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# Fatigue on the Flight Deck: Commercial Pilots' Perceptions of Fatigue-Related Performance Impairment and Its Duty-Related Causes

Author: Ranvijay Singh Yadav
Institution: Shiv Nadar School, Gurgaon
Mentor: Captain Abhinav Yadav

## ABSTRACT

Fatigue is a long-standing hazard in commercial aviation. Laboratory studies show that sleep loss and circadian disruption slow reactions and impair attention and decision making. Far fewer studies ask working pilots how fatigue affects their own flying, or which parts of their rosters they blame for it. This study is built on original survey data collected by the author from 51 commercial pilots. They answered anonymously about how often they feel fatigued on duty, how it affects their flying, which duty factors contribute to it most and whether they know how to report it. The results are read against sleep research, earlier pilot surveys, accident studies and the fatigue rules of the International Civil Aviation Organization (ICAO), the Federal Aviation Administration (FAA), the European Union Aviation Safety Agency (EASA) and India's Directorate General of Civil Aviation (DGCA). Most pilots (88.2 percent) felt fatigued on duty at least sometimes in the previous three months and 29.4 percent often or always. Two-thirds reported at least one microsleep on the flight deck outside planned controlled rest, including every pilot who was fatigued often or always and answered the question. Almost all agreed that fatigue slows their reactions. Descent and approach was the phase most often named as affected by fatigue. Extended duties, consecutive early starts and crossing time zones were rated the biggest contributors to fatigue, while long duty hours came eighth out of ten. Captains and first officers did not differ significantly, and neither did more and less experienced pilots or short- and long-haul pilots, although some groups were small. Pilots generally knew how to report fatigue, yet several described reports being dismissed or logged as sick leave. For these pilots fatigue is a routine part of flying and the way duties are timed and stretched seems to matter more than length.

***Keywords****:* Pilot Fatigue, Flight Duty Time Limitations, Aviation Safety, Human Factors, Circadian Disruption, Fatigue Risk Management, DGCA, Survey

# 1. INTRODUCTION

Commercial aviation is still one of the safest ways to travel, mostly due to the fact that the industry assumes that skilled people will still make mistakes and builds checklists, crew procedures and automation around that assumption, fatigue makes those mistakes more likely. A tired pilot is still a trained professional but their attention drifts and their reactions may slow, often at the moment an unexpected event needs them most fatigue also leaves no physical evidence, so it is noticed only after something has gone wrong.

The International Civil Aviation Organization (ICAO) defines fatigue as a physiological state of reduced mental or physical performance which results from sleep loss, extended wakefulness, circadian phase or workload, which can impair a crew member's alertness and ability to operate an aircraft safely (ICAO, 2015). Accident investigators have repeatedly found fatigue to be among the conditions that preceded disaster. The U.S. National Transportation Safety Board (NTSB) identified fatigue issues in its investigation of Korean Air Flight 801 in Guam in 1997 (NTSB, 2000) and examined crew fatigue at length after the crash of Colgan Air Flight 3407 in 2009 (NTSB, 2010), an accident that helped drive the overhaul of U.S. flight and duty rules.

The issue is especially current in India. In January 2024 the Directorate General of Civil Aviation (DGCA) notified revised Flight Duty Time Limitations. Weekly rest went up to 48 consecutive hours, the definition of night was widened to midnight to 6 a.m. and night landings and consecutive night duties were capped (DGCA, 2024). At the airlines' request the rules came into effect in two phases, first in July 2025 and the second in November 2025.

Within weeks of the second phase, crew shortages at India's largest airline had led to mass cancellations, and the regulator granted temporary relief from some of the new night-duty rules (Tribune News Service, 2025). The episode shows the basic tension in fatigue regulation. Limits that protect pilots also reduce how much an airline can fly and when the two clash the pressure to relax the limits comes quickly.

This paper does not ask whether fatigue impairs performance, because the laboratory evidence on that point is already strong. It asks how fatigue is experienced by the people who fly. The central question is how commercial pilots perceive the impact of fatigue on their in-flight performance and which duty factors they associate most with fatigue.

Pilots' own accounts matter because they show which impairments are noticeable on a real flight deck, and which parts of a roster feel most tiring. These may not be the parts that regulations

limit most tightly. Fatigue management systems also rely on pilots recognising and reporting their own fatigue, so the way pilots understand fatigue shapes the data that safety decisions rest on.

The paper's central claim is that what makes pilots tired is less how long they fly than how their duties are timed and stretched. Extensions, early starts, time-zone changes and late-to-early transitions do much of the damage, and because fatigue rules are built mainly around duty length, a large part of pilot fatigue falls outside them. The survey suggests this kind of fatigue is part of ordinary line flying.

The paper's main contribution is original data. The author designed and distributed a survey to working airline pilots and collected 51 responses between 17 and 22 October 2026, so the findings come straight from the pilots who operated these flights. It goes further than most earlier surveys by asking pilots about their personal fatigue levels and their performance in particular areas while also studying how different pilot positions, experience levels and operational settings affect their responses.

The paper is structured as follows, Section 2 reviews the literature, from the science of sleep and fatigue to pilot surveys and the regulation of duty time, Section 3 sets out the research questions, hypotheses and method, Section 4 presents the findings of the author's pilot survey, tests the paper's claim against them and discusses what the findings mean, Section 5 offers policy suggestions, Section 6 considers the future outlook, and Section 7 concludes.

## 2. LITERATURE REVIEW

This review moves from the science of why fatigue builds up to what it does to performance, how it shows up in real flying, and how regulators have tried to control it. Running through all of it is a point that matters for this paper. The timing and pattern of duties shape fatigue at least as much as their length.

### 2.1 Why Fatigue Builds Up

The most influential account of sleepiness is the two-process model (Borbély, 1982). The level of alertness in people depends on their homeostatic sleep pressure which accumulates during wakefulness and releases through sleep and their circadian rhythm which operates as an internal 24-hour clock to promote daytime alertness and nighttime sleepiness. The time between 2 and 6

a.m. represents the circadian low which aviation authorities have designated as the window of circadian low because people experience their lowest alertness when they stay awake for extended periods during this specific time.

For pilots, this explains why the timing of a duty matters as much as its length. Night duties put work inside the circadian low. Early starts force pilots to wake during it and usually shorten their sleep. Crossing time zones shifts the external day faster than the body clock can follow. Sleep loss also accumulates. Van Dongen et al. (2003) showed that two weeks of six-hour nights produced attention deficits comparable to total sleep deprivation, while participants' ratings of their own sleepiness levelled off. Consecutive duties with short rest should therefore produce cumulative fatigue, and pilots' own reports may understate it.

