MEMORANDUM

To: Innovation Incubator Selection Panel

From: Bryan Blanc & Esther Needham (Nelson\Nygaard)

Date: April 23, 2021

Subject: Innovation Incubator Application – Keeping Buses Moving: From Diagnosis to Design

BACKGROUND

Since 2019, our team has worked with multiple public transit agencies to analyze GPS and passenger activity data collected through their bus systems to understand speed and reliability across the entire bus network. The results have been visualized through a web-based interactive dashboard, named the Bus Delay Analysis Tool[1] (BDAT).

This work is impactful and in high demand with our regular transit agency clients. Buses are the workhorses of most transit systems, carrying nearly half of transit ridership pre-pandemic, and an even higher proportion during the pandemic, reaching 2/3 of national transit ridership in April-May of 2020[2] (Figure 1). In the Portland, Oregon Metro region, where this work was first developed, buses carry approximately 60% of daily transit ridership. Despite their importance, buses are slowing down nationwide. Increasing traffic congestion, among other factors, is reducing reliability and increasing travel times on the same routes. This adds inconvenience for delayed passengers, but also adds cost to keep up with slower travel times. As travel times per route increase, agencies must add more buses and resources to maintain the

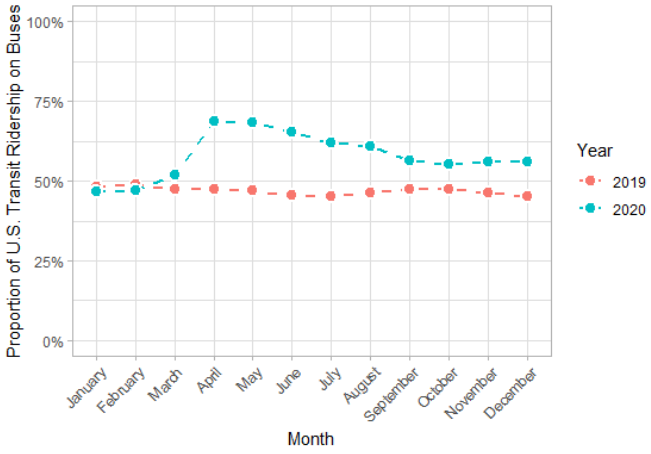


Figure 1 **Proportion of U.S. Transit Ridership on Buses by month, 2019-2020 (from APTA)**

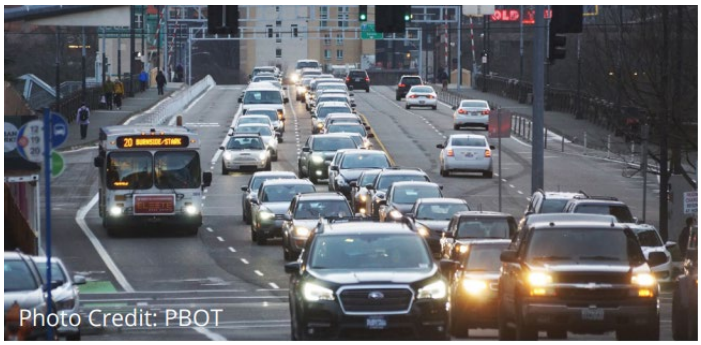
Figure 2 **Congestion requires increasing resources to keep up service frequency**

[1] An explanation and demonstration of the original version of the BDAT tool developed for TriMet was presented at a NACTO conference in December 2020 and is recorded on Nelson\Nygaard's YouTube channel: https://www.youtube.com/watch?v=7wpg1jRpqik&ab_channel=Nelson%5CNygaard

[2] Data from the American Public Transportation Association: https://www.apta.com/research-technical-resources/transit-statistics/

same service frequency (Figure 2). TriMet spends $1-$2 million per year adding service just to keep up with congestion.

