FRAMEWORK and APPROACH TO FERRY DEMAND MODELING IN THE PORTLAND METRO

ECOnorthwest

Study commissioned by FRIENDS OF FROG FERRY

ECONOMICS • FINANCE • PLANNING
Friends of Frog Ferry Demand Modeling: Summary of Technical Report

March 2020

**Goal:** Estimate ridership for key stops as designated by PBOT, TriMet and Metro along the proposed transit route.

**Methodology:** TriMet required the use of Metro’s Travel Demand Model (TDM) which is frequently used to determine demand for planned transit investments with the Portland-Vancouver metropolitan region. The TDM generally is comprised of trip generation, trip distribution, mode choice, and trip assignment. It should be noted that the Portland regional TDM was not built for ferry operations, as water transit has specific characteristics that are difficult to characterize in a model built for land-based transportation modes. A traveler’s mode choice is a function of four key variables: travel time, travel cost, household characteristics and the physical urban environment.

1. We ran the initial model in Summer 2019 and the results were inconclusive, due to the model not taking into consideration the differences a ferry service presents.
2. In Fall 2019, Friends of Frog Ferry hired ECONorthwest to reach out to other West Coast ferry services to bring their best practices and approaches to the Portland’s regional TDM. ECONorthwest brought what they learned and applied them to the assumptions, working with Metro, PBOT and TriMet, to get a more optimistic set of results. **This report reflects this work.**
3. To Be Determined: In 2020 or 2021, we will need to contract with a Passenger Ferry Demand Agency consultancy to help assess rider profiles, pricing, and drivers determining mode choice to get a better assessment for the benefit-cost analysis.

**Ferry Service Passenger Characteristics:** Studies have identified that users of ferry services valued safety, reduced stress, and vessel comfort as relevant characteristics for choosing that mode\(^1\),\(^2\). Additionally, researchers have found that travelers are willing to trade longer travel times for increased amenities on water transit services, resulting in different perceptions of how travelers weigh the benefits and costs associated with that mode choice. Passengers value on-time reliability, the highest use of their time/commute experience, time and cost.

**San Francisco Bay Ferry/WETA:** Determining ridership for new routes was analytically challenging. Their initial attempts to use travel-demand models to estimate ridership were inconclusive. As a result, they launched an extensive market study to determine appropriate strategies for route selection and understand which characteristics of ferry travel were relevant for measuring traveler preferences for service across various segments.\(^3\)

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Kitsap County/Seattle: Like San Francisco Bay Ferry, an analytic approach using a TDM was eventually used for sensitivity testing but was a result of an extensive data collection process, rather than the foundation of further analysis. This approach was a success for the county. The surveys and community engagement helped identify key strategies that would yield the desired outcomes for a pedestrian ferry service. A key outcome of resulting from this effort was that connectivity to the ferry service was a critical component of the service.

Like San Francisco Bay Ferry, Kitsap County also found that demand for the service extended beyond commuters. During peak summer months, non-peak weekday service can include up to 30 non-commuter trips (~25 percent of capacity) and weekend service to Seattle can often be at capacity during that time. Since launching the service, Kitsap County has continued refine its scheduling and reservation system to work out inefficiencies but has generally found that demand was in-line with their early ridership estimates.

Friends of Frog Ferry Model Outputs and Estimated Ridership Summary: Based on the parameter changes described above, ridership estimates across all the Express routes increased from the initial Demand Modeling attempt. Across all three segments, park-and-ride users accounted for a large portion of the increased ridership. Using park-and-ride as a proxy for access to the terminal suggests that access is a critical feature to increasing ridership. This generally aligns with feedback from ferry planners that increasing the catchment area for connectivity to the terminal is a key feature of successful ferry service. However, some caution should be used in interpreting these results. We do not have a complete set of comparisons across all parameter changes and interactions in the model, making the marginal effect of each parameter change difficult to describe without further information.

Recommendation: In effect, this analysis attempts to build a “best case” scenario of ridership demand within the existing specifications of Metro’s regional transportation model. As Metro notes within their own description of the results, these ridership estimates are intended to be exploratory and are not official forecasts of ridership. In order to demonstrate the viability of ferry service, a financial feasibility study should be completed to ensure revenues can be generated to cover the cost of providing that service. Within that context, the revised demand estimates may be sufficient to sustain a financially feasible initial phase of operations proposed by Frog Ferry. Therefore, we recommend using this analysis as a foundation to further investigate the range of potential benefits associated with Frog Ferry’s proposed service.

