MOD

MOBILITY ON DEMAND

MOD SANDBOX DEMONSTRATIONS INDEPENDENT EVALUATION

TRIMET - OPEN TRIP PLANNER SHARED-USE MOBILITY EVALUATION PLAN

U.S. Department of Transportation

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16. Abstract

The Mobility on Demand (MOD) Sandbox Demonstration Program provides a venue through which integrated MOD concepts and solutions – supported through local partnerships – are demonstrated in real-world settings. For each of the 11 MOD Sandbox Demonstration projects, the MOD Sandbox Independent Evaluation includes an analysis of project impacts from performance measures provided by the project partners, as well as an assessment of the business models used.

This report constitutes the Evaluation Plan for the TriMet OTP SUM Sandbox project. It includes the following chapters: project overview; evaluation approach and process; evaluation schedule and management; and data collection & analysis plan.

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Project Overview

This chapter gives a brief introduction to the TriMet OTP SUM MOD Sandbox project that will be evaluated through this independent evaluation.

Introduction

Created in 1969, the Tri-County Metropolitan Transportation District of Oregon (TriMet) is a special district of the State of Oregon, governed by a 7-member Board appointed by the Governor. TriMet serves a population of approximately 1.8 million in the 533 square miles of the urban portion of the three-county Portland metropolitan area. It provides a full range of services through five light rail lines (MAX), some 84 bus routes, and a commuter rail line (WES). In FY2018, TriMet's bus ridership was 56.7 million and its rail ridership was nearly 39 million. TriMet also provides a door-to-door paratransit service (LIFT) for qualified persons with mobility challenges who are unable to ride on TriMet's fixed route services. TriMet's door-to-door LIFT service is supported by 258 LIFT buses, 15 vans and 52 taxis. These services are fully ADA-compliant, with most of buses and light rail vehicles featuring step-free, low-floor boarding. TriMet also provides operating support for Portland Streetcar.

Project Scope

The OpenTripPlanner (OTP), initially released as an open source project by TriMet in 2009, was the first to introduce multiple modes in one trip with the original focus on incorporating biking and walking networks with transit. Adoption of OTP has been strong, with implementation in dozens of cities and countries worldwide. TriMet is now building upon the core of OpenTripPlanner to incorporate shared-use mobility (SUM) options.

TriMet's OTP SUM project aims to create a complete open platform for the integration of transit and shared-use mobility options. The open data, software, and user interfaces, responsive on both web and mobile, will help customers make informed decisions about their mobility choices, including the critical first and last miles of transit trips where a bus or train alone doesn't always provide full access.

TriMet's project includes the development and expansion of two core data frameworks that current and future collaborative OTP initiatives can be built upon, producing replicable software and results for communities across the country. These two foundational core project elements are to:

- Extend the OpenTripPlanner code base to support the integration of transit trip planning with shared-use mobility modes, such as bike share and transportation network companies (TNCs), as well as updated real-time transit information.
- Implement a fully functional and comprehensive open geocoder built off the existing Pelias geocoder. Geocoding, or address locating, is a primary requirement for trip planning. A non-proprietary and non-restrictive option for address locating would substantially lower the barrier to entry for many transit

systems to offer trip planning, and can achieve significant cost savings for transit agencies, government agencies, and the public.

In addition to core elements on the foundation frameworks, the project also includes:

- Development of a comprehensive new web-based user interface that will allow users to make intermodal trip plans including shared-use mobility and demand-responsive service.
- Improvements to basemap data so the trip planner can support enhanced pedestrian accessibility information, and to regional address data that will make location search and geocoding more effective and user-friendly.
- Design and implementation of compatibility for future booking and payment options in moovel's RideTap product, so customers can plan and pay for their trips in one app.

Key Partners

TriMet's key partners are Conveyal, IBI Group, Cleared For Takeoff, moovel, and Oregon Metro. Other contributing partners include AC Transit, LA Metro, Vermont Agency of Transportation, Santa Clara Valley Transportation Authority, RTD Denver, City of Portland, Lyft, Uber, Motivate, Trillium Transit, Cambridge Systematics, Fehr and Peers; and Center for Urban Transportation Research.

Project Timeline

The main milestones for the TriMet OTP SUM project are captured in the timeline below. The evaluation timeline is provided in a later chapter of this report.

1. **January 18, 2017** – TriMet OTP Shared-Use Mobility Kickoff Workshop.
2. **January 20, 2017** – Phase I Start.
3. **Quarter 1 2017** – Milestone 1: Itinerary-Based Trip Planning.
4. **Quarter 2 2017** – Milestone 2: Geocoding, Bikeshare Support, Profile-Based Trip Planning.
5. **Quarter 3 2017** – Milestone 3: Real-Time Integration, Advanced Transit Mapping.
6. **Quarter 4 2017** – Milestone 4: Pedestrian Routing, Stop and Route Viewers
7. **Quarter 2 2018** – Milestone 5: Shared-Use Mobility, Extended UI Functionality
8. **April 18, 2018** – TriMet OTP Shared-Use Mobility Integration Design Workshop and Project Phase II Start.
9. **May – August 2018** – Test Version 1 and Field Demonstration Start
10. **October 2018** – Heuristic Study 1 and Subsequent Development Enhancements
11. **November 2018** – Heuristic Study 2
12. **December 2018 –** IE Online Survey
13. **January 20, 2019** – Project Close.

TriMet will collect data that is relevant to this MOD demonstration between August 2018 and January 2019. This data will be shared with the Independent Evaluation (IE) team for conducting the evaluation. More details on data collection planning is provided in Chapter 4 of this report.

Evaluation Approach and Process

For each of the 11 MOD Sandbox projects, the IE team developed an evaluation framework in coordination with the project team. The framework is a project-specific logic model that contains the following entries:

- **MOD Sandbox Project** – Denotes the specific MOD Sandbox project.
- **Project Goals** – Denotes each of the project goals for the specific MOD Sandbox project. The project goals capture what each MOD Sandbox project is trying to achieve.
- **Evaluation Hypothesis** – Denotes each of the evaluation hypotheses for the specific MOD Sandbox project. The evaluation hypotheses flow from the project-specific goals.
- **Performance Metric** – Denotes the performance metrics used to measure impact in line with the evaluation hypotheses for the specific MOD Sandbox project.
- **Data Types and Sources** – Denotes each of the data sources used for the identified performance metrics.
- **Method of Evaluation** – Denotes the quantitative and qualitative evaluation methods used.

This chapter details the evaluation approach and process, as finalized in the evaluation logic model for the TriMet MOD Sandbox project. This includes project goals, evaluation hypotheses, performance metrics, data types and sources, and methods of evaluation.

Project Goals

The project goals denote what TriMet is aiming to achieve through the MOD Sandbox demonstration. The project goals include the following:

1. Provide OTP users with comparable matching of addresses and other points of interest (POIs) such as business names, transit stop ID's, park and ride facilities relative to other leading trip geocoders.
2. Provide accurate geocoding results with regards to the point location when using OTP relative to other leading geocoders.
3. OTP SUM will provide users with travel options that allow them to get to their destinations more quickly.
4. Ensure trip planning results are accurate.
5. Enhance OTP's pedestrian routing logic to take advantage of newly added sidewalk tags, as well as other attributes of OpenStreetMap that reflect safety and pleasantness for pedestrians, to improve pedestrian trip plans.
6. Produce results for trips that currently do not return itineraries due to lack of transit service.

7. Develop data improvements that can be utilized by enhanced pedestrian routing logic.
8. Allow users to get information about and compare SUM options in addition to transit, bike, and walking options in OTP.
9. Improve the usability and design of the web-based OTP interface.
10. Provide users with real-time information regarding their trip plans, and any impact thereon.
11. OTP SUM will encourage travelers to use public transit for trips that previously faced first-mile or last-mile challenges.
12. Produce lessons learned through Stakeholder interviews.

The project goals set the foundation for the evaluation hypotheses.

