment or time modifications are made, the vehicle assignments (blocking) can be optimized to best allocate the changes. If there are any issues, Optibus provides an interface with alerts and information about the open issues, allowing users to make the necessary corrections. The optimization process is very fast. A system of the size of Palm Tran took just a few seconds for the vehicle optimization.
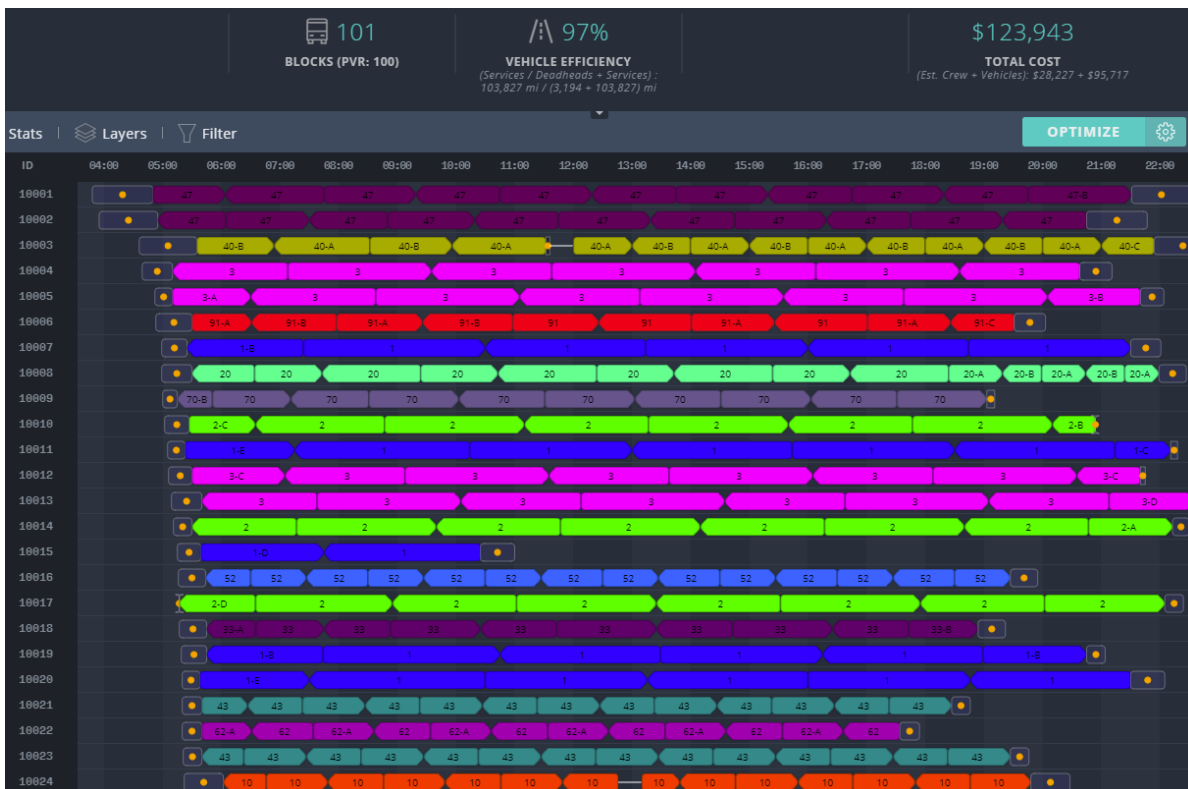
Figure 4-21. Optibus Vehicle Scheduling

The crew schedule or runcutting took just a few minutes to run. Figure 4-22 shows a screenshot of the Optibus crew scheduling. In this area, users can find different information such as

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operator/driver IDs, route numbers, patterns, service IDs, trip numbers, times, etc. This visual representation allows schedulers to easily identify the pieces of work (duties) of all operators/drivers.

Figure 4-22. Optibus Crew Scheduling

From the review of the scheduling module, it is worth pointing out some of the features and capabilities that Optibus offers beyond the regular vehicle and crew features. This includes the preferences, Sync feature, Key Performance Indicators (KPIs), and the system capability to run what if scenarios.

Optibus includes many settings and configurations in the planning and scheduling modules. In scheduling, users can set preferences for vehicles, crews, depots, or miscellaneous settings. This allows schedulers customize their systems to comply with government regulations, union agreements, and rules and agency preferences. For instance, Figure 4-23 shows the user interface where the settings for duty types can be entered. The system also includes automatic validations that help schedulers from violating these settings.

The Sync feature is particularly interesting because it allows the collaboration between planning and scheduling. After following some simple steps to initialize the sync feature, users will be able to synchronize the planning and scheduling modules. Therefore, any changes in the planning module will automatically be reflected in the scheduling module. Having the planning and scheduling integrated saves time and effort and helps streamline the workflow.
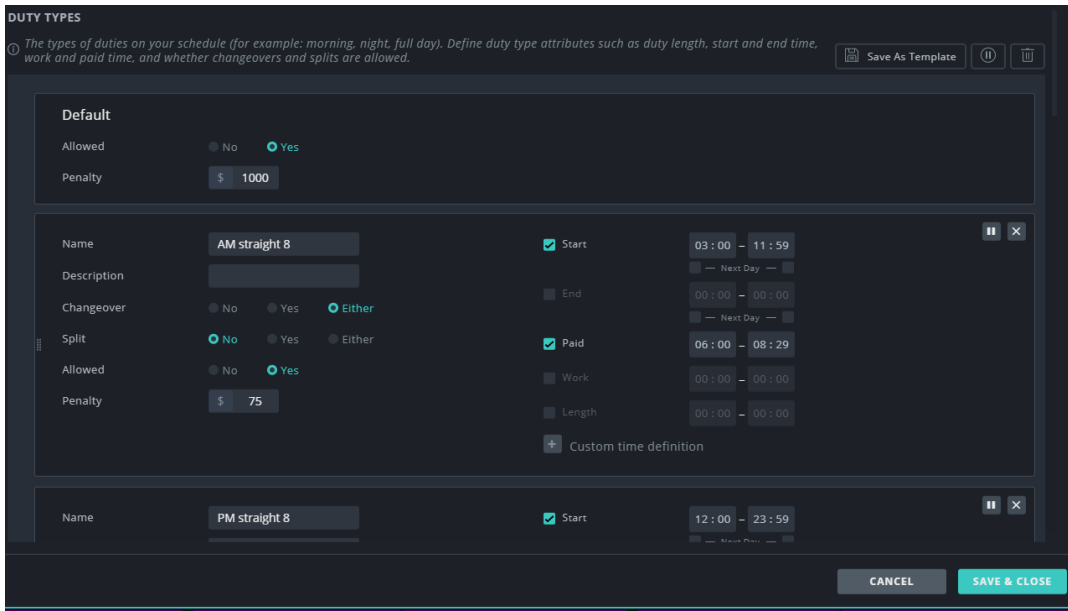
Figure 4-23. Optibus Settings for Duty Types

The Optibus KPIs provide the necessary information needed to assess the system performance. In the planning module, the KPIs provide information like the number of trips, trips by pattern, and trips by hour. In scheduling, the KPIs provide information such as the number of blocks, vehicle efficiency, and total cost. Figure 4-24 presents an example of the scheduling performance indicators. As it can be seen, it provides plenty of useful information for transit planning, scheduling, operations, and management. The Optibus KPIs can be used to quickly assess the impacts of any transit changes or improvements.
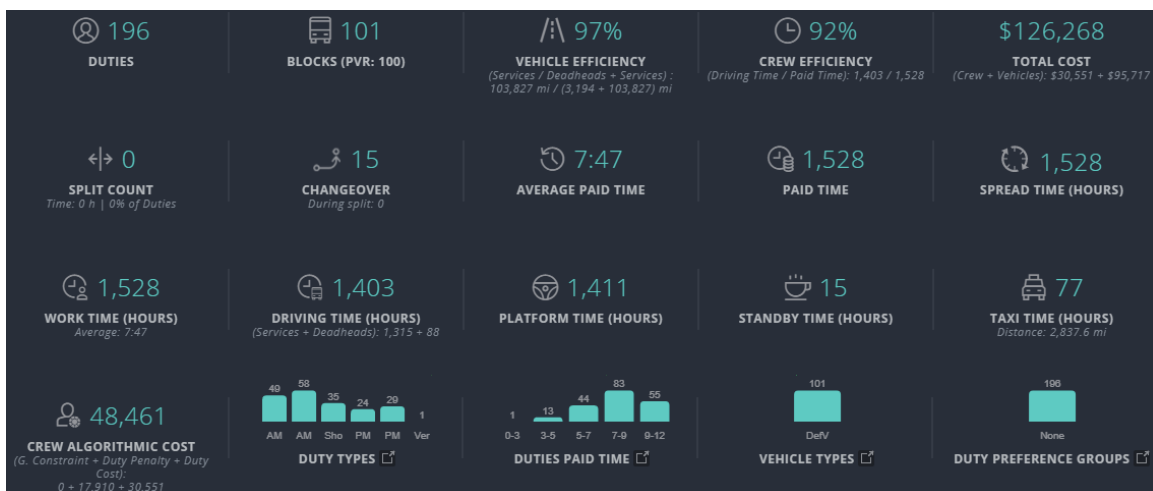
Figure 4-24. Optibus Scheduling KPIs

An issue that has been discussed for many years is the capability of schedulers to run what if scenarios to reduce costs and provide the best service possible with the available budget. However, schedulers often complain that it takes time to run these scenarios and that there are

not enough human resources. With platforms like Optibus, running what if scenarios can be easily achieved due to the speed of this cloud-based platform, allowing transit agencies to be more efficient.

The use of the Amazon Web Services (AWS) cloud service by Optibus enables it to take advantage of AWS' huge computing power, storage, and database services. This is reflected on the time it takes to run the vehicle and crew optimizations that usually take very long time to process. With this capability, transit agencies can run multiple scenarios and select the best scenario that meets the agency goals. For instance, agency may have the opportunity to evaluate if interlining is appropriate or if they would allow bus operators to work more overtime instead of hiring more operators. Having the opportunity to work on different scenarios and see the cost and service impacts is a huge benefit. It allows management and transit agencies become more efficient and make the best use of the resources they have.

4.2.7. Remarks

- Optibus provides excellent online resources as part of its user support. This is especially critical for a sophisticated platform involving complex transit scheduling functions.
- Optibus allows users to freely import and remove their local data. It eliminates the wait times experienced by users of platforms that do not provide the option, i.e., data can only be imported by the platform vendors.
- Not only does Optibus provide a direct linkage to Census data, it also affords its users the flexibility of setting up formulas to calculate performance measures on the fly.
- The Optibus planning module continues to be developed to offer transit agencies with a more comprehensive planning tool. As Optibus offers both planning and scheduling, it presents a good option for transit agencies that do not want to have separate planning and scheduling software platforms.
- Schedulers and planners can test multiple what-if scenarios and arrive at the best possible scenarios, delivering better passenger service and lowering operating costs.
- As Optibus is cloud-based platform, the software can be made immediately available for users. There is no need for IT support, hardware installation, or database management. The software is accessible from any computer with Internet access, making it easy to work remotely. Software upgrades and new features are immediately available on the platform.
- The Electric vehicle module can be used to build and optimize an EV or mixed-fleet schedule that includes trips and charging events. Users can make adjustments and define the preferences for batteries, chargers, vehicle type, and optimize schedules for battery discharge based on charger locations and capacity.
- The optimization tools can optimize vehicle and crew schedules separately or simultaneously.
- Optibus is flexible and allows users to have one timeplan and one schedule, one timeplan and different schedules, or multiple timeplans and multiple schedules. This type of flexibility enables users to test a variety of planning and scheduling conditions and see the cost and service impacts of the different scenarios.

4.3. REMIX

The Remix platform provides a comprehensive set of tools to assist transit planners visualize and analyze data and make transit service planning decisions. Examples of its applications include improving transit services, assessing transit service accessibility and equity, and estimating the service costs of different alternatives. First released in 2014, Remix has become the most used platform for transit service planning in Florida and across the U.S. This review is based on a view-only shared project link provided by the Miami-Dade Transit (MDT) to the research team. The shared link provides only limited Remix functions.

4.3.1. System Platform and Data

Remix is a browser- and cloud-based platform that works with transit and geographic and socioeconomic data. Remix's street networks are based on the OpenStreetMap service from Mapbox. Remix provides a comprehensive set of socioeconomic data including the Census demographic data and the Census Transportation Planning Package (CTPP) journey to work data. The transit data, including route, stop, and scheduling information, are provided initially via agencies' GTFS data feeds. Additional local data such as ridership, origin-destination data, traffic accidents, turning movement counts, and related GIS files (e.g., Health Centers) can also be added to the platform. However, these data must be provided to Remix for uploads, as Remix currently does not provide data import functions directly from its user interface. The data can be provided in common file formats, such as shapefile and GeoJSON, and data uploads are usually completed in a short period of time, after the agencies provide the data. The import service is provided as part of Remix's licensing agreement with agencies. On the other hand, Remix allows users to output transit network scenarios, indicators, and visualizations in various formats including shapefile, Excel, GTFS, embeddable map with annotations, and maps in various graphic formats.

4.3.2. Main Interface

Figure 4-25 shows the main screen of a project link shared by the MDT with the research team. It provides access to all of MDT's transit routes (bus routes and rail lines) and their stops, stations, and terminals. The interface consists of mainly a left panel and a map visualization panel. The left panel lists the transit routes on top and key demographic statistics (in the transit catchment areas) at the bottom. The map panel displays the routes in colors that match the corresponding routes on the list. It also provides several action buttons for different mapping functions, including a search function for locating street addresses and landmark locations, a Reach Map function called Jane, a map background selection function, and three basic map display function for resetting map bearing to north up, and zooming in and out. Figure 4-25 also shows a list of six different map backgrounds users can select. The map can be panned at all time and can be turned in different directions using the mouse and by holding down the Shift key. Further, right clicking on any place on the map would allow it to display the map coordinate (latitude, longitude) and the nearby transit lines. Users can also choose to open the place in Google Street View. Lastly, the interface includes a "Post Comment" button that allows users to post messages about a particular place on the map. This can be helpful for sharing

location-specific comments with coworkers or for getting feedback from transit riders about a specific problem or service. Note that because the shared link was read-only, no map editing functions could be tested by the research team as part of this review.
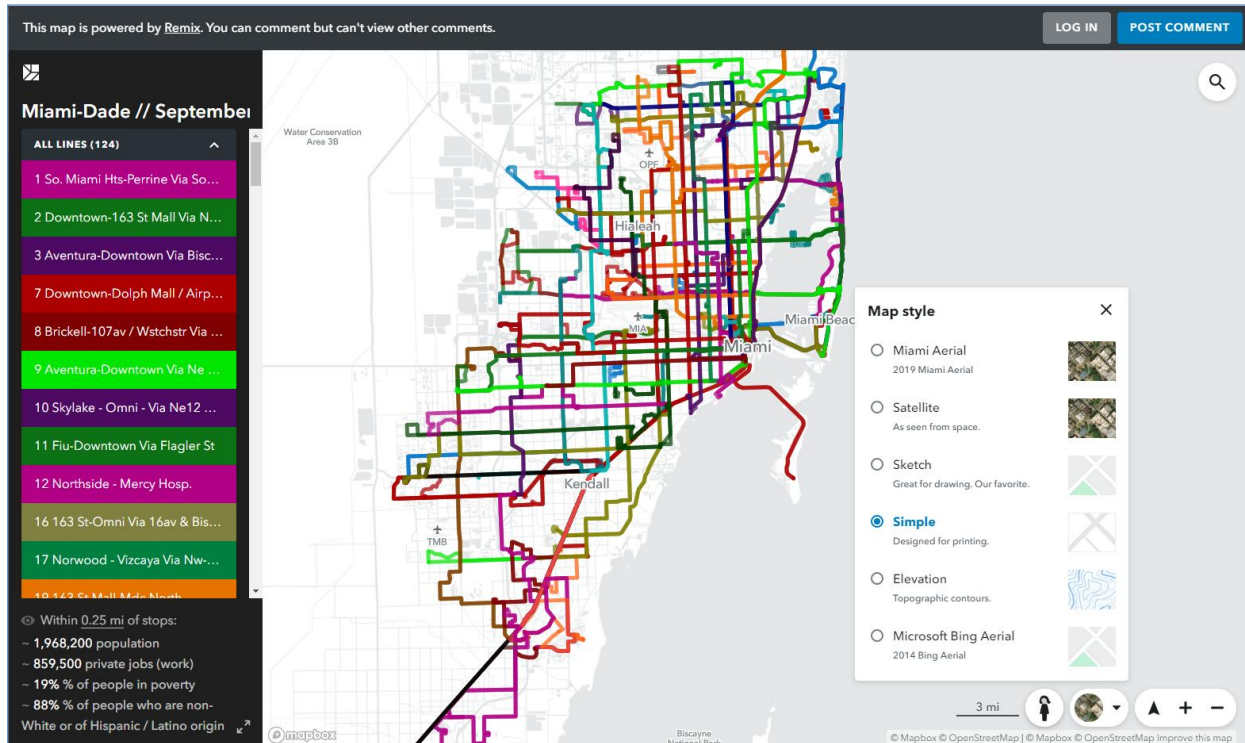
Figure 4-25. Remix MDT System Map

In Figure 4-25, the transit routes listed on the left panel can be individually selected. Figure 4-26 shows the selected MDT Route 11, which runs between the Florida International University (FIU) Main Campus and Downtown Miami. The map display highlights the selected route and the stop locations along the route, while the other routes are dimmed but remain in the background for ease of reference. As shown in Figure 4-26, stop location information can be displayed by hovering the mouse over a stop. The stops are displayed only when the selected route is sufficiently zoomed in. The stops contain information such as name, ID, and if they are timepoints.

When a route is selected, the left panel is replaced with route-specific information, including the span of service, run times, layover, average speed, and number of vehicles by time period. The demographic information, displayed at the bottom of the left panel, is specific to the selected route. The information on the left-panel is also directional, which is categorized as either Inbound or Outbound. Users can quickly switch between the two directions by clicking the Inbound and Outbound button on the map. As examples, Figures 4-26 and 4-27 show the Inbound and Outbound route directions, respectively. Figure 4-27 further shows that the route includes three route patterns, with pattern B selected. The display also includes the number of stops, distance in miles, and the number of weekly trips associated with each pattern. Lastly,

Figure 4-27 further shows an expanded left panel that displays the complete route information, including the speed, number of vehicles, and capacity.
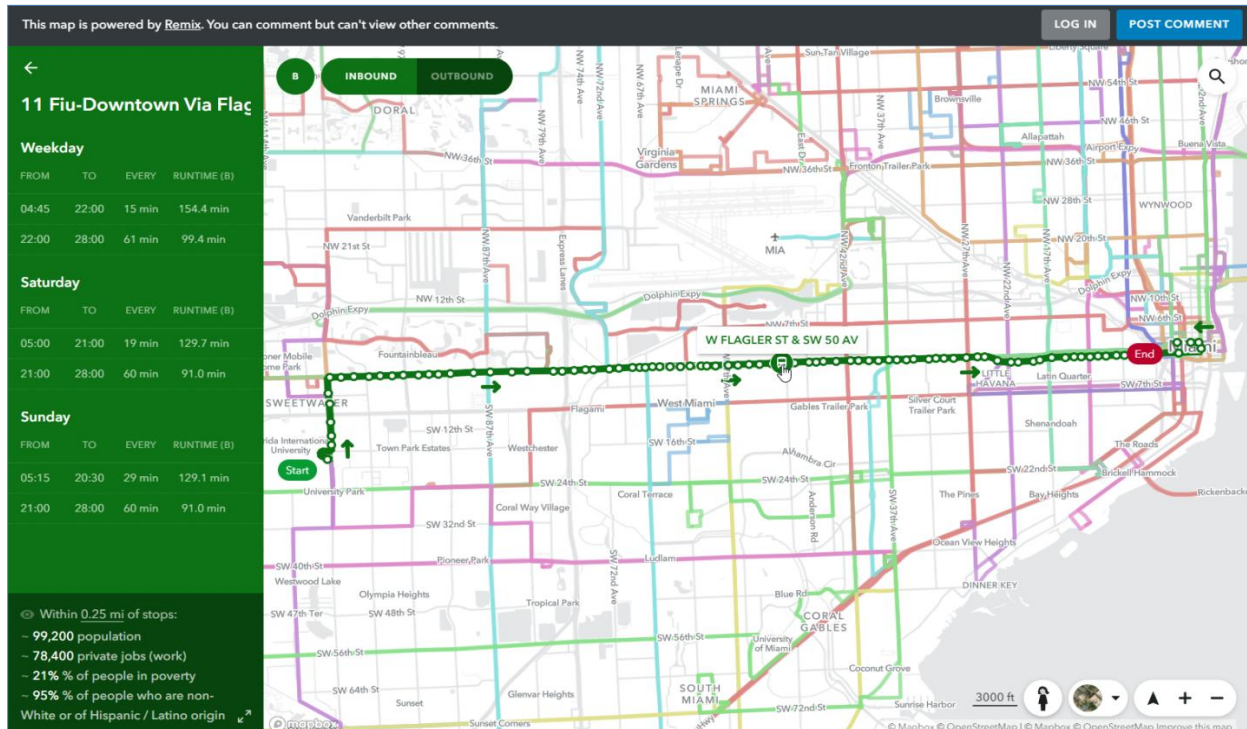
Figure 4-26. Remix MDT Route 11 Inbound with Scheduling Information
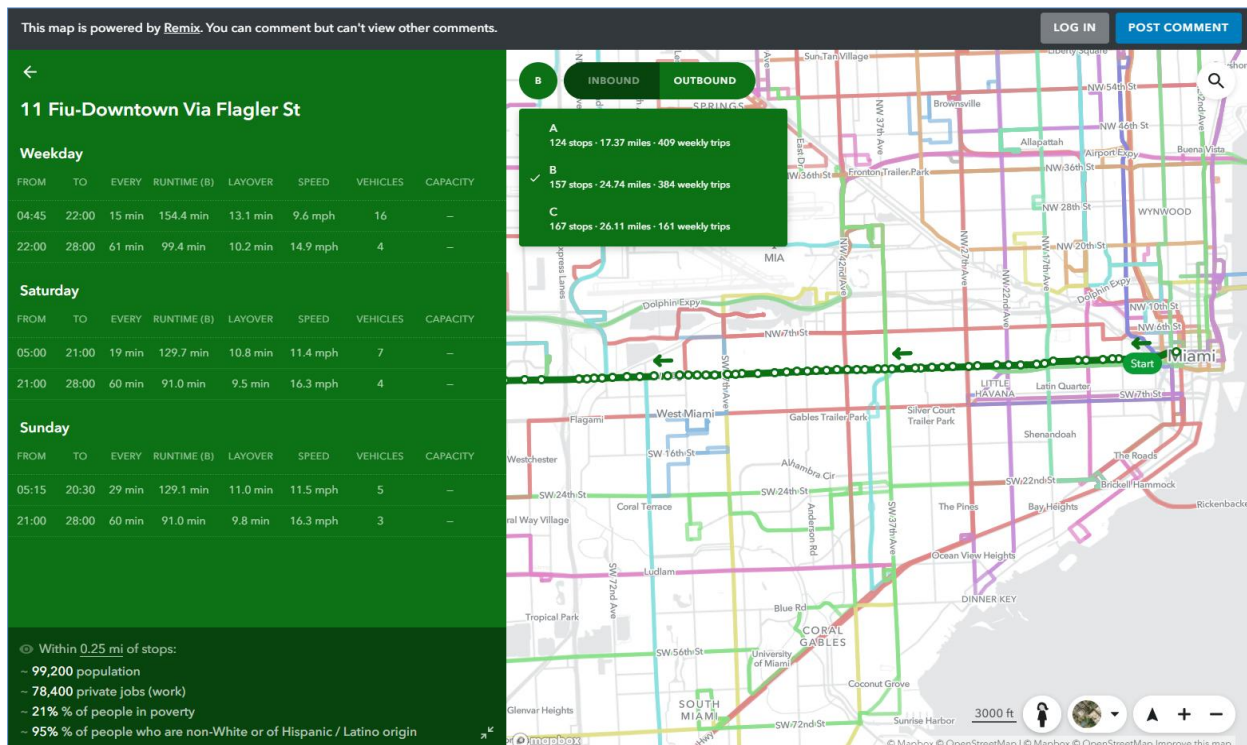
Figure 4-27. Remix Route 11 Outbound with Scheduling Information

4.3.3. Transit Accessibility and Equity Analysis

Remix allows very easy and fast creation of buffers around a route and provides the underlying demographic information. Figure 4-28(a) shows MDT Route 3 with a ¼ mile buffer. Figure 4-28(b) presents the demographic data of route 3. The buffer distance can be easily changed and the results are updated instantaneously. Remix also allows users to select particular information from the demographic data, so they can be displayed at the bottom of the left menu for easy reference. For instance, as marked on the right side in Figure 4-28(b), the following information was selected: population, % of people in poverty, and % of households that are car free. Once this is customized, the setting will remain throughout the whole system. This can help transit staff understand and compare the demographic characteristics of the different transit lines and provides the basis and data needed for transit accessibility and equity analysis.

| (a) MDT Route 3 with ¼ Mile Buffer | (b) Buffered Route 3 Demographic Data |

Figure 4-28. Remix MDT Route 3 with ¼-Mile Buffer and Buffered Data

4.3.4. Transit Service Coverage

As noted earlier, Remix includes a Reach Map tool called Jane that can be used to create isochrones to show how far Jane can go to and from a particular place. Figure 4-29 depicts the time isochrones that can help determine how far Jane can go from Downtown Miami at 9:00 a.m. during a weekday by transit in 15, 30, 45, and 60 minutes, which are represented by their respective color-coded isochrone bands. The function also estimates the cumulative demographic statistics for each band and the data can be exported to an Excel file and downloaded in GIS shapefiles.

Similarly, Figure 4-30 depicts the time isochrones that can help determine how long it will take for somebody from a particular location, at 9:00 a.m. during a weekday, to reach Jane (downtown Miami) by transit. Besides the different travel directions, Figures 4-29 and 4-30 have two additional differences: (1) the transit wait time in Figure 4-29 uses the average wait times based on the frequency of routes, while in Figure 4-30 the transit wait time is based on the timetables, which follow the exact schedules of each trip; (2) the walking distance in Figure 4-29 is based on how far Jane can go using the pedestrian network, while in Figure 4-30 the walking distance is based on a direct radius from each transit stop. The radius-based walking distance can clearly be seen from the round buffers shown in Figure 4-30.
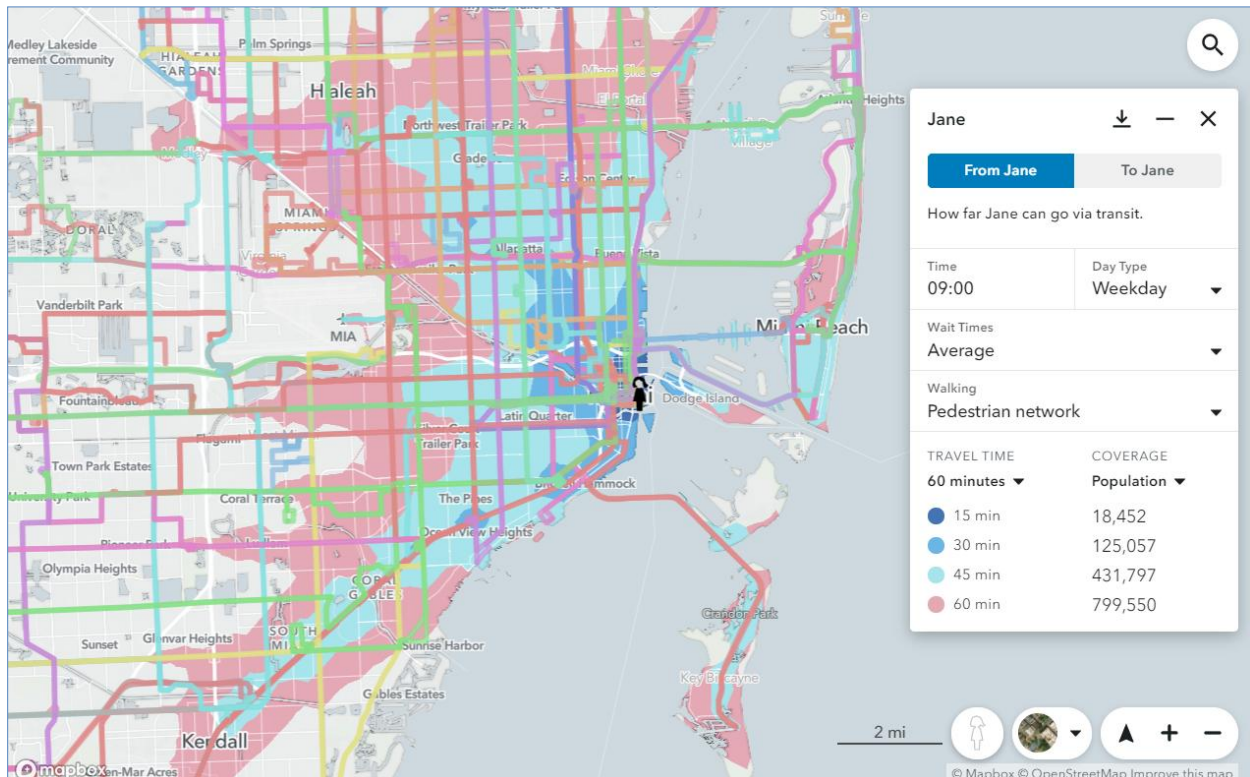
Figure 4-29. Remix Reach Map Isochrones Using Pedestrian Average Wait Times and Walk Buffer
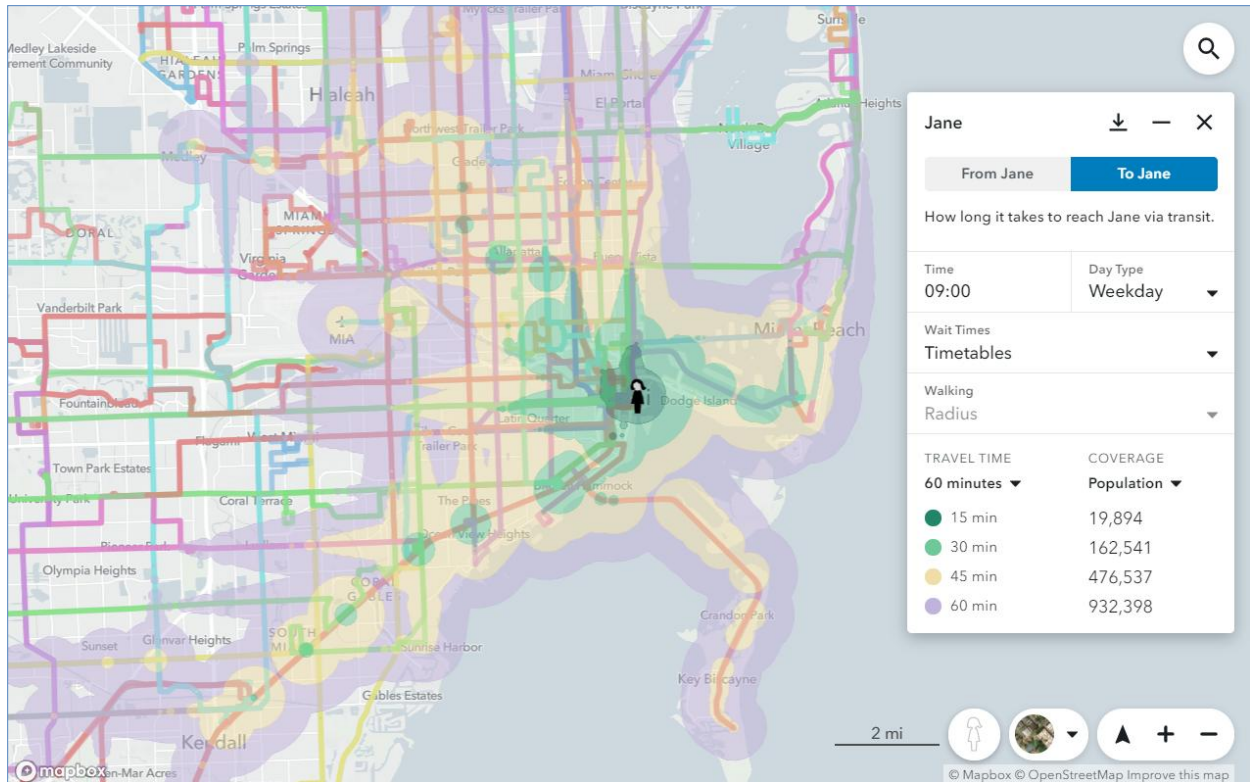
Figure 4-30. Remix Reach Map Isochrones Using Timetable Wait Times and Radius Buffer

4.3.5. Remarks

- Remix specializes in route planning analysis and is well-known for its ease of use and user-friendliness.
- Although the platform makes use of some basic schedule information to estimate service costs, it does not include a comprehensive schedule system.
- Remix offers many route planning capabilities. Although Remix demonstrated most of its capabilities, some of them cannot be included in this review because of the limitations of the shared link provided by the Miami-Dade Transit (MDT).
- Although Remix's mapping capabilities are developed using Mapbox and OpenStreetMap, it also integrates and takes advantage of the popular Google Street View and Microsoft Bing aerial images.
- As Remix is cloud-based platform, the software can be made immediately available for users. There is no need for IT support, hardware installation, or database management. The software is accessible from any computer with Internet access, making it easy to work remotely. Software upgrades and new features are immediately available on the platform.