### 2.2 What Fatigue Does to Performance

Dawson and Reid (1997) showed that after 17 to 19 hours awake, performance on a coordination task matched performance at a blood alcohol concentration of 0.05%. Reviews of aviation fatigue describe slower reactions, lapses of attention, poorer decision-making and degraded communication as typical effects (Bendak & Rashid, 2020; Caldwell, 2005; Caldwell et al., 2009), and a meta-analysis found attention and vigilance to be the functions most sensitive to sleep loss (Lim & Dinges, 2010). Pilots themselves describe sleepiness, slowed thinking, difficulty concentrating and irritability (Petrie & Dawson, 1997).

Fatigue alone rarely causes an accident. Reason's (1990) model treats accidents as failures at several levels lining up, and the Human Factors Analysis and Classification System places fatigue among the preconditions for unsafe acts (Shappell & Wiegmann, 2000). This places responsibility on rostering decisions and regulatory limits as well as on the individual pilot. The system shows that other safety barriers including a second pilot and air traffic control (ATC) personnel identify most fatigue-related errors during their operations.

### 2.3 Fatigue in Real Operations and Accident Records

Operational studies support the importance of timing. Roach et al. (2012) found that short-haul pilots slept progressively less the earlier their duty started. Honn et al. (2016) showed that regional pilots were more fatigued on days with more take-offs and landings, and Vejvoda et al. (2014) found time awake to be a strong predictor of fatigue on short-haul flights.

Accident records add a further perspective, though they show how hard fatigue is to measure after the event. Becker (2023) examined 70 U.S. airline (Part 121) accidents between 2000 and 2019 and found no significant link between accidents and later duty hours. Almost two-thirds (64.3%) occurred in the first quarter of the duty day. Even so, 5% happened after the eleventh hour, which fits Caldwell's (2005) observation, based on Goode (2003), that accidents are over-represented in the small share of duty time beyond 13 hours. Becker also noted that the NTSB named fatigue as a probable cause in only 7 of the 70 accidents, and that duty time understates time awake because commuting to base is not counted as duty.

### 2.4 What Pilots Report

Surveys of pilots, the approach closest to this study, find fatigue widespread. Bourgeois-Bougrine et al. (2003) surveyed 739 airline pilots and found that short-haul pilots blamed multiple sectors and early starts, while long-haul pilots blamed night flights and time-zone changes. Jackson and Earl (2006) found a high prevalence of fatigue among United Kingdom (UK) pilots, many of whom said it had led them to make errors. Reis et al. (2016) and Aljurf et al. (2018) reported similar findings in Portugal and the Gulf states, where 45.1% of pilots said they had fallen asleep at the controls at least once. Coombes et al. (2020) found that a quarter of 294 UK pilots had less than six hours' sleep opportunity after their duties. Brezonakova (2023) surveyed 43 short-haul pilots at a UK airline, who knew their reporting procedures well and most often blamed long duty hours and extended duties.

Surveys also show how poorly fatigue is reported. In a 2014 survey of 2,202 UPS pilots, 96% said they had felt fatigued on duty without reporting it, and 75% said they would rather call in sick (Independent Pilots Association, 2014, as cited in Becker, 2023). Survey evidence has limits, since fatigued people underestimate their impairment (Van Dongen et al., 2003). But subjective sleepiness is a sensitive indicator of insufficient sleep and impaired function (Åkerstedt et al., 2014), and only surveys show how pilots themselves interpret fatigue and which duties they think should change.

### 2.5 Regulatory Context

ICAO requires states to regulate crew fatigue through prescriptive limits on flight time, duty and rest, through Fatigue Risk Management Systems (FRMS), or both, but leaves the detail to each state (ICAO, 2015). In the United States, the Colgan Air accident led to Part 117 of Title 14 of

the Code of Federal Regulations (14 CFR Part 117), which took effect in 2014 and makes the maximum duty period depend on the start time and the number of segments (FAA, 2011). All-cargo operations were not required to comply, and bills to extend the rule to cargo pilots had still not passed by 2023 (Becker, 2023). European operators have applied EASA flight time limitations since 2016. These also vary duty limits with reporting time and sectors, and allow extensions of up to one hour no more than twice in seven days (European Commission, 2014). India's revised Civil Aviation Requirement, notified in January 2024, raised weekly rest from 36 to 48 hours, defined night as midnight to 6 a.m., reduced permitted night landings and limited pilots to two consecutive night duties (DGCA, 2024). It took full effect in November 2025, but within weeks crew shortages at IndiGo led the DGCA to withdraw the bar on substituting leave for weekly rest and to grant a temporary exemption from some night-duty limits (Tribune News Service, 2025). The exemption ended on 10 February 2026, when IndiGo told the regulator it would comply fully (Business Today, 2026).

All three systems now recognise that when duties happen matters as well as how long they last. But prescriptive rules protect only against the factors they cover, and factors such as roster changes, unrealistic block times and late-to-early transitions are hard to capture in numerical limits (Dawson & McCulloch, 2005). Duty limits also stop at the airport. Commuting to base is not counted as duty in U.S. rules, and a National Research Council (2011) study of more than 25,000 U.S. pilots found that 22% lived more than 1,200 km (750 miles) from their base.

### 2.6 The Gap

Most pilot surveys come from Europe or North America, and many predate current rules. Few ask pilots which areas of their own performance fatigue affects, and almost none cover pilots flying under India's revised limits. This study helps fill that gap with original data.

## 3. METHODOLOGY

The aim of this paper is to understand how commercial pilots experience fatigue in routine line operations. The research study investigates the frequency of pilot fatigue during their work hours while identifying which aspects of their flight duties they think it affects most. It also asks which duty factors they associate most strongly with fatigue, and whether these perceptions differ by role, flying experience or type of operation.

Earlier research suggests what the answers should be. A majority of pilots should report fatigue on duty at least sometimes, and those who report it more often should also report greater impairment. Duty-length factors such as long duty hours and extended duties should rank among the strongest contributors, as they did in earlier surveys. And the factors should differ by operation, with short-haul pilots rating early starts and multiple sectors higher and long-haul pilots rating night duties and time-zone crossings higher.