Evaluation Hypotheses

The evaluation hypotheses flow from the project-specific goals and denote what should happen if each project goal is met. The evaluation hypotheses include the following:

1. The matching of addresses and other POIs in Pelias is comparable to other leading geocoders.
2. The accuracy of the geocoding results from Pelias with regards to point locations are comparable to other leading geocoders.
3. Trips planned using OTP will show faster travel times with shared mobility options incorporated, as compared to leading trip planners without shared mobility options.
4. The resulting itineraries and choices will be valid.
5. When routing pedestrians, OTP favors streets with sidewalks and lower environmental stress (e.g., lower speed limits and traffic volume).
6. Including multiple mode options should provide alternatives that currently do not exist with single modes.
7. Sidewalk presence/absence information is available for all streets in the TriMet trip planner region.
8. The project improves the accessibility of information for SUM options relative to prevailing options.
9. The usability and design of the web-based OTP interface is considered improved by testing respondents in the population.
10. The real-time information provided by the OTP interface will provide improved information that is considered useful to the user.
11. Users report that SUM options improve their ability to overcome first-mile/last-mile challenges.
12. The process of deploying the project will produce lessons learned and recommendations for future research, development and deployment.

The success of each evaluation hypothesis is measured by the performance metrics described below.

Performance Metrics

The performance metrics are used to measure impact in line with the evaluation hypotheses for the TriMet IE. These performance metrics include the following:

1. Difference between number of addresses and POIs correctly matched in Pelias and number of addresses and POIs correctly matched from other leading geocoders.
2. Difference between number of accurate address locations from Pelias and number of accurate address locations from other leading geocoders.
3. Difference in trip times of test trips from OTP and other leading trip planners on the market.
4. Survey response to questions probing reliability of planned trips.
5. Number of sample trips where new OTP can be configured to take a slightly longer but safer walking route rather than the shortest route.
6. Number of planned trip options and results.
7. Number of random samples where the OTP back-end contains correct sidewalk information, verified through Mapillary street-level imagery.
8. Survey response to questions probing perception of utility of SUM options in OTP.
9. Survey response to questions probing perception of usability and design of OTP web-based interface.
10. Survey response to questions probing perception of utility of real-time information presented by the updated OTP.
11. Survey response to questions probing perception of first-mile/last-mile information in OTP.
12. Qualitative documentation from stakeholder interviews.

The performance metrics will draw from a set of data sources that are specific to the project.

Data Types and Elements

The following data types and elements are used for computing the performance metrics that are defined for this evaluation:

1. System Testing Results (*Geocoding Test Results, OTP Accuracy/Validity, OTP Enhanced Pedestrian Accessibility, OTP Feasible Itineraries, Sidewalk Tests*):
    a. Array of test addresses and resulting geocoded locations
    b. Array of test trips that will be run through the trip planner to evaluate outputs
    c. Origin/Destination pairs (for comparison of walking trips)
    d. Randomly selected street segments in Portland metro area (to test for the presence and accuracy of sidewalk information)
2. Survey Data:
    - ***OTP Beta User Group*** (group surveyed once the primary development of the OTP is complete)

        a. Individual travel patterns
        b. Vehicle ownership
        c. Basic travel needs including:
            i. Home location
            ii. Up to three common destinations
        d. Correctness and reliability of the search outputs
        e. Solicited input on how outputs could be improved
        f. Response to the presence of shared-use mobility options in the OTP
        g. Perception of utility of real-time information presented by the updated OTP
        h. Perception of utility of information to overcome first-mile/last-mile challenges

i. Response to the OTP design and reliability based on feedback from the user testing.
j. Demographics.

3. Stakeholder Interview Data

Note that there is no one-to-one matching between the performance measures and the data types and elements. The mapping between performance measures and data types and elements is demonstrated in the evaluation logic model provided later in this chapter.

Data Sources

The following sources of data are used for the TriMet IE data collection :

1. Geocoding Test Data, which will consist of an array of test addresses and POIs with validated locations.
2. OTP Test Data for (a) Time and Cost Testing, (b) Accuracy Testing, (c) Walkability Testing, and (d) Feasible Itineraries Testing, which will consist of several origin-destination pairs with known travel time, commute modes, and transportation options.
3. Sidewalk Testing Data, which consists of tagging accuracy results for 100 random street segments, along with links to each segment with imagery.
4. Survey of Beta User Group, conducted once after the primary development of the OTP is complete.
5. Stakeholder Interview Data.

Data Sources Mapping

The following diagram shows the mapping of data sources, data sets, and performance measures that will be used in the independent evaluation of the TriMet MOD Demonstration. As shown, the datasets include both quantitative and qualitative data, and will be submitted to the USDOT ITS Public Data Hub.

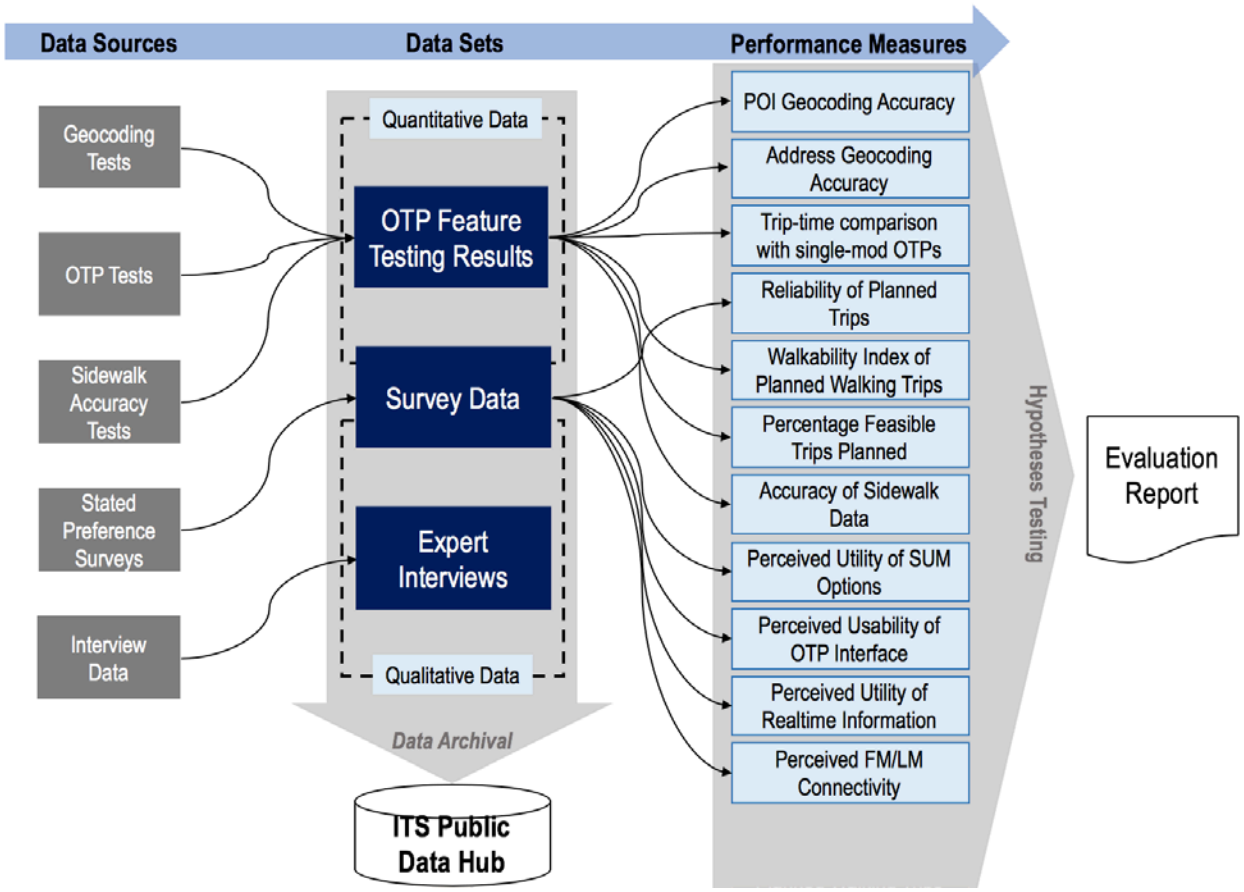


Figure 1. Map of Data Sources, Data Sets, and Performance Measures

Methods of Evaluation

The quantitative and qualitative evaluation methods used in the TriMet IE include:

- Statistical analysis of results, which are either correct (within validated polygon) or increasingly distant from polygon (increasingly wrong)
- T-test on count of binomial variables
- Statistical analysis of average travel times
- Survey of OTP beta group
- Multimodal trip comparisons against OTP and other leading trip planners
- Quality control of data
- Survey analysis
- Summary of expert interviews

Further details about the analysis methods by evaluation hypothesis are provided in Chapter 4.

Evaluation Logic Model

Table 1 below represents an extract from the final TriMet evaluation logic model. Building on the project goals, the logic model lists evaluation hypotheses, performance metrics, and data sources for the TriMet project.

