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SIMULATION MODELING OF ALTERNATIVES TO AVOID INTERRUPTIONS OF THE X-RAY SCREENING OPERATION AT SECURITY CHECKPOINTS

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ABSTRACT

A simulation model of a standard security checkpoint of the Transportation Security Administration (TSA) is compared to two other simulation models, which represent two different alternatives designed to alleviate the congestion of passengers at the exit roller area of a generic representation of a security checkpoint. Both alternatives consist of separately processing passengers who travel for business from those who travel for leisure. However, for the second alternative, a non-stop circulating conveyor is modeled in place of the exit roller of the checkpoint line. The results show that the non-stop circulating conveyor decreases the system time for both business and leisure passengers, and it significantly improves the hourly throughput of passengers.

1 INTRODUCTION

As the globalization process has transformed the world into an increasingly integrated global economy, air transportation has become one of the primary means to support this process by providing the most efficient way to physically connect people in distant places. However, the current performance of security checkpoints in the U.S. undermines the system effectiveness. Security checkpoint related processes have become one of the major bottlenecks among airport operations due to increasing mandatory security requirements, reduced staffing from federal budget cuts and increasing passenger traffic.

In an effort to provide solutions to the major causes of constrained flow, the x-ray has been identified as the main impediment of continuous traffic of passengers and items for two reasons: passengers do not divest appropriately when preparing for screening, and passengers do not collect their items expeditiously after having been screened. The last reason represe]nts a concern for airports with a high percentage of leisure passengers, who usually take longer at collecting their items due to the number of items they carry, their travel experience or the fact that they are more likely to travel with children or elders. Several efforts have been made in regards to preventing passengers from divesting inappropriately; however, very few studies have been conducted on incentivizing passengers to move away expeditiously from the composure area where they collect their belongings.

This paper examines two different alternative solutions designed to address this last matter. Discrete-event simulation is employed, using Arena Rockwell Software, to develop and evaluate three models. A base model represents the current configuration of the system, while the other two models represent each of the proposed alternatives. We present the configuration of the checkpoint lines where disruptions of the x-ray operation due to passengers staying in the composure area occur often, because leisure passengers constitute 63% of the passenger traffic (Magenheim 2007).

In Section 2, we discuss some relevant efforts made on improving the performance of security checkpoints using simulation. In Section 3, we describe in detail the system under study, the conceptual modelling, and the constructs used in Arena to implement the models. In Section 4, we summarize the methods by which the data was collected, and the efforts made in validating the models. Lastly, in Section 5, we explain the experimentation methods and the results obtained from evaluating the models.

2 LITERATURE REVIEW

After the TSA was established in 2001, the processing rate of passengers dramatically decreased due to the newly implemented security procedures. Thus, alleviating bottlenecks within the security screening operations became a priority to the TSA and a topic of interest for several studies.

Ju, Wang, and Che (2007) address the long waiting lines in a checkpoint by designing an optimization solution to the panning capacity problem. The tool consists of a simulation model in Arena that takes inputs of the airport being studied, and it provides insights for the possible bottlenecks at the checkpoint facilities. They also present an optimization model suggests the relocation of resources that would guarantee an improvement of the performance measures in question. Similarly, Wilson, Roe, and So (2006) present the security checkpoint optimizer developed by Northrop Grumman for the TSA. This is a java-based application driven by a discrete event simulation engine, which was designed to perform "what-if" analysis of changes and additions to the checkpoints facilities (Wilson, Roe, and So 2006).

Tomber and Barros (2007) present their study on improving the passenger throughput of the security checkpoints at Seattle-Tacoma International Airport. Using simulation modeling, they evaluate a series of scenarios, which differ on the number of items allowed per passenger, the size of divesting and repacking tables and the use of secondary medal detector screeners (Tomer and Barros 2007). They conclude that to reduce the number of items to one item per passenger is the most effective measure. In 2001, the Federal Aviation Administration limited the number of carry-on items to one carry-on and one personal item per passenger (Blalock, Kadiyali, and Simon 2015).

Similarly, in an effort to mitigate interruptions of the x-ray operation due to failures in divesting, the TSA introduced the use of divesture officers. These officers have the fundamental role of reducing false alarms by ensuring that passengers divest appropriately before the screening. Results show that those security checkpoints that provide oral instructions to passengers during the divesture stage, have an average throughput of 140 passengers/h/lane, 9% higher than that of checkpoints that do not employ divesture officers (Passenger Facilitation 2012).

Further, in 2006, the planning department at the Dallas Fort Worth International Airport, studied the impact of extending the exit rollers at the standard passengers' checkpoint lanes. A test was performed in terminal D, where two lanes were used (DFW Planning Department 2006). An extension of 6 feet was placed in Lane 2, so items would be ejected farther away from the x-ray before passengers could collect them. Lane 1 and Lane 2 had 241 and 254 passengers of throughput, respectively (DFW Planning Department 2006). However, the total duration of delays in Lane 2 was 46 seconds, significantly lower than in Lane 1, which had a total duration of delays of 3 minutes and 50 seconds (DFW Planning Department 2006). It was observed that having the composure area farther away from the x-ray would not only give more space to passengers, but would also diminish the occurrences in which passengers would stay around the roller beds (DFW Planning Department 2006). Additional suggestions include providing additional benches toward the checkpoint exit, and signage to direct passengers beyond the x-ray area (DFW Planning Department 2006).

