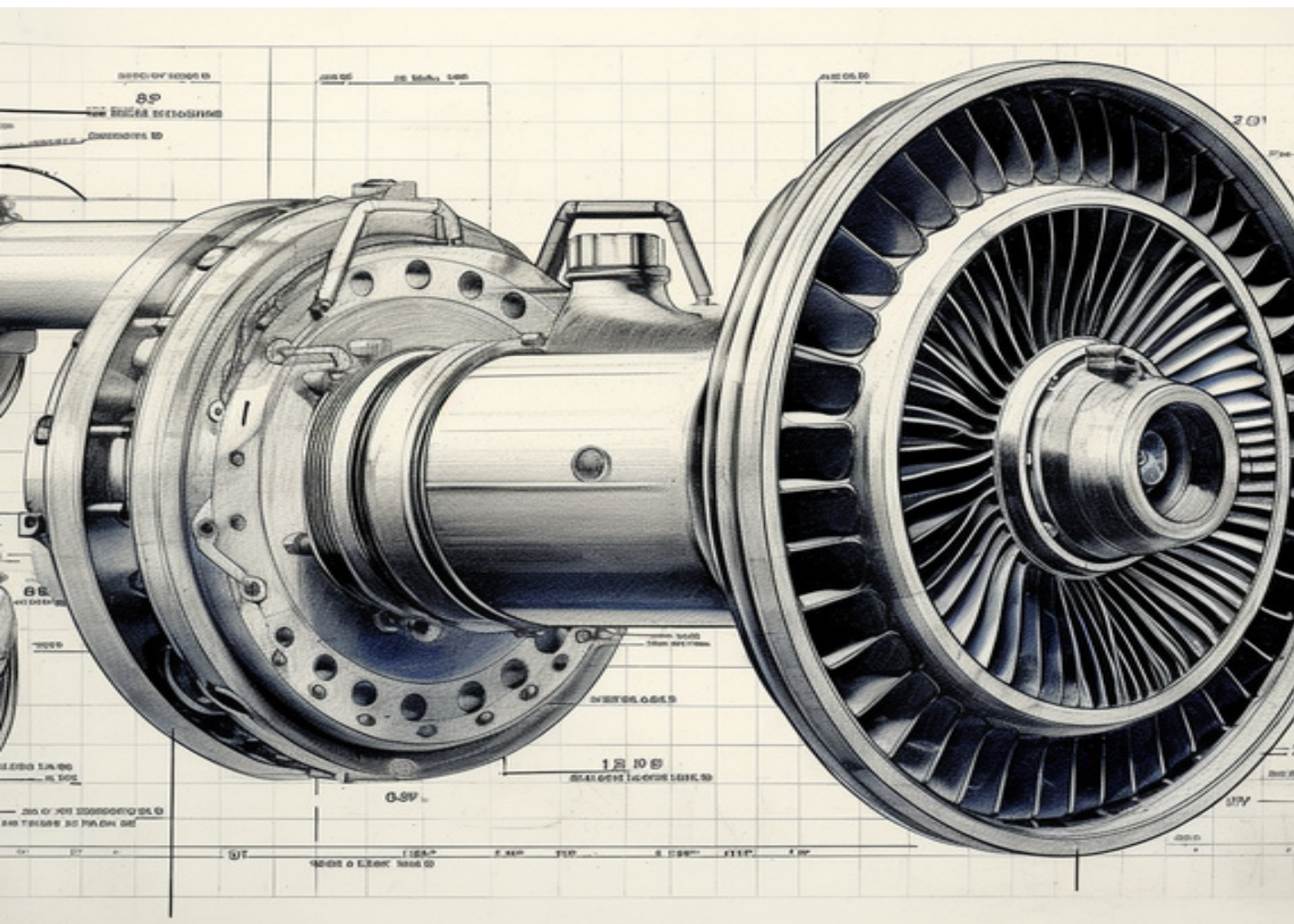




Lufthansa
Innovation Hub

Report

The first-ever comprehensive patent analysis in the airline industry



A photograph of a white commercial airplane on a tarmac. The cabin door is open, and the stairs are extended. The word "Introduction" is overlaid in large, bold, black text. The background shows a clear sky and some trees in the distance.

Introduction

The airline industry often faces criticism for its perceived stagnation when it comes to innovation. Critics (including ourselves) argue that despite the advancements in technology and the changing consumer landscape, the sector appears to be stuck in a time warp.

But is this accusation grounded in truth or merely a misconception?

Our comprehensive patent analysis seeks to shed light on this contentious debate.

While patents may be seen merely as legal documents, they are, in reality, a treasure trove of insight, revealing the strategic innovation efforts of the industry at large.