Table 1. Evaluation Hypotheses, Performance Metrics, and Data Sources for the TriMet OTP SUM Sandbox Project

Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
1. The matching of addresses and other POIs for transit users in Pelias is comparable to other leading geocoders.	Difference between number of addresses and POIs correctly matched in Pelias and number of addresses and POIs correctly matched from other leading geocoders	Geocoding Test Results [Test Address/POI ID.	Geocoding Test Results
2. The accuracy of the geocoding results from Pelias with regards to point locations are comparable to other leading geocoders.	Difference between number of accurate address locations from Pelias and number of accurate address locations from other leading geocoders.	Geocoding Test Results [Test Address ID; Zone ID; Binary Test Score (1 = inside test polygon, 0 = outside test polygon); Distance from Centroid (ft)]	Geocoding Test Results
3. Trips planned using OTP will show faster travel times with SUM incorporated, as compared to leading trip planners without SUM.	Difference in trip times of test trips from OTP and other leading trip planners on the market.	OTP Time and Cost Comparison Results [Trip ID, origin, destination, departure time, estimated arrival time, trip cost] with single-mode and SUM-OTPs	OTP Time and Cost Comparison Results
4. The resulting itineraries and choices will be valid.	Survey response to questions probing reliability of planned trips.	Elements from Survey: Survey date; Age Bracket; HH Income Bracket; Disability Status; HH Size; Frequency of use of OTP (old version); User perception on accuracy of trip planning; User perception on reliability of planned trips.	OTP User Survey

Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
5. When routing pedestrians, OTP favors streets with sidewalks and lower environmental stress (e.g., lower speed limits and traffic volume).	Number of sample trips where new OTP can be configured to take a slightly longer but safer walking route rather than the shortest route.	Elements from new version of OTP: Trip ID, Origin, Destination, Walking Time, Walking Distance, Walkability Index	Walkability Trip Testing Results
6. Including multiple mode options should provide alternative that currently do not exist with single modes.	Number of planned trip options and results.	OTP Trip Comparison Results [Trip ID, origin, destination, number of trip options/results presented]	OTP Trip Comparison Results
7. Sidewalk presence/absence information is available for all streets in the TriMet trip planner region.	Number of random samples where the OTP back-end contains correct sidewalk information, verified through Mapillary street-level imagery	Test Sidewalk Test Elements: Link ID, Sidewalk Presence in OTP back-end, Sidewalk Presence in Mapillary Imagery and Aerial Photography	Sidewalk Test Results
8. The project improves the accessibility of information for SUM options relative to prevailing options.	Survey response to questions probing perception of utility of SUM options in OTP.	Survey Elements: Age Bracket; HH Income Bracket; Disability Status; HH Size; Frequency of use of OTP (old version); Mode share currently and with future expected use of OTP, Perceived usefulness of OTP in trip-planning, Perceived usefulness of having SUM options in OTP	OTP User Survey
9. The usability and design of the web-based OTP interface is considered improved by testing respondents in the population.	Survey response to questions probing perception of usability and design of web-based OTP interface	Survey Elements: Age Bracket; HH Income Bracket; Disability Status; HH Size; Frequency of use of OTP (old version); Perceived usability of OTP interface	OTP User Survey
10. The real-time information provided by the OTP interface will provide improved information that is considered useful to the user.	Survey response to questions probing perception of utility of real-time information presented by the updated OTP.	Survey Elements: Age Bracket; HH Income Bracket; Disability Status; HH Size; Frequency of use of OTP (old version); Perceived utility of real-time information	OTP User Survey

Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
11. Users report that SUM options improve their ability to overcome first-mile/last-mile challenges.	Survey response to questions probing perception of first-mile/last-mile information in OTP.	Survey Elements: Age Bracket; HH Income Bracket; Disability Status; HH Size; Frequency of use of OTP (old version); Perceived improvement in FM/LM connectivity	OTP User Survey
12. The process of deploying the project will produce lessons learned and recommendations for future research, development and deployment.	Qualitative documentation from stakeholder interviews.	Stakeholder inputs	Stakeholder Interviews

Documentation and Reporting

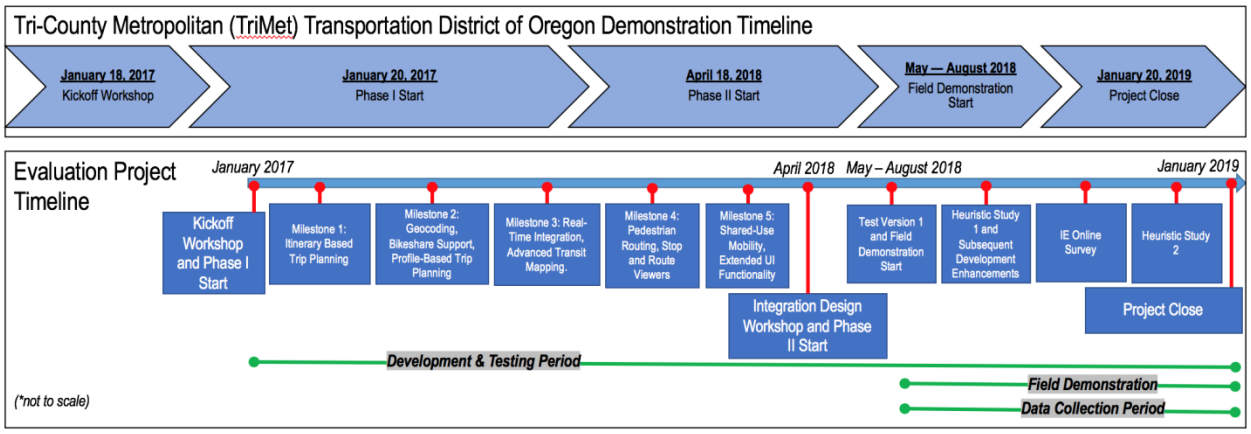
The IE team will develop an evaluation report for this MOD Sandbox demonstration project. The report will include a summary of major findings of the project in the executive summary section, followed by multiple sections providing demonstration details, evaluation hypotheses, data collected, analysis performed, findings, and results. The results will be reported through a mix of exhibits including tables, graphs, and charts.

Evaluation Schedule and Management

This chapter provides details on the evaluation project schedule and other details on the management of the evaluation project.

Evaluation Schedule

Figure 2 shows the IE schedule from the beginning of the quantitative and qualitative data collection that spans throughout the demonstration period and leads to the analysis, whose results are included in the site-specific evaluation report. Note that interim data spot checks and sample analyses will be performed during the demonstration period to proactively mitigate data-related risks.



Source: Booz Allen Hamilton, August 2018

Figure 2. MOD Sandbox Evaluation and Demonstration Schedule

Data relevant to the project will be collected between May — August 2018 and January 2019. This data will be shared with the IE team for evaluation purposes. More details on the data types, elements, and collection timeframes are provided in Chapter 4.

Roles and Responsibilities

The three main entities involved in the evaluation and their corresponding high-level roles are as follows:

The site team coordinates the collection of the requested evaluation data from the various project partners throughout the demonstration period and transfers the data to the IE team.

The IE team supports the site team in defining the requested data elements. This team also performs analysis using the data provided by the site team.

The USDOT team supervises the work and provides support for topics that encompass more than one site (e.g., coordination with transportation network companies who are partnering with several Sandbox sites).

Data Transfer and Storage

Various types of qualitative and quantitative data sources are involved in the evaluation, as specified in Chapter 4. Figure 3 below shows the overall data collection framework, including the steps and parties involved in data design, collection, transfer, and storage.