Lastly, Nie et al. (2011) discuss the benefits of grouping passengers according to risk perceived levels. They propose a simulation-based design to effectively utilize a selectee lane resource. In their solution, passengers are assigned to the selectee lane according to the number of passengers that are already in the lane. They conclude that this solution increases the probability of true alarms while it maintains the system time of passengers under the TSA required limits (Nie et al. 2011).

In the following sections, the system under study and the two alternatives solutions will be discussed in detail. We will give especial emphasis to the modelling approach of the base model and the two other configurations, and the constructs used in Arena to implement the three models.

3 SIMULATION MODELING

The system under study consists of the passengers and their interface with the officers, and with the technical security equipment. It extends from the time passengers join the queue for having checked their documents with a Travel Document Checker (TDC) until they have removed the last item from the exit roller, and they have moved away from the composure area. The system is modeled as it is documented in the Revision 5.1 of the TSA Checkpoint Design Guide (2014). Figure 1 displays a layout of a standard security checkpoint with the system under study enclosed in red.

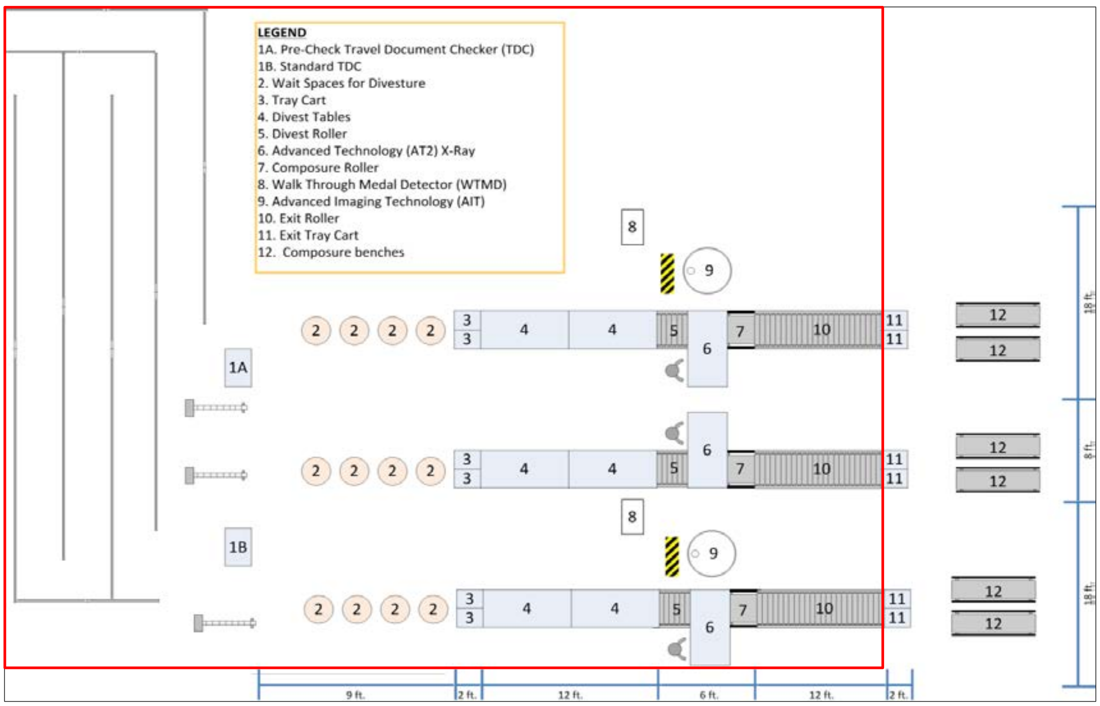

Figure 1: Layout of a TSA standard security checkpoint.

The base model is represented as the TSA standard checkpoint currently operates. The system is divided into three lanes. The first lane is dedicated to Pre-check passengers, who are not required to take off their shoes, or take out liquids or laptops from their carry-on bags. The other two lanes are dedicated to standard passengers, who are not part of the Pre-Check program. For this study, standard passengers are classified as expedited and leisure passengers, where, on average, 37% of the passengers are expedited, and 63% are leisure passengers. The term "expedited" is used by the TSA to identify passengers with perceived low risk who are processed more rapidly by omitting some steps of their screening process. However, for this research, the term is used to identify passengers who seem to employ at most two trays for divesting, or seem to have more experience in airports. On the other hand, a passenger is classified as leisure passenger if he travels in a group or seems to employ more than two trays for divesting.

Two performance measures are used to evaluate the performance of the models. The time to composure corresponds to the time from when passengers join the queue for checking their documents with a TDC, up to the time when they are able to pick up their belongings from the exit roller or composure tables. The hourly throughput of standard passengers corresponds to the average number of passengers processed in an hour for every type of passenger.

In the next section, the flow of the passengers and items through the system will be described, and a summary of how the system was built using Arena constructs will be briefly discussed.

3.1 Conceptual Modeling

The screening process involves several security steps. Upon arrival, passengers join the queue for document verification by a TDC. There is one TDC dedicated to the Pre-Check lane, and one TDC dedicated to the standard passengers' lane. TDCs also direct passengers to the lanes for the divesting process. There can be at most four passengers per lane waiting for divesting. Thus, if there is no space available for passengers to wait, the Pre-Check TDC must wait until a space opens in the Pre-Check lane, and the standard TDC must wait until a space opens in either of the two standard lanes.

