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| Abstract             | <p>For decades, fatigue has been identified as a significant risk factor in commercial air transport. The two main approaches to manage the fatigue risk in aviation are prescriptive and risk-based (performance-based). Countries' aviation authorities mandate either of these approaches or a combination of both through their national regulatory frameworks. This study investigated the content, context and implementation of International Civil Aviation Organization (ICAO) Standards and their recommended practices to manage flight crew fatigue risk in eight South Asian countries. The research design tabulated the fatigue-related regulations and conducted a comparative analysis of the approaches by assessing published standards, recommended practices, and regulations.</p> <p>The findings show a considerable variability among these South Asian countries on the limits imposed for flight time, flight duty periods, duty periods, and rest periods. Notably, no country had implemented all three types of limitations (flight time, flight duty period and duty period) in their regulations. Most countries use a combination of two limitations as a minimum however, Bhutan, Sri Lanka and the Maldives only using flight duty periods in their regulations. All eight South Asian countries impose minimum rest limits. Additionally, the regulations vary with regard to crew composition, the start time of flight time/flight duty periods, and in-flight rest requirements.</p> |   |

The results highlight the varying limitations imposed in these South Asian countries on flight time, flight duty period, duty period and rest periods. It is hoped that these findings will be considered by regulatory bodies for aviation and airlines in the South Asia region in order to enhance existing regulatory frameworks.

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Keywords  
(separated by '-')

Fatigue - Prescriptive - Limitations - Flight duty period

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# Content and Context Analysis of Fatigue Management Regulations for Flight Crew in the South Asian Region

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**Abstract.** For decades, fatigue has been identified as a significant risk factor in commercial air transport. The two main approaches to manage the fatigue risk in aviation are prescriptive and risk-based (performance-based). Countries' aviation authorities mandate either of these approaches or a combination of both through their national regulatory frameworks. This study investigated the content, context and implementation of International Civil Aviation Organization (ICAO) Standards and their recommended practices to manage flight crew fatigue risk in eight South Asian countries. The research design tabulated the fatigue-related regulations and conducted a comparative analysis of the approaches by assessing published standards, recommended practices, and regulations.

The findings show a considerable variability among these South Asian countries on the limits imposed for flight time, flight duty periods, duty periods, and rest periods. Notably, no country had implemented all three types of limitations (flight time, flight duty period and duty period) in their regulations. Most countries use a combination of two limitations as a minimum however, Bhutan, Sri Lanka and the Maldives only using flight duty periods in their regulations. All eight South Asian countries impose minimum rest limits. Additionally, the regulations vary with regard to crew composition, the start time of flight time/flight duty periods, and in-flight rest requirements.

The results highlight the varying limitations imposed in these South Asian countries on flight time, flight duty period, duty period and rest periods. It is hoped that these findings will be considered by regulatory bodies for aviation and airlines in the South Asia region in order to enhance existing regulatory frameworks.

**Keywords:** Fatigue · Prescriptive · Limitations · Flight duty period

## 1 Introduction

Managing the fatigue risk experienced by flight crew is essential to establishing a safe air transport system. Research indicates that 15 to 20 per cent of fatal accidents and incidents in commercial air transport are attributable to fatigue [1]. Flight crew have reported fatigue associated with the following three causation factors: (1) Sleep factors

AQ1

AQ2

AQ3

(i.e., early duty start times, late night and early morning flights, crossing multiple time zones); (2) work factors (i.e., high or low workloads in the cockpit, long duty periods, the intensity of job functions, the availability of resources, confined working environments); and (3) health factors (i.e., sleep apnea, insomnia, the consumption of alcohol, use of caffeine and medication) [2–4]. The International Civil Aviation Organization (ICAO), the specialized agency that specifies Standards and Recommended Practices (SARPs) to the aviation industry recommends two distinct approaches to address the fatigue risk experienced by flight crew. The SARPs specified by ICAO are adopted by the Member States and are enforced at the national level through each country's domestic legal framework. The two fatigue management approaches recommended by ICAO in Annex 6 are prescriptive and performance-based (risk-based) approaches. Each national Civil Aviation Authority prescribes the maximum flight time, flight duty period (FDP), and duty period limitations with the minimum rest requirements based on scientific knowledge and experience in the prescriptive approach [4, 5]. Air operators develop and obtain approval to implement a fatigue risk management system (FRMS) by the National Civil Aviation Authority in a performance-based approach. The FRMS is based on the principles of risk management and considers elements such as an individual's varying capacity (i.e., productivity, decision-making, problem-solving), sleep, and circadian levels relative to flight time/flight duty period, and the start and end times of each crew member's flights [3, 5].