Action: Based on these findings TriMet agreed to move the ODOT Statewide Transit Improvement Fund grant award of $200,000 forward (as the grant sponsor since FFF is not a designated direct recipient as a nonprofit agency), which triggers a $40,000 match from PBOT to fund the Operational Feasibility Study and Finance Plan, which will be conducted in Q1 and Q2 2020. Both plans will be created by Friends of Frog Ferry with support from sub-contracting ferry operations and dock engineering experts.
The Oregon Department of Transportation (ODOT) awarded a Statewide Transportation Improvement Fund (STIF) grant to investigate the feasibility of a pedestrian ferry service in the Portland Metro. Tri-Met agreed to be the partner public agency to administer the grant. As part of that process, Metro conducted an initial demand study in collaboration with Friends of Frog Ferry (FFF), the Portland Bureau of Transportation (PBOT), and Tri-Met. The initial ridership estimates, resulting from the demand modeling, demonstrated low ridership across each of the FFF proposed routes. Appendix A presents the full results from the initial demand modeling study (May 24, 2019).

ECONorthwest (ECO) was not involved in the creation of the assumptions for the initial demand modeling of the proposed ferry system. Subsequently, FFF asked ECO to review the results of the initial demand modeling to determine if the approach was like those used by other regional ferry services, and to see if there were any best practices or suggested revisions to the initial methodology and assumptions.

This technical memorandum outlines the steps taken to build on the preliminary ridership estimates and describes the results of that effort. Additionally, it describes key highlights from discussions with other transit agencies regarding their approaches to model ridership for ferry service.

This process was a collaborative effort with Metro as it involved updating some of the assumptions in their initial travel demand model. The focus of the update was on: (1) assumptions that influence a change in mode of transportation toward ferry service and (2) assumptions that represent a range of perceived costs and benefits associated with ferry service. The results of the updated modeling efforts are summarized in this memo, along with results from Metro’s memorandum, attached as Appendix B.

OVERVIEW

To estimate ridership along the proposed water transit routes, Tri-Met requested the use of Metro’s travel demand model (TDM), which is frequently used to model demand for planned transit investments within the Portland-Vancouver Metropolitan region. TDM’s are analytic tools used to forecast travel patterns and evaluate the effectiveness of proposed infrastructure and transit projects in a region’s transportation network. There are several methods for developing TDM’s, but trip-based models generally revolve around four primary steps to estimate demand: trip generation, trip distribution, mode choice, and trip assignment.

MODELING APPROACH

To estimate ridership along the proposed water transit routes, Tri-Met requested the use of Metro’s travel demand model (TDM), which is frequently used to model demand for planned transit investments within the Portland-Vancouver Metropolitan region. TDM’s are analytic tools used to forecast travel patterns and evaluate the effectiveness of proposed infrastructure and transit projects in a region’s transportation network. There are several methods for developing TDM’s, but trip-based models generally revolve around four primary steps to estimate demand: trip generation, trip distribution, mode choice, and trip assignment.

EXHIBIT 1. CONVENTIONAL FOUR-STEP TDM PROCESS

Each of the four steps are complicated and data intensive. This memo does not describe Metro’s TDM in detail. For those who are curious about modeling travel demand broadly, or Metro’s
model specifically, more information is available on their website. Relevant to this analysis is understanding the “mode choice” or the number of travelers choosing to use the various modes of transportation included in the model. Broadly, mode choice is a function of several key variables:

**TRAVEL TIME:** time spent in-vehicle or out-of-vehicle to reach destination.

**TRAVEL COST:** the cost of parking, transit fares, tolls, and operating vehicle.

**HOUSEHOLD CHARACTERISTICS:** household size, income level, age, number of workers, and auto ownership.

**URBAN FORM:** the physical characteristics, such as density, shape, and size that make up the built area being studied.

The number of trips estimated for each mode of travel is a function of how competitive the mode is across each of these variables, conditioned on the demand for travel between each of the origin-destination pairs. Underlying this choice of mode is an assumed utility function, which describes the benefits and costs of that mode to each hypothetical person included in the model. In this context, “utility” simply means the benefits that a consumer derives from using a particular mode of transportation. In the context of travel demand modeling, benefits account for the perceived advantages from traveling to a location, while costs account for the real and perceived costs of using that mode for travel.