Next, passengers proceed to the divestiture stage. First, they pick up their trays to place their belongings and go through the x-ray. It is assumed that all passengers have one carry-on item of the size of a single tray, and a number of trays that varies according to the passenger type. Pre-Check passengers may have 0 to 1 trays; expedited passengers may have 0 to 2 trays; leisure passengers may have 2 to 4 trays. The time passengers take to pick up their trays depends on the number of trays they need. It is assumed that one passenger at a time picks up his trays. Thus, passengers seize a space resource in front of the tray cart, and they release it only after they have been able to seize the space for their first tray on the divesture table. Next, passengers continue in the queue until they have seized a space for each of their trays. Up to 6 trays fit simultaneously, and each passenger is assumed to wait for the passenger in front to move forward. Passengers divest as they move along the tables to make their trays go through the x-ray. The divestiture time varies according to the number of trays. Thus, some passengers may have finished divesting by the time they arrive to the opening of the x-ray; others, on the other hand, may delay some extra time after they have arrived to the opening of the x-ray in order to complete divesting.

Next, trays enter the x-ray area, which consists of three resources: an upstream roller that takes trays to the x-ray; the x-ray, where trays are processed individually; and the downstream roller that delivers the trays to the exit roller. At the same time, Pre-Check passengers proceed to the Walk Through Medal Detector (WTMD) while standard passengers go through the Advanced Imaging Technology (AIT). The Pre-Check lane has its own WTMD and AIT while the two standard lanes share these two resources.

After the x-ray, trays and carry-ons continue through the exit roller, where they stay until their passengers pick them up. Different from the divestiture stage, where passengers are assumed to enter from the first space of the tables and utilize each of the 6 spaces until they get to the x-ray, in the composure stage, passengers are assumed to seize any of the 6 spaces of the exit roller to collect their items. Passengers search their trays and compose until they have made sure they have recovered all of their items. Up to 6 trays fit on the exit roller, so if there is not a space available for the x-ray operator to continue delivering cleared trays, the operator will have to stop the screening process until a space opens for a tray to be delivered. After passengers complete taking all of their items away from the exit roller, they place their empty trays on the tray cart at the end of the lane, and leave the system. The trays, on the other hand, are held on the tray cart until 30 trays have been stacked on the cart, and an officer is ready to take them back to the start of the lane for new passengers to have trays available for proceeding through screening. Figure 2 displays the flow of the passengers and trays through the system in the base model.

This flow of passengers and items slightly changes for modeling the alternative solutions. In the following sections, the two alternative solutions will be described in detail, and emphasis will be made on how the flow of entities is different in each alternative from the base configuration.

