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Prospects for Predictive Modelling of the Airport's Post Pandemic Performance

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AGENDA

- Introduction
- Case Study
- Methodology
- Results

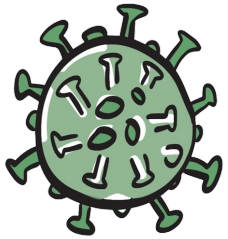
In 2022 while the World is recovering from the COVID-19 pandemic, the question of forecasting of aviation enterprises performance indicators faces a number of critical challenges.

Introduction

Forecasting has a significant importance for aviation industry, because it:

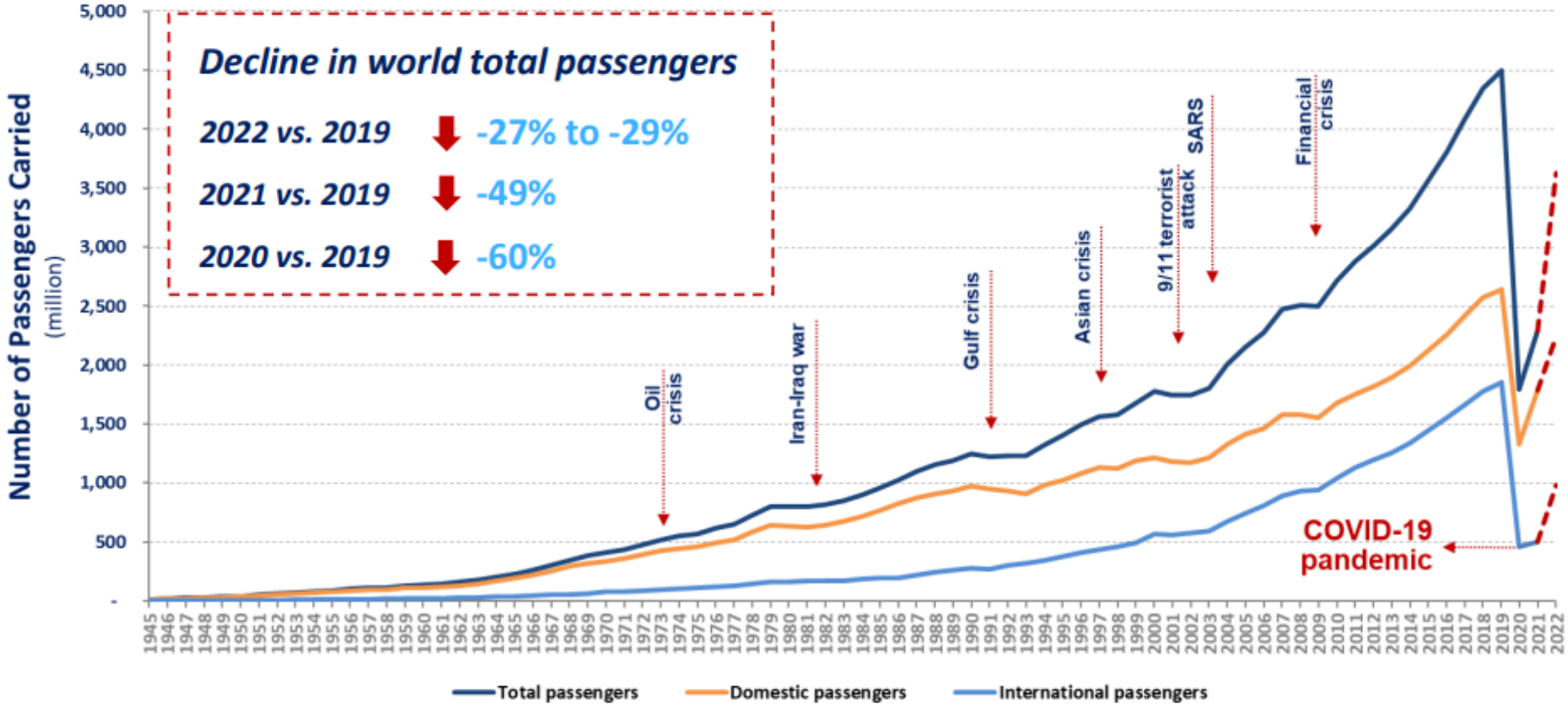
- assist all levels of government in the planning of airspace and airport infrastructure (air traffic control, terminal facilities, access roads, runways, taxiways, aprons);
- assist airlines in the long-term planning of equipment and route structure;
- assist aircraft manufacture in planning future types of aircraft (size, range, time of development)

How to make a forecast of airport's performance indicators in post-pandemic period?



