

Building a Safer Sky
An Analysis of International Airline Safety Concerns

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— *ABSTRACT* —

The air transport industry plays a significant role in global economic activity and development. It seems obvious that air travel would not have evolved the way it has in recent years if it weren't secure - if passengers hadn't trusted that their flight would arrive at its destination without any life-threatening incidents. Security, therefore, is not only a pillar for the development of aviation but has actively contributed to the passenger number growth we have witnessed in recent years. It is really heart-wrenching to witness airplane crashes or other accidents leading to the deaths of hundreds of people. In the last two years, there have been several incidents of safety breaches in Indian airlines. In 2022 alone, 43 airprox (air proximity) incidents were investigated according to the Ministry of Civil Aviation data and two such incidents were categorised as "serious" by the Aircraft Accident Investigation Bureau. As the world comes back to normalcy and travel figures return to the pre-COVID levels (before the COVID-19 crisis, global air transport demand was expected to triple between 2020 and 2050), it is pertinent that we analyse the safety situation in the aviation industry. This paper attempts to identify and recommend ways to tackle those areas of concern to ensure the growth trajectory of the aviation sector remains turbulence-free!

Introduction

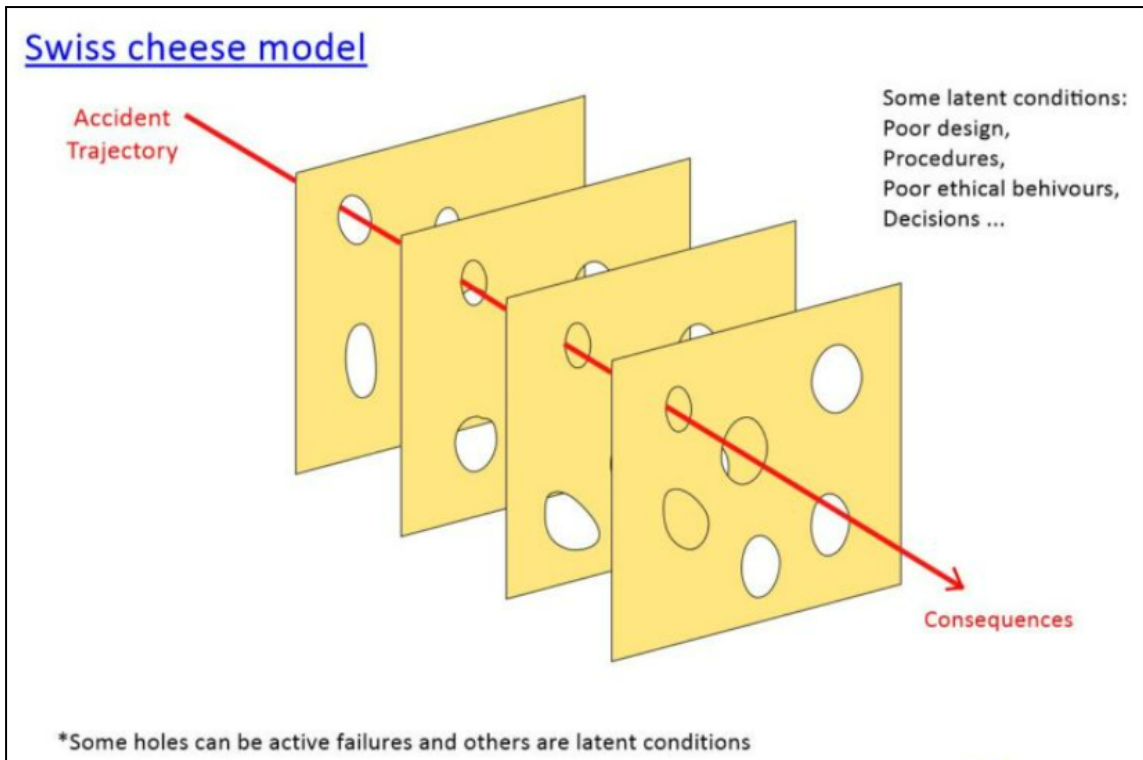
According to Article 29 of the Convention on International Civil Aviation, *'Before an international flight, the pilot in command must ensure that the aircraft is airworthy, duly registered and that the relevant certificates are on board the aircraft'*.