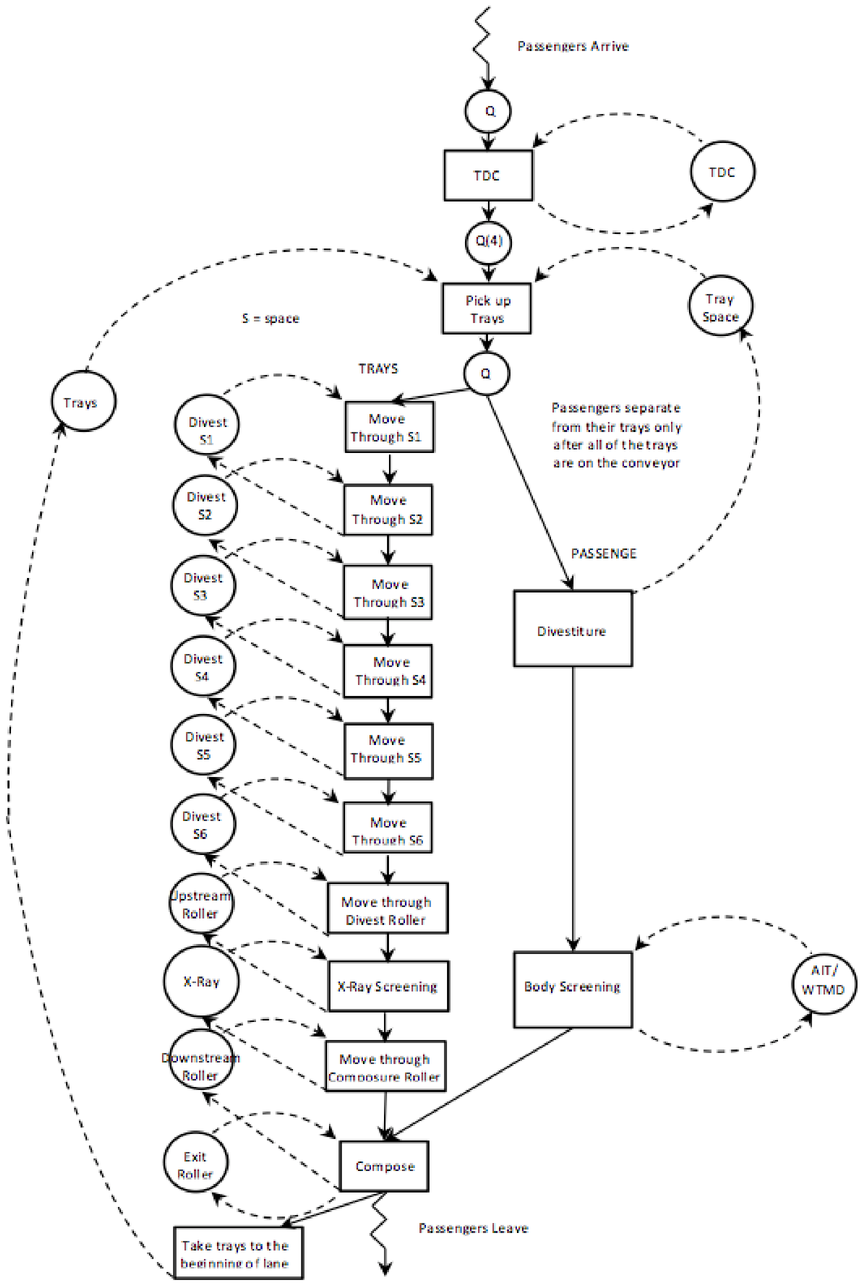

Figure 2: Base Model conceptual configuration.

3.1.1 Alternative 1 Model

We identified leisure passengers as a significant cause of congestion in the composure area, because they usually take longer than the average passenger at collecting their items from the composure roller. This alternative proposes separating leisure from expedited passengers, and processing them in separate lanes. Similar to Pre-Check passengers, expedited and leisure passengers will have a separate TDC queue and a separate lane for each type. However, the AIT will still be shared between the two lanes. For evaluation purposes, it was assumed that leisure passengers do not start processing through the expedited lane if this lane becomes idle. Figure 3 displays the system with this solution incorporated.

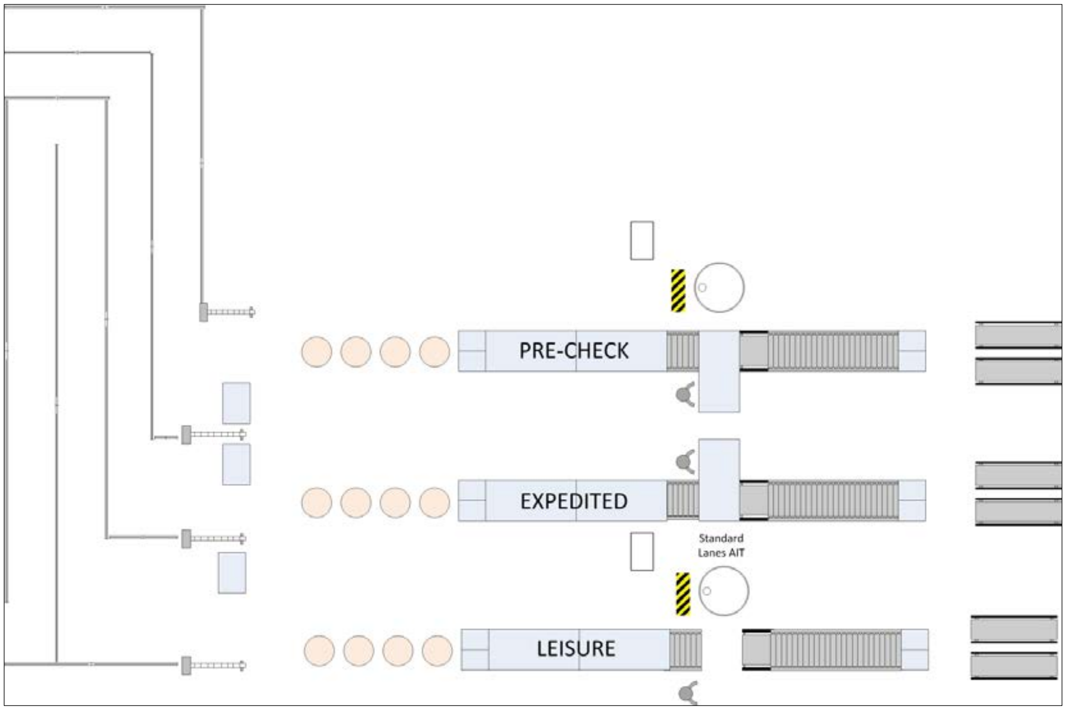

Figure 3: Alternative 1 layout.

The Alternative 1 model is expected to not be able to process passengers within 10 minutes each when the percentage of leisure passengers is high, because the leisure lane might get too congested while the expedited lane may be idle for most of the time. However, if the main bottlenecks of the leisure lane are alleviated, separating leisure passengers from expedited passengers as in the Alternative 1 model may be a viable solution.

3.1.2 Alternative 2 Model

Alternative 2 was designed to clear the congestion of passengers at the composure area of the leisure lane. It proposes classifying standard passengers into expedited and leisure passengers as in Alternative 1, but it suggests replacing the exit roller of the leisure lane with a continuously circulating conveyor that incentivizes leisure passengers to move away from the composure area as soon as they are able to pick up their items. Figure 4 illustrates how this circulating conveyor should appear if it is incorporated into the Alternative 1 layout.