4.4. NetPlan

NetPlan is a planning platform that can be used to analyze and design transit routes and service levels. The platform is part of the HASTUS software family marketed by GIRO, Inc. As shown in Figure 4-31, HASTUS includes multiple platforms for planning, scheduling, operations, customer service, plus integration tools to connect HASTUS with external systems.
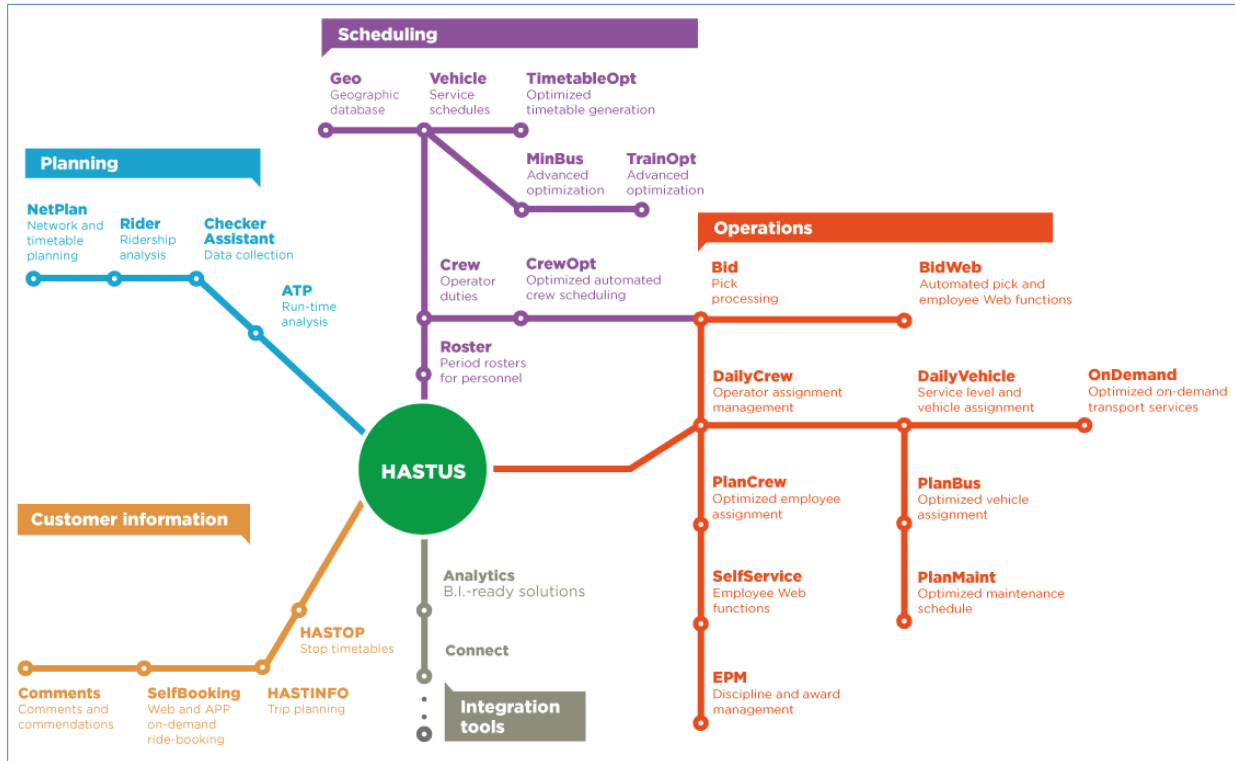
Figure 4-31. Netplan's HASTUS Family of Software Platforms

Unlike the other browser-based platforms included in this report, NetPlan is a client-server application that is integrated with its other family of applications, especially its scheduling platform, which provides the scheduling data needed to assess transit service levels and associated costs. The fact that NetPlan is an application that is hosted at the transit agencies makes it difficult for the vendor to provide the research team remote access to the platform. As such, the review below for NetPlan is based on information obtained from meetings with the GIRO and Los Angeles (LA) Metro teams, plus materials that are publicly available on the Web.

4.4.1. Transit Route and Stop Editing

NetPlan's map-based editing tools allow creation of a new route by selecting existing stops or creating new ones. It can also combine segments of existing routes to create new routes. Service levels on the new route can be added and copied from an existing route. For agencies that use HASTUS in scheduling, NetPlan can take advantage of the existing scheduling data for analyzing service levels. The example below shows how NetPlan's different editing capabilities are used to create a new project scenario, which is to create an express route. As

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shown in Figure 4-32, the scenario starts with three existing routes: 68, 70, and 260. The left panel allows the user to make route selection and display statistics including minimum vehicles, service distances, service hours, and population served.
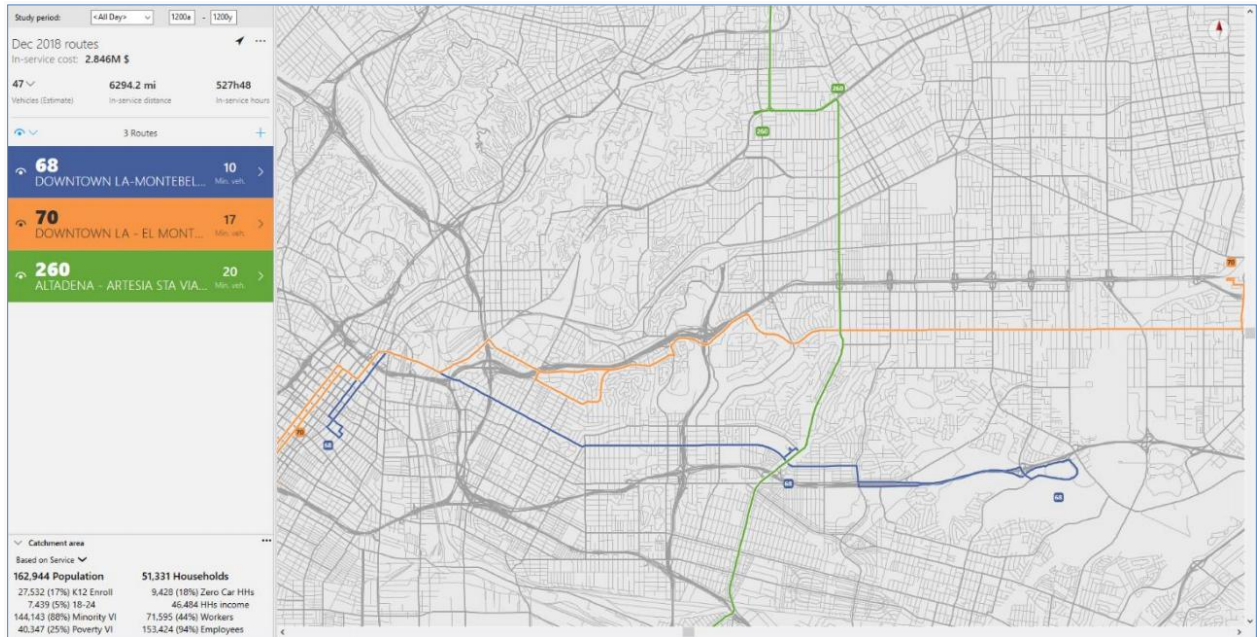
Figure 4-32. NetPlan Map-based Interface Displaying Three Existing Routes

Figure 4-33 shows a new Route 70 combining segments from the three existing routes. The left panel shows the both overall and directional route information for the selected route.
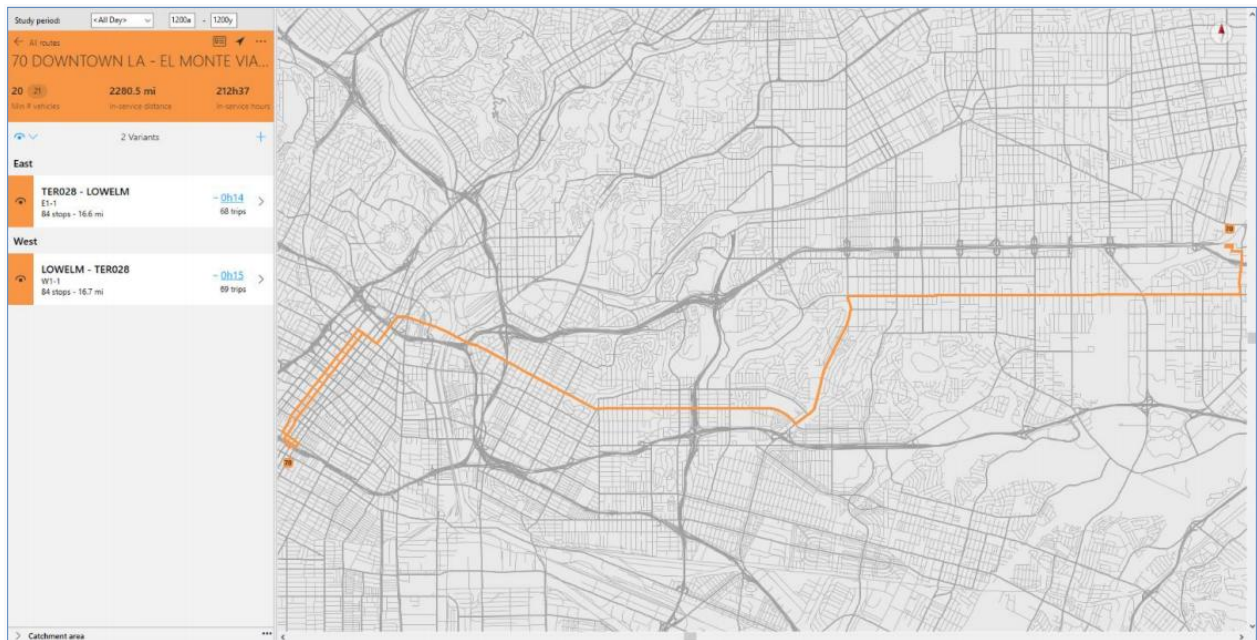
Figure 4-33. NetPlan Creation of a New Route by Combining Segments from Existing Routes

Figure 4-34 shows part of the new route (in red) being modified to create new route path (in black). The left panel shows scheduling and operational details for different time periods. including editable headways and the estimated run times, average speeds, etc. Figure 4-35 highlights the addition of a new stop on the newly created route path.
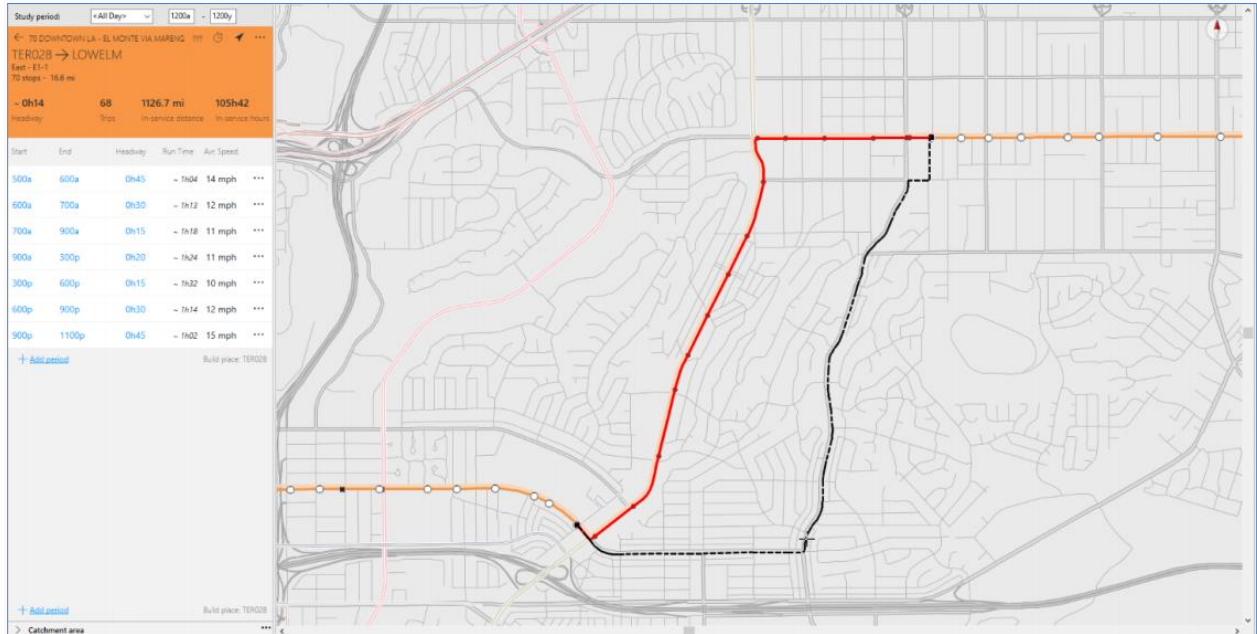
Figure 4-34. NetPlan Modification of a Route Path
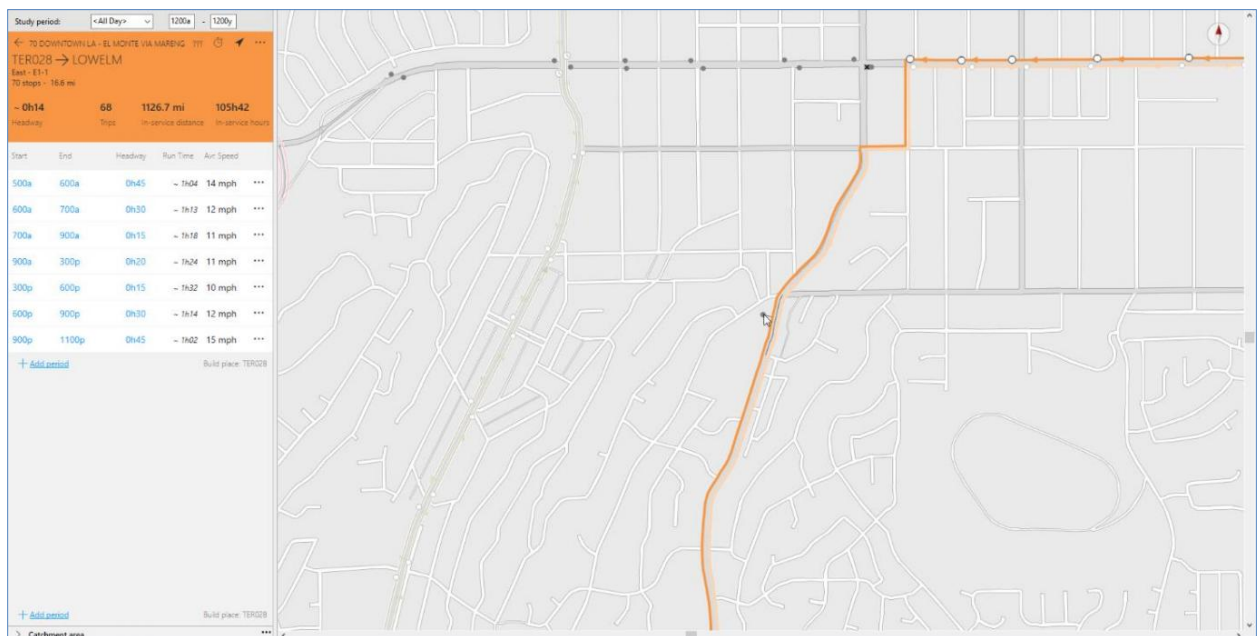
Figure 4-35. NetPlan Addition of a New Stop to a New Path Segment

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Once the new express route is created, the user can change evaluate different itineraries and service levels. During the process, the user can apply NetPlan's various features to analyze potential project impacts on the passengers and service costs.

4.4.2. Transit Service Accessibility

NetPlan allows importing census demographic data for estimating demographic statistics in transit catchment areas. The catchment areas are defined based on a buffer distance around each transit stop. The distance can be based on a radius or it can follow the street network. Figure 4-36 shows stop buffers overlaid on a thematic map of population density. The population statistics of the transit catchment areas are estimated and displayed at the screen's lower right corner. The thematic map overlay also allows for a quick visual assessment of how well the routes and stops serve the high population density areas.

Figure 4-36. NetPlan Buffer Function Estimating Population Captured in Transit Service Area

4.4.3. Transit Service Coverage

Similar to Remix's Jane feature, NetPlan includes a Reach map feature to assess customer travel times on different network scenarios from an origin or to a destination. Figure 4-37 depicts the travel time isochrones showing the time it takes to reach a Los Angeles downtown location. Figure 4-38 shows the differences in travel time between the base network and a proposed project. It allows the planners to quickly identify regions that are advantaged (blue areas) or penalized (red areas) by the proposed project.
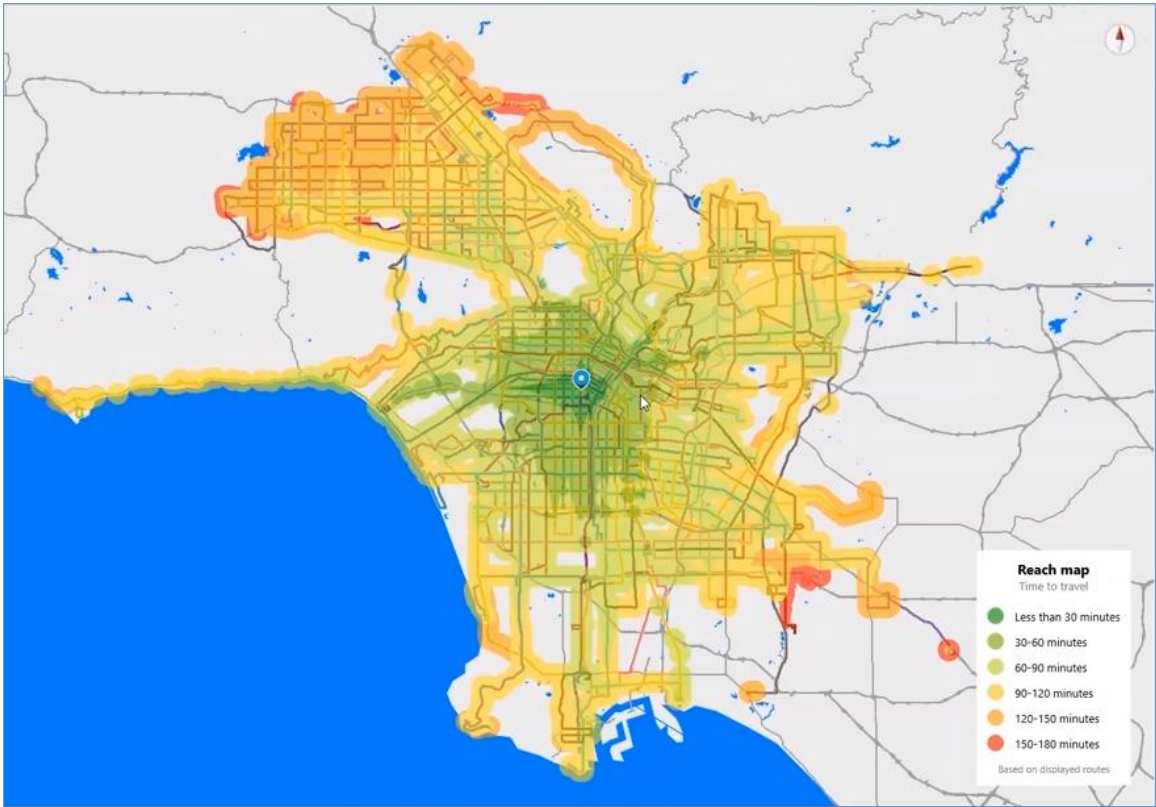
Figure 4-37. NetPlan Reach Map Showing Areas with Different Travel Times to a Destination
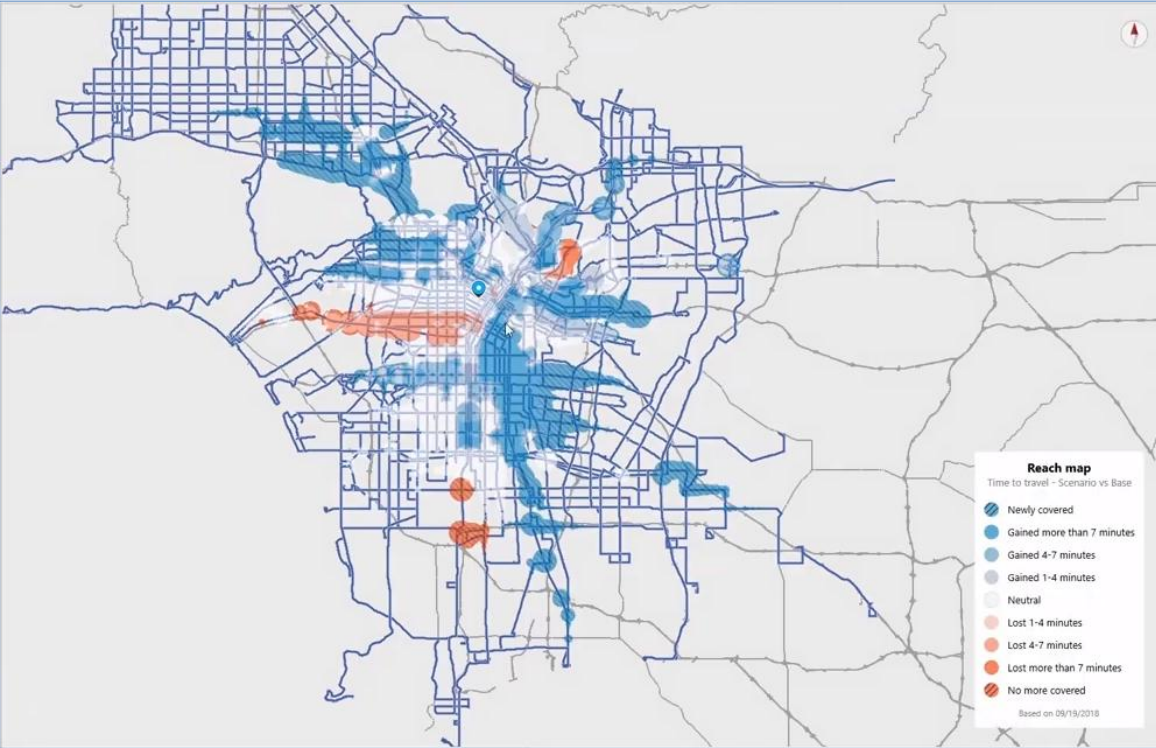
Figure 4-38. NetPlan Reach Map Showing Areas with Different Travel Time Impacts

4.4.4. Ridership Analysis

NetPlan allows ridership data to be imported for visualization and analysis. Figures 4-39 and 4-40 show ridership at the route and stop levels, respectively. The same ridership data can also be used to identify overcrowded segments by comparing the passenger loads with the bus occupancy capacity of each segment. Figure 4-41 shows an example highlighting segments with different crowing levels based on seat occupancy.
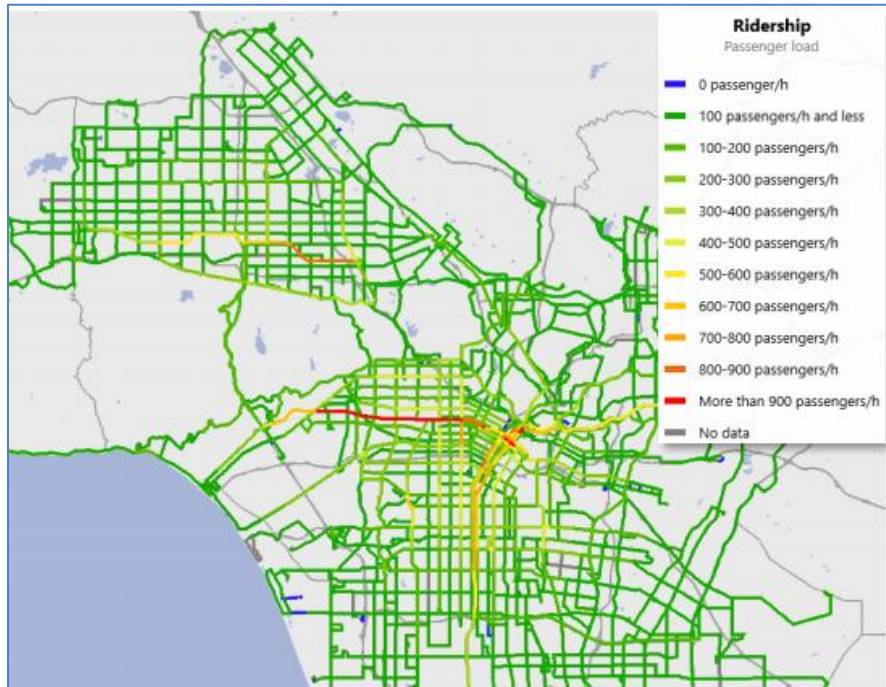
Figure 4-39. NetPlan Display of Ridership Levels by Route
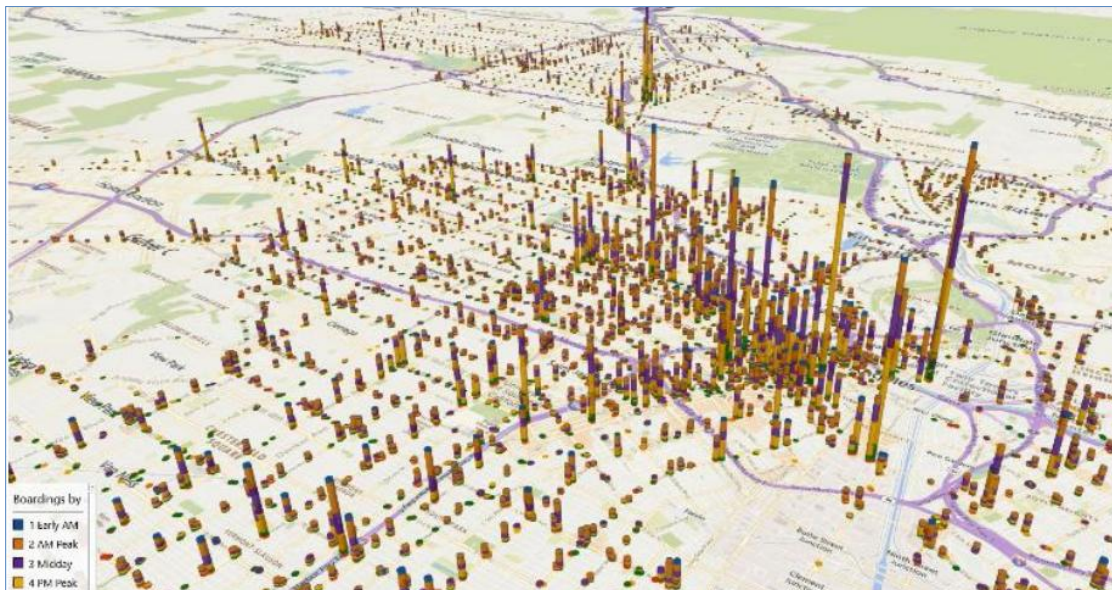
Figure 4-40. NetPlan Display of Ridership Levels by Stop
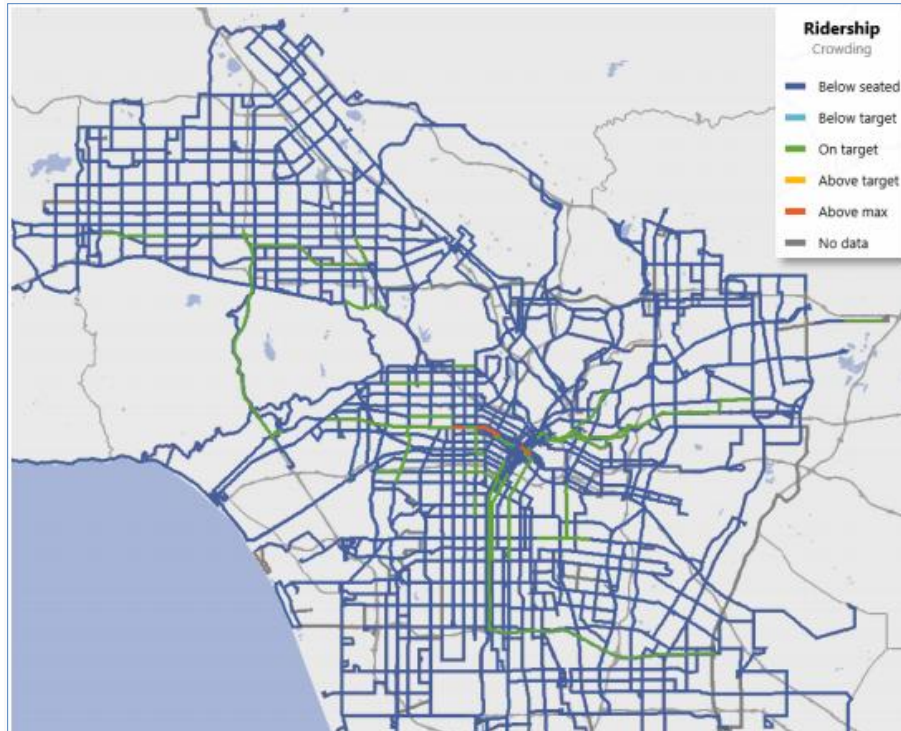
Figure 4-41. NetPlan Display of Segment Crowing Levels

4.4.5. Customer Impact Simulator and Dashboard

In collaboration with LA Metro for its NextGen Bus Study, GIRO developed a Customer Impact Simulator (CIS) in NetPlan that can evaluate the impacts of different scenarios on both the service costs and the customers. The simulator makes use of detailed schedules to represent the service provided and the origin-destination trip matrices for customer demand. The simulator then calculates each origin-destination trip pair's best path in each scenario to estimate the impacts on bus transfers, bus runtimes, etc.