With the increasing number of air travellers and the increasing globalisation of the world economy, the importance of ensuring the safety of passengers has become even more crucial. The very first step in aviation safety risk management is the analysis and scrutiny of the factors that determine aviation safety, ie. the structural design of aircraft and airports, technical

training of ground personnel and flight crew members, aircraft maintenance, airfields, communication facilities, and implementation of air traffic control procedures and much more. We shall start our study of the international concerns over airline safety by doing a brief analysis of the challenges faced by the aviation sector followed by some recommendations.

Aviation Safety Risk Management: the Swiss Cheese Model

A scientific principle used when evaluating risks in aviation safety is the Swiss cheese model. Introduced by Dante Orlandella and James T. Reason from Manchester University in the early 1990s, the model is named after Swiss cheese because it *'compares complex human systems to several slices of Swiss cheese piled up together, reducing the severity of every threat to it by its different layers and individual defences which are layered one after another'*. According to the model, holes (representative of system shortcomings) in one layer of defence are not the single cause of an accident, since there are other layers of defence supporting it and although each layer may have imperfections, having multiple defences (or cheese layers) against risk can help lower the risk of accidents in the end. Many aviation authorities, such as the International Civil Aviation Organization, accept the Swiss cheese model to investigate the causes of complex accidents. It stipulates that there is not just a single cause of any given accident, and threats materialise due to cumulative effects and many layers of defences failing to deal with it. Thus, the Swiss Cheese model can be effectively used to analyse aviation safety. We must overcome the tombstone mentality of having a pervasive attitude of ignoring design defects until people have died and make concerted efforts to maximise an aeroplane's airworthiness. Some major areas of concern vis-a-vis aviation security are discussed below.



Swiss Cheese model Diagram

Source: <https://www.aviationfile.com/swiss-cheese-model/>

Areas of Concern

One of the biggest issues facing the aviation industry is the rising number of accidents. While the overall number of accidents has been decreasing, there has been an increase in fatal accidents in recent years. This has led to increased scrutiny of the industry and calls for stricter safety regulations to address such issues as the lack of adequate infrastructural facilities at the airports, the ageing fleet, and operational And system deficiencies. poor safety regulations, and inadequate training for pilots and air traffic controllers.

1. Lack of Standardisation in Aviation Regulations: A major area of concern is the lack of standardisation in aviation regulations worldwide. Countries have different rules and regulations, leading to confusion and inconsistencies in safety practices. This can also make it more difficult for airlines to operate internationally, as they must comply with different regulations in different countries.

2. The issue of maintenance and inspection is also a major concern. Airlines and aircraft manufacturers are facing increased pressure to reduce costs, leading to cutbacks in maintenance and inspection programs. This can lead to a decline in the overall safety of the aircraft and put passengers at risk.
3. Diversification of the Airspace: Another issue related to technology is the integration of unmanned aerial vehicles (UAVs), or drones, into the airspace. The rapid growth of the drone industry has raised concerns about the safety and security of these devices, especially concerning their potential to collide with other aircraft.
4. Human factors: Pilot training and fatigue are also areas of concern. In recent years, several accidents have been caused due to pilot errors, and there is evidence suggesting that some of these errors may have been caused by fatigue. Usually, pilots experience fatigue because of "long duty shifts, unpredictable working hours, and lack of adequate sleep". This highlights the importance of providing pilots with adequate rest and training, besides ensuring they have the resources and support needed to perform their jobs safely. Pilot error and improper communication are often factors in the collision of aircraft. These factors can produce a combination of sleep deprivation, circadian rhythm effects, and 'time-on-task' fatigue. Experts suggest that the regulators' attempts to mitigate these challenges often fall short of their goals.
5. Cost Cutting by airlines: The industry is notoriously competitive and cost-sensitive. Airlines are always looking for ways to reduce costs and increase profits. However, this drive for profitability has sometimes come at the expense of safety. In 2020, an employee of AirAsia India revealed how the airline was saving fuel by risking passengers' lives. He alleged that the airline had asked its pilots to mandatorily do 98 per cent of landings in "Flap 3" mode, which allows it to save fuel. Otherwise, it would be considered a violation of its standard operating procedure (SOP). Following the complaint, the

