Air Traffic Forecasting Methodology by IATA

1. Principles of the EIA Forecasts

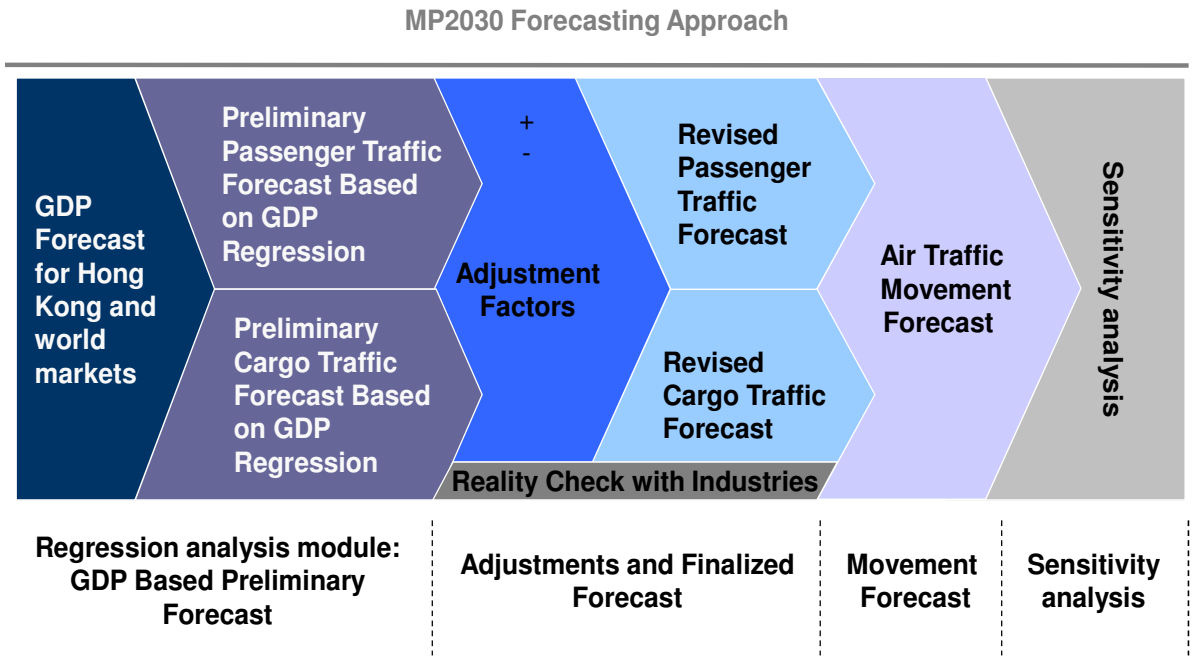
The forecasts used to underlie the EIA study are derived from the MP2030 forecasts. The relevance of the MP2030 forecasts models was checked and confirmed. Assumptions to the forecasts were updated where needed, in particular actual traffic numbers for 2009, 2010, 2011 and 2012 were factored in. Future passenger airlines' and cargo operators' strategies were also surveyed extensively to increase the robustness of the forecasts. To that effect, inputs on development strategies and future fleet were collected from the main HKIA passenger airlines and cargo operators. Eventually one traffic adjustment was added to reflect the impact of runway capacity constraints on traffic: Contrary to the MP2030, the EIA forecasts are constrained by the capacity of the runway system.

The approach used by IATA is in-line with airport forecasting best practices. Comprehensive airport forecasts generally follow such an approach combining market demand, airline supply considerations and adjustment factors to reflect changes in the airport business environment. ICAO's, ACI's and IATA's publications recommend following an approach that include these ingredients. Similar approaches were used by IATA and other forecasters to undertake the forecasts of several international airports such as London-Heathrow, London-Gatwick, Sydney, Singapore and Bangkok.

Nevertheless IATA used in their model forecasting parameters specific to HKIA, such as historical traffic numbers, fleet mix, passenger and cargo load factors and the market share evolution over the PRD.