Additional fatigue mitigation methods are identified in scholarly articles and include in-flight napping, the crew composition, flight duty period/flight time/duty start time, and the number of time zones crossed which are considered when formulating fatigue regulations [6–11]. Research confirms that in-flight sleep for flight crew is a primary fatigue mitigation strategy effective in long-range flights that provide an environment favorable to sleep [7, 10–12]. However, most commercial flights are operated with two flight crew on duty, which limits their opportunity to rest in flight. Research demonstrates that medium-range flights with two flight crew, may develop a pattern of building up fatigue while operating within the flight duty/flight time limits [9, 13, 14]. For example, evidence shows that significant risk is observed in flights that commence in the early morning (e.g., 0000–0559) rather than flights scheduled for later in the morning or the afternoon or at night, especially if the flight time/flight duty period starts in the window of circadian low (WOCL) (0200–0600). The WOCL is defined by ICAO as the time in the circadian body clock when the subjective fatigue and sleepiness is at a peak and individuals are least able to do mental and physical tasks [4]. Furthermore, in terms of risk, research has also identified a relationship between the time of the day and the level of error [6, 8]. For example, a study analyzed the records of 155,327 flight hours of Brazilian airlines from 1st April to 30th September 2005 by categorizing a 24 h day into the four periods of: (1) early morning; (2) morning; (3) afternoon; and (4) night. The results revealed that risk increases by 50 per cent during the early morning compared to the morning, and neither afternoon nor night flights were associated with significant risk [8].

Although extensive research has been conducted on the causes of fatigue, its impairments, and methods to measure fatigue, research that investigates flight crew fatigue

regulations related to flight time, FDP, duty period, and rest is limited to a few studies. Wegmann et al. [15], for example, compared the flight crew fatigue regulations of nine countries and identified a considerable difference in the scope and applicability of regulations in these countries. Subsequently, Cabon et al. [16] and Missoni et al. [17] updated and expanded this area of research to 35 countries in five geographical regions (Europe, America, Asia, Africa, and Oceania). Together, these studies have compared flight time, FDP, and rest and work schedules, finding both similarities and differences in how these countries implemented ICAO principles and whether these regulations can prevent fatigue [16, 17]. These studies reveal that different geographical regions have varied flight times, FDPs, and duty period limitations and that different countries use a combination of traditional and flexible regulations (prescriptive and risk-based).

It is also noteworthy that the above-mentioned studies analyzed aviation fatigue management regulations for flight crews in Europe, the Middle East, and countries including Australia, New Zealand and the United States. However, no studies have focused on implementing SARPs for fatigue management in the South Asian region. Therefore, this research aims to examine this area and address this gap by examining the content, context and implementation of ICAO Standards in eight South Asian countries by tabulating and conducting a comparative analysis of their fatigue-related regulations. The present study will assess published standards, recommended practices, and regulations in order to investigate the overarching fatigue management regulatory framework in the South Asian region.

## 2 Materials and Methods

### 2.1 Documents and Selection

The present study examines 12 documents from ICAO and eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka). For each country, these documents include the Standards and Recommended Practices (SARPs), Regulations and the Implementation Guidance for fatigue risk management in the aviation industry. As publicly available documents, ICAO Annex 6 and Doc 9966 were downloaded from the official website of ICAO and the regulations of each of the eight countries were downloaded from the official websites of the respective national aviation authorities. Table 1 lists all the documents used in the analysis.

### 2.2 Method of Analysis

The SARPs and regulations regarding flight crew fatigue were extracted and recorded in two tables that contain both text and numerical data. The key terms of duty, duty time, duty period, flight time, FDP, and flight deck duty time as included in ICAO Annexes and the regulations of eight South Asian countries are detailed in Table 2. This table also records the limits on flight time (FT), FDP, duty (D) and the rest periods (RP) of the eight countries. The data recorded in the tables were analyzed using a comparative analysis framework that focused on: (1) factors considered when defining flight crew fatigue; (2) the maximum limits for the FT, FDP, D, and RP with varying complements of flight crew;

**Table 1.** List of SARPs, regulations and documents.

| Organisation/<br>Country | SARP/Implementation Guidance/Regulation  |
|--------------------------|--|
| ICAO                     | 1. Annex 6 to the Convention on International Civil Aviation Operation of Aircraft, Part I - International Commercial Air Transport – Aeroplanes<br>2. Manual for the Oversight of Fatigue Management Approaches Document 9966 |
| Afghanistan              | Afghanistan Civil Aviation Regulations - Operations - Part 8   |
| Bangladesh               | Air Navigation Order ANO (OPS) A.10 - Flight Operations Requirements Part A - Flight crew training, licensing and authorisation  |
| Bhutan                   | Bhutan Civil Aviation Requirements - BCAR OPS 1, Commercial Air Transport – Aeroplanes   |
| India                    | Civil Aviation Requirement, Section 7 - Flight crew standards training and licensing, Series J Part III  |
| Maldives                 | Maldivian Civil Aviation Regulations MCAR - Air Operations   |
| Nepal                    | Flight Operations Requirements - Aeroplane FOR-A   |
| Pakistan                 | Air Navigation Order - ANO-012-FSXX-6.0  |
| Sri Lanka                | Implementing Standard - SLCAIS 054<br>Guidance Material SLCAP 4210   |

and (3) the rest period prior/after long-range, extended long-range and ultra-long-range operations [16, 17]. This comparative analysis framework uses a combination of models published by Cabon et al. [16] and Missoni et al. [17] to analyze the fatigue management regulations of flight crew.