To help communicate with the public and decision makers about proposed service changes, the simulator generates dashboards to summarize and present the impacts to the stakeholders. Figure 4-42 shows an example dashboard presenting how the customers from an area are impacted by service changes (base versus new scenario) during the different time periods of a day. Similarly, Figures 4-43 and 4-44 show two dashboards presenting the impacts of service changes on customer transfers and travel times, respectively.
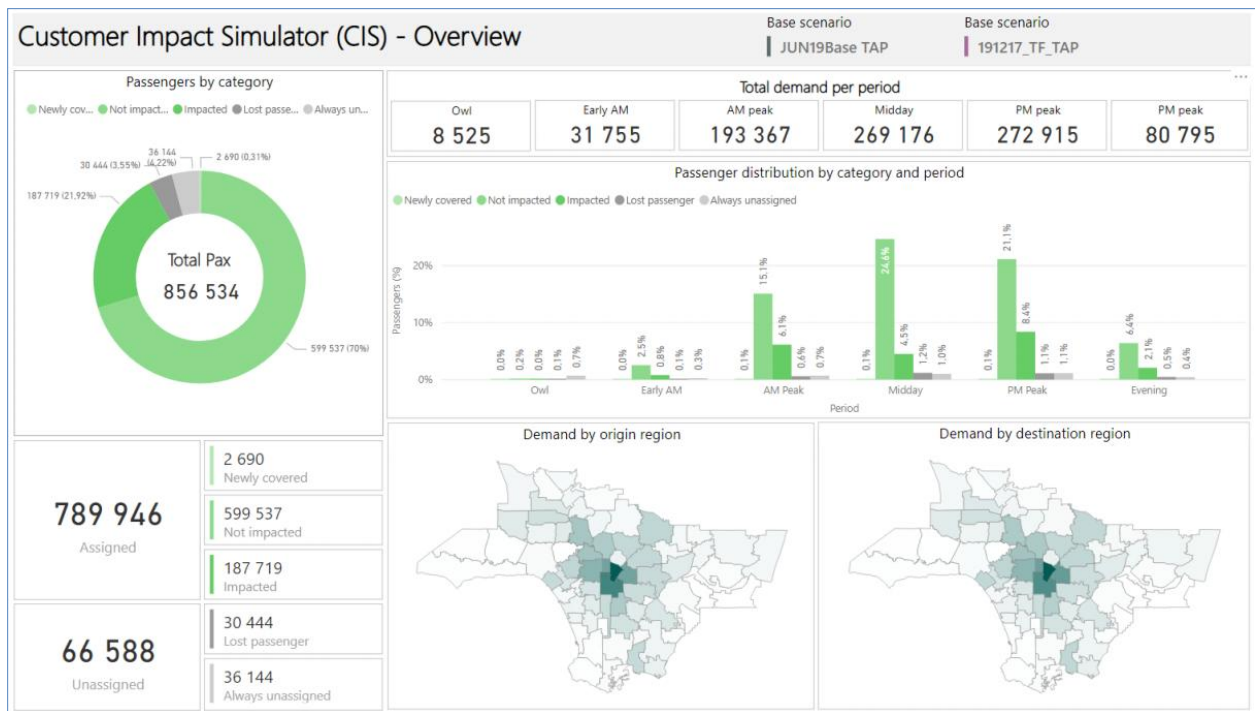
Figure 4-42. NetPlan Dashboard Presenting Overall Project Impact on Customers
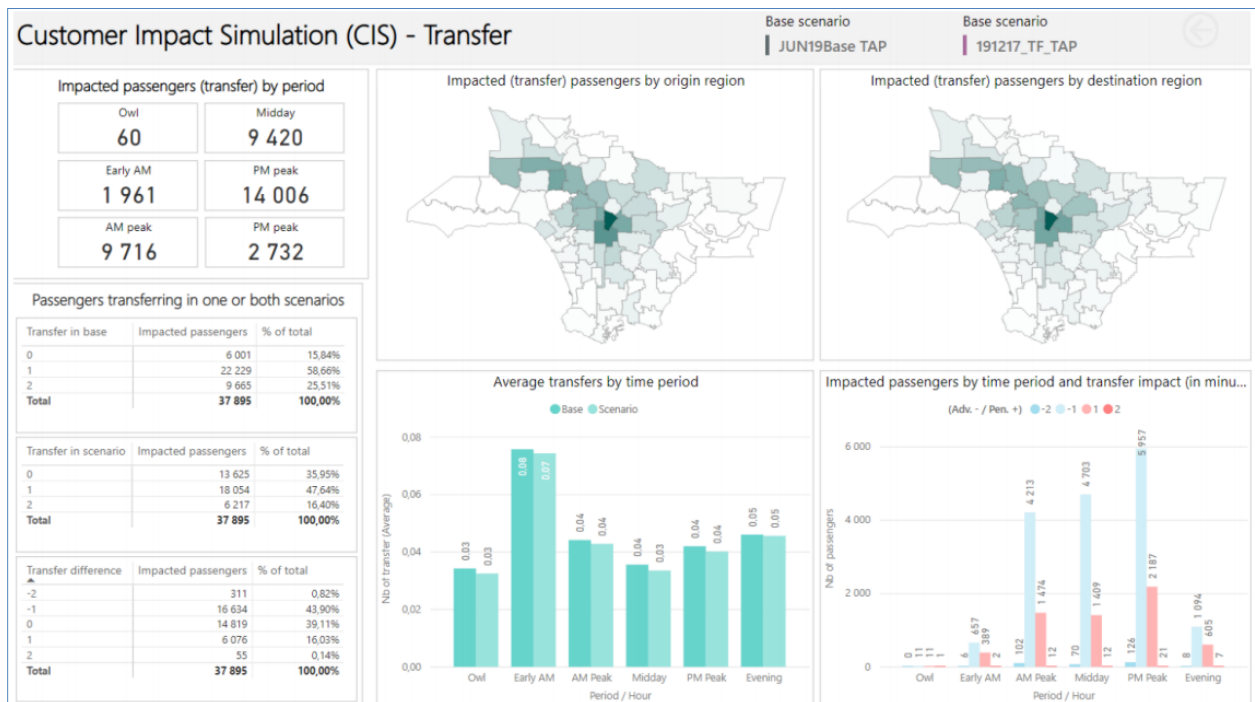
Figure 4-43. NetPlan Dashboard Presenting Project Impacts on Customer Transfers
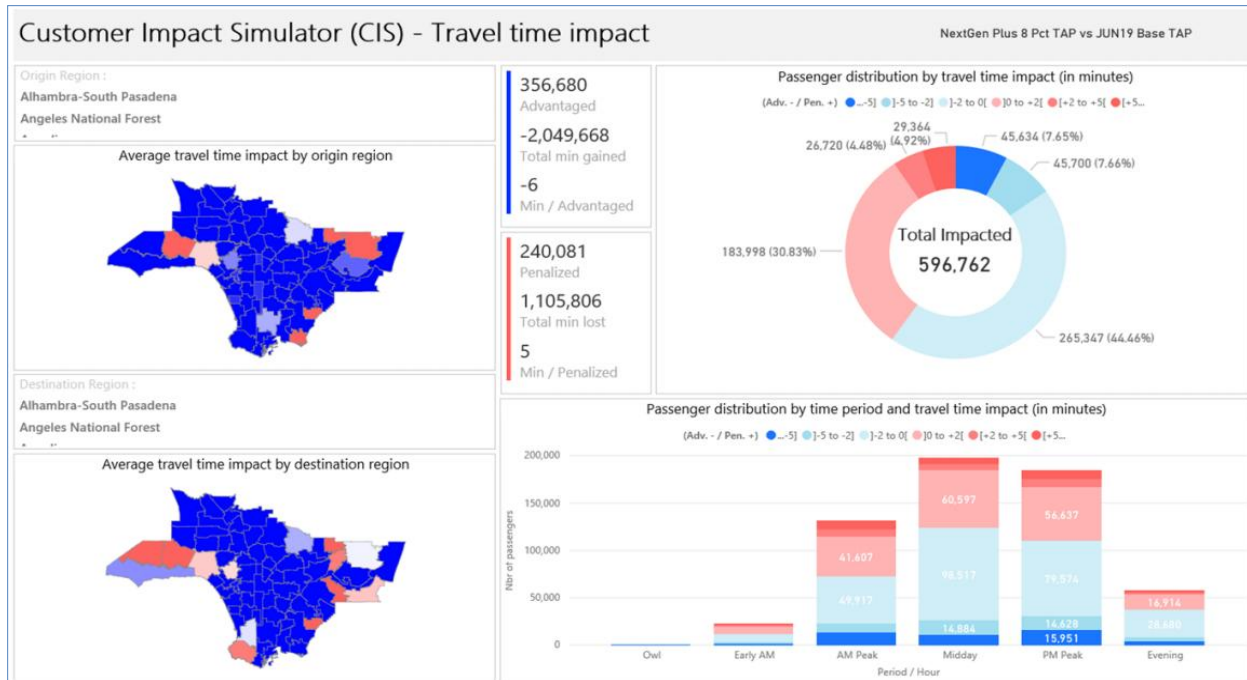
Figure 4-44. NetPlan Dashboard Presenting Project Impacts on Customer Travel Times

4.4.6. Remarks

- NetPlan is a highly sophisticated client-server application with comprehensive features and capabilities.
- The fact that the application is hosted at the agencies servers, to access the system remotely, users may need something like a Virtual Private Network (VPN) with permission from the agencies to securely access the system.
- For agencies that use HASTUS in scheduling, NetPlan is an attractive option as it can take full advantage of the existing scheduling data for analyzing service levels and accurately determining the cost of current or potential service changes.
- While NetPlan provides a modern and user-friendly interface, the system's complexity and integration with other HASTUS will require additional personnel training and the resources to fully realize its potentials.
- NetPlan may be more suitable for larger agencies that not only have the need for, and can benefit from, a comprehensive planning system, but also have necessary personnel and financial resources to support and maintain the system.
- As the research team did not have access to the NetPlan platform, this review is based on information gathered during the meetings with the GIRO and the Los Angeles (LA) Metro, with supplemental materials found on the Web. The specific sources include:
  - o "*How LA Metro Reimagined the Bus Network in Los Angeles using NetPlan*" (https://www.giro.ca/en-ca/news-insights/case-studies/la-metro/)
  - o "NEXTGEN Bus Study: Reimagining the Transit Network" (https://www.giro.ca/media/rsvpfzjp/nextgen-apta-multimodal.pdf)
  - o "*Using Big Data for Demand-Responsive Service Planning*" (https://www.giro.ca/media/lprni0zo/giro_uitp_asia-pacific-conference_data_20201022.pdf)

4.5. SWIFTLY

The Swiftly platform uses data from transit agencies to help them improve their operations, planning, scheduling, and customer service. As Figure 4-45 depicts the Swiftly system process, the main datasets include GTFS and AVL/GPS and may include optional feeds such as trip assignment, operator ID, run ID, speed, and passenger count data. Swiftly integrates these data to generate live information for on-time performance monitoring and real-time arrival predictions, as well as to preserve data for historical review and analysis. The information is accessible through the Swiftly dashboard. For this review, Swiftly provided the research team with read-only dashboard access to the Miami Dade Transit (MDT) system. Figure 4-46 shows the dashboard which is divided into the main menu, the filter panel, and the visualization panel. The main menu provides access to five core modules: Live Operations, GPS Playback, On-Time Performance (OTP), Run-Times, and Speed Map. They are reviewed below in further details.
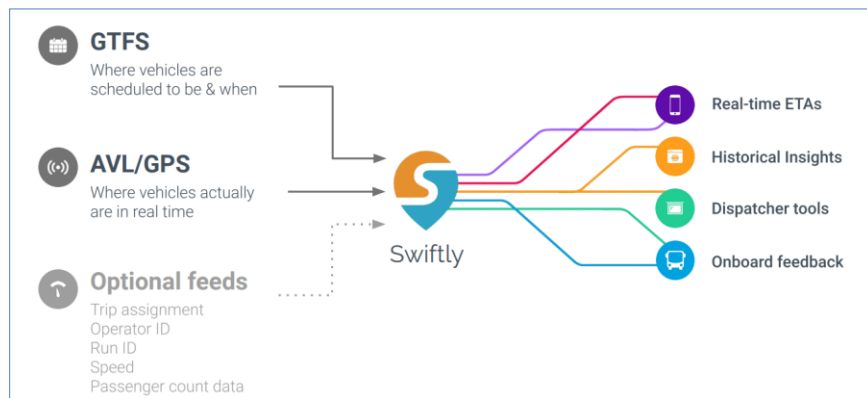
Figure 4-45. Swiftly System Process
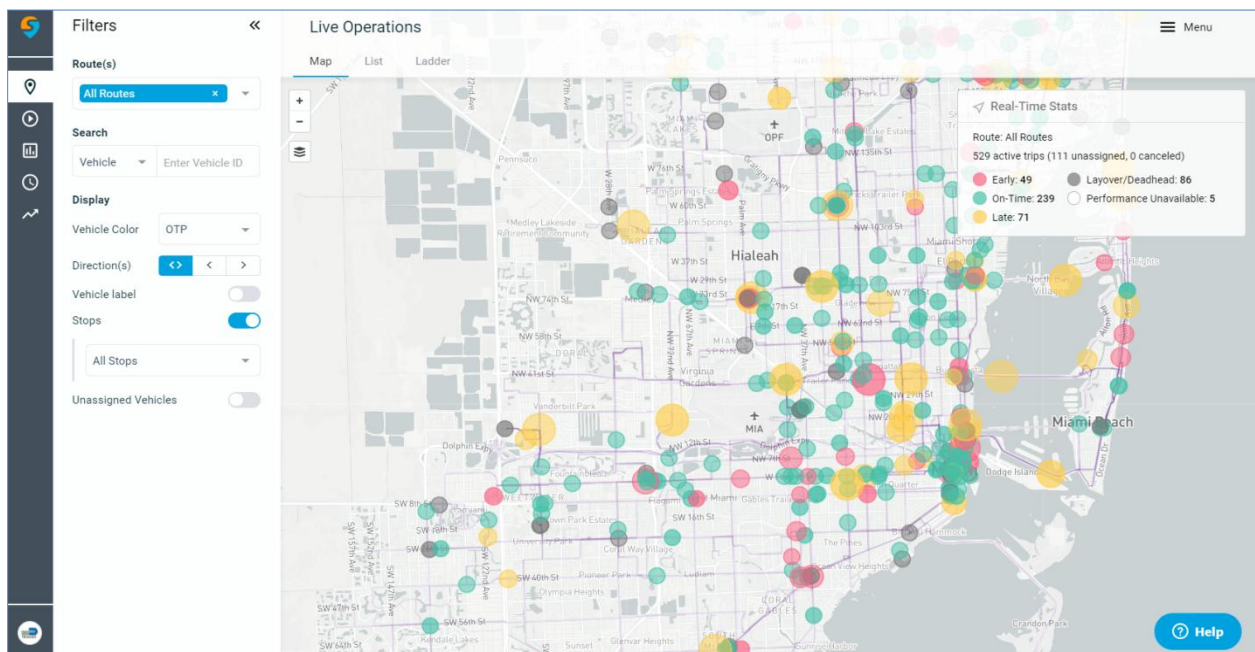
Figure 4-46. Swiftly Systemwide Display of On-time Status of Active Vehicles

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4.5.1. Live Operations

The *Live Operations* module provides real-time vehicle locations and system health statistics, such as headway status, on-time performance, route assignment information. The module includes three different views for data visualization: Map, List, and Ladder. In Figure 4-46, the *Map* view displays the active vehicles along all transit routes. The vehicles are represented by colored circles to indicate their on-time performance (OPT) status, i.e., green is on-time, red is early, and yellow is late. Instead of all routes, users can select one or more particular routes. Figure 4-47 displays the OPT status of vehicles on selected Routes 8 and 11. The figure also displays all the stops (purple circles) and timepoints (solid purple circles) in both directions.
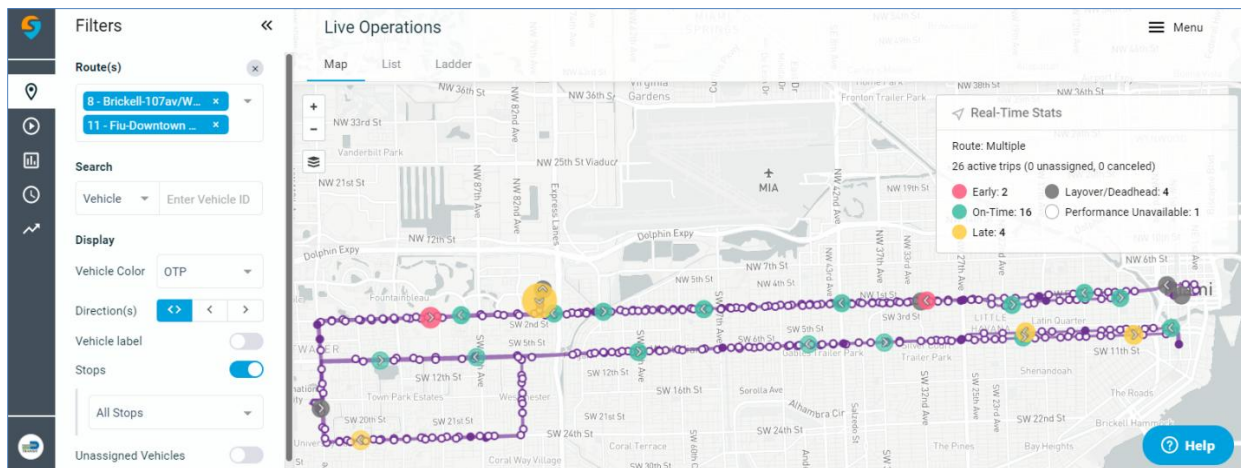
Figure 4-47. Swiftly Display of On-time Status of Active Vehicles on Routes 8 and 11

Figure 4-48 uses a different set of filters from Figure 4-47. Instead of OTP, the colored circles show the real-time vehicle headway status, i.e., red is bunched, green is expected, and blue is gapped. The figure includes only timepoints and the vehicles are for one direction only and are labeled with vehicle ID for easy identification. As the figure also shows, users can use the Search box to quickly locate specific vehicles, operators, blocks, runs, and stops.
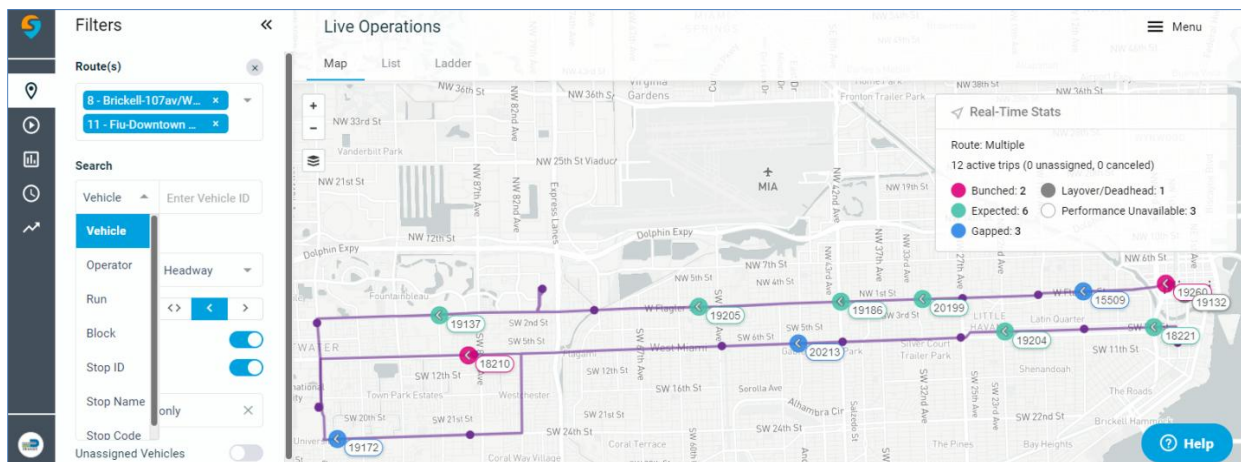
Figure 4-48. Swiftly Display of Headway Status of Active Vehicles on Routes 8 and 11

The *List* view of the module lists all the vehicles and their OTP/headway status in a tabulated format. Figure 4-49 shows a list of three late vehicles on Routes 8 and 11. For each vehicle, the list identifies its schedule adherence, headway deviation, route, operator, trip, and block.
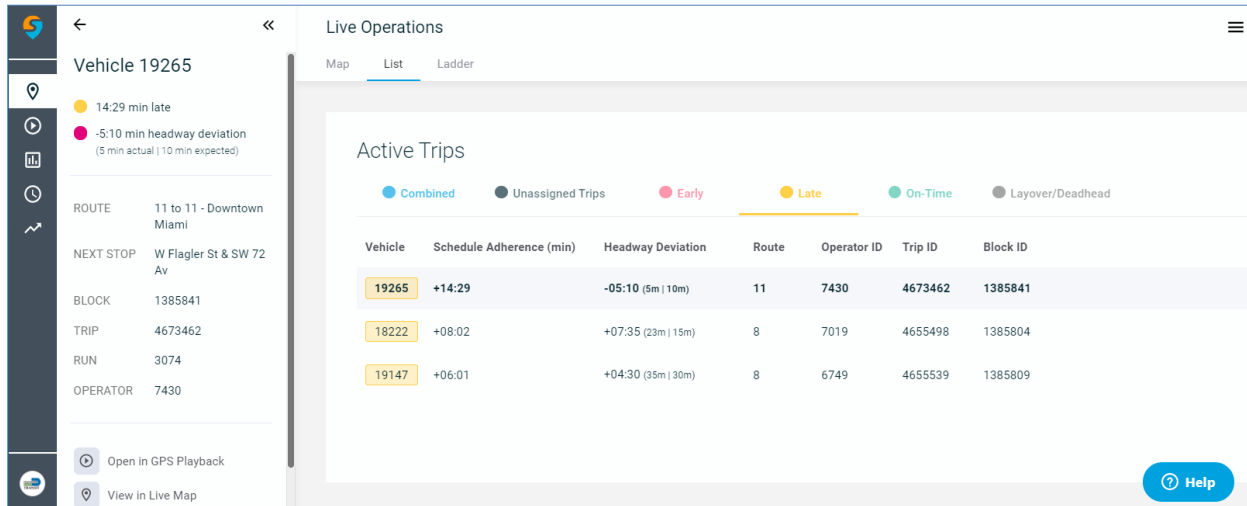
Figure 4-49. Swiftly Vehicle List View

Finally, the *Ladder* view shows the vehicle locations and their OTP/headway status in the schematic ladder format. Figure 4-50 displays Routes 8 and 11 in the ladder format. For each route, it shows both the inbound and outbound directions and the real-time vehicle locations and their OTP status. For each direction, it displays each route pattern separately.
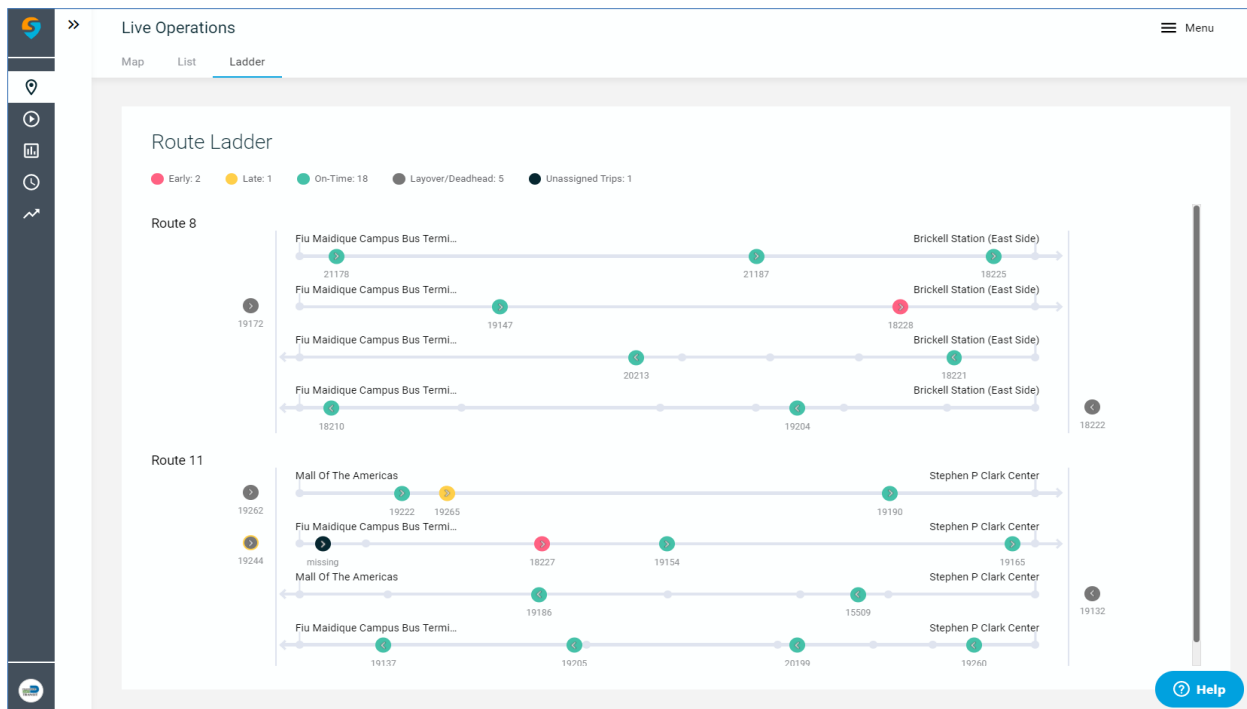
Figure 4-50. Swiftly Vehicle Ladder View

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4.5.2. GPS Playback

The *GPS Playback* module allows users to replay the historical locations of all vehicles or an individual vehicle on a route. It is useful for planning, operations, scheduling, as well as for transit investigations. Figure 4-51 shows an example that replays the locations of all vehicles on Route 8 during a chosen date and time period. As the figure shows, users can click on any vehicle during the replay to view additional details on the vehicle.
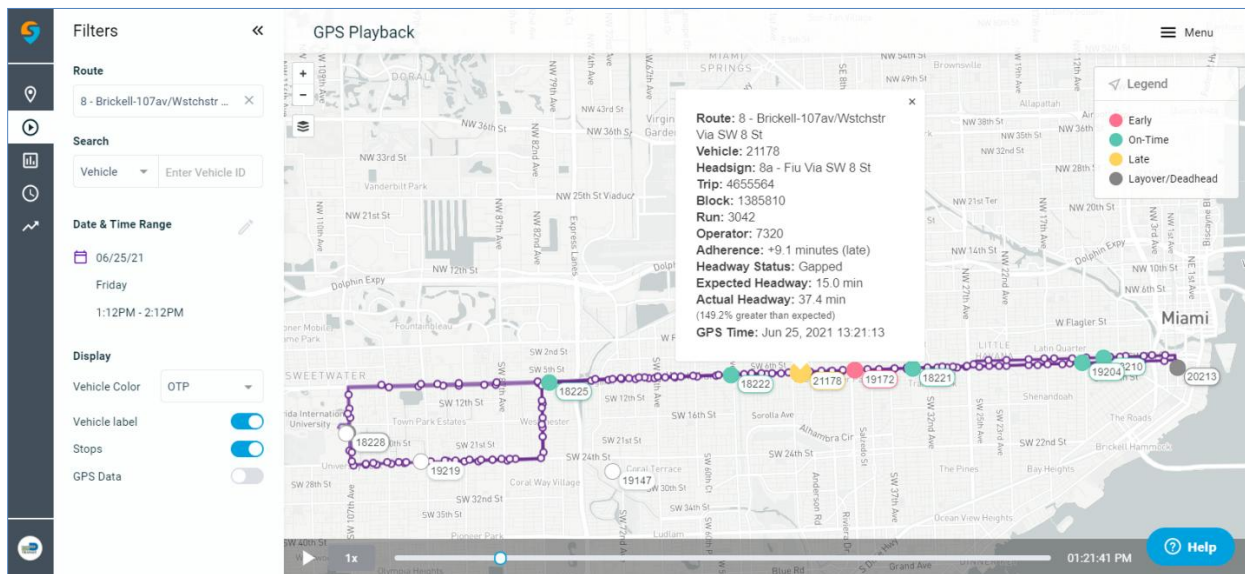
Figure 4-51. Swiftly GPS Playback of Archived Data for Historical Review and Analysis

4.5.3. On-Time Performance

The *On-Time Performance* module in Swiftly can generate a variety of OTP reports for the entire system or an individual route. It allows users to easily visualize data based on selected routes, days of the week, and stop type (all stops or timepoints only) within a date and time range. The default OTP thresholds, which are user-definable, are 2 minutes for early and 6 minutes for late. The OTP results can be presented in a variety of different charts.

Figure 4-52 shows the OTP summary for the month of May 2021. It includes the overall OTP summary, the changes compared to a month ago, and the OTP trend over the last 26-week period. Figure 4-53 shows a table listing the detailed OTP results at each stop. The results can be downloaded and automatically opened in Microsoft Excel.

Further, Figure 4-54 shows the OTP status by time of day, and Figure 4-55 shows the OPT status in a histogram to help visualize the route's schedule adherence. Finally, Figure 4-56 shows a partial OTP schedule heat map that allow users to quickly identify problem time periods and stop locations. The heat map uses different color shade levels to represent the degrees of earliness (red shades) and lateness (yellow shades). Together, all of these OTP visualization methods can help planners and schedulers make data-driven schedule adjustments to increase OTP and improve transit service.
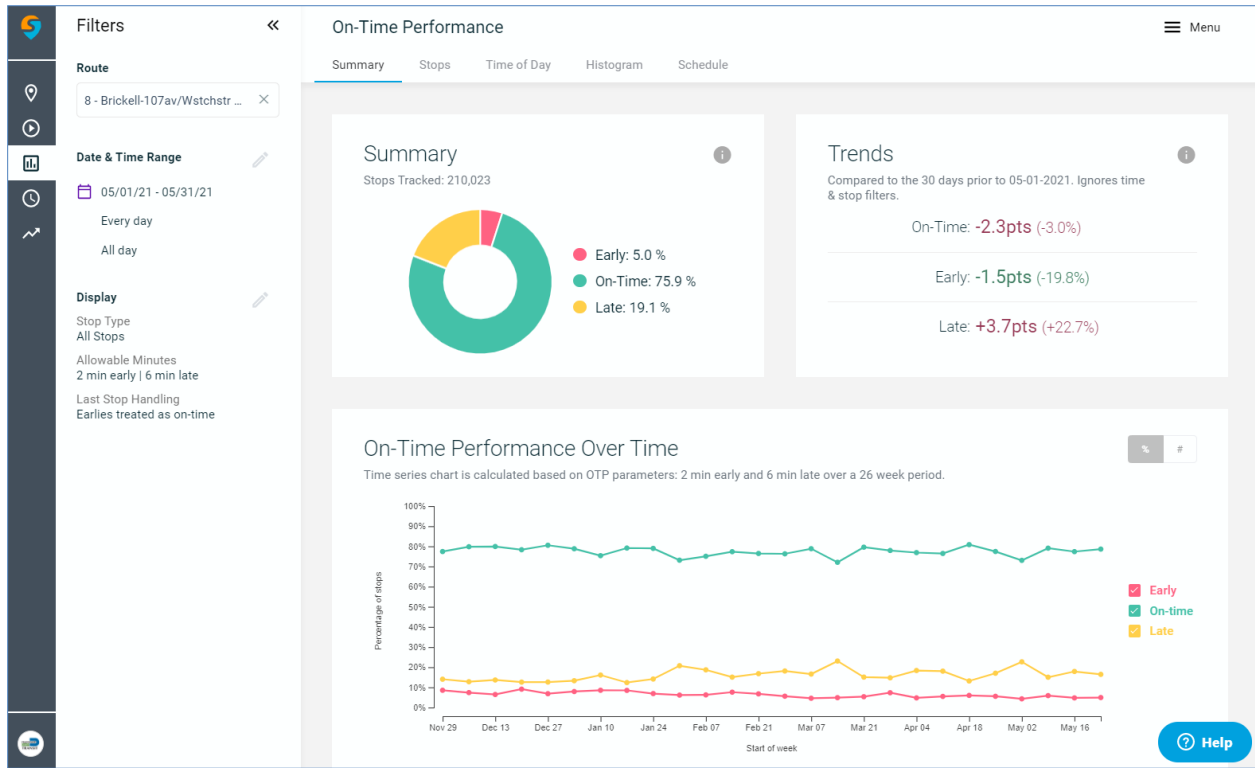
Figure 4-52. Swiftly Overall OTP Summary View
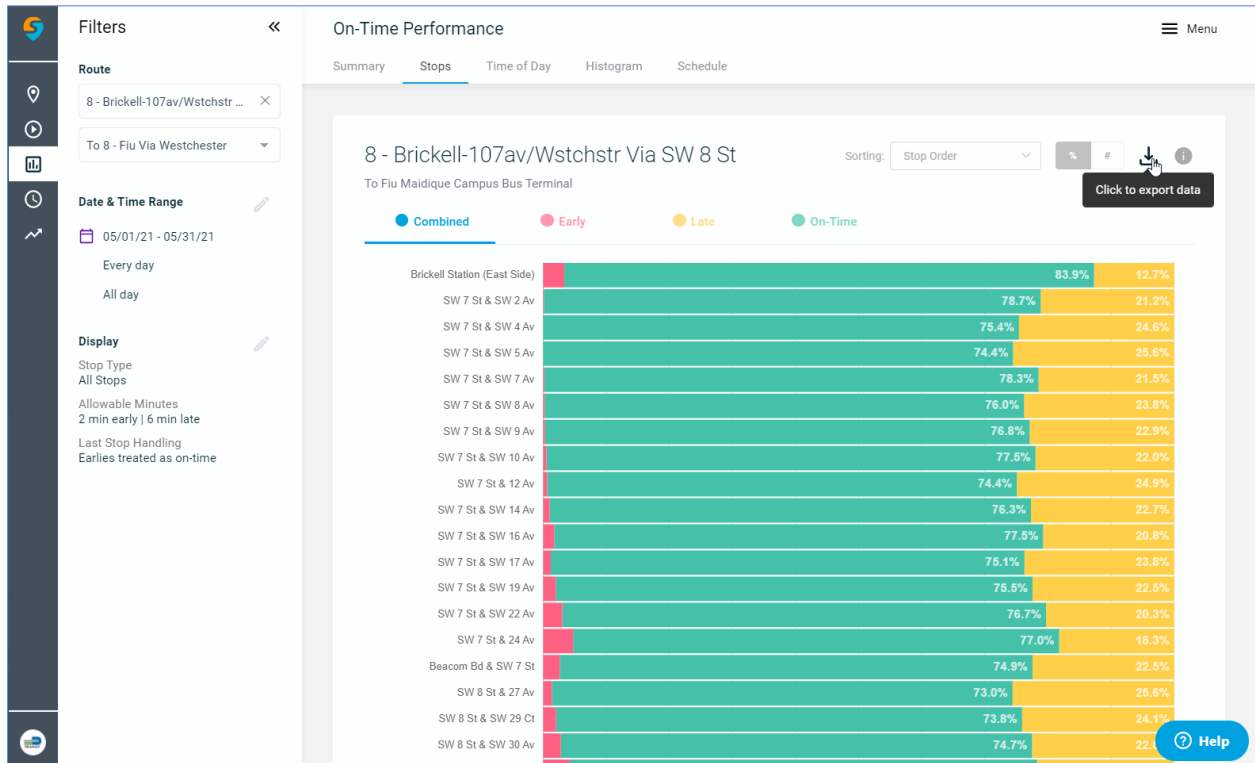
Figure 4-53. Swiftly Display of OTP Results by Stop
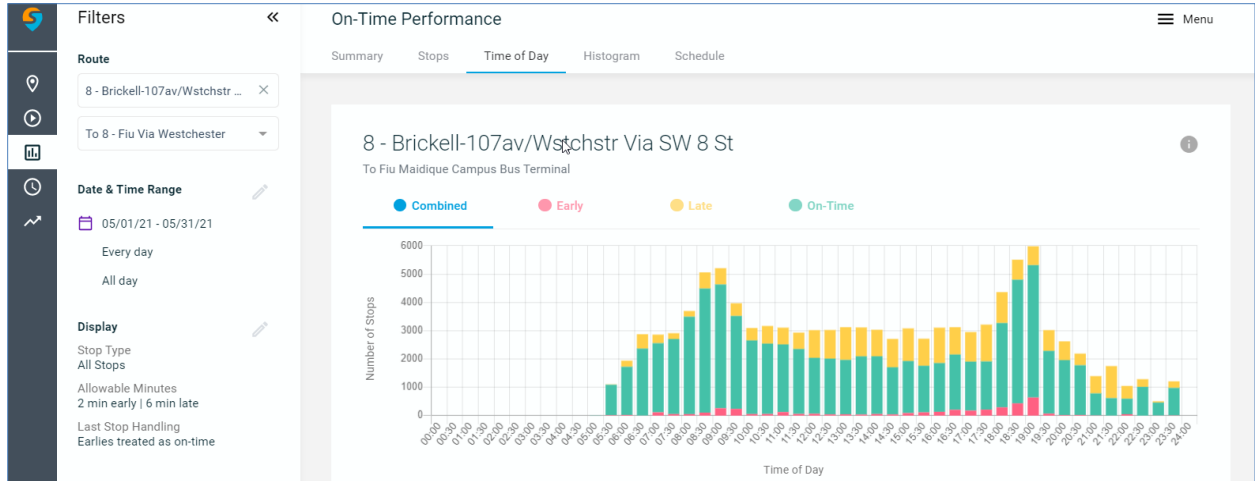
Figure 4-54. Swiftly Display of OTP Results by Time of Day
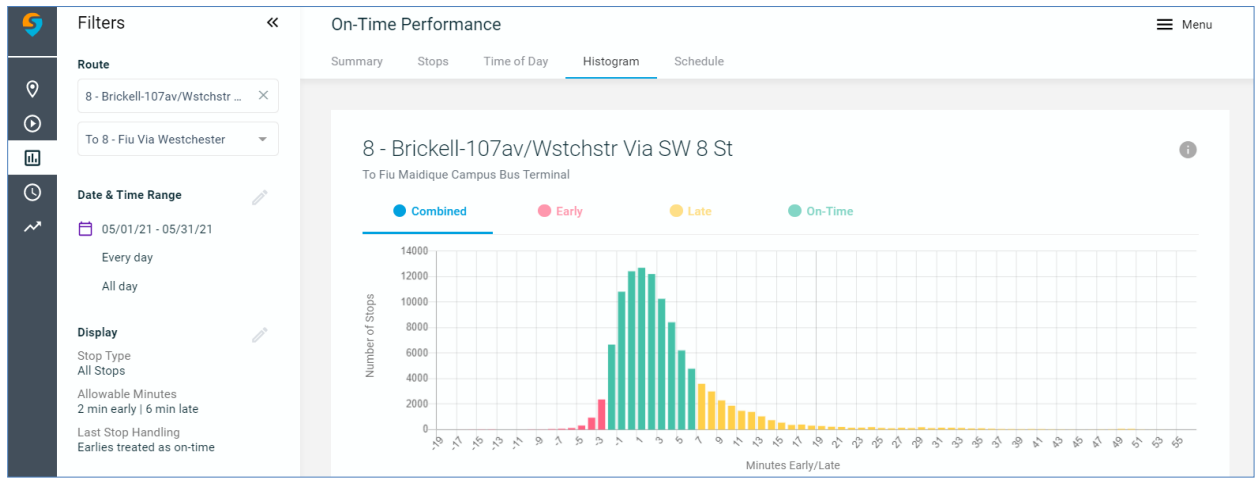
Figure 4-55. Swiftly Display of OPT Results by Histogram
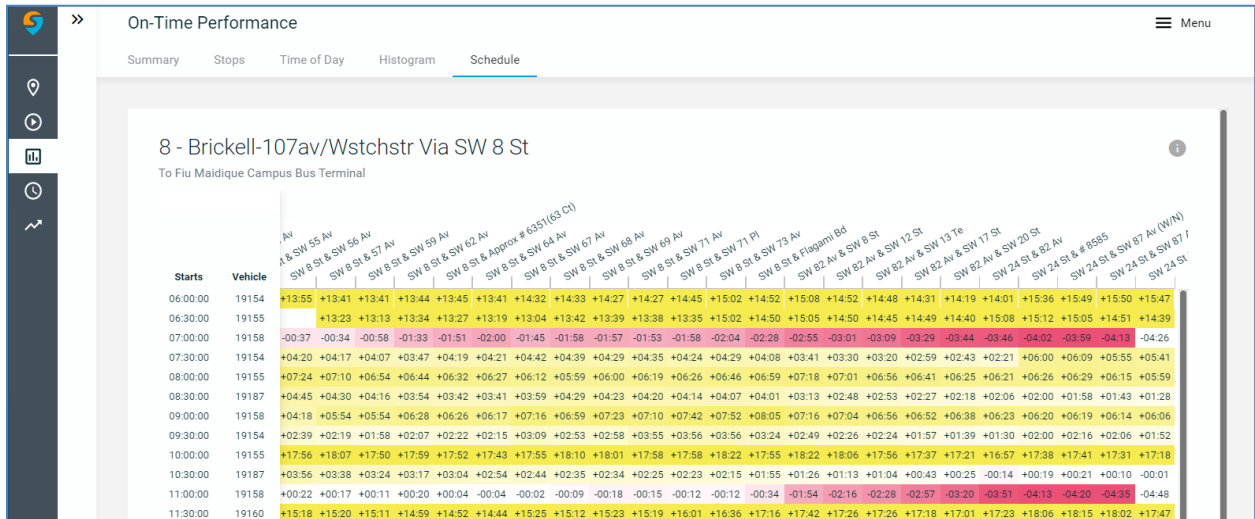
Figure 4-56. Swiftly Partial Display of OTP Route Schedule Heat Map