There is space for six trays and six passengers to wait for their items around the conveyor. Thus, upon having been screened by the AIT, leisure passengers proceed to one these six spaces, and they wait until their trays circulate in front of them. We assumed that passengers do not go running after their trays. Further, it is assumed that passengers will be able to see their items at all times, and that nobody will pick up somebody else's belongings. Passengers do not leave until they have collected all of their items. Therefore, trays circulate separately, each occupying one cell of the conveyor, and stop at every space to be identified by their owners. When a tray is identified by its owner, the tray is removed from the conveyor, and it waits until the last tray associated with the owner is identified. After the last tray is taken off the conveyor, the trays are grouped together by the passenger. There is no delay time associated with composing, assuming passengers will pick up their belongings and leave immediately after their items have been removed from the conveyor. Items that are not identified by a passenger and picked up, will circulate back around until they are picked up by their owner.

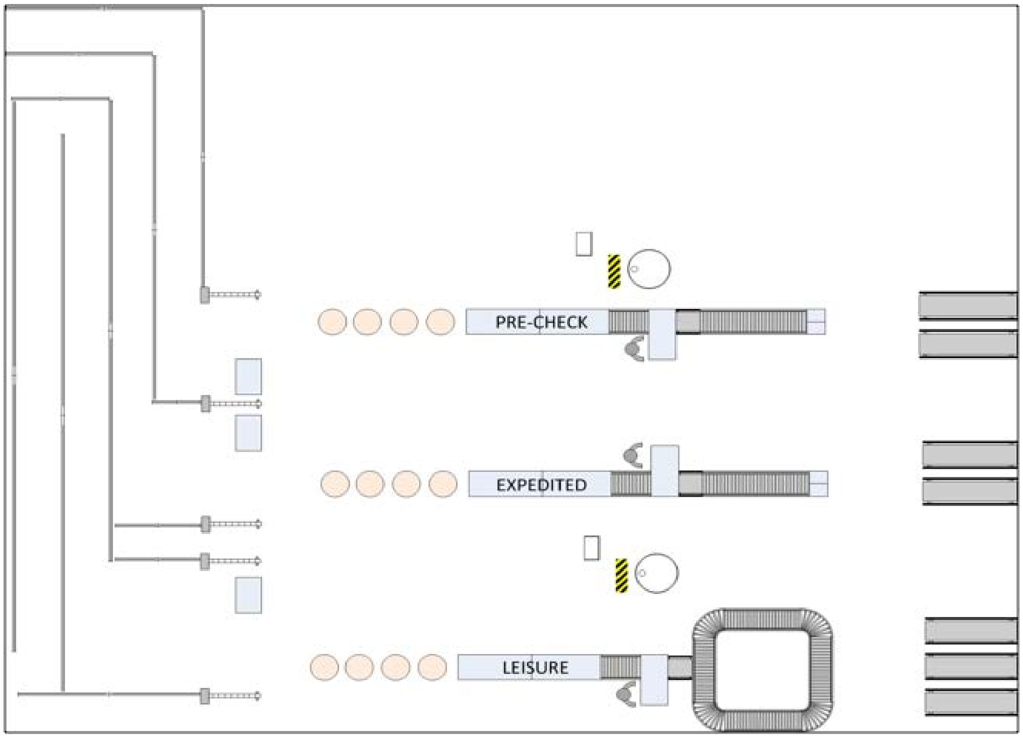

Figure 4: Alternative 2 layout.

3.2 Arena Modeling

Arena Rockwell Software and discrete-event simulation were used to develop the three simulation models. This section discusses the key modelling aspects in each of the three models.

The TDCs as well as the trays, and the different spaces for trays and passengers throughout the lanes were modeled as resources. Note that even if trays represented separate entities for the screening and composure stages, trays were also modelled as resources with a capacity of 30 for each lane in order to account for the fact that passengers need trays to move forward through the lanes.

In the divesture stage, passengers were separated from their tray and carry-on entities as soon as they seized their trays from the tray cart in order to simplify the seizure of spaces on the divesting tables. Figure 5 displays the pseudo-codes for the flow of the passengers, the trays and a delay entity in the divesture stage.

PASSENGER	DELAY ENTITY	TRAYS
HOLD until all trays are on divesting table RELEASE Tray Space SEIZE AIT	DELAY for divestiture eDivestTime(myNumCells) ASSIGN vSearchCellNum == Entity.SerialNumber SEARCH in HOLD for divesting passenger If vSearchCellNum == Entity.SerialNum (Found) SIGNAL Tray (Not Found) HOLD delay entity DISPOSE delay entity	ASSIGN vCounter == vCounter + 1 myCellIndex == vCounter ACCESS Divestiture DELAY placement on divesting tables TRIA(0.5, 0.75, 1) DECIDE if myCellIndex == myNumCells RELEASE Tray Space CONVEY to x-ray DECIDE if myCellIndex == myNumCells (True) ASSIGN vSearchPassNum == Entity.SerialNum SEARCH in HOLD for divesting passenger if vSearchPassNum == Entity.SerialNum (Found) SIGNAL passenger (Not Found) HOLD tray

Figure 5: Divestiture stage pseudo-code.