Finally, eight graphs were plotted to show the flight times, flight duty periods, duty periods and rest periods in the eight countries.

### 3 Results and Discussion

The study reveals that not all eight South Asian countries incorporated flight time, FDP, and duty period limits into their regulations. There is extensive variability in the regulations among the eight countries in this geographical region, including the definitions related to flight crew fatigue (flight time, FDP, duty period, and rest period). The results of the analyses are presented and discussed in the following section.

#### 3.1 ICAO SARPs and Guidance Material

ICAO has prescribed the standards and recommended practices related to flight crew fatigue in commercial aviation in Annex 6, Part I and the additional implementation guidance in Document 9966 (Doc 9966). ICAO SARPs urge its Member States to implement limitations on flight time, FDP, duty period, and rest periods in order to manage the fatigue risk in air transport [18]. ICAO Annex 6, Part I and Doc 9966 state that fatigue management regulations should be based on scientific principles, knowledge, and operational experience. ICAO further recommends that countries promulgate regulations to establish a fatigue management approach (prescriptive or performance-based or a combination) [4, 18]. A performance-based approach can take the form of a FRMS and should include a method to identify fatigue-related safety hazards and the resulting risk(s), remedial action to mitigate risk(s) and associated hazard(s), and a continuous

improvement of the overall performance [19]. Doc 9966 provides further guidance to establish flight time, flight duty and duty period limitations, rest periods, an extension of duty time, positioning, split duty and standby requirements applicable for flight crews.

### 3.2 Definitions Related to Flight Crew Fatigue

The following six definitions used in the context of flight crew fatigue are identified in the present study: (1) duty; (2) duty time; (3) duty period; (4) flight time; (5) FDP; (6) flight deck duty period; and (7) rest period. Table 2 lists the definitions for these seven terms as per ICAO Annex 6. If any South Asian country defined the term differently to Annex 6, this information is also included in the table for comparison. ICAO regulations do not define duty time and flight deck duty time, but the aviation authorities in Afghanistan and Bangladesh use these two terms in their regulations. The majority of the South Asian countries define the other terms similarly to ICAO Annex 6 if those terms are included in the respective regulations as indicated in the third column of the below table.

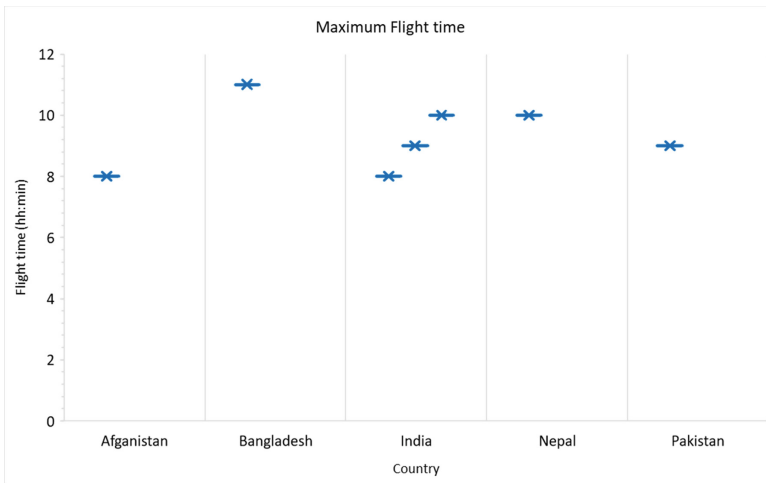
**Table 2.** Definitions in the context of flight crew fatigue

