Proceedings of the 2024 Winter Simulation Conference
H. Lam, E. Azar, D. Batur, S. Gao, W. Xie, S. R. Hunter, and M. D. Rossetti, eds.

STREAMLINING SECURITY: USING AGENT-BASED SIMULATION TO REDUCE CONGESTION AND ENHANCE CAMPUS SECURITY SCREENING

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ABSTRACT

The National Institutes of Health (NIH) main campus, in Bethesda, MD, has more than 95 buildings located on over 300 acres. The West Drive Visitor Screening Facility ("Building 68") is the primary entrance where visitors and their vehicles must go through a security inspection. The building infrastructure dates from before 9/11, after which the security requirements that are in effect today were formulated. In any given hour, there are up to 50 vehicles that use this entrance. NIH developed plans for a facility expansion to reduce both vehicle and pedestrian congestion. MOSIMTEC utilized simulation modeling to provide NIH with insight on the impact of potential layout changes to the building. This presentation further describes the project, the system being modeled, the simulation model's inputs and outputs, and the key modeling approach, which includes integration of AnyLogic's road and pedestrian libraries. This presentation also highlights the analysis completed.

1 OVERVIEW

The NIH Clinical Center, located in Bethesda, MD, is one of the world's largest hospitals that is devoted to clinical research. It sees thousands of patients annually. All visitors going to the Clinical Center, including patients and their friends & family, are directed to use Building 68 because it is located directly north of the Clinical Center. The entrance was constructed prior to 9/11, when visitors could enter freely without security inspections. However, due to security screening requirements post 9/11, Building 68 was converted to a security screening facility. Consequently, Building 68 cannot efficiently manage the high visitor volumes during certain periods of the day. This causes bottlenecks in the flow of visitors and vehicles. Furthermore, the congestion poses a security concern as it makes it difficult for staff to identify potential threats.

The Office of Research Services ("ORS"), which provides support services to enable NIH's research mission, plans to expand the security entrance in order to reduce both pedestrian and vehicle congestion. As the ORS team was formulating the initial designs for the expansion, they also explored relocating equipment and furniture to enhance the screening experience for visitors and improve situational awareness for staff.

ORS worked with MOSIMTEC to develop an agent-based vehicle and pedestrian simulation model using AnyLogic. The goal of the simulation was to enable NIH to understand and quantify:

1. The impact of proposed future layouts for Building 68 across various vehicle arrival rates.
2. The density of visitor flow at the security entrance.

2 SOLUTION

The AnyLogic-based simulation model was composed of an animation that included a to-scale layout of the internal pedestrian layout within Building 68. The model also included a to-scale representation of the roads that surround the security entrance. The Excel-based front-end to the simulation model allowed users to configure the security screening layouts, allowing them to evaluate and understand different hourly arrival rates of vehicles.

Vehicles, represented as 'vehicle agents', arrived based on an hourly arrival rate. Upon arrival at the vehicle security check point, visitors, referred to as 'pedestrian agents', exited the vehicle for security screening within the building. All model inputs were configurable via Excel input tables. These included:

- Layouts
- Vehicle arrival rates
- Number of visitors per vehicle
- Security screening times (vehicles & visitors)
- Number of check-in desks open
- Security screening failure probabilities

Visitors in the model always enter the building, pass their baggage through an x-ray, walk through a metal detector, and visit a check-in desk. The logic was intelligent enough for visitors to always follow this process, even if the x-ray machine, check-in desks, and queuing locations changed between layouts. Additionally, each car could not proceed past the security gate until every visitor that exited the car finished the check-in process.

The ability to define scenarios in Excel gave NIH the flexibility needed to evaluate various layouts for Building 68, including the impact of different vehicle and visitor screening capacities.

The animation in the simulation model included a heat density map within the building to demonstrate how the layouts affected visitor movement during the security screening process. The key metrics reported by the model, both as point values and as graphs over time, included:

- Throughput of vehicles and visitors
- Vehicle and visitor time in system
- Vehicle and visitor queue size for security screening
- Staff utilization

3 BENEFITS

The NIH security entrance simulation model enabled NIH to test various security layouts combinations for different visitor and vehicle arrival patterns. Given the unknown impacts of these layouts for the security screening process, 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 the visitor security screening experience and campus safety. This could be seen across different layouts. Furthermore, NIH could identify the maximum hourly arrival rate of vehicles that each potential security layout is able to process.

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 visitor and vehicle routing logic or security screening metrics.

The learnings from the outputs of the simulation model enabled NIH to finalize the design of Building 68 prior to construction. This reduced the probability of capital costs during or after completion of construction due to unforeseen circumstances.