The paper is based on primary data. It combines a cross-sectional survey of pilots, designed and run by the author, with a review of the scientific literature and a comparative analysis of fatigue regulation. A survey was chosen because the research question concerns pilots' own perceptions, which cannot be obtained from accident data or laboratory studies. The survey was built in Google Forms and deliberately kept to ten questions, taking about three minutes. An earlier and longer version was pilot-tested with a small group of pilots, and their feedback that it took too long led to it being shortened to reduce the risk of respondents abandoning it partway through. Each remaining question either answers one of the research questions or allows comparison with earlier pilot surveys.

The survey began by asking participants about their role, total flying hours and main type of operation, The survey asked pilots about their experience with fatigue during their last three months of duty and their occurrence of microsleep episodes while they were on the flight deck. The survey contained six statements which asked participants about how fatigue affected their reactions, concentration, situational awareness, decision-making, checklist use and communication, followed by a question on which phase of flight it affects most. Pilots then rated ten duty factors. The last section used three statements on knowing when, where and why to report fatigue, adapted from Brezonakova (2023) and an optional comment box. The full survey is given in Appendix B.

Participants were commercial pilots currently flying, recruited through professional contacts and pilot networks using convenience and snowball sampling. The responses analysed here were collected between 17 and 22 October 2026, participation was voluntary and anonymous. No names, email addresses or airline names were collected, and pilots gave informed consent on the first page before any questions appeared. All 51 pilots who completed the survey gave consent, and all 51 responses were included. Rows in the grid questions were not compulsory, so a few

pilots skipped individual items. Where fewer than 51 answered an item, the number answering is reported.

Responses were analysed in Python using the pandas and SciPy libraries. Results are reported as the percentage of pilots choosing each response, with medians for ordinal items. The six performance statements were averaged into a single performance impairment score, and duty factors were ranked by mean rating. Groups were compared using Mann–Whitney U and Kruskal–Wallis tests, associations between items were tested with Spearman's rank correlation and Fisher's exact test, and significance was set at $p < 0.05$. Because some groups were small (eight first officers, eight pilots with fewer than 5,000 hours and eight short-haul pilots), group comparisons are treated as exploratory. Open comments were analysed thematically (Braun & Clarke, 2006).

The survey data are the core of the paper. The study depends on peer-reviewed articles about sleep and fatigue effects on pilot performance and on regulatory texts and accident reports from ICAO, the Federal Aviation Administration (FAA), the European Union Aviation Safety Agency (EASA), the DGCA and the NTSB.

Two limitations should be noted at the outset. The survey records what pilots perceive, and their actual performance was not measured. The sample was also a convenience sample. The findings show how one group of working pilots experience fatigue and they should not be read as precise estimates for the whole profession.

## 4. RESULTS AND DISCUSSION

### 4.1 Participants

The findings in this section come from the author's own survey of working pilots. In total, 51 pilots completed it (Table 1). The sample was highly experienced. Of the 51, 43 (84.3%) were captains and 43 (84.3%) had more than 5,000 flying hours, including 33 (64.7%) with more than 10,000. Long-haul was the most common type of operation (39.2%), followed by mixed (25.5%), medium-haul (19.6%) and short-haul (15.7%). Nationality was not asked, but several comments refer to the DGCA and to Indian operators, which suggests that most respondents fly for Indian airlines.

**Table 1: Participant Characteristics (N = 51)**

| Characteristic | Category | n | % |
|---|---|---|---|
| Role | Captain | 43 | 84.3 |
| | First Officer | 8 | 15.7 |
| Flying hours | Under 1,500 | 1 | 2.0 |
| | 1,500–5,000 | 7 | 13.7 |
| | 5,001–10,000 | 10 | 19.6 |
| | Over 10,000 | 33 | 64.7 |
| Operation | Short-haul | 8 | 15.7 |
| | Medium-haul | 10 | 19.6 |
| | Long-haul | 20 | 39.2 |
| | Mixed | 13 | 25.5 |

### 4.2 Fatigue Incidence

Fatigue on duty was close to universal but mostly occasional (Table 2). Of the 51 pilots, 30 (58.8%) felt fatigued sometimes, 15 (29.4%) often or always, and only 6 (11.8%) rarely or never. In total, 45 pilots (88.2%) felt fatigued on duty at least sometimes in the previous three months.

**Table 2: Frequency of On-Duty Fatigue in the Past Three Months (N = 51)**

| Response | n | % |
|---|---|---|
| Never | 2 | 3.9 |
| Rarely | 4 | 7.8 |
| Sometimes | 30 | 58.8 |
| Often | 11 | 21.6 |
| Always | 4 | 7.8 |

Microsleeps were common. In the previous three months, 23 pilots (45.1%) reported more than one microsleep on the flight deck outside planned controlled rest, 11 (21.6%) reported one and 9 (17.6%) reported none. Another 8 (15.7%) preferred not to say. In all, 34 pilots reported at least one microsleep, which is 66.7% of the whole sample and 79.1% of the 43 who answered. All 13 pilots who were fatigued often or always and answered the question reported at least one microsleep, and 11 of them more than once. Among the other 30 pilots who answered, 21 (70.0%) did. This difference was statistically significant (Fisher's exact test, $p = 0.039$).

### 4.3 Perceived Effects on Performance

Pilots agreed most strongly that fatigue slows their reactions. Of the 51, 50 (98.0%) agreed or strongly agreed and one was neutral (Table 3). Agreement was also high for difficulty concentrating (88.2%) and reduced situational awareness (80.4%). It was lower for poorer decision-making (66.7%), communication with ATC or crew (62.7%) and missing or rushing checklist items (54.9%). The six items formed a reliable scale (Cronbach's alpha = 0.78), giving a mean performance impairment score of 3.90 out of 5 (median 4.00, interquartile range 3.50–4.17). Pilots who were fatigued more often reported slightly greater impairment, but the link was not significant (Spearman's rho = 0.25, p = 0.082). Pilots who reported more impairment did, however, rate the duty factors as more fatiguing overall (rho = 0.28, p = 0.044).

