



工 作 文 件

第十一届统计专业会议

2022 年 4 月 4 日至 8 日，虚拟会议

议程项目 3：长期航空业务量预测

国际民航组织长期业务量预测和 COVID-19 后情景

(由秘书处提交)

执行摘要

本工作文件报告了根据大会第 A40-9 号决议所开展的预测和规划活动。该决议要求理事会对一套长期业务量预测 (LTF) 予以更新，以便用于编制量身定制的和/或更为详细的预测。对以 2018 年为基线的长期业务量预测进行了更新，并通过长期业务量预测多学科工作组 (MDWG-LTF) 拟定了 COVID-19 后预测情景。在 2021 年 6 月举行的第三次会议上，航空数据和分析专家组 (ADAP) 批准了最新预测及由长期业务量预测多学科工作组拟定的 COVID-19 后预测情景。本工作文件进一步讨论了通过将国际民航组织统计方案下报告的数据与广播式自动相关监视 (ADS-B) 和市场情报数据传输 (MIDT) 等大数据来源相结合来提高预测更新频率的必要性和方法。

专业会议的行动见第 4 段。

参考文件:	Doc 10140 号文件：《大会有效决议》(截至 2019 年 10 月) A40-WP/19-EC/4 号文件：国际民航组织统计方案和大数据分析 A40-WP/20-EC/5 号文件：关于最新长期业务量预测的报告 《航空数据和分析专家组第三次会议的报告》(ADAP/3, 黄色封页)
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1. 引言

1.1 自 2016 年编制国际民航组织第一套长期业务量预测 (LTF) 以来，秘书处根据大会第 A40-9 号决议，通过与航空数据和分析专家组 (ADAP) 下设的长期业务量预测多学科工作组 (MDWG-LTF) 合作，一直在对预测进行定期更新。

1.2 提交给大会第 40 届会议的长期业务量预测使用 2015 年作为基线 (参见 A40-WP/20-EC/5 号文件)。作为针对第 A40-9 号决议开展的一项后续工作，同时为了对航空环境保护委员会 (CAEP) 的要求做出响应，2020 年年初对长期业务量预测进行了更新，使用 2018 年作为基线，并将预测期延长至

2050年(以下简称 COVID-19 前长期业务量预测)。由于 COVID-19 大流行病的重大影响,2021年年初做了进一步更新,以虑及大流行病年份内估计会出现的业务量下降和恢复路径,及其对长期预测的影响(以下简称 COVID-19 后长期业务量预测)。最新预测在2021年6月举行的航空数据和分析专家组第三次会议上获得批准。

## 2. 根据 COVID-19 后情景更新长期业务量预测

2.1 COVID-19 前客运和货运长期业务量预测模型的详细说明见附录 A。利用预测模型中的估计系数和经济合作与发展组织国际运输论坛(ITF-OECD)提供的经济前景数据,计算了2019年至2050年每个航线组的年收入客公里(RPKs)和每个地区的年货运吨公里(FTKs)。

2.2 根据这一 COVID-19 前的估计,对于此项32年期预测,预计2018年至2050年全球客运业务量和全球货运业务量的年增长率将分别为4.2%和3.5%。

2.3 由于 COVID-19 大流行病的影响,现在可以肯定的是,此次危机前编制的这些业务量预测将不再作为参考。鉴于围绕着恢复的不确定性很大,秘书处与长期业务量预测多学科工作组和航空环境保护委员会各成员合作,按航线组编制了2018年至2050年 COVID-19 后情景下的预测。这三种情景为中等、高等、低等情景,其结构如附录 B 中所示。

2.4 对客运长期业务量预测予以更新,以便同时考虑到 COVID-19 大流行病的短期影响和长期内的最终恢复,这要求将最新宏观经济数据和所估测的航空业需求所受到的冲击(以收入客公里的变化来衡量)纳入进来。我们采取了如下措施,将最新信息纳入进来,以编制 COVID-19 后情景下的预测:

- 1) **纳入最新宏观经济数据。**COVID-19 大流行病前和 COVID-19 大流行病后国家一级的经济数据预测由 IHS Markit 提供,可用于度量与 COVID-19 大流行病有关的实际国内生产总值(GDP)和人口的变化<sup>1</sup>。将这些值汇总至航线组业务量预测中,并计算出2050年之前每个年度 COVID-19 大流行病前和 COVID-19 大流行病后经济前景之间的增长率差异。按预测情景,即中等、高等和低等经济前景,将这一百分比差值适用于经济合作与发展组织国际运输论坛的 COVID-19 前经济数据。然后,在保持模型系数值不变的情况下,使用最新经济数据重新处理旅客长期业务量预测。
- 2) **COVID-19 收入客公里调整因子。**在量化 COVID-19 带来的经济衰退对航空业务量和潜在恢复路径的近期影响时,对基于地区的收入客公里预测进行了调整,以便与国际航空运输协会(IATA)关于业务量将在2024年恢复到2019年水平(中等情景)的假设一致。使用最新经济数据对客运长期业务量预测进行再次处理,并适用这些调整因子,在完成估计之后指导进行 COVID-19 大流行病影响期间各种情景(中等/高等/低等)下的收入客公里预测。使用最新经济数据确定的预测增长率能够在界定的 COVID-19 大流行病影响期之后恢复,具体取决于情景。

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<sup>1</sup> COVID-19前长期业务量预测(以2018年为基线)使用经济合作与发展组织国际运输论坛的经济数据来估计,但不能获取经济合作与发展组织国际运输论坛的最新宏观经济数据来编制COVID-19后预测。

2.5 使用以 2018 年为基线的国际民航组织长期业务量预测模型，按照与客运量预测类似的方式对货运长期业务量预测进行重新估计，同时考虑到最新经济预测、2020 年经济衰退的程度，以及根据长期业务量预测多学科工作组和国际航空运输协会提供的信息所获知的近期恢复情况。

2.6 各种情景下的旅客预测结果列于附录 C。第一个表格对以 2018 年为基线的 COVID-19 大流行病前客运长期业务量预测与三种 COVID-19 后情景下的复合年增长率(CAGRs)进行了比较。第二个表格按航线组对三种情景的 32 年复合年增长率进行了比较。在中等情景下，全球 32 年复合年增长率为 3.6%，而 COVID-19 前长期业务量预测所对应的为 4.2%。此种降低意味着 2020—2050 年期间全球经济损失约达 40 万亿美元，座位数量减少约达 100 万亿(以可用座位公里计算)。

2.7 各种情景下的货运预测结果列于附录 D。第一个表格对以 2018 年为基线的货运长期业务量预测和三种 COVID-19 情景下的复合年增长率进行了比较。第二个表格按地区对三种情景的 32 年复合年增长率进行了比较。在中等情景下，全球 32 年复合年增长率为 3.5%，与 COVID-19 前长期业务量预测水平相似。

### 3. 预测工作的现代化

3.1 最新的业务量预测对于有效交付国际民航组织所有战略目标的成果至关重要，包括但不限于：对噪声、排放和微粒物质的未来趋势进行估计；在制定航空基础设施方案和计划以及航空系统组块升级(ASBU)时进行商业案例研究、成本效益分析、经济影响分析和成本有效性分析；建立与全球航空安全计划(GASP)、全球空中航行计划(GANP)、全球航空安保计划(GASeP)和适当监督体系相一致的评估和监测框架。

3.2 鉴于在恢复阶段市场条件不断变化，业务量波动很大，成员国和航空利害攸关方必须能够获得最新预测，以满足其大流行病后的规划和实施需求。提高长期业务量预测的更新频次，将使成员国和利害攸关方能够更好地使运力与预期需求保持一致，从而减少不确定性所带来的风险。同时，在生成未来的预测时须缩小基准年的差距，例如，在 2022 年生成一组新的预测时，可将 2020 年作为基线。

