Moore's Law of aviation: Flying keeps getting safer

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Many airline passengers naturally worry about flying. But on a worldwide basis, commercial air travel keeps getting safer, according to a new study by MIT researchers.

The risk of a fatality from commercial air travel was 1 per every 13.7 million passenger boardings globally in the 2018–2022 period—a significant improvement from 1 per 7.9 million boardings in 2008–2017 and a far cry from the 1 per every 350,000 boardings that occurred in 1968–1977, the study finds.

"Aviation safety continues to get better," says Arnold Barnett, an MIT professor and co-author of a new paper detailing the research results.

"You might think there is some irreducible risk level we can't get below," adds Barnett, a leading expert in air travel safety and operations. "And yet, the chance of dying during an air journey keeps dropping by about 7% annually, and continues to go down by a factor of two every decade."

To be sure, there are no guarantees of continual improvement; some recent near-collisions on runways in the U.S. have gained headlines in the last year, making it clear that airline safety is always an ongoing task.

Additionally, the COVID-19 pandemic may have caused a sizable—though presumably temporary—new risk stemming from flying. The study analyzes this risk but quantifies it separately from the long-term safety trend, which is based on accidents and deliberate attacks on aviation.

Overall, Barnett compares these long-run gains in air safety to "Moore's Law," the observation that innovators keep finding ways to double the computing power of chips roughly every 18 months. In this case, commercial air travel has gotten roughly twice as safe in each decade dating to the late 1960s.

"Here we have an aerial version of Moore's Law," says Barnett, who has helped refine air travel safety statistics for many years.

In per-boarding terms, passengers are about 39 times safer than they were in the 1968-1977 period.

The paper, "Airline safety: Still getting better?" is published in the August issue of the *Journal of Air Transport Management*. The authors are Barnett, who is the George Eastman Professor of Management Science at the MIT Sloan School of Management, and Jan Reig Torra MBA '24, a former graduate student at MIT Sloan.

COVID-19 impact

The separate, additional finding about the impact of COVID-19 focuses on cases spread by airline passengers during the pandemic. This is not part of the top-line data, which evaluates airline incidents during normal operations. Still, Barnett thought it would also be valuable to explore the special case of viral transmission during the pandemic.

The study estimates that from June 2020 through February 2021, before vaccines were widely available, there were about 1,200 deaths in the U.S. from COVID-19 associated, directly or indirectly, with its transmission on passenger planes. Most of those fatalities would have involved not passengers but people who got COVID-19 from others who had been infected during air travel.

In addition, the study estimates that from March 2020 through December 2022, around 4,760 deaths around the globe were linked to the transmission of COVID-19 on airplanes. Those estimates are based on the best available data about transmission rates and daily death rates, and take account of the age distributions of air passengers during the pandemic.

Perhaps surprisingly, older Americans do not seem to have flown less during the COVID-19 pandemic, even though their risks of death given

infection were far higher than those of younger travelers.

"There's no simple answer to this," Barnett says. "But we worked to come up with realistic and conservative estimates, so that people can learn important lessons about what happened. I believe people should at least look at these numbers."

Improved overall safety

Overall, to study fatalities during normal airline operations, the researchers used data from the Flight Safety Foundation, the World Bank, and the International Air Transport Association.

To evaluate air travel risks, experts have used a variety of metrics, including deaths per billion passenger miles, and fatal accidents per 100,000 flight hours. However, Barnett believes deaths per passenger boarding is the most "defensible" and understandable statistic, since it answers a simple question: If you have a boarding pass for a flight, what are your odds of dying? The statistic also includes incidents that might occur in airport terminals.

Having previously developed this metric, Barnett has now updated his findings multiple times, developing a comprehensive picture of air safety over time:

Commercial air travel fatalities per passenger boarding

- 1968–1977: 1 per 350,000
- 1978–1987: 1 per 750,000
- 1988–1997: 1 per 1.3 million
- 1998–2007: 1 per 2.7 million

- 2007–2017: 1 per 7.9 million
- 2018–2022: 1 per 13.7 million

As Barnett's numbers show, these gains are not incidental improvements, but instead constitute a long-term trend. While the new paper is focused more on empirical outcomes than finding an explanation for them, Barnett suggests there is a combination of factors at work. These include technological advances, such as collision avoidance systems in planes; extensive training; and rigorous work by organizations such as the U.S. Federal Aviation Agency and the National Transportation Safety Board.

However, there are disparities in air travel safety globally. The study divides the world into three tiers of countries, based on their commercial air safety records. For countries in the third tier, there were 36.5 times as many fatalities per passenger boarding in 2018–2022 than was the case in the top tier. Thus, it is safer to fly in some parts of the world than in others.

The first tier of countries consists of the United States, the European Union countries, and other European states, including Montenegro, Norway, Switzerland, and the United Kingdom, as well as Australia, Canada, China, Israel, Japan, and New Zealand.

The second group consists of Bahrain, Bosnia, Brazil, Brunei, Chile, Hong Kong (which has been distinct from mainland China in air safety regulations), India, Jordan, Kuwait, Malaysia, Mexico, the Philippines, Qatar, Singapore, South Africa, South Korea, Taiwan, Thailand, Turkey, and the United Arab Emirates. In each of those two groups of nations, the death risk per boarding over 2018–22 was about 1 per 80 million.

The third group then consists of every other country in the world. Within the top two groups, there were 153 passenger fatalities in the 2018–2022 period, and one major accident, a China Eastern Airlines crash in 2022

that killed 123 passengers. The 30 other fatalities beyond that in the top two tiers stemmed from six other air accidents.

For countries in the third tier, air travel fatalities per boarding were also cut roughly in half during the 2018–2022 period, although, as Barnett noted, that can be interpreted in two ways: It is good they are improving as rapidly as the leading countries in air safety, but in theory, they might be able to apply lessons learned elsewhere and catch up even more quickly.

"The remaining countries continue to improve by something like a factor of two, but they're still behind the top two groups," Barnett observes.

Overall, Barnett notes, notwithstanding COVID-19, and looking at accident avoidance, especially in countries with the lowest fatality rates, it is remarkable that air safety keeps getting better. Progress is never assured in this area; yet, the leading countries in air safety, including their government officials and airlines, keep finding ways to make flying safer.

"After decades of sharp improvements, it's really hard to keep improving at the same rate. And yet they do," Barnett concludes.

More information: Arnold Barnett et al, Airline safety: Still getting better? *Journal of Air Transport Management* (2024). DOI: 10.1016/j.jairtraman.2024.102641