4.5.4. Run Times

The *Run Times* module generates reports regarding the run-time performance of the entire system or an individual route. It can suggest running times between stops or time points to improve OTP which can be useful to planners and particularly to schedulers. For instance, the suggested run times in Figure 4-57 can be used to prepare a timetable that improves OTP. It allows schedulers to visually compare the existing running times with the actual running times before they create the timetables for the next line-up period. The module also provides many detailed analysis options that can be used for improving OTP. For example, Figure 4-58 shows a list of individual trips, including their observed run-time components (fixed, variable, and dwell), scheduled run-time, and next trip start time. Users can click on each trip to further drill down to examine the same detailed information at the stop level.
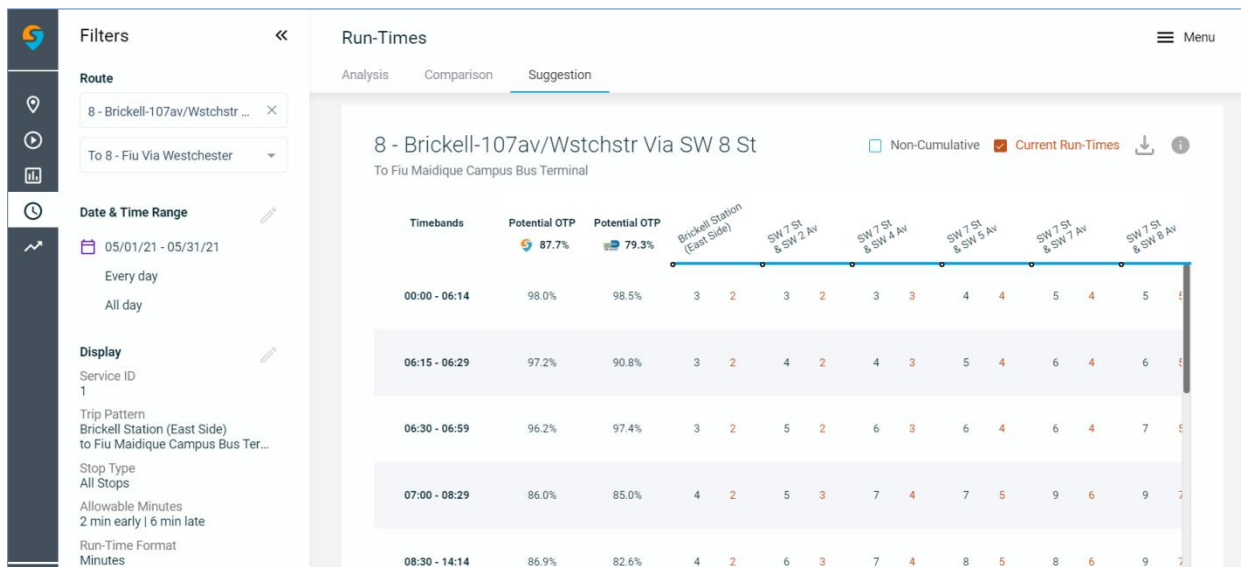
Figure 4-57. Swiftly Suggested Run-Times
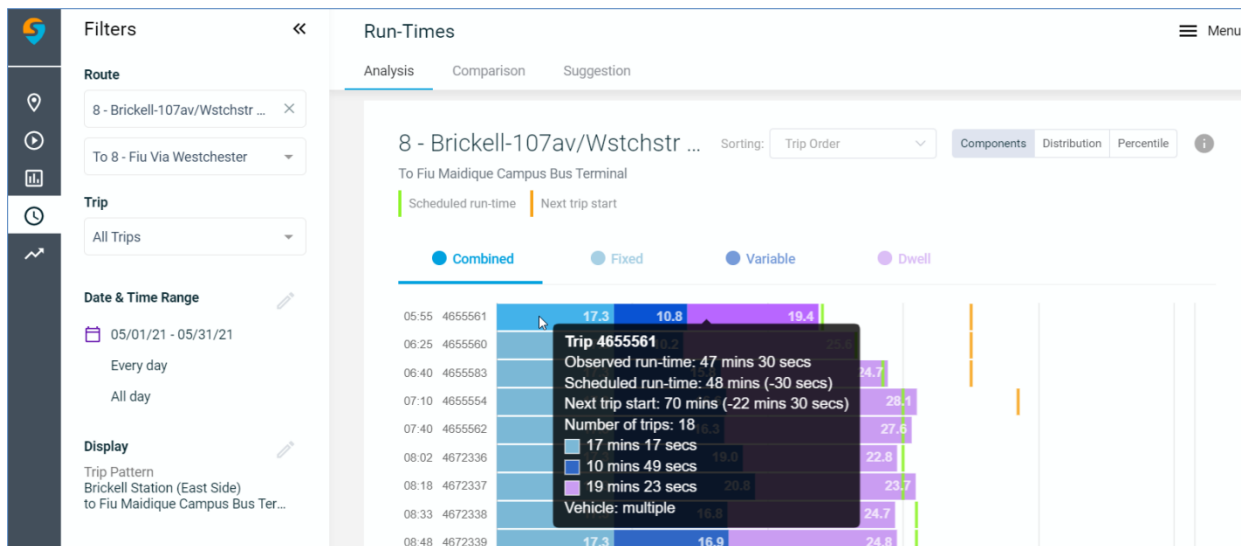
Figure 4-58. Swiftly Analysis of Scheduled and Observed Run-Times

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4.5.5. Speed Maps

The *Speed Map* module provides the average speeds of vehicles along a route over a selected date-time period. This module can be filtered by route and date and time. Speed maps allow transit personnel and management to see segments along a route where the different speeds are shown. The information allows planners and schedulers to identify congested segments and develop measures including schedule adjustments and potential route changes. Figure 4-59 shows the average speeds between each pair of stops along Route 8. Figure 4-60 shows a similar map based on smaller sub-segments within a stop-to-stop segment. The figure also shows that users can define the average speed thresholds for the color scale.
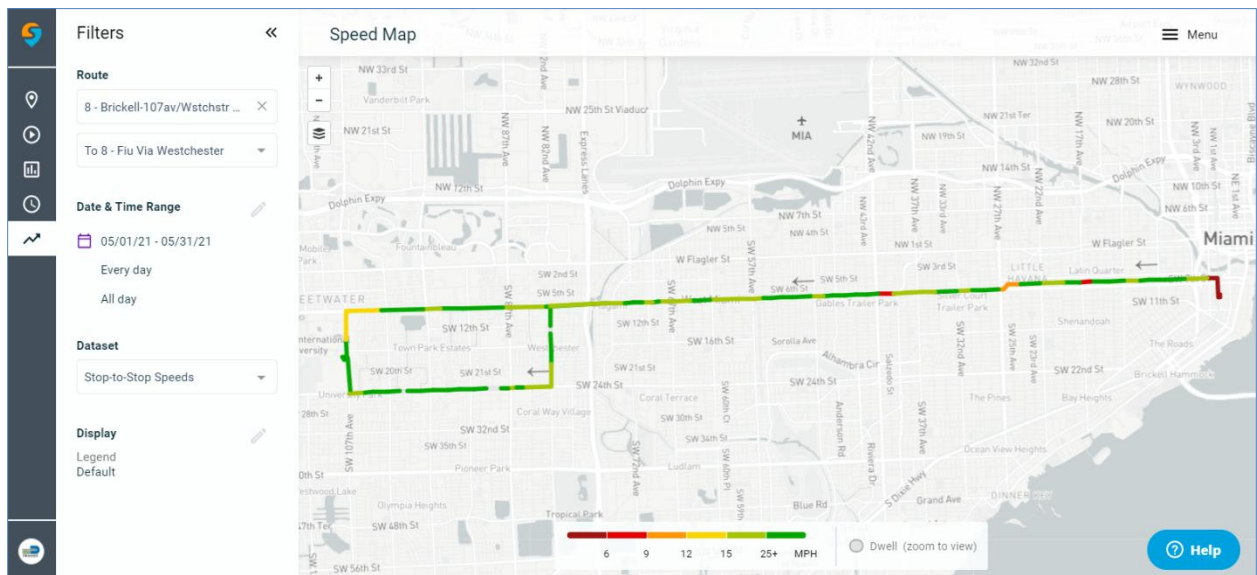
Figure 4-59. Swiftly Speed Map by Stop-to-Stop Route Segments
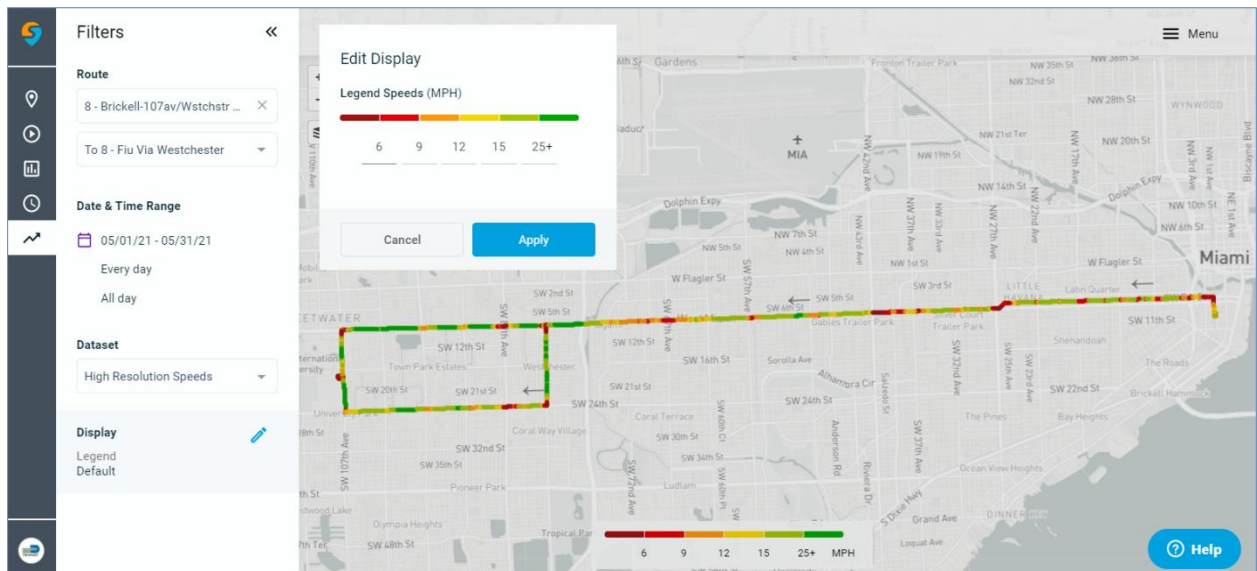
Figure 4-60. Swiftly Speed Map by Small Route Segments

4.5.6. Application Programming Interfaces (APIs)

The Swiftly APIs allow users to retrieve data not included in the dashboard. The API covers many areas, including agency information, real-time predictions, alerts, different types of exports, scheduling and operational information, and much more. Although APIs are mainly used by IT personal, the interface is relatively friendly and allows entering different parameters and generating the API code from the user interface. For this review, the research team was provided access to 19 APIs listed in Figure 4-61. As shown in Figure 4-62, Swiftly provides a detailed reference guide for each of its API. The APIs can be tested using the screen shown in Figure 4-63.

Figure 4-61. Swiftly API List of Module

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Figure 4-62. Swiftly API Reference Guide

Figure 4-63. Swiftly Interface for API Testing

To test the APIs, the research team modified the generated API code as shown below to download one month of OTP route data for the month of December of 2020:

```
curl --request GET \

  --url 'https://api.goswift.ly/otp/miami/by-
route?lastStopOfTrip=earliesAsOnTime&allowableLate=6&allowableEarly=2&endTime=23%3A59&beginTime=
00%3A00&endDate=12-31-2020&startDate=12-01-2020' \

  --header 'authorization: 785c0396406f831feb1e3b0afa6913b8' >> OTP.json
```

The research team ran the code in a Windows 10 Dell Precision T5810 machine using the Windows Subsystem for Linux (WSL) with Ubuntu Linux and the download worked quickly and flawlessly. Note that the output file is in JSON format, which may require specialized tools or coding to be able to read the data. The research team used the Scala programming language in Apache Spark to covert the JSON data into a Spark Sql to be able to run queries. Below is the schema of the OTP.json file:

```
root
 |-- route: string (nullable = true)
 |-- success: boolean (nullable = true)
 |-- data_early: long (nullable = true)
 |-- data_late: long (nullable = true)
 |-- data_name: string (nullable = true)
 |-- data_onTime: long (nullable = true)
 |-- data_routeShortName: string (nullable = true)
 |-- data_total: long (nullable = true)
```

The research team also downloaded the stop data in csv format using the API code below:

```
curl --request GET \

  --url 'https://api.goswift.ly/otp/miami/csv-export?endDate=01-02-2021&startDate=01-01-2021' \

  --header 'authorization: 785c0396406f831feb1e3b0afa6913b8' >> otp.csv
```

Since the stop dataset can be large, only the days of January 1, 2021 and January 2, 2021 were used. This yields 396,799 rows of detailed stop data. As with the JSON file, the download of the csv file was fast and without any problems.

Using the shell in Apache Spark, the schema of the otp.csv file is presented below:

```
root
 |-- block_id: string (nullable = true)
 |-- trip_id: string (nullable = true)
 |-- route_id: string (nullable = true)
 |-- route_short_name: string (nullable = true)
 |-- direction_id: string (nullable = true)
 |-- stop_id: string (nullable = true)
```

```
|-- stop_name: string (nullable = true)
|-- headsign: string (nullable = true)
|-- vehicle_id: string (nullable = true)
|-- driver_id: string (nullable = true)
|-- gtfs_stop_seq: string (nullable = true)
|-- start_time: string (nullable = true)
|-- sched_adherence_secs: string (nullable = true)
|-- scheduled_date: string (nullable = true)
|-- scheduled_time: string (nullable = true)
|-- actual_date: string (nullable = true)
|-- actual_time: string (nullable = true)
|-- is_arrival: string (nullable = true): string (nullable = true)
|-- direction_id: string (nullable = true)
|-- stop_id: string (nullable = true)
|-- stop_name: string (nullable = true)
|-- headsign: string (nullable = true)
|-- vehicle_id: string (nullable = true)
|-- driver_id: string (nullable = true)
|-- gtfs_stop_seq: string (nullable = true)
|-- start_time: string (nullable = true)
|-- sched_adherence_secs: string (nullable = true)
|-- scheduled_date: string (nullable = true)
|-- scheduled_time: string (nullable = true)
|-- actual_date: string (nullable = true)
|-- actual_time: string (nullable = true)
|-- is_arrival: string (nullable = true)
```

As this is a comprehensive dataset at the stop level, more granular data analysis can be performed. For instance, the schedule adherence can be analyzed at the route, block, and stop level in combination with other parameters like vehicle, direction, date, time, etc. In addition, a list of the operators that consistently drive very slow or very fast or that are early or late most of the time can be identified for counseling or training. With a sophisticated data analysis strategy, on-time performance issues can be addressed, which can help improve the reliability of the transit system.

Lastly, to help visualize on-time performance and as an example on the use of the data, the research team used Apache Zeppelin to present some of the results. Figure 4-64 shows a chart with the on-time performance in seconds (y axis) of MDT Route 11 by time of day (x axis). Charts like this provide information on the performance of the system at different times of the day, which can help planners and schedules visualize on-time performance issues.
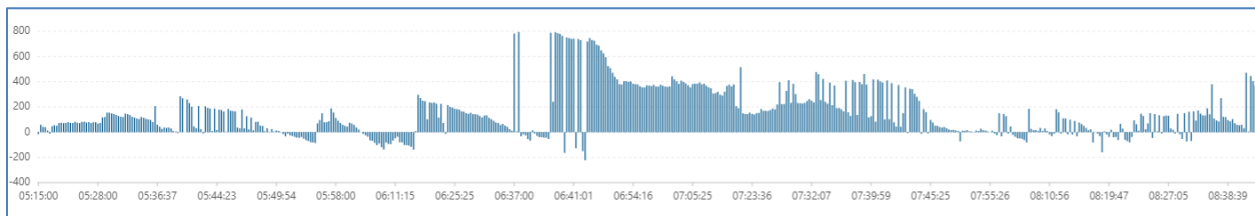
Figure 4-64. Swiftly MDT Route 11 OTP by Time of Day

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4.5.7. Remarks

- The Swiftly platform is very intuitive, which allows users to quickly find the information they want.
- In addition to Miami-Dade Transit, Bay Town Trolley is another agency in Florida that uses the Swiftly platform.
- The Swiftly dashboard provides lots of information that can provide information to management, customer service, operations, and planning and scheduling. It is a user-friendly tool, yet powerful enough for retrieving data and information from the system.
- The Swiftly dashboard presents information mainly as graphs, maps, diagrams, and charts.
- The modules shown in the dashboard depends on the modules purchased by agency or organization. One of the new modules from Swiftly is the Operator Reports that shows OTP performance to help the agencies improve schedule adherence/OTP.
- Data can be downloaded directly from the dashboard or the API. For instance, from the dashboard OTP data can be downloaded to a csv file. The system allows downloads of up to one month of data at the stop level. The API can also be used to download up to one month of stop data.
- Swiftly uses data from the GTFS, AVL, scheduling, and operational systems. However, there are plans to start using data from their APCs.
- The data downloaded using the Swiftly API matches the data in the dashboard charts.
- The download of data is restricted to up to one month of detailed stop data from the dashboard or API.
- To be able to use the Swiftly API, IT support may be needed.

4.6. Hopthru

Hopthru is a relatively new data platform that came into the market in 2019. The platform specializes in analyzing ridership data from automatic passenger counters (APCs) and can provide valuable information for transit service planning. The platform is browser-based and runs on Amazon's AWS cloud platform, which allows for fast data processing and analysis. Hopthru includes two component platforms: Hopthru Cleanse and Hopthru Analyze.

As the name suggests, the purpose of Hopthru Cleanse is to cleanse and prepare the data for use in Hopthru Analyze for analysis and visualization. More specifically, Hopthru Cleanse performs three major tasks: (1) data expansion, which fills in missing data using historical averages; (2) anomaly correction, which identifies and corrects bad data based on a set of rules; and (3) load calculation, which calculates various passenger load related performance indicators. Using Hopthru Cleanse's APIs, passenger count data are transferred automatically from agency to Hopthru Cleanse each night or on a set schedule.

This review focuses on the second component platform, Hopthru Analyze, which provides a user-friendly interface for applying the cleansed data for detailed analysis. For this review, the research team was given two user accounts for read-only access to the Hopthru Analyze platform. The accounts had direct access to the platform's main interface, which allowed analysis at the full system, route, and stop levels.

4.6.1. Main Interface and Full System Level Analysis

As shown in Figure 4-65, the main interface is automatically loaded with the Palm Tran data and displays the agency's system map. The left panel of the main interface allows users to select the level of analysis and the performance indicators. The list of performance indicators includes:

- Average daily boardings
- Total boardings
- Average daily alightings
- Total alightings
- Average daily activity (boardings and alightings)
- Total activity (boardings and alightings)
- Boardings per revenue hour
- Average load
- Maximum load.

The performance results at the full system level are presented on maps and graphic charts for easy visualization. The results are based on a selected performance indicator for a selected date-time period. As shown in Figure 4-66, users can select the available date range, the days of the week, and the time periods of the days. The time periods are customizable by agency. Palm Tran chose to include all day plus four time-of-day periods, i.e., morning peak, midday, afternoon peak, or evening. By default, the platform includes the all-day data for the latest two weeks, up to the day before the current date. Users may also select a second date-time period to compare performances and assess changes. This is further detailed in Section 4.6.4.
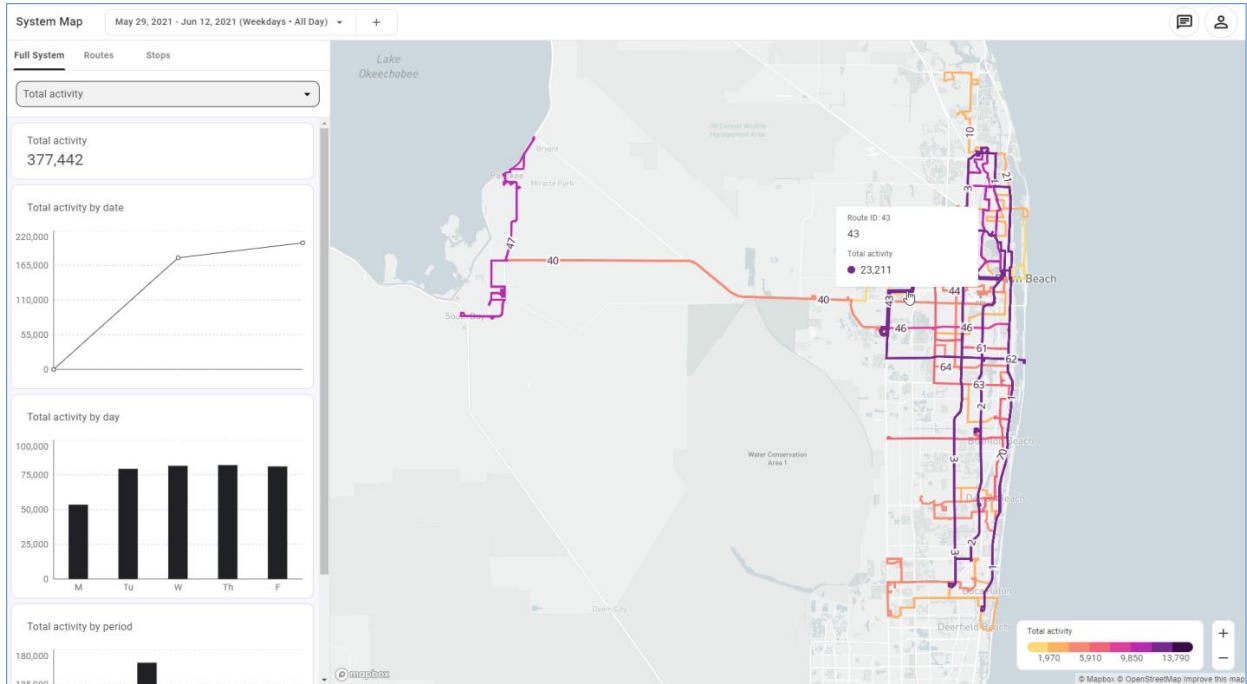
Figure 4-65. Hopthru Display of Palm Tran System Map

Figure 4-66. Hopthru Selection of Date Range and Time Periods

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As shown in Figure 4-65, Hopthru uses Mapbox and OpenStreetMap for its mapping functions. The map interface allows fast and easy panning and zooming in and out. The individual routes are numbered with Route IDs and color-coded based on a selected performance indicator. Users can move the mouse over each route to see route-level information, which includes the Route ID and the selected performance indicator.

The left panel of the main interface also displays the performance results in line and bar charts. These charts can be very useful for visualizing passenger information. For example, using the same date range (05/29/2021 – 06/12/2021) for all day during weekdays, as shown in Figure 4-66, Hopthru charts similar to the ones presented in Figure 4-67 can be obtained. Figure 4-67(a) shows that, except for Monday, which included the Memorial Day on May 31, 2021, the average daily boardings are relatively stable across the weekdays. Figure 4-67(b) shows that the highest average passenger load occurred during the afternoon peak period.

(a) Performance by Day   (b) Performance by Time-of-Day Period
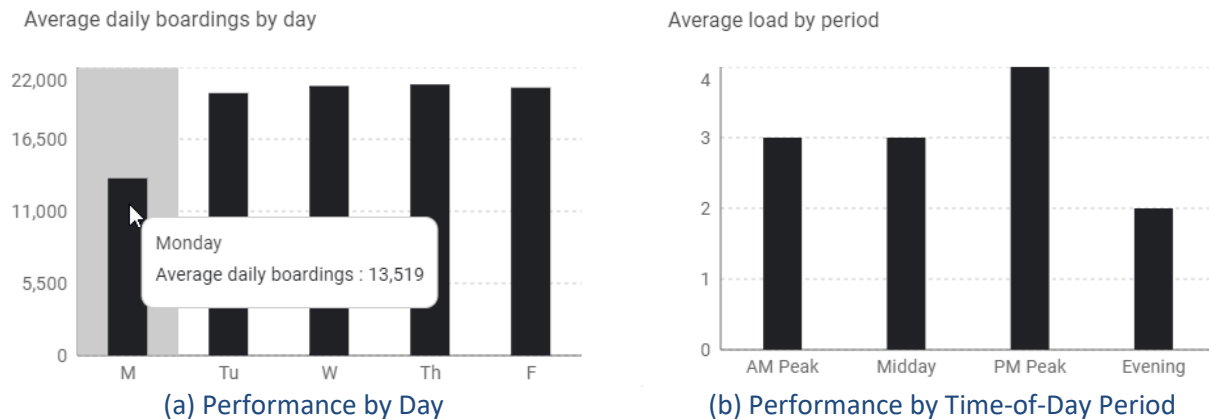
Figure 4-67. Hopthru Charts

4.6.2. Route and Stop Level Analysis

Beyond the agency-wide statistics as described above, users can quickly retrieve and list performance results for individual routes and stops. The list of routes or stops can be sorted by route/stop names or performance values. The list can also be filtered by one or more query conditions. More specifically, the routes can be filtered by conditions based on the nine performance indicators aforementioned. For example, Figure 4-68 lists the routes that had a maximum load of greater than 20. The information can help agencies identify routes that need more vehicles for social distancing. Multiple filters can be defined for more complex queries.