3.3 为了满足所有这些需求，国际民航组织将利用其统计方案中的官方报告业务量数据及利用大数据来源(即广播式自动相关监视(ADS-B)和市场情报数据传输(MIDT))对业务量预测进行更新(见 STA/11-WP/3 号文件)。这些数据将与从外部来源获得的宏观经济数据(如国内生产总值、油价和人口)结合在一起使用。将这些不同的数据库与长期业务量预测的计量经济学模型进行整合，将可构成对预测进行季度更新的依据，这反过来会显著缩短当前年度与预测起始年之间的滞后。

3.4 计划于 2022 年 6 月对业务量预测进行第一次更新，届时基线将从 2018 年移至 2021 年。将不断使用各国的报告数据来替换非官方来源(MIDT 和 ADS-B)的数据，并按季度更新业务量预测。每年 6 月，基线将提前一年，并将重复一个循环，即使用报告数据替换非官方数据以及对业务量预测进行季度更新。附录 E 说明了对不同数据源进行整合、用官方数据进行替换和进行季度更新的过程。

3.5 将通过国际民航组织民用航空数据解决方案(iCADS)平台 <https://data.icao.int/icads>，向成员国提供最新预测以及所有运行和业务量参数，即机场、城市、国家乃至航线组一级的航班、座位、乘客和货运吨数。

#### 4. 专业会议的行动

##### 4.1 请专业会议：

- a) 注意航空数据和分析专家组在编制长期业务量预测方面的工作；
  - b) 支持更频繁地更新长期业务量预测，并通过对官方报告数据和大数据来源进行整合来缩短基线年与当前年度之间的滞后；和
  - c) 鼓励成员国通过国际民航组织民用航空数据解决方案平台获取持续更新的业务量预测，以满足其大流行后的规划和实施需要。
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## APPENDIX A

### DATA AND MODEL SPECIFICATION FOR LTF

#### Passenger Forecasts

Demand for passenger air travel is measured by Revenue Passenger-Kilometres (RPKs). The historical time-series data set of RPKs by city-pair and carrier was extended from 1995–2015 to 1995–2018 for both international and domestic operations.

The compilation of the data sets includes following sources:

- a) actual traffic data reported by States to ICAO through the Air Transport Reporting Forms A, B and C, the coverage of which was over 90 per cent of passenger traffic and 95 per cent of freight traffic;
- b) actual origin and destination passenger traffic data collected through the Market Intelligence Data Transfer (MIDT) big data (STA/11-WP/3 refers); and
- c) estimated traffic data based on the airline schedules published in the Official Airline Guide (OAG) and Automatic Dependent Surveillance—Broadcast (ADS-B) big data (STA/11-WP/3 refers), which were used to fill the gaps.

Similar to the previous LTF, passenger traffic data were segmented into 40 international and 10 domestic route groups. The 50 route groups were also assigned to six different “tiers” according to the income level and market maturity in the same manner as previous forecasts. The income thresholds to segregate the tiers were updated from the most recent World Bank data of low, lower-middle, upper-middle and high-income economies.

After reviewing the original econometric model with a series of diagnostic tests, it was decided to use the same model which captures the main economic and demographic drivers of air traffic demand and best fits the input data. The model examines how passenger demand (passenger traffic in RPKs) is affected by real Gross Domestic Product (GDP) per capita and cost of travel (airfares), and predicts annual change in RPKs for each route group. The passenger forecasts model is as the following:

$$\Delta \log \widehat{RPK\_PC}_{rt} = \sum_{i=1, j=1}^6 \beta_i (T_j * \Delta \log GDP\_PC_{rt}) + \beta_{oil} \Delta \log_{rt} Oil_{rt} Year\ Indicators$$

i: Tier Coefficient Index, j: Tier Index, t: Time, r: Route Group

Economic and demographic data were sourced from the International Transport Forum at the Organization for Economic Co-operation and Development (ITF-OECD). This includes real GDP per capita in 2011 constant USD, which varies from the data in 2005 constant USD used for the previous

forecasts. As there is no coherent methodology to obtain specific airfare costs, oil prices were used as a proxy for cost of travel, consistent with recent literature on this topic.

