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The illusion of aircrews' fatigue risk control

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ABSTRACT

In the fragmented European airline sector, companies are operating in a highly competitive environment amid rising cost of labour, fuel and airport fees. Fatigue risk management systems (FRMS) contribute to flexibly optimizing crew “utilization” through deviations and derogations from prescriptive European limits on duty times and rest durations. However, the flexibility gained comes at a price: it introduces an internal bureaucracy to mitigate the risks associated with crewmembers' fatigue and to develop, maintain and document fatigue related safety performance indicators. This paper questions the effectiveness of the FRMS framework and suggests that the bureaucratic process of the FRMS provides an illusion of fatigue risk control. More specifically four questions will be addressed: Why an operator needs an FRMS? Why the FRMS involves a bureaucratic process? What are the limits of the bureaucratic accountability of the FRMS and, finally, how might we manage fatigue risk effectively while keeping everyone happy, the shareholders as well as stakeholders?

1. Introduction

Occupational fatigue is an universal issue across many 24/7 industries and has been studied by international scholars in domains such as road transport, aviation, oil and petrochemical industries, railroads, health sector, maritime transport, etc. Human Factors and Ergonomics approaches have been widely used to analyse and mitigate employee fatigue by focusing on the root causes of fatigue such as sleep debt related to work and rest hours, wakefulness (time since awakening, prior duty plus time on task), circadian factors (late finish, night shift, transitions, jet lag) and operational workload and hassles (Neville et al., 1994; Härmä, 1995; Dawson and Reid, 1997; Cabon et al., 2002, 2012; Bourgeois-Bougrine et al., 2003a, 2003b; Goode, 2003; Dawson and McCulloch, 2005; Jones et al., 2005; Folkard and Lombardi, 2006; Caldwell, 2012; Allen et al., 2007; Powell et al., 2007; Holmes et al., 2012; Signal et al., 2012).

To mitigate the build-up of fatigue in diverse 24/7 industries, many scholars and regulators across the world have recommended these last two decades, the implementation of a hybrid strategy combining prescriptive rules and a fatigue risk management system (FRMS). Indeed, the FRMS which, was first tested by road transport regulatory authorities in Australia, is now recommended by regulators such as the European Union Aviation Safety (EASA, 2016, 2019), the International Air Transport Association (IATA, 2015), The International Civil Aviation Organisation (ICAO, 2011), the American Petroleum Institute (API, 2010), etc. ICAO defined the FRMS as a "*Data driven medium that continuously monitors and manages fatigue safety risks, based on scientific principles and knowledge, as well as on operational experience, which aims to ensure that the staff concerned perform their duties with a satisfactory level of vigilance*” (ICAO, 2011 — p. 1-1).

Any operator, who works under FRMS, must keep track, analyse, and mitigate the risks associated with employees' fatigue, which require an internal bureaucracy, accountability and the use of fatigue safety performance indicators (Gander et al., 2014; IATA, 2014). The literature of recent decades suggests that the bureaucratization of risk management, which consists of documenting, analysing, reporting incidents and accidents to excess, presents negative side effects on safety (Amalberti, 2013; Bieder and Bourrier, 2013; Dekker, 2014; Provan et al., 2017). This paper explores that claim and questions the effectiveness of the FRMS framework in the European airline sector. More specifically four questions will be addressed: Why an operator needs an FRMS? Why the FRMS involves a bureaucratic process? What are the limits of the bureaucratic accountability of the FRMS and, finally, how might we manage fatigue risk effectively while keeping everyone happy, the shareholders as well as stakeholders?

To answer these questions, the perspective adopted in this paper goes beyond the approach of Human Factors and Ergonomics that consider mostly the impact, at individual and crew levels, of factors such as work schedule or sleep hygiene. To take into account the complexity of pilots fatigue issue, this review addresses macro level factors such as labour management practices, safety climate, economic and regulatory constraints. To back our argument, this review will synthesize knowledge from multiple disciplines and sources and give a voice to aircrew by means of their

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confidential reports published by CHIRP between 2011 and 2018. Finally, the conclusion will address the implications of our review in terms of policy changes and future research for labour management and sociotechnical solutions to improve crew fatigue management.