The sequential nature of the four-step trip generation process, along with the constrained choice set for how individuals choose to move through a transportation network, make these types of models an efficient tool for forecasting and decision-making. Like any analytic tool, however, TDMs have limitations. For example, trip-based models do not account for non-utilitarian travel, including tourism or novelty trips. They instead focus on home-based trips to work. Network reliability is also not typically a component of these models. Therefore, travel costs associated with variable congestion are not considered within the individual’s choice set.

Water transit has specific characteristics that are difficult to characterize in a model built for land-based transportation modes. Studies have identified that users of ferry services valued safety, reduced stress, and vessel comfort as relevant characteristics for choosing water transit. Additionally, researchers have found that travelers are willing to trade longer travel times for increased amenities on water transit services, resulting in different perceptions of how travelers weigh the benefits and costs associated with choosing water transit. With these limitations and distinctions in mind, ECO collaborated with regional transit planners and Metro to refine key model parameters so that they are reflective of user preferences for ferry service within the existing model’s structure.

Ferry service is not a mode of transportation included in Metro’s TDM. Therefore, to best approximate consumer decision making, ECO modeled ferry service as a new light rail line (MAX). In the construct of the Metro TDM, light rail has the highest individual utility making it the most likely mode to induce a mode split relative to other modes of transportation in the model.

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1 Oregon Metro provides a well-written overview on the components of transportation modeling, which can be found at: https://www.oregonmetro.gov/sites/default/files/2014/05/22/transportation_modeling_overview.pdf

2 For a more detailed discussion of the general limitations and future op of the four-step travel demand model, see Mladenovic’s & Trifunovic’s 2014 article titled “The Shortcomings of the Conventional Four Step Travel Demand Forecasting Process” published in the Journal of Traffic and Tomorrow Engineering.


ECO reached out to several west coast ferry operators to discuss their approaches for route selection and demand modeling as well as to provide technical advice, based on their experiences, to help refine key parameters in the TDM. ECO consulted with San Francisco Bay Ferry and Kitsap County. Both conversations provided useful context and insight for our work. The highlights from those conversations are:

**San Francisco Bay Ferry**
The San Francisco Bay Area Water Transit Authority went through a process of determining how to expand commuter ferry service within the region. Determining ridership for new routes was analytically challenging. Their initial attempts to use travel-demand models to estimate ridership were inconclusive. As a result, they launched an extensive market study to determine appropriate strategies for route selection and to understand which characteristics of ferry travel were relevant for measuring traveler preferences for service across various segments. The results of the analysis provided a better understanding of key characteristics for route selection and served as the foundation for an analytic tool for estimating demand.

In addition to evaluating commuter routes, the agency uses intercept surveys to estimate tourism and non-commuter traffic. This allows trips to be segmented by purpose in addition to origin-destination pairs, cost, and household characteristics. In other words, this approach provides San Francisco Bay Ferry a glimpse into how, when, and why people choose to use the ferry system. This additional step is important for San Francisco Bay Ferry because on several routes 25-30 percent of passengers are non-commuters.

The time San Francisco Bay Ferry spent refining their approach appears to be successful. According to San Francisco Bay Ferry, the East Bay Corridor generates an average of 280,000 trips per day. During peak hour traffic, this can represent up to 10 percent of total demand for trips along that corridor. Ridership is highly dependent on the corridor measured. However, average ridership estimates show increases in both new users and loyal users (those riding 10+ years) of the ferry system. San Francisco Bay Ferry expects this trend to continue into future years.

**Kitsap County**
The Puget Sound region has an extensive history of ferry service dating back to the early 20th Century. Passenger-only service declined after World War II as the road network expanded, despite several attempts to revive this service. Kitsap County recently went through the process of developing a business plan and implementing a passenger-only ferry service for direct commute service to Seattle. After exploring several approaches for their route selection, the County settled on a robust community engagement approach. This included numerous community meetings with local stakeholders to gauge interest in the service. Additionally, they used intercept surveys to understand where residents were commuting to work and their existing mode of transportation.

Like San Francisco Bay Ferry, an analytic approach using a TDM was eventually used for sensitivity testing. This was a result of an extensive data collection process rather than the foundation of further analysis. This approach was a success for the county. Their surveys and community engagement efforts helped identify key strategies that would yield the desired outcomes for a pedestrian ferry service. A key outcome resulting from this effort was connectivity to the ferry service — a critical component of the service.

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In addition to developing optimal routes and testing sensitivity to fare structure, Kitsap County developed park-and-rides and aligned bus schedules and routes to ensure residents could use multiple modes to access the ferry terminal. Since the service was implemented, the County has worked with Sound Transit to expand their connective services into Pierce County to meet demand. Since December 2018, Kitsap County’s fast ferry service averaged just under 40,000 riders per month,\(^7\) operating near 78 percent capacity.

