Simulation and Analysis of the Passenger Flow System for Departure of Domestic Flights of the Ninoy Aquino International Airport – Terminal 2

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Abstract – **Travelling is where most people spend their leisure time, while others visit their loved ones, and for some, it's a part of their job. Because of this airport are known to be a very busy establishment. Especially since passengers and cargo would come in and out of the different countries or states. With the focus of this paper being on the Ninoy Aquino International Airport – Terminal 2, the research takes a closer look at the administered, 12, 847 domestic flights in total, the past year with more than a million passengers. With the airport coordinating with different airlines, these specific airlines would need to coordinate and provide the necessary information for their passengers to utilize the complete process. This paper determines, through simulation, the average waiting time of a passenger before getting boarded using the Discrete Event Simulation Model created with Any Logic**.

Keywords – **Discrete Event Simulation Model, Airport, Domestic, Simulation, NAIA, Flights, Airlines**

Introduction

Travelling is where most people spend their leisure time, while others visit their loved ones, and for some, it's a part of their job. Travelling, in general, has many options where a person can choose from, and when they want to travel, they often prefer travelling by plane, even with the limitations with regards to pets, baggage, and seat price. Although safety is also an important aspect, a lot of people prefer travelling by air, rather than by sea or land. Efficiency is the name of the game and out of all of the transportation option, one cannot deny the effectiveness of travelling by plane.

Besides travelling, airports also play a crucial role in the economic growth of cities, nations, and regions. Since tourism is a must for any country to have an extra way of producing funds, airports, serving as an airline service provider, and transferring cargo, they directly impact economies. Both the consumers and industry, gain from the mobility of people and things [1]. With all things considered; Airports are one of the busiest establishments in the Philippines. With that reason, airlines like the Philippine Airlines advise passengers to arrive at least 4 hours early before the flight for international fights and 3 hours early for domestic flights to allot time for security checks, and immigration [2].

The scope of this project would be limited to only the NAIA Terminal 2,

which is currently exclusive to the Philippine Airlines' Domestic and International Flights. However, the model would be focused on the Domestic Departure Procedures only. Last December 2021, the abovementioned terminal anchored an average of 6,389 passengers daily. [3]

Objectives

The objectives of the project are to develop a model that would showcase the process of boarding a departure flight through Discrete-Event Simulation in AnyLogic.

Background of the Study

When going on a domestic flight, there are specific steps that you would have to go through before getting boarded to the plane assigned to your flight.

Procedure	What happens:
Gate Security Check	As a passenger enters the entrance of the terminal, their bag would be placed through an Xray scanner, then checked for any contrabands, while they walk through a metal detector.
Interview Rooms	This is where the passengers would be put on hold if their luggage or themselves have been detected with any malicious items.
Check-in Kiosks	This is where the passengers confirm their seats on the plane, check-in any luggage and get their boarding passes.
Online Check-in	This is usually done, hours before a flight and for only those who has a hand carry bag. They can confirm their seats online and save their boarding pass from there.
Bag Drop Off Counter	This is where the passengers who are already checked in online drop off their luggage if they have any.
Boarding Lobby	This is where the passengers for departure wait to get boarded.
Boarding	This is when the passengers present their boarding passes, and start entering the plane one by one, preparing for departure.

Table 1. Stations in the Flow and Descriptions

Proceeding from the gate towards the inside of the terminal, for domestic flights, two possible things can happen during the security check. One would that the passenger could be cleared for continuing to the next steps, and another output is that the passenger could be put on hold due to detecting malicious items during the scan, they could either be cleared or be passed on to the authorities in this phase.

If the cleared passenger hasn't checked-in online yet, they could either go to the weighing scale to check the weight of their luggage or go directly to their designated check-in kiosks, then they would go to the waiting lobby to wait for their boarding and departure. However, if the passenger has already checked-in online, and if they have extra baggage other than their hand carry, they will have to drop off their luggage on the drop off counter, but if not, they could go directly to the waiting lobby.

The Security Check per passenger doesn't take that long since their bags would be placed through an Xray scanner while they walk through the metal detector. The reason why it takes them at least 5 minutes to get over with this procedure, is that they have to remove all of their accessories that has metal on them like their jewelry, belts, etc. This also includes your gadgets that are not inside your baggage.

Since checking-in can be done online with their airline's mobile application or website, passengers with hand carry bags check in through there. However, people who has luggage that can't be considered as a hand carry, needs to check-in on site for their baggage and confirm their seat on the plane or if they are checked in online, they could just drop off their bags at the counter specially for these cases. There are two unfavorable things that could happen while checking-in, and those are if the passenger's overweight baggage, they can either pay extra money or leave the things there.