They act as a roadmap of innovation, indicating where an industry is heading in terms of technology and development.

By studying these patents, we can uncover the truth about the state of innovation in the airline industry.

Are airlines truly lagging, or are they silently pushing the boundaries of air travel?

Our study marks the first public patent analysis of this magnitude within the airline industry.

By exploring the number, focus, and origin of patents, we aim to reveal whether the industry is indeed innovating more or less than before, who the leading innovators are, and where their areas of focus lie.

To fully appreciate the insights this analysis provides, it's necessary to first understand the potency of patents as proxies for innovation.

The Power of Patents: Proxies for Industry Innovation

Patents have long been considered a key barometer for gauging industry innovation—a sentiment backed by a multitude of high-impact scientific studies, see [here](#), [here](#), or [here](#).

These legal instruments endow the rights holder, typically a company, with an exclusive privilege to use, sell, or manufacture the protected technology for a specified duration, usually 20 years.

A closer look at the pharmaceutical sector can help elucidate the significance of patents. Here, companies frequently invest billions of dollars to bring a new drug to market. The patent system, in turn, incentivizes these enormous initial expenditures by offering protection against potential imitators who might reproduce the product once it hits the market, thus avoiding the heavy upfront costs.

Consequently, patents occupy a pivotal role in the business ecosystem, fostering innovation by rewarding innovators and safeguarding their inventions. This principle applies as much to the pharmaceutical industry as it does to any other sector like the airline sector, even if airlines themselves aren't typically involved in the manufacturing of hardware products like aircraft.

Therefore, the patent landscape within any industry serves as a robust measure of its dynamism.

A continuous flow of new patented technologies—whether replacing obsolete ones with disruptive new ideas or offering incremental improvements—indicates the industry's innovation potential and provides glimpses into its future trajectory.

Setting the Stage: Scope and Limitations of Our Patent Analysis

Before diving into the actual insights derived from our patent analysis, it's important to briefly outline our methodology for the sake of research courtesy and clarity. We examined the patent portfolios of the top 50 airlines worldwide by revenue, provided they had filed at least one patent based on the earliest priority date within the last 20 years.

We focused our lens on the core operations of these airlines. To maintain a level playing field, we excluded all Maintenance, Repair, and Overhaul (MRO) subsidiaries of airlines, such as Lufthansa Technik. This approach allowed us to compare apples to apples, as not all airlines operate MRO businesses.

While our patent analysis offers a broad and in-depth view of innovation in the airline industry, it does come with a few caveats.

→ Data for 2022 and 2023 should be interpreted with caution. The reason for this is that patents are typically published 18 months after submission to one of the patent offices. As a result, our analysis does not fully reflect the most recent innovation dynamics within the past two years.

→ It's essential to note that the volume of patent filings in the airline industry tends to be lower compared to closely related industries, like the broader transportation sector. This discrepancy is due to the fact that the airline industry, much like service-oriented businesses, such as law firms, is primarily non-hardware-centric. Consequently, the industry inherently gives rise to fewer patentable inventions.

With these considerations in mind, the following findings and observations provide illuminating insights into the innovation landscape of the airline industry, the leading innovators, and the focus of their efforts.

Let's start with a high-level overview of patent trends, before delving into some of the most interesting observations.

1. A Declining Trend in Airline Patent Filings

The patent filing trends in the airline industry over the last two decades reveal some unsettling insights. The below chart paints a vivid picture of the landscape and allows us to delineate three distinct phases over the past twenty years:

- The Steady State (2000-2012): A consistent flow of patent filings, averaging 19.5 per year.
- The Sudden Peak (2013): A significant increase in patent filings, driven primarily by American Airlines' exponential ramp-up in innovation efforts during that year, marked a distinctive peak in patent activity.