Like San Francisco Bay Ferry, Kitsap County also found that demand for the service extended beyond commuters. During peak summer months, non-peak weekday service can include up to 30 non-commuter trips (-25 percent of capacity) and weekend service to Seattle can often be at capacity during that time. Since launching the service, Kitsap County has continued to refine its scheduling and reservation system to work out inefficiencies. In general, however, the County has found that demand was in-line with their early ridership estimates.

\(^{7}\) Kitsap County created a dashboard to monitor route performance, which can be found at: https://www.kitsaptransit.com/agency-information/fast-ferry-program
Based on our discussions with the ferry planners and review of technical literature, several modeling recommendations emerged. Recommendations were incorporated into the revised demand analysis (see appendix B). The recommended strategies focused on modifying parameters around cost, quality, access, and reliability to better reflect a ferry service (as opposed to light rail as initially modeled). These strategies generally aligned with the literature on modeling travel demand for ferry services and sought to include them using the following approach:

RELIABILITY: Metro’s regional transportation model does not constrain for capacity; those strategies were noted but not directly included in this analysis.

COST: During the preliminary analysis, Metro developed cost parameters intended to mimic the fare structure of ferry service. Because the cost parameters were already considered to be a reasonable comparator to other modes, we chose to focus on the amenity value associated with ferry service. This is intended to minimize the perceived cost of choosing the ferry over other modes.

ACCESS: To encompass the connectivity required for successful ferry service, it was recommended that ECO expand the catchment areas to be as generous as possible. The most expedient approach to incorporate access in the existing TMD is to increase park-and-ride services at the proposed ferry terminals.

QUALITY: A higher quality ride represents increased consumer utility, which Metro attempted to account for by assuming that ferry is preferred to other transit modes. Additionally, we attempted to capture other measures of quality by reducing the perceived walking and waiting time (“transfer penalty”) required to access the ferry system. We also increased ferry speeds to capture the perceived benefit of that mode, which incorporates research demonstrating that ferry travelers are willing to accept longer trip times for increased amenities.

After identifying the set of parameters that would be revised, ECO worked with Metro to operationalize changes within their regional transportation model. Cost and time were barriers to major revisions of the model scenarios. However, after several discussions we determined that there were specific parameters that could be modified to reflect the behavioral responses that reflected preference for ferry service.

TRANSFER PENALTY (COST):
- Preliminary: Ten-minute walk for St. John’s (due to distance and slope); five-minute walk for all other terminals
- Supplemental: Assumed five-minute walk to reach all terminals

DRIVE ACCESS (ACCESS):
- Preliminary: 30 available park-and-ride spaces at St. Johns and Sellwood terminals
- Supplemental: Increased to 500 park-and-ride spaces at the Oregon City, St. John’s, and Vancouver terminals

AVERAGE SPEED (QUALITY):
- Preliminary: 23.98 knots (27.6 mph)
- Supplemental: 24.77 knots (28.5 mph)

FARE STRUCTURE (QUALITY):
- Preliminary: One-way fare: $2.50
- Supplemental: Changed to the existing TriMet fare structure ($1.39-$1.72) based on origin and destination

Preferences for ferry service cannot be measured directly within the existing model. Instead, we must rely on indirect measures (proxies) of preference for ferry service that induce a mode split. In other words, we are seeking to condition the set of parameters in the model to act “as if” they are representative of the perceived costs and benefits associated with traveler preference for ferry service.

This approach allows for identification of key parameter changes that may be most effective at inducing a mode split along the proposed corridors. TDMs are complex and there are many interactive effects between variables. As such, it is difficult to measure the impact of a single input/assumption through sensitivity testing.

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8 Metro has indicated that research on this topic is emerging and may be included in subsequent iterations of their regional transportation model.
9 In Metro’s regional transportation model, light rail is the preferred mode of transit. Within that mode they ensured that ferry service was given preferential treatment.
Several routes were proposed for the preliminary analysis. Table 1 displays each of the proposed routes, along with the cities that would be served for each alternative. Each of the routes are intended to serve slightly different populations. Both Express routes emphasize routes and schedules that focus on commuter traffic originating on the north end or south end of the Portland Metro region. The Circulator route is intended to also capture non-commuter pedestrians who are traveling to the downtown corridor for reasons other than morning or evening commutes (i.e. errands, meetings, etc.). The hybrid route encompasses both populations, but with reduced service.