Methodology

A Discrete Event Simulation is a system's operation that is represented as a chronological sequence of occurrences. Each event occurs at a single point in time and represents a change in the system's state [4].

There are different objects that needs to be identified in the simulation model. Which are Entities, Classes, Events, Activity of Each Entity, the Process, and the Simulation Clock.

Object	Description
Entities	• Passengers • Metal Detectors • Xray Scanner • Luggage • Staff
Classes	• Security Scanners (Metal Detectors & Xray Scanners) • Type of Check-in (Online or on-site)
Events	• Enters the gate • Security Check • On-Hold • Weighing of Bags • Check-in • Waiting in the Lobby • Board for Departure
Activity of Each Entity	• Passenger – Get checked / Check-in / Wait / Board • Metal Detectors – Scan passenger for any weapons • Xray Scanner – Scan luggage and hand carry for suspicious items. • Baggage – Be scanned and Checked-in • Staff – Makes sure that the passenger is clear and monitors activities.
Process	I. Passenger enters the gate of terminal II. Passenger puts baggage and any items that has metal on the Xray Scanner III. Passenger walks through the Metal Detector IV. Passenger gets their baggage from the Xray Scanner. V. If passenger is detected with any possible contrabands, they would be put on hold until they are either cleared or passed on to the authorities. VI. If the cleared passenger has checked in online with no other luggage than their hand carry, they could go directly to the waiting lobby. VII. If the cleared passenger has checked in online, but has extra baggage, they would drop it off at the Bag Drop Off Counter, then go to the waiting lobby. VIII. If the cleared passenger has yet to be checked-in, they would go to the check in kiosks. Then they can go to the waiting lobby. IX. Board the Plane
Simulation Clock	The basis is per minute

Table 3. List of Objects for the Simulation Model

After the objects have been identified, a flowchart was created to make the development of the logic easier.

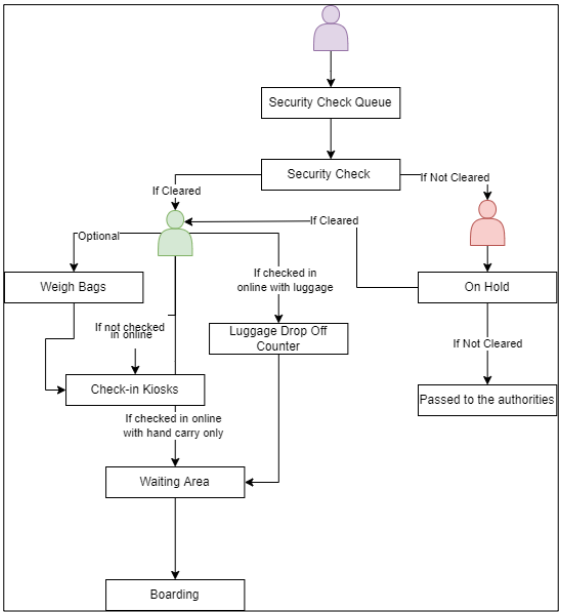

Diagram 1. Domestic Departure Flight Flowchart

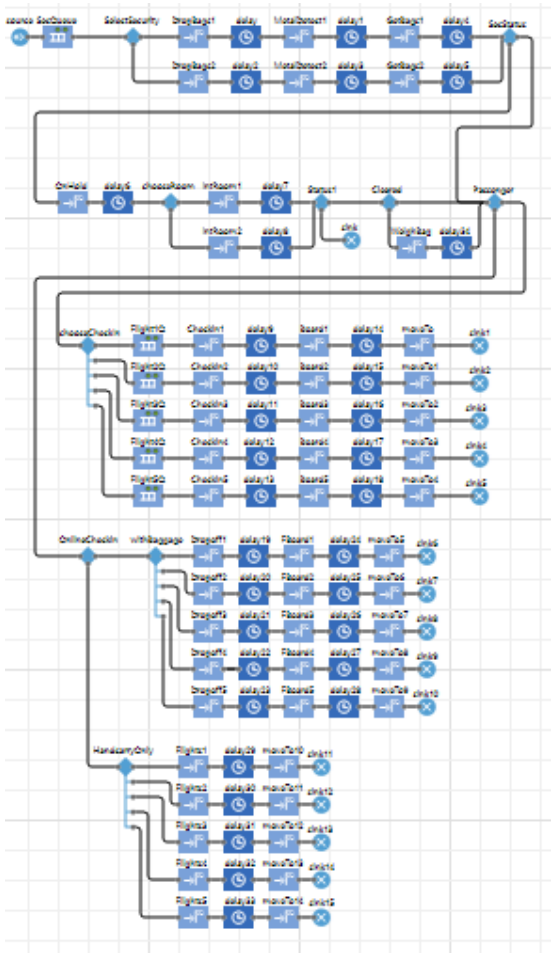

Diagram 2. Logic Flow of the Simulation Model on AnyLogic

The logic flow of the simulation was made with the blocks and nodes from the Process Modelling Library. The source block is used to generate the agents in a specific location. A selectOutput block and multiple selectOutput5 was used to form the conditional outputs or events that the model shows. The queue block was used for events that requires falling in line like the check-in kiosks and the security check. The moveTo block was used to direct the agents, which in this case the passengers to their designated locations that are marked as point nodes or rectangular nodes. The delay blocks were used to show how long a single agent would be delayed or paused before moving on to its next action block. Lastly, the sink blocks were used to dissolve the agents when needed.