**Table 3: Perceived Effects of Fatigue on Performance (Percentage of Pilots, N = 51), Ordered by Agreement**

| When fatigued on duty... | Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Agree or strongly agree |
|---|---|---|---|---|---|---|
| My reactions are slower | 33.3 | 64.7 | 2.0 | 0.0 | 0.0 | 98.0 |
| I find it harder to concentrate | 23.5 | 64.7 | 9.8 | 2.0 | 0.0 | 88.2 |
| My situational awareness is reduced | 27.5 | 52.9 | 15.7 | 3.9 | 0.0 | 80.4 |
| My decision-making is poorer | 17.6 | 49.0 | 25.5 | 7.8 | 0.0 | 66.7 |
| My communication with ATC or crew suffers | 17.6 | 45.1 | 23.5 | 11.8 | 2.0 | 62.7 |
| I miss or rush checklist items | 15.7 | 39.2 | 29.4 | 15.7 | 0.0 | 54.9 |

Almost half the pilots (25, 49.0%) named descent and approach as the phase most affected by fatigue, followed by cruise (16, 31.4%), landing (9, 17.6%) and take-off and climb (1, 2.0%). Descent, approach and landing together accounted for two-thirds of answers (66.7%). The answer depended on type of operation. Half of the 20 long-haul pilots named cruise, while 6 of the 8 short-haul pilots named descent and approach, and medium-haul pilots were split evenly between landing and descent and approach (4 each of 10).

### 4.4 Duty Factors

Extended duties were rated the strongest contributor to fatigue, with a mean of 4.00, and 72.0% of pilots said they contributed very much or extremely (Table 4). Consecutive early starts (mean 3.80) and crossing time zones (3.78) came next. Multiple sectors in one duty was rated lowest, at 3.43. Every factor except multiple sectors had a median of 4 ("very much"), and the means spanned only 0.57 points. Pilots therefore regarded nearly every factor as a substantial contributor.

**Table 4: Duty Factors Contributing to Fatigue, Ranked by Mean Rating (1 = Not at All, 5 = Extremely)**

| Rank | Factor | n | Mean (SD) | Very much or extremely, % |
|---|---|---|---|---|
| 1 | Extended duties | 50 | 4.00 (1.09) | 72.0 |
| 2 | Consecutive early starts | 49 | 3.80 (1.06) | 69.4 |
| 3 | Crossing time zones | 49 | 3.78 (1.05) | 69.4 |
| 4 | Night duties | 46 | 3.74 (0.98) | 65.2 |
| 5 | Late-to-early roster transitions | 48 | 3.73 (1.14) | 66.7 |
| 6 | Short rest between duties | 46 | 3.70 (0.96) | 69.6 |
| 7 | Unrealistic block times | 49 | 3.69 (1.16) | 63.3 |
| 8 | Long duty hours | 50 | 3.60 (0.93) | 62.0 |
| 9 | Roster changes | 46 | 3.54 (1.09) | 54.3 |
| 10 | Multiple sectors in one duty | 46 | 3.43 (1.13) | 50.0 |

*Note.* SD = standard deviation.

### 4.5 Fatigue Reporting

Most pilots knew how to report fatigue (Table 5). Of those who answered, 84.0% agreed that they had a clear idea when to report fatigue, 90.0% where and 90.2% why. Knowing when to report was the weakest of the three. Only three pilots disagreed with any statement, all on knowing when to report, and two of the three were first officers with fewer than 5,000 hours.

**Table 5: Knowledge of Fatigue Reporting (Percentage of Pilots)**

| Statement | n | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
|---|---|---|---|---|---|---|
| I have a clear idea when to report fatigue | 50 | 32.0 | 52.0 | 10.0 | 4.0 | 2.0 |
| I have a clear idea where to report fatigue | 50 | 48.0 | 42.0 | 10.0 | 0.0 | 0.0 |
| I have a clear idea why to report fatigue | 51 | 43.1 | 47.1 | 9.8 | 0.0 | 0.0 |

### 4.6 Differences Between Groups

None of the main outcomes differed significantly between captains and first officers, between pilots with fewer and more than 5,000 hours, or between short-haul and medium- or long-haul pilots (Table 6). Across all four operation types, fatigue frequency (Kruskal–Wallis $H = 5.48$, $p = 0.140$) and performance impairment ($H = 2.19$, $p = 0.533$) also did not differ.

No single duty factor differed significantly between groups either, although a few came close. First officers rated short rest between duties higher than captains (4.25 vs 3.58, $p = 0.058$), and pilots with fewer than 5,000 hours did the same compared with more experienced pilots (4.25 vs 3.58, $p = 0.058$). Seven of the eight first officers were also in the under-5,000-hour group, so these are largely the same finding. Long-haul pilots rated long duty hours higher than all others (3.90 vs 3.40, $p = 0.077$), and short-haul pilots rated multiple sectors higher than medium- and long-haul pilots (4.12 vs 3.33, $p = 0.104$).

**Table 6: Outcomes by Pilot Group (Group Means and Mann–Whitney U Test Results)**

| Outcome | Captain (n = 43) vs First Officer (n = 8) | Under 5,000 h (n = 8) vs 5,000 h+ (n = 43) | Short-haul (n = 8) vs medium/long-haul (n = 30) |
|---|---|---|---|
| Fatigue frequency (1–5) | 3.21 vs 3.25, p = 0.907 | 3.25 vs 3.21, p = 0.907 | 3.12 vs 3.40, p = 0.260 |
| Performance impairment score (1–5) | 3.87 vs 4.08, p = 0.314 | 4.08 vs 3.87, p = 0.314 | 3.71 vs 4.01, p = 0.278 |
| Mean duty factor rating (1–5) | 3.61 vs 3.76, p = 0.765 | 3.84 vs 3.59, p = 0.484 | 4.01 vs 3.67, p = 0.258 |
| Highest-rated factor | Extended duties vs short rest | Short rest vs extended duties | Extended duties vs extended duties |
| Knows when to report (1–5) | 4.19 vs 3.50, p = 0.145 | 3.50 vs 4.19, p = 0.145 | 4.00 vs 4.03, p = 0.793 |

*Note. Mixed-operation pilots (n = 13) are excluded from the short- vs medium/long-haul comparison.*

### 4.7 Open Comments

Sixteen pilots (31.4%) left a comment. Thematic analysis identified five recurring themes, and a single comment could contribute to more than one.