2. Trust but verify: bureaucratisation of fatigue risk management

During the talks of the first treaty reducing the Soviet and American nuclear arsenals, Ronald Reagan made popular the Russian proverb "*Trust but verify*" to emphasize the extensive verification procedures that would enable monitoring compliance with the treaty (Shipler, 1987). Applying a "trust, but verify" approach to aircrew fatigue risk management relates to the regulator's examination of the organizational practises as well as internal audits with regard to FRMS. Two questions are addressed in this section: Why an operator needs an FRMS? Why is a bureaucratic approach necessary?

2.1. Why an operator needs an FRMS?

The FRMS enables an operator to partially or completely bypass the governmental working time limitations and rest requirements schemes (ICAO, 2011). For example, around 2004/2005, EasyJet was the first airline in Europe to be granted derogation to work outside the UK regulations to manage fatigue risks under FRMS (Stewart et al., 2006). EU Member States are not required to comply with FRMS guidelines but some specific situations would make it mandatory. For instance, when a deviation or derogation from the European Flight Time Limits (EASA-FTL) concerns a reduced minimum rest period or the assignment of longer duties to crewmembers in unknown states of acclimatisation, fatigue risks are to be managed under FRMS (EASA, 2018a). Indeed, these are well-known contributor factors to fatigue risk and compliance with FRMS guidelines is, therefore, a prerequisite for the processing of the operator's application. The operator must present a safety case, implement a FRMS and demonstrates to EASA that the level of safety is equivalent to the prescriptive limits. For example, France request, on behalf of HOP!, to reduce the minimum rest period, from 10 h out of base to 7.5 h was approved once EASA was satisfied with the data, the FRMS, and the safety case presented by the operator (EASA, 2018b). Similarly, the UK and Austria were granted, on behalf of easyJet UK[1] and Europe, a deviation from the rule which reads: *"If a transition from a late finish/night duty to an early start is planned at home base, the rest period between the 2 FDPs includes 1 local night"* (EASA, 2017).

The aforementioned examples suggest that the FRMS seeks to achieve a realistic balance between safety, productivity, and cost by allowing operators to optimize crew utilisation through "efficient" rostering practices. The requested deviations and derogations could be linked to economic pressure to cut costs as well as to a potential pilot supply shortage. The European Union is, indeed, home to 135 airlines and since the start of 2017, many European airlines have entered bankruptcy, collapsed or are barely hanging on (Spero, 2019). Labour costs, aircraft fuel and airport fees are the three most important expenses for any airline (De Juniac, 2019), and staff costs are consistently considered the most controllable expense, putting many airlines under pressure. Moreover, higher minimum pilot qualification requirements, expensive pilot training and the prospect of low starting salaries could have an impact on commercial pilot supply (Stewart and Harris, 2019; Lutte and Lovelace, 2016).

2.2. Why is a bureaucratic approach necessary?

The FRMS applies the principles and methods derived from the Safety Management System (SMS) promulgated by ICAO in its safety management manual (ICAO, 2009). The principles and guidelines of the SMS share commons features with the recently adopted international standard ISO31000: 2010 — Risk management. ISO 31000 is an 'umbrella standard' that goes beyond the Safety Management Manual guidelines and offers a mature approach to manage all types of risk including human fatigue (ISO, 2010 revised in, 2018; ICAO, 2010). The new risk management standard, ISO 31000, states that the purpose of risk management processes is the creation and protection of value. It defines risk as *"the effect of uncertainty on objectives"*. Uncertainty is the state, even partial, of lack of information concerning the understanding or the knowledge of an event, its consequences or its likelihood. A greater emphasis is placed on the iterative nature of risk management and the explicit formalization and separation of responsibilities between managers and operational staff (Fig. 1).

Similarly, the FRMS is a top down system, which means that the accountable manager of the organisation is responsible for the implementation and continuing compliance of the FRMS (Fig. 1). The FRMS policy explicitly separate responsibilities between managers and operational staff by including two operationally focused components (Fatigue risk management processes & Fatigue safety assurance) and two organizationally focused components (FRMS policy and documentation & FRMS promotion processes). The Fatigue Safety Action Group (FSAG) has the responsibility for coordinating FRMS activities and the day-to-day running of the FRMS.

