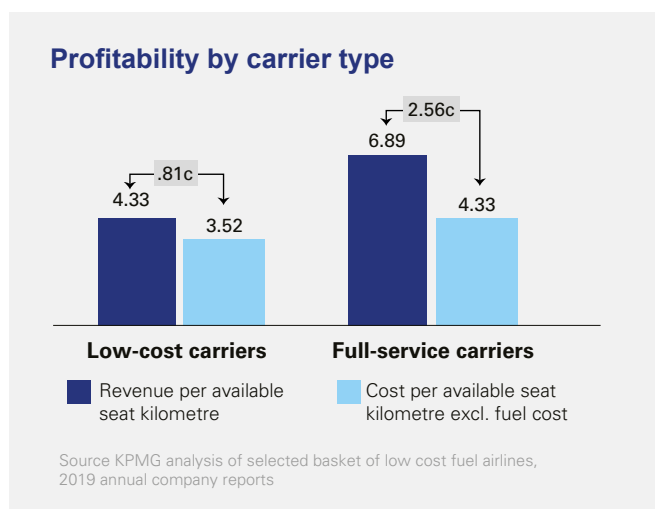**KPMG**

Aviation 2030
AI flight scheduling

Can low-cost-carriers squeeze more flights into their already packed schedules? Computer says yes.

Flight schedules are probably airlines' most critical factor towards commercial success and for decades flight scheduling analysts have been tasked with the critical but challenging role of making sure they are profitable

Arranging flight schedules is probably the most critical factor for determining if an airline thrives or flounders.

- Increasing aircraft utilization[1] is the number one strategic goal of all the low-cost carrier CEOs with which we have spoken.

- Why? The airline industry is highly capital intensive and operates on razor thin profit margins. This is especially true for low-cost carriers (LCCs), for which the margin per available seat kilometer is only around 0.8 Euro cents, compared to 2.6 Euro cents full-service carriers; approximately 70% less.

Profitability by carrier type

Low-cost carriers: Revenue per available seat kilometre 4.33, .81c, Cost per available seat kilometre excl. fuel cost 3.52

Full-service carriers: Revenue per available seat kilometre 6.89, 2.56c, Cost per available seat kilometre excl. fuel cost 4.33

	Revenue per available seat kilometre	Cost per available seat kilometre excl. fuel cost

Source KPMG analysis of selected basket of low cost fuel airlines, 2019 annual company reports

- Abrupt changes in the broader operating environment can quickly make such economics untenable.

- This reality came into stark relief during the COVID-19 pandemic of 2020 and 2021, during which 63 airlines failed or restructured, including LCCs such as Norway's Norwegian Air, the UK's Flybe and South Africa's Mango Airlines.[2]

Maximizing airplane utilization by increasing the number of sectors (a flight leg between two points) an aircraft can serve over a given period is achieved through optimizing the flight schedule.

Not only does maximizing aircraft utilization drive top-line uplift, but it also yields improvements in bottom-line performance.

- **Aircraft operating costs:** Boeing has calculated how airlines can reduce aircraft related operating costs by increasing airplane utilization. A 5% reduction in aircraft related operating costs is achievable by increasing aircraft utilization by 20% when the average flight distance is 500 miles (800 kilometers) or less, which is a typical flight length for low-cost regional and domestic carriers.[3]

- **Cabin crew costs:** Improving aircraft utilization can directly increase daily flight hours per crew member, and improvements in crew productivity can lead to significant improvements in operating costs. Prior to the pandemic, Lufthansa modelled a 0.20 Euro cents improvement on CASK for its Eurowings subsidiary between 2019-2022 by taking various steps to improve crew productivity, of which one lever was flight schedule optimization.[4]

Network planning and scheduling analysts play a critical role in taking care of the mind-boggling task of creating an optimized flight schedule, given the multitude of constraints they must consider

- Many low-cost carriers try to eliminate complexity from their operations by adopting tactics such as only using aircraft from a single manufacturer and using point-to-point networks rather than a hub-and-spoke model.

