Proceedings of the 2014 Winter Simulation Conference
A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

SIMULATING THE DEPARTURE BAGGAGE HANDLING SYSTEM OF SANTIAGO DE CHILE'S INTERNATIONAL AIRPORT

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1 INTRODUCTION

The baggage handling system (BHS) of the Santiago International Airport, follows a semiautomatic scheme, in which routing and security scanning are performed automatically by the conveyor belts' system, while the sorting of bags and the loading of carts that are finally located in planes, are performed manually by the operators of the company in charge of the ground handling operations of the airport.

Nowadays, the major problems of the operation in the airport are due to uncontrolled simultaneity in the design of flights' scheduling, which leads to high demand peaks that exceed the system's designed capacity. This demand has increased notably over the last five years. In addition, there are multiple actors involved in the airport operation (particularity, counter employees and baggage handling personnel) that are neither directly communicated nor coordinated in the process, resulting in operational problems and disruptions due to their narrow visibility over the impact of their actions on the performance of others. Both situations results in poor efficiency. The problems increase due to a declared no interest of investing in major infrastructure until the construction of a new airport planned to 2017.

Today the managers are interested in understanding the system as a whole, to make a proper diagnosis and provide useful insights for improvement and coordination in the operation. In order to do that, we need first to identify the bottlenecks in the system and finally explore alternative operation protocols in the baggage handling sector. To accomplish with these goals, we have constructed a micro simulation platform to properly model the whole system as described in detail next.

2 SIMULATING THE BAGGAGE HANDLING SYSTEM FOR DEPARTURES

After analyzing the real problem, it was decided that a good and feasible option for getting an holistic view of the baggage handling associated with departures, was to construct a simulation platform to emulate the flow of bags through the system from the moment a passenger arrives and joins the queue in front of a counter prior to check-in, until the bags end up stored in the airplane's cargo hold.

Previous models were found in the literature, developed to properly capture BHS operational details at specific airports. Savrasovs (2009) for example, in the context of the Riga airport in Letonia, used discrete event simulation to model check-in areas as well as scanning devices connected with conveyor belts to measure the impact of increments in passenger flows. Lazzaroni (2012) also uses simulation to model the flow of passengers through the different areas of the Vancouver International airport, including check-in, security, boarding areas, and baggage claim.

In the present case study of the Santiago International Airport, the proposed simulation scheme was split in 3 mayor subsystems: *Counters*, *BHS* and *Baggage Yard.*

In the *Counters* subsystem, every process related to passengers is properly modeled; namely, queues in counters, check-in attention and bags' dispatch into the BHS system. Even though the number of open counters is previously scheduled, during the real operation the airlines's supervisors can make modifications, by opening or closing counters dynamically in response to the observed status of the queues, so proper rescheduling algorithms were coded to emulate such kind of decisions.

The core of the simulator is the *BHS* subsystem. This was coded at a microscopic level using a traffic simulator package, in which through an API, a system of conveyor belts was modeled using vehicles moving in batch at constant speed on roads (emulating the bags movement). In this microscopic platform, we simulate the movement of bags through the airport's BHS, including belts, scanners, diverters and the carrousels where the sorting and loading processes are conducted. This module is able to model jams due to bad handling of bags in belts, possible failures and detections, and the redirection of suspicious bags to higher security zones, where stricter checking is performed by powerful scanners.

The last subsystem is the *Baggage Yard*; in which the last stage of the process was simulated, from the moment the bags arrive at the carrousels (the end of the BHS) up to when they are sent to the planes. This module simulates mostly the "manual" part of the process, putting attention in emulating the sorting of bags and loading them into carts, the movement of tractors and finally loading the planes. This module was very important for testing different operational strategies, from assigning a single operator to each flight, having a single operator working on various flight simultaneously or pooling several workers on a single difficult flight. Like in the Counters module, the scheduling of available personnel is decided beforehand; however, we add certain rules in the simulator to include last minute decisions depending on current conditions as made by managers during operation in real situations.

As mentioned before, the BHS subsystem was coded in the context of a commercial traffic microsimulation software . The other two subsystems were coded in C++. The interaction among the different modules was made through the microsimulation software's API.

3 EXPERIMENTS AND RESULTS

The most successful application was the use of the simulator to quantify the impact of improper handling of bags on belts in the counters sector, with a high probability of causing delays due to jams, implying serious delay on flights' departures. Most belts stops are solved in minutes (even seconds sometimes). However, when the frequency of occurrence of such events (mainly on peaks) becomes high, the resulting capacity to inject bags is reduced considerably, effect historically underestimated by the company managers. Typical handling mistakes were identified, estimating the associated probability of causing an incident. With the simulation tool, we predicted a reduction of around 60% of bags arriving to the carrousels late (after the time at which the flight was closed) only by reducing the handling errors in counters.

Responding to these results, the company implemented a three week pilot experiment to test several protocols and measures in order to improve the operation in counters. During this period the number of belt stops dropped from a daily average of 10 to less than one per week. These protocols were later adopted to the full operation.

Other positive experiments involved evaluating several new operation strategies in different points of the BHS. In the baggage yard, we tested different sorting priorities for bags coming from connections as well. In the counter's sector we simulated different ways to group check-in's queues, depending on the complexity of each specific flight. Today the company is operating under the new protocols suggested from the discussed simulation studies.

REFERENCES

Savrasovs, M., Medvedev, A., & Sincova, E. (2009). "Riga Airport Baggage Handling System simulation". *Proceedings 23rd European Conference on Modeling and Simulation*, 384-390. Madrid, Spain.

Lazzaroni, M. (2012). Modeling Passenger and Baggage Flow at Vancouver Airport. http://www.simio.com/case-studies/Modeling-Passenger-and-Baggage-Flow-at-Vancouver-Airport.