World passenger traffic collapses with unprecedented decline in history

World Passenger Traffic Evolution 1945 - 2022

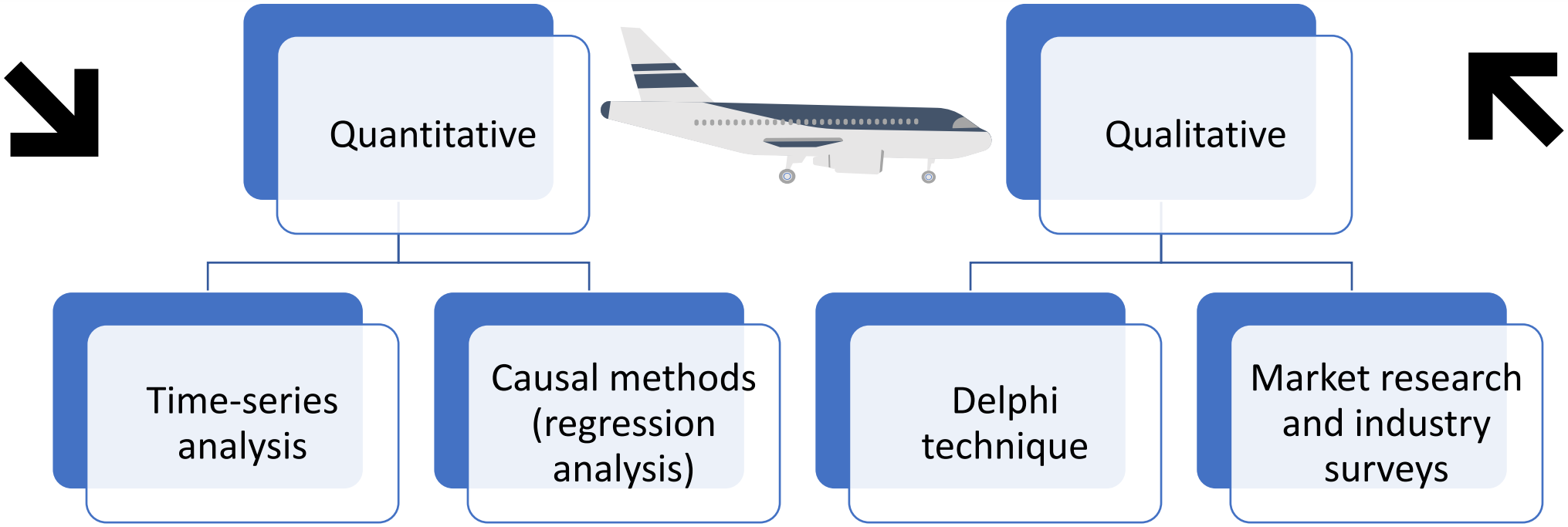


On the one hand, pandemic led to a sharp decline in the operating performances, which may create critical noise in data sampling and correlation errors in predicting.

On the other hand, it is impossible to predict enterprise dynamics with the available post-failure indicators, because the data sample is too small.