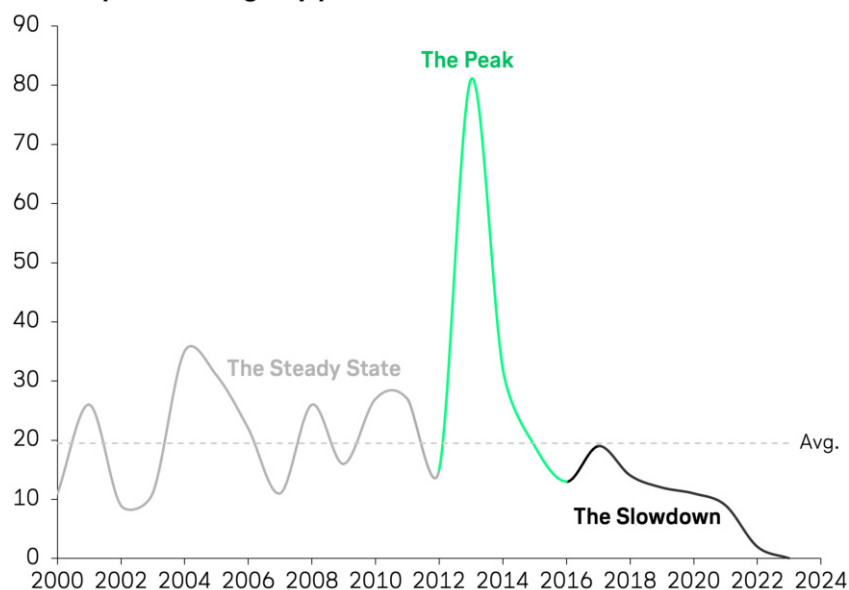
- The Slowdown (2016-present): A troubling phase marked by a persistent decline in patent filings, falling significantly below the previous average.

The slowdown, in particular, raises concern, indicating a potential deceleration in innovation. In 2021, the patent filings of the world's top 50 airlines by revenue dropped dramatically to a mere two. This declining innovation trend aligns with the shrinking number of new airline startups, a topic we dissected [in a previous analysis](#).

TNMT

Patent activity in the airline industry has fallen to an all-time low

Airline patent filings by patent count



Note: '22 & '23 data incomplete due to time lag of patent publication by 18 months after filing
Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

What are the factors driving this decline?

Firstly,

the decreasing emphasis on innovation within airlines could be a consequence of industry consolidation. The reduced number of competitors lessened the need for airlines to innovate and file patents.

Secondly,

the constant financial pressure due to the low-profit-margin nature of the airline business and the subsequent high costs and uncertain ROI of patentable inventions have resulted in less spending on such innovations. The recent economic fallout due to the COVID-19 pandemic, where many airlines had to slash their innovation budgets to stay afloat, might have compounded this effect.

Thirdly,

outsourcing of innovation to suppliers and partners has become more prevalent in recent years. It's not uncommon for airlines to increasingly rely on aircraft manufacturers and suppliers (e.g. seat manufacturers), as well as FinTech firms, in the case of booking features for payment administration, to take over the R&D burden, rather than nurturing in-house developments.

Lastly,

other forms of innovation and strategic considerations may offer a higher return on investment for airlines than long-term innovation bets via patents. These can include brand and reputation enhancement through the use of other forms of IP (such as trademarks), as well as non-patentable business model innovation (like adopting a pure low-cost or leisure model).

As we delve further into the analysis, it's crucial to remember these wider contextual factors that might influence the number of patents filed by airlines.

2. Some Expected and Some Surprising Patent Frontrunners

Having laid out a broader view of the airline industry's patent activity, we now shift our focus to the specific players making waves within this sector.

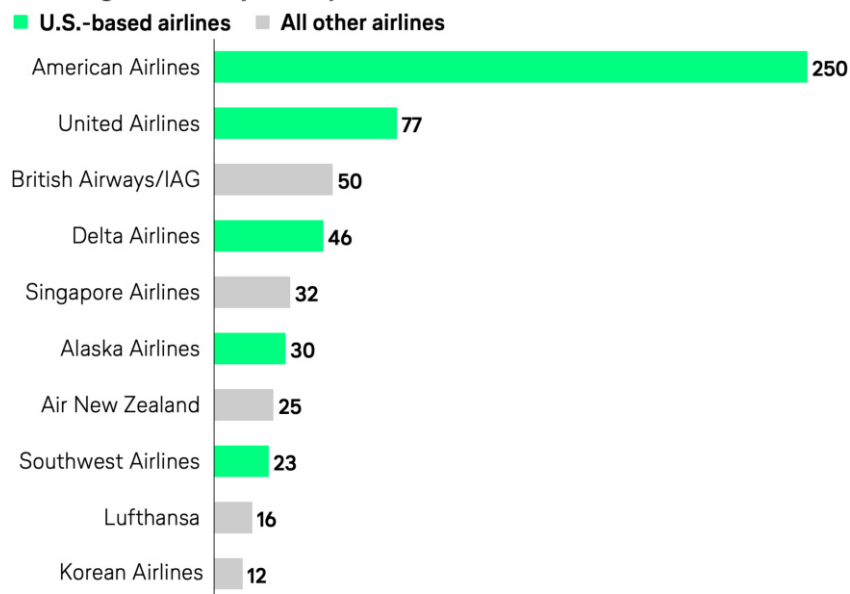
Our analysis reveals that American Airlines tops the list of the most active patent filers, boasting

an impressive 250 patents since 2000. This sizable lead over United Airlines, with its 77 patents, indicates that American Airlines is perhaps investing more heavily in R&D to generate valuable innovations than most other airlines in the world.