**Table 7: Themes in Open Comments (n = 16)**

| Theme | Pilots | What pilots said |
|---|---|---|
| Regulation and oversight seen as inadequate or not independent | 7 | Limits need revising; fatigue is cumulative and individual, which regulations miss; FRMS should be set by the regulator, not designed by operators; airlines and the regulator are too close; independent monitoring is needed |
| Rest and accommodation | 4 | Minimum rest at layovers, poor hotels far from town, travel to and from hotels, limited seat recline on the flight deck |
| Distrust or difficulty of fatigue reporting | 3 | Reports dismissed or recorded as sick leave; reporting forms too long; reports not investigated independently |
| Rostering and use of duty time | 3 | Very early starts with halts, frequent roster changes, delays caused by ground handling, standbys, training tasks added after flights, continuous night duty |
| Organisational and mental stress | 2 | Pay, financial stress, management attitudes and administrative load ("read and sign") producing fatigue that is "more mental than physical" |

The largest theme concerned regulation. One pilot wrote: "Fatigue is cumulative and most importantly specific to each individual. This is missed in most regulations." Another argued that "fatigue management should be in form of a CAR [Civil Aviation Requirement] rather than operators making FRMS to suit their own motives." Comments on reporting described a gap between procedure and practice. One pilot said that fatigue reports were not accepted and were instead recorded as sick leave, reducing the pilot's leave allowance.

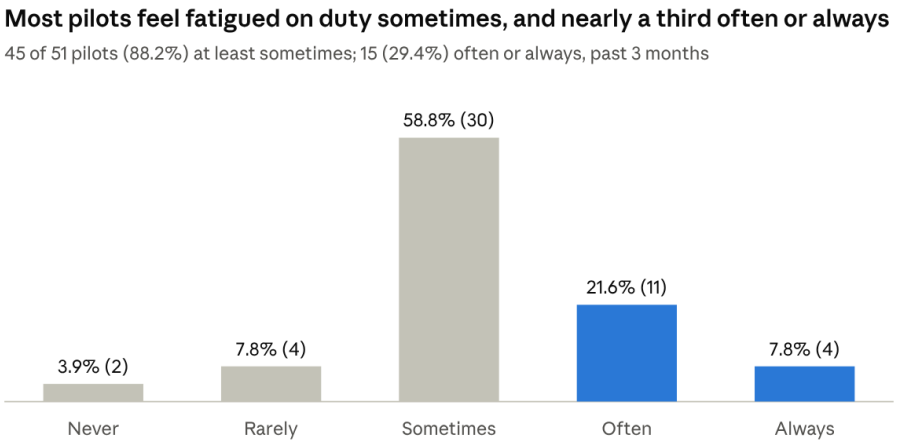
### 4.8 Trends and Statistical Analysis

If the paper's claim holds, fatigue should be common among working pilots and not limited to unusual rosters. Its effects should fall mainly on attention, which sleep research identifies as the most vulnerable function. Pilots should also rate the way duties are timed and stretched above the length of duties. The data bear this out.

Fatigue is a routine part of line flying for the pilots surveyed, and even occasional fatigue reaches unsafe levels. In all, 88.2% felt fatigued on duty at least sometimes, although most (58.8%) chose "sometimes" over "often" or "always" (Figure 1). Microsleeps, however, were reported by two-thirds of all pilots (66.7%), an outcome in which the pilot briefly stops monitoring the aircraft. Every pilot who was fatigued often or always and answered the question

reported one, a significantly higher rate than among the rest ($p = 0.039$). Yet microsleeps were not confined to the most fatigued pilots, since 19 of the 25 pilots (76.0%) who were fatigued only sometimes also reported one. Occasional fatigue therefore appears to be enough to produce the most dangerous kind of lapse.

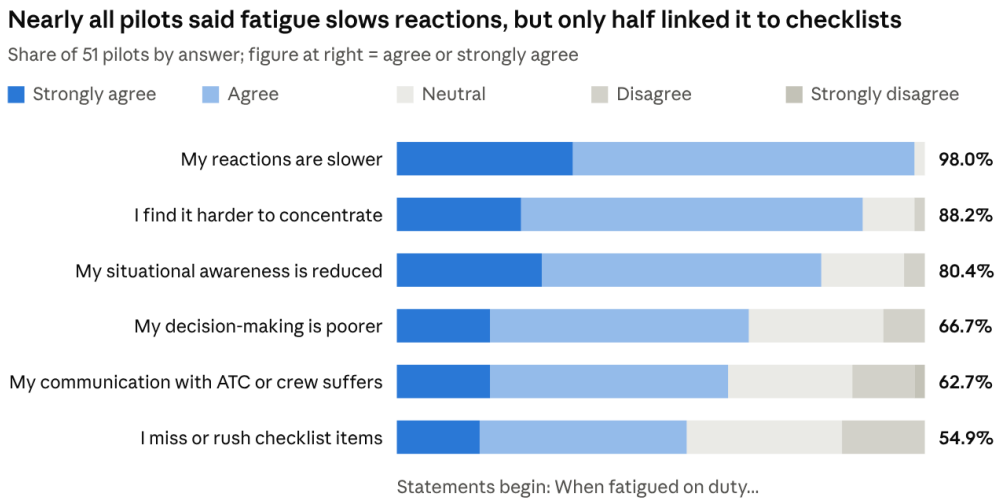
**Figure 1: Frequency of On-Duty Fatigue in the Past Three Months**




*Note.* Data from the author's survey, 17–22 October 2026 (N = 51), question 4.

Pilots see fatigue as affecting attention more than procedure. Agreement was near-unanimous for slower reactions (98.0%) and high for difficulty concentrating (88.2%) and reduced situational awareness (80.4%), but lower for checklist use (54.9%) and communication (62.7%) (Figure 2). This order matches laboratory evidence that attention and vigilance are the functions most sensitive to sleep loss (Lim & Dinges, 2010), while well-practised procedures hold up better.