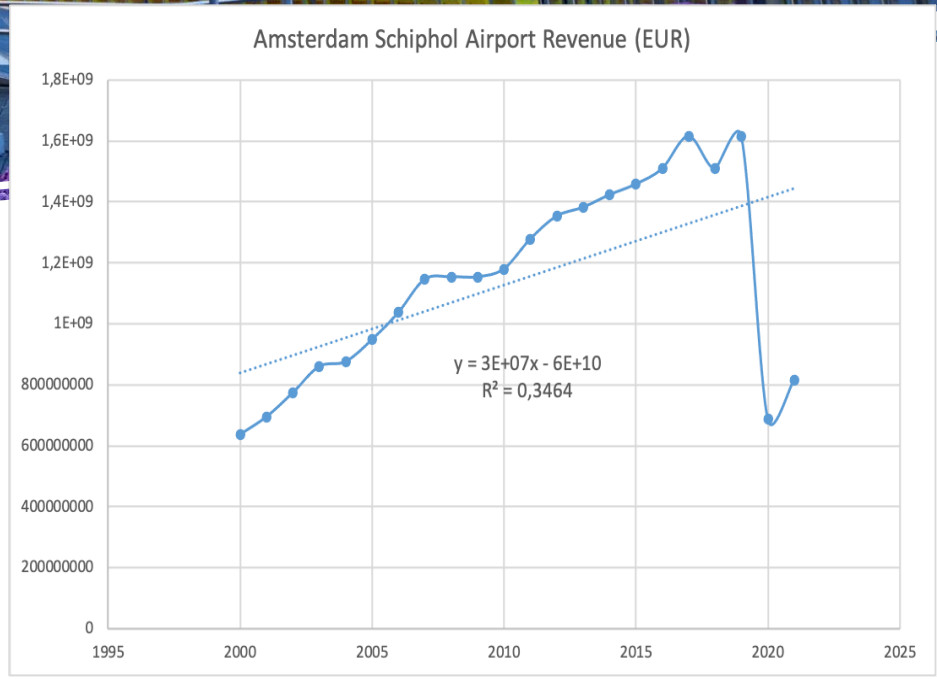
Source: ICAO Air Transport Reporting Form A and A-S plus ICAO estimates.

Alternative Forecasting Techniques

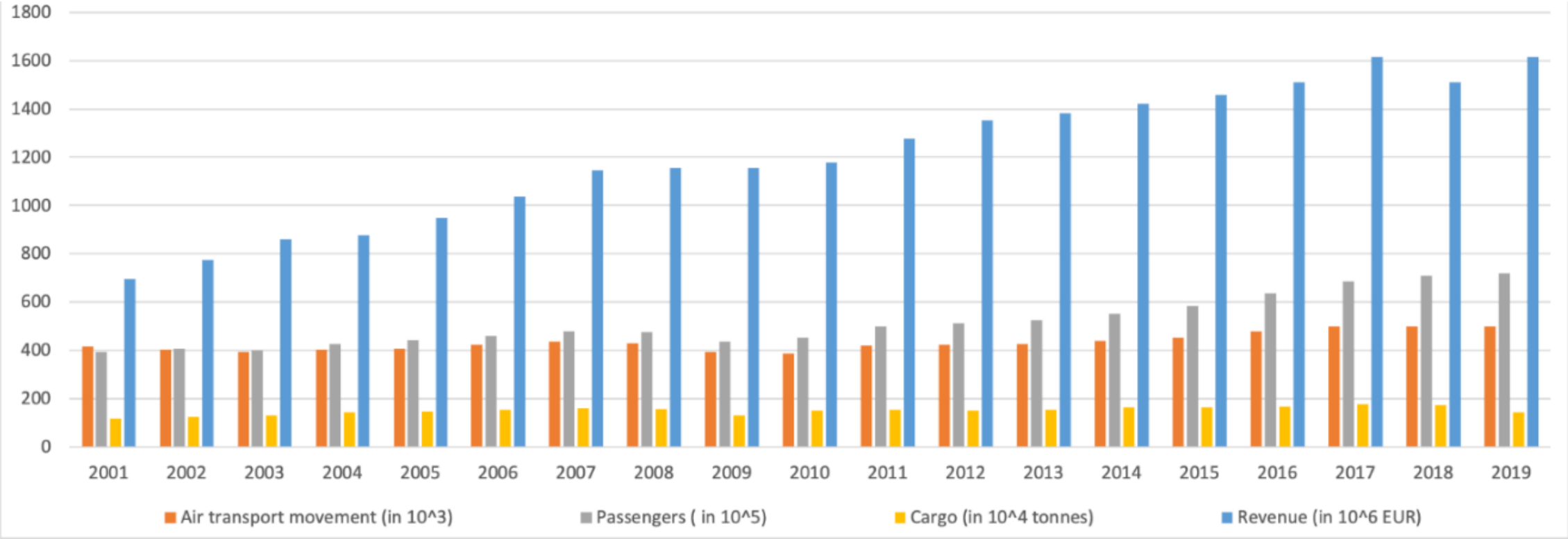


Case Study:

Amsterdam Schiphol Airport (AMS)