DGCA conducted a probe into this matter, and two Senior Airline Executives were suspended after ascertaining the facts and finding them guilty.

6. Overdependence on Technology: Additionally, the increasing use of technology in aviation operations raises safety concerns. For example, the widespread use of automation in the cockpit can make flying safer. Still, it also introduces new risks, such as the potential for cyberattacks or technical malfunctions.
7. Electromagnetic interference: Using certain electronic equipment might interfere with aircraft operation, such as causing compass deviations. For example, using a mobile phone is prohibited on most flights because in-flight usage creates problems with ground-based cells. Also, personal electronic devices are prohibited when an aircraft is below 10,000 feet (3,000 m), taking off or landing. Recently, concerns have also been expressed over the rollout of 5G technology.
8. Terrorism: Terrorism is also a major concern for the aviation industry. The 9/11 attacks in 2001 had a significant impact on the industry, and security measures have increased significantly since then. However, increasing terrorist acts in the last years; acts like aircraft hijacking by terrorist groups, make it necessary to review universal rules, penal sanctions, and security procedures.

Weather and Aviation: The Intersection of Climate Change and Airline Safety

New findings from a study published in the journal - Advances in Atmospheric Sciences suggest that the effects of climate change on jet streams are expected to make hazardous turbulence on flights far more frequent. Using supercomputer simulations, scientists found that doubling carbon dioxide (CO₂) levels in the atmosphere would harm airline safety. The study predicts that doubling CO₂ levels will increase light turbulence by 59%, light-to-moderate turbulence by

75%, moderate turbulence by 94%, moderate-to-severe turbulence by 127%, and severe turbulence by 149%.¹

A growing number of studies indicate that erratic air circulation patterns are aggravated by the climate crisis, and the results can have serious implications for passenger safety. For instance, in March 2019, a Boeing 777 flight operated by Turkish Airlines from Istanbul to New York encountered severe clear-air turbulence (CAT) over Maine, hospitalising 30 people, including a flight attendant with a broken leg. According to experts, there is a likelihood of more disruptions in airline operations as thunderstorms and atmospheric phenomena like CAT and jet streams are already being influenced by global heating.

Additionally, recent calculations estimate about 12 per cent more lightning strikes globally for every 1C of global warming, suggesting more route deviations. Also, heat waves will increasingly affect flight take-offs and landings, especially at airports with short runways. New studies find surface air temperature has increased in Asia over the last century, causing stronger, more frequent and longer heatwaves.

Safety vs Profitability: a trade-off?

The question of safety versus profitability is an ongoing debate in the aviation industry, and striking the right balance between the two is crucial for the long-term sustainability of the industry. In recent years, there have been several incidents where airlines have cut corners on safety to save money. For example, there have been cases where airlines have delayed or deferred maintenance on their aircraft to save money on maintenance costs. There have also been cases where airlines have cut back on the number of pilots and crew members on flights to save money on salaries and benefits.

¹ Sankaran, V. (2022, September 7). How the climate crisis is making flying more dangerous. The Independent.
<https://www.independent.co.uk/climate-change/news/climate-change-airline-safety-efficiency-b2147352.html>

While these cost-cutting measures may result in short-term financial gains for the airlines, they can have serious consequences for safety. Delaying or deferring maintenance can increase the risk of mechanical failures, resulting in accidents. Cutting back on the number of pilots and crew members can also increase the risk of accidents, as there may need to be more personnel to respond to emergencies or unexpected situations.

