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BSAN 6040

Report on Simulations on O'Dare Airport

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Overview:

To determine the issues O'Dare Airport currently faces, we decided to conduct a simulation based on the 1 full length runway that is available. And to gain further insights into what are our best strategies for expansion, we conducted a simulation with 2 different potential plans.
Here are the two plans:

- 1 additional full-length runway.
- 1 additional partial-length runway capable of handling up to mid size jets.

We ran simulations for up to around 20 hours of operating hours for a day and repeated each simulation model up to 365 days in order to replicate one year of operation. This report will first go into the logic of the models, and some details about each model, and then compare the model and offer concrete insights and recommendations.

Parameters:
Before going into the simulation, here are the parameters we use to base our simulations upon. We gain these data by analyzing the flight history for O'Dare airport from the past 5 years.

Table 1. Probability distribution for gaps between requests to Control Tower

Time (mins)	Probability
0	0.10
6	0.40
9	0.28
12	0.22

Table 2. Probability distribution of action request types

Action Type	Probability
Take-Off	0.50
Landing	0.50

Table 3. Probability distribution of aircraft types

Jet Type	Probability
Jumbo	0.35
Medium	0.45
Small	0.20

Table 6. Fees

Service Fees		
Aircraft	**Action Type**	
Type	**Take-offs**	**Landing**
Small	$ 850.00	$ 850.00
Medium	$1,200.00	$1,200.00
Jumbo	$1,600.00	$1,600.00

Table 5. Cost and other data

ITEM	DATA	COMMENTS
Cost of Runway Construction that can handle jumbo jets	$110 Million	
Cost of Runway Construction that can handle up to midsize jets	70% of the Cost for a Full length Runway with ability to handle Jumbo Jets	
Jumbo Jets Fuel Burn Rate	6500 pph/engine	Take-Offs
Mid Size Jets Fuel Burn Rate	2000 pph/engine	Take-Offs
Small Size Jets/Commuter Planes Fuel Burn Rate	600 pph/engine	Take-Offs
Jumbo Jets Fuel Burn Rate/Idling on the ground	1100 pph/engine	Waiting to take off
Mid Size Jets Fuel Burn Rate/Idling on the ground	800 pph/engine	Waiting to take off
Small Size Jets/Commuter Planes Fuel Burn Rate/Idling on the ground	100 pph/engine	Waiting to take off
Jumbo Jets Fuel Burn Rate/Waiting to land	4500 pph/engine	(waiting to land)
Mid Size Jets Fuel Burn Rate/Waiting to land	1500 pph/engine	(waiting to land)
Small Size Jets/Commuter Planes Fuel Burn Rate/Waiting to land	350 pph/engine	(waiting to land)

Currently market fuel price: $2.41/gallon

Simulation Logic:

As shown in the parameters, we first aggregate the historical data and find the probability distributions of each possible event, then generate random possibilities in order to simulate the occurrence of the random events.

Here is a list of random events we generated in all models of our simulations:

- Arrival Gap
- Aircraft Type
- Actions Type (Take-off/Landing)
- Completion Time (Aircraft type based)

Based on these random events we then calculate the arrival time of each aircraft, when will the runway become available for them, how long they will wait before they can execute the action, how much fuel they would waste during the waiting, and fees collected from each plane action. One individual simulation simulated an average operating time of 20 hours a day, then, we repeated the simulation 1,000 times, and proportionally calculated each indicator for 1 year, 365 days.

Simulation 1 – 1 Full-Length Runway (Current):

With the current set up, as expected, the runway utilization rate is at nearly 100% at all times. And there is substantial wait time for a large quantity of the airplanes, which leads to a considerable amount of fuel waste. The daily average wasted fuel in dollar amounts at the current airport is around $295,000. To put things in perspective, O'Dare airport is able to service around 140 planes on average per day. And on average, the daily fees collected is about $180,000. There is a tremendous fuel waste occurring for airlines. Since the airlines are supportive of the idea of building an additional runway, and they are willing to share up to 10% of their savings in fuel cost, we have a great incentive in considering an expansion.

Simulation 2 – 2 Full-Length Runways (Plan 1):

By adding the utilizations rate of both runways, we see a significant increase in the total runway utilization rate. The total utilization rate for 2 full length runways is on average 115% with a

minimum of 100% and maximum of 130%. This means the current airport set up is not capable of servicing all the aircrafts that are coming to our airport.