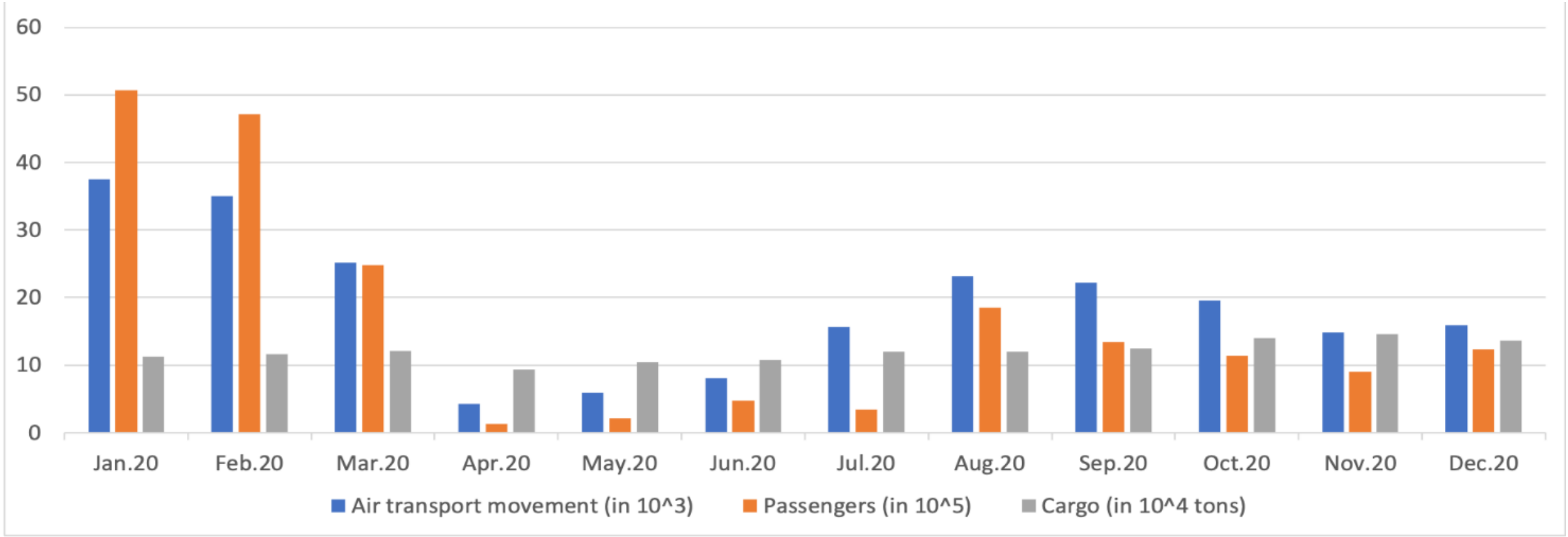


Yearly Production Statistics of the Amsterdam Schiphol Airport, 2001 - 2019



Source: Royal Schiphol Group. 2000-2021 Royal Schiphol Group Annual Report.

2020 monthly production statistics of Amsterdam Schiphol Airport



Source: Royal Schiphol Group. 2000-2022 Royal Schiphol Group traffic and transport figures.

Methodology

Quantitative approach.

Usage of Monte-Carlo simulations for airport's post pandemic performance indicators forecasting.

Testing of the proposed model on the example of Amsterdam Schiphol Airport

Proposed predictive simulation model

Stage 1. Development of a mathematical model for establishing general correlations between operations and revenue (multiple regression model).

Stage 2. Development of a simulation model for short-term operations prediction, based on the available post-failure indicator dynamics (Monte-Carlo simulations).

Stage 1. Mathematical Model

AIM - to create multiple regression model, based on the airport's production statistics for establishing general correlations between operations and revenue

Multiple regression model:

$$REV_{Schiphol} = 32{,}641 - 2{,}758 \cdot \alpha + 32{,}364 \cdot \beta + 354{,}786 \cdot \gamma$$

$REV_{Schiphol}$ *–revenue of Schiphol Airport, in millions EUR;*

α *- number of air transport movement in thousands (ATM);*

β *- number of transported passengers, in millions;*

γ *- transported cargo, in million tonnes.*

Initial Data:

- air transport movements;
- transported volumes of passengers;
- transported volumes of cargo.