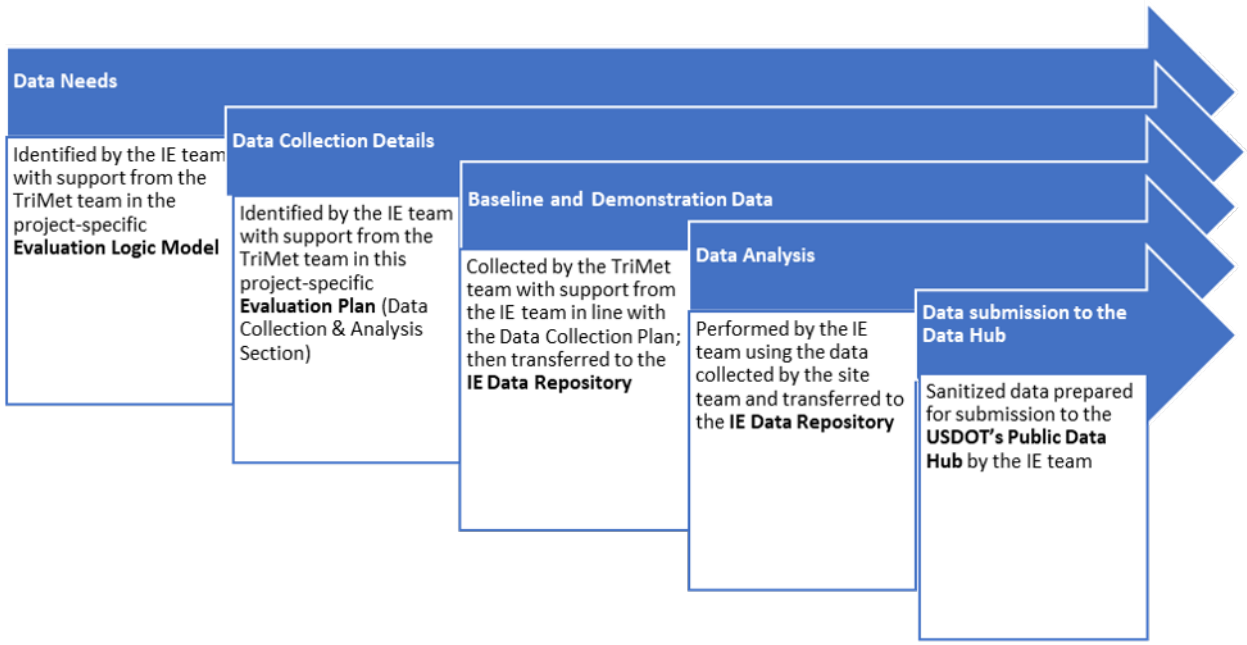


Figure 3. TriMet Data Collection Framework

Data Collection Responsibilities

Table 2 denotes the data collection responsibilities for the various data types required for the evaluation.

Table 2. Data Type and Data Collection Responsibilities for TriMet Sandbox Evaluation

Data Type	Data Collection Responsibilities
System Testing Data	• Six OTP tests are included in the data collection, which will be executed by the IE Team. They are (a) Geocoding Accuracy, (b) OTP Time/Cost Comparison, (c) OTP Accuracy/Validity, (d) OTP Pedestrian Walkability, (e) OTP Feasible Itineraries, and (f) Sidewalk Availability. • The TriMet team will provide test trips and other relevant data and transfer it to the IE team for analysis.

Data Type	Data Collection Responsibilities
Survey Data	• Survey questions are developed by the IE team in collaboration with the TriMet team (*draft questions are provided in Appendix A of this document*) • Surveys are administered by the IE team through the Qualtrics platform • The TriMet team is responsible for sending out survey links via email
Expert Interviews	• Interviewees are identified by the IE team in collaboration with the TriMet team • The IE team is connected to the interviewees by the TriMet team • The IE team conducts the expert interviews via phone or in person

Risk Management

The IE team will continually monitor risk in an ongoing process throughout the demonstration period and identify the best resources within the team to address each risk.

Some of the main risks involved in the evaluation are included below.

Schedule:

The IE team will maintain a demonstration tracking schedule to track progress and contact the demonstration teams for data and documentation. The team will keep an up-to-date integrated schedule that reflects updates from the site teams on a constant basis. Components of the evaluation reports will be created throughout the demonstration period, as the data and documentation for the project becomes available. The site team should inform the IE team of any changes in schedule that could affect the overall evaluation schedule (e.g., delays in the demonstration schedule).

Data Quality Assurance:

The IE team will perform spot checks on the data as it is being collected throughout the demonstration period to proactively manage risks related to data quality. This will allow for:

- Avoiding insufficient data on performance of MOD demonstration to reliably estimate impacts and/or benefits
- Addressing challenges in empirical data including lack of consistency, biases, and incompleteness
- Identifying and controlling sources of error
- Consideration of quality and quantity issues in data collection
- Ensuring data privacy and proprietary protections in line with human subjects' protections
- Consideration of confounding factors.

Table 3 includes risk mitigation strategies that will be employed to ensure the availability of the requested data types for the evaluation.

Table 3. Data Type and Risk Mitigation Strategies for TriMet Sandbox Evaluation

Data Type	Risk Mitigation Strategies
System Testing Data	• The system testing data importantly relies on having idealized ground-truth data. Having a less than statistically significant number of data points is a significant risk. The TriMet team should acknowledge this risk and proceed to ensure that ground-truth trip data is available for testing the validity and accuracy of the OTP.
Survey Data	• The TriMet team will recruit a Beta User Group and will ensure that these OTP users are willing to take the surveys.
Expert Interviews	• The TriMet team will facilitate the connection between the IE team and expert interviewees, and will help in getting their commitment to participate in the interviews.

Data Collection & Analysis Plan

This chapter describes the plan for data collection and analysis for the TriMet MOD Sandbox project evaluation. It summarizes the data that needs to be collected, and how that data should be processed and delivered to the IE team. Where possible, the IE team will help the Sandbox project team with processing the data in order to get the requested data format to conduct the calculations necessary for the evaluation. Any personally identifiable information will need to be removed when present in the data.

The data collection plan follows the evaluation logic model, with each data field discussed in association with a hypothesis and performance metric(s). Certain types of data collected address multiple hypotheses. In cases where the data structure is the same for more than one hypothesis, the plan refers to the data structure for a hypothesis already described.

The TriMet project is a technically rigorous project that is very focused on system and user testing. In addition to OTP tests that will be conducted by the IE team and are outlined in this report, the TriMet team will also be conducting a Heuristic Usability Study. The results of this study will be shared with the IE team and may be included for comparison in the final report. The main data collection components of the project relevant to the IE team include testing of the system to identify relative performance attributes along key dimensions of interest. In addition, the project will collect survey data from a *Beta User Group*. The Beta User Group will be surveyed once after the primary development of the OTP is complete. The Beta User Group will provide input and feedback that can be useful for further OTP design and development. Remaining data can be collected in coordination with the project team or independently.

Table 4 summarizes the data types, data elements, collection periods, and hypothesis alignment for the TriMet Sandbox project evaluation. The table is followed by a more detailed data collection and analysis plan for each evaluation hypothesis.

Table 4. Data Type, Data Elements, Period of Collection, and Hypothesis Alignment for TriMet Sandbox Project Evaluation

Data Type	Data Elements	Period and Frequency of Data Collection	Hypothesis Alignment
System Testing Results	• Array of test addresses and resulting geocoded locations • Array of test trips that will be run through the trip planner to evaluate outputs • Origin/Destination pairs (for comparison of walking trips) • Randomly selected street segments in Portland metro area (to test for the	The test addresses should be collected at least one month prior to testing the project geocoder. Testing of various related hypotheses would happen sequentially, as detailed in the analysis procedure for each hypothesis below.	1, 2, 3, 5, 6, 7

Data Type	Data Elements	Period and Frequency of Data Collection	Hypothesis Alignment
	presence and accuracy of sidewalk information)		
Survey Data (Beta User Group, which will be surveyed once, after the primary development of OTP is complete) (*sample survey is provided in Appendix A*)	Survey questions addressing: ● Individual travel patterns ● Vehicle ownership ● Basic travel needs including: o Home Location o Up to three common destinations ● Correctness and reliability of the search outputs ● Solicited input on how outputs could be improved ● Demographics ● Response to the presence of shared-use mobility options in the OTP ● Perception of utility of real-time information presented by the updated OTP ● Perception of utility of information to overcome first-mile/last-mile challenges • Response to the OTP design and reliability based on feedback from the OTP	The Beta User Group will be surveyed once, after the primary development of the OTP is complete.	4, 8, 9, 10, 11
Expert Interviews	Qualitative documentation from stakeholder interviews	Conducted at or shortly after the end of the project demonstration	12

Detailed Data Collection and Analysis Plan by Evaluation Hypothesis

Hypothesis 1: The matching of addresses and other POIs in Pelias is comparable to other leading geocoders.

Performance Metric: Difference between number of addresses and POIs correctly matched in Pelias and the number of addresses and POIs correctly matched in other leading geocoders.

Data Elements & Sources:

- Test addresses and resulting geocoded locations.