| Definition                   | ICAO   | Status of South Asian Countries   |
|------------------------------|--|---|
| <b>Duty</b>                  | Any task that flight or cabin crew members are required by the operator to perform, including flight duty, administrative work, training, positioning and standby when it is likely to induce fatigue.   | Not defined by BH, IN, MA, NE, PK and SL  |
| <b>Duty time</b>             | No ICAO definition   | AF - The total time from the moment a person identified in these regulations begins, immediately after a rest period, any work on behalf of the certificate holder until that person is free from all restraint associated with that work.<br>BA - the period of elapsed time beginning from 1 hour before the scheduled departure time (Blocks off) of all International flights and 45 minutes for Domestic flights; and ending at 30 minutes after actual arrival time (Blocks on) of all flights in connection with assigned duty of a flight crew. |
| <b>Duty period</b>           | A period which starts when a flight- or cabin-crew member is required by an operator to report for or to commence a duty and ends when that person is free from all duties.  |   |
| <b>Flight time</b>           | The total time from the moment an aeroplane first moves for the purpose of taking off until the moment it finally comes to rest at the end of the flight.  | Not defined by IN and MA  |
| <b>Flight duty period</b>    | A period which commences when a flight or cabin crew member is required to report for duty that includes a flight or a series of flights and which finishes when the aircraft finally comes to rest and the engines are shut down at the end of the last flight on which he is a crew member | Not defined by AF and BA  |
| <b>Flight deck duty time</b> | No ICAO definition   | BA - any portion of flight time spent at a position for which a flight crewmember is required.<br>BA - elapsed time between two consecutive duty periods (i.e. from the end of one duty period until the beginning of next duty period, when crewmembers are free of all restraint or any kind of duty and are free of all responsibility for work or duty should the occasion arise.) A horizontal resting period must be availed by the concerned flight crew.  |
| <b>Rest</b>                  | A continuous and defined period of time, subsequent to and/or prior to duty, during which flight or cabin crew members are free of all duties  | BH and IN defines defined rest period similar to ICAO but provide examples for duties (standby and reserve)   |

Note: Afghanistan (AF), Bangladesh (BA), Bhutan (BH), India (IN), Maldives (MA), Nepal (NE), Pakistan (PK), Sri Lanka (SL)

### 3.3 Maximum Flight Time and FDP

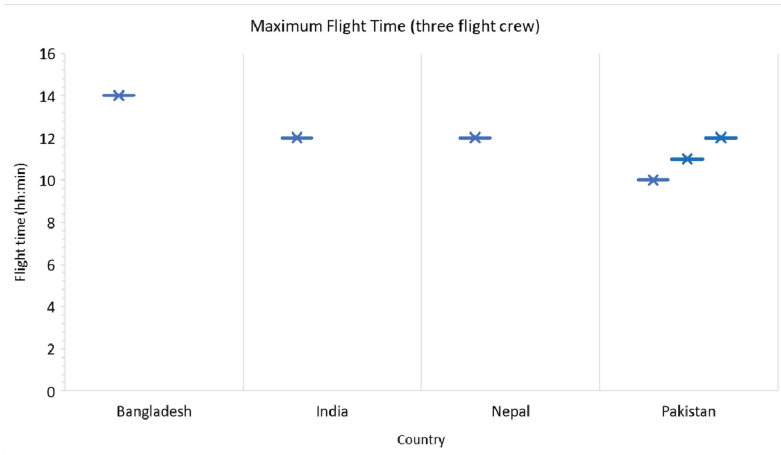
**Maximum Flight Time.** ICAO defines flight time as ‘the total time from the moment an aeroplane first moves for the purpose of taking off until the moment it finally comes to rest at the end of the flight’ [4]. Afghanistan, Bangladesh, India, Nepal and Pakistan have imposed limitations on flight time to regulate flight crew fatigue (see Figs. 1, 2 and 3). Afghanistan has mandated a limit of 8 flight hours in the Afghanistan Civil Aviation Regulations - Operations - Part 8-8.12 and does not specify the number of flight crew required for the flight [19]. Bangladesh imposes a limitation of 11 h, which the air operator can extend to 14 h with three flight crew and two flight engineers, and 16 h with four flight crew and two flight engineers as shown in Figs. 1, 2 and 3 [20]. India has a diverse range of flight times from 8 to 14 h as the following two factors influence the wide range of flight times: (1) the crew complement (i.e., the number of crew members operating the flight); and (2) the number of landings/sectors performed within the flight time [21].



**Fig. 1.** Maximum flight time

Nepal has a flight time limitation of 10 h (see Fig. 1) for two flight crew operations which increases to 12 h for three and four flight crew member operations; (see Figs. 2 and 3 for extended flight time limitations) [22]. The regulations in Pakistan have a minimum flight time of 9 h and a maximum of 18 h [23]. A two flight crew complement allows airlines to operate a flight time of 9 h (Fig. 1), and with three flight crew, it is extended to 10 h (see Fig. 2) [23]. A three flight crew complement can include two flight crew and a flight engineer. An augmented crew complement of three flight crew and one flight engineer allows a flight time of 11 h, and three flight crew with two flight engineers can operate up to 12 h, as shown in Fig. 2 [23]. A further increase of up to 16 flying hours is allowed for a double crew complement (see Fig. 3). Pakistan also specifies flights of long-range (16 h) duration, extended long-range (17 h), and ultra-long-range (18 h) duration for two and three sets of flight crew, respectively (see Fig. 3) [23].

