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UTILIZING SIMULATION TO EVALUATE SHUTTLE BUS PERFORMANCE UNDER PASSENGER COUNTS IMPACTED BY COVID-19

Yusuke Legard
Nate Ivey

MOSIMTEC, LLC
297 Herndon Parkway, Suite 302
Herndon, VA 20170, USA

Antonio R. Rodriguez
Joseph Wolski

Office of Research Services
National Institutes of Health
31 Center Dr.
Bethesda, MD 20892, USA

ABSTRACT

As with many organizations, the National Institutes of Health (NIH) has seen a dramatic shift to remote work due to the COVID-19 pandemic. The NIH main campus in Bethesda, Maryland operates a shuttle bus system to take employees between key buildings, along with transporting employees from off-site locations in Montgomery County, Maryland. NIH has utilized simulation modeling to understand the impact of shifting bus schedules and reduced vehicle capacity under varying passenger demand. This simulation tool can be used to understand how bus schedules may need to be altered to accommodate staggered work patterns and how bus frequency should increase as workers begin returning to the NIH campus.

1 INTRODUCTION

The NIH main campus, is located in Bethesda, MD. It is home to more than 75 buildings on over 300 acres. Shuttle services are provided to assist employees, patients, contractors, and visitors in navigating within the campus. The shuttle service also provides additional routes between key off-campus locations, such as airports, Metro stops and satellite facilities.

As with many organizations, the NIH campus quickly shifted to a remote work model in spring of 2020 when the COVID-19 pandemic started to impact the United States. This resulted in reduced demand for shuttle buses.

As NIH formulates plans to bring employees back to campus in a safe way, the office of research services (ORS), which provides support services to enable the research mission of the NIH, realized the demand for shuttle services may look very different in a post-COVID or transitioning to a post-COVID environment. Some of the differences may include:

1. Overall decrease in ridership due to remote work or employees wanting to avoid public transportation.
2. Changes in the pattern of demand over the course of the day, as work schedules are staggered to reduce congestion in key areas.
3. Changes in the origin to destination patterns of riders, as some departments/buildings may be more likely to work remotely than others.
4. A need to proactively limit the capacity of buses to ensure adequate spacing between riders.

The ORS and MOSIMTEC built a discrete event simulation model in SIMIO in order to understand the impact of various shuttle bus strategies for a wide variety of demand patterns.

2 SOLUTION

The SIMIO-based simulation model includes a 3D animation of the NIH campus, with routes and shuttle stops drawn to scale. Passenger entities arrive with a demand pattern that varies over the course of the day. Entities randomly select an origin shuttle stop and required destination. The logic is intelligent enough for passengers to skip getting on a shuttle to their destination, in order to wait for another shuttle that will be arriving soon and be able to get to their destination faster due to traveling a different path.

Shuttle entities follow a detailed schedule with start and stop times, along with detailed time checks where they will be departing stops. This mimics the real system, where buses may dwell at a stop until their published departure time. The model is programmed to build out a full bus schedule, based on user defined inputs, such as number of buses on a route, the start and stop time of buses on a route, and stops along a route. This allows the user to quickly test out various shuttle scheduling strategies without having to explicitly build a full day's shuttle schedule for each one.

The model also accounts for riders utilizing wheelchairs and scooters. Each shuttle has a user-defined capacity for each rider type, as well as, separate times for each rider type to board or disembark.

All model inputs, including shuttle schedule parameters, arrival patterns, overall demand, and delay times, were configurable via model input parameters or Excel input tables. This was very important given the level of flexibility NIH needed in evaluating extreme demand patterns that could be triggered by the COVID work patterns.

The key metrics reported by the model, both as point values and as graphs over time, included:

- Passenger wait times by bus stop and passenger type
- Bus fill rates by route chronologically
- Count of times passengers did not get on a bus because it was full

3 BENEFITS

The NIH shuttle bus simulation model enabled NIH to test out various shuttle strategies for a variety of demand patterns. Given the unknown nature of COVID's impact on work patterns, simulation modeling was an ideal approach, as model inputs can be changed to play what-if analysis and understand performance under a wide range of demand scenarios. For example, with a given bus schedule, NIH can ask the question "What happens if we have significantly more people return to work faster than expected? Does the plan still accommodate that? At what ridership level does our planned shuttle bus strategy stop working?"

The visual nature of the simulation model is also critical to explain the model to non-technical resources. The 3D animation allows stakeholders to connect with and visualize the operations without having to fully understand the details of routes or shuttle metrics.