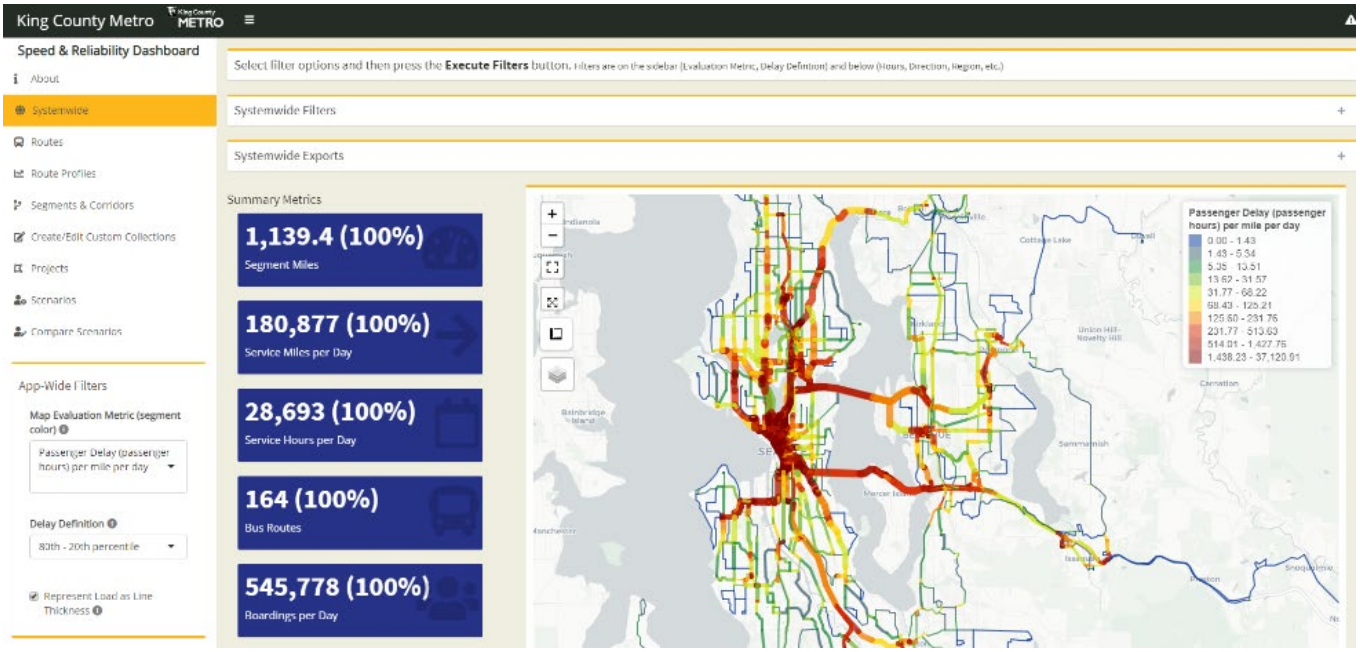
Figure 3: Example of Bus Only Lane leaving Downtown Portland during PM peak on the Burnside Bridge



National transit ridership sharply declined to 20% of the 2019 average in April 2020 during the initial onset of the COVID-19 pandemic, but ridership has been steadily recovering since. Cities across the country remain committed to making buses an attractive travel choice by creating networks of transit priority corridors. Agencies need to invest in infrastructure that reduces delay and increases reliability. Our analysis and visualization work through BDAT has helped agencies both pinpoint the locations to construct high-performing transit priority improvements and provided the data tools to justify the projects to the public and decision makers. We have seen increasing demand for this work over the past year and have projects completed or in the works with King County Metro, Seattle Department of Transportation, TriMet, TransLink, San Francisco Municipal Transportation Agency, and Denver Department of Transportation and Infrastructure.

PROJECT DESCRIPTION

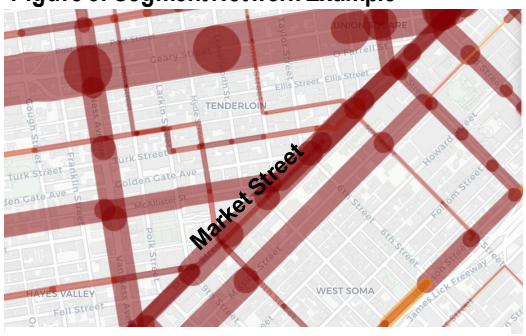
A variety of capital and operational improvements can be made to improve bus speed and reliability, each with their own benefits and costs. We have been working on a new module within BDAT to help agencies experiment with different types of improvements and estimate the travel time and reliability benefits of each, as well as a planning level cost estimate. We had previously been doing this analysis using spreadsheets, which lacked the ability for agencies to experiment on their own and geographically sketch out treatments. This Innovation Incubator grant would expand and improve this



Project Treatment Module and empower agencies to move from analysis to solutions and onward into design and construction more quickly.