The stops, on the other hand, can be filtered by not only conditions based on the performance indicators, but also a variety of other data elements, including stop inventory (e.g., presence of benches and shelters; whether it is on near side, middle block, or far side; whether it is ADA-compliant; etc.); roadway type (e.g., whether stop is on local road, county road, or limited access road); and cities, townships, and places (e.g., Boca Raton, Jupiter, Mangonia Park, etc.). As an example, Figure 4-69 shows the stops that had more than 50 average daily boardings, but did not have any benches and shelters. Such information can help agency identify and prioritize stop locations for bus stop facility improvements.
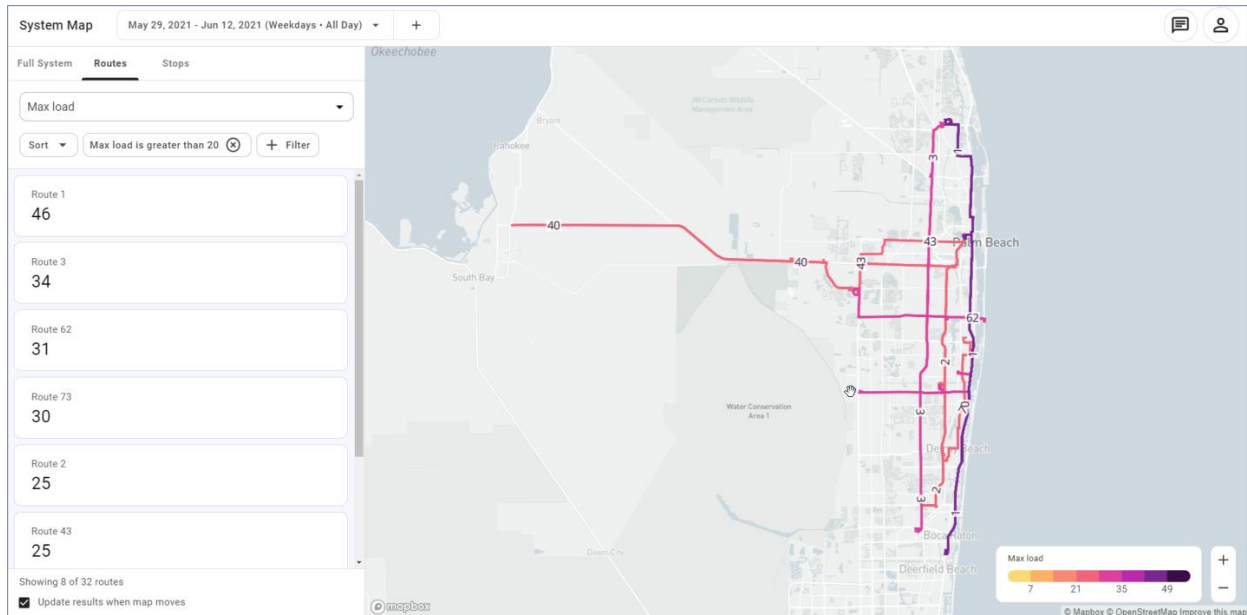
Figure 4-68. Hopthru Use of Route Filter to Identify Routes for Improvements
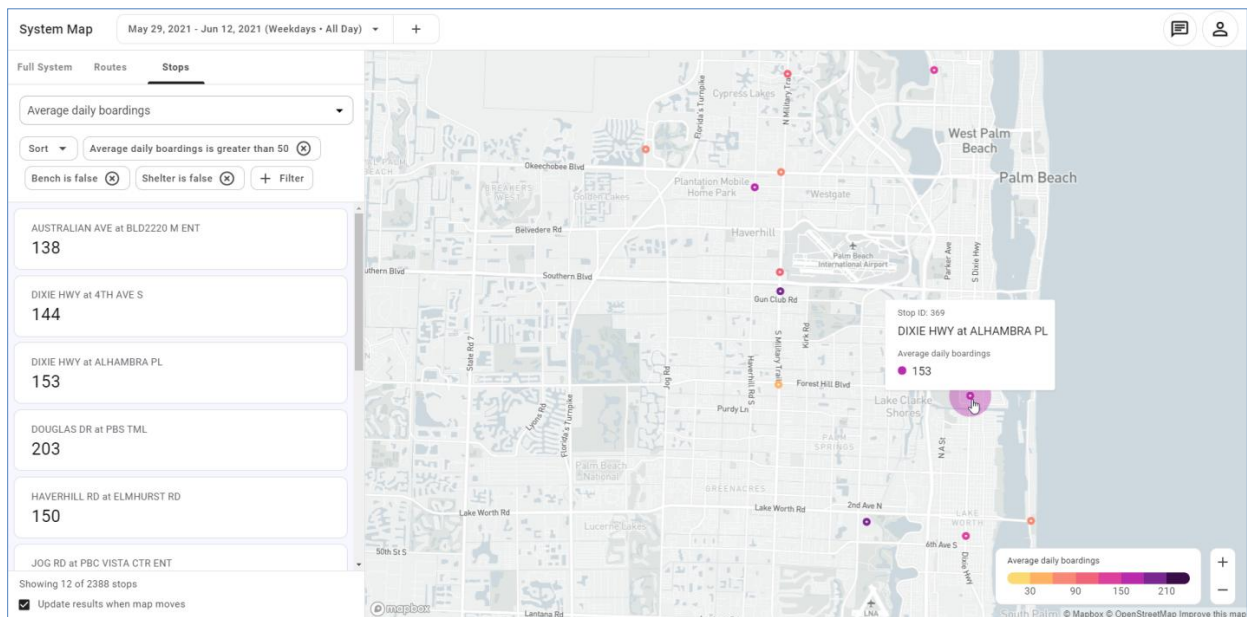
Figure 4-69. Hopthru Use of Stop Filters to Identify Stops for Improvements

4.6.3. Individual Route, Route Segment, and Stop Level Detailed Analysis

After particular routes or stops are identified using filters, users can further drill down to individual routes, route segments, or stops of interest for more detailed analysis. Users can select a particular route to quickly obtain information on boardings, alightings, activity, load, and maximum load. Figure 4-70 displays the total activity data for Route 44. The left panel summarizes the route-level data by charts and the map shows the route layout and the associated stops which are also color-coded based on the level of total activity. User can further

click on a stop to obtain detailed stop activity information. Figure 4-71 shows the stop activity and attribute information for Stop ID 4019. In this case, the charts on the left panel provide stop-level activity information by day and time period. For stops that serve multiple routes, user may choose to obtain data for all routes or a specific route. Figure 4-72 shows route segments color-coded with different levels of maximum load. They can help to quickly identify crowded segments. Users can get the individual route segment information by moving the mouse over the route segments.
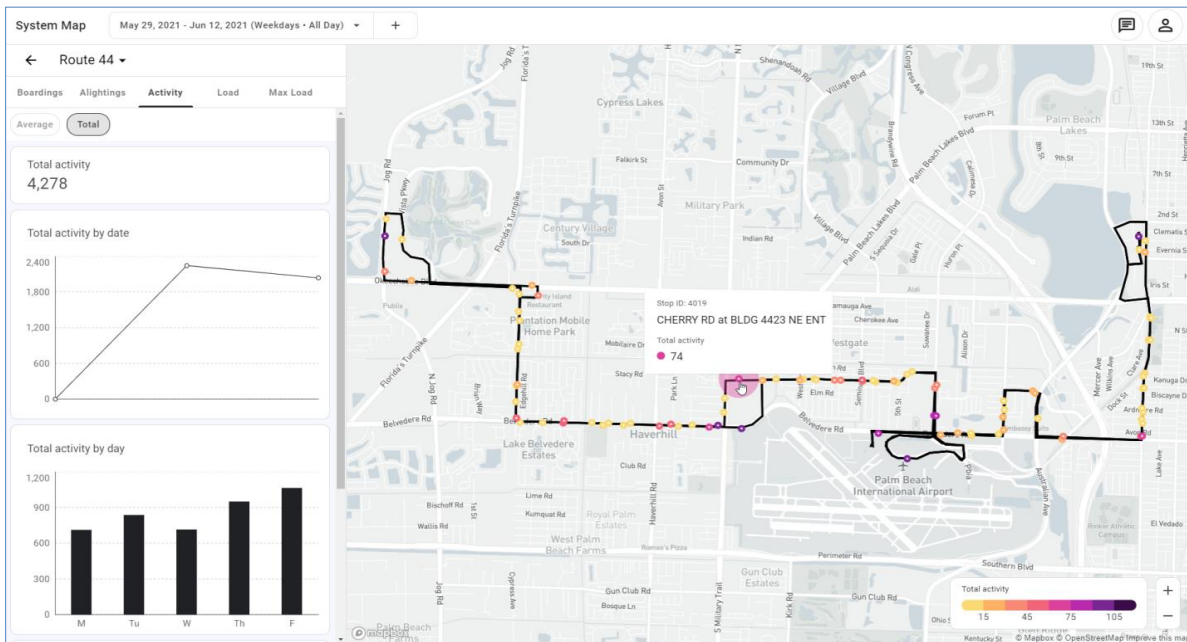
Figure 4-70. Hopthru Individual Route Detailed Analysis
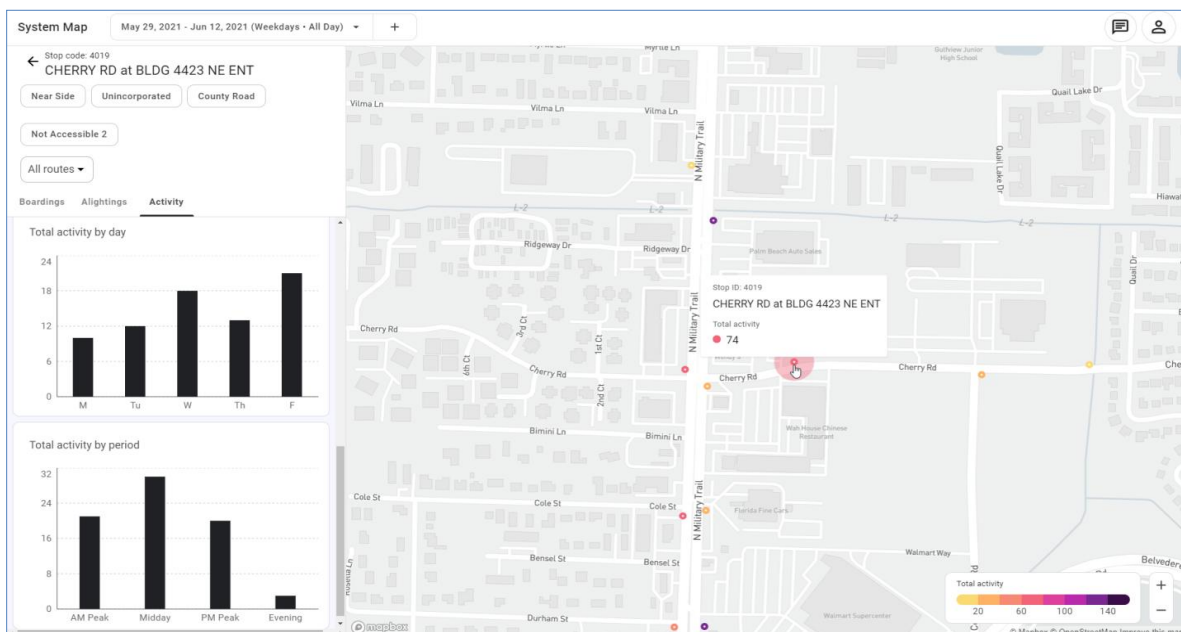
Figure 4-71. Hopthru Individual Stop Detailed Analysis
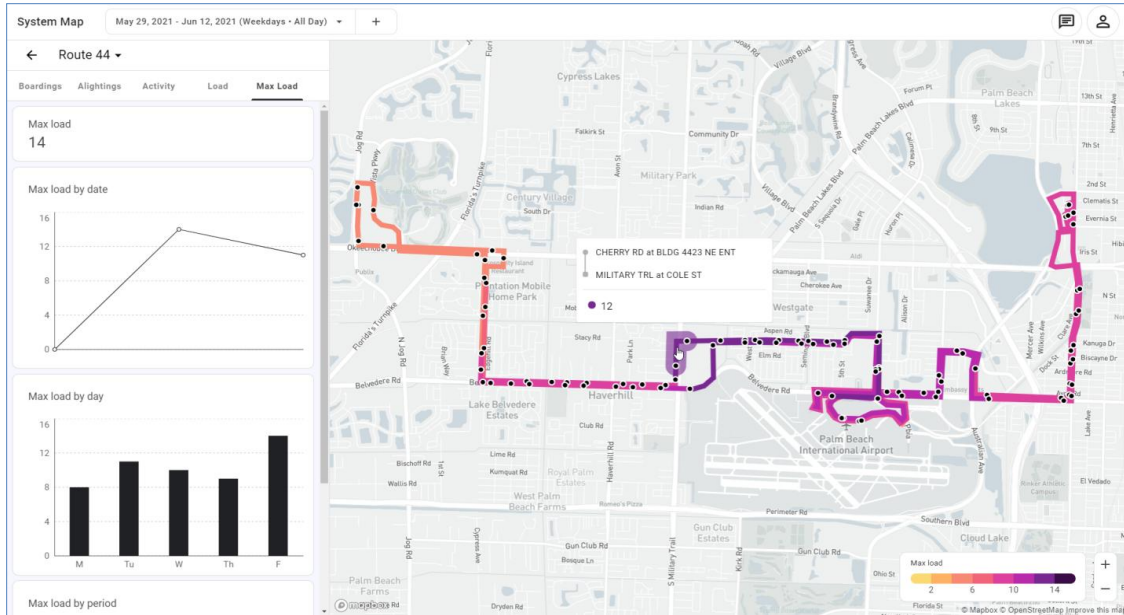
Figure 4-72. Hopthru Individual Route Segment Detailed Analysis

4.6.4. Comparative Analysis

Hopthru allows users to select two data date-time ranges to quickly see the performance changes. This can be very useful for transit service planners to assess the ridership changes due to normal seasonality, route or system changes, or special events such as COVID-19. For example, Figure 4-73 shows that the total activity during the two-week period (05/29/2021 – 06/12/2021) increased by 17.44%, compared to a two-week period in November 2020, when COVID-19 was still in full swing.
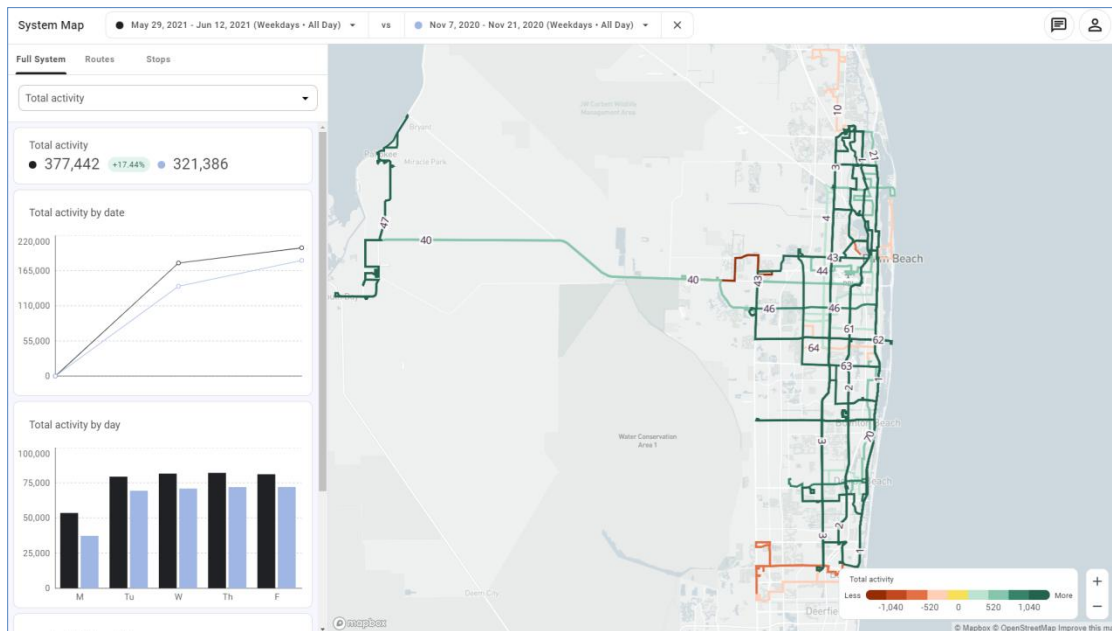
Figure 4-73. Hopthru Comparative Analysis at Full System Level

Figure 4-74 shows a similar comparative analysis at the route level. It shows that the maximum loads for Route 3 increased by 17.24% between the two periods. The same figure also shows an increase of 17.39% in maximum load for a route segment. Figure 4-75 shows an example that further drilled down to the stop level. It shows that the total boardings at that stop increased from 33 to 62, or an 87.88% increase.
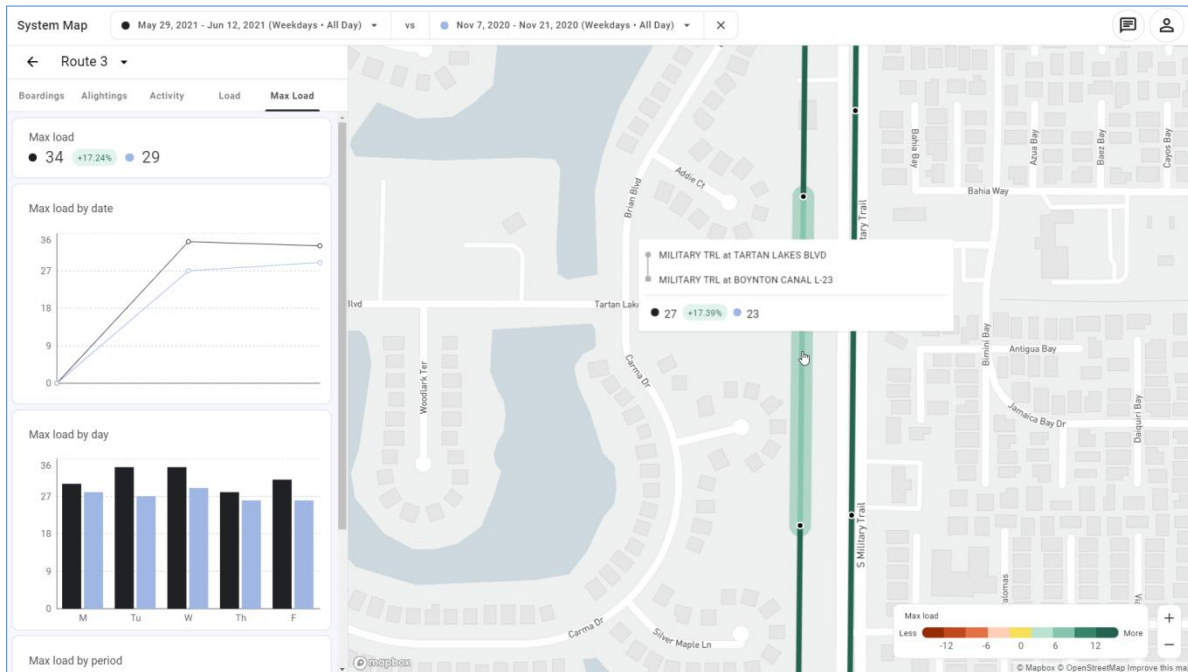
Figure 4-74. Hopthru Comparative Analysis at Route Level
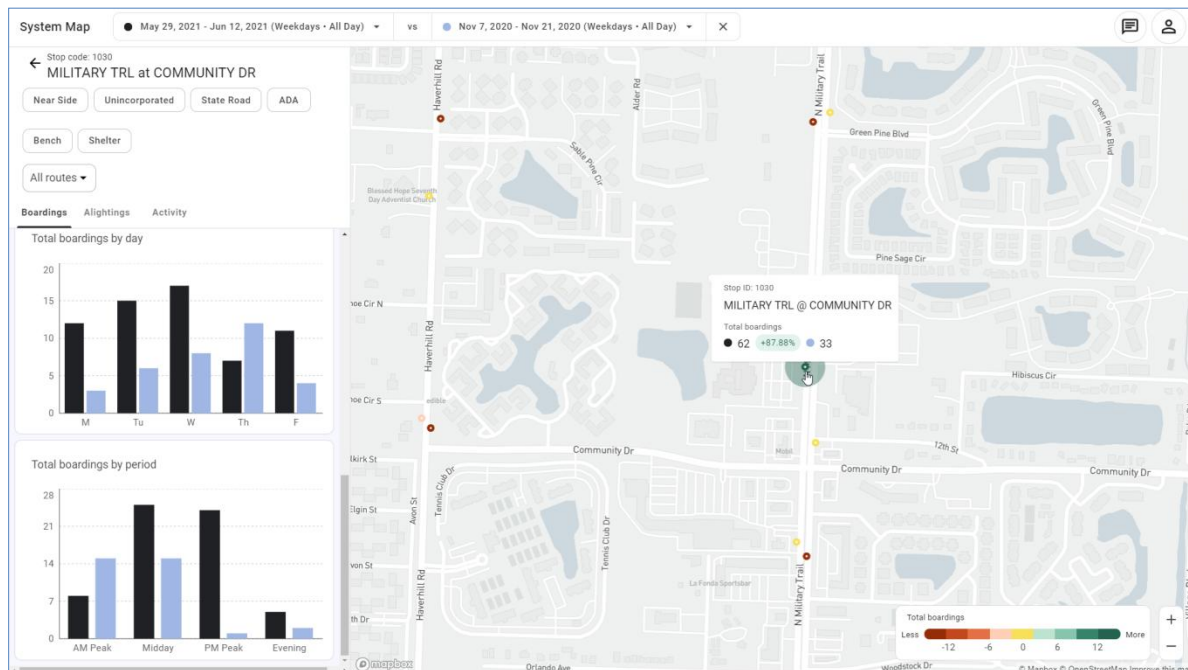
Figure 4-75. Hopthru Comparative Analysis at Stop Level

4.6.5. User Support

Hopthru provides two online user support options on its platform. As shown in Figure 4-76(a), users can send a message or book a time for a Zoom meeting from the platform. Figure 4-76(b) shows that users can easily reserve a meeting slot with Hopthru and a Zoom invite is automatically sent to the user's calendar.
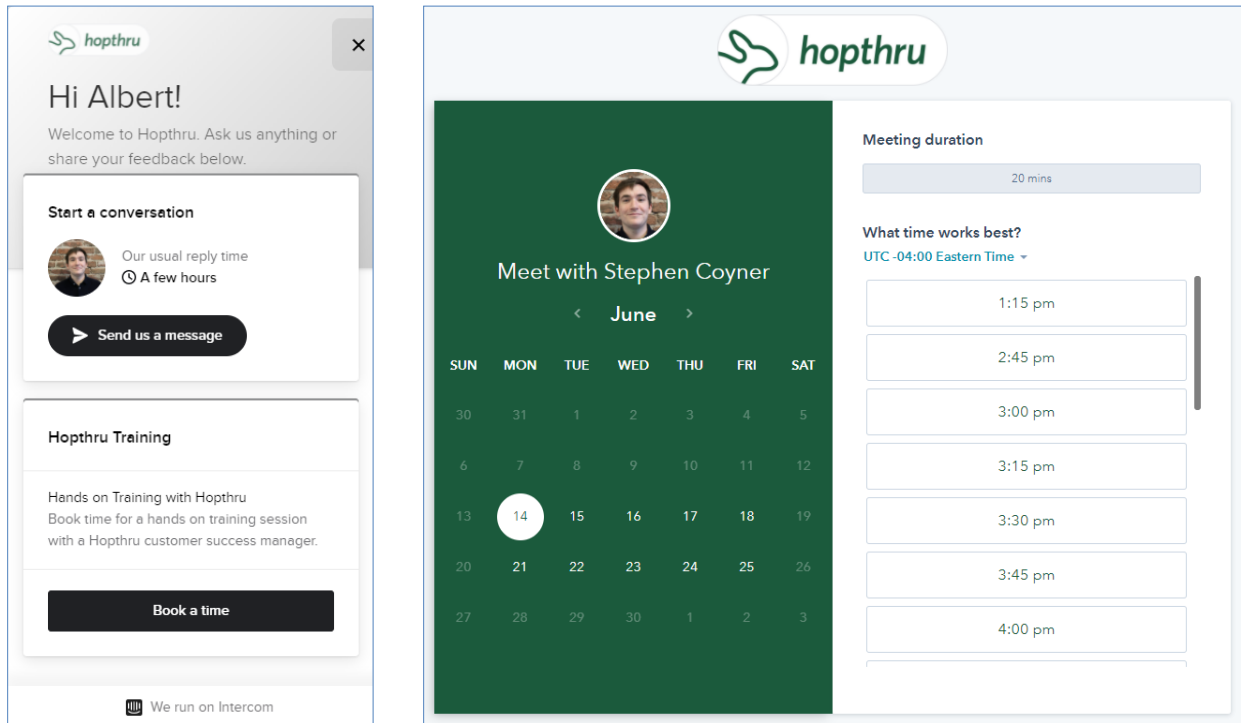
(a) Support Options   (b) Booking a Zoom Meeting

Figure 4-76. Hopthru User Support Options

4.6.6. Remarks

- This review was limited to features available in a read-only version provided by Hopthru to the research team.
- The platform allows quick access to ridership data at the full system, route, and stop level. When combined with other data such as stop inventory, the platform can provide useful information for transit service planning and facility management.
- The ability of the platform to quickly calculate differences between two time periods allows transit planners to quickly perform before-after analysis.
- Since the platform is relatively new in the market, new features are expected to continue to be added in the near future.
- At the time of this review, Hopthru was near a new release that will include trip level analysis based on individual trips, and allow filtering by route direction and pattern.

4.7. Teralytics

Like Swiftly and Hopthru, Teralytics is mainly a data platform that provides helpful information for transit service planning. In this case, Teralytics provides travel mobility information, including trip origins, trip destinations, trip travel times, or travel patterns. The information can help transit planners learn about where and when people make their trips, and assess the current service provided and consider making service improvements based on people's travel patterns. Teralytics offers the following four browser- and cloud-based modules:

- Matrix: It allows users to see how people are travelling within a chosen region throughout the day, weekdays to weekends, season to season, year on year.
- Matrix Trends: It extends Matrix's capabilities to allow users to analyze key mobility trends over time.
- Matrix Custom: It allows users to see how people travel within an area based on select parameters (e.g., geographic reach and timeframe) and overlaid own data.
- Pulse: It provides insights into current trip distribution across a transportation network to help users run their services and act on anomalies as they occur.

For this review, Teralytics provided the research team with access to a preview version of its main module, Matrix. The preview data covers those from the Miami, Fort Lauderdale, and West Palm Beach metropolitan areas, collectively known as the South Florida region.

4.7.1. Data Sources

Unlike Swiftly and Hopthru, which make use of the AVL and APC data that are well-known to the transit industry, Teralytics' method of acquiring its travel mobility data is unique, i.e., it sources its data using mobile device signals sent and received between mobile devices and cell towers. As a mobile device moves in the vicinity of a cell tower, the strength of the signal it receives varies. In general, the signal is stronger when a mobile device is closer to a cell tower, and weaker when they are further apart. Using its analytics engine and machine learning capabilities, Teralytics mines the mobile signal data to identify and estimate person trips, including their locations, times, movements, and patterns. As mobile devices are nearly always on and continuously interact with cell towers, they produce a steady stream of location data. This allows Teralytics to capture large and continuous data samples that can provide a good representation of the travel activities of the population. Teralytics emphasized that all of its data are anonymized to protect customer privacy.

According to Teralytics, the customer bases from which their mobile signal data are harvested account for up to 30% of the regional population. The harvested data samples are then factored using census demographic data to estimate trips that represent those from 100% of the population. Consequently, the trip data are also summarized and presented based on Census geographic areas. The areas may be grouped, and their data aggregated, on the fly to meet specific analysis needs.

Teralytics believes its data are superior to similar data acquired through other methods, such as those from traditional surveys, which it believes taking too long and costing too much to deliver; or from GPS-enabled devices, from which data are intermittent and often measured only when users open a relevant app on their devices. Table 4-2 shows Teralytics' comparison of its mobility data with other data sources in terms of their sample sizes, stability, quality and accuracy, spatial resolution, etc.

Table 4-2. Comparison of Teralytics Mobility Data with Other Data Sources

	⅃ᐭ TERALYTICS	Location Based Services from Apps	In-Vehicle Navigation GPS	Comments
Data Source	Teralytics has the only technology to unlock global mobility insights from telecom network data. Mobile network data is the only inclusive data source (across all demographics, modes of transportation, regions).	Requires users to install apps and use them regularly to collect enough signals to model mobility.	In vehicle navigation solutions that work with data aggregators. Limited availability, scale and mode of transport (car).	App install requirement in competitive market creates significant impediment to scale. Often dramatic geographic differences. Teralytics offers consistent mobility insights across the globe.
Sample Size and Stability	Large enough to represent whole population in the country. Top tier telecoms operators maintain a stable subscriber base making the data source consistent and reliable.	Small and fluctuating sample size dependent on Daily Active Users DAU)/Monthly Active Users (MAU).	Very small sample size on single mode of transit.	Accurate extrapolation to nationwide insights requires a stable sample of at least 15% of population.
Data Quality and Accuracy	Representative across all demographics, modes of transport across the entire country.w	Dependent on Daily Active Users (DAU)/Monthly Active Users (MAU)	High quality for traffic speed measurement. Non-existent for any other mode of transport.	Accuracy and reliability of app data depends upon DAU/MAU metrics vs. inherently always-on telco data.
Platform Risks	Long-term strategic partnerships with global top tier telecom operators. Any country has 3-4 telecoms providers with large subscriber bases. GDPR compliant & ISO 27001 certified.	Significant risk of Apple & Android further restricting use of location services. Data privacy issues and leaks in a crowded ad-tech market lead to tighter regulation.	User opt-in only. Google and Waze dominate the market.	Data collection depends on platform operator T&Cs (which are changed regularly, e.g. privacy settings). App based location data is exposed to changing T&Cs by the Google, Apple and the app publishers.
Bias	Very low and easy to correct for, as very large and representative sample to begin with.	Very high towards specific user groups of apps and frequency of use (e.g. weather app is used usually once a day in the morning, certain apps only used by specific demographic).	Only singular mode of transportation, often geographically biased.	Only representing mobility needs of digital natives and specific app users' results in inaccurate insight into population-level mobility. Very dangerous when making infrastructure decisions. Only telecom data is inclusive data.
Data Depth	Captures both regular / commuting and occasional trips due to long term location tracking, mode of transport, home and work.	Limited depth due to short term and infrequent use of apps.	Main use case is traffic speed detection. Very few other.	Insight into use cases only when app is opened and used creates bias within data set.
Spatial Resolution	Cell tower density tends to be proportionate to transport network density.	Street level, whenever available.	Street level on highways and streets for car traffic.	Most mobility use cases require a comprehensive view across multiple geographies and modes of transport offered by Teralytics.

4.7.2. Matrix Main Interface

Teralytics' Matrix module includes a highly interactive and fast interface that allows users to select, visualize, and analyze trip data. Figure 4-77 shows the full interface which includes a main menu on top, a left panel for displaying filters and charts, and a right panel for map visualization. The main menu allows users to toggle the left panel and to select the map display style, the map type, the map layers, and the method for map area selection. Based on these selections, the results from the selection are instantly updated on the map and three bar charts located at the bottom portion of the left panel.
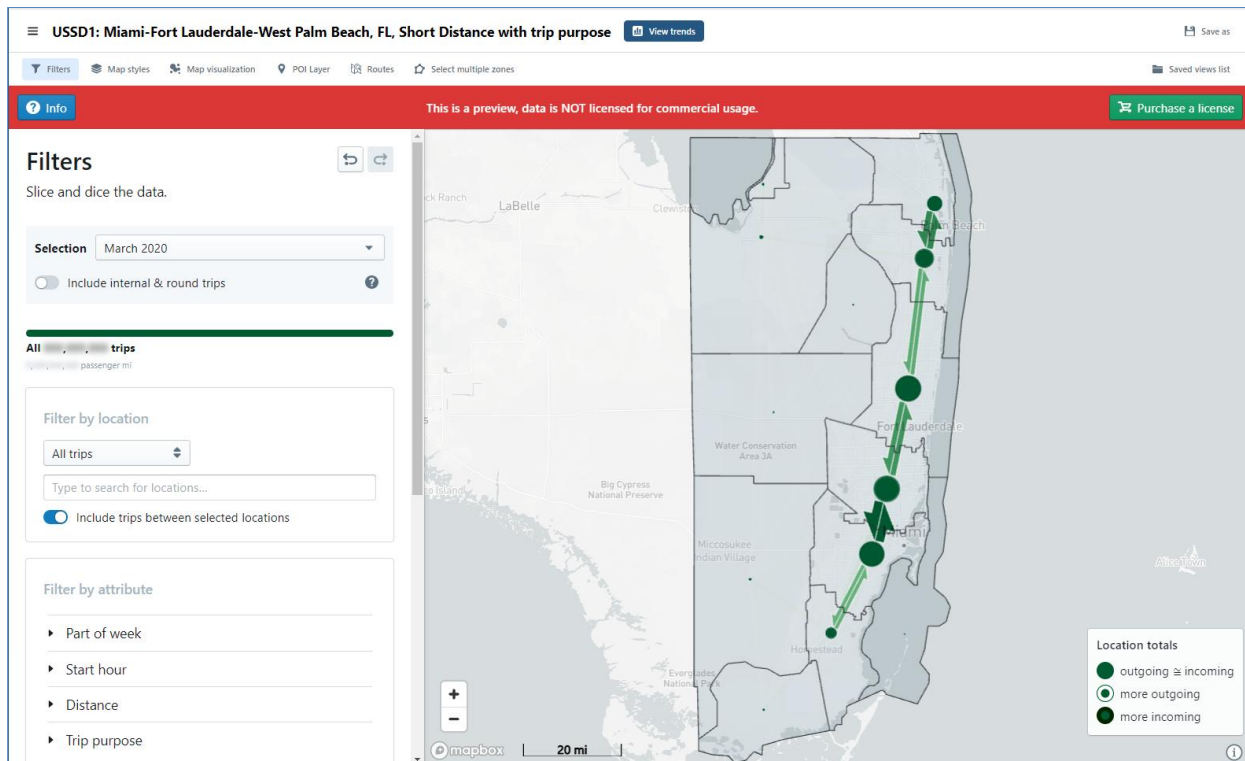
Figure 4-77. Teralytics Matrix Display of Entire Data Region

4.7.3. Map Features

Teralytics uses Mapbox and OpenStreetMap to build its mapping functions. Figure 4-77 shows the South Florida region that the research team was provided access to. At this whole region view, the map displays only the major zones in the region. As the map is zoomed in, it automatically displays smaller zones. Figure 4-78 shows a map that is zoomed to an intermediate level which provides finer data based on smaller zones. The left panel in this figure displays three bar charts (only two are fully visible) which list the top 10 trip flows, origins, or destinations, respectively. This information can be useful to transit planners when analyzing the flow of key origins and destinations. Figure 4-79 shows that users can further mouse over the bars on a chart to highlight the detailed trip flows of a specific zone. Note that because it is a preview version of Matrix, all trip numbers on the screen are blurred out by the platform.
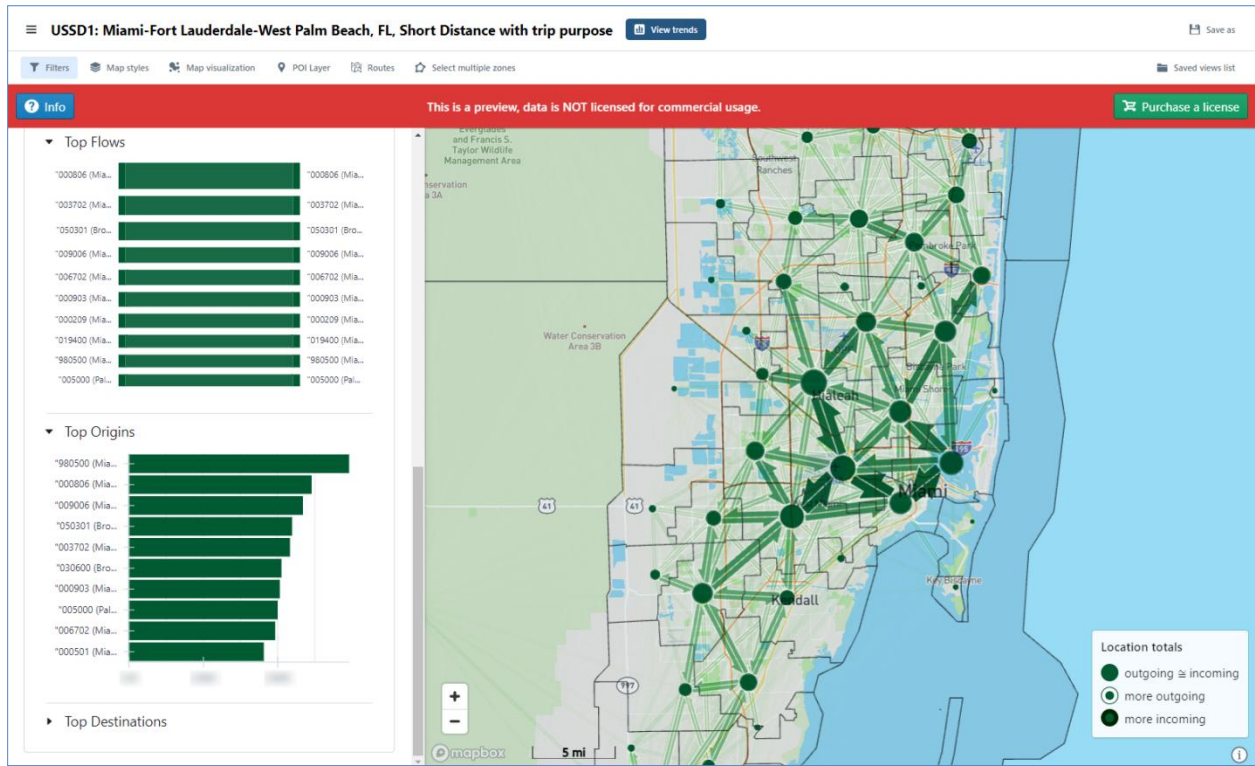
Figure 4-78. Teralytics Matrix Display of Intermediate Level Zones and Top Zone Charts
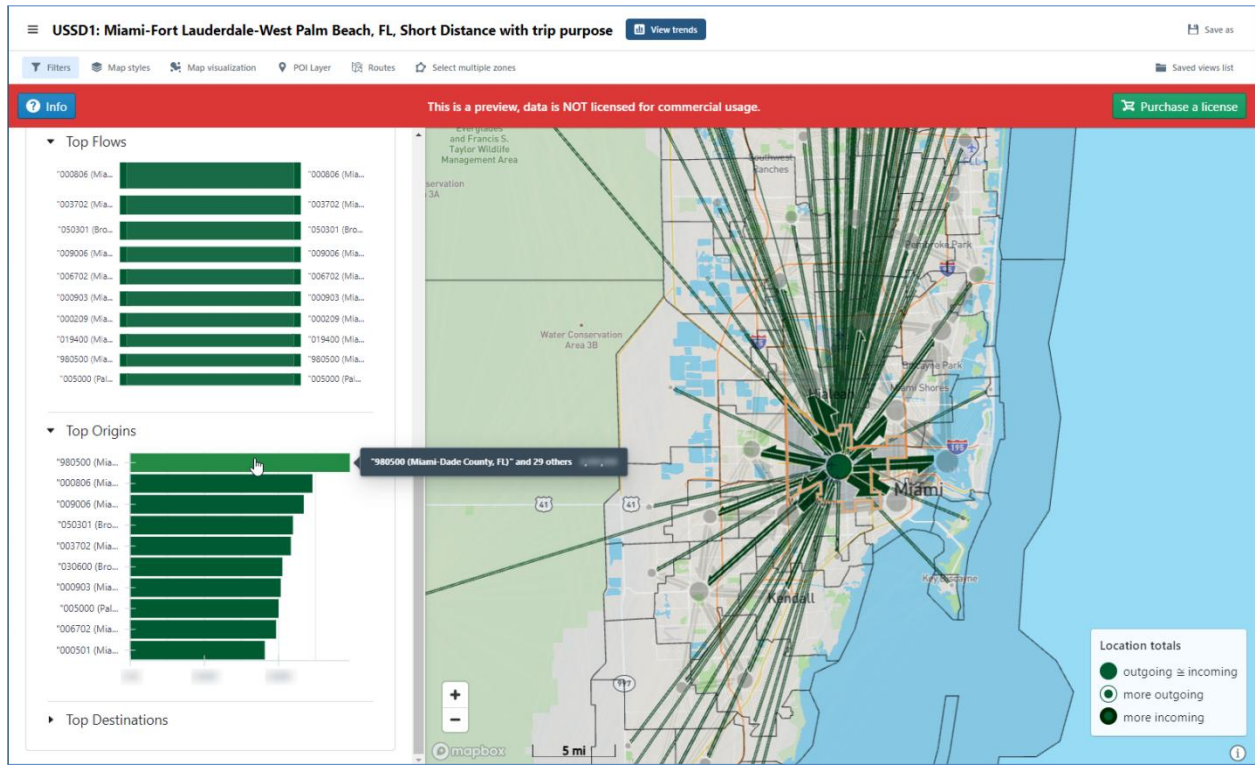
Figure 4-79. Teralytics Matrix Display of Detailed Trip Flows of a Specific Zone