The modeling of these three types of entities and the use of HOLD and SIGNAL constructs ensure that passengers stay around the divesting tables until they have found a space for each of their items. The delay entity ensures that the last tray of every passenger does not proceed to the x-ray until the passenger has finished divesting completely. Different from the divestiture stage, the composure stage employs only two entities. Figure 6 displays the pseudo-code of the flow of these two entities.

```
PASSENGER

SEIZE AIT
DELAY AIT (TRIA(3,5,7) sec)
DECIDE if successful scan 90%
(True) RELEASE AIT
(False) DEAY AIT (TRIA(3,5,7) sec)
        RELEASE AIT
SEIZE space around conveyor from Resource Set
(Save mySetIndex)
        Space 1.Resource
        Space 2.Resource
        Space 3.Resource
        Space 4.Resource
        Space 5.Resource
        Space 6.Resource
DELAY walk time to Space
        (eDelayWalkTime(mySetIndex))
HOLD in Space of HOLD Set
        Space 1.Hold
        Space 2.Hold
        Space 3.Hold
        Space 4.Hold
        Space 5.Hold
        Space 6.Hold
```

```
TRAY

SEIZE Upstream Roller
EXIT Divestiture
SEIZE x-ray
RELEASE Upstream Roller
DELAY x-ray TRIA(5, vXRay, 12) sec
SEIZE Downstream roller
RELEASE x-ray
ACCESS circulating conveyor
RELEASE Downstream Roller
CONVEY by sequence to Station in Station Set
        Space 1.Station
        Space 2.Station
        Space 3.Station
        Space 4.Station
        Space 5.Station
        Space 6.Station
```

```
A: (For every Station) ASSIGN mySetIndex
      vSN == Entity.SerialNumber
      J == 0
    SEARCH Passenger
    MEMBER(Holds Set, mySetIndex)
    Starting Index: 1
    Ending Index:
      NQ(MEMBER(Holds Set, mySetIndex)
    Search: vSN == Entity.SerialNumber
    DECIDE if  j == 0
      (True) DECIDE if Entity.Job.Step == 6
             (True) ASSIGN Entity.JobStep == 0
                    CONVEY by sequence
                    Goto A
             (False) EXIT circulating conveyor
                    BATCH by Entity.SerialNumber
                    (Batch Size: myNumCells)
                     REMOVE passenger from HOLD Set
                    (MEMBER(Holds Set, mySetIndex)
                     DISPOSE Extra entity
                     RELEASE Space around Conveyor
                     DISPOSE Passenger
SEPARATE Trays according myNumTrays
BATCH Trays (Batch Size: 30)
ROUTE to tray cart beginning
RELEASE 30 Trays
DISPOSE Tray entity
```

Figure 6: Composure stage pseudo-code.

As we can observe, the composure stage has a very interesting modelling approach. Passengers seize one of the six spaces available around the conveyor, and they enter in the HOLD queue of the space that they seized. Trays, on the other hand, circulate through each space, and look for the passenger in the HOLD queue. If trays find their passenger, they exit the conveyor; otherwise, they continue circulating until they find their passengers. Later, the collective entity of trays that is batched after trays exit the conveyor, removes the passenger from the HOLD queue. Later, the collective entity is separated into separate trays, which are batched again into a collective entity of 30 trays. This collective entity is routed to the beginning of the lane, where it releases 30 tray resources, and it is disposed.

Lastly, several constructs are used to obtain statistics on the hourly throughput of standard passengers, and the time to composure. ASSIGN modules, attributes and RECORD modules are used to record the time to composure of passengers. On the other hand, variables, entities, and RECORD and ASSIGN modules are used to compute the average hourly throughput of passengers. Variables are used to count the number of passengers in key segments of the models. Further, every hour an entity is created to record the values of the variables, and reset them to 0 before being disposed. The quantities recorded by the hour entities are used to compute the average hourly throughput of passengers after composure.

4 DATA COLLECTION AND MODELS VALIDATION

This section presents a summary of the methods used to collect the data and validate the three models. The procedures and sources used to collect the data were conducted with the purpose of obtaining reasonable ranges of data, not necessarily perfect estimates, for the input parameters of the models. The probability distribution function for the classification of standard passengers into types was obtained from studying the case of the Orlando Airport (MCO), where leisure passengers constitute 63% of the passenger traffic (Magenheim 2007). Distribution functions for the processing times, and routing times were obtained from the Thirteenth Annual IIE/Rockwell Automation Simulation Contest Problem: Airport Security by Rockitecture Architects. Further, a survey was distributed among the Industrial Engineering Department of the University of Arkansas in order to collect reasonable estimates on the number of trays that each type of passengers employs when travelling. In addition, a sensitivity analysis on the arrival rate was conducted in order to find the base arrival rate that would yield an average time to composure of 10 minutes per passenger (the current TSA standard system time limit), with a 95% confidence interval. It was found that 144 and 135 pre-check and standard passengers, respectively, would represent a reasonable estimate for the base arrival rates. Lastly, using the Half-With Ratio method described by Rossetti (2016), it was found that at least 40 replications would be necessary in order to be 95% confident that a we could achieve a half width of one person in the hourly throughput of standard passengers. Additional assumptions based on previous experience in airports were made for the data that was missing. Statistical analysis on the validity of these assumptions is out of the scope of this paper.

Additional validation consisted of ensuring that key steps of the screening process, relevant to the performance of the alternatives proposed, were being modelled appropriately. The validation was performed by conducting 2^k factorial designs on the two performance measures of this study. Low and high values for passenger arrival rates, mean proportion of leisure passengers, and mean processing times for the TDC and the x-ray were simulated to observe how the change in parameters would affect the hourly throughput of standard passengers and time to composure. Main effect plots were developed for the two performance measures of expedited and leisure passengers. These experiments confirmed our expectations in regards to the responses.