BDAT relies on a unique analysis framework built upon a custom street segment network developed at the beginning of each project. After the street segment network is created, we use automated vehicle location (AVL) and automatic passenger count (APC) data to estimate delay, passenger load, and travel time metrics for each segment, for each hour, over the course of the day. Basing this analysis on custom street segments is an innovation in our approach that allows agencies to view data across routes which share streets. BDAT enables agencies to visualize their data in this way without time-consuming, one-off manipulation that is challenging for them to accomplish with limited budget and staff resources.

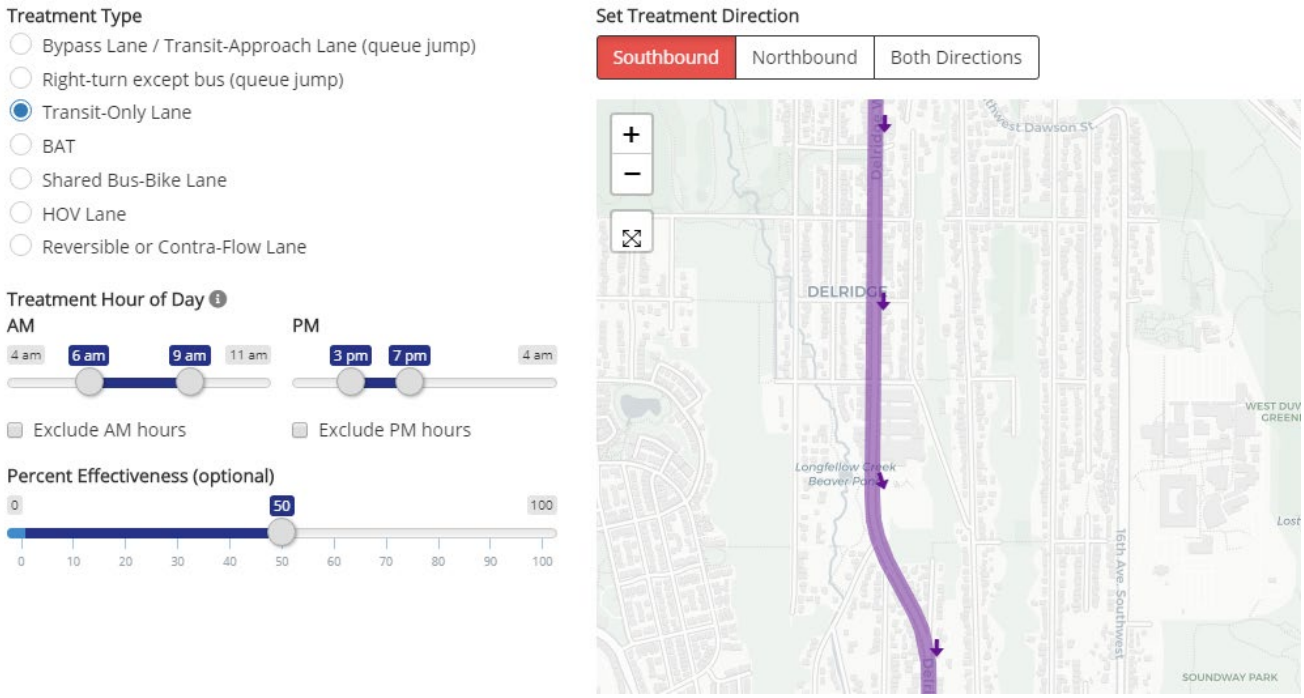
Figure 5: Segment Network Example



A quick-turnaround application without custom-defined segments understates passenger delay along Market Street in San Francisco due to overlapping stop-stop segments for each route.