The FRMS promotion component relies on effective communication throughout the organization and requires the implementation of fatigue-related training programmes for operational personnel, schedulers, managers and the executive accountable for the FRMS. The aim of these programs is to provide an appropriate understanding of the key principles of fatigue science to all stakeholders.

The operator must develop and update the FRMS documentation that describes and records "FRMS training programmes, training requirements, and attendance records; scheduled and actual flight times, duty periods and rest periods with significant deviations, and reasons for deviations noted," amongst other things.

Fatigue risk management component is the process of identifying and evaluating fatigue risks, deciding what and how to mitigate them, and establishing the fatigue metrics to allow the effectiveness of the mitigations to be assessed. It involves a) risk analysis (fatigue hazards identification in predictive (examining planned work schedules), proactive (monitoring fatigue levels in current operations) and reactive approaches (assessing the contribution of fatigue to incidents and events)), b) risk estimation in terms of likelihood and the severity of the consequences of fatigue-affected performance, c) risk evaluation (comparison of the estimated risk against given risk criteria to determine the significance of the risk and to assist in the decision to accept or to treat a risk) and d) risk treatment (process of selection and implementation of measures which can include avoiding, optimizing, transferring or retaining/accepting risk).

Fatigue safety assurance is focused on the FRMS performance. As Kaplan and Norton (1996) stated *"you cannot manage what you cannot measure"*. Risk governance through performance indicators (SPIs) is part of the growing trend of transparency, openness and accountability. The FRMS does not escape the requirement of a performance measurement system for effective management. As reported in Fig. 2, fatigue related SPIs are complex and include several operational SPIs that monitor roster metrics, pilots' objective performances (Line Operations Safety Audit & Flight Data Analysis), crew fatigue reporting and fatigue survey, subjective alertness assessment, sleep-wake diary and objective sleep metrics. Each type of measurement has its strength and weakness in terms of cost, effort and time. The operators identify the SPIs according to the specificity of the operational context as well as the expected fatigue level and set the targets that will be used to assess the FRMS performance. The State reviews, assesses the robustness, and agrees on the operator's identified SPIs. For example, to monitor the effectiveness of fatigue related mitigations, the operator might use the trends of the crew fatigue reporting rates, which is simple and cost effective, but are "*subject to possible bias and requires an effective reporting culture"* as presented in the next section (ICAO, 2016 p. 175).

[1] EasyJet Europe is based in Austria. It was established on July 2017, following the UK referendum vote to leave the European Union, in order to continue operating flights across and within European countries after the UK leaves the EU