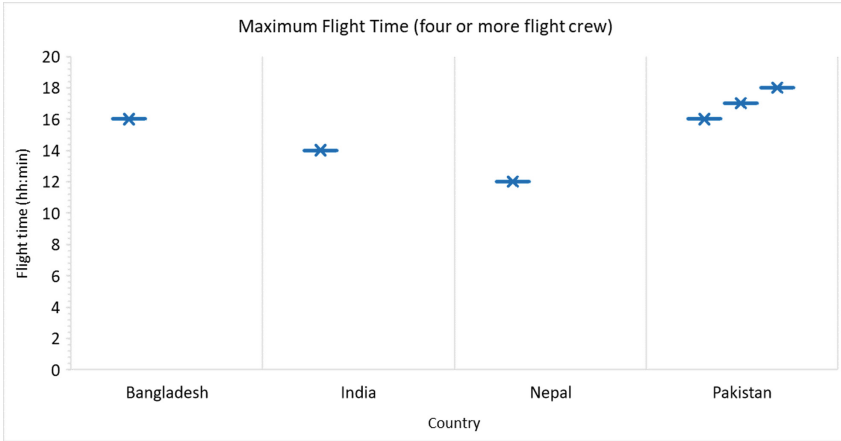




**Fig. 2.** Maximum flight time (three flight crew)

The results presented in the analysis show that the maximum flight time within the eight countries can range from 8 to 18 h and can also depend on the number of crew operating the flight. Countries such as Afghanistan and India allow a flight time of 8 h, which is the minimum flight time in the eight countries, whereas Pakistan allows a flight time of up to 18 h as a maximum flight time among the eight countries [19, 23]. Afghanistan Civil Aviation Regulations - Operations - Part 8 does not include any information on the number of flight crew members when mandating the maximum flight time [21]. It is of interest that India associates the flight time with the number of landings performed [19] and India and Pakistan are the only two countries that classify long-range, extended, and ultra-long-range flights. According to the results, some South Asian countries consider various aspects (i.e., crew complement, sectors performed, flight distance) in stipulating the maximum flight time. In contrast, certain countries only impose a limitation on flight time and provide little information on the rationale/evidence for their limits.

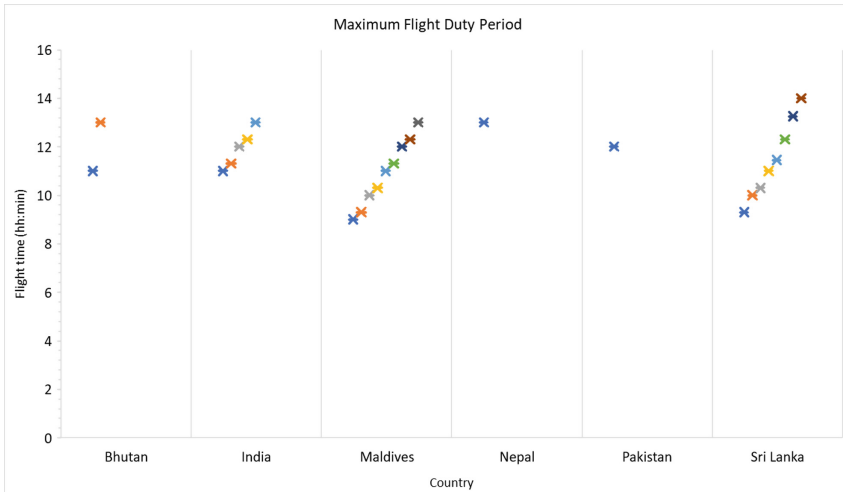
**Maximum FDP.** Six out of the eight countries in the South Asian region impose a limitation on FDP for flight crew. ICAO defines a flight duty period as ‘a period that commences when a flight or cabin crew member is required to report for duty that includes a flight or a series of flights and which finishes when an aircraft finally comes to rest and the engines are shut down at the end of the last flight on which he is a crew member’ [4]. Sri Lanka and the Maldives have multiple FDPs, as shown in Fig. 4. These FDPs are established in reference to: (1) FDP start time; and (2) the sectors flight crew can operate within the FDP [24, 25]. The first FDP reference time commences at 0600 until 1329, then there are seven FDP reference time clusters with an interval of 29 min between the start and end times until 1659. The next time cluster starts at 1700 and runs until 0459. Finally, there are four time clusters with an interval of 14 min between the start and end time finishing at 0559. According to this criteria, there are 104 FDPs in the Maldives regulations. Figure 4 shows only the maximum FDPs out of the 104 for acclimatized flight crew in the Maldives. Furthermore, the Maldives has established a separate FDP for operators under a FRMS.



**Fig. 3.** Maximum flight time (four or more flight crew members)

The FDP limitations in Sri Lanka take a similar form to the regulations in the Maldives however, only five FDP start time clusters are in the Sri Lankan Regulations [24]. The first period starts at 0600 and ends at 0759, thus the lapse time between the first cluster is one hour and 59 min. Each of the two subsequent time clusters have a lapse time of four hours and 59 min, the next cluster is three hours 59 min, and the last cluster is seven hours and 59 min (2200 to 0559). If the flight duty commences between 0800 to 1259 flight crew can work the maximum FDP according to the number of sectors they perform, as depicted in Fig. 4.