  The TriMet project team is supplying an array of at least 2,000 test addresses and points of interest that will determine if the geocoder correctly matches the text submitted, e.g., "Powell's City of Books" should return a location that includes the street address "1005 W. Burnside Street". A result is considered a match if it returns the correct name or address for a search, e.g., Portland International Airport when searching for "PDX'. The IE team may supply additional test addresses randomly drawn from the Portland metro area to complement the test addresses provided by TriMet and fill any gaps.

Data Collection Period:

The test addresses from TriMet have already been compiled. The IE team will identify any additional test addresses at least one month prior to testing the project geocoder.

Analysis Procedure:

The test addresses will be run through the following geocoders to obtain resulting geocoded locations for each geocoder:

- Google[1]
- Mapbox
- ArcGIS
- OpenStreetMap (Nominatim)
- Oregon Metro RLIS
- Geocode Earth
- SOLR
- Pelias

The IE team will identify which addresses were correctly geocoded (falling within the identified polygon) and those which were incorrectly geocoded. For those that were incorrectly geocoded, the IE team will determine the distance from the identified polygon as a measure of how "off" the resulting geocoded location was from the correct (validated) location.

In addition to the addresses prepared by the TriMet project team, the IE team will collect an array of addresses to test the geocoder. The IE team will then geocode the addresses using the Google API and the OTP. A small radius will be drawn around each point geocoded with Google. If a point geocoded by the OTP falls within the radius geocoded by Google, then the two agree, and it will be assumed that they are both correct. If they are both wrong, then they are both wrong in precisely the same way, which is possible, but unlikely. If the OTP geocoding falls outside the radius, then that point will be evaluated manually, to determine which (if either) is correct. The correct point will be recorded, and an error rate determined.

[1] Google geocoding results from July 2018, prior to the Google license and cost restrictions imposed.

The IE team will compare these results across the different geocoders to determine whether there is an overall superior geocoder among the ones considered. More specifically, the IE team will conduct a t-test on the count of binomial variables to determine whether there is a statistically significant result. A similar test could be used to compare the distances from polygons among incorrectly matched addresses.

Hypothesis 2: The accuracy of the geocoding results from Pelias with regards to point locations are comparable to other leading geocoders.

Performance Metric: Difference between number of accurate address locations from Pelias and number of accurate address locations from other leading geocoders.

Data Elements & Sources:

- Array of test addresses.

  For each test point, the project team prepared and validated an acceptable polygon, rather than a single point, because for many locations picking a single point would be arbitrary. Results that fall within the correct polygon are considered correct. Those outside the polygon are evaluated on their geodesic distance from the polygon. For example, “Powell’s City of Books”, should return coordinates, e.g., 45.5230525600, -122.681384800, that fall within the validated polygon for that location. Accuracy is defined by the distance (in feet) of the geocoding result to the actual location (as defined by the validated location polygons). The IE team may supply additional test addresses randomly drawn from the Portland/TriMet service area to complement the test addresses provided by TriMet and fill any gaps.

Data Collection Period:

The Tri-Met test addresses were compiled in Quarter 2 2017 and will be re-analyzed after completion of Task 4 final Milestone in Quarter 3 2018. The IE team may supply additional addresses beyond this period.

Analysis Procedure:

This hypothesis will take the dataset that was created through the OTP comparison with Google and then run the same analysis against several freely available geocoders as listed in Hypothesis 1.

The data tested will be validated in the initial comparison conducted with addresses against Google. This validated dataset will be evaluated against the other freely available geocoders using the same method. Additional mismatches will be evaluated in the same manner as in Hypothesis 1. Any errors discovered that were simultaneously present in Google and OTP will be used to inform outputs of Hypothesis

Hypothesis 3: Trips planned using OTP will show faster travel times with shared mobility options incorporated, as compared to leading trip planners without shared mobility options.

Performance Metric: Trip times of test trips from trip planners on the market.

Data Elements & Sources:

- Array of test trips that will be run through the trip planner to evaluate outputs

  Test trips will be used from the analysis of first OTP release in 2011. At that time, comparisons of times of 15 trips were captured and compared for OTP Bike-to-transit trips, Google transit trips, and the former TriMet propriety transit trips. Because we cannot compare multimodal trips to other planners (don't currently exist, we will be comparing the following trip time outputs from Google Transit Trips, TriMet Transit Trips, TriMet Transit + TNC trips. The travel times associated with each trip are the desired outputs.

Data Collection Period:

This analysis will be performed and data captured after the final Heuristic Usability Study is conducted.

Analysis Procedure:

The test trips will be run through the new version of OTP to get the travel times associated with each trip. Each OTP trip will offer an option to integrate shared mobility as an option for the trip. The same trips will be run through the other trip planning applications noted above that do not have shared use mobility included to obtain the corresponding travel times (E.g. Google Transit, TriMet Transit Trips). Since the travel times will be dependent on the test trip origin and destination distances, the IE team will first consider trip-by-trip comparisons. This will be in the form of taking the differences between the travel times associated with OTP and the travel times associated with another trip planner (e.g. Google) on a trip-by-trip basis. The IE Team will conduct a t-test to see whether the average difference in reported travel times by the trip planners differs significantly from zero (0). Additionally, the IE team will conduct a breakdown of the types of trips (or O/D pairs) that exhibit significant differences in reported travel times.

Hypothesis 4: The resulting itineraries and choices will be valid.

Performance Metric: Survey response to questions probing reliability of planned trips.

Data Elements & Sources:

- **Origin/Destination pairs**

  A survey will be deployed to a beta user group. During the survey, the user will be asked to supply one location that they travel to with regularity. They will be asked to plan the trip using the OTP. Respondents will be asked a short set of questions assessing the reliability and validity of the OTP outputs.

- **Survey of OTP beta user group**

  The material covered by the survey includes:

  - Individual travel patterns
  - Vehicle ownership
  - Basic travel needs including:

    - Home location
    - One common destination
- Correctness and reliability of the search outputs
- Solicited input on how outputs could be improved
- Response to the presence of shared-use mobility options in the OTP
- Perception of utility of real-time information presented by the updated OTP
- Perception of utility of information to overcome first-mile/last-mile challenges
- Response to the OTP design and reliability based on feedback from the OTP
- Demographics

Data Collection Period:

The survey will be jointly designed by the IE team and the project team. The project team will report when the application is ready for review by the beta user group, which will include members of the Riders Club that agreed to take the survey (about 1000 consented to this, aiming for a response rate of about 200). The survey will be set up in Qualtrics and deployed to the beta user group through email links that the TriMet project team sends out. The beta user group will be surveyed once, after the primary development of the OTP is completed.

Analysis Procedure:

The analysis of the survey data will evaluate the response of the beta user group participants to their inputs of home and a desired destination. The users will provide ordinal responses evaluating the reliability and validity of the OTP output to their stated input. OTP outputs that are reported to be problematic by the beta user group survey will be given to the TriMet project team for further review and testing.

Hypothesis 5: When routing pedestrians, OTP favors streets with sidewalks and lower environmental stress (e.g., lower speed limits and traffic volume).

Performance Metric: Number of sample trips where the new OTP can be configured to take a slightly longer but safer walking route rather than the shortest route.

Data Elements & Sources:

- Origin/Destination pairs supplied by project and IE teams

  The IE team will identify a sample of test trips with hand selected origins and destinations. These will be chosen with the guiding principle that there are several walking trip options of comparable length, but with differing sidewalk coverage and stress levels. The pairs have to be specially selected to cover walking trips that are faster via a more hostile pedestrian environment. The TriMet project team and the IE team will aim to develop at least 25 O/D pairs to test.

Data Collection Period:

The data collection period will occur after the release of the public beta survey. r

Analysis Procedure:

The test trips will be run through both versions of OTP to obtain resulting routes for each origin/destination pair. The O/D pair may also be run through Google, to identify the comparative result reported for walking trips. The IE team will then identify the route reported by each trip planner. The identified route will be scored using a composite walking score. The average difference in walking score will be evaluated across the identified test trips.

The IE team would then conduct a t-test on the count of binomial variables to determine whether there is a statistically significant result. Non-parametric tests will also be applied. The IE team would expect that the new version yields significantly more instances of success.

Hypothesis 6: Including multiple mode options should provide alternatives that currently do not exist with single modes.

Performance Metric: Increase in planned trip options and results.

Data Elements & Sources:

Address points, TriMet service district boundary, and walkshed.

Data Collection Period:

The data collection period for the addresses and subsequent analysis will occur after the release of the public beta survey.