Recently the Harvard Business Review conducted research into airlines' management of the complex trade-off between safety and cost-cutting measures and, in particular, how financial performance affects an airline's focus on safety.² The study found that financially struggling airlines are the most willing to spend more on safety. One reason can be how organisations think about survival: Airlines whose high profits can survive a scandal, and their executives know it. Their less successful peers may already be bordering on failure and could ill afford the public outcry that a prominent accident would cause. Their findings show that their impact notwithstanding, managers' choices in navigating tough trade-offs like safety versus profitability will change based on context. When the stakes – in both financial and human terms – are high, decision-makers safety over profitability, choosing pricey survival over low-cost risk.

Thus, safety and profitability are critical for the airline industry's long-term sustainability. The key is to take a strategic approach to safety. This means developing safety policies and procedures aligned with the airline's overall business strategy and priorities. For example, airlines can invest in new technologies that improve safety while reducing costs, such as fuel-efficient aircraft or automated maintenance systems. Airlines can also improve customer service and satisfaction, enhancing safety by reducing stress and distractions for passengers and crew.

5G Telecoms and Airline safety

² Greve, H. R. (2021, September 17). Research: Why Struggling Airlines Spend More on Safety. Harvard Business Review. <https://hbr.org/2019/03/research-why-struggling-airlines-spend-more-on-safety>

Recently, the US Federal Aviation Administration (FAA) warned that the new 5G technology could interfere with sensitive navigation equipment such as altimeters, leading to "catastrophic disruptions." Consequently, it released a Special Airworthiness Information Bulletin (SAIB AIR-21-18), Risk of Potential Adverse Effects on Radio Altimeters, seeking additional information from manufacturers and operators. The major concern is that the functioning of Altimeters, which measure how far above the ground an aeroplane is travelling, operating in the 4.2-4.4 GHz range, which sits too close to the frequency of C range (a radio frequency band between 3.7 and 4.2 GHz), may get hampered.

RTCA (Radio Technical Commission for Aeronautics) also published a report entitled "Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations." Among other things, the RTCA found "a major risk that 5G telecommunications systems in the 3.7–3.98 GHz band will cause harmful interference to radar altimeters on all types of civil aircraft—including commercial transport aeroplanes; business, regional, and general aviation aeroplanes; and both transport and general aviation helicopters." In addition to altitude, altimeter readouts are also used to facilitate automated landings and to help detect dangerous currents called wind shear.

However, telecom companies have argued that C band 5G has been deployed in 40 other countries without aviation interference issues. In Europe, including the United Kingdom, the switch to 5G is happening without a problem. The reason is technical. In Europe, companies offering 5G services are using the spectrum's slower 3.4 to 3.8 GHz range. Europe's 5G has a larger buffer.³

Thus it is pertinent that sufficient research and deliberation take place on this issue because technological advancement is inevitable and will possibly cause more interference with aviation security in the coming future.

³ Wolf, Zachary B. "5G Vs. Airline Safety: This Is Why We Have a Government | CNN Politics." CNN, 2022, www.cnn.com/2022/01/19/politics/5g-airplanes-airlines-safety-what-matters/index.html

Analysis

The annual report (2022) of Flight Global, an online news and information website which covers the aviation and aerospace industries suggests that the 'safety performance of airlines in 2022 reflected the stability that has been seen over the past ten years, with steady, relatively low accident numbers. Indeed, following the industry's previous decades of emphatic improvement, safety figures have been almost flatlining since 2012. Last year saw 12 fatal accidents globally across all airline operational categories and aircraft sizes, resulting in 229 fatalities. These figures can be compared with an annual average of 15.4 and 302 in the ten years from 2013, making 2022 appear rather good. However, this is statistically insignificant; fatalities climbed from a 2021 total of 134, caused by 15 deadly crashes.