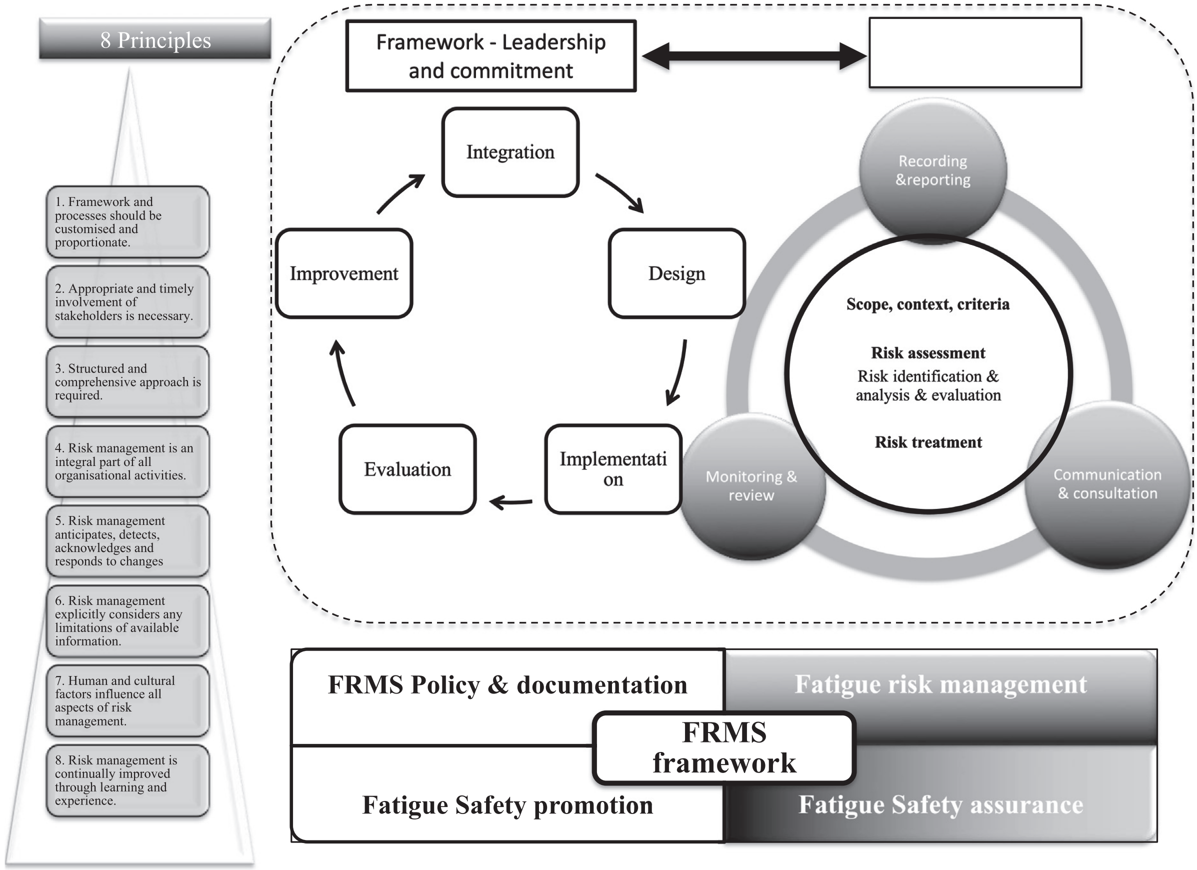

Fig. 1. The FRMS framework and its link with ISO31000. The aim of the eight risk management principles is to create and protect value. Similar to the standard, ISO31000, the FRMS places greater emphasis on the role of the governance of the organisation, the iterative processes and the separation of responsibilities between managers and operational staff.

3. What are the limits of the FRMS bureaucratic accountability?

Three categories of limits will be addressed below: the probabilistic approach of fatigue risk management, conflicts of interest and safety climate.

3.1. Limits of the probabilistic approach of fatigue risk management

The probabilistic approach quantifies risk by combining the probability of occurrence of harm and the severity of that harm. Unlike assessing the risks associated with chemicals or other products, there are limitations to evaluating immaterial risks such as fatigue. As reported by ICAO, *"current methodologies for evaluating the level of risk, when applied to fatigue, are all limited to some degree. Further, the usefulness in application of all risk assessment methodologies is directly related to the knowledge and experience of the user"* (ICAO, 2016, p. 111). Individual differences, personal factors and operational context cannot be predicted precisely making the evaluation of probabilities related to fatigue risk more challenging. Individuals are indeed, not equal when it comes to their sleep needs, personality, chronotype and how they are affected by poor sleep, etc. (Pilcher and Huffcutt, 1996; Van Dongen and Belenky, 2009; Van Dongen et al., 2006; Hockey et al., 1998). In addition to personal characteristics, fatigue and wellbeing in general could be affected by socio-psychological factors such as the choice of the work pattern, social rhythms and work-life balance (Arlinghaus et al., 2019; Barton, 1994). Furthermore, the level of fatigue risk depends on the operational context in which the task is being performed. As long as situational factors, such as weather conditions, are favourable and operational demands low, a fatigued crew will still manage to operate at an appropriate level.

More importantly, the evaluation of the risk associated with the hazard of "fatigue" considers the individual's ability instead of the crew's ability to perform adequately. Indeed, the severity of the consequences is based on individual-oriented performance tasks rather than overall crew performance (Petrilli et al., 2006; Rosekind et al., 2006; Rosekind et al., 1995; Dinges et al., 1990; Dorrian et al., 2003; Jewett et al., 1999). However, flight simulator-based studies suggest that fatigue has a complex relationship with the operational performance of the crew (Foushee, 1986; Roach et al., 2006). For example, a tired crew, which had recent operational experience together, performed better than a rested crew that had not flown together recently (Foushee, 1986). It has been observed that the familiarity that results from sharing a recent flight experience improves communication between tired members of the crew, resulting in fewer operational errors. More recently, the effects of fatigue on the management of threats and crew errors have been evaluated in a Boeing 747-400 flight simulator (Roach et al., 2006). The results, while confirming that fatigue has a negative impact on operational performance, showed that fatigue was associated with better error detection and crosscheck optimization. Tired crews also tend to make more conservative decisions. Similarly, using the Line Operations Safety Audit methodology (ICAO, 2002; Klinect, 2002), we observed that Crew Resources Management (CRM) represent a good barrier against fatigue (Unpublished results). The increase of the number of errors, with sleep loss and fatigue accumulation, was counterbalanced by an improvement of CRM. The rating of the observable behavioural markers, which are an indicator of the quality of CRM, was significantly improved for fatigued crews compared to non-fatigued crews. As Roach et al. (2006) suggested, fatigue is associated with increased monitoring of performance as an adaptive strategy to compensate for the increased likelihood of error.