[AQ4]



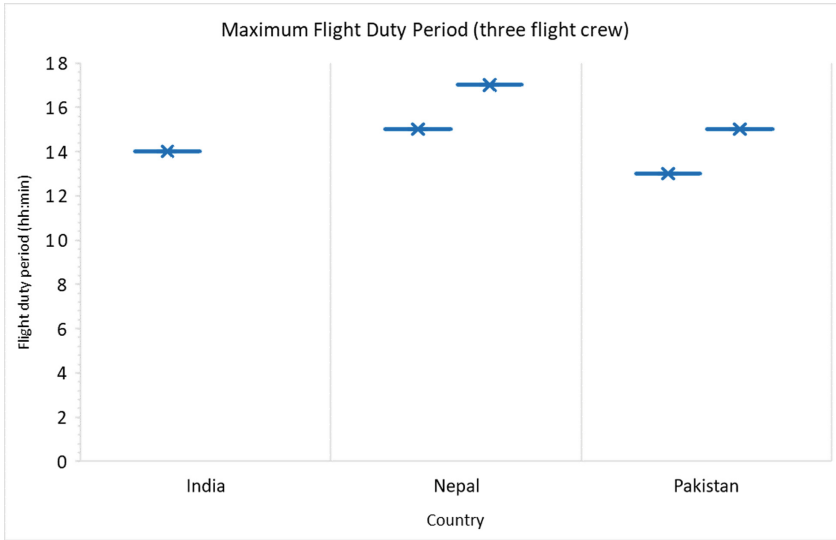
**Fig. 4.** Maximum flight duty period. Note: Different color shadings are used to mark the FDPs in Bhutan, India, Maldives, and Sri Lanka for clarity as multiple FDPs are illustrated in the graph

Sri Lanka specifies the FDP is applicable for two or more acclimatized flight crew and the Guidance Material Sri Lanka Civil Aviation Procedure (SLCAP) 4210 also mandates a separate FDP for two or more flight crew who are not acclimatized to the sector. Furthermore, in India, the FDPs also consider the maximum number of landings that the flight crew can perform. The maximum applicable FDPs for two flight crew operations across six countries are shown in Fig. 4. The maximum FDP is 13 h with one landing, and if the landings are increased to six, it allows the flight crew to operate up to 11 h. From Fig. 4, it is evident that there are five FDPs, each with an addition of 30 min to the previous FDP (i.e., 1100, 1130, 1200, 1230, 1300). As the FDPs in India are associated with number of landings each 30 min extended in the FDP results in reducing one landing that flight crew can perform. The maximum FDP in Bhutan is 13 h, and if more than two sectors are performed the FDP reduces by 30 min for each sector from the third sector onwards for a maximum total reduction of two hours [26]. Pakistan allows a 12 h FDP period for two flight crew operations and 13 h in Nepal with three or four flight crew complement.

With regard to three crew member operations, India allows the FDP to be extended to 14 h (see Fig. 5), and with four or more flight crew, it can be extended to 18 or 22 h (see Fig. 6) [21]. These flights are considered long-range and ultra-long-range operations, respectively. Unlike the other countries in the region, Nepal has a higher maximum FDP limitation of 13 h. Three flight crew operations with a class 2 (e.g., seat in an aircraft cabin with flat or near flat sleeping position) or class 3 rest facility (e.g., seat in an aircraft cabin or flight deck with at least 40 degree recline capability and leg and foot support) can operate up to a FDP limit of 15 h (see Fig. 5) [22] which can be increased to 16 h with a class 2 or 3 rest facility, and 18 h with a class 1 rest facility (i.e. bunk or other surface with flat sleeping position separate from flight deck and passenger cabin) if four or more flight crew are engaged in operations (see Fig. 6). Pakistan allows a FDP of 13 h for three crew operations, including two flight crew and a flight engineer or with two captains and a first officer (see Fig. 5).