Developed model has been programmed with RStudio software

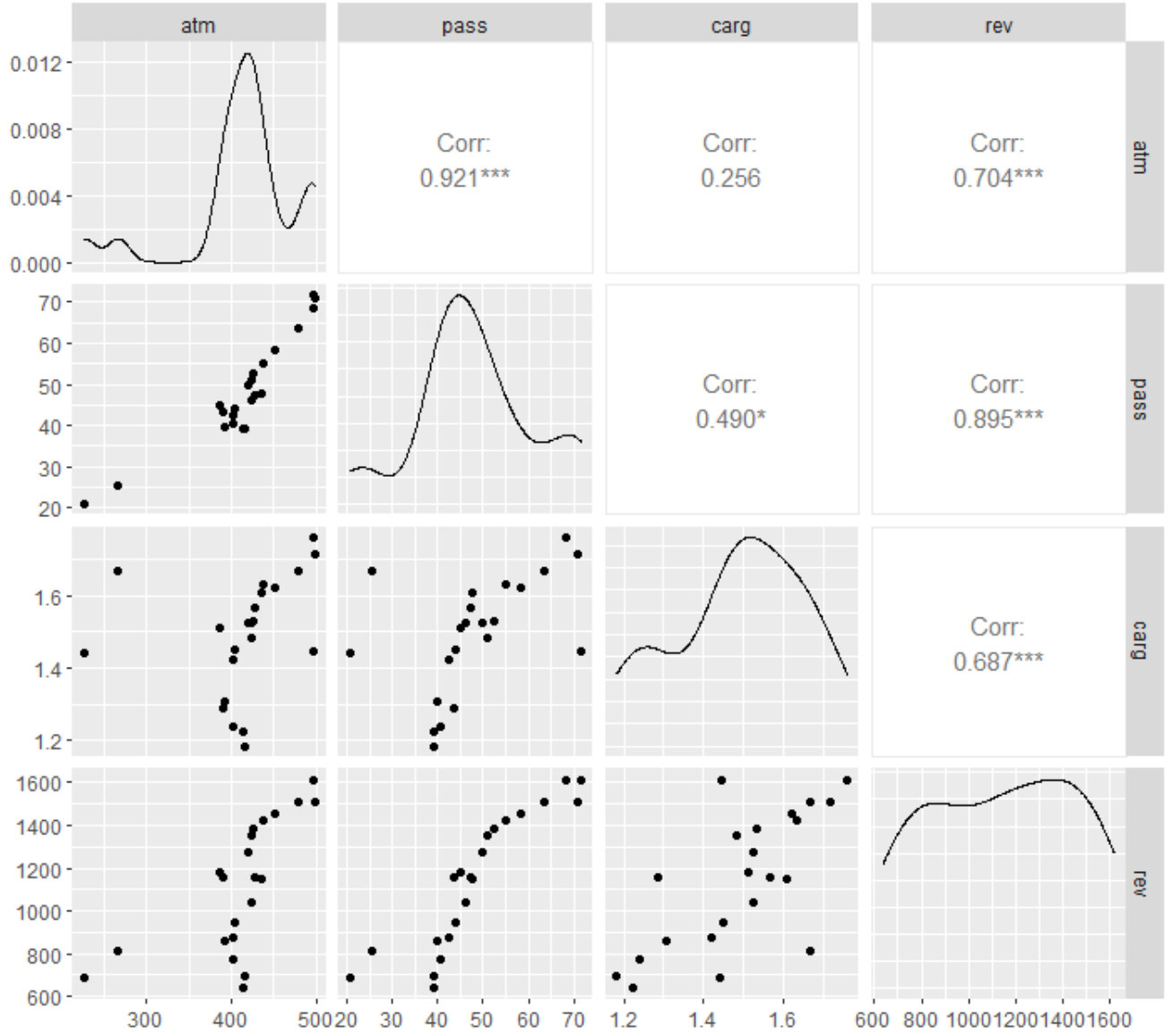
```
Call:
lm(formula = rev ~ atm + pass + carg, data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-211.62  -62.95  -14.27   55.13  175.77

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   32.641     92.389   0.491   0.6294
atm           -2.758      1.071  -2.574   0.0191 *
pass          32.364      5.896   5.489 3.26e-05 ***
carg         354.786    187.666   1.891   0.0749 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 100.4 on 18 degrees of freedom
Multiple R-squared:  0.9143,    Adjusted R-squared:    0.9
F-statistic: 64.02 on 3 and 18 DF,  p-value: 8.428e-10
```

Result code of Schiphol Airport Revenue multiple regression model

Correlation of multiple regression model indicators (developed in RStudio)

The results may be interpreted as follows:

- adjusted R-squared, which shows model accuracy, is $0{,}90$ (high level $\geq 0{,}85$);
- there is a correlation of revenue and air transport movements; the significance is high ($p - value = 0{,}0191 < 0{,}05$);
- positive correlation of revenue and number of transported passengers; the significance is high ($p - value = 0{,}0000326$);
- positive correlation of revenue and transported cargo; the significance is medium ($p - value = 0{,}0749$).



