INDIAN CIVIL AVIATION-INTERNATIONAL ROUTES

PRESENT AND THE FUTURE

Nandhini S. *Niveditha N.*
2nd year – MSc Data Science,
Department of Computing,
Coimbatore Institute of Technology.

DESCRIPTION:

In recent years, there has been an exponential growth in civilian air transport globally. Even though it is expensive, it is popular since it saves great amount of time for air passengers. This had led to the birth of various airline brands globally. India also experienced similar growth in civil aviation. Currently 6 Domestic airlines and 83 Foreign airlines are operating in India offering international services. This project aims to give a comparison of performances of both domestic and international airlines, in terms of persons travelled and cargo moved over a period of 5 years. It focuses mainly on how the movement is observed and the situation of the near future. Time Series and its concepts were deployed for data analysis and inferences. Data of both passengers and cargo, to and from India were considered for analysis. The comparison of performance is plotted as graph to illustrate the progress with time.

INTRODUCTION:

The Indian civil aviation[5] dates back to 18 February 1911 for a local fair in Allahabad. However, the sector under Indians skyrocketed in 15 October 1932 by JRD Tata, who flew a consignment of mail from Karachi to Juhu. This incident had its own significances: the mark of world's first official airline service and the birth of Tata Air Services, which was later renamed as Air India. The Post-independence era witnessed the rise of several airlines like the deccan airways, Airways India, Bharat Airways, Himalayan Aviation and Indian airlines (later Indian). In the end most of these newly formed airlines were forced to merge with either Indian or Air India and finally Indian was forced to merge with Air India ultimately making it the lead in public sector. On the other hand, several private industries emerged in the digital age. This not only increased the competition, but also the connectivity between places reducing the time.

In the recent years, civil aviation in India had a rapid growth in the international sector, with several foreign companies investing in Indian routes. This breakthrough led to nationalization of some Indian airlines as well as the fall of some airlines.

DATASET:

All the airlines serving the nation in the international routes are classified into some zones. The dataset contains the data of both passengers and goods carried in and out the nation for a quarter from 2015 to 2019.

courtesy:

http://dgca.nic.in/reports/stat-ind.htm

FACTORS AFFECTING THE FREQUENCY OF PASSENGERS:

Overall, there are various factors that affect the flow of passengers. However, the key issues are the air fares, diplomacy issues that decides the relation between two nations, nationalism, competition.

Air fares[1]:

The most basic and the key factor of airline industry is its fares. These fares are determined by the fuel surcharge, distance

between two destinations (with the factor of airspace permit), Empty seats.

1. *Competition:*

   Competition within airlines over a same route is a very crucial factor with its own effects. This competition will turn to be toughest if both mainstream and low-cost airlines serve the same routes since it will force the mainstream airline to reduce its fare so that it can par with the low-cost airline.

2. *Empty Seats:*

   No airline would prefer flying with empty seats. If that case is encountered, they reduce the fares to attract people. If this strategy fails again, the step down by reducing the total capacity and further terminating the route.

3. *Fuel Surcharge and hauls:*

   Flights are separated into long haul and short haul based on the distance between destinations covered. If in the case of long hauls, these flights need stopovers for fuel refilling.

   These stopovers may be within the nation or outside the nation. When the case of having an international stopover and having fuel refilled, the amount is calculated according to their system. Some countries have an easy access and cheaper fuel whereas some have a difficult access and expensive fuel.

4. *Timings of booking and travel:*

   This is almost a hidden factor in the air fare. It is observed that the fares keep increasing as it reaches nearer to the date of journey. The booking made in advance are cheaper than the booking made at the last minute.

   Similarly, tickets for travelling in festive season, weekends and the peak periods cost a higher amount besides the weekdays.

   Thus, one can conclude that the demand determines the fare and vice versa.

5. *Occasional Factors:*

   Besides the tourists and businessmen, the airlines are at a demand whenever there lies a very special occasion, either related with the cultural aspects of a place or sport events, a small demand is created.

Nationalism:

It is general for the passengers to prefer the flights that are from their nation and choose to stay loyal. Other factors that leads to nationalism are the convenience from the crew, the cuisine and the sense of patriotism.