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Figure 4-80 shows an example in which the map is further zoomed in to see the trip flows based on even smaller zones. The same figure also shows that the left panel can be toggled off to give the map a larger view. The same figure further shows a menu drop-down that allows users to select from three different map backgrounds: Light, Streets, and Bright. The map in Figure 4-80 is displayed using the Bright map background. For comparison, the map in Figure 4-77 is displayed with the Light background and the maps in Figures 4-78 and 4-79 are displayed with the Streets background.
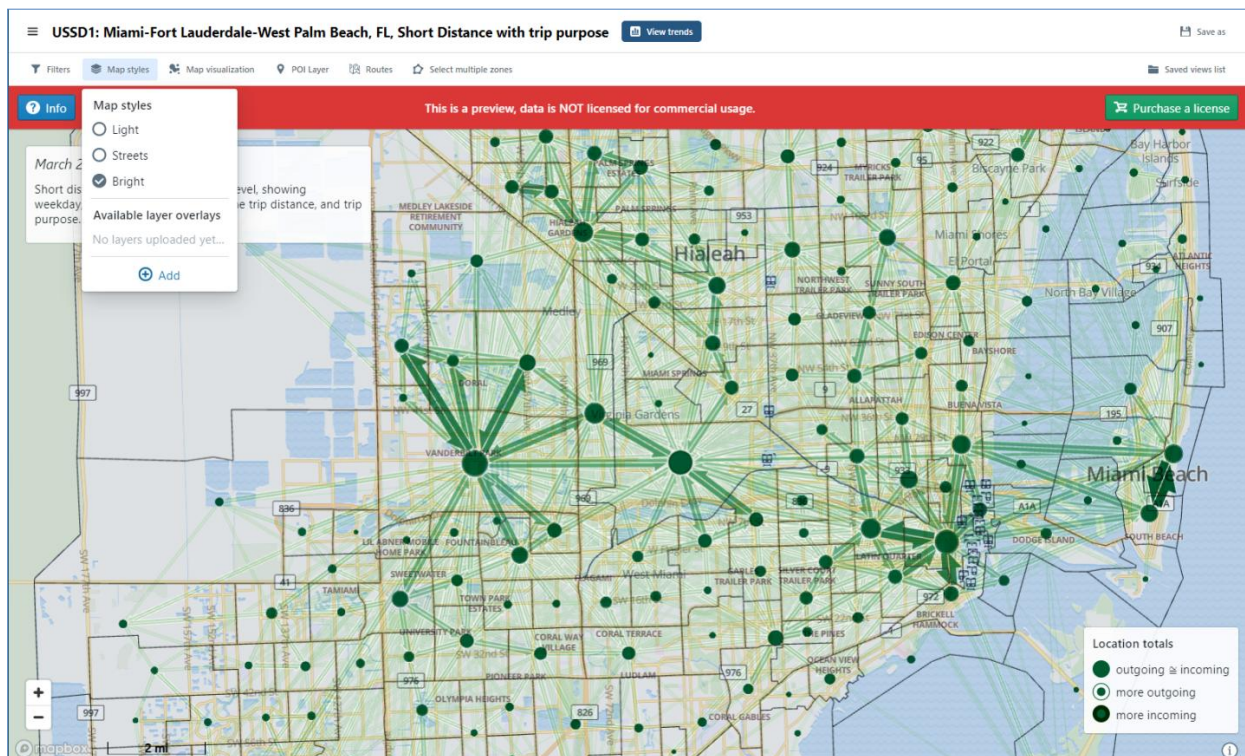
Figure 4-80. Teralytics Matrix Display of Detailed Zone Level in Full Map View

Teralytcis assumes all trips start and end at zone centroids. As such, the trips associated with each zone are represented by a single node in the zone. The larger the node, the more trips a zone has. As shown in the map legend, three different node shapes are used to indicate if a zone has more incoming trips, more outgoing trips, or about the same. The trips made between any two zones are represented by directional arrows, with their widths representing the trip volume level – the higher the number of trips, the wider the arrow. In addition to flow maps, the interface also allows users to plot choropleth maps (thematic maps) which represent different trip levels using color shades. Figure 4-81 shows such an example.

In addition to trip data, the interface also allow users to upload additional local data layers in GeoJSON file format. Users can enter the name of the layer, write a description, and assign a particular color the layer. Figure 4-81 shows sample train routes and train stations that were preloaded in the platform. These additional local data can provide reference information for transit service planning, e.g., if a busy zone is provided transit access.
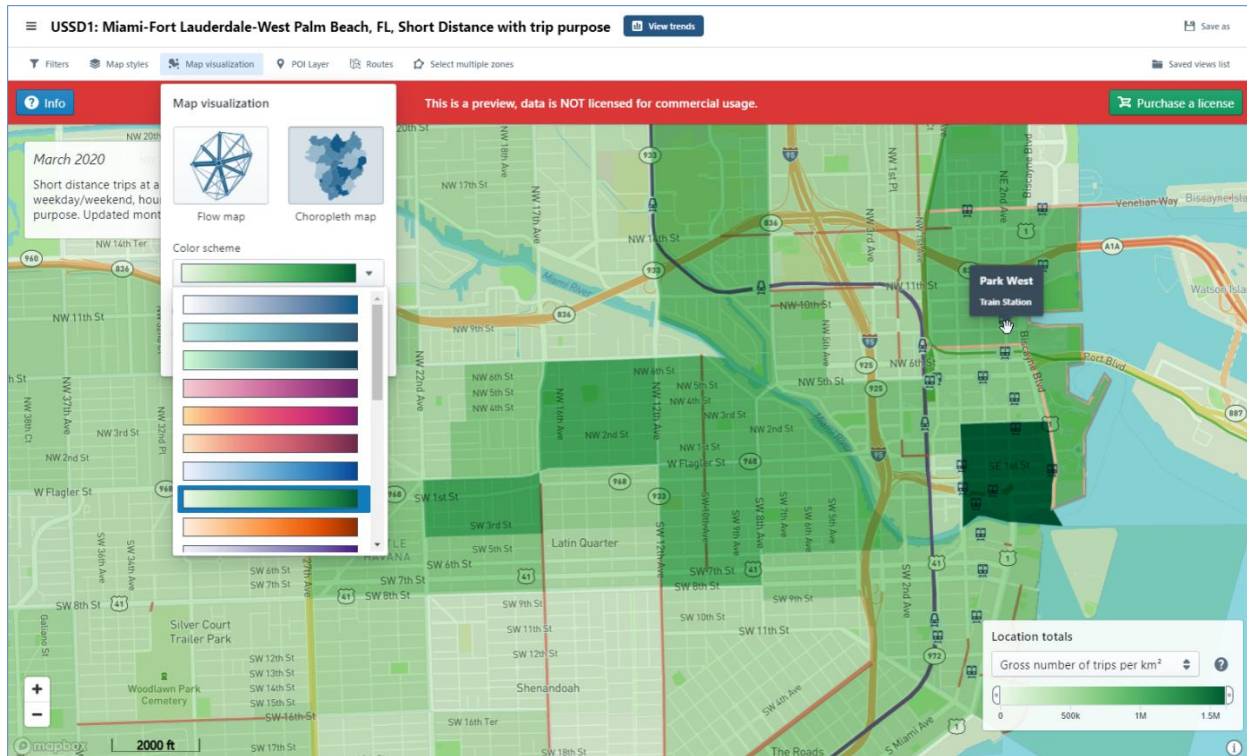
Figure 4-81. Teralytics Matrix Display of a Choropleth Map

4.7.4. Filter Features

The filters in Matrix allow users to select the month and year of trips, the trip location, and the trip type such as all trips, trips by direction, trip between two zones, or trips from one zone to another. Users can optionally select whether to include internal trips, which by definition start and end in the same zone. The trips can also be selected by weekday or weekend as well as by time of day, distance traveled, or trip purpose. The three trip purposes included are to-home, to-work, to-other. Teralytics indicated that it was able to differentiate the trip purposes through various inferences it uses. For example, work trips are identified from those that regularly visited the same employment locations.

As an example to show how the filters can be used to select the target trips, Figure 4-82 shows the incoming, "to-other" trips, made during weekends from 4:00 pm to 7:00 pm in March, 2020, to the Miami International Airport (MIA) zone from within a 10-mile surrounding zones. It can be seen from the figure that, as expected, the main incoming trips to the airport came from three surrounding hotel areas located on the south and north sides of the airport, a warehouse zone to the west, two Miami Beach zones, and from downtown Miami. Using the same trip date and time selections, Figure 4-83 shows an example that is based on all trips among three selected zones, including the MIA zone and the two aforementioned Miami Beach zones. Figure 4-84 shows another capability of Matrix, which allows multiple zones to be grouped and the data aggregated. In this case, the two Miami Beach zones are grouped to form a single zone. One special note is that all views created can be saved and retrieved for future direct access.

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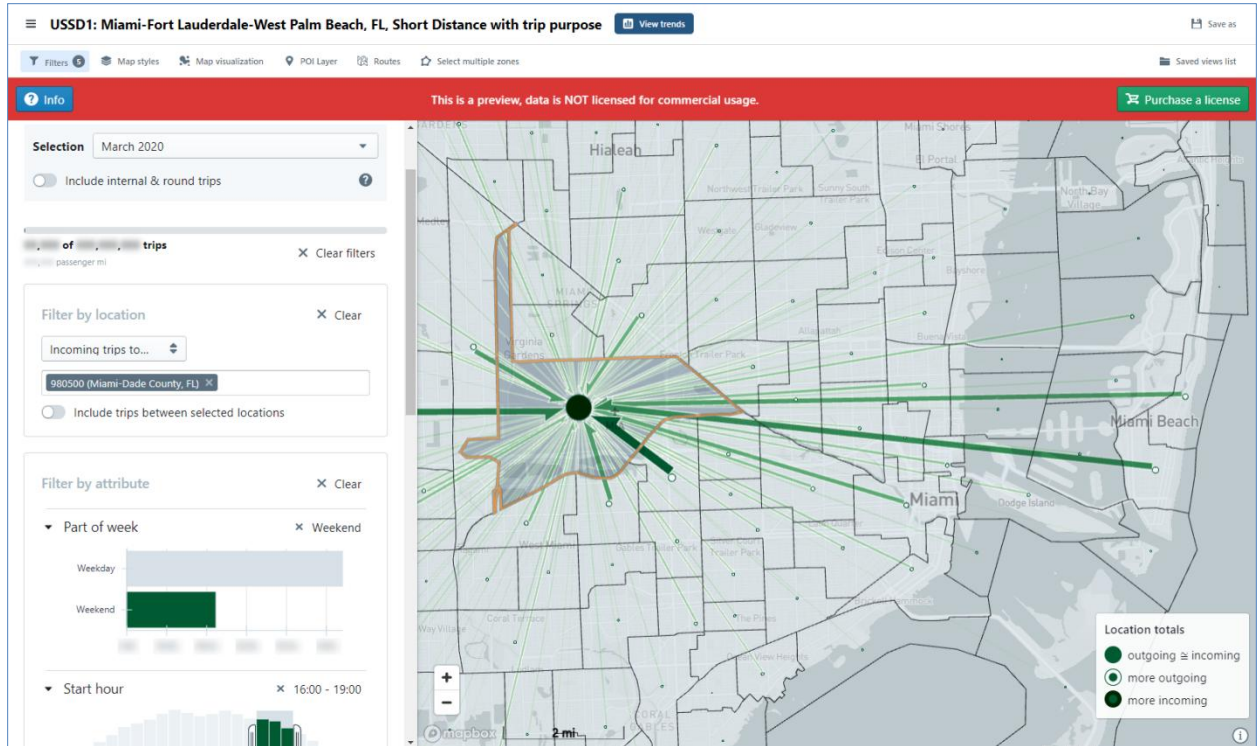
Figure 4-82. Teralytics Matrix Display of Surrounding Incoming Trips to MIA
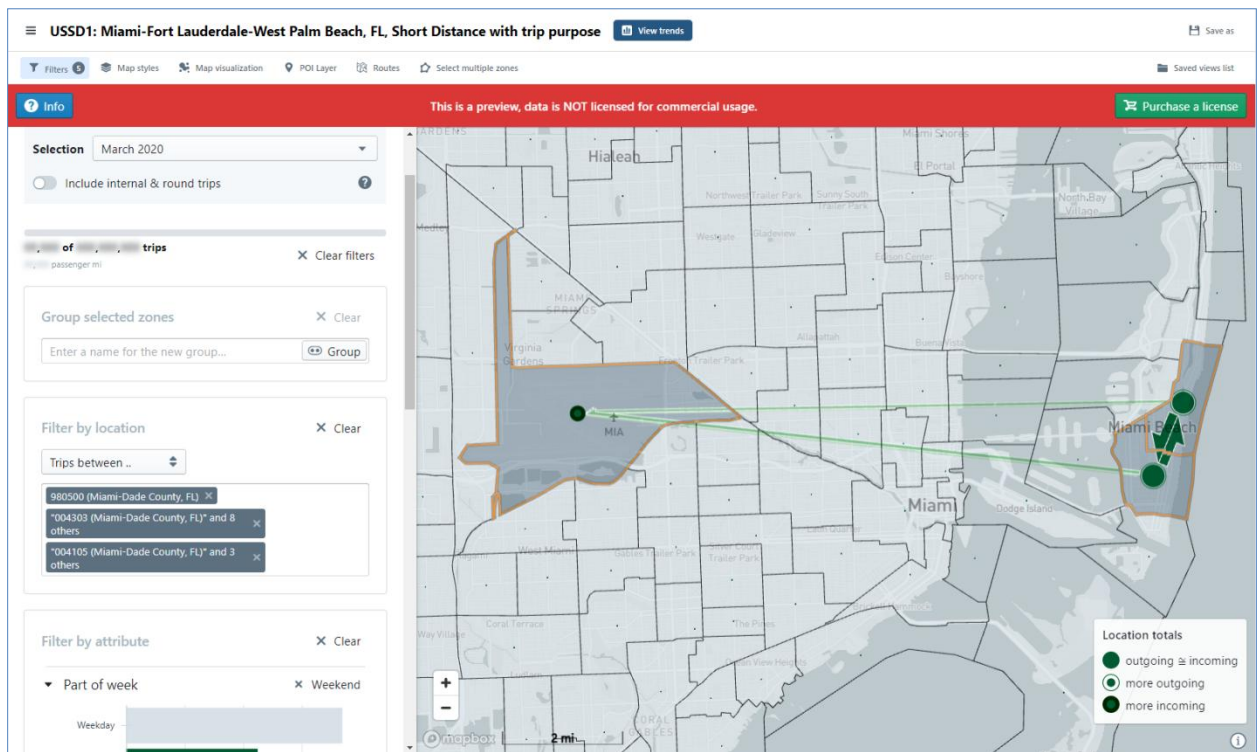
Figure 4-83. Teralytics Matrix Display of All Trips among MIA and Two Miami Beach Zones
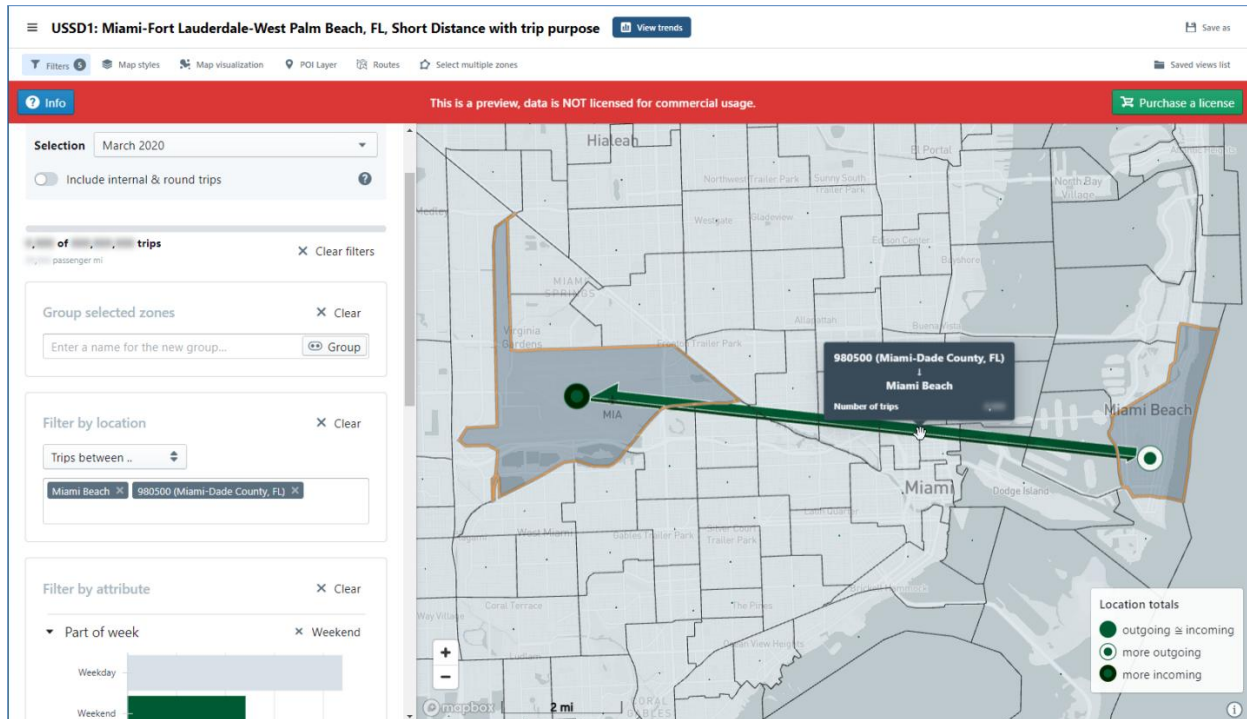
Figure 4-84. Teralytics Matrix Display of Trips between MIA and a Grouped Miami Beach Zone

4.7.5. Remarks

- Unlike the more specialized platforms like Swiftly and Hopthru that use transit data such as AVL, APC, and scheduling, operational, and stop inventory data, the Teralytics platform can be used by other transportation sectors. The general trip data can be used for addressing and improving mobility services such as road transport, transport operators, smart roads, and smart cities.

- Mobility providers can use Matrix to understand people's travel needs that can help them run their operations more efficiently. For instance, they can use the Teralytics Matrix for identifying how their services can best match people's daily journeys and demonstrating where their services can complement public transportation.

- Teralytics' Matrix module is highly interactive and user-friendly.

- Transportation and transit planners can use Teralytics to visualize and analyze the people's travel behavior in their communities.

- Teralytics also offers additional features that were not included in the preview site that they provided to the research team.

- At the teleconference, the Teralytics representative mentioned that they have worked in projects to define the travel by modes based on the calculated speeds from the mobile device data.

CHAPTER 5
IDENTIFICATION AND DEMONSTRATION OF TRANSIT SERVICE PLANNING APPLICATIONS

This chapter describes the efforts to identify and demonstrate four transit service planning applications. The efforts involved three major steps. The research team first researched and identified potential applications that might be of interest to agencies but have either not been included, or only partially, in existing software platforms. As the applications are expected to be data-driven, the next step was to identify the available data sources and acquire the datasets, identify the available data attributes, and extract and prepare the data in the form appropriate for specific applications. The third step was to develop a software platform that integrated all the data from different data sources and demonstrate the applications using the data. The next three sections describe each of these steps in detail.

5.1. Transit Service Planning Applications

As noted, the applications to be demonstrated should be of potential interest to agencies and not having been included, or only partially so, in existing software platforms. The later is confirmed through the evaluation of existing software platforms described in the previous chapter. As the data needed to support the applications must be available, the search for potential applications that are also feasible must consider the data availability. Consequently, the following four potential applications were identified for this project:

1. *Prioritizing Bus Stops for Improvements*: One way for transit agencies to improve service for its customers is to improve bus stop amenities such as benches, shelters, and lighting. Agencies may also aim to improve bus stops specifically for seniors and persons with disabilities by further adding ADA-compliant features including sidewalks, loading pads, and curb-cuts. However, as agencies typically have only a limited budget to invest in such improvements, it is important that they target the most desirable bus stops for improvements. This application demonstrates the use of a combination of bus stop inventory, ridership, and demographic data to allow users to quickly identify desired bus stops for bus stop amenity and ADA improvements. It is noted that the Hopthru platform implemented a similar application, which allows users to query stops based on bus stop ridership and amenities inventory. This application extended the application to include demographic data.

2. *Balancing Bus Stops*: Bus stops tend to be added over time to accommodate different requests, thus making them increasingly close to each other. Closely spaced bus stops not only reduce the bus travel speed, they can eventually impact the ridership, as taking long travel times to reach destinations is a primary reason people do not use transit. Balancing or consolidating bus stops could reduce bus travel time and increase ridership. Figure 5-1 shows a schematic diagram illustrating the desired criteria for identifying bus stops for balancing (Miatkowski and Hovenkotter, 2019). As the figure illustrates, the set of criteria for considering bus stops for balancing include if a bus stop serves major points of interest, is a transfer point, serves significant seniors and persons with disabilities, is highly utilized, is close to another bus stop, lacks accessibility for riders with mobility challenges, and

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experiences pedestrian safety issues. This application makes use of a variety of data sources to allow agencies to consider each of these criteria to help identify potential bus stops for balancing.
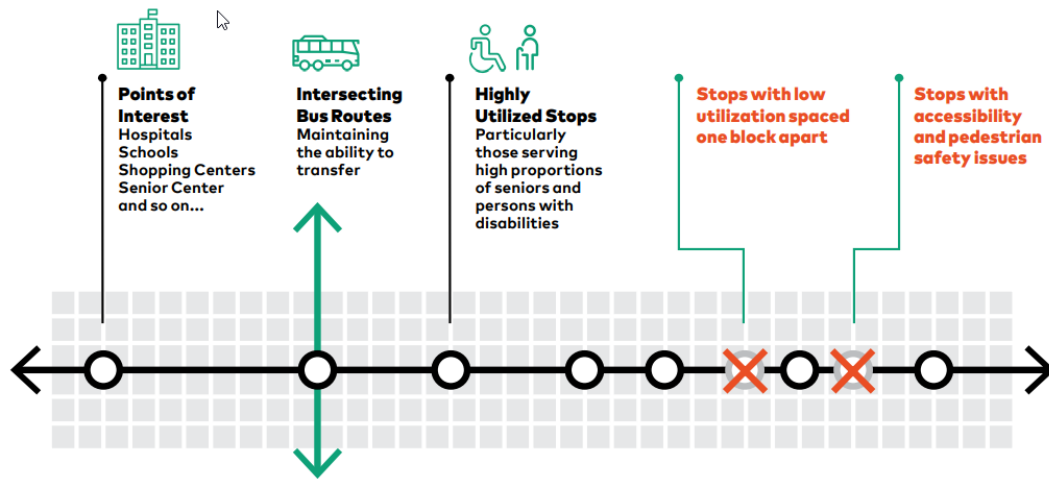
Figure 5-1. Criteria for Identifying Bus Stops for Balancing

3. *Identifying Transit Supportive Areas*: As the name implies, transit supportive areas (TSAs) are areas that are determined as having a good potential for significant transit ridership. The second edition (also the first edition) of the *Transit Capacity and Quality of Service Manual* (*TCQSM*) (Kittelson & Associates, et al., 2003) describes a method to identify TSAs based on household and employee densities. The method defines three levels of transit supportiveness, i.e., low, medium, and high, based on the household and employee densities in an area. An area is classified as one of the three TSA levels if it meets at least one of the two density criteria. This application uses a combination of census and employment data to demonstrate how an agency can quickly identify TSAs and visualize how well the TSAs are being served by existing transit service.

4. *Estimating Transit Service Coverage Level of Service*: As an extension to the TSA application described above, this application further demonstrates a way to quantify how TSAs are being served by existing transit service. This is done by defining the transit level of service (LOS), which is determined based on the percentage of transit supportive areas (TSAs) covered by transit service. Table 5-1 gives the LOS criteria and the corresponding service conditions. In this application, the covered areas are based on access to local bus service where pedestrian connections to transit are available from within 0.25 mile (air distance) of the surrounding area. The TSAs are based on a household density of at least three units per acre or an employment density of at least four jobs per acre. In short, this application extends the previous application to estimate the bus transit service LOS.

Table 5-1. Fixed-Route Transit Service Coverage Level of Service (LOS)

LOS	% TSA Covered	Comments
A	90.0-100.0%	Virtually all major origins & destinations served
B	80.0-89.9%	Most major origins & destinations served
C	70.0-79.9%	About ¾ of higher-density areas served
D	60.0-69.9%	About two-thirds of higher-density areas served
E	50.0-59.9%	At least ½ of the higher-density areas served
F	<50.0%	Less than ½ of higher-density areas served

5.2. Data Acquisition and Processing

As stated previously, the identification of potential applications goes hand-in-hand with the data sources available to support specific applications. This section describes the effort to acquire and process the datasets to obtain the target data attributes. For demonstration purposes, the research team selected Palm Tran for its willingness to support this project, its medium system size, as well as its data availability including a bus stop inventory.

After a dataset was acquired, the research team first familiarized with the dataset and identified the data attributes that could be applied to meet specific application needs. While data for some data attributes could be extracted directly, others required special software implementation and use of existing software tools, including ArcMap and Excel, to manipulate the data. The final datasets are organized in three separate GIS layers in the GeoJSON format for bus stop, bus route, and demographic data, respectively. The subsections below document the data attributes included in each of these data layers, their data sources, the special data processing effort taken, and any associated data limitations.

5.2.1. Bus Stop Layer

The bus stop layer is a key point feature class that was created by integrating data from five different data sources.

1. *Bus Stop Inventory*: Palm Tran maintains a relatively comprehensive bus stop inventory using the Automated Transit Stop Inventory Model (ATSIM), a web-based system developed by FIU for the FDOT Transit Office for the collection, maintenance, and visualization of bus stop attributes. For this project, the following bus stop attributes were extracted from the inventory and incorporated into the bus stop layer:

   - Stop number
   - Latitude
   - Longitude
   - Route number
   - Route direction
   - On-street name
   - At-street name

- Stop name (on-street @ at-street names)
- Presence of shelter
- Presence of bench
- Presence of Simme-seat
- Presence of trash bin
- Presence of lighting
- Presence of sign post
- Municipality
- ADA status

It is noted that Palm Tran serves a total of 31 municipalities in Palm Beach County, each represented by a three-character code in its bus stop inventory. It is also noted that the ADA status can be one of the following four conditions, with the last three considered to be not in compliance:

- ADA: In full ADA compliance
- NA1: Requires modifications behind sidewalk
- NA2: Requires modifications from curb to sidewalk
- NA3: Requires modifications from edge of pavement (no curb) to sidewalk

In addition to the above data attributes from Palm Tran's bus stop inventory, a program was developed using the bus stop inventory data to find the distances of each stop to its upstream and downstream stops. The distances are used in the bus stop balancing application of this project to identify closely-spaced stops. The program makes use of the first five bus stop attributes listed above, together with a set of logic rules to first identify the upstream and downstream stops and then calculate their straight-line distances. The program was able to correctly obtain the distances for a majority of the stops, except for a few that were situated on diverted routes, i.e., routes that enter a street and then turn around and exit from the same street in the opposing direction. This results in incorrect straight-line distances between pairs of stops which must be manually adjusted and corrected.

2. *GTFS Feed*: Palm Tran's GTFS feed provides all the bus stop locations and bus routes. The GTFS feed also allows identification of two additional data attributes for this project. The first is the bus stops that serve as timepoints, which were identified using the *stop_times_schedule.txt* file. A second is the bus stops that serve as a timed transfer point, which were identified using the *transfers.txt* file. The timed transfer points require that the departing vehicle wait for the arriving one, with sufficient time for a passenger to transfer between routes. For this project, it was also of interest to identify the "non-timed" bus stops which provide additional transfer opportunities for the passengers. As this cannot be identified from the GTFS feed, a special program was developed to spatially identify pairs of bus stops that are nearby and each serves a different route. For this application, a straight-line distance of less than 400 feet between two bus stops from different routes is used to identify the non-timed transfer points.

3. *Stop-Level Ridership*: The ridership data, including total boardings, total alightings, and total boardings and alightings, at each stop for the month of July 2021 was provided by Palm Tran. For this project, these monthly totals were divided by 31 to get the average daily averages.

4. *Pedestrian Crashes*: Pedestrian crash data are used in the bus stop balancing application to identify bus stops with pedestrian safety issues. Pedestrian crash records were downloaded from the Signal Four Analytics system, which is a statewide interactive, web-based geospatial crash analytical tool hosted at the Geoplan Center at the University of Florida (UF). It was decided that the latest four years of data would be used. A total of 2,062 pedestrian crashes in Palm Beach County from 2017 to 2020 were identified and downloaded. Of these crash records, 686 (33.3%) crashes were found to have missing coordinates and had to be excluded. As such, the data application must assume that the excluded crashes are evenly distributed across the service area. For the remaining pedestrian crashes, a special program was written to spatially locate and count the number of pedestrian crashes occurring within the vicinity of each stop. As there is not a standard definition for vicinity, it was decided to count the number of pedestrian crashes within 100 feet to 500 feet, with an increment of 100 feet. This resulted in following five data attributes:

   - Number of pedestrian crashes within 100 feet of a stop
   - Number of pedestrian crashes within 200 feet of a stop
   - Number of pedestrian crashes within 300 feet of a stop
   - Number of pedestrian crashes within 400 feet of a stop
   - Number of pedestrian crashes within 500 feet of a stop

5. *Land Use Parcel Data*: The 2019 statewide land use parcel data file was downloaded from UF's Florida Geographic Data Library (FGDL). Due to its large file size, the data are stored in a File Geodatabase. The data set can be downloaded directly from this Web address: https://download.fgdl.org/pub/state/parcels_2019.zip. The file was open in ArcMap and the records for Palm Beach County were exported to a CSV file. The CSV file contains the centroid location of each parcel together with the 3-digit land use classification code (i.e., DORUC). The code was used to determine the presence of points of interest, including schools, colleges, hospitals, shopping centers, and senior centers, within 0.25 mile of each stop. The results provide data for the following four binary (yes if present) data attributes:

   - Presence of schools or colleges within 0.25 mile of a stop (DORUC = 072, 083, 084)
   - Presence of hospitals within 0.25 mile of a stop (DORUC = 073, 085)
   - Presence of shopping centers within 0.25 mile of a stop (DORUC = 013, 014, 015, 016)
   - Presence of senior centers within 0.25 mile of a stop (DORUC = 006)

One limitation from using parcel centroids is that the 0.25 mile buffer distance may cause some stops to miss the centroid of large parcels, such as a large university campus, which could be more than 0.25 mile away from any bus stops surrounding the campus area.