**Figure 2: Perceived Effects of Fatigue on Performance**

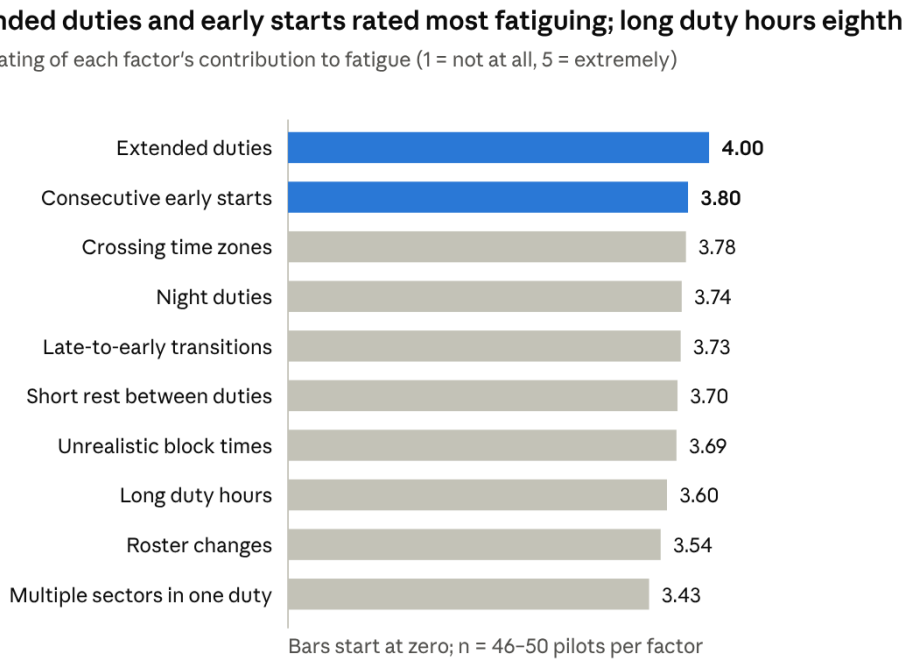



*Note.* Data from the author's survey, 17–22 October 2026 (N = 51), question 6.

The expected link between fatigue frequency and impairment was positive but weak, and not significant (rho = 0.25, p = 0.082). A likely reason is that fatigue frequency varied little, since well over half the pilots gave the same answer, and almost every pilot agreed that fatigue impairs them however often it occurs. The phase findings follow the same logic. Descent and approach, where workload rises sharply after a long and quiet cruise, was named most often (49.0%). Long-haul pilots, whose cruise phases are longest, most often named cruise (50.0%).

The duty factors pilots rate highest have to do with how duties are extended and timed, and less with how long they are. The top five factors were extended duties (4.00), consecutive early starts (3.80), crossing time zones (3.78), night duties (3.74) and late-to-early roster transitions (3.73). Long duty hours ranked only eighth, at 3.60 (Figure 3). This differs from earlier short-haul research, in which long duty hours were the most frequently cited cause (Brezonakova, 2023). The larger share of long-haul pilots in this sample (39.2%), whose rosters include more night flying and time-zone crossing, may explain part of the difference. The spread of means was narrow (3.43–4.00), so pilots saw almost every factor as contributing substantially.

**Figure 3: Duty Factors Ranked by Mean Contribution to Fatigue**

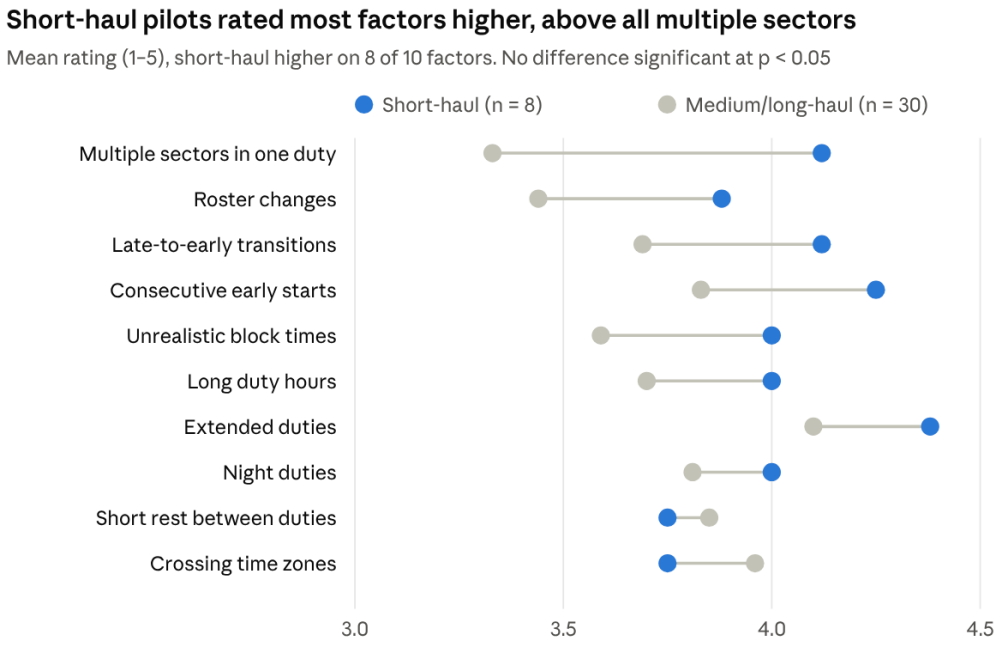



*Note.* Data from the author's survey, 17–22 October 2026 (N = 51), question 8.

Support for the hypotheses was mixed. Fatigue was common, as expected, and pilots who were fatigued more often were significantly more likely to report microsleeps. They did not, however, report significantly greater impairment. Extended duties ranked first, in line with earlier surveys,

but long duty hours came only eighth. The predicted split between short- and long-haul pilots appeared only as a trend. Short-haul pilots rated multiple sectors higher (4.12 vs 3.33, $p = 0.104$) and long-haul pilots rated long duty hours higher (3.90 vs 3.40, $p = 0.077$), but with only eight short-haul pilots neither difference was significant (Figure 4).

**Figure 4: Highest-Rated Duty Factors by Type of Operation**




*Note.* Data from the author's survey, 17–22 October 2026, question 8; mixed-operation pilots (n = 13) excluded.

These patterns have implications for how fatigue is managed. If the most fatiguing parts of a roster are extensions, early starts, time-zone changes and late-to-early transitions, then limits on total duty length address only part of the problem. Fatigue management must also govern when extensions are used, how duties are sequenced and how quickly start times change. The relevance of this point to India's revised limits is discussed in Section 4.9.

### 4.9 Discussion

Fatigue appears to be a normal part of line flying for these pilots. With most of them fatigued at least sometimes and two-thirds reporting microsleeps, it looks less like an exception caused by an unusual roster and more like an ordinary working condition. Earlier surveys found much the same (Bourgeois-Bougrine et al., 2003; Jackson & Earl, 2006). Most pilots chose "sometimes", yet microsleeps were common even among them, which suggests that pilots understate how often they are fatigued. The microsleep rate is also higher than among Gulf airline pilots, 45.1% of

whom reported falling asleep at the controls at least once (Aljurf et al., 2018), although the questions and timeframes differ.