5 EXPERIMENTATION AND RESULTS

The experimentation for this study consisted of investigating whether any of the alternative solutions could achieve a higher throughput of standard passengers in security checkpoints with high proportion of leisure passengers while maintaining the TSA system time limits of 10 minutes per passenger.

First, the base model was run to obtain an initial value for the two performance measures. According to this run, on average, 129 passengers per hour were processed through the AIT. Expedited passengers spent on average 9.12 minutes from the TDC to the exit roller, while leisure passengers spent 9.43 minutes.

Later, the Alternative 1 model was run using the same input parameters as in the base model. This alternative improved the experience of expedited passengers, because their time to composure dropped down to less than one minute. However, this alternative hurt the experience of leisure passengers, because the time to composure for these passengers increased to around 85 minutes. Consequently, this alternative lowered the standard passengers overall throughput to 108 passengers per hour. This resulted from the fact that with such a high percentage of leisure passengers as 63%, all the leisure passengers queued up in the leisure passengers' lane while the expedited passengers' lane remained idle for most of the time, as was expected.

A sensitivity analysis was conducted to determine the proportion of expedited passengers that would result in the same hourly throughput of standard passengers as in the base model, and the time to composure within the TSA limits of 10 minutes per passenger. Figure 7 displays this analysis.

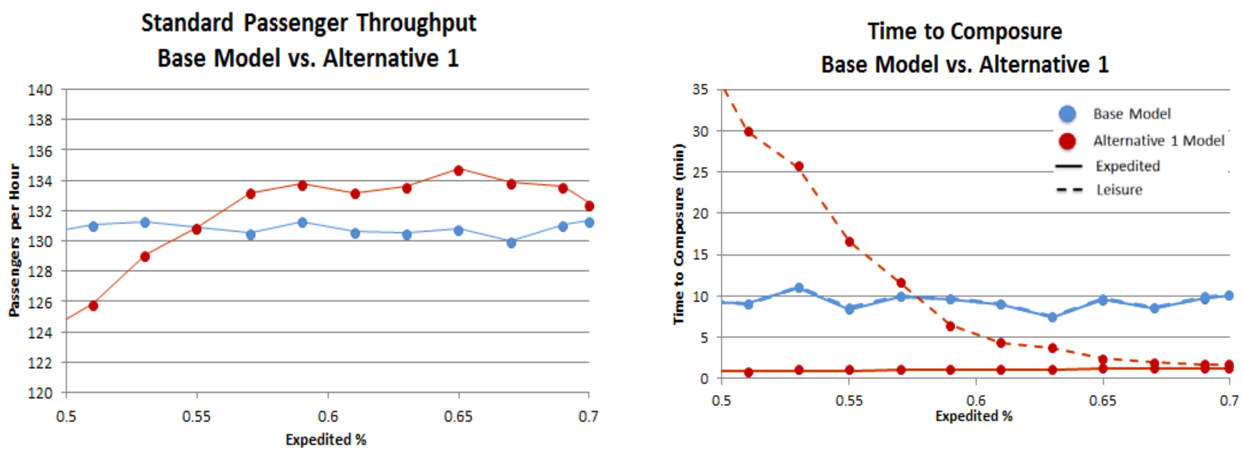

Figure 7: Sensitivity analysis with base model and Alternative 1 model.

The first graph represents the sensitivity of the hourly throughput of standard passengers overall when changing the expedited passengers' percentage in both the base model and the Alternative 1 model. The second graph represents the sensitivity of the time to composure of expedited and leisure passengers when changing the expedited passengers' percentage in the base model and the Alternative 1 model. This analysis shows that it was necessary to have at least 60% of expedited passengers in the Alternative 1 model in order to achieve a throughput similar to the one achieved by the base model.

Alternative 2 was designed to improve the throughput of standard passengers of Alternative 1 by providing a solution to the congestion of passengers in the composure area of the leisure lane. Thus, a similar sensitivity analysis was performed between the base model and the Alternative 2 in order to investigate how much we could lower the percentage of expedited passengers while staying within the same performance measures as in the base model. Figure 8 displays this analysis.

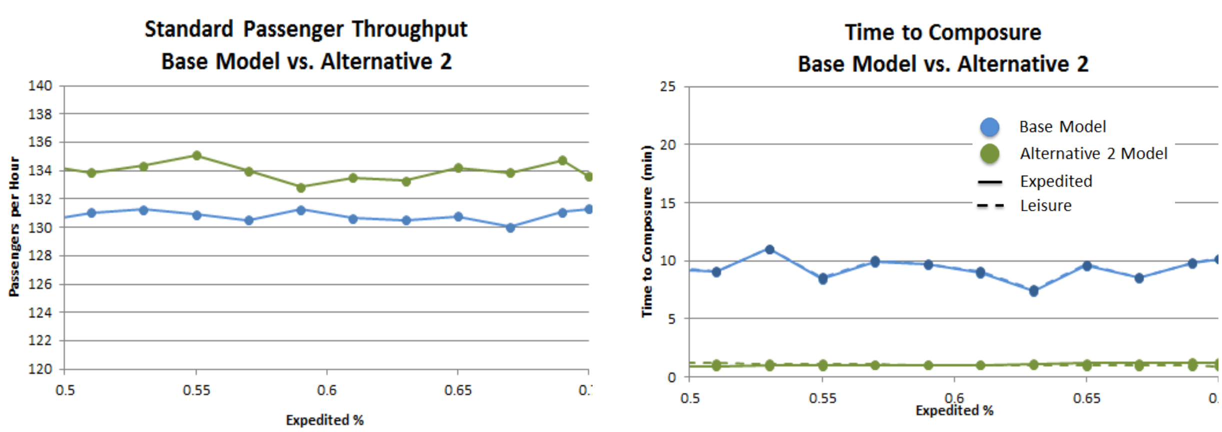

Figure 8: Sensitivity analysis with base model and Alternative 2 model.