### **Freight Forecasts**

Demand for freight is measured by Freight Tonne-Kilometres (FTKs). The historical time-series data set of FTKs at the regional level were extended from 1995–2015 to 1995–2018 for both international and domestic operations. The data sets were compiled from the similar sources as for the passenger forecasts with the exception of MIDT data.

Economic data was taken from the same source as the passenger traffic forecasts and aggregated by region to preserve the relatively large heterogeneity amongst the different regions in terms of the relationship between FTKs and real GDP. Forecasting model remains similar to previous freight forecasts. The freight forecasts model is as the following:

$$\log FTK_{Rt} = \widehat{\alpha} + \beta \log GDP_{Rt}$$

t: Time, R: Region

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APPENDIX B

POST-COVID-19 FORECAST SCENARIO ASSUMPTIONS

Passenger LTF Assumptions

Commercial Passenger Market							
Scenario/Assumption	Vaccine	Global Economic Activity	Regional Variation	Route Variation -- Domestic/International	Business Travel Demand	Return to 2019 RPKs	Return to pre-crisis Trend (levels)
<b>High</b>	Announced early 2021 Available/wide spread use mid/late 2021	V-shaped recovery -- back to 2019 levels in early 2021	--Solid and sustained global recovery --Asia (China) pick-up quickly in 2021 --Recovery in traffic tracks economic growth (NA/EUR follow Asia)	--Domestic traffic responds quickly particularly in U.S./Europe/Asia (China) --International lags somewhat (2022) --solid income growth drives leisure travel	-- Business Travel growth resumes late 2021 --Returns to normal levels in 2022 -- Drives solid recovery in both markets (B2B and conferences)	2023	Yes -- around 2030
<b>Mid</b>	Announced mid-2021 Available/wide spread use early/mid 2022	Return to 2019 levels in late 2021/2022 (running behind the optimistic outlook)	-- Recovery lags economic growth (some behavioral changes/lower incomes) -- Resumption in domestic traffic first -- International lags --China/Asia leads the recovery, followed by NA and EUR	--Domestic traffic growth resumes in 2022 U.S./Europe/Asia (China) --International lags (2023) -- Lower incomes reduce leisure travel	--Business Travel growth resumes in late 2022/2023, but never fully returns to normal levels (i.e., some permanent reduction due to substitutes -- Zoom, etc.)	2024	No -- permanent shift due to substitution of online technologies for business and changes in household vacation/travel patterns

Commercial Passenger Market							
Scenario/Assumption	Vaccine	Global Economic Activity	Regional Variation	Route Variation -- Domestic/International	Business Travel Demand	Return to 2019 RPKs	Return to pre-crisis Trend (levels)
<b>Low</b>	Announced early 2022 Available/wide spread use late 2022/early 2023	Return to 2019 levels by 2023/2024	--Recovery lags economic growth -- resumption in domestic traffic slow to gain traction --International lags further behind --China/Asia and developing nations lead recovery. NA and EUR lag.	--Domestic traffic resumes growth in 2024 Asia (China) --International lags (2025) -- Lower incomes reduce leisure travel	--Business travel does not fully recover --Permanent and sustained loss in domestic/international travel as a result.	2027	No -- permanent shift due to substitution of online technologies for business and changes in household vacation/travel patterns