Stage 2. Monte-Carlo Simulation Model

AIM - to create a Monte-Carlo simulation model in MO Excel for short-term forecasting of the airport performance indicators.

Table 1. Main characteristics of the critical statistical data sample, calculated with the help of MO Excel built-in functions

Data	Min	Max	Mean	σ
Air transport movement (thousands)	4,242	23,125	14,376	5,520614045
Passengers (millions)	0,126015	1,854786	0,94799	0,504904633
Cargo (million tons)	0,09325489	0,15320616	0,12323052	0,015330566

The main idea is that 10^5 iterations are being processed for each indicator determination with the built-in MO Excel operator:

$$= NORM.INV(Probability; Mean; Standart\ Deviation)$$

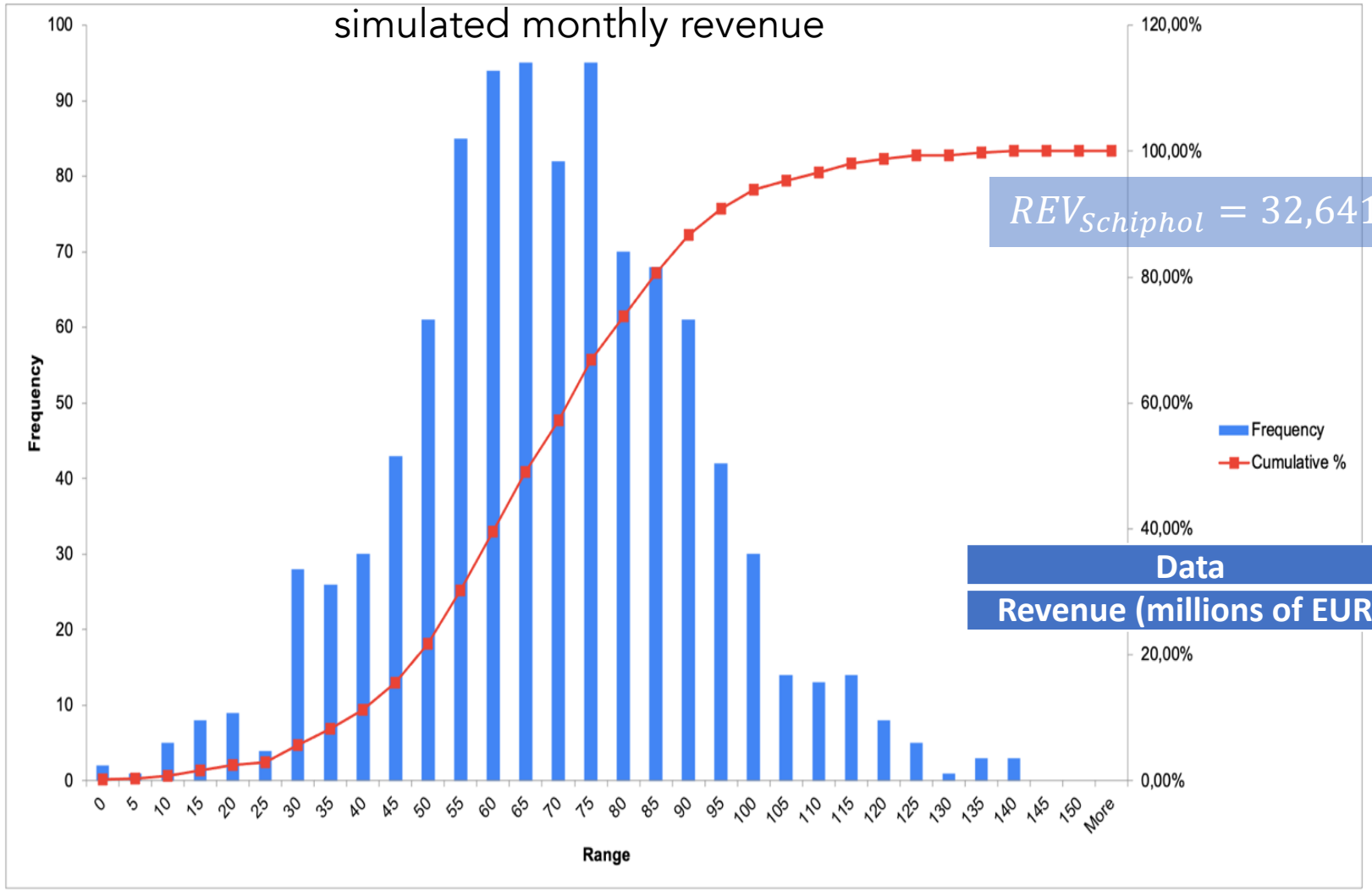
NORM.INV *– function, which returns the inverse of the normal cumulative distribution;* ***Probability*** *- threshold value of the return function, which is simulated by* $RAND()$ *function.*

