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UTILIZING SIMULATION TO EVALUTE THE DESIGN OF A GREENFIELD MULTI-STORY PARKING STRUCTURE AND IMPACTS TO SURROUNDING AREAS

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ABSTRACT

The National Institutes of Health (NIH) main campus in Bethesda, Maryland currently contains 30 parking structures. On any given day, 12,000 vehicles enter the campus. NIH is planning for the south side of the campus to become the main parking areas for employees and visitors. Central to this vision is replacing a surface lot, which contains 241 parking spaces, with the construction of a greenfield six story parking structure that has a planned capacity of 1420 parking spaces. NIH wanted to prioritize the employee experience and emphasize the safety of pedestrians and vehicles. MOSIMTEC utilized simulation modeling to provide NIH with insight on the impact of various entrance and exit combinations into the parking structure. This presentation will further describe the project, the system being modeled, the inputs and outputs of the simulation tool and the outcome upon the design of the greenfield parking structure.

1 INTRODUCTION

The NIH main campus, located in Bethesda, MD, is home to more than 95 buildings and 30 parking structures located on more than 300 acres. On any given day, 12,000 vehicles enter the campus. NIH is formulating a plan to accommodate a greater number of employee and visitor vehicles on the campus. The Office of Research Facilities ("ORF") identified the south side of campus as an area that can serve to accommodate the majority of vehicles. The central piece of this vision lies within replacing the surface lot, Lot 42, with a greenfield six story parking structure, Multi-Level Parking 12 ("MLP 12"). The ORF team plans to increase the number of parking spaces by nearly six-fold, from 241 spaces to over 1420 spaces.

As the ORF team was formulating the initial designs for MLP 12, they realized the impacts on the employee parking experience and pedestrian safety may vary depending on the entrance and exit locations for MLP 12 throughout the parking structure in conjunction with the location of roads in the south campus.

ORF worked with the Office of Research Services ("ORS"), which provides support services to enable NIH's research mission, and MOSIMTEC teams to develop an agent-based vehicle simulation model using AnyLogic. The goal of the simulation was to enable NIH to understand and quantify:

1. The impact of potential entrance and exit combinations for MLP 12.
2. The density of traffic flow in the south side of the NIH campus.

2 SOLUTION

The AnyLogic-based simulation model was composed of an animation that included a to-scale layout of the south side of the NIH campus along with the four primary parking structures. The model also included a to-scale representation of roads, parking spaces, and stop-sign intersections. The Excel-based front-end to the simulation model allowed the users to configure the entrance and exit locations to MLP 12, allowing them to test different traffic flow options.

Cars represented as 'vehicle agents' arrived based on demand pattern that varied over the course of the day. Based on model input probabilities, vehicles would randomly sample for the:

- Origin road to enter the south side of campus
- Preferred parking structure
- Entrance to the parking structure
- Parking space (and floor) cars would park in
- Duration cars are parked
- Exit location from the parking structure and the south side of campus

The logic was intelligent enough for passengers to resample for a different parking structure or a different floor should the initial parking structure or lot be full. Additionally, the model accounted for both employee and visitor vehicles. Each vehicle type had a user-defined preference for parking structures and specific durations for parking time.

All model inputs, including MLP 12 entrance and exit locations, vehicle arrival patterns, vehicle speeds, overall vehicle demand for parking structures, and parking times, were configurable via Excel input tables. The ability to define scenarios in Excel provided NIH with the level of flexibility required to evaluate different entrance and exit locations for MLP 12. This flexibility to test different vehicle routing rules was useful in developing traffic flow rules under increased vehicular demand for parking over time and impact of road closures made for pedestrian safety.

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

- Time taken by cars to park
- Time taken by cars to exit the south side of campus
- Total time spent by cars stopped in traffic
- Parking space utilization
- Road utilization north of MLP 12, that has high pedestrian density

3 BENEFITS

The NIH south campus parking simulation model enabled NIH to test out various MLP 12 entrance and exit combinations for a variety of demand patterns. Given the unknown impacts of these combinations for MLP 12 – simulation modeling proved to be an ideal approach, as the user could quickly change the model inputs to study a variety of what-if analysis scenarios. In doing so, NIH could quantitatively compare and understand the sensitivity of various input parameters on employee parking experience and pedestrian safety. This could be seen across different entrance and exit combinations. Furthermore, NIH could identify the maximum parking capacity of vehicles for the south side of campus.

The visual nature of the simulation model proved to be critical in explaining the recommendations to non-technical team members. The animation allowed stakeholders to connect with and visualize the operations without having to fully understand the intricacies of the vehicle routing logic or parking metrics.

The learnings from the outputs of the simulation model enabled NIH to finalize the design of the greenfield multi-story parking structure prior to construction. This reduced the probability of capital costs during or after completion of construction due to unforeseen circumstances.