2. Reminder on the Approach for the MP2030 traffic forecasts

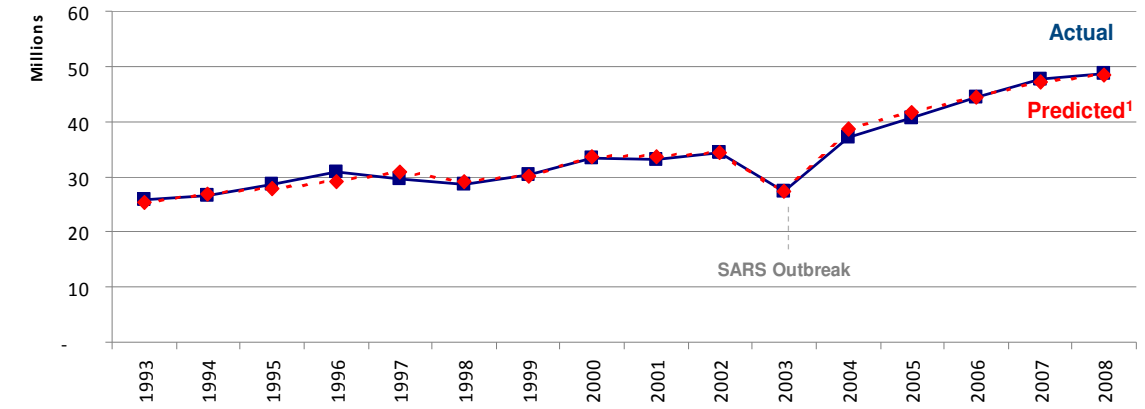
The figure below summarises the approach that has been used to forecast MP2030 traffic.



The original MP2030 forecasts (for passenger, cargo and Air Traffic Movements) were prepared by IATA in 2009. Detailed information on the forecasting approach is available in the MP2030 report issued in 2010. In short the following dual methodology was used:

- Top-down approach: The top-down approach aimed at projecting the market air demand in line with the market socio-economic characteristics. IATA carried out regression analysis against several socio-economic variables. The airport historical traffic was found very strongly correlated to Hong Kong and key global market GDPs. The statistical characteristics of the regressions (R2~0.99 for the passenger total traffic) reflected very robust correlations.

Actual and predicted[1] HKIA passenger traffic– 1993 to 2008



Source: AAHK traffic data, IATA estimates

[1] Predicted traffic is derived from the equation

- Bottom-up approach: The bottom-up approach addressed the supply side. IATA analysed the relevance of the traffic forecast in light of the airline and airport strategies and the anticipated development of the competitive intensity. In particular it was checked that airlines would provide sufficient seat capacity and flights for the latent demand to materialise.

- The outcome of the dual methodology was the baseline forecast. As the baseline forecast was derived from the analytical regressions of historical traffic, it implicitly assumed that the historical relationships between the causal variables and traffic would prevail for future traffic. Therefore IATA subsequently examined more than a dozen factors that are known to influence air traffic demand (see Chart below) and factored in the model the ones expected to have an impact on the future traffic above and beyond the baseline forecast. These are the so-called adjustment factors:

  - Adjustment #1: Implementation of the Direct Links (negative impact on both passenger and cargo traffic);

  - Adjustment #2: Intensifying competition with the cargo hubs (negative impact on cargo transshipment traffic);

  - Adjustment #3: UPS and FedEx strategies to establish hubs in the PRD (negative impact on cargo traffic);

Adjustment Factors Examined as part of the MP2030 Traffic Forecast

Regulation	↗ Air Service Agreements ↗ Direct Links ↗ Trade Agreements ↗ Travel policy
Demand	↗ Tourism ↗ Cross Boundary Infrastructures ↗ Travelers' preferences
Airlines	↗ Airlines' strategies (Hong Kong based, PRD based and foreign carriers) ↗ UPS & FedEx settlement in the PRD
Competition	↗ Competition on OD traffic from PRD airports ↗ Competition on TT traffic from other Hub airports
Substitution	↗ Mainland China High Speed Train ↗ Sea containerized shipping

In red, adjustment factors estimated to have an impact on traffic

It was assessed that the other factors (highlighted in blue in the above Chart) would maintain their contribution to the traffic baseline in the same proportion as in the past.