Analysis Procedure:

Capture number of address points within Walkshed and TriMet service boundary and subtract that from total address points within TriMet service boundary. This will provide a measure to demonstrate potential SUM options in conjunction with transit that transit alone cannot provide. Resulting statics from geospatial queries.

Hypothesis 7: Sidewalk presence/absence information is available for all streets in the TriMet trip planner region.

Performance Metric: TriMet will provide a count of street segments and linear miles that were tagged during the project. A random sampling of 100 street segments will be verified using Mapillary street-level imagery and results will be documented, including links to these 100 segments.

Data Elements & Sources:

- Randomly selected streets in Portland metro area

  Set of 100 identified street segments to test. The IE team is interested in both the presence of sidewalk information as well as the content and whether it is actually correct. This content will be checked against aerial imagery data, which will cover the same street segments, as well as Mapillary street-level imagery.

Data Collection Period:

The selected street segments can be produced anytime during the project period of performance, following the completion of Hypothesis 2.

Analysis Procedure:

The selected street segments will be run through the new version of OTP as described above. The desired outputs are twofold: the presence of sidewalk information (framed as success/failure for each street) and the accuracy of sidewalk information (also framed as success/failure for each street). The accuracy will be obtained by comparing the OTP results with the aerial imagery data, as well as Google Street View. The success and failures found for the sidewalk content will be used as counts in statistical tests, like the t-test

Hypothesis 8: The project improves the accessibility of information for SUM options relative to prevailing options.

Performance Metric: Likert scale response to survey questions designed to assess the perception of utility of SUM options in OTP.

Data Elements & Sources:

- **Survey of OTP beta user group**

The survey will be implemented as described in Appendix A. Draft Survey Questions: Beta User Survey.

Data Collection Period:

The data collection period for the survey is as described in Hypothesis 4.

Analysis Procedure:

The survey data would be used to evaluate this hypothesis. The survey will ask users about their perception of shared mobility options in the updated OTP, and whether these additional options have improved their overall mobility and accessibility. The survey will also ask about their usage of shared mobility and about how useful the shared mobility information is (or isn't) within the planner. These responses will be aggregated according to specific metrics that capture relevant information, such as the percentage of users who feel as though the SUM options have increased their overall mobility and accessibility.

The survey will be deployed to the identified beta user group. Since the survey will include the elderly, minority populations, low income persons, and people with disabilities — all of which will be identifiable through survey questions — the IE team will disaggregate the analysis on separate demographic cohorts as necessary.

Hypothesis 9: The usability and design of the web-based OTP interface is considered improved by testing respondents in the population.

Performance Metric: Change in perception of usability and design of OTP web-based interface between a preliminary and final heuristic study, demonstrating improvements in satisfaction and feedback.

Data Elements & Sources:

- Survey of OTP beta user group

The survey will be implemented as described in Appendix A. Draft Survey Questions: Beta User Survey.

Data Collection Period:

The data collection period for the survey is as described in Hypothesis 4.

Analysis Procedure:

The survey data would be used to evaluate this hypothesis. The survey will ask users to evaluate the OTP interface as compared to previous versions of the OTP as well as other leading trip planners. The survey will also ask users to identify and assess any improvements that were made and rate their overall satisfaction with the product. These responses will be aggregated, either by group/use case or across the entire user population, and various metrics will be computed. The IE team will report measures such as the percentage of users who noted that improvements to design increased OTP's usability.

Hypothesis 10: The real-time information provided by the OTP interface will provide improved information that is considered useful to the user.

Performance Metric: Change in perception of utility of real-time information presented by the updated OTP.

Data Elements & Sources:

- Survey of OTP beta user group

  The survey will be implemented as described in Appendix A. Draft Survey Questions: Beta User Survey.

Data Collection Period:

The data collection period for the survey is as described in Hypothesis 4.

Analysis Procedure:

The survey data would be used to evaluate this hypothesis. The survey will ask users whether real-time information improved their ability to travel. These responses will be aggregated, either by group/use case or across the entire user population, to compute metrics of interest. For example, the IE team would calculate the percentage of users that indicate that the real-time information within OTP influenced how they plan and book their trips.

Hypothesis 11: Users report that SUM options improve their ability to overcome first-mile/last-mile challenges.

Performance Metric: Survey questions assessing response to first-mile/last-mile information in OTP.

Data Elements & Sources:

- Survey of OTP beta user group

  The survey will be implemented as described in Appendix A. Draft Survey Questions: Beta User Survey.

Data Collection Period:

The data collection period for the survey is as described in Hypothesis 4.

Analysis Procedure:

The survey data would be used to evaluate this hypothesis. The survey will ask users about their perception of first/last mile access and whether information on SUM options improved their access. This will allow the IE team to compute metrics like the percentage of users who express improved first/last mile access as a result of utilizing the SUM options.

Hypothesis 12: The process of deploying the project will produce lessons learned and recommendations for future research, development and deployment.

Performance Metric: Qualitative documentation from stakeholder interviews.

Data Elements & Sources:

- Stakeholder interviews

  This data is qualitative in nature. The project team will identify members that can be available to interview with the IE team (see Table 5 below). The project team should specify at least three people with enough knowledge on the project to talk candidly about its successes and challenges. The IE team will interview these candidates to understand the lessons learned from project implementation.

Table 5. Suggested Interviewee Name, Role/Affiliation, and Contact Info

Interviewee	Role/Affiliation	Contact Info
Ritesh Warade	Key Partner, IBI	ritesh.warade@IBIGroup.com
Courtney Longfellow	Key Partner, moovel	courtney.longfellow@moovel.com
David Emory	Key Partner, Conveyal	demory@conveyal.com
Aaron Antrim	Partner, Trillium Transit	aaron@trilliumtransit.com
Marshall Ballard	Partner, Fehr & Peers	M.Ballard@fehrandpeers.com
Sean Barbeau	Partner, CUTR	barbeau@cutr.usf.edu

Data Collection Period:

The data collection for stakeholder interviews should occur at the end, or near the end of the demonstration period.

Analysis Procedure:

An expert interview protocol will be developed. The interviews will be conducted and synthesized from notes and recordings into a summary describing key insights from experts directly involved in the project.

Appendix A. Draft Survey Questions: Beta User Survey

This section of the document describes the survey that will be implemented as part of the evaluation of the TriMet MOD Sandbox project. The *Beta User Group* survey will capture the user response to the OTP SUM. This survey probes respondents to report on one trip that they would plan with the OTP. They will then use the test OTP to plan that trip and report on the reliability of the results. This serves as the basis to address Hypothesis 4. The remaining questions asked to the Beta User Group will focus on the response and utility of the system, to address Hypotheses 8 through 11. *These questions are draft. Questions may be added, revised, and deleted from this version.*

Suggested Survey Process

TriMet will recruit from the Rider's Club those that have shown interest in participating in the survey. Approximately 1,000 riders will receive an email containing a link to a pre-survey, which will collect demographic information. This information will be used as the basis for selecting 250 testers that will be sent the full Beta User Survey (draft below).

Draft Survey

1. Including yourself, how many people live in your current household?

    - o 1
    - o 2
    - o 3
    - o 4
    - o 5
    - o 6
    - o More than 6

>>>>>>>>>>>>>>>>>>>>>>>>**Branch Rule: HOUSEHOLD**>>>>>>>>>>>>>>>>>**START**

IF (Response > 1) THEN NEXT

>>

2. How would you describe the other people in your current household? (e.g., if you live with your mother, select "Parent/Guardian(s)").

    Please check all that apply.

    - o Parent/Guardian(s)

- o Relatives (e.g., siblings, etc.)
- o Housemates/Roommates
- o Partner/Significant Other
- o Children (who are under your guardianship)

3. Please select the option that best describes your financial relationship to other people in your household. This question helps us correctly categorize your responses in terms of either household or individual.

    - o We share some expenses, like rent and utilities
    - o We share expenses and income, and make financial decisions together, like buying a car
    - o Other, please specify:__________________

>>>>>>>>>>>>>>>**Branch Rule: HOUSEHOLD**>>>>>>>>>>>>>>**END**

4. How many vehicles do **< you / your household > currently** own or lease?

    - o 0
    - o 1
    - o 2
    - o 3
    - o 4
    - o 5 or more

>>>>>>>>>>**Branch Rule: CURRENTLY_OWNS_VEHICLES>>>>>**>>>>**START**

If Response /= 0 THEN NEXT

>>>

5. Please list the year, make, and model of the vehicle(s) that **< you / your household > currently** own or lease as well as your best estimate of the miles driven on each during the last 12 months year (e.g., 2008 Honda Civic, 2000 miles per year).