- However, when it comes to flight scheduling, complexity cannot be fully avoided: analysts need to consider the availability and usage terms of landing and departure slots, consider oscillating seasonal demand, review the probability of late departure at locations, check for the availability of flight crew, ensure the plane is at a certain location for set period for maintenance and inspection, and a myriad of additional variables.

- Flight scheduling planners have the unenviable job of being tasked with cutting through this complexity and building profitable flight schedules.

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1 Measure of aircraft productivity. Typically presented in block hours per day. A block-hour is the time from the moment the aircraft door closes at departure of a revenue flight until the moment the aircraft door opens at the arrival gate following its landing.

2 Dr. Stuart Hatcher, "IBA records 63 airlines failures and restructurings 2020-2021", IBA, January 20 2022

3 Mansoor Mirza, "Economic Impact of Airplane Turn-Times", Boeing Economic and Financial Analysis Group

4 Lufthansa, "Capital Markets Day 2019 – Slide 61", June 24 2019

The functionality of schedule planning software has not kept pace with the demands of modern, lean airlines

Since the 1970s, virtually all airlines' schedule planning functions have adopted computerized support to help analysts plan networks and set flight schedules

- Aviation has been one of the most technologically innovative industry sectors since the mid-twentieth century. From the early application of mainframes for ticketing, through to pioneering satellite communications, introducing the concept of dynamic pricing for revenue optimization, and running some of the earliest big data platforms and analytics for frequent flyer programs.

- Flight scheduling software was first introduced in the 1970s to help analysts with the job of creating flight schedules. This software receives data inputs from flight scheduling analysts and after (often lengthy) computation, helps suggest a schedule.

- Such tools have played a role in helping the global aviation industry to function at the scale it has achieved; it reached just under 40 million flights per year in 2019.

However, present flight scheduling software solutions are creaking under the pressure of the contemporary operating environment

- The growing scale and complexity of the variables and data-points relevant to optimization of a flight schedule is leaving many in the industry to question the capabilities of the existing computational tools employed to build schedules.

- Scheduling teams complain that existing flight scheduling applications – which are meant to alleviate this pain – have also become complex, bloated, unwieldy and slow. For example, a frequent complaint is that the UI/UX of these applications is typically characterized by clutter and a furious array of options and toggles.

- This isn't helped by the fact that competition in the space is not so intense as only a few vendors serve the market and there is perhaps a lack of incentive for vendors to radically innovate.

Consequently, many scheduling teams revert to filling out tabular data in standard business productivity software like Microsoft Excel and Google Sheets to create and/or adjust schedules.

Do planners at your airline ever use standard office productivity software at any point during the flight schedule planning process? e.g. Microsoft Excel, Google Sheets, LibreOffice Calc, etc.[5]

40%

60%

■ Always
■ Often
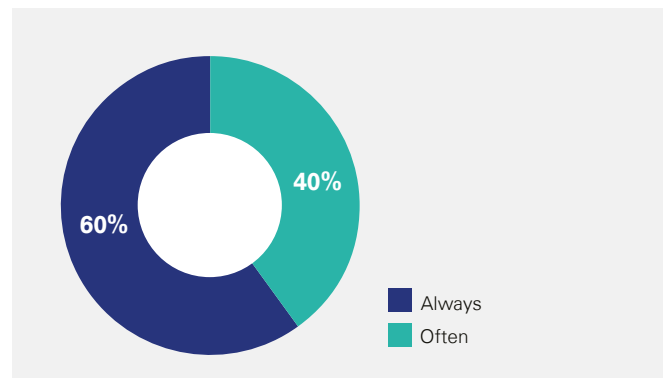
There are three shortcomings of this way of working:

01. Analysts spend too much time creating the flight schedule

02. Errors and biases can be introduced into the flight schedule

03. Analysts are left with insufficient time to test alternative scenarios

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01. Analysts spend too much time creating the flight schedule

- In terms of basic operational readiness, many airlines will spend months or weeks tweaking a draft schedule before finalizing, due to the manual and cumbersome nature of the software packages they use.