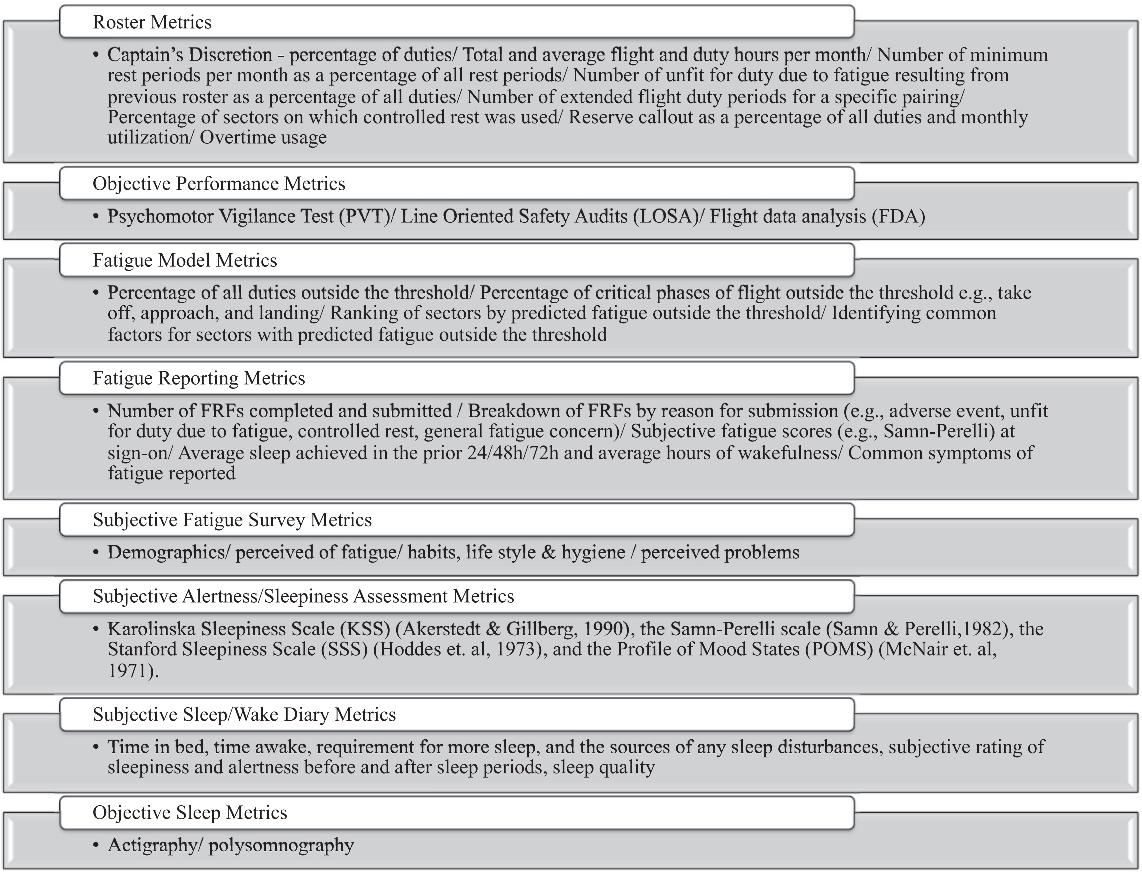

Fig. 2. Fatigue related safety performance indicators and examples of metrics. FRF: fatigue reporting form.