3. The MP2030 forecast is unconstrained

'Unconstrained' means that no capacity constraint was factored in our model, either at the airport level (runway, parking stands or terminal) or in terms of airspace. Airside, terminal and airspace are assumed in sufficient quantity to handle the forecasted volume of passengers, cargo and ATM all along the forecasting period.

According to best practices, airport master plans should be derived from the identification of the future capacity requirements to handle the unconstrained demand. Therefore it is a common practice to elaborate airport master plans based on unconstrained demand forecasts.

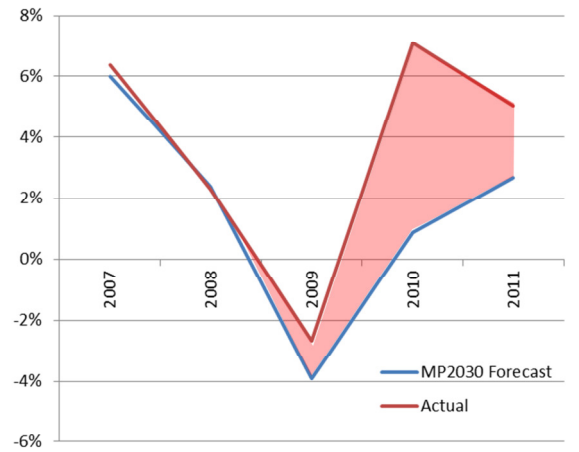
4. The original MP2030 traffic forecast[1] underestimated

The original MP2030 traffic forecast (base case) appeared to be very conservative: HKIA reached 56.5 million passengers in 2012, 3 years ahead of the original forecast.

The conservative economy outlook is responsible for the conservative forecast. MP2030 forecast was developed in 2009 in the middle of one of the most severe crisis that ever hit Hong Kong and the world. Back then it was uncertain when and how strong the recovery would be. As illustrated in the left hand side chart, Hong Kong economy actually bounced back earlier and stronger than anticipated by Global Insight in July 2009.

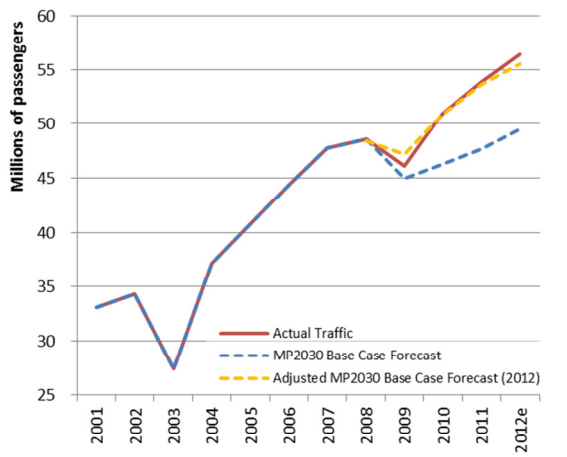
[1] All reference to MP2030 forecast in this document refers to the Base Case unless otherwise specified.

Comparison of Forecasted and Actual HKSAR real GDP



Source: IHS Global Insight, IATA analysis

Comparison of HKIA actual pax traffic against the MP2030 base case forecast and the adjusted MP2030 base case forecast



Source: AAHK, IATA analysis

5. The model underlying the MP2030 forecast was correct

In 2012, IATA reviewed the model developed in 2009 and concluded that the passenger and cargo equations were still valid. The demand drivers were re-checked and it was confirmed they were still applicable. The right hand side chart in the figure above actually shows that the MP2030 base case model (i.e. equations) with the right GDP assumptions returns a predicted traffic very close to HKIA actual traffic.

6. The original MP2030 forecast was adjusted to reflect the higher traffic

IATA kept the MP2030 model as it proved to be valid and reflected the stronger traffic dynamic by taking into account the actual and short-term traffic forecast numbers:

- 2009-2012: Actual traffic numbers were used to reflect the recent market conditions.
- 2013-2014: Forecasts have been adjusted and fine-tuned based on the latest GDP outlook, the latest actual monthly traffic figures and the airline schedules published by Innovata and information directly collected from the airlines.
- 2015 onwards: New traffic figures were estimated factoring in the actual and projected traffic until 2014 as well as the GDP forecasts adopted in MP2030. IATA reviewed the latest GDP forecasts from Global Insight and Consensus Economics that aggregate estimates from over 250 prominent financial and economic forecasters and concluded that the GDP forecasts underlying the original MP2030 forecasts were reasonable from 2015 onwards.