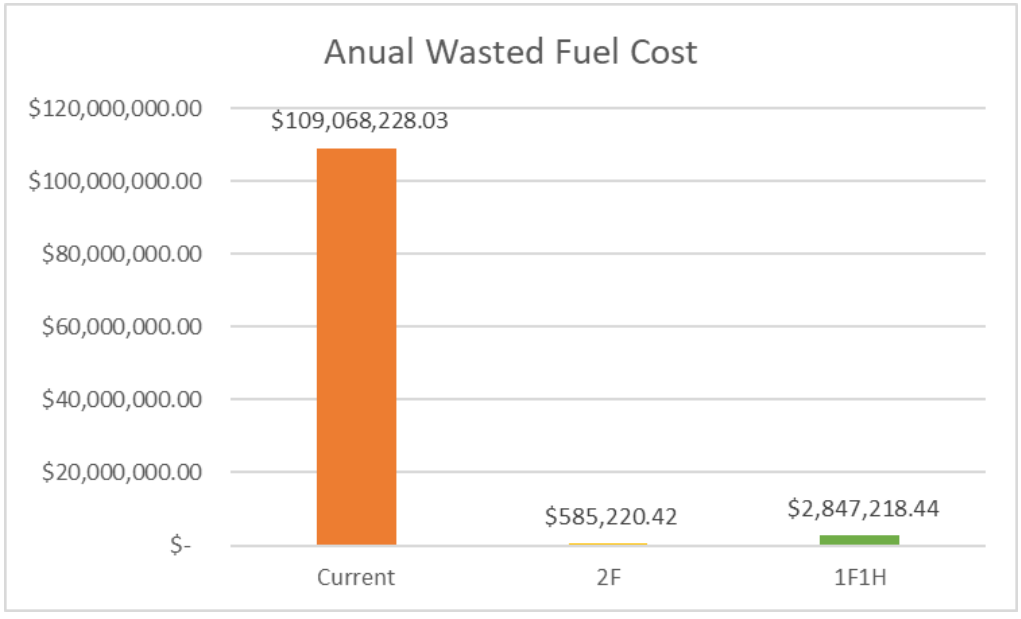
With an additional full-length runway, we observed a substantial decrease in the aircraft wait time and wasted fuel cost. The 2F plan has an average daily fuel waste of a mere $1600, with the possibility of having no waste at all. The simulated average daily fees collection is around $200,000

Simulation 3 – 1 Full-Length & 1 Half-Length Runways. (Plan 2):

The second plan features an additional half-length runway, which is capable of servicing planes up to a mid size jet, in other words, jumbo jets have to use the full-length runway. This model is capable of servicing about the same number of aircrafts per day, but it has an average utilization rate of 98%. The half-length runway understandably has a slightly lower utilization rate than the full-length one. The wasted fuel cost is lower than the current situation. The average daily wasted fuel cost is about $1,600, and the fees collected is similar to the 2F version, which is $200,000.

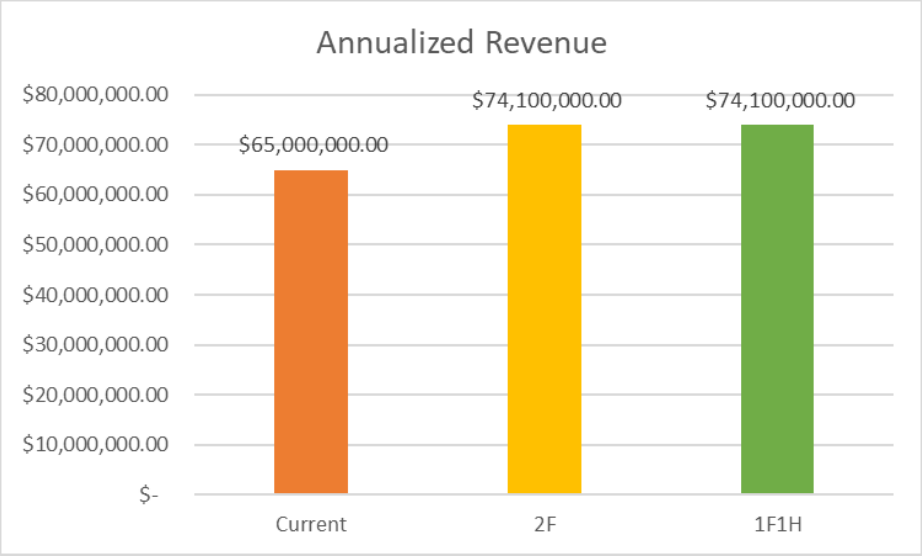
Comparison and Analysis:

By comparing the annualized cost and fees collected, we can gain a better insight of how the two potential plans can improve O'Dare Airport.



Currently, airlines waste about $109,068,228 on fuel annually. The simulations show that by building an additional full-length runway, the wasted fuel cost would decrease dramatically by 99%. If we only build the half-length runway, the cost would be slightly higher but still considerably lower than the current situation.

As mentioned in the earlier part of the report, the current airport is capable of handling around 140 airplanes daily. However, O'Dare airport would be able to service up to 160 aircrafts on average daily. This would translate directly to an increase in the airport's revenue.