It took a concentrated effort by organisations such as the US Commercial Aviation Safety Team (CAST) and its EU and ICAO equivalents to reach the impressive standard achieved by the world's safest aviation nations today. This began in the 1990s, with their effort to lift their relatively poor safety performance to the levels that have now been achieved. Success happened by assembling operational data that enabled the bodies to identify the causes of the accidents still suffering in significant numbers. That knowledge allowed them to design strategies to reduce risk.⁴

Thus, over the years, safety has improved from the better aircraft design process, engineering and maintenance, the evolution of navigation aids, safety protocols and procedures and safety improvement initiatives at the international level.

Safety improvement initiatives

⁴ Learmount, D. (2023, January 19). Can airline safety improve from average performance in 2022? Flight Global.
<https://www.flightglobal.com/airlines/can-airline-safety-improve-from-average-performance-in-2022/151714.article>

The safety improvement initiatives are aviation safety partnerships between regulators, manufacturers, operators, professional unions, research organisations, and international aviation organisations to enhance safety further. Some major safety initiatives worldwide are:

- the Commercial Aviation Safety Team (CAST) in the US and the European Strategic Safety Initiative (ESSI), which have been established to further enhance safety for citizens worldwide through safety analysis, implementation of cost-effective action plans, and cooperation with other safety initiatives worldwide.
- In addition to the efforts of CAST and its multinational partners, the IATA Operational Safety Audit (IOSA) programme – launched in 2003 – has delivered performance dividends for most of the world’s larger airlines: fatal accidents have almost been eliminated among IOSA participants.

A Critical Analysis of India's Aviation Safety Record

According to Section 2(u) Part I of the Aircraft Rules (Security) 2011, “*security*” means a combination of measures, human and material resources intended to be used to safeguard civil aviation against acts of unlawful interference’.

Directorate General of Civil Aviation (DGCA) is the regulatory body governing the safety aspects of civil aviation in India. With the revision to Section 4A of the Aircraft Act, 1934 in September 2020, the DGCA has been formally recognized as a body constituted by the Central Government with the responsibility to carry out safety oversight and regulatory functions in respect of matters specified in the Act or the rules made thereunder. The Airworthiness

Directorate, Air Safety Directorate, Flight Standards Directorate, and the State Safety Programme Division in the DGCA deal with aviation safety.

According to the Organisation Manual released by the Office Of The Director General Of Civil Aviation (2021), the DGCA is expected to perform the following functions vis a vis air safety, -

(2) Formulation of standards of airworthiness for civil aircraft registered in India and grant of certificates of airworthiness to such aircraft;

(7) The Air Safety Directorate in the DGCA is responsible for carrying out the investigation of serious incidents to aircraft up to 2250 kg and aircrafts other than turbojet engine aircraft. The directorate also carries out accident prevention work;