    Make sure to report all miles driven on the vehicle(s) by anyone in your household. Please list the vehicle that you drive most first.

<Show only number of vehicles selected in Q4>

	Year	**Make**	**Model**	**Approximate Miles Driven in the Last 12 Months**
Vehicle 1				
Vehicle 2				
Vehicle 3				
Vehicle 4				

	Year	Make	Model	Approximate Miles Driven in the Last 12 Months
Vehicle 5				

6. Currently, about how many miles do **you drive alone** in personal vehicle every month?

<Drop down menu of miles>

>>>>>>>>>>>>>>>>>>>>>>>>>>**CURRENTLY OWNS VEHICLES: END**>>>>>>>>>>>>>>>>

Next, we will ask you about how you've traveled in the Portland region over the past 12 months.

7. Which of the following modes of transportation have you used in the **Portland region during the last 12 months**?

   Please check all that apply.

   - o Drive alone
   - o Drive/Ride with family/friend (non-commute)
   - o Carpool (for commuting)
   - o Walk (to a destination)
   - o Personal Bicycle
   - o Local Bus
   - o MAX & Streetcar
   - o WES
   - o Aerial Tram
   - o BIKETOWN
   - o Park & Ride
   - o Uber
   - o Lyft
   - o car2go
   - o Intercity Bus (e.g., Greyhound)
   - o Intercity Rail (e.g., Amtrak)
   - o Other ride-hailing or ride-sharing services (not Uber or Lyft)
   - o Taxi
   - o Motorcycle or Scooter
   - o Vanpool
   - o Microtransit and Commuter Vans (e.g., Chariot, Via, dollar vans)
   - o Employer Shuttle (for commuting)
   - o Car Rental within the Portland region
   - o Other, please specify: _____

8. Please indicate how frequently you **currently** use the following modes.

   <Only show modes selected in Q7>

	Not available to me or not in my area	Never in the last year	Once a year	Once every 6 months	Once a month	Twice a month	1-3 times per week	4-6 times per week	7-13 times per week	2-4 times per day	More than 4 times per day
<Mode selected in Q7>											
<Mode selected in Q7>											
<…>											

9. Which trip planner do you use most often to plan your travel?

- o TriMet trip planner (the old version)
- o Google Maps
- o Waze
- o Apple Maps
- o Bing Maps
- o Mapquest
- o Other, please specify: _____
- o None

TriMet has built a new trip planner that we would like you to help test for feedback and development. In the questions that follow, we will ask you about a specific location you may travel to, and ask you to test the trip planner with this location.

10. Please indicate two streets that cross near your **home** location as well as the city.

City: _____
Street #1:_____
Street #2:_____

We'll ask you to test the trip planner using this location.

Please think of one **destination** you may travel to from home, in which you may use the trip planner. You do not have to indicate what kind of destination this is, just indicate streets that cross near the destination as well as the city.

Cross streets are preferable, but if you do not remember the cross streets of the destination, you may indicate the name of that destination instead.

City: ____
Street #1:_____________________________________
Street #2:_____________________________________

Name: _______________________________________

Now, please go to the trip planner via the link below. Please conduct the trip planning search going from your home to the destination. The link below will open a new tab in your browser. After conducting the search, please return to this tab to complete the survey.

You may enter the locations as you did above (e.g., city and cross streets), or as exact addresses. You may also change any of the settings as you desire (e.g., changing the default modes of travel), just remember to keep track of any changes you make. It may be of use to keep the trip planning tab open as you answer the following questions about the results of your search.

Link: [not given here because not publicly available yet]

11. Please specify how you entered your **home** location within the trip planner for your search.
    - o I entered the city and cross streets
    - o I entered the exact address
    - o I entered something initially and then selected one of the suggested dropdown locations
    - o I selected the address by right-clicking on the map
    - o Other, please explain: ___________________

12. Please specify how you entered the **destination** within the trip planner for your search.
    - o I entered the city and cross streets
    - o I entered the name of the destination
    - o I entered the exact address
    - o I entered something initially and then selected one of the suggested dropdown locations
    - o I selected the address by right-clicking on the map
    - o Other, please explain: ________________________

13. Did you make any changes to the default settings?

    Please check all that apply.
    - o I changed the default modes of travel by adding or removing modes
    - o I changed the maximum mileage to walk or bike
    - o I changed the speed of walking or biking
    - o I changed which factor to optimize for
    - o I changed the time of the trip
    - o Other, please explain: ___________________

>>>>>>>>>>**Branch Rule: CHANGED SETTINGS>>>>>**>>>>**START**

If changed modes THEN NEXT

>>

14. Please indicate which modes were selected in your search.

Please check all that apply.

- o Bus
- o MAX & Streetcar
- o WES
- o Aerial Tram
- o Walk
- o Bicycle
- o BIKETOWN
- o Park & Ride
- o Uber
- o Lyft
- o car2go
- o I do not know

If changed maximum mileage, THEN NEXT

>>

15. Please indicate what the maximum **<walking or biking>** mileage was in your search.

<answer choices dependent on modes given>

If changed speed, THEN NEXT

>>

16. Please indicate what the **<walking or biking>** speed was in your search.

<answer choices dependent on modes given>

If changed optimization factor, THEN NEXT

>>

17. Please indicate which factor you optimized for in your search.

<answer choices dependent on modes given>

If changed time, THEN NEXT

>>

18. In which way did you change the time of your trip?

- o I changed it according to an exact departure time
- o I changed it according to an exact arrival time
- o I do not know

19. Please enter the exact time and date of your <departure or arrival> that was input into your search.

Hour:_____

Minute:___________

AM or PM: ________

Day: _____________

Month: ___________

Year: ____________

>>>>>>>>>>>>>>>**Branch Rule: CHANGED SETTINGS**>>>>>>>>>>>>>>**END**

In the questions that follow, we are interested in your response to and opinion of the outputs you got from your trip planning search.

20. How many results (trip options) were returned for your search?

- o 0 (there were no viable options)
- o 0 (a functional error appears to have occurred
- o 1
- o 2
- o 3
- o More than 3

>>>>>>>>>>**Branch Rule: GOT RESULTS>>>>>**>>>>**START**

If Response /= 0 THEN NEXT

>>

21. In your opinion, how **correct** were the results returned for your search?

- o Totally correct (e.g., both locations were accurate)
- o Some parts correct, some parts incorrect (e.g., only one location was accurate)
- o Totally incorrect (e.g., neither location was accurate)
- o I don’t know

22. In your opinion, how **reliable** were the results returned for your searches?

- o Totally reliable (e.g., the suggestions were plentiful and reasonable/doable; my trip needs were completely met)
- o Some parts reliable, some parts unreliable (e.g., the suggestions were limited with some uncertainty as to whether they were reasonable/doable; my trip needs were only partially met)
- o Totally unreliable (e.g., the suggestions did not make sense and clearly were unreasonable/undoable; my trip needs were not at all met)
- o I don’t know

23. Which option did you consider to be the best for you in your search?

<only show number of options selected in Q20>

- o Best Bet (Option 1)
- o Option 2
- o Option 3
- o Other, please specify: _____
- o None

24. Which option did you consider to be the worst for you in your search?

<only show number of options selected in Q20>

- o Best Bet (Option 1)
- o Option 2
- o Option 3
- o Other, please specify: _____
- o None

25. Overall, how would you rate the results returned for your search? Please rate on a scale of 1 to 10, where 10 is Excellent and 1 is Very Poor.

- o 1 (Very Poor)
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7
- o 8
- o 9
- o 10 (Excellent)

>>>>>>>>>>>>>>>>>>>>>>>>>>**GOT RESULTS: END**>>>>>>>>>>>>>>>

26. Do you have any feedback for the content or format of your search?

<text box>

These next questions will ask about your overall opinion of and experience with the trip planner. Feel free to explore it more and try out different features before answering the following questions.

27. Overall, how would you rate the usefulness of the real-time information within the trip planner? Please rate on a scale of 1 to 10, where 10 is Very Useful and 1 is Not At All Useful.