For the purpose of the EIA Study, the forecast was extended from 2030 to 2038, using the same forecasting model (and equations).

This revised forecast has been used to feed the EIA and is referred to as the “Latest Unconstrained Forecast” in the rest of the document for ease of understanding.

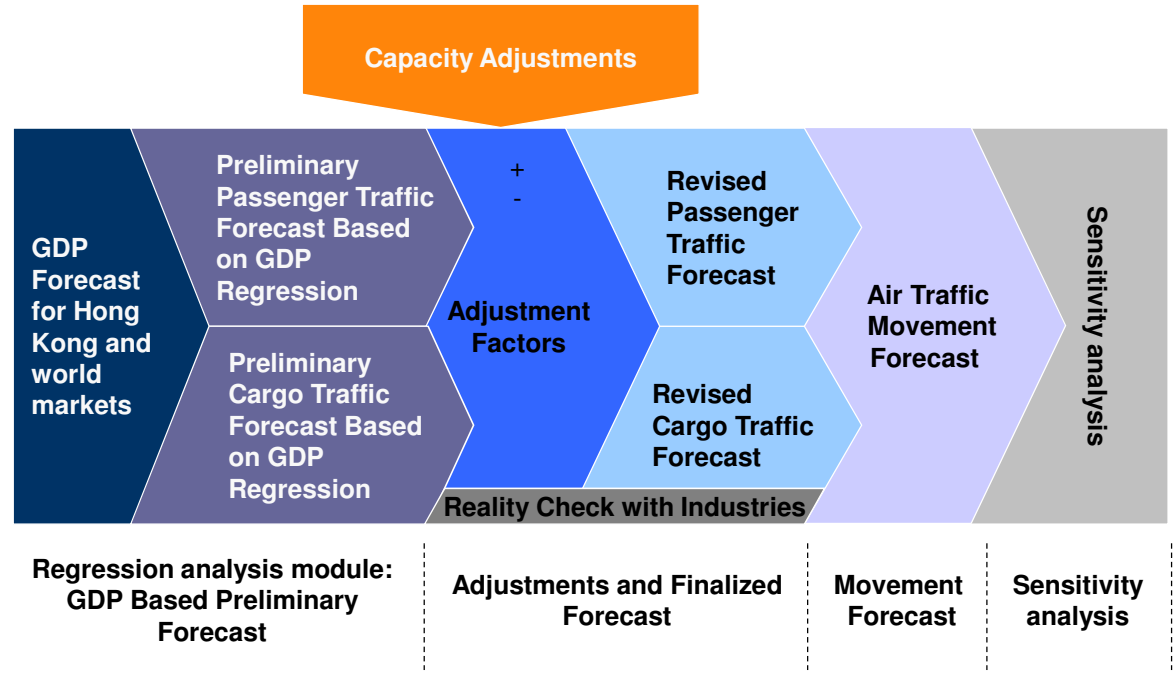
7. The EIA forecast was derived from the Latest Unconstrained Forecast

The main difference between the latest unconstrained and EIA forecasts relates to how the limited capacity of the runway is factored in.

As mentioned above and in-line with best practices, MP2030 was based on an unconstrained forecast. The EIA forecast is a constrained one. It includes the impact on traffic of the runway system saturation. Once the runway system gets saturated, airlines and cargo operators will adjust their fleet and their network strategy. Passenger and cargo traffic will keep growing but at a much slower pace than the unconstrained demand. Other potential infrastructure related constraints such as parking stands, passenger terminal or airspace are not taken into account as it was estimated that the runway is the most constraining factor.

In conclusion the EIA forecast is an "extension" of the MP2030 forecast sharing the same methodology with the capacity of the runway system as an additional adjustment factor.