For example, assume India. Plenty of Indian airlines serve all destinations globally and from the list of passengers' nationalities, the majority were found to be Indian. These Indians are well adapted to the Indian cuisine, ethics and comfortability that they get on any Indian airlines easily but not on all other non-Indian airlines.

STATISTICAL CONCEPTS:

- Time series[2]
- Forecasting by Holt-Winters Additive Method
- Deseasonalization[3]
- Exponential Smoothening
- Moving Average

Time Series:

Time Series[2] is a series of observations on a variable, recorded after successive equal time intervals. Here, the time period assumed is for quarterly data. The objectives to analyse time series are to study the past behaviour and to make forecasts for future.

A time series consists of four components namely trend, cycle, seasonal and irregular.

1. **Trend** – It is the broad long term tendency of either upward or

downward movement in the average value of forecast.

2. **Cycle** – It is the upward or downward oscillation of uncertain duration due to the effect of seasonal cause. It may be either of long time or short time.

3. **Seasonal** – It is the special case of cyclic component of a time series where the duration does not vary but happen at a regular interval each year.

4. **Irregular** – It is the erratic movement in a time series with a short-term effect caused due to unforeseen circumstances that cause severe fluctuations.

Forecasting by Holt-Winters Additive Method:

Triple Exponential Smoothing, also known as the Holt-Winters method, is one of the many methods or algorithms that can be used to forecast data points in a series, provided that the series is "seasonal", i.e. repetitive over some period.

Time series forecasting methods are used to extract and analyse data and statistics and characterize results to more accurately predict the future based on historical data.

The Holt-Winters forecasting algorithm allows users to smooth a time series and use that data to forecast areas of interest. Exponential smoothing assigns exponentially decreasing weights and values against historical data to decrease the value of the weight for the older data. In other words, more recent historical data is assigned more weight in forecasting than the older results.

The updating equations are:

$L_t = a\,(L_{t-1} + T_{t-1}) + (1 - a)\,y_t / S_{t-s}$
for the level,
$T_t = b\,(L_t - L_{t-1}) + (1 - b)\,T_{t-1}$
for the trend, and
$S_t = g\,S_{t-s} + (1- g)\,y_t / L_t$
for the seasonal factor.

The three smoothing parameters a, b, and g must be positive and less than one

Deseasonalization:

The seasonalised[3] data gives the observer an idea of how the commodity has performed over a time period. But this data includes both waves and nodes occurred by the seasonal effect. In order to get the exact effectivity of the commodity or service, the data is deseasonalized by adjusting the seasonal effect.

The simplest example is the sales of a smartphone company. Whenever there is a new launch or a flash sale, the sales increase. Whenever the competitor creates a demand in the consumer market, the sales fall. But overall, these companies see a rise.

Exponential Smoothing:

Exponential smoothing is a type of moving average technique which weights past data in an exponential manner so that the most recent data carries more weight in the moving average. To this data, triple exponential smoothing is deployed since the data has seasonal factors.

The equations are repeated as in the forecasting model by Holt-Winters additive method.

Moving Average:

Moving average[6] is a calculation of the movement of the data subset taken from the full data set. Moving average is usually associated with time series to smooth out short-term fluctuations and highlight the long-term trends.

For this dataset, simple moving average is used which is actually the unweighted mean of the previous n data. Simple moving average is given by:

$$SMA = \frac{A_1 + A_2 + \ldots + A_n}{n}$$

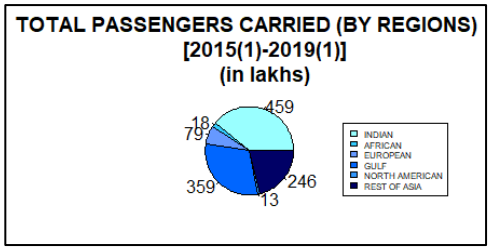
where:

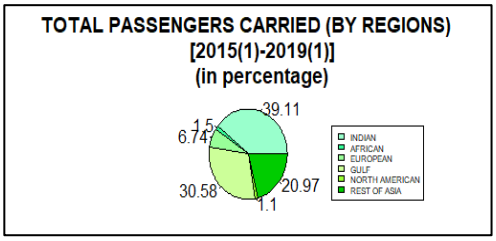
A = average in period n

n = number of time periods

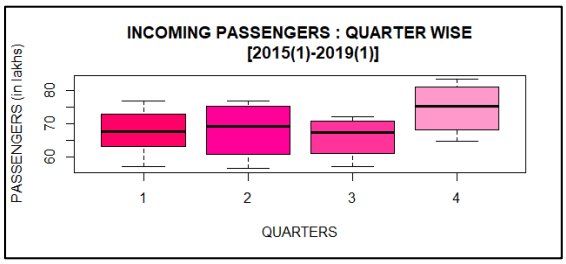
PASSENGERS TO INDIA (SET I):

GRAPHS AND OUTPUTS:

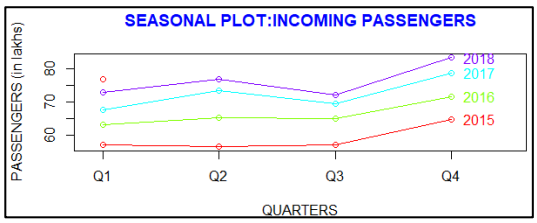




This pie chart gives an approximation of the passengers carried to the nation from the first quarter of 2015 to the first quarter of 2019. It is seen that the Indian markets rule the Indian aviation (459) followed by the Gulf (359).



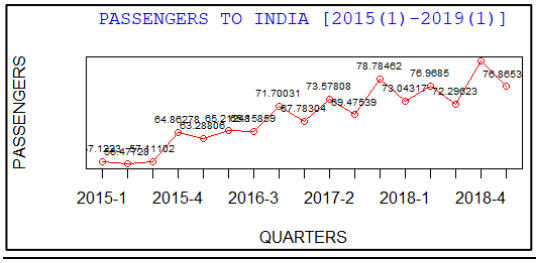
This boxplot gives the approximation of the passengers carried in each quarter of a year for four years and a quarter. This graph further scrutinizes that the fourth quarter is the busiest compared to the second quarter.



This seasonal plot is a further breakdown of the boxplot. This plot clearly indicates the number of passengers carried in each quarter and also shows that there is a significant rise in every passing year

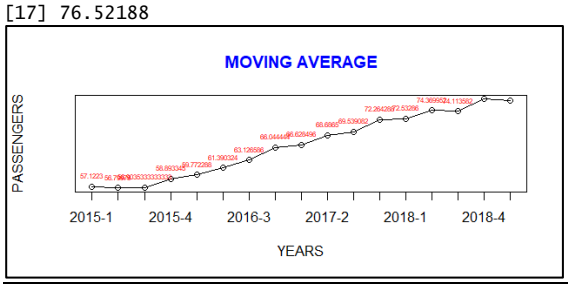
Time series:

```
         Qtr1     Qtr2     Qtr3     Qtr4
2015 57.12230 56.47728 57.11102 64.86278
2016 63.28806 65.21248 65.15859 71.70031
2017 67.78304 73.57808 69.47539 78.78462
2018 73.04317 76.96850 72.29623 83.43621
2019 76.86531
```



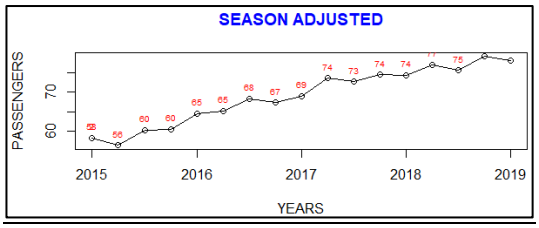
Moving Average:

```
[1] 57.12230 56.79979 56.90353 58.89335 59.77229
61.39032 63.12659 66.04444

[9] 66.62850 68.68650 69.53908 72.26429 72.53286
74.36995 74.11358 76.90575

[17] 76.52188
```



Seasonal Adjusted:

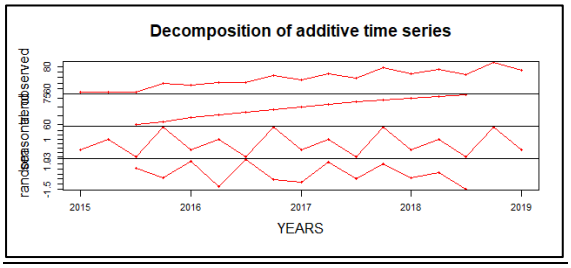
```
      Qtr1     Qtr2     Qtr3     Qtr4
2015 58.37956 56.41044 60.29264 60.49075
2016 64.54532 65.14564 68.34021 67.32828
2017 69.04030 73.51124 72.65701 74.41259
2018 74.30043 76.90166 75.47785 79.06418
2019 78.12257
```



Decomposed series:

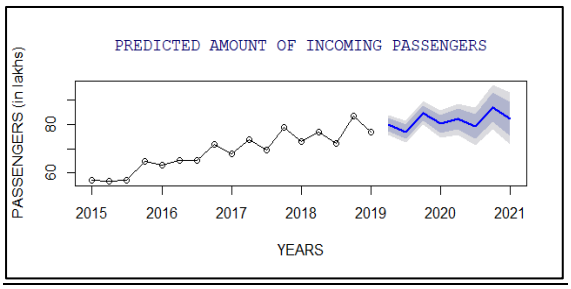
```
$x
      Qtr1     Qtr2     Qtr3     Qtr4
2015 57.12230 56.47728 57.11102 64.86278
2016 63.28806 65.21248 65.15859 71.70031
2017 67.78304 73.57808 69.47539 78.78462
2018 73.04317 76.96850 72.29623 83.43621
2019 76.86531

$seasonal
       Qtr1       Qtr2       Qtr3       Qtr4
2015 -1.5222895  0.9526972 -3.1391161  3.7087084
2016 -1.5222895  0.9526972 -3.1391161  3.7087084
2017 -1.5222895  0.9526972 -3.1391161  3.7087084
2018 -1.5222895  0.9526972 -3.1391161  3.7087084
2019 -1.5222895

$trend
      Qtr1     Qtr2     Qtr3     Qtr4
2015       NA       NA 59.66407 61.52669
2016 63.62453 65.48517 66.90173 68.50930
2017 70.09461 71.51974 73.06280 74.14412
2018 74.92052 75.85458 76.91380       NA
2019       NA

$random
       Qtr1       Qtr2       Qtr3       Qtr4
2015         NA         NA  0.5860711 -0.3726134
2016  1.1858183 -1.2253859  1.3959736 -0.5177034
2017 -0.7892755  1.1056391 -0.4482927  0.9317941
2018 -0.3550655  0.1612241 -1.4784489         NA
```

```
2019          NA

$figure
[1] -1.5222895  0.9526972 -3.1391161  3.7087084

$type
[1] "additive"

attr(,"class")
[1] "decomposed.ts"
```



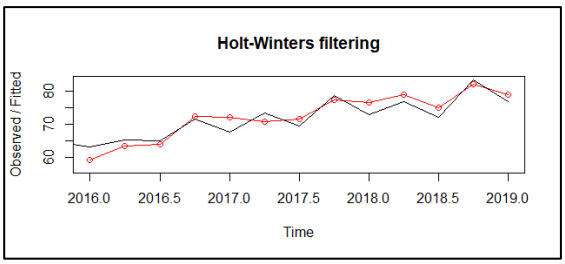
Forecast:

```
Forecast method: Holt-Winters' additive method

Model Information:
Holt-Winters' additive method

Call:
 hw(y = cst)

  Smoothing parameters:
    alpha = 0.17
    beta  = 0.17
    gamma = 1e-04

  Initial states:
    l = 54.3816
    b = 1.7944
    s = 3.997 -3.1352 0.2408 -1.1026

  sigma:  2.0741

     AIC     AICc      BIC
 80.15612 105.87040  87.65504

Error measures:
                    ME      RMSE       MAE         MPE
MAPE      MASE
Training set -0.4253305 1.509102 1.319412 -0.5991966 1.95
3406 0.2318109
                   ACF1
Training set -0.4781849

Forecasts:
     Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
5 Q2       79.74547 77.08745 82.40349 75.68038 83.81056
5 Q3       76.93472 74.12727 79.74216 72.64110 81.22833
5 Q4       84.63220 81.51462 87.74978 79.86428 89.40013
6 Q1       80.09779 76.49417 83.70141 74.58653 85.60905
6 Q2       82.00652 77.75306 86.25998 75.50142 88.51163
6 Q3       79.19577 74.15175 84.23979 71.48161 86.90993
6 Q4       86.89326 80.93955 92.84696 77.78785 95.99866
7 Q1       82.35885 75.39367 89.32402 71.70653 93.01116
```



