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CREATING AND VALIDATING A MICROSCOPIC PEDESTRIAN SIMULATION TO ANALYZE AN AIRPORT SECURITY CHECKPOINT

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ABSTRACT

Aim of this simulation case study is to analyze waiting times and throughput at the security checkpoint of an international medium sized airport. The simulations shall provide the airport operator with the ability to easily change main impact parameters of an airport security checkpoint e.g. to test new security procedures, a flightplan with more passengers and also to optimize the security operation schedule.
The simulation is implemented with the microscopic pedestrian simulation and social force model of Anylogic. To achieve validation, Anylogic's Pedestrian Libarary is tailored and extended for specific needs of the simulated airport.

1 MODEL DEVELOPMENT

The main impact parameters for the security check simulation are the flight plan stating the schedule of the flights, the number of passengers booked on every flight, opening periods of every security lane and the process times per security lane. Before a simulation run all these parameters are imported from an Excel sheet. It is also possible to change the opening periods and process times during runtime of the simulation. The arrival distribution for each flight is based on passenger survey data.
As a direct output the simulation provides waiting times for economy and business/first class passengers, a cost summary for security lanes, sum of checked passengers, maximum waiting time and the number of passengers having to wait more than 35 minutes.
The initial output of the simulation already showed the characteristic diurnal variations with two traffic peaks, as expected.

2 VALIDATION

However, in detail there is always a need for validation and adjustment of initial simulation models. For validation, data records from the airport, real world observations as well as feedback meetings with the airport and security employees are used. The data records contain information about the planned security operation schedule, the realized operations schedule, observed queue lengths, waiting times and the flight plan with actual numbers of passengers.
An important improvement to achieve validation and to convince airport practitioners is realized by a refinement of the queue selection algorithm for the security lane as well as of the simulated passenger behavior in the waiting queue and before the security check. Anylogic's standard algorithm, in which passengers always choose the queue displaying the smallest number of actual waiting passengers, is not sufficient in this case. The algorithm is augmented by an additional check considering which queue is closest to the passenger if queue length of the queues in choice only differ by a small amount. To also

cover the situation where queue lengths develop differently after a passenger already has chosen a queue, every 3 simulated minutes and when a new queue opens, the simulation checks for each passenger whether there is a "better" queue. Depending on distance and queue length the passenger may then even opt to change the queue as can be observed in real life.
In order to enable a better comprehension of the pedestrian flow characteristics inside the simulation and to foster a more detailed data analysis, the simulation is equipped with a data-snapshot capability. For every simulation step, coordinates and properties of all simulated passengers are stored in a data file.
Based on this data, a 3D-animation is created (see figure 1). This animation allows an improved visual analysis of the considered environment of the simulation. Moreover this provides the possibility of moving back and forth in time to facilitate that simulation variances and abnormalities can be recognized and eliminated. Furthermore, individual passenger characteristics can be made visible in the video. For example, waiting times of the individual passengers can be visualized. Passengers, who have a lower than 10 minute waiting time are shown in blue. Persons with a cumulated waiting time of 10 to 20 minutes are marked in yellow and passengers with a waiting time longer than 20 minutes are shown in red.

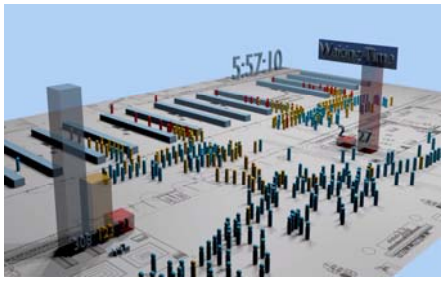

Figure 1: 3D-Model of the simulation

3 CONCLUSION

The simulation provides the airport operator with a powerful tool to analyze the main impact parameters of an airport security. With the simulation now being close to reality, it enables exploring more of the system's potential. By varying the schedule of the security operations plan peak and average waiting times could be reduced substantially (see figure 2). It was possible to reduce the maximum waiting time between 6:00 and 8:00 am from over 25 minutes to 15 minutes and between 10:30 to 12:30 from 26 to 22 minutes. Average waiting time decreased from 17 to 12 minutes while employing the same amount of staff.
One next step is to use the built-in optimization software optquest® to determine an optimum resource management by balancing waiting time and operating costs and bring this plan from simulation to the real world. Another enhancement is envisaged for the future by incorporating train-arrival schedules in the simulation, as arriving trains also induce passenger peaks at the security checkpoints.

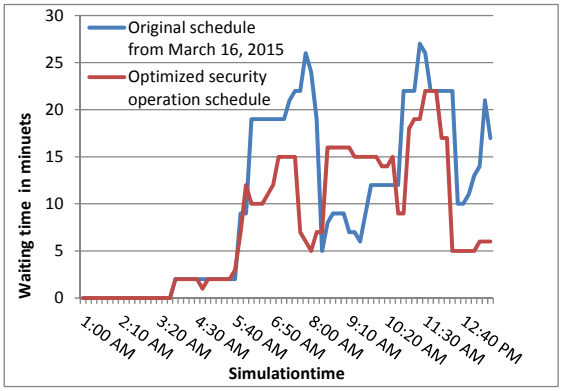

Figure 2: Optimized security operation schedule