TNMT

U.S.-based airlines clearly dominate patent activity with AA in the lead

Leading airlines by total patent count since 2000



Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

A deeper dive into the ranking reveals interesting insights.

Firstly,

the leading patent filers are geographically diverse, with representatives from North America, Europe, and Asia. However, U.S.-based airlines, with five entries in the top ten, dominate this list, suggesting a strong focus on innovation within this region.

It should be noted that this could also be a reflection of a more litigious U.S. environment (see selected examples [here](#)) and a greater propensity for innovation due to the country's economic might and potential for [high compensatory damage payments](#) in patent infringement cases. For instance, in 2021, Delta AirLines was hit with a [\\$1 billion USD lawsuit](#) for alleged intellectual property theft from a former employee.

Secondly,

some global heavyweights, such as Korean Airlines and our parent company, Lufthansa Group, are found at the lower end of the top ten list.

This indicates that these airlines put less emphasis on proprietary technology for competitive advantages or that their innovation strategies do not necessarily result in patent filings.

Finally,

the presence of smaller airlines like Southwest Airlines and Air New Zealand among the top ten patent filers is intriguing. It suggests that an airline's size and financial resources don't necessarily equate to its innovative capacity. For instance, Southwest, a low-cost carrier, primarily files patents related to increasing operational efficiency, while Air New Zealand focuses on enhancing the passenger experience within the cabin, particularly with innovative seating designs.

Air New Zealand exemplifies this innovation strategy beautifully, turning patented ideas into marketable products.

- Its Economy Skycouch™, a transformable three-seat configuration for enhanced comfort, has already been implemented and sold to customers.
- The newly launched Skynest™, a six-pod sleep zone featuring full-size pillows, sheets, and blankets, as well as reading lights and ventilation outlets, is another example of its innovative prowess.

By securing patents for these unique products in key markets like the U.S., Canada, China, Australia, Japan, and the EU, Air New Zealand

has effectively differentiated itself from its competitors, creating a unique selling proposition for passengers on its long-haul flights.

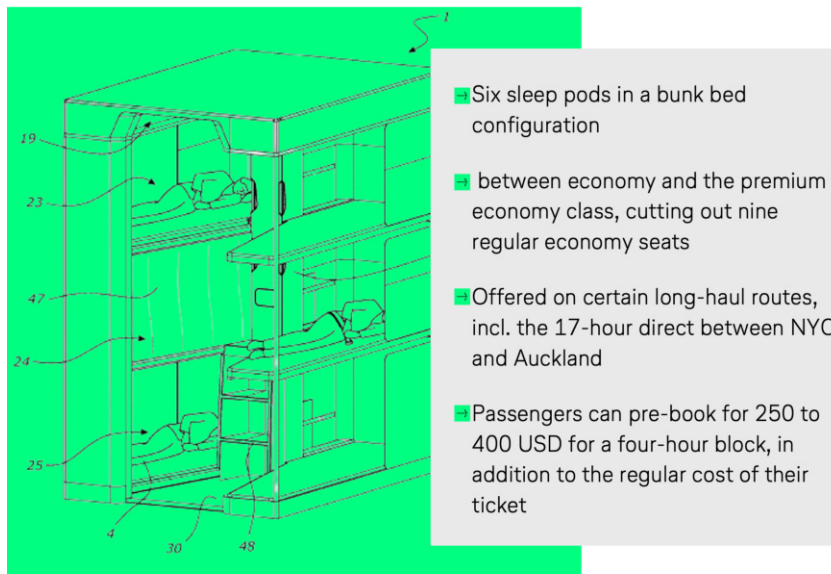
This focus on seat innovation, typically the domain of suppliers, is particularly noteworthy. By cutting out the supplier (like Diehl Aviation, B/E Aerospace or Recaro), Air New Zealand has ensured that no other airline can offer these products, thus maintaining its exclusivity and enhancing its competitive edge.

In the fiercely competitive airline industry, these examples serve to underscore the power of patents in driving and safeguarding innovation.

TNMT

Air New Zealand turns patented ideas into marketable products

Details of Air New Zealand's Skynest™ patent



Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

3. American and United Airlines Are Setting Industry Standards

In the next part of our study, we dive even deeper into the patent portfolios of the airline industry.

Specifically, we look at which airlines have patents that have been cited most often by other companies. This analysis can provide insights into the quality and relevance of a patent, since high citation rates often imply incremental innovation and follow-up work by the citing companies in similar technological areas. What we discovered was intriguing.