  "Simply by using the standard industry solutions, building a schedule for 300 to 400 aircraft could take us two to three months of manual work: moving flights around, trying to get the right times – that's a lot of time wasted."

  Network Optimization and Planning Manager, low-cost carrier

02. Errors and biases can be introduced into the flight schedule

- Until recently, building clean sheet scheduling (bottom-up creation of new schedules rather than relying on input from previous seasons) simply wasn't possible due to technical limitations of the software packages.

- This still means, for many carriers, that flight schedules are rolled over from one season to the next with little variation.

- An unfortunate side-effect of this approach is that flawed schedules can easily become deeply embedded in airlines' operations

- Because of human intervention and overwrites, flight schedules become error laden (Raymond Panko, a University of Hawaii professor, discovered that, in general, 88% of Microsoft Excel spreadsheets have 1% or more errors in their formulas)[6] and unduly influenced by schedule planning teams' unconscious biases.

"Data analysis is absolutely key to plan a network and a schedule; but everyone is using the same tools, data and processes, and therefore coming to the same conclusions. This means that presently the difference is made by human intuition, which is fallible."

Senior Vice President, JetBlue

- Consequently, it is not unusual for schedule analysts to lack confidence in the schedules they prepare.

03. Analysts are left with insufficient time to test alternative scenarios

- In terms of more proactive operational readiness, the available tools and ways of working are too cumbersome for airlines to prepare for various operating scenarios by running alternative schedule simulations in advance.

- This means that carriers are less able to react with agility to sudden demand and operating environment shocks – e.g., the recent COVID-19 upheaval suffered by the industry

  "Instead of tinkering with a master version of the flight schedule for weeks or months, we feel we could get more benefit if we could do more scenario planning to really fine tune getting the right flights to the right routes, or, for example, to identify the best hubs at which to base our aircraft."

  Network Optimization and Planning Manager, low-cost carrier

  "Network and route planners have told me that the COVID-19 period was the most exhilarating period of their careers - but by the same token, they had been working from six in the morning until midnight manually reconfiguring umpteen different versions of the flight plans - which is a recipe for stress, burnout, and mistakes."

  John Strickland, veteran independent aviation industry analyst

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6 Raymond R. Panko, "What we know about spreadsheet errors," Journal of End User Computing, Vol. 10, No. 2, Spring 1998

Can airlines maximize value creation in their schedules with better technology?

- Airline analysts are doing the best job possible with the tools at their disposal; it's just the tools at their disposal were not built for the demands of modern airlines; particularly the lean, ultra-efficient, route rich LCC model.

  "The job has gotten a lot more complicated and the skies above Europe have gotten so congested that, when it comes to creating and fine-tuning our schedules, we can't keep going the way we used to. The old systems and ways of working don't suit our needs anymore."

  Network Optimization and Planning Manager, European low-cost carrier

- We therefore ask, can technology offer a better solution?

Airlines can maximize aircraft utilization by using artificial intelligence (AI) and machine learning (ML) powered tools to automate and optimize their schedules

Airlines should adopt AI and ML to achieve schedule optimization

- So, we've established that the scheduling products on the market today lack ease-of-use, automation, and optimization. They are largely manual and cumbersome to work with. Conversely, airlines and schedulers are required to be more agile (the old days of spending weeks or months developing a suboptimal schedule are over), they need to work through more complex operating permutations, and they need to remove human biases and intuition from the equation.

- The best way to achieve this is by truly embracing emerging technology in the advanced fields of artificial intelligence such as machine learning, deep learning, and neutral networks.

  "Using data from different sources is key but it can only be truly actioned through advanced analytics that move beyond simple code and into techniques such as advanced algorithms, deep learning and complex neural networks."