MP2030 Forecasting Approach with the Capacity Adjustment Factor



8. Estimating and factoring in the capacity adjustments

International best practices recommend assessing (terminal and airside) airport capacity constraints and requirements on the basis of a typical busy day. The 9th edition of the Airport Development Reference Manual (ADRM) issued by IATA is used by most Civil Aviation Authorities, Airports and Airlines worldwide as industry standards to develop new airport infrastructures. Section F4.1 of the ADRM states that:

> *Determining airport capacity and requirements largely depends on predicting the impact of projected airline schedules on the various airport facilities. Requirements, capacity and level of service are based not only on operating conditions and rules, but also upon the particular demand profiles created by the mix of flights and flight sectors* ***for a typical busy day***[2]*.*
>
> *Typical peak period or peak hour demand should be used wherever possible for planning purposes, rather than annual figures.*

Following best practices, IATA has estimated the impact of the runway capacity constraints on HKIA busy day after developing a set of busy day schedules for each year of the period 2013 - 2038:

- Unconstrained busy day schedules reflecting the latest unconstrained forecast
- Constrained busy day schedules based on the unconstrained busy day schedules, the hourly and daily runway capacity constraints established by CAD and adjusted schedule parameters reflecting the constraints. Mainly three parameters have been adjusted to reflect the runway constraints:
  - The aircraft type: As runway gets congested, airlines will use larger aircraft subject to the availability of larger aircraft in their fleet for the destination flight range. For most airlines, aircraft type adjustments were made based on airline feedback collected during a survey.
  - The load factor: As seat capacity cannot grow unconstrained, load factor will tend to increase. Constrained load factor assumptions were made based on a series of analysis including a benchmarking against airports that underwent runway saturation episodes.
  - The flight time: Whenever possible flights above the runway hourly cap were rescheduled to another time.
- Finally conversion factors were estimated to project annual traffic from the constrained busy day schedules.

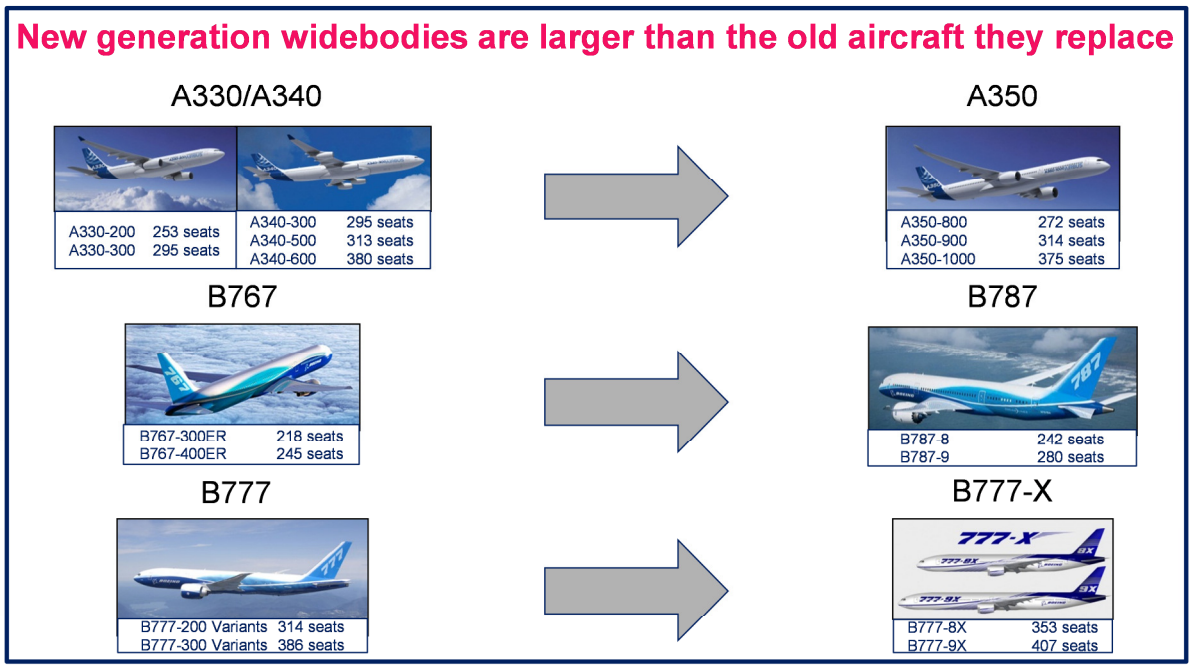
9. The approach used in the EIA (constrained) forecast is sophisticated and very robust

The approach considered in detail the trends observed during the busy days of the last five years (2008 to 2012).