Schedule and budget limited the number of alternatives considered for this analysis. As a result, we focused our attention on the North and South Express routes. Additionally, we included a St. John’s terminal as an option in these alternatives, as it met several conditions for a successful ferry service:

- There is a relatively direct path along the waterway between St. John’s and Portland’s downtown area.
- Congestion along the St John’s bridge and lack of access to rapid transit in the area could make ferry service an effective alternative to existing modes.
- The location of St. John’s downtown area, along with increasing density in Cathedral Park make the site attractive for potential connective service along the waterfront.

Aside from this adjustment, we did not make any modifications to the proposed routes developed in the preliminary analysis.

**TABLE 1. PROPOSED ROUTES FROM PRELIMINARY ANALYSIS**

<table>
<thead>
<tr>
<th>CITY</th>
<th>EXPRESS-NORTH</th>
<th>EXPRESS-SOUTH</th>
<th>HYBRID</th>
<th>CIRCULATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vancouver</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>St. John’s</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Portland, Downtown</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>South Waterfront</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sellwood</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Milwaukie</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Lake Oswego</td>
<td></td>
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<td>X</td>
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<tr>
<td>Oregon City</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Source: Oregon Metro Transportation Research and Modeling Services
MODEL OUTPUTS AND ESTIMATED RIDERSHIP

Based on the parameter changes described above, ridership estimates across all Express routes increased. Across all three segments, park-and-ride users accounted for a larger portion of the increased ridership. Using park-and-ride as a proxy for access to the terminal suggests that access is a critical feature to increasing ridership. This generally aligns with feedback from ferry planners that increasing the catchment area for connectivity to the terminal is a key feature of successful ferry service. However, some caution should be used in interpreting these results. We do not have a complete set of comparisons across all parameter changes and interactions in the model.

This makes the marginal effect of each parameter adjustment difficult to describe without further information.

From the limited model runs conducted, it appears that access to the terminals through optimal placement and connective services is likely to be a key driver of demand for a proposed route. For a more detailed description of the results, we provide Metro’s memorandums in appendices A and B, which also provides intermediate outputs for the test scenarios used in the preliminary analysis.

<table>
<thead>
<tr>
<th>PRELIMINARY AND SUPPLEMENTAL RIDERSHIP ESTIMATES BY PROPOSED ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXPRESS-NORTH</strong></td>
</tr>
<tr>
<td>Preliminary Analysis</td>
</tr>
<tr>
<td>Supplemental Analysis</td>
</tr>
<tr>
<td>Increase from P&amp;R Riders (%)</td>
</tr>
<tr>
<td>Increase from non-P&amp;R Riders (%)</td>
</tr>
</tbody>
</table>

Source: Oregon Metro Transportation Research and Modeling Services

**RECOMMENDATIONS**

The intent of this analysis was to analyze ridership estimates for the preliminary Frog Ferry demand analysis by looking to modify parameters that could represent a range of perceived costs and benefits associated with traveler preference for ferry service. In effect, this analysis attempts to build a “best case” scenario of ridership demand within the existing specifications of Metro’s regional transportation model. As Metro notes within their own description of the results, these ridership estimates are intended to be exploratory and are not official forecasts of ridership.

We cannot determine, based on this analysis alone, whether there is enough demand to justify ferry service in the region. These estimates are context dependent and comparison to existing modes of transit may not be relevant. Ferry service has a different carrying capacity and financial structure than land-based modes of transit. The basis for understanding whether these estimates are sufficient can only be determined within the context of similar modes of transit.

To demonstrate the viability of ferry service, a financial feasibility study should be completed to ensure enough revenues can be generated to cover the cost of providing the service. Within that context, the revised demand estimates may be sufficient to sustain a financially feasible initial phase of operations proposed by Frog Ferry. Additionally, this analysis cannot, on its own, speak to the efficiency of the proposed program. That measure should be quantified through a benefit-cost analysis which can help determine if the benefits of using public dollars to invest in this service outweigh the costs. Finally, this demand analysis does not answer questions about equity and how the service may improve the well-being of low-income and vulnerable populations in the Metro area.

Each of these analyses provide a different lens to understand the demand estimates reported by this study. Therefore, we recommend using this analysis as a foundation to further investigate the range of potential benefits associated with Frog Ferry’s proposed service.
APPENDIX A

METRO PRELIMINARY DEMAND MODELING MEMO
APPENDIX B

METRO SUPPLEMENTAL DEMAND MODELING MEMO