The significance of the patent portfolios held by

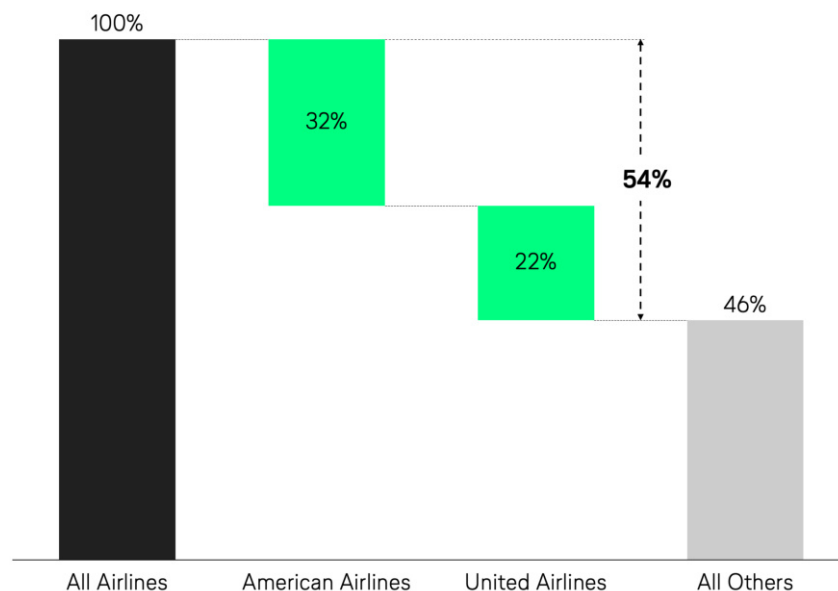
American Airlines and United Airlines cannot be overstated. As we previously observed, these two airlines are not only the most active patent filers (see previous section), but their portfolios also have the highest relevance and quality in the industry, as indicated by the sheer volume of citations their patents have garnered.

Over half of all forward citations across airline patents are linked to patents held by these two airlines, an undeniable demonstration of their technological leadership. Their patents are frequently cited by other firms, highlighting their innovation's foundational role within the industry.

TNMT

Patents by American and United are the most technologically relevant

Share of received patent citations from other firms



Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

Consider, for instance, American Airlines' patent titled **"Airline Flight Reservation System Simulator for Optimizing Revenues."** This patent, which is a tool that allows airlines to predict the effect of changes in flight schedules on their revenues, has been cited by Google, IBM, Concur Technologies, Sabre, and Priceline. The patent's broad application and implications are clear—it can be used to optimize fare pricing, assess the impact of external factors, and even enhance ancillary revenue. This underscores how influential and potentially beneficial American Airlines' innovations can be not only for airlines but also for other online booking platforms.

Likewise, United Airlines' patent for **"Automated Check-In for Reserved Service"** has been cited by tech giants such as Snap and Foursquare. This technology, which improves customer service by automating the check-in process, also offers a wealth of potential benefits for social media platforms, such as improved customer experiences, personalized services and upgrades, and enhanced tracking and marketing opportunities.

It's not difficult to see why it has been noted by other companies in and outside of the airline industry.

These patents and their citations underline the pivotal role that American Airlines and United Airlines play in defining the industry's technological frontiers. Their patents are not mere theoretical constructs; they are practical, influential innovations that other companies are building upon. In turn, these patents can potentially translate into substantial economic value if said firms enter into licensing agreements or if the two airlines initiate patent litigation procedures against patent infringers.

But the significance extends beyond monetary value. The fact that so many patents are cited by others, including by many well-known tech players, indicates that these two airlines are ideally positioned for potential collaborations. This has become particularly relevant in recent years as the airline industry has become increasingly tech-focused.

TNMT

Patents by AA and United are relevant beyond the aviation sector

List of the top ten forward citing companies by airline portfolio

■ Tech companies ■ Travel companies

American Airlines

Rank	Company	No of Patents
01	Boeing	66
02	IBM	33
03	Microsoft	28
04	Amadeus	20
05	General Electric	16
06	Honeywell	11
07	Google	9
08	Hewlett-Packard	7
09	SAP	6
10	Delta Airlines	6

United Airlines

Rank	Company	No of Patents
01	American Express	73
02	Intellectual Ventures	24
03	IBM	11
04	Boeing	11
05	SAP	7
06	Waymo	6
07	Google	4
08	Microsoft	4
09	American Airlines	4
10	Apple	3

Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

As a result, this dominance also highlights a potential vulnerability for other airlines. If a considerable part of the industry's innovation is driven by just two companies, it could create dependencies, as other airlines might need to license technologies from these industry leaders or circumvent the protected innovations, potentially at high costs. Even if a company doesn't hold any patents, it doesn't mean they are safe from litigation. In fact, they become more vulnerable and dependent upon others. This is the situation Delta Airlines currently faces, with a lawsuit amounting to \$1 billion USD for alleged patent infringement.