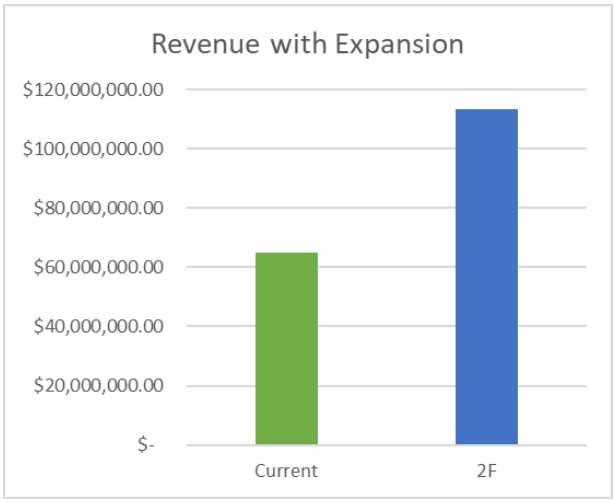
As shown in the graph above, we can see that both potential plans can bring about a 14% increase in the annualized revenue for the airport. Although 14% is not a groundbreaking increase, it is calculated with the current arrival frequency. The current simulation shows that, in both plans, neither runway is operating at anywhere near full capacity. This indicates that there is an opportunity for O'Dare to expand its service to more aircrafts.

- Business Expansion Opportunities

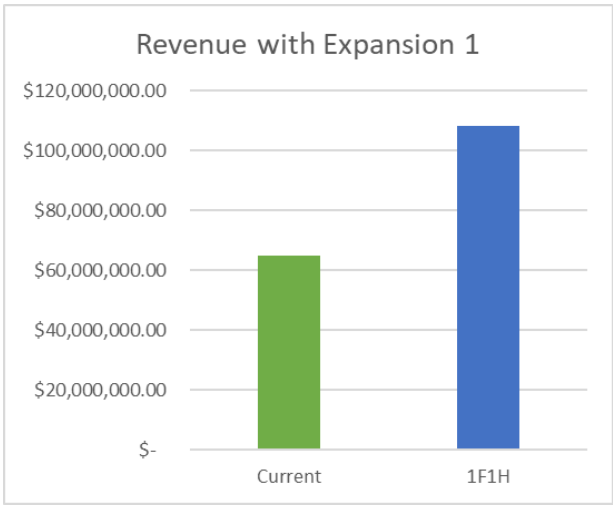
Since the runways in both plans have idle time, we decided to further our analysis by investigating how the business of the airport can be expanded.

With the 2F plan, the model shows that if we expand the airport operation by 35% (We simulated that by increasing the aircraft arrival frequency by 35%), we can service up to 245 aircrafts on average per day. With this increase, we are still able to keep annual wasted fuel cost under $9,000,000, which is still almost $100,000,000 lower than the current fuel waste. Meanwhile, by

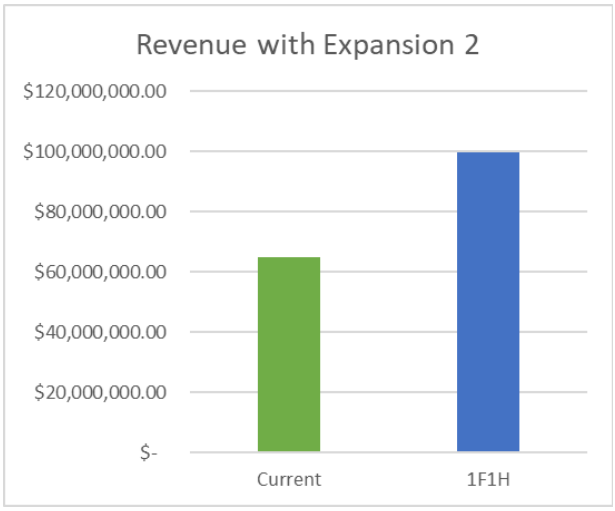
servicing more aircrafts, we could potentially increase our annual revenue to $113,500,000, which is almost double of the current revenue.



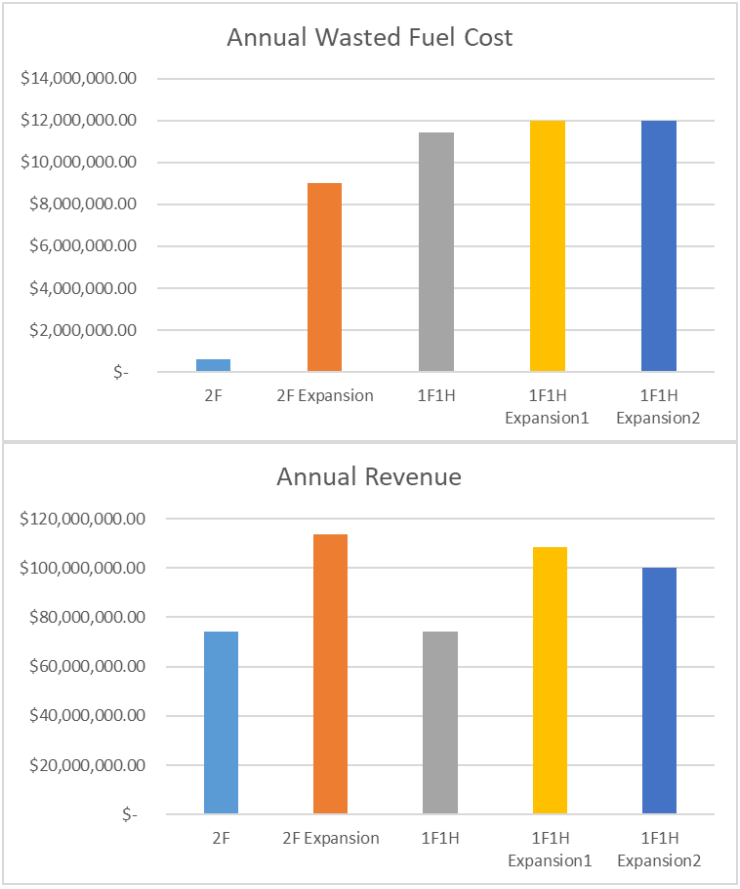
On the other hand with the 1F1H, there are two possible ways of expansion. First, since the additional runway can only handle up to medium aircraft, the most ideal expansion would be servicing more small and medium aircrafts. If that is achievable, with 35% operation expansion, service on average 25% jumbo jets, 50% medium jets and 25% small jets, the airport will be able to service up to 245 jets daily. And the annualized wasted fuel cost can be contained under $12,000,000 while producing an annual revenue of $108,500,000.



The other expansion assumes that the distribution of jet types cannot change, which reduces the second 1F1H plans' expansion level to only 25%. However, under this expansion, we are still able to keep fuel waste under $12,000,000 while generating revenue of $100,000,000.



Here is a chart for simulated annual waste fuel cost and revenue for both plans and their expansion possibility:



Cost & Cost Recovery Analysis:

In this section, we will break down the cost and cost recovery for both potential plans.
For the 2F plan, building an additional full-length runway cost $110 million. With no operation expansion considered, the new airport setup would save airlines around $108,415,000 annually. The airlines that O'Dare is currently working with are willing to share 10% of that saving for the next 5 years. This would translate into a consistent $10,800,000 annual income for the next 5 years. Assuming a 2.5% discount rate, a 10% profit margin, the cost of the runway will be recovered in about 7 years. However, if the operation expansion is possible, then the cost recovery time for the new runway can be as short as 5 years.
For the 1F1H plan, building the additional runway would only cost about 70% of the full-length version, which is around $77 million. Without considering the expansion plan, the airport would be able to recuperate the cost of building the runway in 3 to 4 years. If expansion 1 (service more small and medium jets) is possible, the cost recovery would be done in a little over 2 years. If expansion 2 (similar ratio of jumbo, mid and small) is possible, the cost recovery would be around 3 years.

Summary & Recommendations:

The current setup for O'Dare airport clearly cannot efficiently support the demand from the airline. The annual fuel waste is as high as $100 million. Therefore, the need for an additional runway is undeniable. Based on our simulation, we have several recommendations.

- With no operation expansion:

If the airport does not see any opportunity for a potential upgrade, here is our recommendation: The most cost efficient option is to adopt the 1F1H plan and build the partial runway that can only service up to medium jets. This plan only requires $77 million funding, which would reduce wasted fuel cost down by around 97% while being able to service 14% more aircrafts that we previously have to turn away. This plan would increase the airport's annual revenue by 14% or $9,000,000.

- Possible expansion with selection of more small and medium jets:

If there is a potential for expansion with the selection of more small and medium jets instead of jumbo jets, the airport should adopt the 1F1H plan. Because with the expansion plan, the airport

would be able to quickly recover the cost to build the additional runway. While containing the annual wasted fuel cost under around $12 million, the airport would be able to increase its revenue by 56% to $100 million per year.

- Possible expansion without selection:

If there is a potential for expansion, but all types of jets increase proportionally, then we would recommend adopting the 2F plan and building the additional full-length runway. This plan does have a higher initial cost of $110 million, but with the potential of expansion, the cost would be recovered relatively quickly. And this plan would offer a lower annual wasted fuel cost of $9 million while bringing in annual revenue of $113.5 million, which is the highest of all simulations.