- o 1 (Not At All Useful)
- o 2
- o 3
- o 4
- o 5
- o 6

- o 7
- o 8
- o 9
- o 10 (Very Useful)

28. To what extent does the real-time information improve your ability to **plan for travel** as compared to the previous TriMet trip planner (the old version, not the one tested with this survey)?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know, I did not use the previous trip planner
    - o I don't know, I did use the previous trip planner, but do not have enough experience to compare them

29. To what extent does the real-time information improve your ability to **plan for travel** as compared to the third-party trip planner you use most often (e.g., <piped from Q9>)?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know, I do not have enough experience with <piped from Q9> to compare them

30. To what extent does the real-time information improve your ability to **book travel** using a trip planner?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know

31. Overall, how would you rate the usefulness of having access to **shared mobility** within the trip planner? Please rate on a scale of 1 to 10, where 10 is Very Useful and 1 is Not At All Useful.

    Note: Shared mobility is defined as the shared use of a vehicle, bicycle, or other travel mode that enables users to have short-term access to a mode of transportation on an as-needed basis. Shared mobility includes modes such as carsharing (e.g., car2go), bikesharing (e.g. BIKETOWN), as well as Uber and Lyft.

    - o 1 (Not At All Useful)
    - o 2
    - o 3
    - o 4
    - o 5
    - o 6
    - o 7
    - o 8
    - o 9
    - o 10 (Very Useful)

32. To what extent does the trip planner improve your access to planning travel with **shared mobility** as compared to the previous TriMet trip planner (the old version, not the one tested with this survey)?

- o Greatly improves
- o Moderately improves
- o Slightly improves
- o No noticeable improvement
- o I don't know, I did not use the previous trip planner
- o I don't know, I did use the previous trip planner, but do not have enough experience to compare them

33. To what extent does the trip planner improve your access to planning travel with **shared mobility** as compared to the third-party trip planner you use most often (e.g., <piped from Q9>)?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know, I do not have enough experience with <piped from Q9> to compare them

34. To what extent do you feel that having access to **shared mobility** options will increase your mobility and accessibility?

    I expect that it will…

    - o Greatly improve my mobility
    - o Moderately improve my mobility
    - o Slightly improve my mobility
    - o Not impact my mobility too much

35. Presently, how good do you feel is your ability to connect **to and from** public transit?

    - o 1 (Very poor)
    - o 2
    - o 3
    - o 4
    - o 5
    - o 6
    - o 7
    - o 8
    - o 9
    - o 10 (Excellent)

36. To what extent do you feel having information on SUM options improve your ability to overcome first-mile/last-mile challenges that you face with public transit?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know
    - o I do not use public transit
    - o I do not face first mile/last-mile challenges with public transit

37. Overall, how would you rate the overall design interface of the trip planner? Please consider how elements of the design affect your ability to navigate, change settings, quickly get search results, etc. Please rate on a scale of 1 to 10, where 10 is Excellent and 1 is Very Poor.

- o 1 (Very Poor)
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7
- o 8
- o 9
- o 10 (Excellent)

38. To what extent does the design interface improve your ability to **plan for travel** as compared to the previous TriMet trip planner (the old version, not the one tested with this survey)?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know, I did not use the previous trip planner
    - o I don't know, I did use the previous trip planner, but do not have enough experience to compare them

39. To what extent do the design changes improve or increase the TriMet trip planner's usability?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know, I did not use the previous trip planner
    - o I don't know, I did use the previous trip planner, but do not have enough experience to compare them

40. To what extent does the design interface improve your ability to **plan for travel** as compared to the third-party trip planner you use most often (e.g., <piped from Q9>)?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know, I do not have enough experience with <piped from Q9> to compare them

41. To what extent does the design interface improve your ability to **book travel** using a trip planner?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know

42. Overall, how would you rate the functionality of the map within the trip planner? Please rate on a scale of 1 to 10, where 10 is Excellent and 1 is Very Poor.

    - o 1 (Very Poor)
    - o 2

- o 3
- o 4
- o 5
- o 6
- o 7
- o 8
- o 9
- o 10 (Excellent)

43. Currently, how would you rate your ability to get to and from public transit in the Portland region? Please rate on a scale of 1 to 10, where 10 is Excellent connectivity and 1 is Very Poor connectivity.

    - o 1 (Very Poor)
    - o 2
    - o 3
    - o 4
    - o 5
    - o 6
    - o 7
    - o 8
    - o 9
    - o 10 (Excellent)

44. To what extent does the trip planner improve your ability to get to or from public transit in the Portland region?

    - o Greatly improves
    - o Moderately improves
    - o Slightly improves
    - o No noticeable improvement
    - o I don't know

45. Do you expect that access to this trip planner will change the ways in which you travel in the future?

    Overall, because of access to this trip planner, I expect to travel by…

    <Only show modes selected in Q7 and modes in trip planner>

	I have not used this mode, and I do not expect to in the future	Much more often	More often	About the same	Less often	Much less often	Will change, but not because of the trip planner
<Mode selected in Q7>							
<Mode selected in Q7>							
<…>							
Walk (to a destination)							
Personal Bicycle							
Local Bus							
MAX & Streetcar							
WES							
Aerial Tram							
BIKETOWN							
Park & Ride							
Uber							
Lyft							
car2go							
Other, please specify: _____							

46. Overall, how would you rate your satisfaction with the trip planner? Please rate on a scale of 1 to 10, where 10 is Excellent and 1 is Very Poor.

    o 1 (Very Poor)
    o 2

- o 3
- o 4
- o 5
- o 6
- o 7
- o 8
- o 9
- o 10 (Excellent)

47. What do you like most about this planner?

<text box>

48. What do you like least about this the trip planner? How could it be improved?

<text box>

49. Have you used the previous TriMet trip planner (the old version, not the one tested with this survey)?

- o Yes
- o No

>>>>>>>>>>**Branch Rule: USED OLD VERSION>>>>>**>>>>**START**

50. On average, how frequently do you use it?

- o More than 4 times per day
- o 2 to 4 times per day
- o 7 to 13 times per week
- o 4 to 6 times per week
- o 1 to 3 times per week
- o Twice a month
- o Once a month
- o Once every 6 months
- o Once a year
- o Never in the last year

>>>>>>>>>>>>>>>>>>>>>>>>>>> **USED OLD VERSION: END**>>>>>>>>>>>>>>>

Now, we will ask you questions about your demographic profile.

51. Which do you identify with?

- o Male
- o Female
- o Transgender
- o Other, please specify: _____
- o Prefer not to answer

In what year were you born?

Drop-down <years>

52. Do you use a wheelchair?

    - o Yes
    - o No

53. Do you have other disabilities that require specialized accommodations for transportation?

    - o Yes
    - o No

54. Do you require transportation vehicles and infrastructure that are ADA compliant (wheelchair or scooter accessible) to get around?

    - o Yes
    - o No

55. What is the highest level of education you have completed?

    - o Less than high school
    - o Currently in high school
    - o High school/GED
    - o Currently in 2-year college
    - o 2-year college degree
    - o Currently in 4-year college
    - o 4-year college degree
    - o Currently in post-graduate program
    - o Post-graduate degree (MA, MS, PhD, MD, JD, etc.)
    - o Prefer not to answer

56. What is your race or ethnicity?

    Please check all that apply.

- o African American/Black
- o American Indian or Alaskan Native
- o Asian/Southeast Asian
- o Caucasian/White
- o Hispanic or Latino
- o Middle-Eastern/North African
- o Native Hawaiian or Pacific Islander
- o South Asian (e.g., Indian, Pakistani, etc.)
- o Other, please specify: _____
- o Prefer not to answer

57. Please indicate the number of household members (including yourself) that fall into the different age groups listed below.

	0 people	**1 person**	**2 people**	**3 people**	**4 people**	**5 people**	**More than 5 people**
0 - 5							
6 - 15							
16 - 18							
19 - 65							
66 or older							

58. What kind of housing do you currently live in?

- o Detached single-family home
- o Attached single-family home
- o Building with more than 100 units
- o Building with between 10 and 100 units
- o Building/house with fewer than 10 units
- o Mobile home/RV/Trailer
- o Other, please specify: _____
- o I don't know

59. Approximately what was <**your or your household's**> gross (pre-tax) household income in last year?

- o Less than $10,000
- o $10,000 to $14,999
- o $15,000 to $24,999
- o $25,000 to $34,999
- o $35,000 to $49,999
- o $50,000 to $74,999
- o $75,000 to $99,999
- o $100,000 to $149,999
- o $150,000 to $199,999
- o $200,000 or more
- o Prefer not to answer

60. Please indicate two streets that cross near your **work** location as well as the city. If you do not commute to work, you can skip this question.

City:_____
Street #1:_____
Street #2:_____

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