But instead of just viewing these patent leaders as threats, other airlines can learn from the patents filed by American and United Airlines. Studying these patents can provide inspiration for their own R&D efforts, help them identify new avenues for innovation, and allow them to create more robust defensive patent portfolios.

In other words, these patents are not just walls; they can also be bridges, providing valuable insights and lessons for the rest of the industry.

4. Airlines Are Focusing on the Wrong Traveler Pain Points

Building on the third insight, another critical lesson for the airline industry is to not only keep a close watch on patent leaders, but also understand the areas in which these patents are focused. This provides a fascinating view into where airlines perceive the most significant opportunities for innovation, and potentially, whether these focus areas align with travelers'

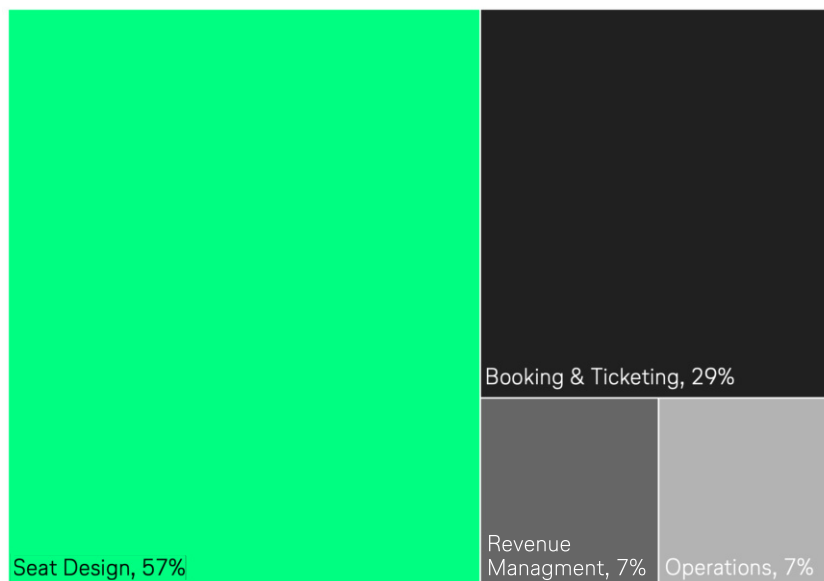
pain points and expectations for a better travel experience.

Upon analyzing all airline patents filed since 2000 and clustering them by technology area, it becomes apparent that seat design is the primary focus.

TNMT

The focus of airline innovation lies primarily on aircraft seats

Share of airline patents by technology area



Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

57%

Over half (57%) of all patents filed by airlines are aimed at the innovation of seating.

It's an interesting focus point that suggests airlines are trying to enhance passenger comfort and onboard experience. Inventions range from ergonomic designs and adjustable features to revolutionary new seat arrangements, like bunk beds, pods, and stacked seats. The leading innovators in seat design are Singapore Airlines, British Airways, and, as previously discussed, Air New Zealand. This concentration on seating innovation demonstrates their understanding of the importance of passenger experience and comfort as a competitive differentiator.

29%

Next in line is Booking and Ticketing, which makes up 29% of the total patents.

The industry leaders in this area are American Airlines, United Airlines, and Delta Airlines.

The innovations in this field aim to simplify the booking process, offer personalized ticketing options, streamline check-in procedures, and present new approaches to pricing and fare structures. The investments in this sector underline the importance airlines place on creating a seamless and user-friendly booking experience, as it often sets the tone for the entire customer journey.

From here, let's move on to the operational side of the airline business.

7%

7% of all patents are related to operations and another 7% focus on revenue management.

American Airlines and United Airlines, again, lead this space, with innovations aimed at better managing flight schedules, maintenance

procedures, crew management, and fuel efficiency.

On the revenue management side, airlines are innovating pricing strategies, demand forecasting models, and capacity management techniques to maximize profits.

This is understandable, given the fact that revenue management is a critical component of how airlines make money and new technologies are enabling airlines to transform their revenue management functions. For example, United Airlines is heavily investing in its MileagePlus loyalty program with patents protecting a system where passengers can use their mobile phones to make flight bookings using reward points.

The last piece of the pie goes to the category of operations, which includes patents related to maintaining reliable service and minimizing delays. American Airlines, Southwest Airlines, and Delta Airlines are the leading innovators in this field, contributing to overall customer satisfaction indirectly through operational efficiency.