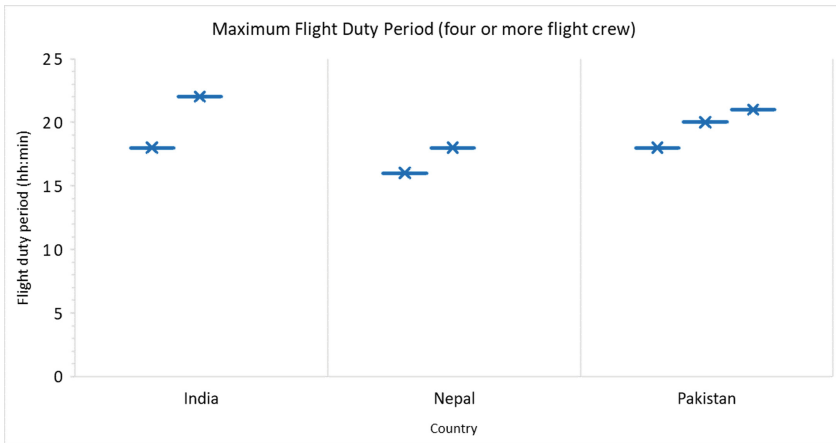
In Pakistan, the FDP can be increased to 15 h if three flight crew and 2 flight engineers are involved in flight operations, and a double crew complement allows a further increase of 18 h (see Fig. 6). Pakistan regulations permit long-range flights with a duration of up to 18 h with two sets of cockpit crew and extended long-range flights with two groups of cockpit crew and a cruise relief flight crew can fly for up to 20 h [23]. Three sets of flight crew can operate a maximum FDP of up to 21 h for ultra-long-range flights (see Fig. 6).

The results reveal that the Maldives and Sri Lanka are the only two countries that combine the FDP with duty start time and the sectors travelled. When mandating the maximum FDP, India, Nepal, Pakistan, and also Sri Lanka take into consideration the number of flight crew members required for the prescribed operation. Only two countries (India, Pakistan) in the region classify different FDPs for flights identified as long-range, extended, and ultra-long-range flights. Across all eight countries, Nepal is the only country that identifies in-flight rest as an essential aspect to extend the FDP. Overall, the results indicate that some South Asian countries formulate their FDP regulations based on: (1) FDP start time; (2) the number of sectors travelled /aircraft landings; (3) crew complement; (4) the duration of the flight; and (5) the period of in-flight rest. However, it



**Fig. 5.** Maximum flight duty period (three flight crew)

is noteworthy that only Nepal identifies the importance of in-flight rest in their in-flight crew fatigue management approach. Furthermore, only two countries base the flight crew FDP on when the duty period commences (see next section).



**Fig. 6.** Maximum duty period (four or more flight crew)

### 3.4 Duty Period

Duty period is ‘a period which starts when a flight or cabin crew member is required by an operator to report for or to commence a duty and ends when that person is free from

all duties' [4]. Afghanistan and Bangladesh impose a duty period limitation of 14 h for flight crew, as shown in Fig. 7 [19, 20]. Bangladesh regulations allow this limitation to increase to 16 h, when at least one flight crew member is added to the minimum crew complement. Furthermore, this can be expanded to 20 h if two more flight crew are assigned to the minimum crew complement. Other South Asian countries do not include a duty period limitation in their regulations.

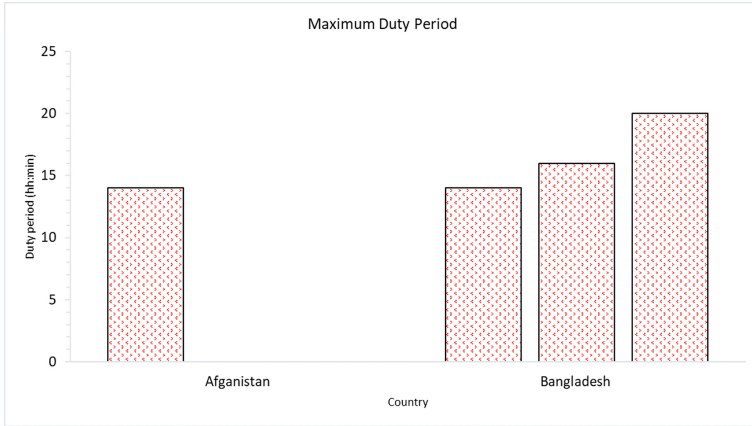
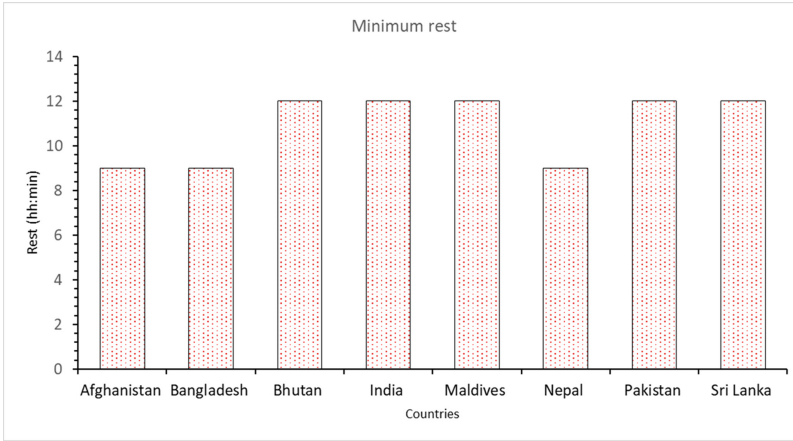