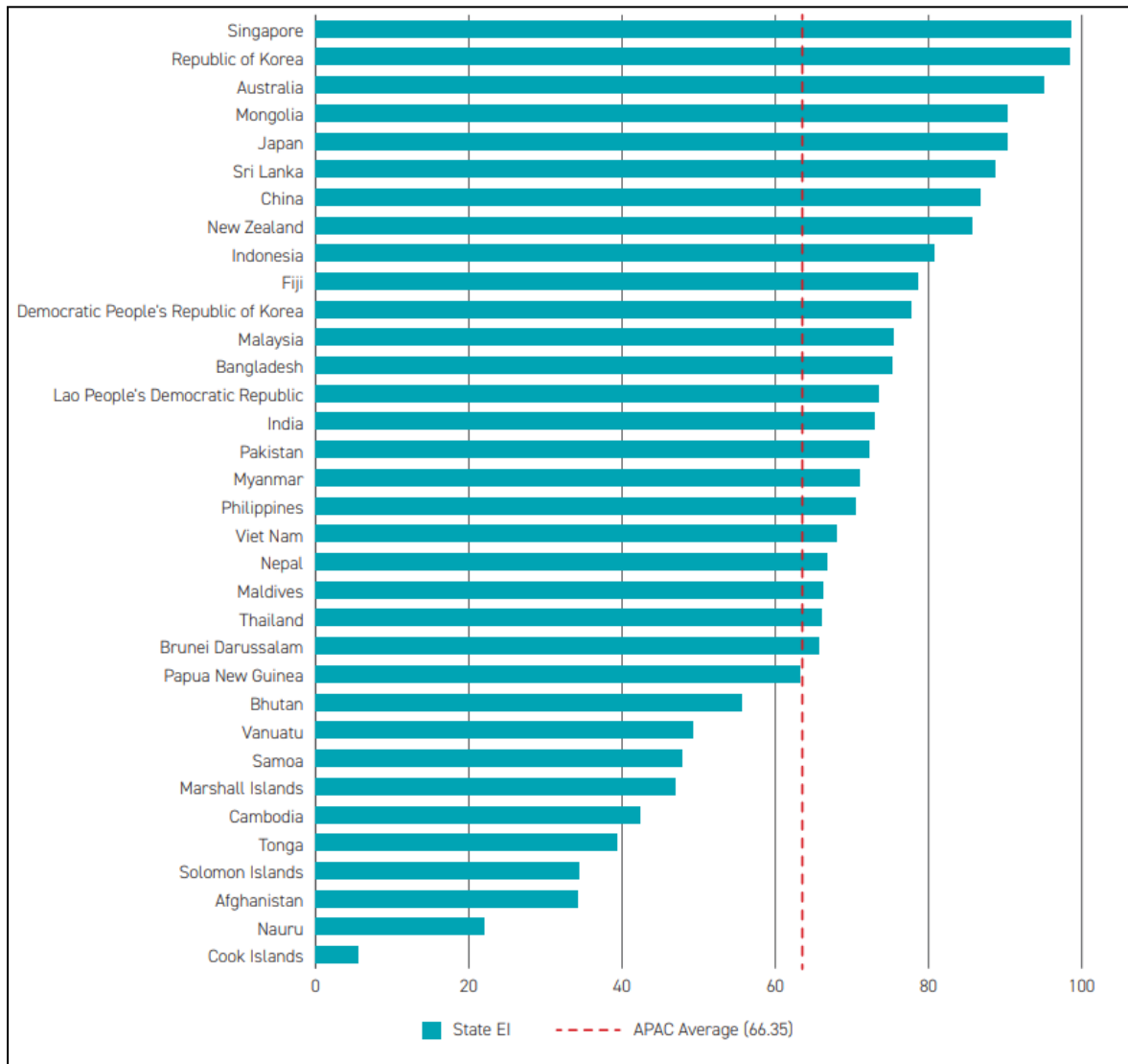
(8) Coordination of ICAO matters with all agencies and sending replies to State Letters, and taking all necessary action arising out of the Universal Safety Oversight Audit Programme (USOAP) of ICAO;

Besides the DGCA, there are multiple authorities/statutes responsible for the regulation of civil aviation and aviation safety in India, like the Ministry of Civil Aviation (MoCA), Airports Authority of India (AAI), Airports Economic Regulatory Authority (AERA), the Suppression of Unlawful Acts Against Safety of Civil Aviation Act 1994 and Bureau of Civil Aviation Security (BCAS). The National Aviation Safety Plan of India incorporates the Safety Enhancement Initiatives (SEI) in the Regional Safety Plan of RASG-APAC. It aligns with the Global Aviation Safety Plan of ICAO. Still, concerns have been expressed about whether the Indian skies are getting safer or unsafe.