What pilots report fits the laboratory evidence, but it probably understates the problem. The effects pilots recognised most, slower reactions and poorer concentration, are the ones laboratory research identifies as most sensitive to sleep loss (Lim & Dinges, 2010). The same research shows that people short of sleep underestimate how impaired they are (Van Dongen et al., 2003). If almost every pilot already agrees that fatigue slows their reactions, actual impairment on their most tiring duties may be greater still. Pilots' reports of fatigue are better read as cautious than as exaggerated.

The concentration of reported impairment in descent and approach also matters for safety, because that is the phase where a slowed reaction leaves the least margin for recovery. Accident records point the same way. Of 70 U.S. airline accidents between 2000 and 2019, 47.1% happened during landing and 37.1% during take-off (Becker, 2023).

The factors pilots find most fatiguing are not the ones that duty-length limits target most directly. Extended duties, consecutive early starts, time-zone crossing and late-to-early transitions all concern when duties happen and whether they run beyond plan. Long duty hours, the factor most directly limited by flight duty period rules, ranked eighth. This supports the argument from risk-based fatigue management that prescriptive limits are needed but cannot do the job alone (Dawson & McCulloch, 2005). It also connects with the regulatory theme in pilots' comments. One pilot observed that fatigue is "cumulative and most importantly specific to each individual", which "is missed in most regulations".

The prominence of extended duties also fits the accident evidence. Becker (2023) found that 5% of accidents happened after the eleventh hour of duty, mirroring Caldwell's (2005) finding that accidents are over-represented beyond 13 hours, and concluded that extensions should be allowed only in emergencies.

Differences between types of operation were weaker than expected. Earlier research found clearly different causes of fatigue in short- and long-haul operations (Bourgeois-Bougrine et al., 2003). Here the differences ran in the expected direction, with short-haul pilots rating multiple sectors higher and long-haul pilots rating long duty hours higher, but were not significant. Extended duties ranked first in both groups. This may reflect the small short-haul group (n = 8). It may also reflect the fact that 25.5% of pilots fly mixed operations, which blurs the distinction.

Knowing how to report fatigue does not mean pilots are protected from it. Reporting knowledge in this study (84.0% when, 90.0% where, 90.2% why) was close to Brezonakova's (76.7%, 93.0%, 93.0%), and knowing when to report was the weakest item in both. Yet two-thirds of the same pilots reported microsleeps, and comments described reports being dismissed, recorded as sick leave or held up by long forms. Reporting knowledge may also depend on experience. Pilots with fewer than 5,000 hours scored lower on knowing when to report (3.50 vs 4.19) and two of the three pilots who disagreed were junior first officers, but the difference was not significant ($p = 0.145$).

Awareness of procedures is a foundation for fatigue risk management but it does not show that pilots trust the system or that reports change rosters. The same gap has been documented elsewhere. As noted in Section 2.4, most UPS pilots surveyed in 2014 said they would rather call in sick than report fatigue. An earlier NTSB survey of U.S. operators found that half of regional airlines recorded a pilot's self-reported fatigue as "sick", "unavailable" or "not fit for duty" instead of as fatigue (NTSB, 2006, as cited in Becker, 2023). One pilot in this study described exactly this practice.

The Indian case shows that fatigue rules depend on trust and enforcement as well as on how they are written. India's revised limits respond directly to several factors examined here, particularly night duties and weekly rest. However, their temporary relaxation within weeks of full implementation (Tribune News Service, 2025) shows that rules which conflict with airline capacity are open to exceptions. Pilots' comments reflect this. The most common theme was that regulation and oversight are inadequate or too close to the airlines, and several pilots called for fatigue management to be set by the regulator instead of designed by operators, with independent monitoring of fatigue reports.

The cap on consecutive night duties in particular rests on strong evidence. Across industries, accident risk rises by 17% on a third consecutive night shift and 36% on a fourth (Folkard & Lombardi, 2006). Relaxing the limit on consecutive nights removes protection at the point where risk rises fastest.

Several limitations apply. The data are perceptions, and objective performance was not measured. The sample of 51 pilots was recruited by convenience and snowball sampling and is dominated by experienced captains, who made up 84.3% of respondents, with 64.7% of the sample having more than 10,000 hours. First officers and junior pilots are therefore under-

represented, and several group comparisons rest on fewer than ten pilots. Pilots concerned about fatigue may also have been more likely to respond.

Questions about the previous three months are subject to recall bias, and 15.7% of pilots preferred not to answer the microsleep question. The term "microsleep" may also have been understood differently by different pilots. Because the survey was kept short to reduce drop-out, some useful questions were not asked. It did not ask about commuting, for example, although one pilot raised travel to and from base. Becker (2023) found that pilots in the accidents he examined lived a mean of 990 km (615 miles) from their base so future surveys should measure time awake before duty. Finally, the cross-sectional design shows associations, not causes.

## 5. POLICY SUGGESTIONS

The evidence in this paper supports seven policy suggestions.

### 5.1 Design Rosters Around the Factors Pilots Rate Most Fatiguing

Airlines should use pilots' own ratings, such as those in Table 4, to identify which roster patterns cause the most fatigue, and redesign those first. In this sample, extended duties and consecutive early starts ranked highest so, schedulers should treat duty extensions as exceptions, not planning tools, and limit runs of early starts instead of simply keeping each duty within legal limits.

### 5.2 Limit the Timing and Sequence of Duties, Not Only Their Length

Regulators should continue the move towards rules based on duty timing, including limits on consecutive early starts and on late-to-early roster transitions. Fixed limits on total hours do not address the circadian and sleep-debt mechanisms that make these patterns fatiguing. Caps on consecutive night duties, such as the DGCA's limit of two, are supported by evidence that accident risk climbs steeply on the third and fourth consecutive night (Folkard & Lombardi, 2006).

### 5.3 Improve Roster Stability and Realistic Scheduling

Late roster changes and unrealistic block times add fatigue that does not appear in duty-hour calculations. Airlines should publish rosters further in advance, limit short-notice changes, and set block times based on actual performance data so that delays do not routinely extend duties.

### 5.4 Tailor Fatigue Management to the Type of Operation

Short-haul and long-haul flying produce fatigue in partly different ways. In this study, long-haul pilots most often named cruise as the phase most affected and rated long duty hours higher, while short-haul pilots rated multiple sectors higher, although these differences were not significant. Fatigue risk management should therefore use separate risk assessments for multi-sector short-haul operations and for night and long-haul operations.