5.2.2. Bus Route Layer

The bus route layer is a line feature class that was created using Palm Tran's GTFS feed. The available data attributes at the route level were provided by Palm Tran and they include:

- On-time departure percentage
- Late departure percentage
- Early departure percentage
- Late departure outlier percentage
- Early departure outlier percentage
- Average daily boardings
- Total boardings

The on-time performance attributes were estimated from the agency's Automatic Vehicle Location (AVL) data and the boarding attributes were derived from the agency's Automatic Passenger Counter (APC) data. The two late and early department outlier percentages represented the portion of erroneous data brought on by AVL or user error. Together, the five departure percentages sum to 100%. It is noted that the total boardings were counted over a 27-day period.

5.2.3. Demographic Layer

The demographic layer is a polygon feature class at the Census block group level. It includes data from two major data sources: the American Community Survey (ACS) five-year (2015-2019) demographic data and the Dun & Bradstreet (D&B) employment data. The ACS data were downloaded directly from UF's Florida Geographic Data Library (FGDL), at https://download.fgdl.org/pub/state/cenacs_2019.zip. The file combines most of the data attributes needed for transportation planning applications. The ACS demographic attributes included are listed below. It is noted that the attributes marked with a "*" were calculated from the original data attributes.

- Total population
- Population per acre
- Total households
- Households per acre
- Household size
- Male population
- Female population
- Percent female population*
- Non-Hispanic White
- Minority
- Percent minority*
- Population 65 years and older
- Percent population 65 years and older*

- Median age
- Population 24 to 64 years with a disability
- Percent population 24 to 64 years with a disability*
- Population below poverty level
- Percent population below poverty level
- Median household income
- Population with a bachelor's degree
- Percent population with a bachelor's degree
- Total workers 16 years and over
- Workers drove to work
- Workers motorcycled to work
- Workers using public transportation to work
- Workers walked to work
- Workers using other transportation means to work
- Workers worked at home

The Dun & Bradstreet (D&B) employment data set, dated January 2020, was obtained from FDOT's Forecasting and Trend Office. The D&B dataset contains point employment locations completing with the number of employees at each location and the NAICS (North American Industry Classification System) business classification code. As the employment data points are stored as a point layer, they were spatially aggregated into the block group demographic layer using ArcMap. A total of five attributes as listed below were created from the employment data set:

- Total employees
- Total industrial employees (*NAICS* code = 11 to 33)
- Total commercial employees (*NAICS* code = 42 to 49
- Total service employees (*NAICS* code = 51 to 92)
- Total employees per acre

The three attributes by key business type (i.e., industrial, commercial, service) were classified using the first two digits of the NAICS code. Their respective NAICS codes used are as indicated above. The last attribute, total employees per acre, which serves as one of two major inputs to the TSA and LOS applications, was calculated by dividing the total employees by the block group acreage. It is noted that these "employees" attributes differ from the "workers" attributes from the ACS in that employees are counted at workplace locations and workers are counted at residential locations.

5.3. Platform Development and Applications Demonstration

A browser- and cloud-based software platform was developed to demonstrate the four transit planning applications described in Section 5.1. The platform integrates the three data layers described in the previous section and provides application-specific filters for users to query the data and visualize the results. The Web address for the demonstration platform is

https://AppsDemo.fiu.edu. As the website contains only publicly available data, it is freely accessible to anyone who wishes to try it.

Figure 5-2 shows the main and only screen of the platform. It includes a left panel for users to select map layers and apply filters, and a right map view for mapping and displaying query results. The mapping capability uses the popular Mapbox mapping platform which renders the OpenStreetMap (OSM). The research team considered both Google Maps and Mapbox for this demonstration platform development. Mapbox was selected for its ability to perform spatial analysis using Turf, which is an open source JavaScript library that can perform a wealth of spatial operations in the browser environment.
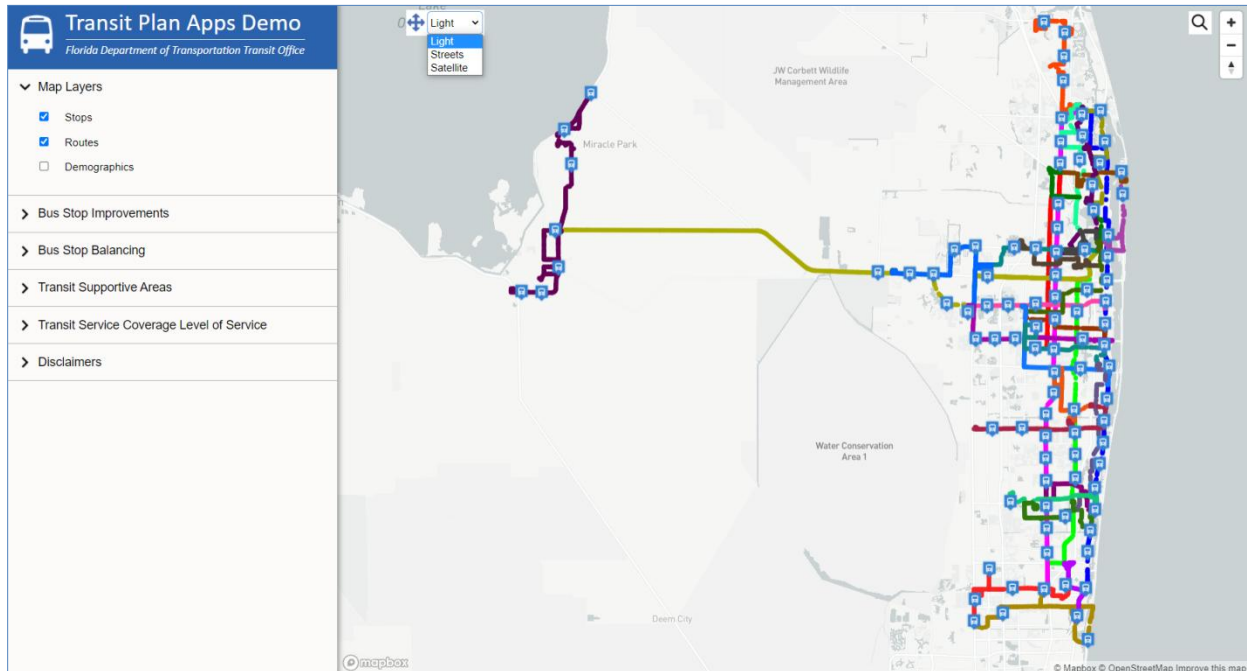
Figure 5-2. Main Screen

By default and as shown in Figure 5-2, the platform displays Palm Tran's bus route and bus stop layers, without the demographic layer. Users can turn on and off a map layer by clicking the layer checkboxes. The map view provides several basic mapping functions, including:

1. The standard pan and zoom functions using the mouse roller or the zoom buttons, plus allowing users to use the mouse to reorient and tilt the map by holding down the Control key.
2. A search function that allows users to enter a stop number or a street name to find a list of matching bus stops. Users can then select from the list of matching stops to locate and zoom into a particular stop on the map.
3. Infobox display of data attributes by hovering the mouse over a route or a stop, or by clicking a block group.
4. A drop-down list that allows users to select the map background, which can be Light (default), Street, and Satellite.

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5. A thematic map function that allows users to select different attributes to create thematic maps. For demonstration purposes, this function is implemented for only the demographic layer based on either the equal interval or quantile classification. Figure 5-3 shows a thematic map based on median household income with five quantile classes. By default, the thematic colors are based on 100% opacity and may be reduced as desired. When the routes and stops are overlaid on top of a thematic map, an agency can quickly visualize and assess how well existing service covers the areas of interest.
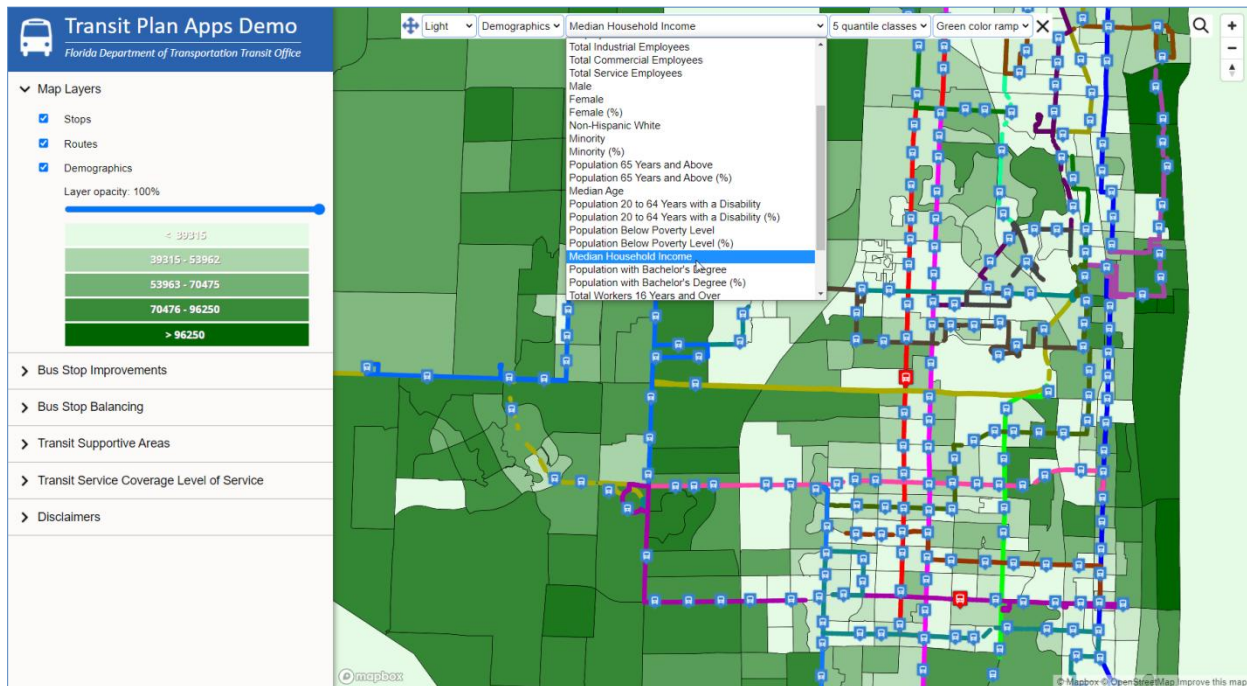

Figure 5-3. Thematic Map Example

The next four subsections describe and demonstrate each of the four applications described in Section 5.1.

5.3.1. Bus Stop Improvements

As described in Section 5.1, the aim of this application is to identify potential bus stops for amenity and ADA improvements. This is done using a set of preset filters that allow users to short-list the bus stops by specifying filter conditions. Figure 5-4 shows the list of preset filters on the left panel. The map view shows a tilted satellite image background and an infobox display of a stop. The filters include attributes from bus stop inventory, stop-level ridership, and demographic data. The filters work as follows:

1. A filter is applied only when there is a user entry. For this particular application, all filters are left unspecified by default. This means that the bus stops are not filtered and the result will include all bus stops in the system.

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2. Unless a filter is preceded with the "OR" logical operator, the "AND" logical operator is assumed and is not shown. The "AND" logical operator requires that all specified filter conditions be met simultaneously, while "OR" requires only one filter condition be met.
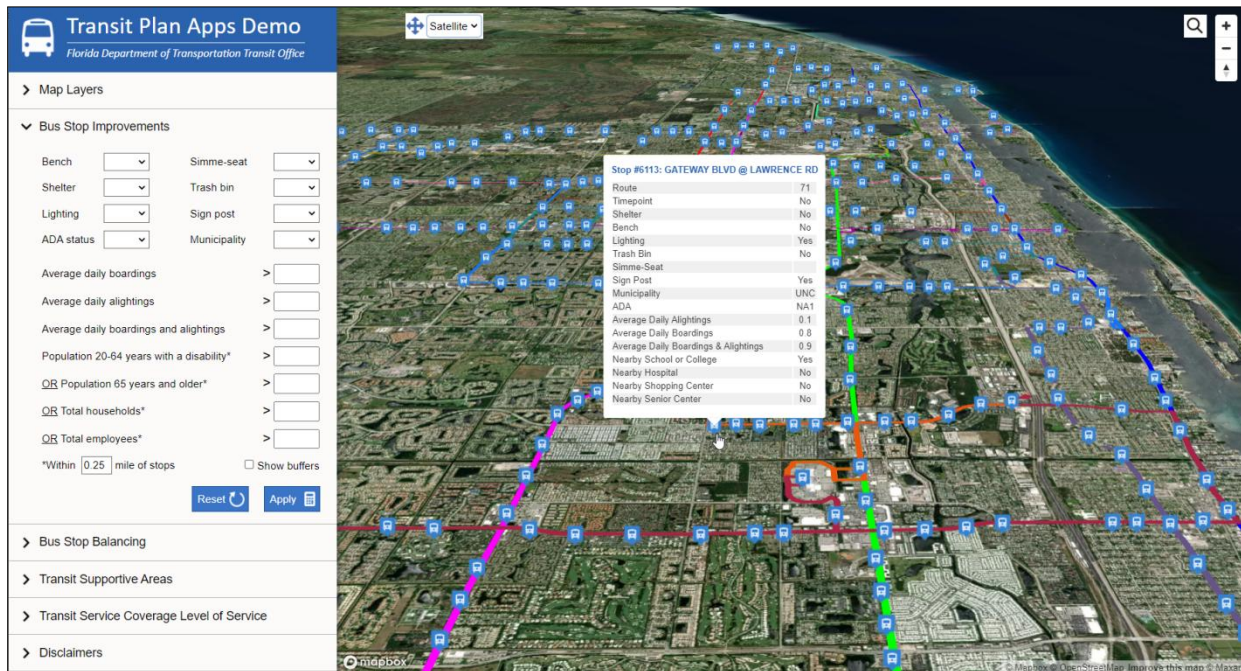

Figure 5-4. Preset Filters for Bus Stop Improvement Application

In this particular application, it can be seen from Figure 5-4 that only the four demographic filters are based on the "OR" logical operator. In this case, a stop would need to meet only one of the four filter conditions for it to qualify for selection. It is noted that data for the last four attributes are marked with a "*" sign to indicate to users that the data are extracted on-the-fly using a default stop buffer of 0.25 mile. Users can select any other buffer distance. Users can also choose to show or hide the buffers using the *Show buffers* checkbox. It can also be seen from Figure 5-4 that the seven ridership and demographic filters are all assigned with the "greater than" comparison operator. This is because, for this application, it is more desirable for improvements to be made at bus stops where they serve high attribute values.

Of the eight attributes from bus stop inventory with a drop-down selection list, the first six attributes are each given three user selections, i.e., "Yes", if an amenity is present; "No", if an amenity is not present; and "Null", if there is no data (i.e., the actual status is unknown). The selection list for the last two of eight bus stop inventory attributes, i.e., *ADA Status* and *Municipality*, were as described in Section 5.2.1, except that, for *ADA Status*, an additional selection option, NA#, is included to allow users to select the three non-compliant options, i.e., NA1, NA2, and NA3, all at once.

Once the desired filters are specified, users can click the *Apply* button to run the query which applies the filters specified. The resulting bus stops are highlighted in red bus stop icons on the map. The total number of resulting bus stops selected is also indicated on the left panel.

As an example, Figure 5-5 shows five specified filters that are aimed at identifying bus stops that serve a significant number of daily boardings and alightings, and are surrounded with significant residents or employees, but they do not have any bus shelters or benches. The filter conditions result in a total of 61 bus stops, which are highlighted in red bus icons.

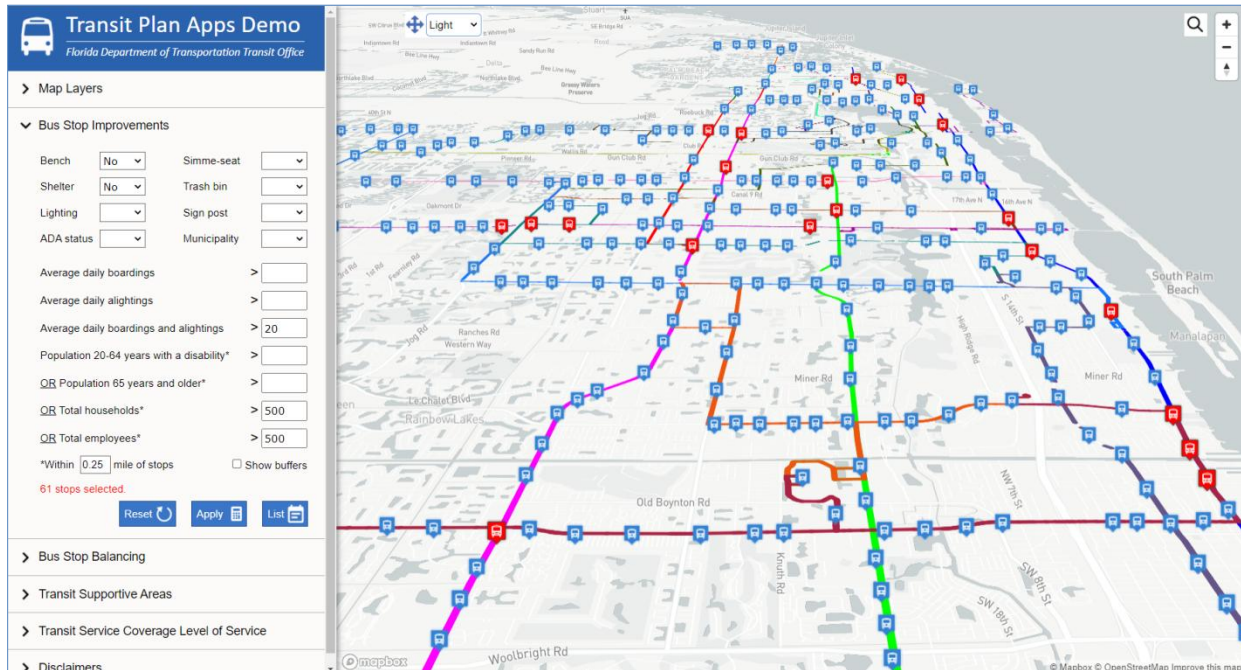**Figure 5-5. Example User Entries and Resulting Bus Stops for Amenity Improvements**

After the query run is completed, a *List* button will appear next to the *Apply* button to allow users to see the list of selected bus stops in a pop-up window. As shown in Figure 5-6, the list includes all the attribute values associated with the filters. Users can export the list using the *Export to Excel* button.

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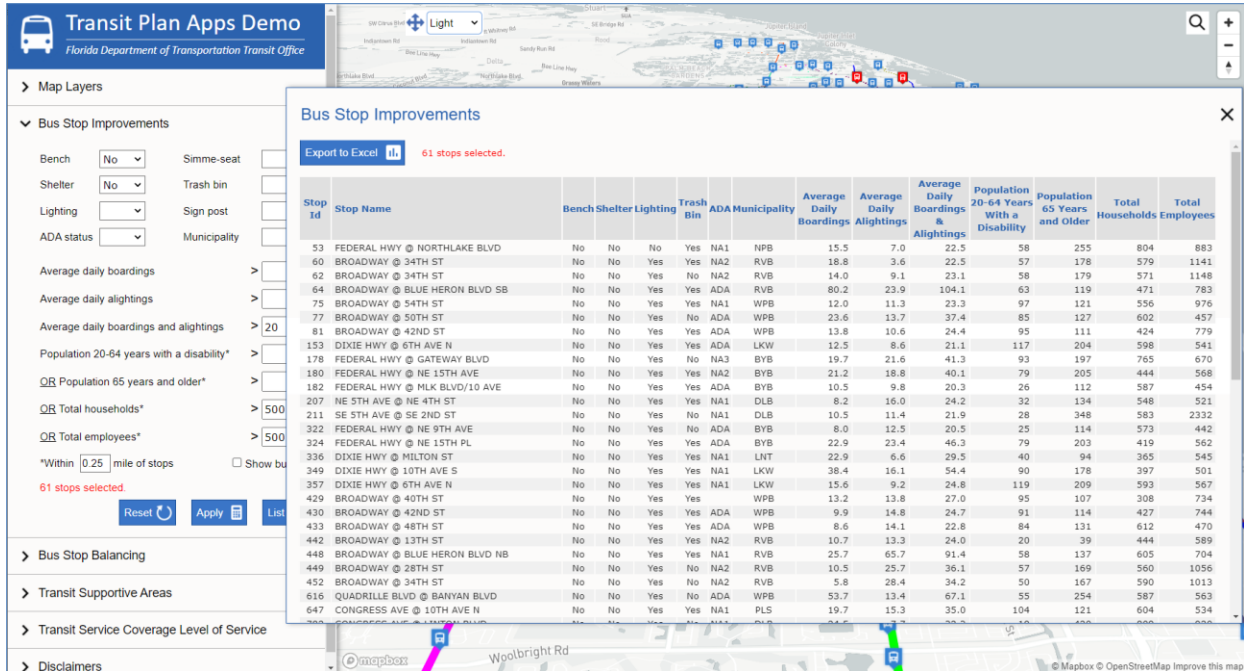
Figure 5-6. Listing of Resulting Bus Stop Records

Figure 5-7 shows another example using three filters to identify bus stops located in areas with significant people with disabilities, but are not ADA-compliant. The filter conditions result in a total of 35 bus stops. The map view is zoomed into a local area to show the buffers which by default is based on an air distance of 0.25 mile.

Figure 5-7. Example User Entries and Resulting Bus Stops for ADA Improvements

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5.3.2. Bus Stop Balancing

In this application, a total of 12 filters based on data from various sources are used to identify bus stops for balancing (or consolidating). The set of filters provided allows users 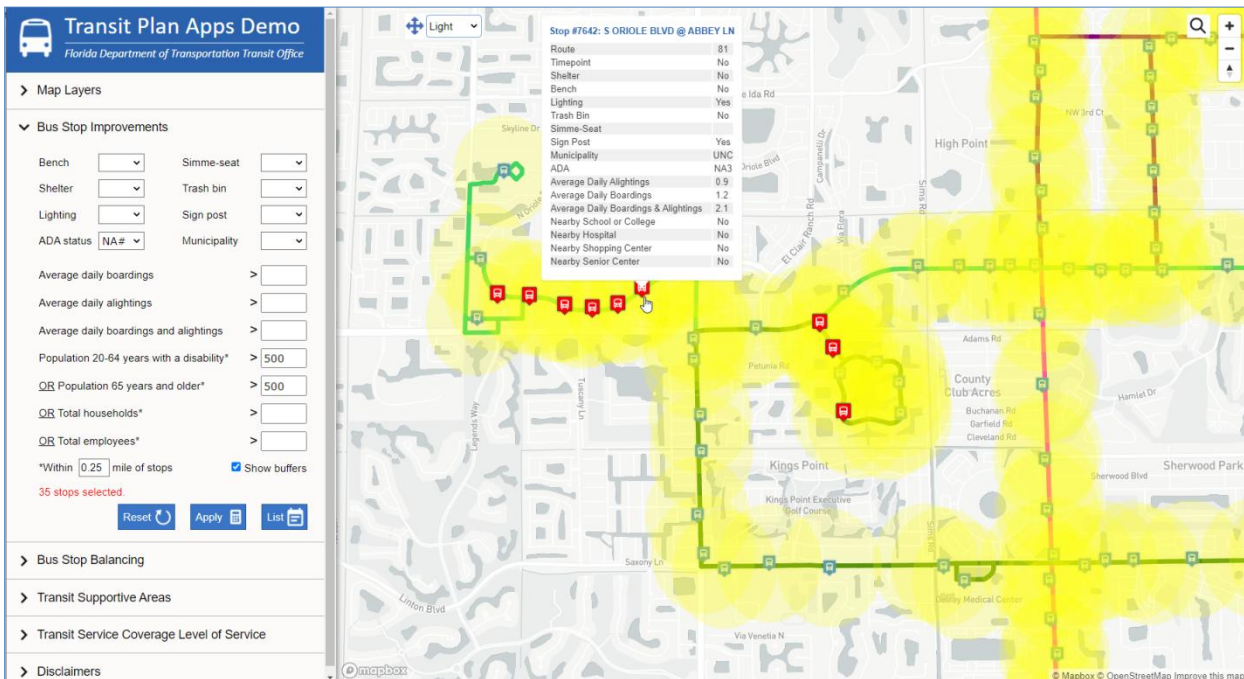to specify conditions under which a bus stop could be considered for removal. Depending on an agency's service objectives, it is not necessarily that all filters be considered. The left panel in Figure 5-8 shows the list of the 12 filters included, together with a set of example user entries.
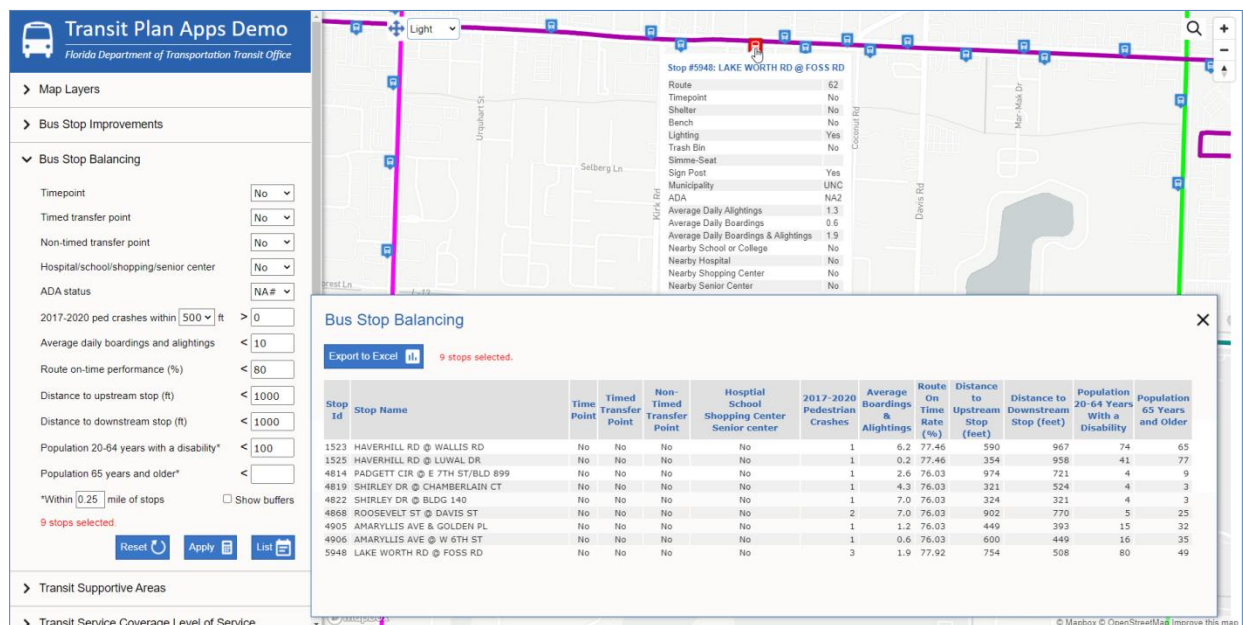

Figure 5-8. Example User Entries and Resulting Bus Stops for Balancing

Details on the data for these filters are given in Section 5.2. The specific user entries shown in Figure 5-8 for each of the 12 filters are further explained below:

1. *Timepoint*: As agencies are likely to want to keep bus stops that serve as timepoints, this filter is set to "No" by default to preclude all timepoint stops from being selected for removal.
2. *Timed transfer point*: This filter is also set to "No" by default as agencies are likely to want to keep bus stops that provide timed transfer opportunities for the passengers.
3. *Non-timed transfer point*: While non-timed transfer points are not as critical as their timed counterpart, agencies are also likely to want to keep these stops to provide general transfer opportunities for their passengers. As such, this filter is also set to "No" by default.
4. *Hospital/school*/shopping/senior center: This filter allows users to exclude bus stops that serve any nearby hospitals, schools and colleges, shopping centers, or senior centers. In this example, "No" is selected to exclude bus stops that serve at least one of these land use types from removal.
5. *ADA Status:* This is set to "NA#" in this example to consider bus stops that are not fully ADA-compliant for potential removal.

The remaining seven filters below require that users specify a number, or leave blank to skip, depending on the conditions for which an agency considers as undesirable:

6. *2017-2020 pedestrian crashes within the vicinity of bus stop*: This allows agencies to target bus stop locations that had experienced significant pedestrian crashes. In this example, the user entry considers bus stops that have experienced at least one nearby pedestrian crash for potential removal. The vicinity in this case is defined as within 500 feet of a bus stop.

7. *Average daily boardings and alightings*: This filter allows agencies to target low-performing bus stops with low ridership for removal. In this example, any bus stops that serve less than 10 average daily boardings and alightings are considered for removal.

8. *Route on-time performance*: This filter allows agencies to target bus stops on low on-time performance routes for removal. The user entry is set to any routes with less than 80% on-time performance. The removal of non-critical and underutilized bus stops could help improve the on-time performance of these routes.

9. *Distance to upstream stop*: This filter allows agencies to target bus stops that are close to one of two adjacent bus stops, in this case, the upstream stop. In this example, a bus stop spacing of less than 1,000 feet is considered as close.

10. *Distance to downstream stop:* Similarly, this filter allows agencies to target bus stops that are close to their downstream bus stop. Similarly, 1,000 feet is used to determine the spacing cut-off point.

11. *Population 20-64 years with a disability:* This filter allows agencies to target bus stops that are not situated in an area with significant number of working adult population with a disability. In this example, the insignificant level is set at 100 persons within 0.25 mile of bus stop service area.

12. *Population 65 years and older:* This filter allows agencies to target bus stops that are not situated in an area with significant older population. The insignificant level in this case is also set at 100 persons within 0.25 mile of bus stop service area.

Figure 5-8 shows that together the 12 user entries in this example result in a total of 9 potential bus stops that could be further examined by agencies for potential removal. The figure also shows the list of selected stops together with an infobox for one of the selected stops.

5.3.3. Transit Supportive Areas (TSAs)

This application demonstrates how agencies can identify transit supportive areas (TSAs) and visually assess how well the existing service covers the TSAs. The application follows the standards set in TCQSM for what constitute an area as a TSA of a specific level, which can be low, medium, or high. The TCQSM standards for each level can be seen in Figure 5-9. As shown, an area is classified as a high TSA if it has more than 10 households per acre or more than 20 employees per acre. Similarly, an area with more than 3 households per acre or more than 4 employees per acre are classified as a medium TSA. Any area with less than 3 households per acre or less than 4 employees per acre is classified as a low TSA.
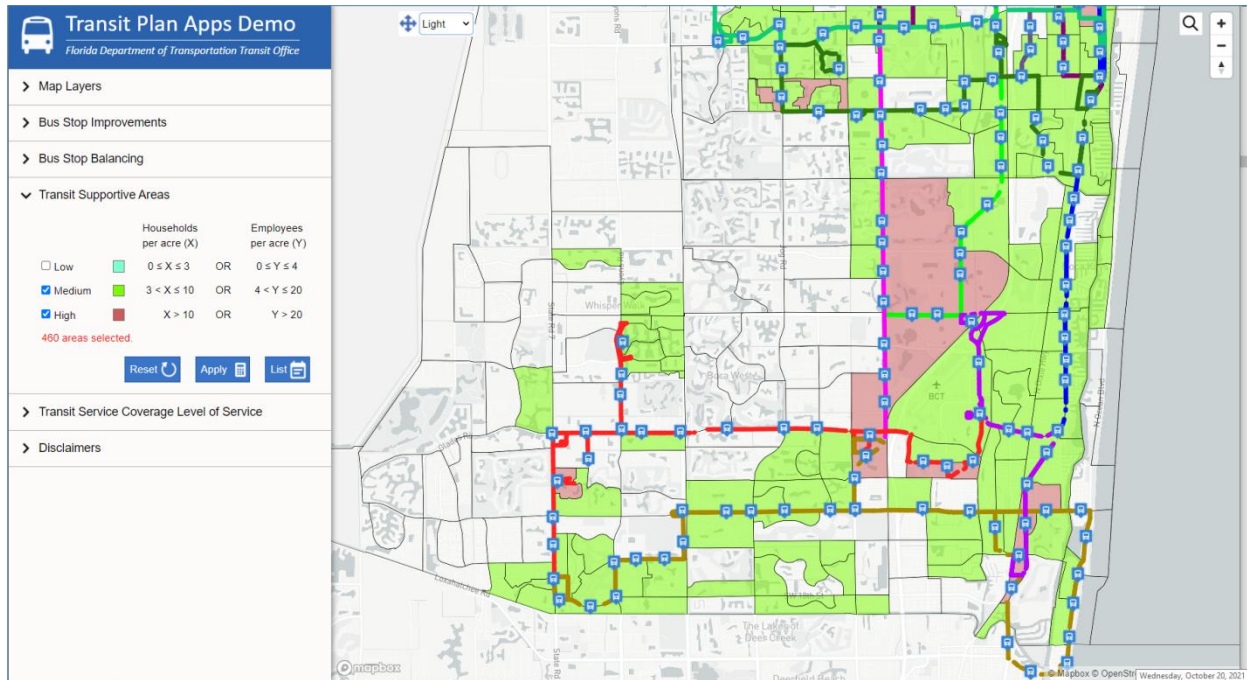
Figure 5-9. Transit Supportive Areas Using *TCQSM* Method

To find TSAs of a particular level, users simply check the corresponding checkbox provided and click the *Apply* button. As shown in Figure 5-9, more than one TSA level may be selected. The resulting TSAs are highlighted in their respective assigned colors. In Figure 5-9, both medium and high TSAs are selected and they result in a total of 460 TSAs. Also, the map is zoomed in to the southernmost region of the county where it shows that all of the high TSAs are covered by some existing service, but several medium TSAs are not.