### Freighter LTF Assumptions

Freighter Market					
Scenario/Assumption	Vaccine	Economic Activity	Regional Variation	Return to 2019 RTKs	Return to pre-crisis Trend (levels)
<b>High</b>	Announced early 2021 Available/wide spread use mid/late 2021	V-shaped recovery -- back to 2019 levels in early 2021	Regional variation will depend upon differences in regional economic activity -- Pacific/Asia & Asia/Middle East will lead, followed by North America/Europe	2021	Yes
<b>Mid</b>	Announced mid-2021 Available/wide spread use early/mid 2022	Return to 2019 levels in late 2021/2022 (running behind the optimistic outlook)	Regional variation will depend upon differences in regional economic activity -- Pacific/Asia & Asia/Middle East will lead, followed by North America/Europe	2022	Yes
<b>Low</b>	Announced early 2022 Available/wide spread use late 2022/early 2023	Return to 2019 levels by 2023/2024	Regional variation will depend upon differences in regional economic activity -- Pacific/Asia & Asia/Middle East will lead, followed by North America/Europe	2023	Dependent upon economic forecast



## APPENDIX C

### POST-COVID-19 PASSENGER LTF

#### Global CAGR RPK Comparison

	10 Year (2018-2028)	20 Year (2018-2038)	30 Year (2018-2048)	32 Year (2018-2050)
<b>COVID-19 : Low</b>	1.2%	2.4%	2.8%	2.9%
<b>COVID-19 : Mid</b>	2.6%	3.3%	3.5%	3.6%
<b>COVID-19 : High</b>	3.6%	4.1%	4.2%	4.2%
<b>2018 LTF</b>	4.2%	4.2%	4.2%	4.2%

#### 32-Year CAGR RPK Comparison by Route Group

Route Group	2018 LTF	COVID-19: High	COVID-19: Mid	COVID-19: Low
<b>Africa</b>	5.3%	5.0%	4.5%	4.0%
<b>Africa - Asia/Pacific</b>	5.1%	4.9%	4.3%	3.5%
<b>Africa - Middle East</b>	5.6%	5.2%	4.6%	3.8%
<b>Africa - North America</b>	2.7%	3.1%	2.5%	1.7%
<b>Africa &amp; Middle East - Central America/Caribbean</b>	5.5%	4.8%	4.3%	3.6%
<b>Africa &amp; Middle East - South America</b>	5.0%	4.7%	4.1%	3.3%
<b>Central America/Caribbean</b>	4.1%	3.9%	3.2%	2.8%
<b>Central America/Caribbean – Europe</b>	3.7%	3.8%	3.2%	2.6%
<b>Central America/Caribbean - North America</b>	3.3%	3.7%	3.0%	2.1%
<b>Central America/Caribbean - South America</b>	4.2%	3.9%	3.3%	2.6%
<b>China – Europe</b>	4.2%	4.0%	3.4%	2.7%
<b>China - Middle East</b>	4.7%	4.5%	3.8%	3.0%
<b>China - North America</b>	4.3%	4.2%	3.5%	2.7%
<b>China &amp; South West Asia - North Asia</b>	6.7%	6.3%	5.5%	4.4%
<b>China &amp; South West Asia - Pacific South East Asia</b>	6.1%	5.9%	5.2%	4.4%
<b>China/Mongolia</b>	4.7%	5.0%	4.3%	3.4%
<b>Europe</b>	3.0%	3.1%	2.7%	2.3%
<b>Europe - Middle East</b>	3.3%	3.3%	2.7%	2.2%
<b>Europe - North Africa</b>	4.3%	4.4%	3.8%	3.1%
<b>Europe - North America</b>	2.9%	3.2%	2.6%	2.1%