Fig. 7. Maximum duty period

### 3.5 Rest Period

All eight South Asian countries impose a minimum rest period for flight crew in their regulations, as shown in Fig. 8. ICAO defines rest as 'a continuous and defined period of time, subsequent to and/or prior to duty, during which flight or cabin crew members are free of all duties' [4]. For example, in Bangladesh, flight crew are allowed to rest for nine consecutive hours on the ground if a duty period is 14 h or less [20]. Air operators can reduce this rest period to eight hours by providing a subsequent rest period of 10 consecutive hours, and if the duty period is between 14 to 20 h, the flight crew must rest for 12 h. The regulations allow this rest to be 10 h, with a subsequent rest period of 14 consecutive hours. Before undertaking a FDP in Bhutan, India, Maldives, and Sri Lanka, the minimum rest period for flight crew is 12 h or a duration equivalent to the preceding duty period, whichever is greater (see Fig. 8) [4, 17, 21, 26]. However, for the FDP that starts away from the home base, a rest period of 10 h or equivalent to the preceding duty period should be provided in Bhutan and the Maldives and this period should include 8 h of sleep opportunity. In India, the minimum rest period can be extended to 18 h if crossing three to seven time zones and 36 h if crossing more than seven time zones. Nepal is the only country that mandates one rest period of a minimum of 9 h before commencing a FDP; see Fig. 8.



**Fig. 8.** Minimum rest period

In Pakistan, the minimum rest period is 12 h or twice the duration of the preceding FDP, whichever is greater [23]. For long-range (LR), and extended long-range (ELR) flights, the rest period should be 24 h before the flight, including one local night. This period is extended to 48 h for ultra-long-range (ULR) flights, including two local nights. The regulations also require a minimum rest period of double the duty time at the home base after operating LR, ELR or ULR flights. After returning to the home base from one of these flights, 48 h or double the FDP is the allowed minimum rest period for the flight crew. In Sri Lanka, if a rest period of 12 h is earned by flight crew away from the home base, the rest period can be reduced by one hour if the operator provides suitable accommodation. However, if the travelling time between the aerodrome and the accommodation is more than 30 min each way, the rest period must be increased by the total time spent travelling and one additional hour.

In summary, Afghanistan, Bangladesh and Nepal allow a minimum rest period of nine hours, whereas Bhutan, India, Maldives, Pakistan and Sri Lanka permit a minimum of 12 h rest. Three (Bhutan, Maldives, Sri Lanka) of the eight countries in the region also specify a rest requirement for rest away from the home base. Furthermore, India and Pakistan have mandated an extended rest period based on time zones crossed and the length of flight (LR, ELR, ULR). The results reveal that minimum rest criteria differ in the South Asian region and that some countries consider aspects including: (1) rest away from the home base; (2) the number of time zones crossed; and (3) the length/type of the flight operated.

## 4 Conclusion

This study reports on significant variability in the aviation regulations of eight countries and their implementation of ICAO SARPs. The majority of the South Asian countries have established regulations that consider key aspects of fatigue that can impact flight crew. However, some countries only impose limits on flight time, FDP, duty or rest

periods. Although in-flight napping is regarded as an effective fatigue mitigation strategy by many scholarly articles [7, 10–12, 27], the results of the present study reveal that only Nepal incorporates it with the flight time and FDP. Aviation regulations in Nepal also consider the condition of the rest facility and environment in the provision of in-flight napping. Another frequently cited strategy for mitigating fatigue in flight crew is duty start times and the number of time zones crossed in flight time/FDPs. Sri Lanka and the Maldives combine duty start time with FDP, and together with these two countries, India also couples the flight time and FDP with the number of landings [6, 8, 13].

However, in addition to considering limitations on flight time, FDP and duty periods as a method to minimize the fatigue experienced by flight crew, regulations should also consider the crew complement, the in-flight rest facilities onboard and away from the crew member's home base, flights across a number of time zones, and duty start times as these factors have been identified as effective fatigue mitigation strategies in the extant literature [6, 8, 10, 13, 27].

A key strength of this study is the ease of access to the data, as the researcher used data and information that is publicly available on the official websites of ICAO and the national regulatory authorities. Therefore, there were no shortcomings to accessing current data about the standards, recommended practices, and regulations. However, it should be noted that in some cases, there is a need for the respective authorities to provide more and clearer information about the intended meaning of some of the regulatory provisions.

The present study evaluated the fatigue management regulations published by international organizations and the regulators in eight South Asian countries. This analysis provides a better understanding of ICAO's standards and recommended practices and the fatigue management regulatory framework of South Asia's eight civil aviation authorities. These research findings will provide international organizations, regulators, and airlines with a better understanding of the commonalities and differences in flight time, FDP, duty, and rest period limitations across these eight countries. It is hoped that the region's national civil aviation authorities will consider and incorporate these findings when reviewing and updating their existing regulatory frameworks and operational procedures.

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## Chapter 28

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