3.2. Potential conflicts of interest

The nature of fatigue related SPIs, the complexity of the FRMS process, the limited access to fatigue specialists and their financial relationship with regulators and or operators increase the probability of conflict of interest. Gander et al. (2011, p.587) indicated that the "*FRMS is arguably becoming a niche market for consultants…Companies introducing FRMS can feel exposed and unsure as to whether, collectively, the systems they are introducing are sufficiently robust…*". During the process of derogation approval, a panel of experts in fatigue science is indeed systematically invited to comment on the operator's proposal, the state authority's assessment of the proposal, as well as EASA's comments. The State Civil Aviation Safety Inspectors (CASIs), which are involved in the FRMS oversight, are trained by fatigue consultants to acquire specific fatigue-related knowledge, and knowledge of how to assess the effectiveness of the FRMS. As part of normal oversight, CASIs are likely to conduct interviews with a variety of people involved with the FRMS, evaluate the content and the effectiveness of FRMS training and education programmes, and might also ask to attend an operator's FSAG meeting to gain better insight into its FRMS processes and audit Fatigue related SPIs.

A conflict of interest might arise in the following situations: a) suitably qualified CASIs *"who works closely with a company to develop and accredit its FRMS and then takes on the role of auditing that FRMS once it is implemented"* (Gander et al., 2011, p. 587), b) a fatigue consultant might have competing interests or loyalties when assisting an operator to apply for a derogation or to implement an FRMS, and at the same time provides support to the state inspectorate on how to assess an FRMS (ICAO, 2011) and c) fatigue experts/consultants could be involved in the process of collecting, analysing the fatigue related SPIs and writing the reports that are provided to regulators. The financial relationship and confidentiality agreement between a consultant and an operator raise the issue of conflicts of interest as they are paid by the operator to provide evidence with regard to the maturity of the FRMS. However, well-meaning and experienced, a fatigue consultant could be under pressure to compromise because of his or her lack of independence.

3.3. Safety climate

The term "safety climate", which describes employees' perceptions, attitudes, and beliefs about risk and safety (Mearns and Flin, 1999; Lee et al., 2019) is addressed in this study through the review of confidential fatigue-related aircrew reports published by CHIRP. One of the most popular fatigue related SPIs is the number of fatigue reporting forms (FRFs) completed and submitted by the crews to their managers. An increase in crew reports should trigger further action by the FSAG and could lead the regulator to amend the approved deviation. Although the CHIRP encourages pilots to report their concerns about rostering directly to the company to inform future roster policy (CHIRP Issue N°106; 2/2013; CHIRP Issue N°121; 1/2017), some pilots, as illustrated below, prefer to abstain from reporting fatigue because of management's lack of responsiveness, pressure and bullying:

- *"We have a fatigue reporting system, yet people are too scared to use it and I meet more and more people who are fatigued, but flying… the manger tells you that if you call fatigued, it will look very bad…This is a safety risk in my opinion, and something should be done to stop managers threatening the use of fatigue reporting "* (CHIRP Issue N°106; 2/2013, p. 7)
- "*Often crew say they can't/don't want to do this, but are reticent to inform crewing as they say they are afraid of retribution from their line managers… an example of the worst type of fear culture that has no place in an airline with a healthy safety culture… Bullying of this nature is endemic* " (CHIRP

Issue N°108; 4/2013, p. 4)

- *"Senior management from the DFO down are well aware through a number of fatigue reports, including my own, of the unease that this practise is causing but seem oblivious to the erosion in morale (evidenced by a high sickness rate) and trust in management…"* (CHIRP Issue N°128; 4/2018, p. 5)
- *"I feel pressured to do so (working several days overtime on his normal days off) as I think the next selection for redundancies will be based on flexibility. I don't want to report fatigued as sickness absence was used in last year's Matrix to select redundancies."* (CHIRP Issue N°123; 3/2017, p. 4)
- *« We have a FRM system, which is hailed as being one of the leading examples in the industry. However, the truth is it is ineffective,… fatigue reports can take a week or more to be acknowledged and often result in no change being made…».* (CHIRP Issue N°111; 3/2014, p. 4)
- *"I filled in the fatigue report form… They put me down as SICK…Before flying I [had an interview to determine the circumstances and background to my reporting fatigue]. May I say that the interview did not feel like a duty of care interview, but more an interrogation into my lifestyle?"* (CHIRP Issue N°122; 2/2017, p. 7)
- *« The Company has previously expressed "disappointment" that its pilots have opted to make their confidential reports via the CHIRP system rather than Company reporting scheme…the system (Confidential Reporting) exists more for the purpose of suppressing, rather than acting upon, safety reports ».* (CHIRP Issue N°99; 3/2011, p. 5)