In recent months, the issue of aviation safety has been brought to the forefront in India due to a series of technical faults and emergency landings; for instance, in October 2022, smoke was detected in a SpiceJet flight cabin, and the aircraft made an emergency landing in Hyderabad. India has witnessed a surge in demand for air travel since the lifting of COVID restrictions, as opposed to the slump in passenger numbers for most of the past two-and-a-half years due to the pandemic. Some experts say airlines are unprepared for this sharp rise in demand, which puts

pressure on the infrastructure. According to the Airports Authority of India, air traffic services would need 40% more staff this year to boost its current strength of 3,163 personnel.

The aviation safety audit conducted by the International Civil Aviation Organisation (ICAO), an organ of the United Nations (UN), ranked India below Bangladesh, Sri Lanka, and other countries in the Asia-Pacific region as per the 2022 audit report published in October 2022. The audit focuses on a State’s capability to provide safety oversight by assessing whether it has effectively and consistently implemented the critical elements (CE) of a safety oversight system. It also determines the State’s level of implementation of ICAO’s safety-related standards and recommended practices (SARPs), associated procedures and guidance material.



The overall effective implementation (EI) for the RASG-APAC region in 2022

(Source: Annual Safety Report 2022 Asia Pacific Region)

Though the DGCA has maintained that a majority of daily incidents had no adverse "safety implications" and were indicative of "a robust safety management system", it has tightened oversight and surveillance in recent months. Ramp inspections of aircraft have been increased. One-off authorisations for aviation medical examiners, a common practice in the past, have been stopped. Airline-specific action, like curtailing the proposed schedule, has been taken in certain cases of negligence. For instance, in July 2022, the regulator slapped a 50% flight capacity restriction on SpiceJet following a dozen safety incidents in the span of weeks.

With concerns being expressed over the effectiveness of DGCA, the government has also tried to strengthen the aviation regulator in the last few months. According to the latest data, the authority is conducting nearly 4,000 spot checks, audits, and night surveillance in a year. This number is up considerably from previous years, and it is likely to continue to grow with the addition of new staff. It plans to increase the workforce from the current 1,300 to at least 1,700 in the next year or two.⁵ 416 new posts have been created for a traditionally short-staffed organisation.

According to former chief Shri Arun Kumar, *'the main area of focus is building up capacity in the accident investigation bureau. India has jumped in the rankings from 130th in 2017 to 49th in 2022 in ICAO's safety oversight capabilities. However, cracking the top 25 will require a larger Air Accidents Investigation Bureau (AAIB)'*. Dehradun, Jaipur, Nagpur and Agartala have added four new sub-regional offices. Additionally, upgrades in the Sub-regional offices have been made and they have been converted into regional offices for better administration. A new regional office has also been established in Ahmedabad.

⁵ Sharma, A. (2023, January 24). DGCA to add 1,000 personnel by 2030 to ensure safer skies | Mint. Mint. <https://www.livemint.com/companies/news/dgca-to-add-1-000-personnel-by-2030-to-ensure-safer-skies-11674580713182.html>

Keeping in mind the wellbeing of the staff involved in the aviation industry, in February 2023, it also issued a directive to set up a mental health assessment as part of certification for new flight crew and air traffic controllers. Moreover, rather than being a punitive assessment, the test aims to pair candidates with those in similar positions currently as part of a Peer Support Program.

Way Forward

The rapid pace of global air traffic increases brings new challenges that must be resolved to ensure that the increased traffic can be handled safely and smoothly by minimising chances for both human and mechanical failure as much as possible. Here are certain recommendations to address some major concerns afflicting the aviation industry.

1. New materials and Computer-aided Aviation - With composite materials and the increasing use of digital technology and electronics, many new technologies have helped improve safety, such as the GPS Aided GEO Augmented Navigation (GAGAN) program, a satellite-based augmentation system (SBAS) jointly developed by AAI and ISRO. However, technology has the potential to create unanticipated consequences, according to Jon Downey, Head of Aviation – US, AGCS. “Once, pilots relied on their ‘steam gauges’ and had very little live data at their fingertips. Now the information available can be overwhelming”. While ‘glass cockpit’ technology gives much better visual awareness, it also raises issues, as was seen in the loss of the Air France Flight 447 in 2009 with 228 people on board. Accident investigators concluded that the pilots became confused by the plane’s instrumentation and took inappropriate action when the Airbus A330 flew into turbulence during a tropical thunderstorm over the Atlantic Ocean.
2. Next-generation aeroplanes - Aircraft design is set to change dramatically, especially when flying is to be kept affordable as fuel costs climb. This would bring about new

forms of innovative propulsion – such as electric, hybrid or solar-powered planes – radical new airframe designs and new techniques, like assisted take-offs or unpowered landings.