This examination of patent focus areas reveals that airlines seem to be investing heavily in areas that directly seem to improve the passenger experience—from the moment a customer books their ticket to the comfort they experience on the flight.

However, it's worth probing whether this disproportionate focus, especially on seating design, truly dovetails with the actual pain points and expectations of the average air traveler.

From our comprehensive analysis of pain points, seat comfort and legroom only emerge as minor irritants for air travelers. By contrast, issues such as flight irregularities and a lack of self-service rebooking options loom larger in the minds of passengers.

Against this backdrop, we question the efficacy of the airlines' patent focus leaning so heavily towards seat innovation. Given the pressing issues that travelers face, we advocate a reorientation of R&D focus towards the operational realm.

By addressing and alleviating key pain points such as flight irregularities and providing self-

service rebooking options, airlines could substantially enhance the customer experience.

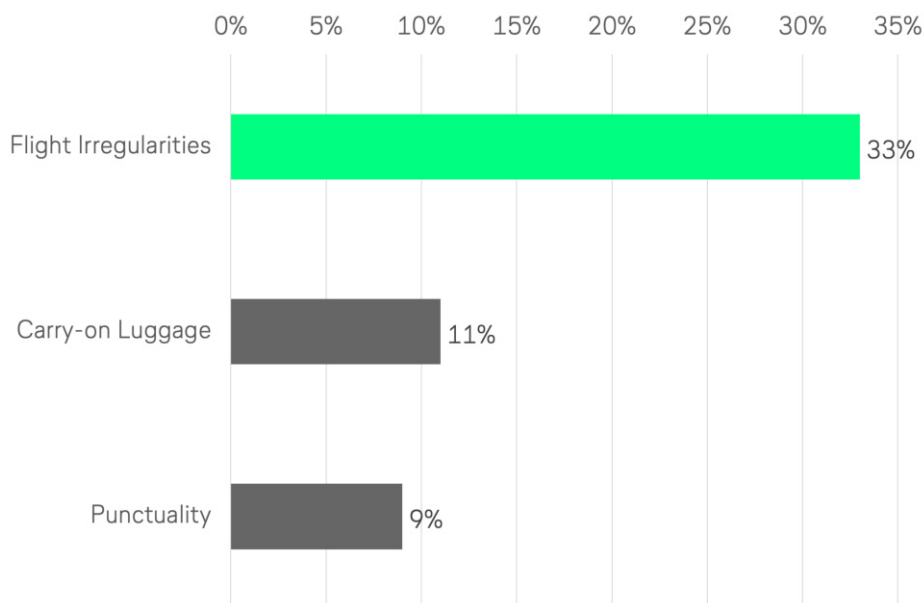
Ultimately, an alignment of innovation focus with genuine customer pain points could prove a more effective strategy in the competitive landscape of the airline industry.

TNMT

Every third negative airline review mentions flight disruptions

Top 3 pain points mentioned by air travelers

Share of negative reviews by topic category



Source: Lufthansa Innovation Hub Analysis, TNMT.com, TripAdvisor, Netbase Quid

5. The Regional Divergence in Airline Innovations

In a bid to better understand the dynamics of airline innovation and the apparent mismatch between airlines' areas of focus and travelers' pain points, we embarked on a follow-up analysis. For this, we mapped out the basic traveler's journey across three stages: the Pre-trip, the At-airport (including operations), and the Inflight experience.

This framework served as our tool for analyzing where more than a dozen of the biggest airlines from the North America, APAC, and EMEA regions are placing their patents, aka innovation bets.

TNMT

Focus of innovation areas varies by geography and business model

Patent activity by major airlines along the traveler journey

Region	Company	Pre-Trip		At Airport		Inflight	
		Booking & Ticketing	Revenue Mgmt.	Security & Biometrics	Operations	Seats	IFE
NA	American Airlines						
	Delta Airlines						
	United Airlines						
	Southwest Airlines						
	Alaska Airlines						
	Air Canada						
	Virgin America						
APAC	Singapore Airlines						
	Japan Airlines						
	Air New Zealand						
	Cathay Pacific						
EMEA	BA & IAG						
	Lufthansa						
	Emirates						
Total		5	1	1	3	7	2

Note: Time range considered for patents: 2000 until 2023
Source: Lufthansa Innovation Hub Analysis, TNMT.com, Lens.org

Our analysis reveals that North American carriers, in line with their overall innovation leadership mentioned earlier, are actively patenting across all stages of the traveler's journey. Of note, they are the only ones making significant strides in the field of operations, an area often overlooked but crucial for minimizing flight irregularities, as mentioned before.