### 5.5 Make Fatigue Reporting Non-Punitive and Visible in Its Effects

Knowledge of how to report fatigue is not enough. Airlines should guarantee that fatigue reports carry no penalty, and show pilots how reports have changed rosters, so that reporting is seen as worthwhile. Regulators should audit how operators respond to fatigue reports, not only whether reporting systems exist. In particular, a fatigue report should never be recorded as sick leave or deducted from a pilot's leave, a practice described by a pilot in this study and documented at U.S. carriers (Becker, 2023).

### 5.6 Maintain Fatigue Limits Under Operational Pressure

The temporary relaxation of India's revised limits shows that capacity shortfalls create pressure to suspend fatigue protections. Regulators should require airlines to demonstrate adequate crew numbers before new limits take effect, and should set clear, time-limited conditions for any exemption.

### 5.7 Account for Time Awake Before Duty

Time spent commuting to base is not counted as duty, so a pilot can begin a legal duty period already tired (Becker, 2023; National Research Council, 2011). Airlines should take commuting into account when rostering early starts. Regulators should consider guidance, like the UK's 1.5-hour threshold, on when crew should stay near base before duty.

## 6. FUTURE OUTLOOK

India's rules are the most immediate question. The revised limits are now fully in force after the IndiGo exemption ended in February 2026, but the episode showed how quickly capacity pressure can reopen them. How much protection the limits give will depend on two things: whether they hold as traffic grows and whether airlines hire enough pilots to fly within them..

A slower change is the move from fixed limits towards fatigue risk management. ICAO already allows states to approve FRMS alongside or in place of some prescriptive limits, and these systems depend on data, including pilots' own reports (ICAO, 2015). The findings of this study suggest that the move will only work if pilots trust the reporting system (Bourgeois-Bougrine, 2020). A system that treats fatigue reports as sick leave will collect little useful data.

Technology may also change how fatigue is measured. Some airlines already use biomathematical fatigue models to test rosters before they are flown (Becker, 2023), and wearable devices that track sleep could give operators objective data to set beside pilots' own accounts. Such tools could address the main weakness of survey research, which depends on what pilots notice and are willing to say, although they also raise questions about privacy and about who controls the data. Combining pilots' perceptions with objective measures of this kind is the clearest direction for future research.

## 7. CONCLUSION

Pilot fatigue is often discussed as a question of hours meaning how long a pilot may fly and how long they must rest. This view is needed but it does not present the full picture. The research paper investigates pilot fatigue experiences from these flight operations and asks what factors they think lead to their exhaustion.

The pilots surveyed did not describe fatigue as a rare event tied to unusual rosters. They described it as part of ordinary line flying, felt first in attention and reaction, and traced it to the way duties are extended and timed. Because these accounts come from the people who fly the duties, they add something that laboratory studies and accident reports cannot supply.

Fatigue protection depends on how duties are extended, timed and sequenced as much as on their total length. Regulators in the United States, Europe and India have moved in this direction. India's experience in 2025 showed how fragile such limits are when they collide with airline capacity, and pilots' comments show little trust in how fatigue is regulated and reported. Rosters need to be built around what pilots actually find tiring, and pilots need a reporting system they believe in.Future research requires bigger sample sizes which should contain equal numbers of first officers and short-haul pilots while using objective measurement tools like actigraphy.

Most of the time, a second pilot, automation or air traffic control catches a fatigue-related error before it causes harm. The current defensive systems should not function as the main strategy to

address fatigue management requirements. Asking pilots when and where they feel the effects of fatigue is a practical way to find the duties that need changing first.

## Conflict of Interest

The author's mentor, Captain Abhinav Yadav, helped share the survey through his professional contacts, alongside other pilot networks. The survey was anonymous, and no names, employers or airlines of the respondents were recorded. No airline took part in designing the survey. The research was not sponsored by any organisation, and the results of the research were not affected by this assistance.

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# Appendix A

## Key Fatigue Regulations

The main regulatory instruments discussed in Section 2.5 are summarised in Table A1.

**Table A1: Key Fatigue Regulations**

| Instrument | Year | Key provision | Relevance to pilot fatigue |
|---|---|---|---|
| ICAO standards and Fatigue Management Guide | 2015 (guide, 2nd ed.) | States must regulate crew fatigue through prescriptive limits, FRMS, or both | Sets the international baseline and defines fatigue |
| FAA 14 CFR Part 117 | 2011 (effective 2014) | Maximum duty period varies with start time and number of segments; rest must include a sleep opportunity | Introduced after Colgan Air 3407; links limits to circadian timing |
| EASA flight time limitations (ORO.FTL) | Applicable from 2016 | Duty limits vary with reporting time and sectors; extensions of up to 1 hour, no more than twice in 7 days | Current European framework; extensions limited to twice in 7 days |
| DGCA revised Civil Aviation Requirement on flight duty time limitations | 2024 (phased in 2025) | 48 hours' weekly rest; night defined as 00:00–06:00; limits on night landings and consecutive night duties | Current Indian framework; partly relaxed in December 2025 |

# Appendix B

## Survey Instrument

**Consent:** I have read the information above and agree to take part. (Yes, I agree / No, I do not agree)

1. Current role: Captain / First Officer / Other
2. Total flying hours: Under 1,500 / 1,500–5,000 / 5,001–10,000 / Over 10,000
3. Type of operation you mostly fly: Short-haul / Medium-haul / Long-haul / Mixed
4. In the past 3 months, how often have you felt fatigued while on duty? Never / Rarely / Sometimes / Often / Always

5. In the past 3 months, have you had a microsleep on the flight deck (outside planned controlled rest)? Never / Once / More than once / Prefer not to say
6. When fatigued on duty, how much do you agree? (Strongly agree to Strongly disagree) My reactions are slower; I find it harder to concentrate; My situational awareness is reduced; My decision-making is poorer; I miss or rush checklist items; My communication with ATC or crew suffers
7. Which phase of flight does fatigue affect you most? Take-off and climb / Cruise / Descent and approach / Landing
8. How much does each factor contribute to your fatigue? (Not at all to Extremely) Night duties; Consecutive early starts; Multiple sectors in one duty; Long duty hours; Extended duties; Short rest between duties; Late-to-early roster transitions; Unrealistic block times; Roster changes; Crossing time zones
9. How much do you agree? (Strongly agree to Strongly disagree) I have a clear idea when / where / why to report fatigue
10. Anything else you'd like to add about pilot fatigue? (Optional)