The latest industry trends were taken into account such as for the future aircraft known to be introduced within the horizon of the EIA forecasts. New airplanes and engines planned to be introduced within the next 5-10 years would be larger and are also expected to be quieter and significantly more fuel efficient. Beyond 10 years and in light with the last decades it is likely that

[2] The busy day is defined as the second busiest day of an average week of the busiest month (in terms of total ATM).

newer aircraft will be rolled out leading to further savings on gas and noise emissions on a per passenger basis. These potential upsides were not factored in the forecast.



Source: Boeing, Airbus **Capacity base on 3-class manufacturer configuration*

The approach is based on the best information available including the outcome of a wide survey seeking detailed inputs from 40 airlines representing 80% of the ATMs on the 2011 HKIA busy day.

Airline inputs addressed all the essential information required to forecast the future busy day schedules:

- Airline unconstrained growth plans at HKIA

- Future average aircraft size
- Aircraft introduction and phasing out
- Future destinations
- Future schedule in particular for additional services
- Typical turnaround times
- Airline constrained growth plans at HKIA including adjustments on average aircraft size, fleet mix, network and schedule when the two-runway system reaches its maximum capacity
- Airline constrained growth plans at HKIA when the planned three-runway system reaches its maximum capacity
- Current and future use of chapter 3 aircraft (i.e. in relation to the gradual phase-out of chapter 3 aircraft)

The approach factors in the results of a benchmarking on 13 airport cases[3] that underwent an episode of runway congestion before extending their capacity by opening an additional runway or relocating to another site. In conjunction with the above, IATA carried out an analysis on the fleet of the home carriers based at these airports. The specific objectives of the benchmarking were to assess the extent to which congestion had an impact on traffic, loads and fleet and to assess the extent to which the capacity extension had an impact on the same.

The above allowed IATA to formulate reasonable assumptions and inputs to the annual forecasts and future busy day schedules: ATM year-on-year growth, passenger year-on-year growth, aircraft size, fleet mix, load factors, flight hours and destinations.

With regard to the gradual phase-out of chapter 3 aircraft by airlines, IATA's analysis supported by the survey and discussions with selected airlines led to the observation that the trend would be similar to that expected in MP2030 when AAHK's consultation with the airline industry representatives in the User Working Group on Airport Infrastructure and Planning Development indicated that their existing Chapter 3 aircraft fleet would be mostly phased out in twenty years' time[4].

10. Comparison of the EIA (constrained) forecast with the original (unconstrained) MP2030 forecast

Following the 2009 and 2012 momentum, HKIA traffic is anticipated to exceed the original MP2030 forecast for most of the period 2013-2022. The two-runway system is expected to reach capacity in 2018 at the latest. Consequently the number of air traffic movements will remain stable until the third runway opens in 2023 and the growth of passenger and cargo traffic will be constrained. Airlines will operate larger aircraft or with higher load factors whenever possible. As a result the 2022 EIA forecasts for passengers and cargo are expected to fall slightly behind the original MP2030 forecasts.

2023-2031: Traffic ramp-up with the new runway in place. Traffic will catch up in 2023 and the following years after opening the third runway. Airlines will deploy new aircraft to compensate for the

[3] The studied airport cases included: Stockholm-Arlanda (2003), Frankfurt (2011), Tokyo-Haneda (2010), Madrid (2006), Tokyo-Narita (2002 and 2009), Beijing (2007), Shanghai-Pudong (2005 and 2008), Sydney (1994), Munich (1992), Hong Kong (1997), Bangkok (2006)

[4] Appendix A of the Final Noise Contour Report – Noise Contour Analysis for Third Runway Alternatives refers (URS, 2010)

2032-2038: three-runway system at capacity (620,000 ATM per year and 1,800 ATM per day) resulting in a constrained growth of passenger and cargo traffic. The three-runway system will reach its full saturation in 2032 when the annual and daily limits are reached. As the number of ATM remains stable, airlines will operate larger aircraft whenever possible. Load factors will also increase where possible. As a result the number of passengers and the cargo payload per ATM will also increase.