Different from the Alternative 1 model, the Alternative 2 model decreased the time to composure for both expedited and leisure passengers to less than one minute. It seems that the Alternative 2 model is insensitive to the change in proportion of expedited passengers, because the circulating conveyor allows processing leisure passengers almost as fast as processing expedited passengers. Further, the Alternative 2 model allows maintaining an hourly throughput of close to 135 standard passengers per hour, higher than in the base model, and equal to the arrival rate of standard passengers with a percentage of expedited passengers as low as 15%. This implies that all passengers manage to be processed completely every hour with the Alternative 2 model. Therefore, increasing the hourly throughput of standard passengers in airports with high percentages of leisure passengers is a possibility with Alternative 2.

A 2^k factorial experiment was conducted to investigate the effect of increasing the arrival rate on the hourly throughput with the three models while maintaining the other parameters the same. Figure 9 displays the results of this analysis including the time to composure in the second graph.

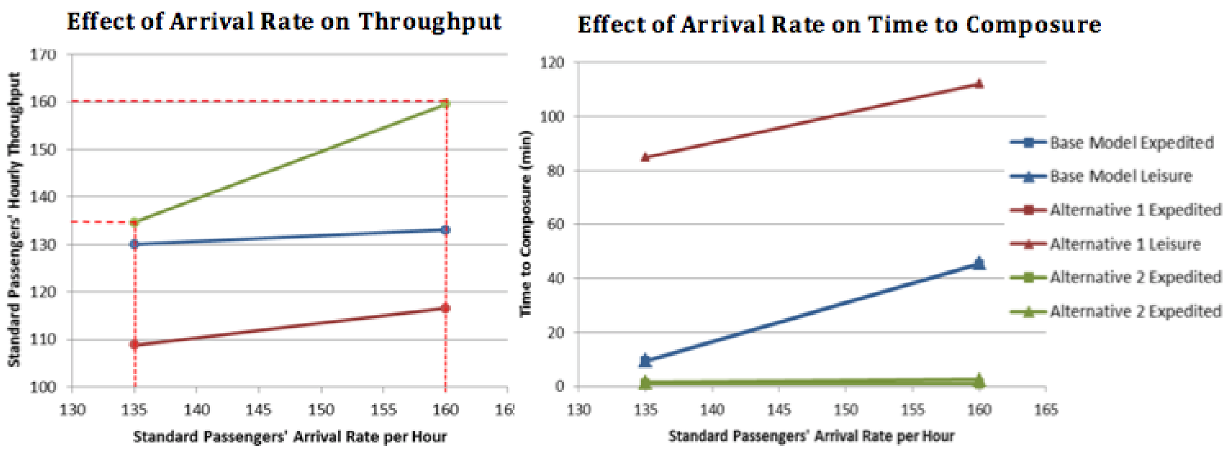

Figure 9: Factorial design on arrival rate.

These two graphs display the effect on throughput and time to composure, respectively, of increasing the arrival rate from 135 to 160 passengers. We can observe from both graphs, that Alternative 2 is the only alternative that has the potential of increasing the hourly throughput to more than 150 standard passengers while still maintaining within the TSA standard limit of 10 minutes of time to composure. With an arrival rate of 160 passengers per hour, Alternative 2 manages to process 100% of the passengers with an average time to composure of 2 minutes.

6 CONCLUSIONS AND FUTURE WORK

The x-ray has been identified by several studies, as the main bottleneck of the security screening process, because of the delays at the divesting and composure stages. Several efforts have been conducted on minimizing the delays at the divesting area, but very few have been conducted at composure area. We have found that separating leisure passengers from expedited passengers, processing them separately, and implementing a continuously circulating conveyor in place of the exit roller may eliminate the delays at the composure area. Through simulation analysis, this solution improved the experience of both expedited and leisure passengers by reducing the security time by 70%. Additionally, results show that it could increase the current average throughput of passenger to more than 160 passengers per hour.

There are several considerations that need to be studied before this solution can be implemented. The TSA has very specific requirements regarding the handling of passengers' belongings. Passengers must be able to see their items at all times of the security process. Thus, the system must be designed in a way that passengers feel confident that nobody will take their items. Additionally, this alternative will be successful only if it manages to move passengers quickly out of the composure area. The speed of the conveyor plays an important role in this endeavor. If the speed is too high, passengers may not be able to collect their items as soon as they get out from the AIT, because items might have passed already by the time they arrive to the conveyor. On the other hand, if the speed is too low, passenger may have to wait longer than what it is necessary to collect their items. We need to find the optimal speed that allows most of the passengers to reach their items as soon as they arrive to the conveyor.

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