The Project Treatment Module currently allows a user to select one or more segments, set the direction of travel, and apply linear, point, signal, and stop treatments based on a simple checklist. For example, a linear treatment may be a transit-only lane while a signal treatment may be transit signal priority. Once treatments are applied, the next step is estimating the benefits of those treatments in reducing delay. Current and future clients have expressed a great deal of interest in this module. They have requested more automation of treatments, more sophisticated stop treatment options, and the ability for the treatment benefit estimation to be more iterative, allowing the statistical model to be improved as real-world evidence of the impact of treatments is gathered.

Figure 6: View of the current Project Treatment Module for line style treatments



Goals

With this Innovation Incubator grant, we would like to further develop the BDAT Project Treatment Module in the following ways:

- Refine and more fully develop the existing treatment options, including automating assignment of treatment benefits; for example, limiting benefits of a transit priority left-turn signal to buses that make the left-turn.
- Develop an enhanced stop treatment module which will include automated analysis of existing stop spacing, suggest improvements (low ridership stops that are closely spaced), and allow users to remove and place new stops.
- Improve existing user interface design and create a demonstration application that can be made available to everyone in the firm.
  - Improve visualization of placed treatments, including offsetting the linear treatments to the correct side of the street.
  - Enhance review and edit capabilities for easier modification of previously placed treatments.
  - Refine and better document the workflow.
- Initiate a database of real-world implemented transit priority projects and before/after measurements of transit delay. This database would feed into a statistical model (developed outside of the Innovation Incubator) to help predict benefits for priority treatments coded in the Project Treatment Module. The team has started compiling this type of data for several agencies (Portland, Seattle, and Vancouver BC) but would use this grant to standardize the data format and create a new data intake process.

Methods

- The Project Treatment Module will be developed using the R programming language and a software package called Shiny for developing web applications.
- The real-world project database will be developed in PostgreSQL, with an accompanying intake form and any necessary R scripts for database interaction.
- The code will live in a GitHub repository for use after the completion of the Innovation Incubator.

PROPOSED DELIVERABLES

The deliverables for the project are anticipated to be the following:

- A demonstration application of the enhanced Project Treatment Module.
- A PostgreSQL database with an intake form for new transit priority treatment implementations and before/after measurements.
- A GitHub repository with the code for the demonstration application and any scripts needed to interact with the database.
- A documentation website (a GitHub pages site in the GitHub repository) documenting both the database and instructions for how to copy the demonstration code onto a client project.
- A short video hosted on a public platform (e.g., YouTube) demonstrating the use of the demo application for sharing internally and externally.

DISSEMINATION

We would promote the outcome of this Innovation Incubator both internally and externally, using the demonstration application and the video mentioned above. The results of this Incubator will slot in to already booked client projects and help us market opportunities for future work.

PROJECT RELEVANCE

This project reflects the goals of the Innovation Incubator program in the following ways:

- The COVID-19 pandemic has starkly highlighted the role of essential workers in maintaining basic economic functions. Buses are **essential mobility**, both for these essential workers and anyone else who relies on public transit. At the height of the pandemic in April 2020, two-thirds of transit ridership nationwide was on buses. Providing tools to our clients for improving bus service recognizes the role of essential mobility, both as we recover from the pandemic and going forward.
- The resulting Project Treatment Module would support our clients to **imagine and innovate** in their own bus transit systems, and supports our clients' ability to **implement** projects which enables Nelson\Nygaard to support through a longer project lifecycle from planning into design.
- Improving tool serves as a **differentiator** in project pursuits and developing client relationships. Nelson\Nygaard has extensively used the early iterations of the tool to win work and introduce ourselves to new clients across the country. These tool improvements make it to the market very quickly and lead to the surprise and delight of our clients.
- The real-world project database would create a platform for a **continually improving** statistical model that learns from real-world data to make better predictions about potential futures. This forecasting of performance benefit is essential to our clients' ability to plan and implement.

SCHEDULE

Figure 7: Project Schedule

Project Step & Details	June	July	August	September
Project Initiation ▪ Gather base application code and real-world project data				
Application Development ▪ Generate demonstration data for use in the application ▪ Develop improvements to Project Treatment Module				
Database Development ▪ Develop project treatment and before/after benefit data tables ▪ Develop data intake form/process for database				
Project Documentation ▪ Develop documentation website to live in GitHub repository				
Deliverable Finalization ▪ Record demonstration video				