<b>Europe - North Asia</b>	2.9%	3.0%	2.5%	2.2%
<b>Europe - Pacific South East Asia</b>	4.0%	4.1%	3.5%	2.8%
<b>Europe - South America</b>	3.3%	3.3%	2.7%	2.2%
<b>Europe - South West Asia</b>	5.0%	5.0%	4.4%	3.7%
<b>Europe - Sub Saharan Africa</b>	2.6%	2.8%	2.3%	1.9%
<b>Intra Africa</b>	5.3%	5.0%	4.5%	4.0%
<b>Intra Central America/Caribbean</b>	4.1%	3.9%	3.2%	2.8%
<b>Intra China &amp; South West Asia</b>	5.0%	4.8%	4.2%	3.4%
<b>Intra Europe</b>	3.0%	3.1%	2.7%	2.3%
<b>Intra Middle East</b>	4.0%	3.6%	3.0%	2.5%
<b>Intra North America</b>	2.7%	3.1%	2.5%	1.8%
<b>Intra North Asia</b>	2.5%	2.6%	2.2%	1.8%
<b>Intra Pacific South East Asia</b>	5.2%	4.9%	4.3%	3.6%
<b>Intra South America</b>	3.4%	3.2%	2.7%	2.2%
<b>Latin America/Caribbean – China</b>	4.7%	4.5%	3.9%	3.1%
<b>Latin America/Caribbean - North Asia &amp; Pacific South East Asia</b>	4.2%	3.9%	3.3%	2.7%
<b>Middle East</b>	4.0%	3.6%	3.0%	2.5%
<b>Middle East - North America</b>	3.0%	3.3%	2.6%	1.8%
<b>Middle East - North Asia &amp; Pacific South East Asia</b>	4.0%	3.8%	3.2%	2.5%
<b>Middle East - South West Asia</b>	8.7%	8.1%	7.3%	6.2%
<b>North America</b>	2.7%	3.1%	2.5%	1.8%
<b>North America - North Asia</b>	2.7%	3.0%	2.4%	1.8%
<b>North America - Pacific South East Asia</b>	3.9%	4.2%	3.5%	2.5%
<b>North America - South America</b>	3.1%	3.3%	2.6%	1.9%
<b>North America - South West Asia</b>	5.2%	5.3%	4.6%	3.5%
<b>North Asia</b>	2.5%	2.6%	2.2%	1.8%
<b>North Asia - Pacific South East Asia</b>	4.3%	4.2%	3.6%	2.9%
<b>Pacific South East Asia</b>	5.2%	4.9%	4.3%	3.6%
<b>South America</b>	3.4%	3.2%	2.7%	2.2%
<b>South West Asia</b>	6.8%	6.4%	5.8%	4.9%
<b>World</b>	4.2%	4.2%	3.6%	2.9%

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## APPENDIX D

### POST-COVID-19 FREIGHTER LTF

#### Global CAGR FTK Comparison

	10 Year (2018-2028)	20 Year (2018-2038)	30 Year (2018-2048)	32 Year (2018-2050)
<b>COVID-19 : Low</b>	2.3%	2.5%	2.6%	2.6%
<b>COVID-19 : Mid</b>	3.5%	3.4%	3.5%	3.5%
<b>COVID-19 : High</b>	4.1%	4.1%	4.2%	4.2%
<b>2018 LTF</b>	3.5%	3.5%	3.5%	3.5%

#### 32-Year CAGR FTK Comparison by region

Region	2018 LTF	COVID-19: High	COVID-19: Mid	COVID-19: Low
<b>Middle East</b>	6.1%	7.2%	6.0%	4.4%
<b>Asia and Pacific</b>	3.0%	3.5%	3.1%	2.6%
<b>Africa</b>	4.1%	4.6%	3.8%	3.0%
<b>North America</b>	3.2%	3.9%	3.2%	2.1%
<b>Europe</b>	1.9%	2.4%	1.9%	1.5%
<b>Latin America/Caribbean</b>	1.2%	1.5%	1.2%	0.8%
<b>World Total</b>	<b>3.5%</b>	<b>4.2%</b>	<b>3.5%</b>	<b>2.6%</b>

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APPENDIX E

QUARTERLY FORECAST UPDATES PROCESS