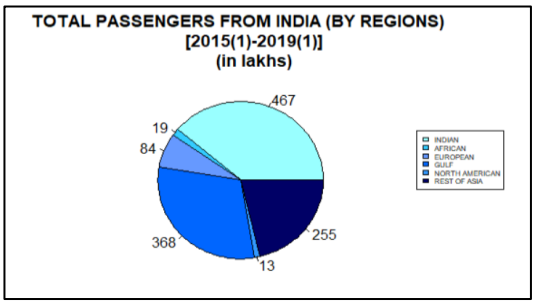
Exponential smoothening:

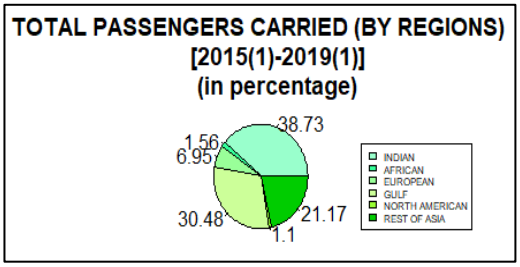
```
Holt-Winters exponential smoothing with trend and
 additive seasonal component.

Call:
HoltWinters(x = cst)

Smoothing parameters:
 alpha: 0.5193032
 beta : 0
 gamma: 0.9335357

Coefficients:
          [,1]
a  80.0995030
b   1.9561157
s1  0.8061141
s2 -4.3296484
s3  4.0803572
s4 -3.1620360
```



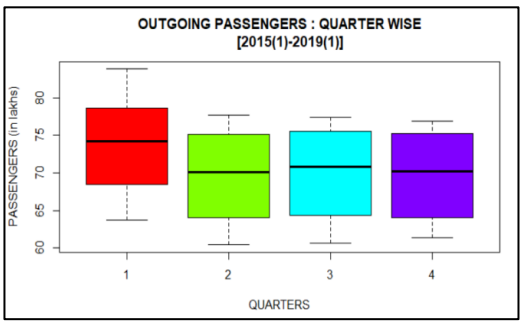
PASSENGERS FROM INDIA (SET II):

GRAPHS AND OUTPUTS:





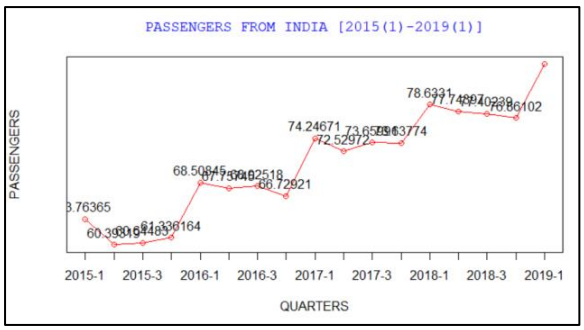
This pie chart gives an approximation of the passengers departed to other nations from the first quarter of 2015 to the first quarter of 2019. Here, the Indian market ant the gulf market compete each other followed by the asian.



Time series:

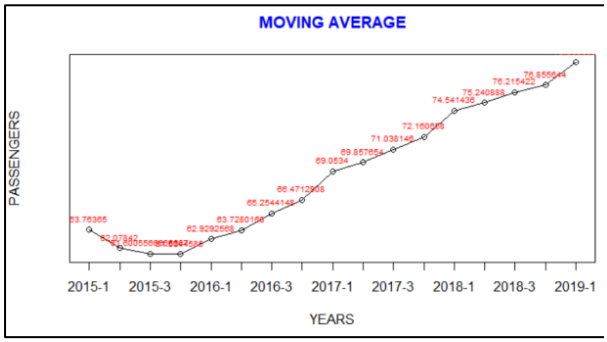
```
          Qtr1     Qtr2     Qtr3     Qtr4
2015 63.76365 60.39319 60.64483 61.33616
2016 68.50845 67.75745 68.02518 66.72921
2017 74.24671 72.52972 73.65991 73.63774
```

```
2018 78.63310 77.74397 77.40239 76.86102
2019 83.85643
```