  Director, Digital Business, European low cost carrier

  "Many existing schedule optimizers claim they use artificial intelligence, but they just use standard computer algorithms that really have nothing to do with AI – but I do believe that we are on the precipice of the true application of AI in scheduling and that it will bring about radical improvements"
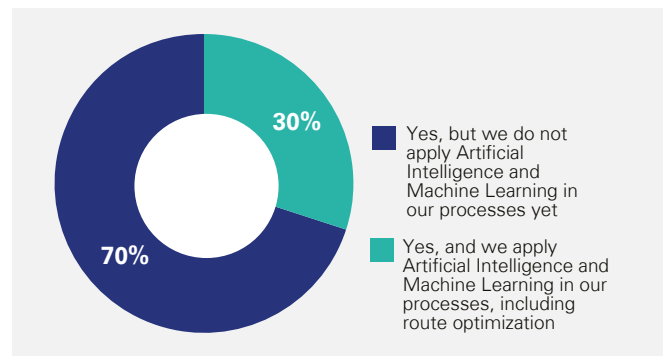
  Senior Vice President, Qatar Airways

- Artificial intelligence is not new in aviation – it's not even new in airline operations. For example, the industry already uses AI to estimate potential demand for a route that is not currently served by crunching huge volumes of search and social media data.

- However, advances in artificial intelligence are only now beginning to be applied in flight scheduling, and the significance of this development is only beginning to be understood within the industry.

Do you have a good understanding of the benefits of applying AI (artificial intelligence) and ML (machine learning) in schedule optimization?

- **30%** — Yes, but we do not apply Artificial Intelligence and Machine Learning in our processes yet
- **70%** — Yes, and we apply Artificial Intelligence and Machine Learning in our processes, including route optimization

Adoption of AI and ML by airlines would result in:

01. Revenue increase, by achieving additional flight sectors;

02. CASK decrease, by improving operational efficiencies such as crew scheduling;

03. Airlines being able to free-up scheduling analysts to do more cerebral scenario planning and wargaming leading to increased confidence in the quality and agility of network design.

- Of course, AI flight scheduling will offer most potential upside to low-cost carriers. Full-service carriers operate under a different set of operating parameters and demand drivers. They may need to respect banked slots to ensure connections for long haul travelers or ensure certain departure and arrival windows to respect the working hours of business travelers.

- Nevertheless, AI in flight scheduling should not be dismissed by full-service carriers. It may still unlock incremental improvements in their flight schedules. And it can jumpstart conversations in these carriers around other operational functions and activities where AI could be applied.

  "For low-cost carriers taking opportunistic approaches to network planning each year, AI will undoubtedly have a significant impact. For full-service carriers, there will be benefit of course, because computers will always be able to find ideas that humans can't conceive. But the benefit may be more marginal due to embedded operating constraints and historical norms."

  Senior Vice President, Qatar Airways

Case Study: Ryanair uses Optifly's Optimization Algorithms to optimize their schedule

Context: At the beginning of the pandemic, Ryanair sought new approaches to help it achieve its aggressive growth targets of carrying 225m passengers by 2026.

Challenge: A crucial part of this ambitious goal was to use technology to maximize the productivity of its fleet. However, the typical scheduling processes had been taking the company many months to settle, even with the help of (non-AI) software. With 500 aircraft, 90 bases, 225 airports, 36 countries and up to 3,000 daily flights, incorporating many operational constraints and commercial objectives, building a commercial and consumer-appropriate schedule had become a near-impossible task.

Solution: Ryanair selected to partner with Optifly, a next-generation AI driven software, in order to increase the number of sectors that their aircraft fly each day.

Optifly offers a cloud-hosted web-application that works in conjunction with Ryanair's existing scheduling software. Users can create clean-sheet schedules, whilst having the ability to turn up and down dials on numerous different constraints to help build both a highly utilized schedule which is operationally reliable and maintenance compliant.