British Airways, as the sole European carrier, also emerges as a notable innovator in the airport phase, however, focusing primarily on security and biometric technologies. Its innovations seek to streamline airport procedures and reduce passenger waiting times, aligning with the global trend towards touchless and efficient travel.

Contrastingly, other airlines based in the APAC and EMEA regions are channeling their innovation efforts predominantly towards the inflight phase. This stage encompasses improvements to seats and the In-Flight

Entertainment (IFE) system, with the overarching goal of enhancing passenger comfort and engagement during flights. Lufthansa, for instance, is venturing into personalization with its Allegris product, offering an astounding variety of 14 different seat categories. Similarly, several airlines are looking to extend the boundaries of the traditional IFE system, enabling strategic partnerships that facilitate ancillary sales and on-ground transportation booking for airport pick-up even while inflight.

These inflight innovations undeniably create a unique and memorable experience for travelers, potentially driving satisfaction and loyalty, and even unlocking new revenue streams via ancillary sales. However, this heavy focus on inflight experience, while important, diverts attention from the pressing issue of flight irregularities, an industry-wide challenge that needs immediate attention.



Wrap-Up: Airline Innovation at a Crossroads

Over the course of this analysis, we have unveiled some intriguing, and at times, disconcerting insights about the state of innovation within the airline industry.

Firstly, we have seen a general decline in innovation effort, evidenced by the dwindling number of patents filed over the past five years. These numbers, reaching historic lows, have prompted us to look closer at the forces driving this trend.

Yet, when we dove deeper, we discovered a more nuanced picture. Some airlines, such as American and United Airlines, are actively defying this trend, leading in both the quantity and quality of patent innovation. The latter has been evidenced by the frequent citation of their patents by other companies, particularly heavyweights in the technology industry like Google, Microsoft, and IBM. These U.S.-based airlines are spearheading the integration of digital products and services, with a particular emphasis on enhancing operational efficiency and the pre-flight customer experience.

However, our investigation has also revealed some worrisome signs. We found a seemingly disproportionate focus on seating innovation, while critical operational improvements to tackle flight irregularities largely fall by the wayside. The exception to this trend is primarily North American carriers again, which are concentrating their efforts on streamlining operations (and enhancing booking and ticketing). In contrast, airlines in the APAC and EMEA regions are directing their innovation efforts more towards seat design, likely as a means to reduce dependency on suppliers and create exclusive products that form a Unique Selling Proposition for their brand. This is particularly true for long- to ultra-long haul carriers, where comfort is a priority for lengthy journeys.

Yet, the most glaring observation from our study is that most airlines, barring a select few, appear not to directly address key customer pain points. These unaddressed issues, such as flight irregularities, automatic rebooking systems, availability of customer service, or baggage tracking, represent significant opportunities for airlines to innovate more effectively and differentiate themselves from the competition. The potential for exploiting AI and digital technologies to optimize flight paths for smoother operations and energy efficiency is enormous. At the same time, fixing customer service via value-adding chatbots and well-functioning re-booking systems is enormous, with patents in these areas presenting potent competitive advantages and markers of leadership.

Thus, as we conclude our analysis, we find the airline industry at a critical juncture, grappling with the balance between customer expectations, operational efficiency, and sustainability. As strategic tools, patents will undoubtedly continue to shape the industry's path. With escalating pressure for decarbonization, the race for innovation is set to further intensify, potentially ushering in a new era of green aviation.

Airlines now face a pivotal question: Do they want to spearhead the industry's journey towards a customer-centric and also sustainable future, or will they stand idle, watching from the sidelines?

We hope, for the sake of customers and the environment, that the answer is self-evident.

By aligning their innovation activity more closely with customer expectations and environmental needs, airlines can contribute to the reshaping of air travel.

Authors

Kolin Schunck

Senior Research & Intelligence Analyst at
Lufthansa Innovation Hub

Lennart Dobravsky

Editor-in-Chief at TNMT



Disclaimer

This content is for informational purposes only and should not be used as a substitute for consultation with professional advisors. Lufthansa Innovation Hub may be involved in business with companies covered in its research reports. Thus, readers should be aware that the firm may have a conflict of interest that could affect the objectivity of this report. The Lufthansa Innovation Hub has taken responsible steps to ensure that the information contained in the report has been obtained from reliable sources.

However, the Lufthansa Innovation Hub cannot guarantee the ultimate accuracy and completeness of the data obtained in this manner. Results are updated periodically. Therefore, all data is subject to change at any time.

© 2023 Lufthansa Innovation Hub. All rights reserved.

Newsletter

Visit [TNMT.com](https://tnmt.com) and sign up for our bi-weekly newsletter obtained from reliable sources

TNMT

The industry deep dive into
Travel and Mobility Tech

**SCAN ME**