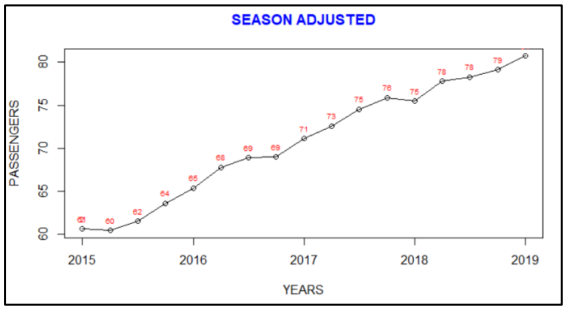
Moving Average:

```
[1] 63.76365 62.07842 61.60056 61.53446 62.92926
63.72802 65.25441 66.47129 69.05340

[10] 69.85765 71.03815 72.16066 74.54144
75.24089 76.21542 76.85564 78.89938
```

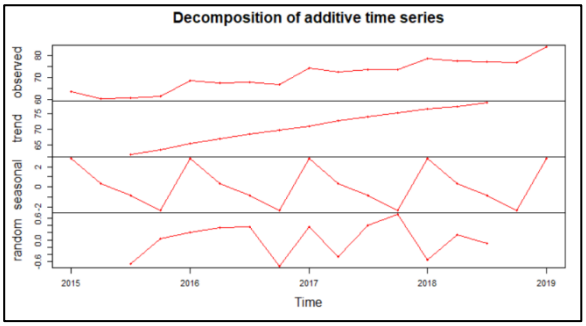


Seasonal adjusted:

```
         Qtr1     Qtr2     Qtr3     Qtr4
2015 60.61938 60.43401 61.50585 63.57860
2016 65.36418 67.79827 68.88620 68.97165
2017 71.10244 72.57054 74.52093 75.88018
2018 75.48883 77.78479 78.26341 79.10346
2019 80.71216
```

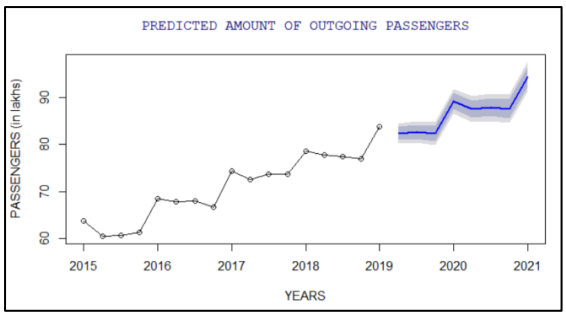



```
$x
         Qtr1     Qtr2     Qtr3     Qtr4
2015 63.76365 60.39319 60.64483 61.33616
2016 68.50845 67.75745 68.02518 66.72921
2017 74.24671 72.52972 73.65991 73.63774
2018 78.63310 77.74397 77.40239 76.86102
2019 83.85643

$seasonal
          Qtr1       Qtr2       Qtr3       Qtr4
2015  2.8066730  0.3425323 -0.8153438 -2.3338615
2016  2.8066730  0.3425323 -0.8153438 -2.3338615
2017  2.8066730  0.3425323 -0.8153438 -2.3338615
2018  2.8066730  0.3425323 -0.8153438 -2.3338615
2019  2.8066730

$trend
         Qtr1     Qtr2     Qtr3     Qtr4
2015       NA       NA 62.12756 63.64119
2016 65.48427 67.08094 68.47236 69.78617
2017 71.08705 72.65495 74.06682 75.26690
2018 76.38649 77.25721 78.31304       NA
2019       NA

$random
             Qtr1        Qtr2        Qtr3         Q
tr4
2015           NA          NA -0.66738470  0.02883
451
2016  0.21750976  0.33397593  0.36816880 -0.72309
974
2017  0.35299076 -0.46776607  0.40843505  0.70470
276
2018 -0.56006299  0.14422768 -0.09530245
 NA
2019           NA


$figure
[1]  2.8066730  0.3425323 -0.8153438 -2.3338615

$type
[1] "additive"

attr(,"class")
[1] "decomposed.ts"
```