Ryanair initially rolled out the software across its Italian network of 90 aircraft (18% of their network) for summer 2022.

The current approach of building schedules twice a year is dead. We're going to move to a much more optimized, agile, AI-driven model that allows airlines to rapidly respond to developing trends in consumer demand and build schedules and route networks that address that demand as quickly as possible. The two key benefits that Optifly provides its airline partners are agility, so the speed, control and flexibility with which to try different scenarios and build schedules very quickly. And the second one is the productivity increase that allows an airline to get more out of its fixed assets, ensuring its aircraft operate more flights every day.

Michael Healy, Director of Network Optimization, Ryanair

Results: Owing to Optifly's ability to build schedules at speed, Ryanair's planning team has been able to run multiple scenarios throughout each working day and ensure that each schedule is meeting its operational and commercial objectives. Ultimately, the team managed to increase seat capacity by 38% for summer 2022 vs summer 2019. This is 3x the seat capacity increase achieved by the airline for the season across the broader network.

Ryanair seat capacity improvement, Summer 2022 vs Summer 2019. Source: SRS Analyzer, Cirium
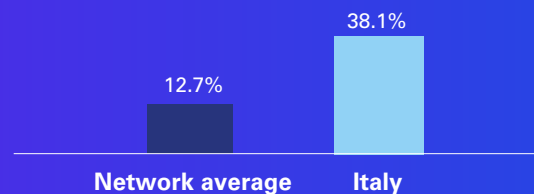
On the back of this successful outcome, Optifly has now been rolled out across Ryanair's entire European fleet for its winter 2022 schedule.

With the track record that Optifly has of successfully building scheduling algorithms across other industries, with the improvements and increase in sectors that we've seen across our Italian bases for our Summer '22 Season and the continued performance improvements we've seen throughout our Winter '22 schedule, we're extremely positive and excited about the potential of this product running across our whole network.

**Ryan Dooney**, Senior Manager Longterm Planning, Ryanair

Although the overall value created by the pilot has not been revealed by the partners, Optifly, which also works with Eurowings (Lufthansa Group's low-cost carrier), reports that it generally achieves a 5-8% increase in utilization gains across the airlines with which it works.

What next? Airlines must dismantle barriers to adopting solutions and start planning for future applications.

Simple but sophisticated solutions exist; carriers must overcome resistance to change that prevents them from finding and implementing these solutions
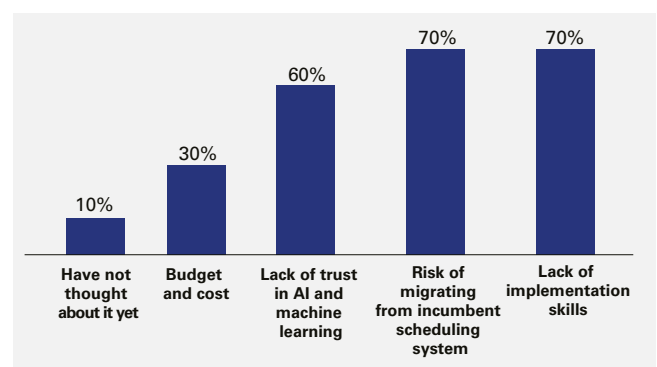
■ Our research shows a strong willingness from airlines to adopt best-in-class flight scheduling solutions; this is a significant or top priority for 80% of LCCs we surveyed.