Since the simulation model was created on AnyLogic, it can be rendered and viewed in a 2D model and a 3D model.

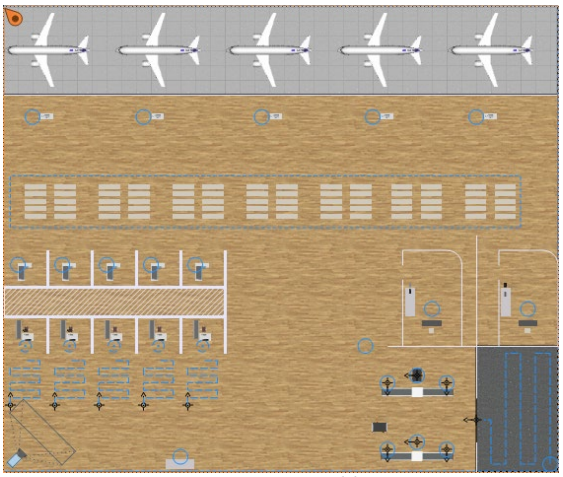

Figure 1. 2D Model

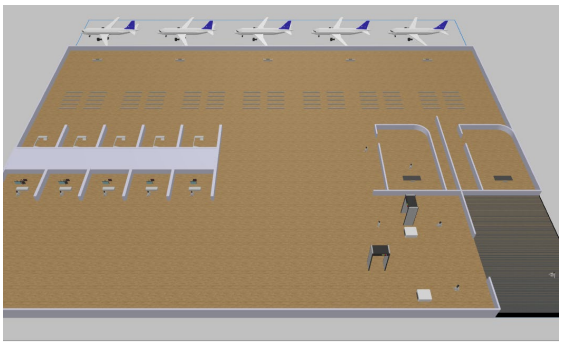

Figure 2. 3D Model

Verification & Validation

Aside from the researched information of how the process of boarding a domestic flight in NAIA, a terminal operations group head of the chosen terminal of the said airport were consulted through a phone call and email about the process and what is the rough estimate of how long this would take.

According to the Terminal Operations Group Head of NAIA Terminal 2, Ma'am Leine Bautista, "A passenger spends about 5 to 10minutes, from the Curbside to check-in process, depending on the number of baggage a passenger has for check-in and/or a passenger has not checked-in baggage and the queue of passengers at the check-in counter. He/she stays at the boarding gates for about 2hours depending on the time of arrival at the terminal. Boarding time is at least 30minutes prior to estimated time of departure.".

To validate the model created, a Two-Sample Paired T-test was used.

Date	Real-time	Simulation
12/1/2021	4,581	4,852
12/2/2021	5,020	4,905
12/3/2021	5,421	4,923
12/4/2021	4,703	4,813
12/5/2021	4,760	4,887
12/6/2021	5,339	4,998
12/7/2021	4,895	4,864
12/8/2021	5,420	4,985
12/9/2021	5,762	4,957
12/10/2021	6,473	4,975

Table 4. Sample Data used in T-Test

Based on the raw data from NAIA Terminal 2's passenger count for the Domestic flights last December 1-7, 2021's, and the model's simulated passenger count. their mean, standard deviation, and variance are needed in order to proceed with the Two-sample Paired T-test.

	Real Time	Model
Mean	5,237	4,916
Standard Deviation	576.21	62.42
Variance	332,015.82	3,896.32

Table 5. The mean, standard deviation, and variance of each sample.

Using the results for each sample, a t-score of -1.92 and a p-value of 0.08728 was the outcome of the test mentioned.

Conclusion

Overall, through sheer trial and error, the study was able to showcase a smooth-running simulation, of the precise process of travelling locally. Using the Any Logic Simulation Software, a 3D and 2D interfaces shows the process of entering the terminal, manually checking in with their associated airline and patiently waiting for their boarding on their flights. With the gathered data from the simulations, together with the raw data from the airport terminal themselves, the resulting t-score is -1.92 and its p-value is 0.08. This shows that there is no significant difference between the two-sample data.

References

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