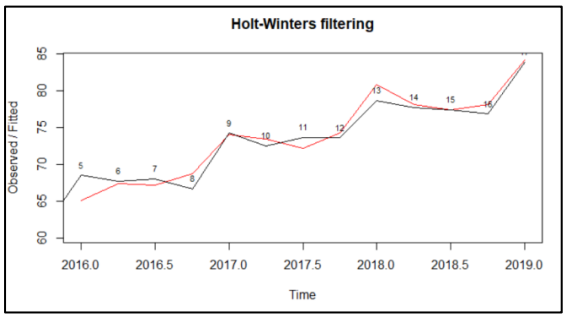


Forecast:

```
Forecast method: Holt-Winters' additive method

Model Information:
Holt-Winters' additive method

Call:
 hw(y = cst)

  Smoothing parameters:
    alpha = 0.4265
    beta  = 1e-04
    gamma = 1e-04

  Initial states:
    l = 58.5697
    b = 1.3041
    s = -2.4248 -0.8214 0.1527 3.0934

  sigma:  1.073

     AIC     AICc      BIC
57.74698 83.46127 65.24590

Error measures:
                     ME       RMSE       MAE
 MPE      MAPE       MASE       ACF1
Training set 0.01847872 0.7806896 0.685902 0.0328
6194 0.9939841 0.1278824 0.1333364

Forecasts:
         Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
2019 Q2       82.33186 80.95681 83.70691 80.22891 84.43481
2019 Q3       82.66194 81.16698 84.15690 80.37560 84.94829
2019 Q4       82.36268 80.75668 83.96867 79.90652 84.81883
2020 Q1       89.18499 87.47511 90.89488 86.56996 91.80003
2020 Q2       87.54838 85.74048 89.35627 84.78344 90.31332
2020 Q3       87.87846 85.97759 89.77932 84.97134 90.78558
2020 Q4       87.57919 85.58966 89.56872 84.53646 90.62192
2021 Q1       94.40151 92.32705 96.47597 91.22890 97.57412
```




```
Holt-Winters exponential smoothing with trend and
 additive seasonal component.

Call:
HoltWinters(x = cst)

Smoothing parameters:
 alpha: 0.8640558
 beta : 0
 gamma: 0.1550236

Coefficients:
          [,1]
a  80.8177148
b   1.6703226
s1  0.6773787
s2 -1.4120867
s3 -2.3659665
s4  3.0688656
```



OVERALL INFERENCES:

From the data segregated region wise, it is found that the gulf airlines have a performance equalling the Indian airlines.

Malaysia, Thailand, Singapore and Indonesia are the major boosters for the Asian sector.

The peak of the passenger incoming is found in Q-2 of every year and drops down drastically in Q-3 of that year. And so, the next rise is found in Q-4 and drops down in Q-1 of next year. On the contrary, the peak of passengers outgoing from the nation is found to peak at Q1 of every year but drops down the next quarter and does not increase again until the next Q1. Combining and comparing both the cases, one can draw the conclusion the months from October to March are the busiest.

It is found that in order to push their markets, airlines introduce special discounts and promotions for the seasonal sale for Q4 and Q1. However, the most expensive prices are found in the periods of June–July and December. Similarly, the lowest fares are found between the periods of April–May and September–October.

Population movement has shown that the best time to visit any country is from the months of October to March.

It is predicted that the Indian aviation industry will reach the third position globally within a decade. India is expected to overtake Germany, Japan, Spain and the UK.[4]

The entire understanding concludes that our nation has got an excellent scope in this sector in the future.

Other Contributions to the seasonal increase:

Q2 (April 2015) – Evacuation of Indians from Yemen and the closure of Indian embassy in Yemen.

Q2 (April 2015) – ICC cricket world cup was held in Australia.

Q3 (August 2016) –The Olympic games were held in Rio de Janeiro, Brazil.

Implementations to boost the sector:

The government has planned to invest around 60 billion dollars for the construction of 100 new airports to accommodate flights

New international routes are being launched by new airlines to expand their markets. It is estimated that around 50 new routes are being added every year.

Several low-cost airlines are introduced within the nation and the existing brands are given international permit to expand from the Indian market side.

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