5.3.4. Transit Service Coverage Level of Service

This application demonstrates how agencies can extend the previous application to further quantify how well their TSAs are served by existing service. For this application, TSAs are identified based on the same TCQSM methodology described in the previous section, i.e., an area is considered transit supportive if the household density is greater than 3 or the employee density is greater than 4. TCQSM further defines the bus service area as within 0.25 mile of each stop for this application. Figure 5-10 shows the bus service coverage results for Palm Tran's bus system. The left panel shows the two criteria used for this application. As the criteria are fixed, they are not editable. Clicking the *Apply* button will start the calculations, which may take as much as one minute to complete. The results are summarized in a table displayed on a pop-up window, also shown in Figure 5-10. The terminologies used in the table are explained below:

- *Service Area*: The total land area, households, employees, covered within 0.25 mile of the bus stops.
- *Total TSA*: The total land area, households, and employees of all TSAs.

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- *TSA Served*: The total land area, households, and employees in the TSAs that are with 0.25 mile of the bus stops.
- *% TSA Served*: The percent of total land area, households, and employees in the TSAs that are served by existing service, calculated as *TSA Served* divided by *Total TSA*, multiplied by 100.

According to the TCQSM definition shown at the bottom portion of the output screen (see also Table 5-1), the service coverage Level Of Service (LOS) for Palm Tran's bus system is rated as "E" (i.e., at least half of the high-density areas served) for both the percent of TSAs served and the percent of households in the TSAs served, and is rated as "D" in terms of percent of employees in the TSAs served. It is noted that the LOS for the percent of households and the percent of employees in the TSAs served are an extension of the TCQSM LOS concept in this application and are not part of the original method prescribed in TCQSM.
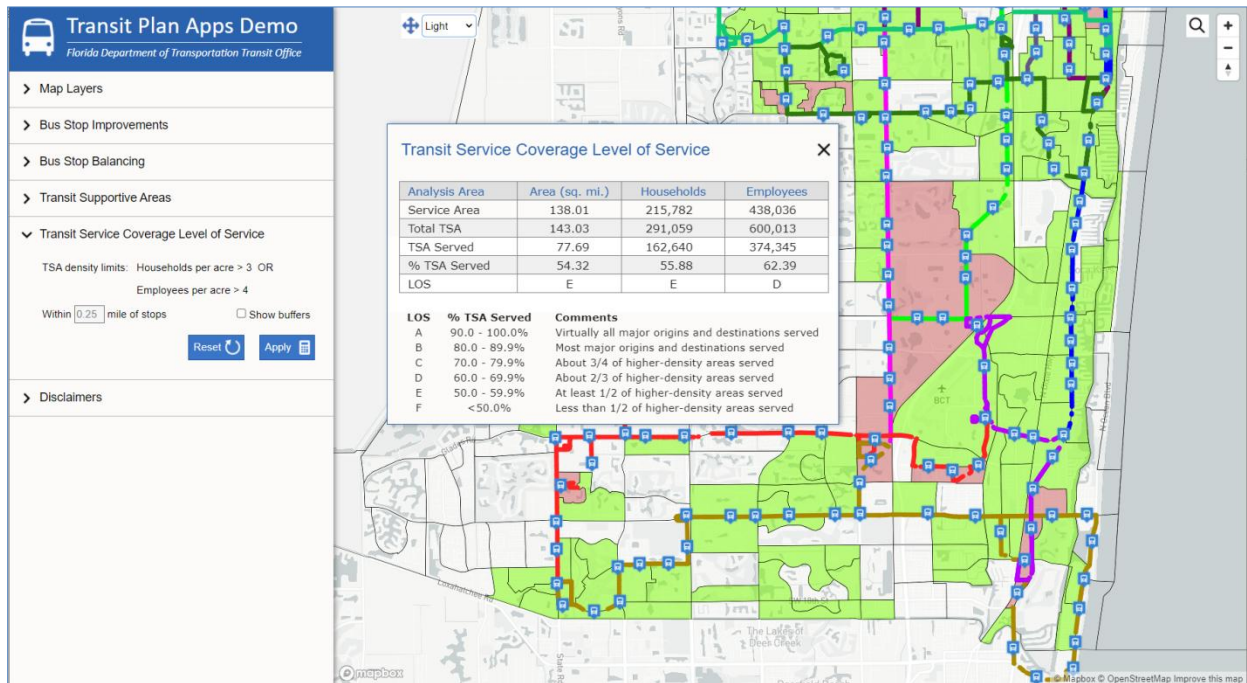

Figure 5-10. Estimates of Transit Service Coverage Level of Service (LOS)

CHAPTER 6
DEVELOPMENT OF CHECKLIST TEMPLATE FOR SOFTWARE PLATFORM EVALUATION

Based on the information and knowledge gathered through all the efforts described in Chapters 2 to 5, a checklist template that includes essential items of consideration when preparing and evaluating platforms by an agency was developed. The template includes checklist items covering the following aspects of software platforms:

- General vendor information
- Platform system information
- General platform features
- Input data
- Data visualization
- Data applications
- Data export
- Licensing options and fees
- User support and training
- Current Florida client list

The checklist template was prepared as a 4-page Microsoft Word form and is included in Appendix D. A separate Word file for only the form and with protected data entry fields was also developed and can be accessed at this link. The protected form allows the users to use the *Tab* key to move through data entry fields to enter data and check the appropriate checkboxes. The form itself was designed for use by both candidate vendors and transit agencies. The form is first given to each candidate vendor to complete. Based on vendors' self-assessed results, agencies can then use the completed forms to verify the results and evaluate the platforms.

CHAPTER 7
SUMMARY AND CONCLUSIONS

This project was aimed at accomplishing three main objectives: (1) identifies and evaluates existing commercially available software platforms used by transit agencies for transit service planning, (2) identifies and demonstrates service planning applications that could be implemented in existing software platforms, and (3) develops a checklist template for use by transit agencies to identify, evaluate, and select software platforms for transit planning.

As part of the project's first task, a survey of Florida transit agencies was conducted to learn about their general service planning practices and to identify software platforms being used by the agencies for service planning. The research team then held Web meetings with select transit agencies to obtain more specific details on the software platforms the agencies use. The above task efforts identified a total of eight commercially available software platforms, six of which were eventually evaluated as part of this project. Based on mainly the platform evaluation results, the project then identified and demonstrated four transit service planning applications that have not been included in the existing software platforms reviewed. Lastly, based on the findings from all of the above task efforts, the research team developed a checklist template that included essential items of consideration for identifying, evaluating, and selecting appropriate software platforms. The sections below summarize the key findings from each of these five project task efforts.

7.1. Identification of Transit Service Planning Practices and Software Platforms

A survey of Florida transit agencies was first conducted to learn about their general service planning practices and to identify software platforms being used by the agencies for transit service planning. A total of 19 agencies participated in the survey. The survey found that:

- Nearly all agencies had conducted COAs or expected to have one done in the coming years, with larger agencies tending to conduct COA studies more frequently.
- All but four agencies (86%) had made at least one type of service changes in response to COVID-19, with a majority of these agencies making multiple types of changes, including reducing the service hours (63%), reducing the service frequency (53%), increasing the number of vehicles to accommodate social distancing (37%), reducing the number of routes due to reduced demands (26%), and increasing the frequency to accommodate social distancing (16%).
- Most agencies (37%) made route change on an as-needed basis, while those on a fixed schedule made their service route changes triannually (21%), semiannually (16%), annually (11%), and quarterly (5%). Similarly, most agencies (26%) made schedule change on an as-needed basis, while those on a fixed schedule make service schedule changes triannually (32%), semiannually (16%), annually (11%), and quarterly (5%).
- The reasons for making service changes are to improve low performing routes (74%), service new areas (68%), respond to customer complaints (58%), and better

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accommodate high performing routes (53%), provide better service for people with disabilities (26%) and expand service due to budget increase (26%).

- All agencies had in-house employees help make service changes for their agencies. Three agencies used off-site contracted employees, and one agency used on-site consultants.
- A majority of the agencies (74%) used some software platforms to assist in their service planning. The most commonly used software was Remix (58%). Other software platforms listed by the participants included Optibus, Swiftly, TransLoc, TBEST, Trapeze, HASTUS, ArcGIS, RouteMatch, Clever Devices, and NextBus.
- Of the five agencies (26%) that did not use any software platform, they relied on analyses using local data including survey and farebox data, input from citizens and vehicle operators, and local knowledge.
- Remix, TBEST, Swiftly, and HASTUS were mentioned by six agencies as software platforms that they would like to have to help with Title VI route analysis and route planning.
- The types of data agencies frequently used to assist in service planning included census data (95%), street maps (89%), on-board survey data (84%), land use data (74%), satellite images (74%), AVL data (74%), and APC data (63%). Less frequently used data included AFC data (37%) and land parcel data (26%). A majority of the agencies (84%) also relied on local knowledge to make service changes.

7.2. Interviews with Transit Agencies

To obtain more details and insights on the software platforms transit agencies use, the research team interviewed ten agencies, including six in Florida and four outside Florida. The key findings from the interviews include:

- Transit agencies may use several software platforms because there is no one software platform that addresses all the needs in one platform.
- Transit agencies use these software platforms mainly for fixed-route service planning. Examples of their applications include planning and modifying transit routes; managing detours; calculating changes to operating costs due to service changes; complying with Title VI and improve service equity; responding to customer complaints; and assisting with the monitoring, improving, and reporting of on-time performance (OTP).
- Transit agencies often received requests from different parties for new service or service changes that required a quick response. Use of software platforms helped them address such requests quickly and meet pressing deadlines.
- Before they had the software platforms, one major challenge agencies faced was that they could not estimate costs of proposed services. Software platforms helped agencies estimate the costs of expanding service.
- The agencies interviewed were generally highly satisfied with the software platforms they used in service planning. They regarded these software platforms as user friendly and the vendors were responsive to their need and provided good technical support service.

- The fact that most of the software platforms are Web-based makes it easy for the agencies to receive timely system and data updates. The updates were usually included or negotiated as part of the license agreement.
- Older platforms that were not Web-based could be very slow and also made it difficult for staff that needed to work remotely, especially during the pandemic.
- As most of the software platforms used in service planning are Web-based and the vendors provide technical support, the role of the IT departments has diminished.
- Agencies used data from different sources such as the census, ACS, and GTFS or scheduling data from platforms like Optibus, Trapeze or HASTUS. Agencies also used data from transit ITS systems like AVL, AFC, and APCs from different vendors including Avail, TransLoc, UTA, Clever Devices, or GFI Genfare.
- Because software platforms such as Remix, Optibus, and NetPlan provided census and other data as part of their software licenses, agencies did not need to prepare the data themselves for demographic analysis. The vendors can upload standardized data such as GTFS into their software platforms quickly.
- Not all agencies would be willing to embrace changes, as the workforce had already been trained in older platforms. Agency leadership and decision makers would need to assess the costs and benefits of implementing more efficient platforms.
- The pricing of the software platforms was generally an annual fee that was based on the number of vehicles and may have some limitations on the maximum number of users. The software license agreement is generally signed for multiple years and covers initial platform setup, training, support, and data updates.
- A statewide license could especially benefit smaller agencies which might not have the financial means to pay for the license fee as well as the staff resources needed to research software platforms and deal with contractual agreements.
- A statewide software license could provide a good economy of scale for the state. It was suggested that this could follow the FDOT program they had with CUTR at USF for the purchase of new transit vehicles, and that the same could be done for all transit platforms, including for planning, scheduling, operations, and paratransit software.
- A statewide license could also help with the coordination between agencies, because all the agencies would be using similar software, which could be particularly helpful, to planning and scheduling of paratransit riders, who often travel across multiple jurisdictional boundaries.

7.3. Evaluation of Existing Transit Service Planning Software Platforms

A total of six software platforms that could help transit agencies perform transit service planning were evaluated. The evaluation focused on the platform features and capabilities, use of data, applications, user support, and user friendliness. Three of these platforms, i.e., Optibus, Remix, and NetPlan, had been designed to perform route planning analysis such as transit accessibility, equity, and service impact analysis. As transit service levels depend on schedules, these platforms are also integrated with scheduling systems at different levels of sophistication. More specifically:

- Optibus includes features for transit service planning, with particular strengths in scheduling optimization. Optibus can offer transit agencies the convenience and capability to perform a thorough service planning that includes planning and scheduling within a single platform. It is particularly suited for agencies that would like to benefit from a powerful cloud-based platform, and desire to have both planning and scheduling functionalities in one integrated platform.
- Remix is the software platform that has been the most widely used in Florida for transit service planning. It includes many user-friendly features that can be used for different transit service impact analyses, such as transit service accessibility, service equity, and service coverage. Currently, Remix provides limited scheduling capabilities. Therefore, agencies using Remix may need to have a separate platform for scheduling. Remix is also a cloud-based platform, and it is particularly suited for agencies that already have a scheduling platform and would like a strong platform for service planning.
- NetPlan is a client-server application that includes many planning features for agencies to conduct comprehensive service planning analysis, especially those that require detailed and accurate service cost estimates. NetPlan is particularly suited for larger agencies or agencies that already have HASTUS as their scheduling platform.

The three other platforms, i.e., Swiftly, Hopthru, and Teralytics, are specialized data platforms that make use of data to provide important information, allowing transit agencies to perform sophisticated planning and scheduling tasks. Unlike the other planning and scheduling platforms, these data platforms do not include direct route, stop, and schedule editing capabilities. Nevertheless, they provide highly specialized and interactive dashboards for selecting and visualizing their specialized data that can be used to improve planning and scheduling. More specifically:

- Swiftly specializes in the application of AVL, scheduling, and operational data to provide live and archived information such as real-time on-time performance monitoring and analysis and review of historical data. The Swiftly dashboard also provides features to analyze vehicle headways and can suggest changes to existing schedules to help improve on-time performance and reduce vehicle bunching, among others. While the Swiftly dashboard already includes many capabilities, it further provides APIs to allow users to retrieve data that can be used for further analysis outside the platform.
- Hopthru mainly focuses on using APC, and also uses stop inventory data, for analyzing ridership at different levels of aggregation and can provide detailed passenger information to help planners and schedulers identify congested segments and develop measures including schedule adjustments and potential route changes. As Hopthru is a relatively new platform, it is expected that additional transit datasets and functionalities be added in the near future.
- Teralytics specializes in general trip data, including trip origins, destinations, and flows, that are constantly extracted and estimated from mobile device signal. Trip origins and destinations are needed to identify the travel activity levels of different areas and trip flows help to understand the travel patterns. Taralytics provides a highly interactive graphical user interface that allows different ways of visualizing travel patterns.

Other than NetPlan, which is a client-server application, all the other platforms evaluated are browser- and cloud-based. Browser- and cloud-based platforms provide easy platform access, high processing speed, convenient data sharing, and frequent data and platform updates. The high processing speed is especially beneficial to platforms that perform scheduling tasks and optimizations, which can take many hours or even days to complete using personal computers or agency servers. These platforms also minimize the need for IT support within the agencies.

The research team was provided full access to Optibus, Swiftly, Hopthru, and Teralytics, and partial access to Remix. All of these platforms were found to give fast processing speed, with only occasional data loading problems that appeared to be due to temporary network issues. All user interfaces were also found to be highly user-friendly, feature-rich, modern looking, and highly professional. All platforms provide similar map visualization functions. Optibus uses Google Maps while the other cloud-based platforms use Mapbox together with OpenStreetMap.

7.4. Identification and Demonstration of Transit Service Planning Applications

This part of the project attempted to identify and demonstrate multiple data-driven transit service planning applications. The research team first researched and identified potential applications that might be of interest to transit agencies but have either not been included, or fully so, in existing software platforms. Because the data needed to support the applications must be available, the search for potential applications that were also feasible must consider the data availability. In other words, the identification of potential applications must go hand-in-hand with the data sources available to support specific applications. The efforts resulted in the following four planning applications:

- Prioritizing bus stops for improvements
- Balancing bus stops
- Identifying transit supportive areas
- Estimating transit service coverage level of service

The available data attributes needed to support these applications were then identified and extracted from their data sources and prepared in the format appropriate for specific applications. Finally, a browser- and cloud-based demonstration platform that integrated all of the data from different data sources was developed to demonstrate each of the four applications. The demonstration platform not only helps illustrate the application concepts, but more importantly, allows potential users to see how each application works, try out different inputs, and visualize the outputs. These applications were presented via a webinar to transit agencies. It was envisioned that agencies interested in these applications could request to have them incorporated by the vendors in their software platform.

7.5. Development of Checklist Template for Software Platform Evaluations

Having gathered all the information and knowledge from the above project tasks, the final project effort developed a checklist template that included essential items of consideration

when preparing and evaluating platforms by an agency was developed. The template included checklist items covering the following aspects of software platforms:

- General vendor information
- Platform system information
- General platform features
- Input data
- Data visualization
- Data applications
- Data export
- Licensing options and fees
- User support and training
- Current Florida client list

The checklist template was designed as a Microsoft Word form, to be given to each candidate vendor to complete and then have the self-assessed results from the vendors be verified by the agencies.

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APPENDIX A:

AGENCY SURVEY INSTRUMENT

Survey on Transit Service Planning Practices and Use of Software Platforms

Dear Transit Service Planner:

Thank you for taking the time to complete this short survey on transit service planning practices. This survey is being conducted by Florida International University for the FDOT Public Transit Office. Its main purpose is to identify general practices of Florida transit agencies on transit service improvements, with an emphasis on agency's use of software platforms to aid in making transit service changes. We greatly appreciate your feedback and we will be sharing the survey results with all of our survey participants. If you have any questions regarding this survey, please do not hesitate to contact Dr. Albert Gan at gana@fiu.edu or (786) 202-8699.

Thank you again!

Q1. Please provide your contact information:

○ Name: _____

○ Position: _____

○ Agency: _____

○ Email: _____

○ Phone: _____

Q2. When was the last time your agency conducted a Comprehensive Operations Analysis (COA)?

○ The last COA was conducted during this year: _____

○ No COA has been conducted

○ Not sure

Q3. When do you anticipate that your agency will conduct the next COA?

○ Within 1-2 years

○ Within 3-4 years

○ Within 5-6 years

○ Within 7-8 years

○ Within 9-10 years

○ None anticipated at this time

○ Not sure

○ Other (*please specify*): _____

Q3. When do you anticipate that your agency will conduct the next COA?

- ○ Within 1-2 years
- ○ Within 3-4 years
- ○ Within 5-6 years
- ○ Within 7-8 years
- ○ Within 9-10 years
- ○ None anticipated at this time
- ○ Not sure
- ○ Other (*please specify*): _____

Q4. What transit service changes have your agency made so far that were due to COVID-19 (*check all that apply*)?

- ☐ No service changes due to COVID-19 have been made
- ☐ Reduced number of routes due to reduced demands
- ☐ Reduced service frequency due to reduced demands
- ☐ Reduced service hours due to reduced demands
- ☐ Increased service frequency to accommodate social distancing
- ☐ Increased number of vehicles to accommodate social distancing
- ☐ Others (*please specify*) _____

Q5. Outside COA and COVID-19, which of the following best represents how often your agency review and make changes to your transit service <u>routes</u>?

- ○ Quarterly
- ○ Triannually
- ○ Semiannually
- ○ Annually
- ○ On as needed basis
- ○ Other (*please specify*): _____

Q6. Outside COA and COVID-19, which of the following best represents how often your agency review and make changes to your transit service <u>schedules</u>?

- ❍ Quarterly
- ❍ Triannually
- ❍ Semiannually
- ❍ Annually
- ❍ On as needed basis
- ❍ Other (*please specify*): _____

Q7. Outside COA and COVID-19, what have been the reasons for which your agency made transit service changes (*check all that apply*)?

- ☐ Improve low performing routes
- ☐ Better accommodate high performing routes
- ☐ Straighten transit routes
- ☐ Service new areas
- ☐ Improve service equity
- ☐ Provide better service for low income population
- ☐ Provide better service for older adult population
- ☐ Provide better service for people with disabilities
- ☐ Respond to customer complaints
- ☐ Reduce service due to budget issues
- ☐ Expand service due to budget increase
- ☐ Others (*please specify*): _____

Q8. Please list up to three most common reasons for which your agency made transit service changes.

- ❍ Most common: _____
- ❍ Second most common: _____
- ❍ Third most common: _____

Q9. Who review and make transit service changes for your agency (*check all that apply*)?

☐ In-house agency employees

☐ Off-site consultants

☐ On-site consultants

☐ Other (*please specify*): _____

Q10. Does your agency use commercially-available software platforms (e.g., Remix) to assist in making transit service changes?

○ Yes

○ No

Q11. If you answered <u>No</u> to Question 10, please describe the general approaches your agency use to make decisions on transit service changes.

_____

_____

_____

Q12. If you answered <u>Yes</u> to Question 10, please provide the information below on the commercial software platforms (up to 3) your agency have used to assist in making transit service changes (*starting with the one that is used the most often*).

Software platform #1:

○ Platform name: _____

○ Year platform first acquired: _____

○ Applications performed using the platform: _____

Software platform #2:

○ Platform name: _____

○ Year platform first acquired: _____

○ Applications performed using the platform: _____

Software platform #3:

○ Platform name: _____

○ Year platform first acquired: _____

○ Applications performed using the platform: _____

Q13. Are there software platforms for transit service planning that you are aware of and would like to have access for your agency?

- ⭕ Yes

- ⭕ No, we already have everything we need

Q14. If you answered <u>Yes</u> to Question 13, please list the names of the software platforms and describe how you think they could be helpful to your agency?

_____

_____

_____

Q15. What data have your agency used to assist in making transit service changes (_check all that apply_)?

- ☐ Census data
- ☐ Land use data
- ☐ Land parcel data
- ☐ One-board survey data
- ☐ Street maps
- ☐ Satellite images
- ☐ Automatic Vehicle Location (AVL) data
- ☐ Automatic Passenger Counter (APC) data
- ☐ Automatic Fare Collection (AFC) data
- ☐ Local knowledge
- ☐ Others (_please specify_): _____

Q16. Will you be willing to meet with the FIU project team via a Web meeting to share more information about your agency's transit service planning practices, use of software platforms, and needs for support that could potentially be provided by FDOT?

- ⭕ Yes

- ⭕ May be

- ⭕ No

Q17. If you have any additional feedback, comments, or clarifications, please use the text box below:

_____

_____

_____

APPENDIX B:

AGENCY SURVEY INVITATION

From: Florida Transit Planning Network <FT-FORUM@LISTSERV.USF.EDU> on behalf of Matthews, Gabrielle <Gabrielle.Matthews@DOT.STATE.FL.US>
Sent: Wednesday, July 29, 2020 5:08 PM
To: FT-FORUM@LISTSERV.USF.EDU<FT-FORUM@LISTSERV.USF.EDU>
Subject:[FT-FORUM] Survey on Transit Service Planning Software Platforms and General Practices

Hello FTPN subscribers,

Hope this email finds you all well and safe!

Our office recently contracted with the Florida International University to conduct a study on agency use of software platforms for transit service planning. One of the first steps of the study is to identify any software platforms (e.g., Remix) your agency may have used, or wish to have used, to aid in making transit service improvements. The survey also includes some general questions on agency's service planning practices.

We would much appreciate if you could forward the survey link below to the person in your agency who best can respond to this survey.

https://fiu.qualtrics.com/jfe/form/SV_9KR0xinyX2TcAAt

We hope to complete the survey by August 15, 2020. Thank you again for your help!

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APPENDIX C:

EMAIL TEMPLATE USED FOR WEB MEETING INVITATIONS

Subject: Software Platforms Used in Transit Service Planning

Dear _____:

Hope this email finds you well!

Thank you for responding to the FDOT survey several weeks ago. We really appreciate the information you provided. As you may recall, the survey was to gather general information on your agency's practice on transit service planning and software applications.

We are especially grateful to you for agreeing to meet with us on a Zoom call for additional details. The focus of the meeting would be on the specific software platforms your agency has used. You have indicated that your agency uses REMIX and Optibus to assist with your service planning. We are particularly interested in seeing how the software platforms are being used to plan for transit service, what data are being used, what are the platform features that you have found to be especially helpful, what additional features you wish the platforms could provide, how the platform licenses were acquired and being maintained, and anything else you can share with us. We know this is a lot to ask, but would really appreciate, if possible, that you and/or your assistant could provide a quick and informal demonstration of the software platforms you use to help us get a better picture of how they are used.

We understand you must be busy dealing with the ongoing COVID-19 situation and we hope you will be able to spare about one hour of your time for the meeting. We are proposing the following potential dates and time slots for your consideration:

- October 29, 2020: 1:00 to 2:00 pm
- October 29, 2020: 2:00 to 3:00 pm
- October 29, 2020: 3:00 to 4:00 pm
- October 30, 2020: 1:00 to 2:00 pm
- October 30, 2020: 2:00 to 3:00 pm
- October 30, 2020: 3:00 to 4:00 pm

Please let us know your availability and we will send you a Zoom link. On behalf of the FDOT Public Transit Office, we thank you for your support for this project and look forward to meeting with you on the Zoom call.

Best Regards,

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APPENDIX D:

CHECKLIST TEMPLATE

Transit Service Planning Software Platform Checklist and Evaluation Form

GENERAL INFORMATION			
Person completing this form:		Date:	
Platform name:		Platform version:	
Company Name:		First release year:	
Headquarters address:			
Local office address:			
Contact name:		Contact title:	
Contact e-mail:		Contact phone:	

PLATFORM INFORMATION			
Application platform:	☐ browser based	☐ client server	☐ desktop
If cloud-based, name of cloud web service:			
If desktop or client server, list minimum system requirements:			
Database system (e.g., *MySQL*, *SQL Server*, *Oracle*):			
Mapping (e.g., *Google Maps*, *Mapbox*, *ArcGIS*):			
Street network source:			
Satellite image source:			
Mobile compatible:	☐ Yes ☐ Partial	☐ No	☐ N/A

	Vendor Column:	*Vendor Column:*	*Agency Column:*	*Agency Column:*
GENERAL PLATFORM FEATURES	Vendor Comments	Good Avg Poor		Agency Comments
Platform provides functions to (*check all apply*):				
☐ search routes		☐ ☐ ☐		
☐ search stops		☐ ☐ ☐		
☐ query stops		☐ ☐ ☐		
☐ query routes		☐ ☐ ☐		
☐ query demographic data		☐ ☐ ☐		
☐ list tabulated data attributes		☐ ☐ ☐		
☐ display route numbers		☐ ☐ ☐		
☐ display stop numbers		☐ ☐ ☐		
☐ display routes using actual transit line colors		☐ ☐ ☐		
☐ displays offset lines for overlapping routes		☐ ☐ ☐		
☐ add, delete, and move stops		☐ ☐ ☐		
☐ add, delete, and move routes		☐ ☐ ☐		
☐ edit stop attributes		☐ ☐ ☐		
☐ edit route attributes		☐ ☐ ☐		
☐ measure distances		☐ ☐ ☐		
☐ customize layer colors		☐ ☐ ☐		
☐ customize stop icons		☐ ☐ ☐		
☐ set line widths		☐ ☐ ☐		

INPUT DATA	Vendor Comments	Good	Avg	Poor	Agency Comments
Platform lets agency upload standard files (*check all apply*):					
☐ GTFS feeds		☐	☐	☐	
☐ GeoJSON files		☐	☐	☐	
☐ Shapefiles		☐	☐	☐	
☐ Stop pictures (JPG, TIFF, BMP, and PNG)		☐	☐	☐	
☐ None. Uploads performed by vendor only		☐	☐	☐	
Platform lets agency (*check all apply*):					
☐ access Census data site directly		☐	☐	☐	
☐ select ACS census data attributes		☐	☐	☐	
☐ calculate performance measures from Census data		☐	☐	☐	
Platform designed to apply agency data (*check all apply*):					
☐ Automatic Passenger Counter (APC)		☐	☐	☐	
☐ Automatic Vehicle Location (AVL)		☐	☐	☐	
☐ Automatic Fare Collection (AFC)		☐	☐	☐	
☐ Bus Stop Inventory (BSI)		☐	☐	☐	
☐ On-time performance data		☐	☐	☐	
Platform designed to apply demographic data (*check all apply*):					
☐ Decennial Census		☐	☐	☐	
☐ American Community Survey (ACS)		☐	☐	☐	
☐ Land use tax appraisal parcel data		☐	☐	☐	
☐ Employment data (e.g., *Dun&Bradstreet*, *InfoUSA* , etc.)		☐	☐	☐	
Platform designed to apply O-D data (*check all apply*):					
☐ Longitudinal Employer Household Dynamics (LEHD)		☐	☐	☐	
☐ National Household Travel Survey (NHTS)		☐	☐	☐	
☐ Census Transportation Planning Products (CTPP)		☐	☐	☐	
Platform designed to apply these other data (*check all apply*):					
☐ Traffic accident data		☐	☐	☐	
☐ Transit security data		☐	☐	☐	
☐ Transit vehicle data		☐	☐	☐	
☐ Transit driver data		☐	☐	☐	
☐ COVID-related data		☐	☐	☐	
☐ National Transit Database (NTD)		☐	☐	☐	
☐ Annual Average Daily Traffic (AADT)		☐	☐	☐	
☐ Roadway geometric data		☐	☐	☐	
☐ Traffic signal data		☐	☐	☐	
☐ Transit signal priority data		☐	☐	☐	
List any other data the platform is designed to use:					

DATA VISUALIZATION	Vendor Comments	Good	Avg	Poor	Agency Comments
Platform provides functions to (*check all apply*):					
☐ create stop-based thematic/Chrolopleth maps		☐	☐	☐	
☐ create route-based thematic/Chrolopleth maps		☐	☐	☐	
☐ create demographic thematic/Chrolopleth maps		☐	☐	☐	
☐ display ridership maps		☐	☐	☐	
☐ display speed maps		☐	☐	☐	
☐ display heat maps		☐	☐	☐	
☐ display origin-destination flow maps		☐	☐	☐	
☐ create charts		☐	☐	☐	
☐ create dashboards		☐	☐	☐	
☐ display buffers		☐	☐	☐	
☐ generate standard reports		☐	☐	☐	
☐ display data tables		☐	☐	☐	
☐ generate cross-classified tables		☐	☐	☐	
☐ sort tables		☐	☐	☐	
DATA APPLICATIONS	Vendor Comments	Good	Avg	Poor	Agency Comments
Platform provides functions to (*check all apply*):					
☐ perform route-based buffer analysis		☐	☐	☐	
☐ perform stop-based buffer analysis		☐	☐	☐	
☐ use walkshed buffers		☐	☐	☐	
☐ create reach map isochrones		☐	☐	☐	
☐ perform equity analysis		☐	☐	☐	
☐ perform transit accessibility analysis		☐	☐	☐	
☐ perform schedule adherence analysis		☐	☐	☐	
☐ perform bus stop balancing analysis		☐	☐	☐	
☐ perform bus stop improvement needs analysis		☐	☐	☐	
☐ perform transit capacity analysis		☐	☐	☐	
☐ perform transit service coverage analysis		☐	☐	☐	
☐ identify transit supportive areas		☐	☐	☐	
☐ plan trips (trip planner)		☐	☐	☐	
☐ optimize schedules		☐	☐	☐	
☐ perform runcutting		☐	☐	☐	
☐ generate timetables		☐	☐	☐	
DATA EXPORT	Vendor Comments	Good	Avg	Poor	Agency Comments
Platform provides functions to (*check all apply*):					
☐ export data using platform APIs		☐	☐	☐	
☐ export shapefiles		☐	☐	☐	
☐ export GeoJSON files		☐	☐	☐	
☐ export CSV and Excel files		☐	☐	☐	
☐ export GTFS files		☐	☐	☐	

LICENSING OPTIONS AND FEES	Vendor Comments	Good	Avg	Poor	Agency Comments
Licensing options (*check all apply*):					
☐ initial license fee with annual fee		☐	☐	☐	
☐ initial license fee with multi-year fee		☐	☐	☐	
☐ license fee based on number of vehicles		☐	☐	☐	
☐ license fee based on number of user accounts		☐	☐	☐	
☐ group licensing (e.g., statewide or regional)		☐	☐	☐	
License fees include (*check all apply*):					
☐ unlimited remote training		☐	☐	☐	
☐ on-site training (*indicate any limits in Comments field*)		☐	☐	☐	
☐ unlimited number of user accounts		☐	☐	☐	
☐ user account setup by agency		☐	☐	☐	
☐ user account setup by vendor only		☐	☐	☐	
☐ guest account with read-only privilege option		☐	☐	☐	
☐ all data uploads by vendor		☐	☐	☐	
☐ data uploads of standard files (e.g., GTFS) only by vendors		☐	☐	☐	
☐ unlimited data storage		☐	☐	☐	
☐ unlimited platform 24/7 access and usage		☐	☐	☐	
☐ all software upgrades		☐	☐	☐	
USER SUPPORT AND TRAINING	Vendor Comments	Good	Avg	Poor	Agency Comments
User support and training options include (*check all apply*)					
☐ email correspondences		☐	☐	☐	
☐ phone calls		☐	☐	☐	
☐ online problem submissions with assigned ticket numbers		☐	☐	☐	
☐ guaranteed response time (*indicate time in Comments field*)		☐	☐	☐	
☐ remote training with video conferencing		☐	☐	☐	
☐ on-site face-to-face training		☐	☐	☐	
☐ regular webinars		☐	☐	☐	
☐ video tutorials		☐	☐	☐	
☐ online help and library facilities		☐	☐	☐	
☐ step-by-step guided tours on platform with animated snips		☐	☐	☐	

CURRENT CLIENTS IN FLORIDA

Current Florida transit agencies using the platform:

ADDITIONAL COMMENTS

Please provide any additional comments below: