Post-COVID Recovery for SIA: Optimizing Passenger-Cargo Fleet Allocation

Group Final Presentation

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Preview
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Optimize the aircraft allocation of SIA's fleet according to the post COVID-19 aviation industry environment through data modelling
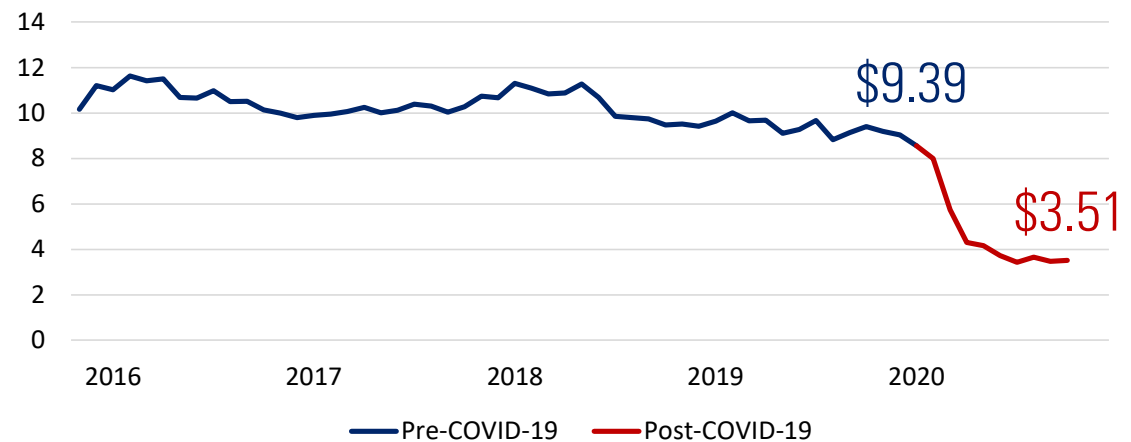
Objective
To optimize the allocation of aircrafts to be put in passenger and cargo operations, storage, or sale in the post COVID-19 recovery period (5 years) to maximize profits.

Background
The global aviation industry has been hit hard by country lockdowns due to COVID-19.

Singapore Airlines experienced a 99.3% drop in of passenger carriage in June 2020 due to COVID-19.

SIA Share Price (C6L)

$9.39

$3.51

Pre-COVID-19 — Post-COVID-19

To maximize profit, SIA has to allocate its fleet across four allocation options: passenger svc, cargo svc, put in storage, sell / retire

SIA Fleet:
133 aircrafts
(Apr 2020)

Airbus A330-300

Airbus A350-900

Airbus A380-800

Boeing 777-300

Boeing 777-300ER

Boeing 787-10
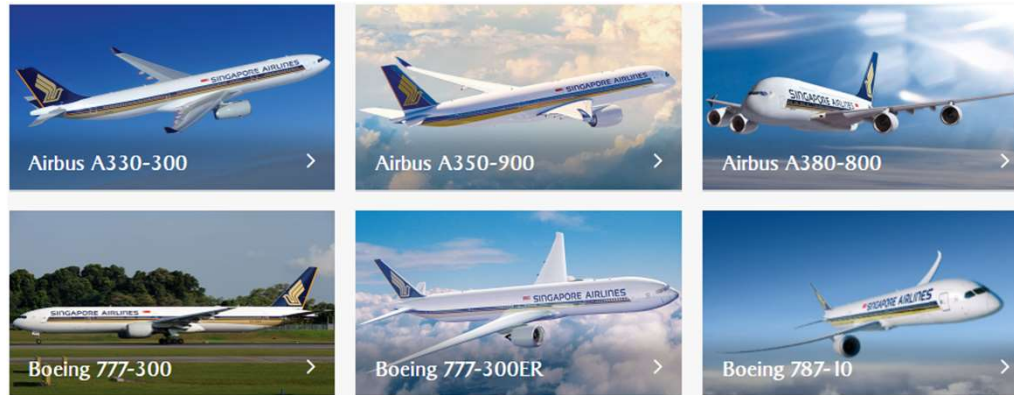
Passenger Service

Cargo Service

Put in Storage

Sell / Retire

The goal of the model is to maximise profits through optimizing the decision of SIA aircraft fleet allocations

Decisions to Optimize

Passenger Service
- number of aircraft

Cargo Service
- number of aircraft

Put in Storage
- number of aircraft

Sell / Retire
- $ price to sell
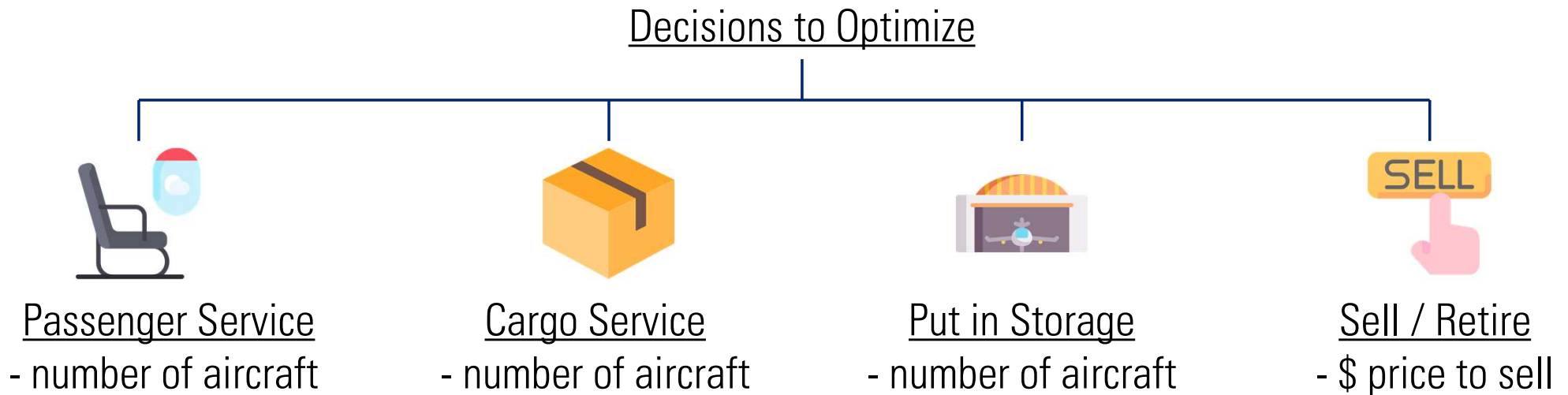
Performance Measure

$$Profit = Revenue - Cost$$

Includes fixed and variable costs

2. Aircraft Allocation Model

Relevant parameters and performance measures were identified to prepare the model to optimize the decision on aircraft allocations

Decisions:

- Number of Aircrafts Allocated to Passenger
- Number of Aircrafts Allocated to Cargo
- Number of Aircrafts Allocated to Storage

Parameters:

- Historic Daily COVID Cases per Capita
- Country Traffic Light Profile Criteria
- Vaccine Availability Date
- Fast Lane Travel Arrangement
- Recovery Rate Banding
- Historic Passenger Revenue
- Historic Number of Passengers
- Historic Passenger Demand
- Historic Average Passenger per Aircraft
- Historic Fuel Cost per Passenger Aircraft
- Fuel Cost Yearly Increase Rate
- Historic Non-Fuel Cost per Passenger Aircraft
- Historic Amount of Cargo Tonnage km
- Historic Price per Cargo Tonnage km
- COVID Cargo Tonnage Recovery Percentage
- Historic Cargo Load per Aircraft
- Historic Passenger Aircraft Fuel vs Non-Fuel Cost Ratio
- Historic Cost per Cargo Aircraft
- Storage Cost per MTOW
- Average Aircraft Tonnage

Blackbox

Performance Measures:

- Total Profit
- Passenger Profit
- Cargo Profit

Consequence Variables:

- Country Max Number of COVID Cases per Capita (past 14 days)
- Direction of Trend of COVID Cases per Day
- Projected Daily COVID Cases
- Reopening Date Banding
- Country Traffic Light Profile
- Country Reopening Date
- Passenger Demand Recovery Rate
- Total Passenger Demand
- Average Passenger per Aircraft
- Price per Passenger
- Number of Passenger Served
- Passenger Revenue
- Fuel Cost per Passenger Aircraft
- Non-Fuel Cost per Passenger Aircraft
- Allocated Cost per Passenger Aircraft
- Passenger Expense
- Total Cargo Demand
- Amount of Cargo Served
- Price per Cargo Tonnage km
- Cargo Revenue
- Fuel Cost per Cargo Aircraft
- Non-Fuel Cost per Cargo Aircraft
- Allocated Cost per Cargo Aircraft
- Cargo Expense
- Storage Cost per Aircraft
- Storage Expense

Aircraft Allocation Model
Overall influence diagram and computation analysis for allocation of aircraft
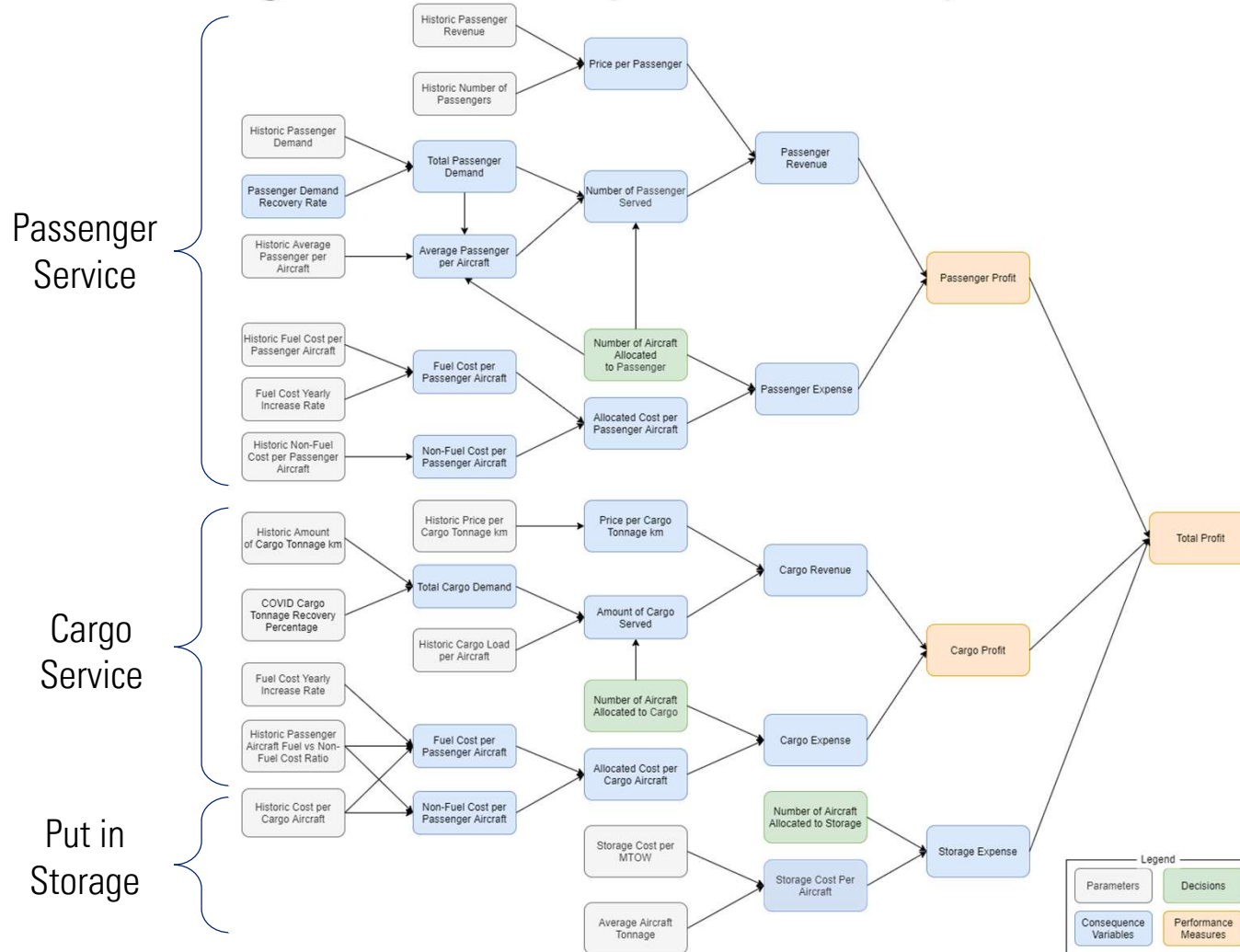
Aircraft Allocation Model
Influence diagram and computation analysis for allocation of aircraft: Passenger Services

Influence diagram and computation analysis for allocation of aircraft: Cargo Services

Influence diagram and computation analysis for allocation of aircraft: Put in Storage
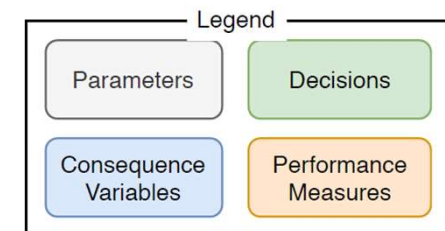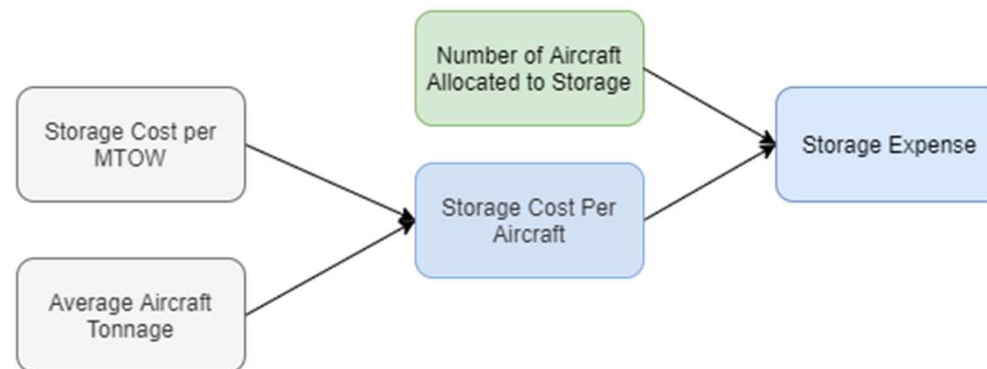
Aircraft Allocation Model
Optimized results: Overall results are closely related to the passenger demand recovery rate post COVID-19

Forecasted Aggregated Profit

Year	Profit	Passenger COVID-19 Recovery Rate
2019	$655,131,500	100%
2020	$112,372,076	2%
2021	$130,249,366	4%
2022	$152,595,978	9%
2023	$259,197,920	28%
2024	$416,286,003	57%
2025	$577,181,611	87%

Legend: Profit — Passenger COVID-19 Recovery Rate

Optimized results: Large initial allocation to storage, and gradual allocation to passenger services as passenger demand recovers

Profit / Loss and aircraft allocation by service type
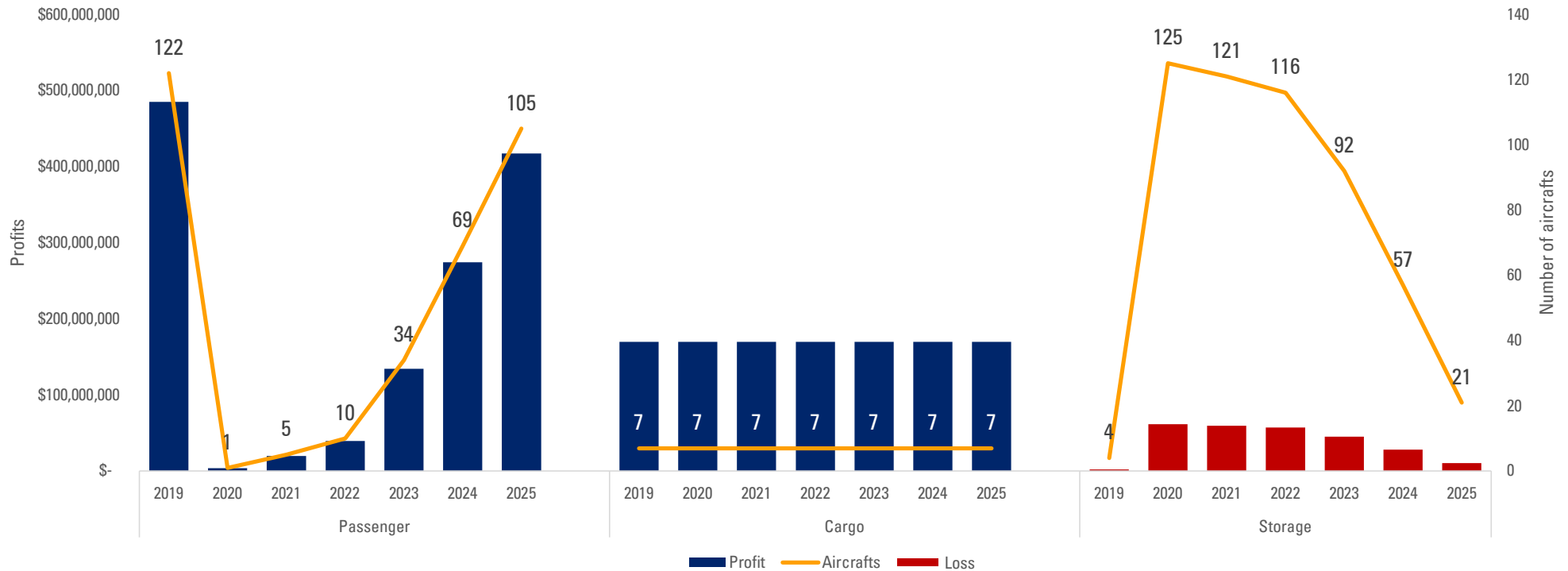
Aircraft Allocation Model
Aircraft Allocation Model Demo Snapshot

Allocation of aircrafts based on financial performance of business units

Business unit	2019	2020	2021	2022	2023	2024	2025
Passenger Profit	$ 485,129,400	$ 3,976,470	$ 19,882,352	$ 39,764,705	$ 134,538,199	$ 274,376,464	$ 417,529,402
Aircrafts allocated to passenger	*122*	*1*	*5*	*10*	*34*	*69*	*105*
Cargo Profit	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100
Aircrafts allocated to Cargo	*7*	*7*	*7*	*7*	*7*	*7*	*7*
Storage expense	$ -	$ 61,606,494	$ 59,635,086	$ 57,170,827	$ 45,342,380	$ 28,092,561	$ 10,349,891
Aircrafts in storage	*NA*	*125*	*121*	*116*	*92*	*57*	*21*

Sensitivity
Fuel Cost (yearly increase) | 0.00%

Allocation table

Business Unit		Historical	Forecast						Remarks
		2019	2020	2021	2022	2023	2024	2025	
Total Profit		$ 655,131,500	$ 112,372,076	$ 130,249,366	$ 152,595,978	$ 259,197,920	$ 416,286,003	$ 577,181,611	

Passenger service

		2019	2020	2021	2022	2023	2024	2025	
Passenger Profit	**Passenger Profit**	$ 485,129,400	$ 3,976,470	$ 19,882,352	$ 39,764,705	$ 134,538,199	$ 274,376,464	$ 417,529,402	Total Revenue - Total Expense
Passenger (Revenue)	Total Passenger Revenue ($)	$ 11,130,878,000	$ 91,236,705	$ 456,183,525	$ 912,367,049	$ 3,101,386,170	$ 6,295,332,639	9,579,854,016	Num of passengers x unit price
	Unit price per passenger	$ 501.44	$ 501.44	$ 501.44	$ 501.44	$ 501.44	$ 501.44	501.44	Assume constant
	Number of passengers served	*22,198,000*	*181,951*	*909,754*	*1,819,508*	*6,185,008*	*12,554,607*	*19,104,836*	Constrain by total demand
	Number of passengers (total demand)	22,198,000	332,970	934,946	1,983,870	6,185,008	12,699,776	19,214,544	= historic (2019) * recovery rate
	Passenger demand recovery rate	*100%*	*1.50%*	*4.21%*	*8.94%*	*27.86%*	*57.21%*	*86.56%*	Forecasted country recovery'!E11:J11
Passenger (Expense)	Total Expense ($)	$ 10,645,748,600	$ 87,260,234	$ 436,301,172	$ 872,602,344	$ 2,966,847,970	$ 6,020,956,175	9,162,324,615	Fuel cost + non fuel cost
	Num of aircraft allocated to passenger	*122*	*1*	*5*	*10*	*34*	*69*	*105*	Constrain by total num of aircraft
	Expense per aircraft	$ 87,260,234	$ 87,260,234	$ 87,260,234	$ 87,260,234	$ 87,260,234	$ 87,260,234	87,260,234	Parameter
	Fuel cost	$ 3,583,259,600	$ 29,370,980	$ 146,854,902	$ 293,709,803	$ 998,613,331	$ 2,026,597,643	3,083,952,934	
	Fuel cost per aircraft	$ 29,370,980	$ 29,370,980	$ 29,370,980	$ 29,370,980	$ 29,370,980	$ 29,370,980	29,370,980	
	Non-fuel cost	$ 7,062,489,000	$ 57,889,254	$ 289,446,270	$ 578,892,541	$ 1,968,234,639	$ 3,994,358,533	6,078,371,680	
	Non-fuel cost per aircraft	$ 57,889,254	$ 57,889,254	$ 57,889,254	$ 57,889,254	$ 57,889,254	$ 57,889,254	57,889,254	
	Load Factor - LF	81.90%	81.90%	81.90%	81.90%	81.88%	81.90%	81.90%	Constrain by 81.90%
	Average psg per aircraft	181,951	181,951	181,951	181,951	181,912	181,951	181,951	Parameter - Num of Passenger / Num of Aircraft
	Total psg capacity per aircraft	222,162	222,162	222,162	222,162	222,162	222,162	222,162	

Aircraft Allocation Model
Aircraft Allocation Model Demo Snapshot (cont'd)

Business Unit		Historical 2019	Forecast 2020	2021	2022	2023	2024	2025	Remarks
Cargo service									
Cargo Profit	**Cargo Profit**	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	$ 170,002,100	
Cargo (Revenue)	Total Cargo Revenue	$ 1,968,908,400	$ 1,968,908,400	$ 1,968,908,400	$ 1,968,908,400	$ 1,968,908,400	$ 1,968,908,400	$ 1,968,908,400	
	Cargo Served		6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	Constrain by cargo load demand
	Cargo Yield (Price / tonne km)	$ 0.30	$ 0.30	$ 0.30	$ 0.30	$ 0.30	$ 0.30	$ 0.30	
	Cargo Demand (million tonne - km)	6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	6,605,000,000	
	Cargo demand recovery rate	100%	100%	100%	100%	100%	100%	100%	
Cargo (Expense)	Total Cargo Expense	$ 1,798,906,300	$ 1,798,906,300	$ 1,798,906,300	$ 1,798,906,300	$ 1,798,906,300	$ 1,798,906,300	$ 1,798,906,300	
	Num of aircraft allocated to cargo	7	7	7	7	7	7	7	Constrain by total num of aircraft
	Cargo cost per aircraft	$ 256,986,614	$ 256,986,614	$ 256,986,614	$ 256,986,614	$ 256,986,614	$ 256,986,614	$ 256,986,614	
	Fuel Cost per aircraft	$ 86,499,295	$ 86,499,295	$ 86,499,295	$ 86,499,295	$ 86,499,295	$ 86,499,295	$ 86,499,295	
	Non-fuel cost per aircraft	$ 170,487,319	$ 170,487,319	$ 170,487,319	$ 170,487,319	$ 170,487,319	$ 170,487,319	$ 170,487,319	
	Load Factor	59.30%	59.30%	59.30%	59.30%	59.30%	59.30%	59.30%	Constrain by 59.30%
	Average load per aircraft (tonne - km)	943,571,429	943,571,429	943,571,429	943,571,429	943,571,429	943,571,429	943,571,429	
	Total load capacity per aircraft (tonne - km)	1,591,182,848	1,591,182,848	1,591,182,848	1,591,182,848	1,591,182,848	1,591,182,848	1,591,182,848	
	Gross Capacity	11,143,300,000							
	Cargo Unit Cost	$ 0.15							
Storage									
Storage (Expense)	**Total Storage Expense**	$ -	$ 61,606,494	$ 59,635,086	$ 57,170,827	$ 45,342,380	$ 28,092,561	$ 10,349,891	
	Storage cost per aircraft per year	$ 492,852	$ 492,852	$ 492,852	$ 492,852	$ 492,852	$ 492,852	$ 492,852	
	Num of aircraft allocated to storage	NA	125	121	116	92	57	21	Constrain by total num of aircraft
	Storage cost per MTOW	$ 4.01	$ 4.01	$ 4.01	$ 4.01	$ 4.01	$ 4.01	$ 4.01	
	Average aircraft tonnage	337	337	337	337	337	337	337	
Total number of aircrafts for passenger and cargo		133	8	12	17	41	76	112	To constraint total num of aircraft

3. COVID-19 Passenger Recovery Model

COVID-19 Passenger Recovery Model
Overall influence diagram for passenger recovery forecast
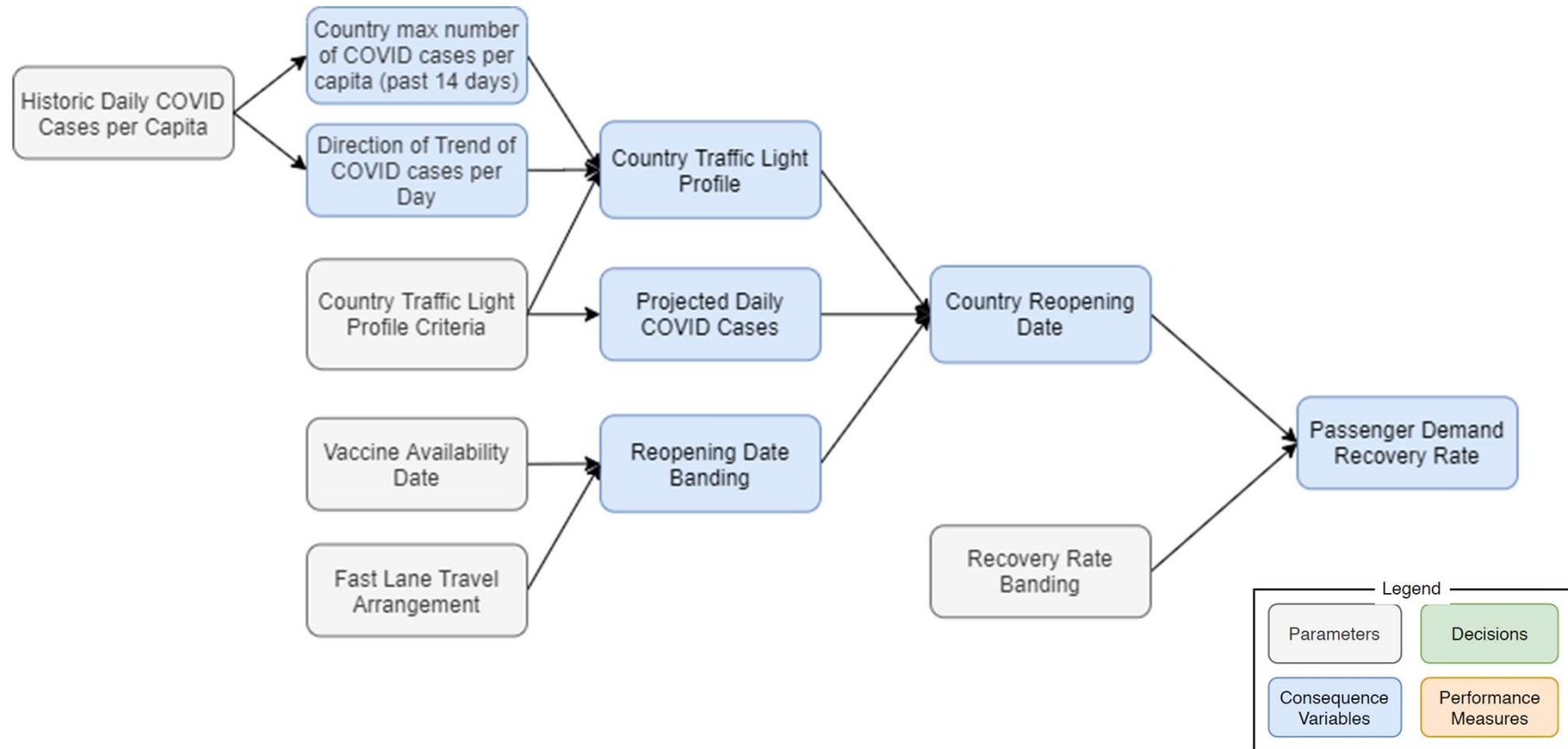
Traffic light profile (adapted from EU CDC guideline)

Countries	Continent	Max new cases per capita past 14d	Traffic light profile
Switzerland	Europe	100.952	Red
Spain	Europe	81.038	Red
France	Europe	69.587	Red
Netherlands	Europe	58.261	Red
UK	Europe	39.312	Red
Italy	Europe	32.483	Red
USA	North America	25.779	Red
Germany	Europe	17.562	Red
UAE	Asia	15.955	Red
Denmark	Europe	14.830	Red
Maldives	Asia	12.765	Yellow
Russia	Europe	11.882	Red
India	Asia	4.906	Yellow
Sri Lanka	Asia	4.044	Red
Malaysia	Asia	3.794	Red
South Africa	Africa	3.635	Red
Myanmar	Asia	3.510	Red
Philippines	Asia	3.171	Yellow
Turkey	Asia	2.567	Red
Indonesia	Asia	1.644	Red
Bangladesh	Asia	1.030	Yellow
Japan	Asia	0.570	Green
New Zealand	Oceania	0.518	Green
S. Korea	Asia	0.302	Green
Brunei	Asia	0.229	Green
Hong Kong	Asia	0.227	Green
Australia	Oceania	0.122	Green
Taiwan	Asia	0.021	Green
Thailand	Asia	0.019	Green
Vietnam	Asia	0.012	Green
China	Asia	0.003	Green

< 1 case per 100,000

Russia

USA

Maldives

India
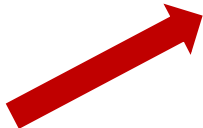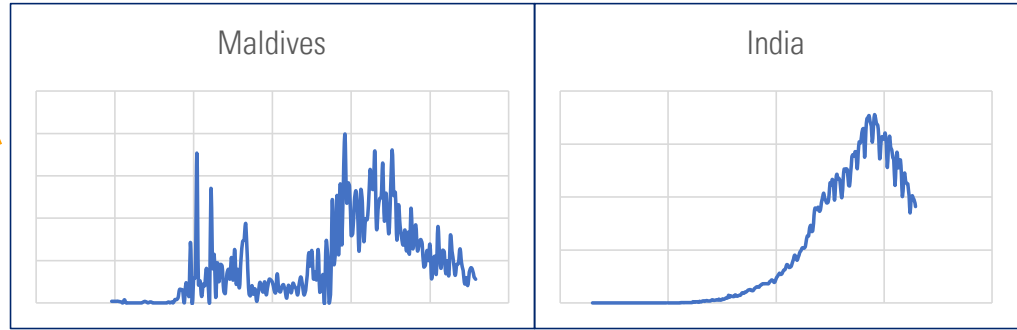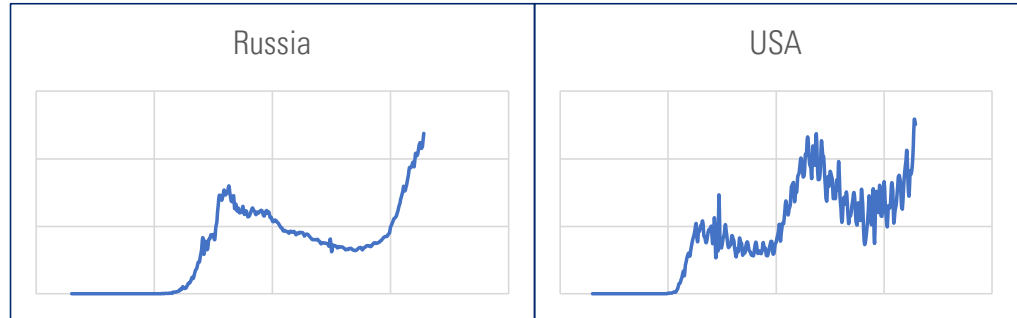
Opening date & % passenger recovery projection

Traffic Light Profile	Partial Opening Date – 16.5%	Full Opening Date – 100%
Green	Currently Partially Open	One year after vaccine gets released
Yellow	Partially Open based on Log-Normal Fit for respective countries	One year after vaccine gets released
Red	Not applicable. Countries in this bucket only reopen one year after vaccine gets released	One year after vaccine gets released

Maldives - Projected daily cases

Partial Reopening:1/1/2021

Forecasted recovery rate by country profile

Full Reopening: 31/12/2022
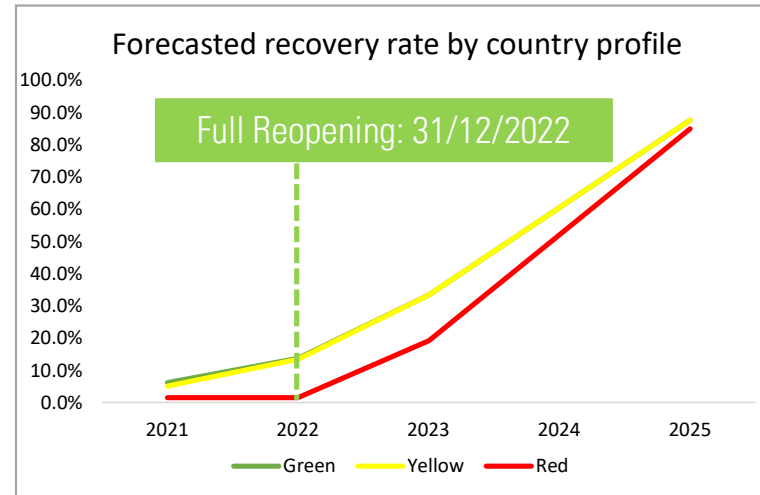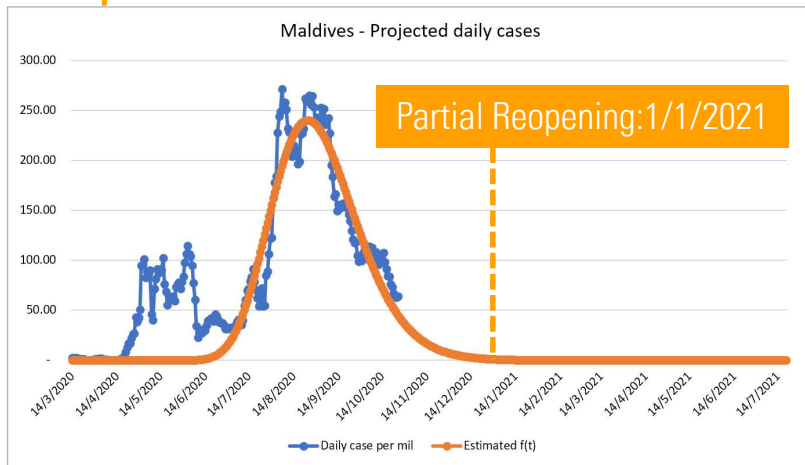
Output:
Passenger recovery rate per year

		No of	Forecasted recovery rate				
SN	Profile	countries	2021	2022	2023	2024	2025
1	Green	10	6.2%	13.8%	33.4%	60.5%	87.6%
2	Yellow	4	5.1%	13.5%	33.4%	60.5%	87.6%
3	Red	17	1.5%	1.5%	19.3%	52.1%	85.0%
Total			**4.2%**	**8.9%**	**27.9%**	**57.2%**	**86.6%**

COVID-19 Passenger Recovery Model
Passenger Recovery Calculation Demo Snapshot

Reopening date and status by country

SN	Countries	Status	Reopening status - 2021												Reopening status - 2022												Reopening status - 2023							
		Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23
1	Australia	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
2	Bangladesh	Close	Close	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
3	Brunei	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
4	China	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
5	Denmark	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
6	France	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
7	Germany	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
8	Hong Kong	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
9	India	Close	Close	Close	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
10	Indonesia	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
11	Italy	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
12	Japan	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
13	Malaysia	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
14	Maldives	Close	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
15	Myanmar	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
16	Netherlands	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
17	New Zealand	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
18	Philippines	Close	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
19	Russia	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
20	South Africa	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
21	S. Korea	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
22	Spain	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
23	Sri Lanka	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
24	Switzerland	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
25	Taiwan	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
26	Thailand	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open
27	Turkey	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
28	UAE	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
29	UK	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
30	USA	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Open	Open	Open	Open	Open	Open	Open	Open
31	Vietnam	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Open	Open	Open	Open	Open	Open	Open	Open	Open

COVID-19 Passenger Recovery Model
Passenger Recovery Calculation Demo Snapshot (cont'd)

Reopening date and status by country

SN	Countries	Base rate	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
			2020	\<--				Reopening rate over time (months) - 2021							-->	\<--				Reopening rate over time (months) - 2022							-->
1	Australia	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
2	Bangladesh	1.5%	1.5%	1.5%	2.2%	2.9%	3.5%	4.2%	4.9%	5.6%	6.3%	7.0%	7.6%	8.3%	9.0%	9.7%	10.4%	11.0%	11.7%	12.4%	13.1%	13.8%	14.5%	15.1%	15.8%	16.5%	18.8%
3	Brunei	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
4	China	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
5	Denmark	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
6	France	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
7	Germany	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
8	Hong Kong	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
9	India	1.5%	1.5%	1.5%	1.5%	2.2%	2.9%	3.6%	4.4%	5.1%	5.8%	6.5%	7.2%	7.9%	8.6%	9.4%	10.1%	10.8%	11.5%	12.2%	12.9%	13.6%	14.4%	15.1%	15.8%	16.5%	18.8%
10	Indonesia	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
11	Italy	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
12	Japan	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
13	Malaysia	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
14	Maldives	1.5%	1.5%	2.2%	2.8%	3.5%	4.1%	4.8%	5.4%	6.1%	6.7%	7.4%	8.0%	8.7%	9.3%	10.0%	10.6%	11.3%	11.9%	12.6%	13.2%	13.9%	14.5%	15.2%	15.8%	16.5%	18.8%
15	Myanmar	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
16	Netherlands	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
17	New Zealand	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
18	Philippines	1.5%	1.5%	2.2%	2.8%	3.5%	4.1%	4.8%	5.4%	6.1%	6.7%	7.4%	8.0%	8.7%	9.3%	10.0%	10.6%	11.3%	11.9%	12.6%	13.2%	13.9%	14.5%	15.2%	15.8%	16.5%	18.8%
19	Russia	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
20	South Africa	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
21	S. Korea	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
22	Spain	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
23	Sri Lanka	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
24	Switzerland	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
25	Taiwan	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
26	Thailand	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%
27	Turkey	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
28	UAE	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
29	UK	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
30	USA	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
31	Vietnam	1.5%	2.1%	2.8%	3.4%	4.0%	4.6%	5.3%	5.9%	6.5%	7.1%	7.8%	8.4%	9.0%	9.6%	10.3%	10.9%	11.5%	12.1%	12.8%	13.4%	14.0%	14.6%	15.3%	15.9%	16.5%	18.8%

COVID-19 Passenger Recovery Model
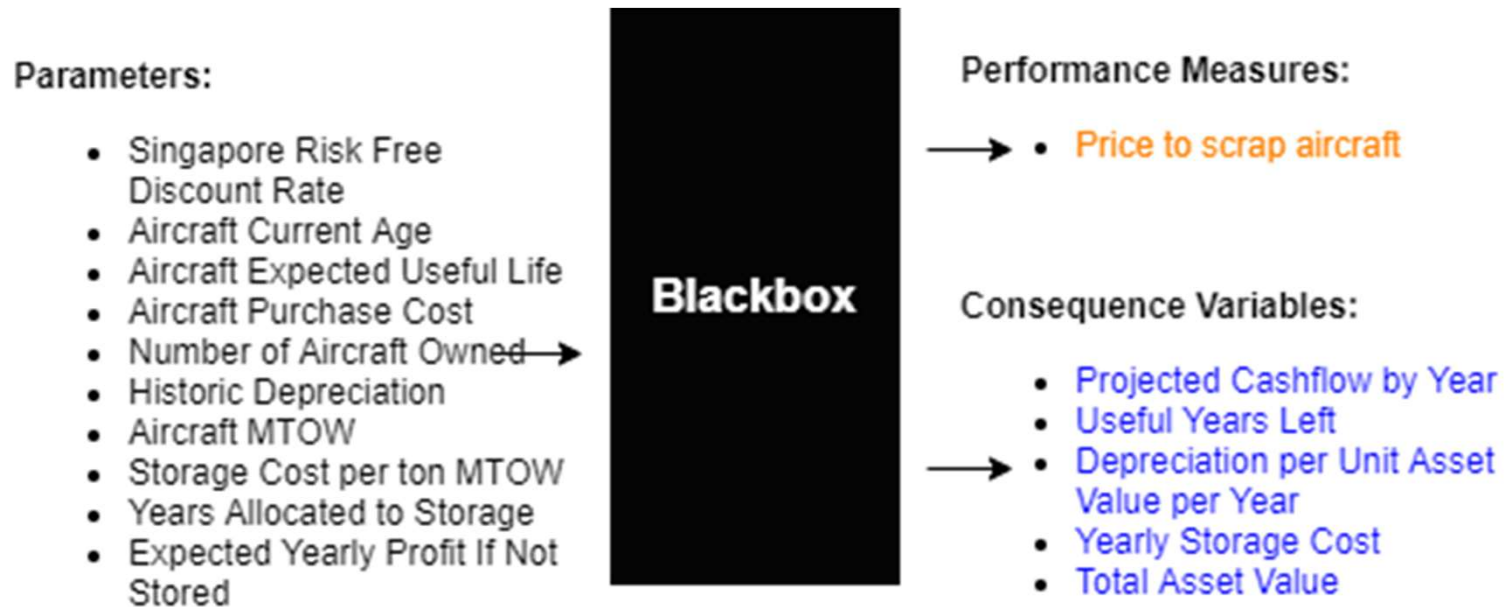# Passenger Recovery Calculation Demo Snapshot (cont'd)

Reopening date and status by country

SN	Countries	Continent	Matrix 1: Status by new cases		Matrix 2: Estimated reopening date			Matrix 3: Forecasted recovery rate (%)					Matrix 4 : Forecasted visitors using recovery rate					
			Max new cases per capita past 14d	Traffic light profile	Partially open date (Based on country's traffic light banding)	Fully open date (Based on vaccine date)	Full recovery date - Y5	2021	2022	2023	2024	2025	Visitors in 2019	2021	2022	2023	2024	2025
1	Australia	Oceania	0.122	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	1,143,305	70,742	158,045	382,157	691,777	1,001,396
2	Bangladesh	Asia	1.030	Yellow	12-Feb-21	31-Dec-22	31-Dec-25	5.3%	13.6%	33.4%	60.5%	87.6%	136,969	7,191	18,577	45,783	82,875	119,968
3	Brunei	Asia	0.229	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	72,603	4,492	10,036	24,268	43,930	63,591
4	China	Asia	0.003	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	3,627,030	224,422	501,382	1,212,359	2,194,598	3,176,837
5	Denmark	Europe	14.830	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	38,046	571	571	7,337	19,829	32,321
6	France	Europe	69.587	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	212,782	3,192	3,192	41,034	110,898	180,761
7	Germany	Europe	17.562	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	380,715	5,711	5,711	73,420	198,421	323,423
8	Hong Kong	Asia	0.227	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	488,524	30,227	67,531	163,292	295,590	427,888
9	India	Asia	4.906	Yellow	30-Mar-21	31-Dec-22	31-Dec-25	4.8%	13.4%	33.4%	60.5%	87.6%	1,417,931	67,689	190,205	473,953	857,944	1,241,935
10	Indonesia	Asia	1.644	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	3,110,416	46,656	46,656	599,835	1,621,088	2,642,342
11	Italy	Europe	32.483	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	102,708	1,541	1,541	19,807	53,529	87,252
12	Japan	Asia	0.570	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	884,304	54,716	122,242	295,585	535,064	774,543
13	Malaysia	Asia	3.794	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	1,220,664	18,310	18,310	235,402	636,186	1,036,971
14	Maldives	Asia	12.765	Yellow	01-Jan-21	31-Dec-22	31-Dec-25	5.7%	13.7%	33.4%	60.5%	87.6%	39,996	2,295	5,479	13,369	24,200	35,032
15	Myanmar	Asia	3.510	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	155,985	2,340	2,340	30,081	81,296	132,511
16	Netherlands	Europe	58.261	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	99,445	1,492	1,492	19,178	51,829	84,480
17	New Zealand	Oceania	0.518	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	152,995	9,467	21,149	51,140	92,572	134,005
18	Philippines	Asia	3.171	Yellow	14-Jan-21	31-Dec-22	31-Dec-25	5.7%	13.7%	33.4%	60.5%	87.6%	829,304	47,595	113,606	277,200	501,785	726,359
19	Russia	Europe	11.882	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	80,255	1,204	1,204	15,477	41,827	68,178
20	South Africa	Africa	3.635	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	42,736	641	641	8,242	22,273	36,305
21	S. Korea	Asia	0.302	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	645,839	39,961	89,277	215,876	390,776	565,676
22	Spain	Europe	81.038	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	65,394	981	981	12,611	34,082	55,553
23	Sri Lanka	Asia	4.044	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	98,737	1,481	1,481	19,041	51,460	83,878
24	Switzerland	Europe	100.952	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	97,970	1,470	1,470	18,893	51,060	83,227
25	Taiwan	Asia	0.021	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	425,624	26,335	58,836	142,268	257,531	372,795
26	Thailand	Asia	0.019	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	528,486	32,700	73,055	176,650	319,770	462,889
27	Turkey	Asia	2.567	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	22,585	339	339	4,355	11,771	19,186
28	UAE	Asia	15.955	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	81,526	1,223	1,223	15,722	42,490	69,257
29	UK	Europe	39.312	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	607,791	9,117	9,117	117,211	316,769	516,327
30	USA	North America	25.779	Red	31-Dec-22	31-Dec-22	31-Dec-25	1.5%	1.5%	19.3%	52.1%	85.0%	729,260	10,939	10,939	140,636	380,076	619,516
31	Vietnam	Asia	0.012	Green	26-Oct-20	31-Dec-22	31-Dec-25	6.2%	13.8%	33.4%	60.5%	87.6%	591,928	36,626	81,825	197,856	358,156	518,457
	Total							4.2%	8.9%	27.9%	57.2%	86.6%	18,131,853	763,686	1,620,472	5,052,061	10,373,478	15,694,896

4. Aircraft Scrap Price Model

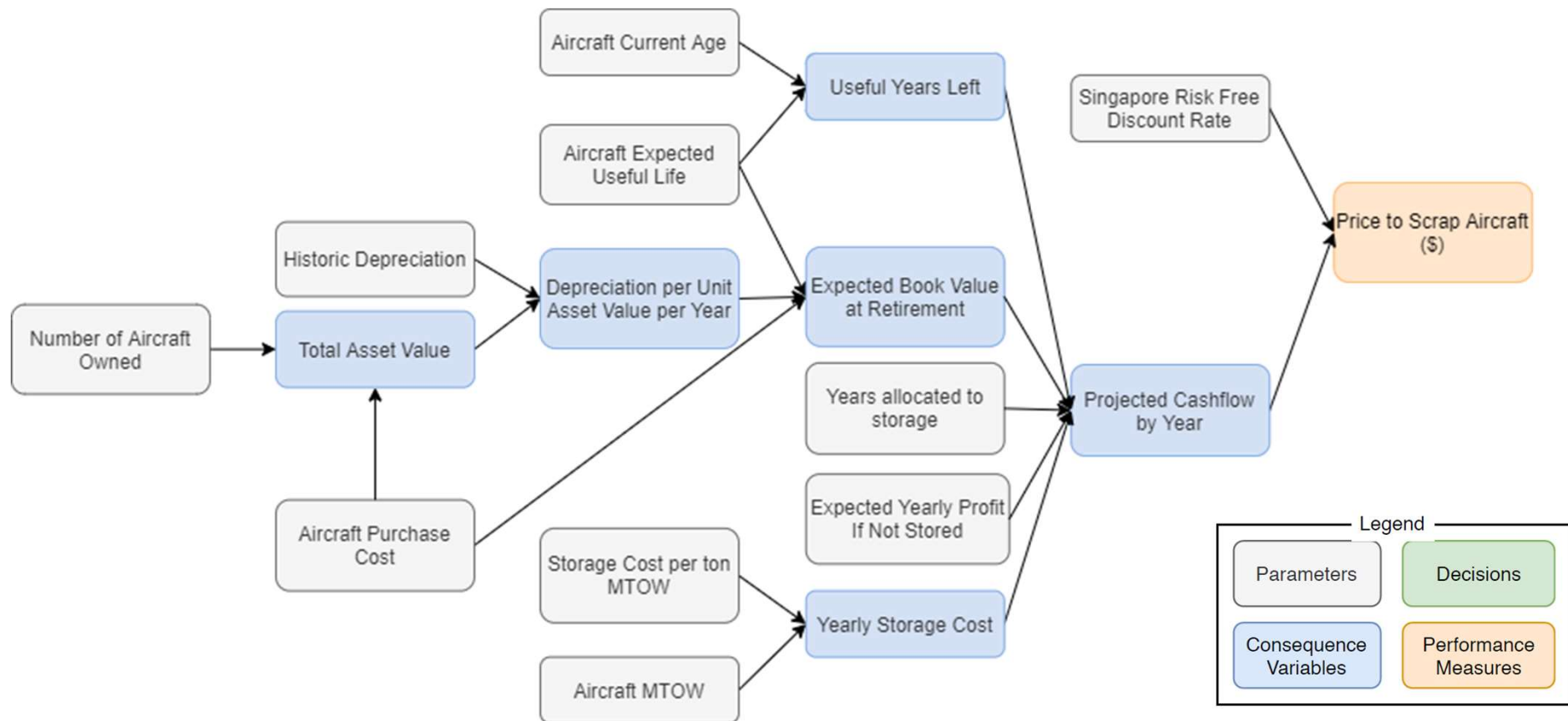# Relevant parameters and performance measures were identified to prepare the model to identify the price of aircraft to be scrapped

Parameters:

- Singapore Risk Free Discount Rate
- Aircraft Current Age
- Aircraft Expected Useful Life
- Aircraft Purchase Cost
- Number of Aircraft Owned
- Historic Depreciation
- Aircraft MTOW
- Storage Cost per ton MTOW
- Years Allocated to Storage
- Expected Yearly Profit If Not Stored

Blackbox

Performance Measures:

- Price to scrap aircraft

Consequence Variables:

- Projected Cashflow by Year
- Useful Years Left
- Depreciation per Unit Asset Value per Year
- Yearly Storage Cost
- Total Asset Value

Overall influence diagram and computation analysis for scrapping price of aircraft in storage

Aircraft Allocation Model Demo Snapshot

Scrap price of aircrafts

Parameters

USD- SGD exchange rate (SGD / USD)	1.35
Expected useful life to SIA (years)	25

Data (except aicraft models)

			Source :	
Historic Depreciation per year (S$ mil)	$	1,710.70	Source :	SIA annual report pg58
Storage Cost / tonne MTOW / day (S$ per ton / day)	$	4.01	Source :	Alice Spring airport charges
Passenger + cargo profit per year per aircraft	$	5.08		
Discount rate (Singapore risk free rate)		1.50%	Source :	Singapore Bonds IR

Storage Allocation

Year	Num aircraft
1 year	121
2 years	116
3 years	93
4 years	57
5 years	21

Aircraft Models

Aircraft Type	Num of Aircraft Owned (Oct-20)	MTOW (tonne)	Purchase Cost (US mil)	Purchase Cost (S$ mil)	Total Asset Value (S$ mi)
Airbus A330-300	6	242.00	$ 264.20	$ 356.67	$ 2,140.02
Airbus A350-900	52	270.00	$ 317.40	$ 428.49	$ 22,281.48
Airbus A380-800	19	575.00	$ 350.00	$ 472.50	$ 8,977.50
Boeing 747-400	7	396.90	$ 240.00	$ 324.00	$ 2,268.00
Boeing 777-200	3	286.90	$ 258.28	$ 348.68	$ 1,046.03
Boeing 777-300	31	351.50	$ 279.00	$ 376.65	$ 11,676.15
Boeing 787-10 Dreamliner	15	254.00	$ 275.00	$ 371.25	$ 5,568.75
Total	**133**	**336.56**			$ **53,957.93**

Depreciation Calculation

Depreciation per unit asset value per year ($ / year for every $1 of asset)	$	0.0317

Aircraft Allocation Model Demo Snapshot (cont'd)

Scrapping Price Calculation

SN	ID (as of Oct 2020)	Aircraft Type	Price to Scrap (S$ mil) (PV of cashflow)	Projected Cashflow by year (at end of year)											
				1	2	3	4	5	6	7	8	9	10	11	12
1	9V-SFI	Boeing 747-400	$ 59.59	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 66.61						
2	9V-SVB	Boeing 777-200	$ 68.77	-$ 0.42	-$ 0.42	-$ 0.42	-$ 0.42	-$ 0.42	$ 77.39					
3	9V-SVC	Boeing 777-200	$ 68.77	-$ 0.42	-$ 0.42	-$ 0.42	-$ 0.42	-$ 0.42	$ 77.39					
4	9V-SYF	Boeing 777-300	$ 73.62	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 83.19					
5	9V-SVE	Boeing 777-200	$ 68.77	-$ 0.42	-$ 0.42	-$ 0.42	-$ 0.42	-$ 0.42	$ 77.39					
6	9V-SFK	Boeing 747-400	$ 63.32	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 72.27					
7	9V-SYH	Boeing 777-300	$ 77.14	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 83.19				
8	9V-SFM	Boeing 747-400	$ 70.60	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 5.08	$ 5.08	$ 72.27			
9	9V-SFN	Boeing 747-400	$ 70.60	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 5.08	$ 5.08	$ 72.27			
10	9V-SFO	Boeing 747-400	$ 74.16	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 5.08	$ 5.08	$ 5.08	$ 72.27		
11	9V-SYJ	Boeing 777-300	$ 84.03	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 83.19		
12	9V-SYL	Boeing 777-300	$ 84.03	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 83.19		
13	9V-SFP	Boeing 747-400	$ 77.67	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 72.27	
14	9V-SFQ	Boeing 747-400	$ 77.67	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	-$ 0.58	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 72.27	
15	9V-SWA	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
16	9V-SWB	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
17	9V-SWD	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
18	9V-SWF	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
19	9V-SWE	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
20	9V-SWG	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
21	9V-SWH	Boeing 777-300	$ 90.71	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
22	9V-SWI	Boeing 777-300	$ 95.90	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
23	9V-SWJ	Boeing 777-300	$ 95.90	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
24	9V-SWK	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
25	9V-SWL	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
26	9V-SWM	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
27	9V-SKF	Airbus A380-800	$ 114.53	-$ 0.84	-$ 0.84	-$ 0.84	-$ 0.84	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 103.07
28	9V-SWN	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
29	9V-SWO	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
30	9V-SWP	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
31	9V-SWQ	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
32	9V-SWR	Boeing 777-300	$ 99.17	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 83.19
33	9V-SWS	Boeing 777-300	$ 102.39	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08
34	9V-SKG	Airbus A380-800	$ 117.51	-$ 0.84	-$ 0.84	-$ 0.84	-$ 0.84	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08
35	9V-SKH	Airbus A380-800	$ 117.51	-$ 0.84	-$ 0.84	-$ 0.84	-$ 0.84	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08
36	9V-SKI	Airbus A380-800	$ 117.51	-$ 0.84	-$ 0.84	-$ 0.84	-$ 0.84	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08
37	9V-SWT	Boeing 777-300	$ 102.39	-$ 0.51	-$ 0.51	-$ 0.51	-$ 0.51	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08
38	9V-SKJ	Airbus A380-800	$ 117.51	-$ 0.84	-$ 0.84	-$ 0.84	-$ 0.84	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08	$ 5.08

Aircraft Scrap Price Model
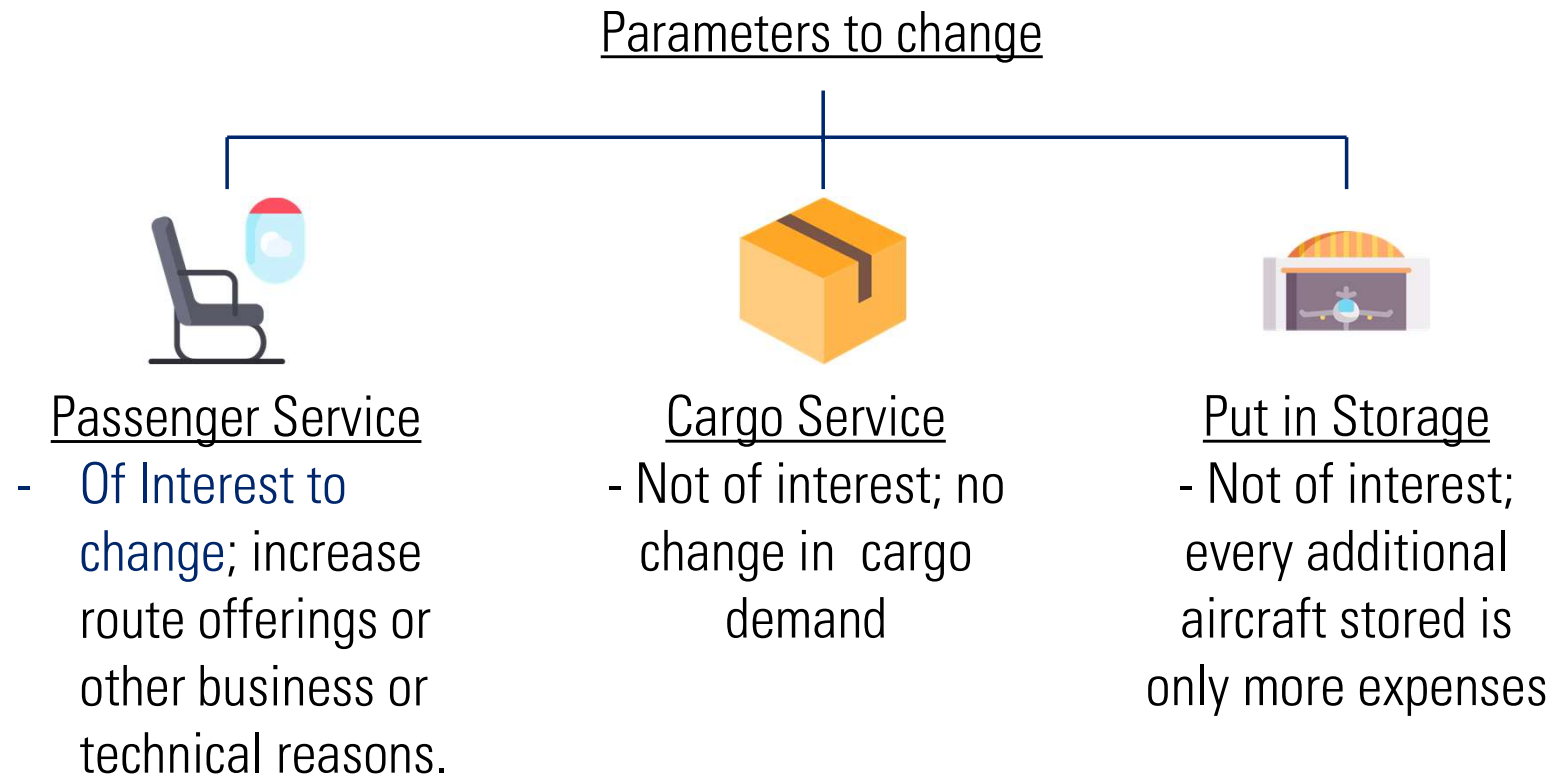# Aircraft Allocation Model Demo Snapshot (cont'd)

Scrapping Price Calculation

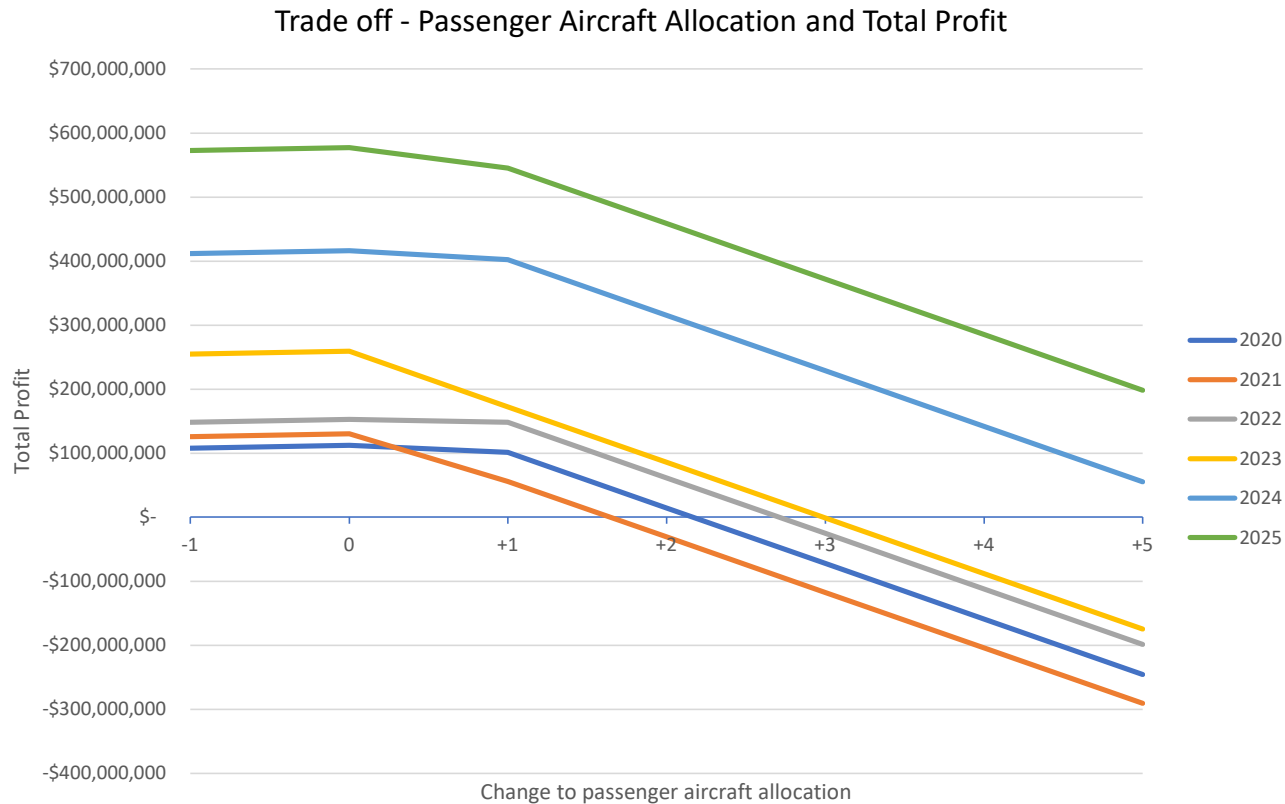| SN	ID (as of Oct 2020)	Aircraft Type	MTOW (tonne)	Purchase Cost (S$ mil)	Age	Yearly depreciation (S$ mil)	Yearly Storage Cost (S$ mil)	Useful years left	Years allocated to storage	Years in use	Expected book value at retirement	Expected yearly profit if not stored	Price to Scrap (S$ mil) (PV of cashflow)
1	9V-SFI	Boeing 747-400	396.9	$ 324.00	20	$ 10.27	$ 0.58	5	5	0	$ 67.19	$ 5.08	$ 59.59
2	9V-SVB	Boeing 777-200	286.9	$ 348.68	19	$ 11.05	$ 0.42	6	5	1	$ 72.31	$ 5.08	$ 68.77
3	9V-SVC	Boeing 777-200	286.9	$ 348.68	19	$ 11.05	$ 0.42	6	5	1	$ 72.31	$ 5.08	$ 68.77
4	9V-SYF	Boeing 777-300	351.5	$ 376.65	19	$ 11.94	$ 0.51	6	5	1	$ 78.11	$ 5.08	$ 73.62
5	9V-SVE	Boeing 777-200	286.9	$ 348.68	19	$ 11.05	$ 0.42	6	5	1	$ 72.31	$ 5.08	$ 68.77
6	63-SFK	Boeing 747-400	396.9	$ 324.00	19	$ 10.27	$ 0.58	6	5	1	$ 67.19	$ 5.08	$ 63.32
7	9V-SYH	Boeing 777-300	351.5	$ 376.65	18	$ 11.94	$ 0.51	7	5	2	$ 78.11	$ 5.08	$ 77.14
8	9V-SFM	Boeing 747-400	396.9	$ 324.00	17	$ 10.27	$ 0.58	8	5	3	$ 67.19	$ 5.08	$ 70.60
9	9V-SFN	Boeing 747-400	396.9	$ 324.00	17	$ 10.27	$ 0.58	8	5	3	$ 67.19	$ 5.08	$ 70.60
10	74-SFO	Boeing 747-400	396.9	$ 324.00	16	$ 10.27	$ 0.58	9	5	4	$ 67.19	$ 5.08	$ 74.16
11	9V-SYJ	Boeing 777-300	351.5	$ 376.65	16	$ 11.94	$ 0.51	9	5	4	$ 78.11	$ 5.08	$ 84.03
12	9V-SYL	Boeing 777-300	351.5	$ 376.65	16	$ 11.94	$ 0.51	9	5	4	$ 78.11	$ 5.08	$ 84.03
13	9V-SFP	Boeing 747-400	396.9	$ 324.00	15	$ 10.27	$ 0.58	10	5	5	$ 67.19	$ 5.08	$ 77.67
14	7V-SFQ	Boeing 747-400	396.9	$ 324.00	15	$ 10.27	$ 0.58	10	5	5	$ 67.19	$ 5.08	$ 77.67
15	9V-SWA	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
16	9V-SWB	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
17	90-SWD	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
18	9V-SWF	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
19	9V-SWE	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
20	9V-SWG	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
21	90-SWH	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	5	6	$ 78.11	$ 5.08	$ 90.71
22	9V-SWI	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	4	7	$ 78.11	$ 5.08	$ 95.90
23	9V-SWJ	Boeing 777-300	351.5	$ 376.65	14	$ 11.94	$ 0.51	11	4	7	$ 78.11	$ 5.08	$ 95.90
24	9V-SWK	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
25	9V-SWL	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
26	9V-SWM	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
27	9V-SKF	Airbus A380-800	575.0	$ 472.50	13	$ 14.98	$ 0.84	12	4	8	$ 97.99	$ 5.08	$ 114.53
28	9V-SWN	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
29	9V-SWO	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
30	9V-SWP	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
31	9V-SWQ	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
32	9V-SWR	Boeing 777-300	351.5	$ 376.65	13	$ 11.94	$ 0.51	12	4	8	$ 78.11	$ 5.08	$ 99.17
33	9V-SWS	Boeing 777-300	351.5	$ 376.65	12	$ 11.94	$ 0.51	13	4	9	$ 78.11	$ 5.08	$ 102.39
34	9V-SKG	Airbus A380-800	575.0	$ 472.50	12	$ 14.98	$ 0.84	13	4	9	$ 97.99	$ 5.08	$ 117.51
35	9V-SKH	Airbus A380-800	575.0	$ 472.50	12	$ 14.98	$ 0.84	13	4	9	$ 97.99	$ 5.08	$ 117.51
36	9V-SKI	Airbus A380-800	575.0	$ 472.50	12	$ 14.98	$ 0.84	13	4	9	$ 97.99	$ 5.08	$ 117.51
37	9V-SWT	Boeing 777-300	351.5	$ 376.65	12	$ 11.94	$ 0.51	13	4	9	$ 78.11	$ 5.08	$ 102.39
38	9V-SKJ	Airbus A380-800	575.0	$ 472.50	12	$ 14.98	$ 0.84	13	4	9	$ 97.99	$ 5.08	$ 117.51

5. Trade Off and Sensitivity Analysis

Trade Off Analysis: How would a change in fleet allocation change profit?

Parameters to change

Passenger Service
- Of Interest to change; increase route offerings or other business or technical reasons.

Cargo Service
- Not of interest; no change in cargo demand

Put in Storage
- Not of interest; every additional aircraft stored is only more expenses

Passenger Service Allocation Trade Off Analysis: experience a negative total profit beyond a certain level of over allocation to passenger services

Trade off - Passenger Aircraft Allocation and Total Profit

Legend:
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025

Y-axis: Total Profit ($700,000,000 to -$400,000,000)

X-axis: Change to passenger aircraft allocation (-1, 0, +1, +2, +3, +4, +5)

SIA may decide to allocate more aircraft to passenger services to increase route offerings or other business or technical reasons.

As demand is the limiting factor, every additional plane allocated reduces profit.

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Sensitivity Analysis: How would vaccine availability dates or changes in fuel prices affect profits?

Parameters to change

Vaccine Availability Dates
When a COVID vaccine becomes available affects when countries reopen borders fully

Fuel- Operating Costs
Different historic fuel costs affecting operating cost

Passenger Recovery Rate Sensitivity Analysis:

Sensitivity analysis - passenger demand recovery rate on vaccine release date

Total profit is highly sensitive to vaccine availability date.

SIA's cashflow management is crucial, given uncertainty in vaccine release date.