3. Incorporating Visualisation Tools - Another next-gen technology researchers are working on is the use of Visualisation Tools. They include an infrared video camera in the nose. Its images appear on a screen, along with data from the aircraft's flight computer, to give pilots the ability to “see” through all the fog. In case of bad visibility, flight crews could pull up a 3-D image of the terrain around them from a vast database of maps. The plane's location within this virtual terrain is continuously updated from GPS data. Researchers also plan to eventually incorporate some of these visualisation tools into helmet-like displays, which would allow pilots to scan their windows without losing track of vital flight information. For instance, EPOQUES is a collection of specific systems which aims to gather and analyse radar recordings and audio communications. It proposes underlying tools and methods to treat Air Traffic Management (ATM) safety occurrences, such as helping operators to detect and analyse situations when two aircraft went beyond safety distance. The Indian aviation sector must take a cue and develop similar systems.

4. Revising the 'outdated' 90-second passenger evacuation standard - Aviation regulators need to ensure that the 90-second passenger evacuation standard as a measure of aeroplane airworthiness is revised according to real experiences. For instance, all passengers and crew survived when an Emirates 777-300 caught fire at Dubai airport in 2016, but evacuation took 6 min 40s. The main point of consideration here is that the evacuation process depends on a multiplicity of factors. These would include a broad range of passenger ages, heights and weights, passengers with reduced mobility, and those who need more communication abilities. The revision should consider the presence of carry-on baggage, plus the effect of seat configuration, size and pitch.

5. Comprehensive Counter-Terrorism/Hijacking Convention - Multiple universal counter-terrorism instruments/conventions on acts affecting in-flight safety already exist - such as the 1963 Convention on Offences and Certain Other Acts Committed On Board Aircraft, 1970 Convention for the Suppression of Unlawful Seizure of Aircraft and the 1971 Convention for the Suppression of Unlawful Acts against the Safety of Civil Aviation. Though these universal instruments create obligations for States parties to adopt substantive criminal and procedural law measures to counter various acts of terrorism, as well as administrative measures in some cases to combat the financing of terrorism, no foundational treaty or comprehensive legal regime currently exists for terrorism and counter-terrorism. In 2000, India informally circulated a draft treaty text for a comprehensive convention to the Ad Hoc Committee on International Terrorism (report C.6/55/L.2, Annex II). Since then, Member States have been negotiating the text of the Draft Comprehensive Convention on International Terrorism.

6. Encouraging a Just Culture - One key to the successful implementation of safety regulation is to attain a “just culture” reporting environment within aviation organisations, regulators and investigation authorities. This effective reporting culture depends on how those organisations handle blame and punishment by creating an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related information - but in which they are also clear about acceptable and unacceptable behaviour. Supports learning from unsafe acts to improve safety awareness through the recognition of safety situations and helps develop conscious articulation and sharing of safety information. Consequently, a Just Culture can be regarded as an enabler and even an indicator of (a good) Safety Culture.

In conclusion, airline safety is a critical issue that requires a proactive and innovative approach. Moving beyond compliance with safety regulations and standards, the aviation industry must embrace a culture of safety that encompasses all aspects of airline operations. This means moving beyond a focus on simply complying with safety regulations and standards and instead taking a more comprehensive approach that considers all aspects of airline operations. By

investing in training, education, and collaboration, airlines can ensure that air travel remains safe and secure for everyone.

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