In terms of technology innovation at your carrier, investment in the best available flight scheduling software is:

- 10%
- 10%
- 10%
- 70%

■ A significant priority
■ Not a priority
■ Somewhat of a priority
■ The top priority
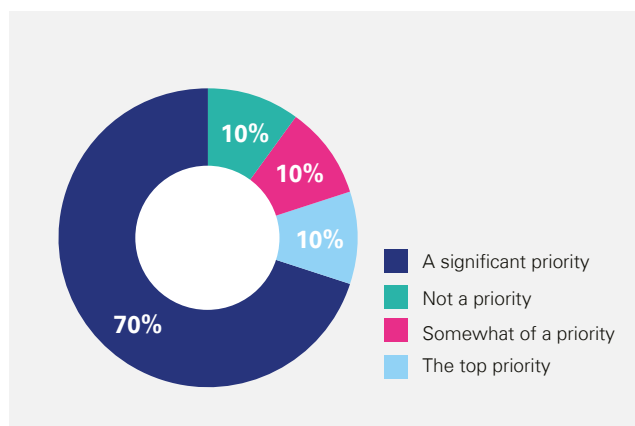
■ So, what's holding them back? Our survey showed that some of the main concerns center around implementation risks, such as the perceived risk involved with migrating from an incumbent scheduling system.

What are / have been the primary concerns raised in your airline regarding the adoption of artificial intelligence and machine learning for flight schedule optimization?

10%	30%	60%	70%	70%
Have not thought about it yet	Budget and cost	Lack of trust in AI and machine learning	Risk of migrating from incumbent scheduling system	Lack of implementation skills

- Yet such concerns may be misplaced. The Optifly solution which features in the case study, for example, is a stand-alone, cloud-based application which does not require integration with any internal system; everything is managed from the industry standard IATA SSIM (Standard Schedules Information) file.

- However, concerns of this nature are understandable. While the Aviation industry has pioneered some marvelous technology over the years, as a regulated industry, there's a certain innate hesitancy around adoption of emerging technologies. Rushing and being experimental can have catastrophic implications and bring down the wrath of regulators. Paradoxically however, there is also a massive driver for players to embrace innovation given the hypercompetitive nature of the sector. Successful implementation of new solutions by respected carriers can act as a bell-weather for others to fall in line.

- According to one industry veteran "We're very much a me-too industry; we copy each other left and right. So, if one carrier has great success with something, then other carriers will adopt it."

- Changing demographics within the industry are also a signal that airlines might be shifting their risk tolerance regarding AI driven decision-making systems.

    "Following the COVID-19 pandemic lots of airlines here in the US offered early-out programs which were accepted by many of the older industry veterans. Younger people who've grown up with technology, are now assuming more management roles and are more likely to embrace technology like artificial intelligence across airline operations compared to the previous leadership"
    Senior Vice President, US-based LCC

To conclude, airlines must also have a strategic vision for how AI and ML powered scheduling can be applied in other aspects of their operations

Once the value case for embracing AI scheduling is proven, potential areas for further value creation can be explored.

- **Slot trading:** One extended use case relates to the slot allocation process. The International Air Transport Association (IATA) coordinated twice-yearly slot conferences allow airlines and other parties to meet face-to-face to review their slot portfolio. Here airlines frequently barter and trade with other airlines to exchange slots. Airlines mock-up routes before they attend, and AI scheduling will certainly help expedite and optimize that process. But as Ben Leon points out, there is a real-time on-the-ground application also,

    "Because of the near-instantaneous output of an AI scheduler, if an unexpected opportunity arises while an airline is attending a slot conference, it could quickly run a scenario to see if it would be worth going for."
    Ben Leon, Chief Commercial Officer, Airline Management Group

- **Other use cases:** Airlines could eventually use AI driven schedule optimization to manage fuel consumption, maintenance and ground handling schedule optimization.

- **Irregular operations:** Inclement weather, strikes and short-term schedule changes are a pain for everyone involved from passengers to airlines – but meeting these challenges head-on and dynamically rescheduling using AI powered flight schedule optimization, perhaps for a sub-set of the network, could help minimize delays and reduce unexpected costs.

    "An algorithm can help ensure that when an aircraft arrives to a hangar city for a maintenance check there is a connecting aircraft on the ground at the same time so we can swap the crews over and let engineers get their checks done."
    Network Optimization and Planning Manager, European low-cost carrier

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