Interface of the forecasting simulation model, developed in MO Excel

Predictive Simulation Model						
	MIN	MAX	MEAN	STD.DEVIATION		
Monthly Air Transport Movements (in thousands)	4,242	23,125	14,376	5,520614045		
Monthly Passengers (in millions)	0,126015	1,854786	0,94799	0,504904633		
Monthly Cargo	0,093254889	0,15320616	0,12323052	0,015330566		
Monthly Air Transport Movements (in thousands)	Random Value	0,2026104				
	Normal Distribution	9,78100875				
				Average Revenue =	66,4226949	
Monthly Passengers (in millions)	Random Value	0,81700318		Std. deviation	23,0676731	
	Normal Distribution	1,40442547		Max	141,912713	
Monthly Cargo	Random Value	0,8103924				
	Normal Distribution	0,13671135				
Iteration	Air Transport Movements	Passengers	Cargo	Simulated Revenue		
1	9,781008748	1,40442547	0,13671135	99,62107776		
2	9,796548814	0,73777211	0,11157183	69,08349916		
3	13,96695482	1,30612184	0,08038305	64,91024823		

Results: Simulated Monthly Revenue

Developed in MO Excel distribution histogram of simulated monthly revenue



Mathematical Model:

$$REV_{Schiphol} = 32{,}641 - 2{,}758 \cdot \alpha + 32{,}364 \cdot \beta + 354{,}786 \cdot \gamma$$

Table 2. Main characteristics of simulated monthly revenue sample:

Data	MEAN	MAX	σ
Revenue (millions of EUR)	66.4226949	141.1912713	23.0676731

Percentile of simulated monthly revenue

Percentile	Revenue
0,05	28,88784158
0,1	36,95226344
0,15	41,74715449
0,2	46,57471619
0,25	51,04351446
0,3	54,4209168
0,35	57,63116061
0,4	61,18603932
0,45	64,21002389
0,5	67,32336094
0,55	70,27680982
0,6	72,95159629
0,65	75,15860066
0,7	78,21345247
0,75	82,25044112
0,8	86,47961938
0,85	90,49937229
0,9	95,971416
0,95	102,9544739
1	141,9127131

Percentile graph, developed in MO Excel

Value of revenue $\leq$ $70{,}277\ millions\ EUR$ with probability 0,55.

Interpretation of the prediction results

1

Percentile table may be used for the prediction of an average monthly Amsterdam Schiphol Airport performance, taking into account the mathematical expectations of the enterprise's result.

2

The percentiles may be used for assessment of optimism/pessimism scenario (like the Hurwitz pessimism criterion), which reflects the company's expectation of a certain outcome.

The annual AMS simulated revenue in 2021 may be calculated as:

$66{,}422 \times 12 = 797{,}064\ millions\ EUR.$

Model accuracy - $92,66\%$.

Application Field of the Proposed Forecasting Model

In case of critical sample noise that may cause false correlations (e.g., cessation of the enterprise operations due to war, pandemic, or critical failure).

In case of lack of a significant data sample for short-term values prediction (e.g. new-born airline that have recently entered the market).

Many thanks for your attention!

Please contact for further questions:

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