Fuel- Operating Costs Sensitivity Analysis: Years with less aircraft in storage are more sensitive to changes in fuel price

Sensitivity analysis - total profit vs fuel cost
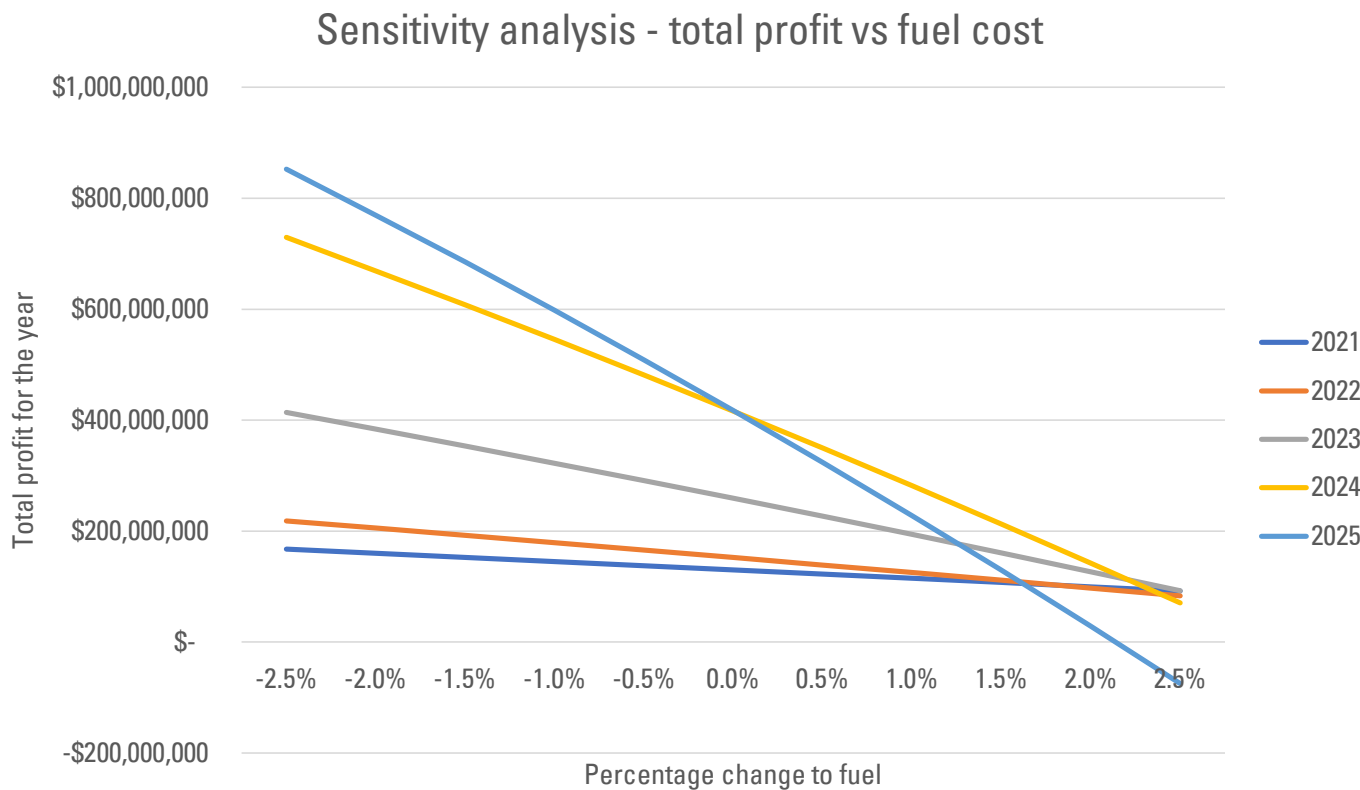
Years that have more aircraft allocated to cargo and passenger services are more sensitive to changes in fuel price.

This matches intuition as fuel price is an operational expense of aircraft that are flying routes.

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SINGAPORE AIRLINES

Objective

To optimize the allocation of aircrafts to be put in passenger and cargo operations, storage, or sale in the post COVID-19 recovery period (5 years) to maximize profits

Key Insights

- 88% Profit Recovery by 2025
- 87% Passenger Recovery Rate by 2025
- SIA Profit Recovery Rate is dependent on COVID-19 Passenger Recovery Rate by destination countries.

Decisions Optimized

Passenger Service

Put in Storage

Cargo Service

Sell/Retire

Trade-off and Sensitivity Analysis Performed

Passenger Service Allocation Trade Off Analysis

Passenger Recovery Rate Sensitivity Analysis

Fuel- Operating Costs Sensitivity Analysis

Thank you for your time

Questions & Answers

Assumptions and Appendix

Assumptions made for this project:

Aircrafts

1. Almost all aircraft types operated by SIA are similar enough to be counted homogenously in modeling output in terms of routing and allocation. All aircraft models, less the A380 or Boeing 747, are twin-engine-wide-bodied aircraft with similar range and passenger carrying capacity[1].

2. SIA retires its plane at 25 years old[2].

3. All aircraft purchases are put on pause, and no plans on acquisition of smaller airlines or new subsidiaries[3].

4. Model does not account for sale of any planes.

Boeing 777-300   Boeing 777-300ER

Aircraft retirements

Aircraft retirement age distribution (1980-2017)

Forbes

EDITORS' PICK | 10,917 views | May 2, 2020, 04:00pm EDT

Singapore Airlines Seeks Fleet Flexibility, In Talks For Deferrals And Sale And Leaseback On Aircraft
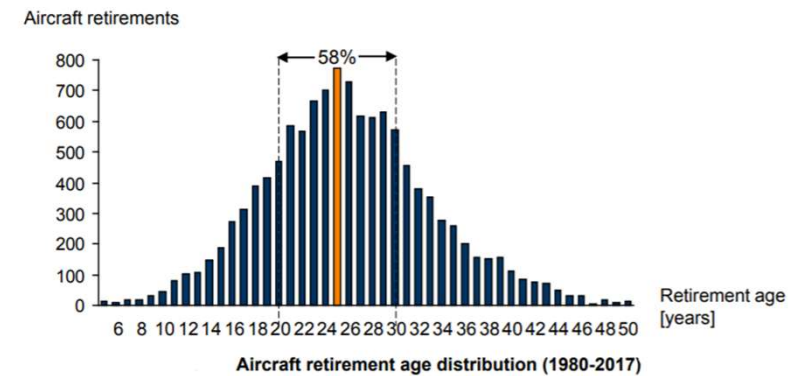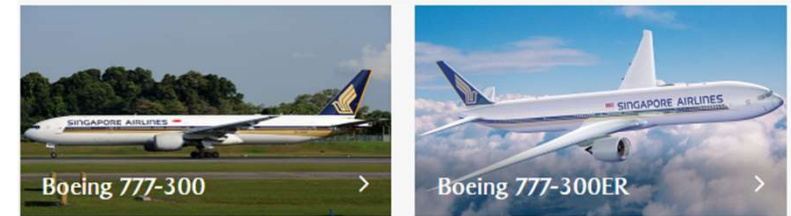
[1] This is aligned with the industry shift to use smaller twin-engine-wide-bodied aircrafts to service routes instead of larger jets with twice the capacity (such as A380 or Boeing 747) due to increase demand in non-hub airports.

[2] Based on a study by the International Air Transport Association (2018), median retirement age for commercial aircraft over the last 36 years is 25 years, with more than half of the aircraft retired between the age of 20 and 30 years.

[3] Horton, W. (2020, May 02). Singapore Airlines Seeks Fleet Flexibility, In Talks For Deferrals And Sale And Leaseback On Aircraft. Retrieved October 14, 2020, from https://www.forbes.com/sites/willhorton1/2020/05/02/singapore-airlines-seeks-fleet-flexibility-in-talks-for-aircraft-deferrals-and-sale-and-leaseback/

Assumptions & Limitations

Assumptions made for this project:

Passenger Recovery Rate

1. SIA recovery rate will be based on the 31 countries where airline has operating flights[4]; country's future performance in COVID recovery projected is based on number of cases[5] per capita snapshot & projected vaccine availability.

2. Vaccine distribution timeline to reach herd immunity is assumed to be 1 year[6].

3. COVID recovery rate per country will be assumed progressive; by end of year 2025, recovery rate is at 100%.

Countries			
Australia	India	New Zealand	Switzerland
Bangladesh	Indonesia	Philippines	Taiwan
Brunei	Italy	Russia	Thailand
China	Japan	Singapore	Turkey
Denmark	Malaysia	South Africa	United Arab Emirates
France	Maldives	South Korea	United Kingdom
Germany	Myanmar	Spain	United States
Hong Kong SAR, China	Netherlands	Sri Lanka	Vietnam

[4] https://www.singaporeair.com/en_UK/sg/plan-travel/destinations/where-we-fly/
[5] Hasell, J., Mathieu, E., Beltekian, D. et al. A cross-country database of COVID-19 testing. Sci Data 7, 345 (2020)
[6] https://www.bmj.com/content/371/bmj.m3846

Assumptions made for this project:

Operating Costs
1. Model does not account for any redundancies and pay cut as projected cost is based on 2019 cost.

2. Model does not account for any changes in flight operating cost (e.g. different number of flights per aircraft per year) as it is based on 2019 cost.

Cargo Demand
1. Model does not account for any changes in cargo as it is based on 2019 demand.

SIA Fleet information as of April 2020

Aircraft Models (as of April 2020)	Number of Aircrafts	Aircraft Type	Passenger Capacity	Cargo Capacity (cu m) underfloor bulk loading
Airbus A330-300	8	Twin engine, wide bodied	285	158.4
Airbus A350-900	48	Twin engine, wide bodied	253 (Long Haul) 161 (Ultra Long Range) 303 (Medium Haul)	172.4
Airbus A380-800	19	Large / Jumbo, High Capacity. 4-engine	441 (Version 1) 379 (Version 2) 471 (Version 3 – with new A380 cabin products) 471 (Version 4 – with new A380 cabin products)	175.2
B777-200 / ER	5	Twin engine, wide bodied	266	150.9
Boeing 777-300	5	Twin engine, wide bodied	284	201.6
Boeing 777-300ER	27	Twin engine, wide bodied	264	201.6
Boeing 787-10	15	Twin engine, wide bodied	337	191.4
Boeing 747	7	Large / Jumbo, High Capacity. 4-engine	0 (purely used for cargo)	46 containers (dedicated cargo variant)
Total	**134**			

Airbus A330-300 · Airbus A350-900 · Boeing 777-300 · Boeing 777-300ER · Boeing 787-10 · Airbus A380-800

This is aligned with the industry shift to use smaller twin-engine-wide-bodied aircrafts to service routes instead of larger jets with twice the capacity (such as A380 or Boeing 747) due to increase demand in non-hub airports.

Appendix 2 – COVID Vaccine Candidates' Availability
As of Oct 2020

Vaccine Name	Company	Country	Stage	Estimated period for vaccine availability
Ad5	CanSino Biologics	China	Approved for limited use in China	Not provided
Sputnik V	Gamaleya Research Institute	Russia	Approved for limited use	Not provided
EpiVacCorona	Vector Institute	Russia	Approved for limited use in UAE	Not provided
First Inactivated Virus Vaccine				
Second Inactivated Virus Vaccine	Sinopharm	China	Approved for limited use in UAE	End of 2020
CoronaVac	Sinovac Biotech	China	Approved for limited use in China	Early 2021
Moderna	Moderna	USA	Phase III	Mar-21
BNT162b2	BioNTech / Pfizer / Fosun Pharma	Germany	Phase III	End of 2021
AstraZeneca	University of Oxford/AstraZeneca	UK	Phase III	First Half of 2021