As the aforementioned confidential reports suggest, there is a poor safety climate in the companies involved that is at odds with the "just safety culture" required under FRMS. In the absence of "just culture" (Reason, 1997), the bureaucratization of safety associated with production pressure can lead to a "structural secrecy" (Vaughan, 1996) where critical safety problems are filtered, categorised or suppressed. Recent disasters have occurred in "performing" organizations with a strong focus on safety and low rates of negative events (INERIS, 2014). As Dekker (2014, p. 351) outlines "*low incident reporting rates might suggest workplaces where superiors are not as open to hearing bad news of any kind, which might explain why those that have fewer incidents are also more likely to suffer fatal accidents—even if these are caused by different factors*".

4. Conclusion: tired of FRMS, what next?

The review highlighted that the critical nature of the requested deviation and derogation requires operators to implement a FRMS and by adopting SMS principles and ISO31000 guidelines, the FRMS process places emphasis on bureaucratic and iterative reviews to ensure the FRMS remains relevant and appropriate. The FRMS made the management of fatigue risk far too complicated compared to the prescriptive approach of FTL scheme and presents limits such as challenges to assess precisely the probabilities of fatigue risk and, in the cases presented, potential conflicts of interest and symptoms of unhealthy safety climate. The application of a bureaucratic approach to managing fatigue risk reinforces the illusion of fatigue risk control and satisfies the need for structure (Bourgeois-Bougrine et al., 2017) and accountability of regulators, risk managers, engineers, etc.

To the question of whether the current FRMS framework is the most effective way to manage aircrew fatigue risk; the answer is no. With regard to the aforementioned examples, it is not the aim of the FRMS that is challenged here but the abuses of its process. The question raised is how might we manage fatigue risk effectively while keeping everyone happy, the shareholders as well as stakeholders? Three main complementary routes to effective fatigue management could be explored: policy changes, future research in both labour management and sociotechnical solutions.

In terms of policy implications, the aviation industry needs to address in more effective way the issues of conflict of interests and promote a better safety culture. Fatigue consultants who play a crucial role in helping airlines to apply for derogations, implement the FRMS, train staff, etc. should not be involved in regulators' expert panels as well. Disinterested experts, acting by professional obligation, rather than by remuneration, should assess the maturity of the FRMS independently. When there is a severe fatigue risk concern, raw and objective data with regard to operational performance (e.g., Line Operations Safety Audit & Flight Data Analysis), should be collected and assessed independently by an academic or safety organisations that have no affiliation or association with airlines or regulators.

In terms of the implications for future research in labour management domain, it is worth to consider the following question: what if the FRMS allows crews to have a greater and responsible "control" over their schedules while at the same time providing flexible operational rostering practices to meet "production" demands? The available scientific data about hour control, flexibility and variability suggest that even when working hours are highly irregular, high worker control (worker-oriented 'flexibility') was associated with better health and well-being than when hours are largely controlled by employers (for more information see Arlinghaus et al., 2019). As outlined by Demerouti et al. (2019) "*intensifying working conditions top-down increases job demands and this harms pilots' well-being when it is not accompanied by a gain in job resources… pilots should have more possibilities to influence their roster…*". How might we make it possible to serve both employer-oriented flexibility and worker-oriented flexibility? How might an airline have unlimited access to "fit to fly" pilots to cover scheduled and disturbed rosters? How might a pilot be able to choose and "craft" his own rosters? Answers to these questions require looking at the problem of aircrew fatigue from a new perspective, involving airline business models, crew "utilisation" and even recruitment.

With regard to future research in the development of new sociotechnical solutions, there is a need to shift the focus of aircrew fatigue research from understanding how to prevent fatigue from happening to finding sociotechnical solutions that allow the recovery and the mitigation of the consequences of aircrew fatigue. By mainly focusing on the causes of fatigue, the FRMS addresses only one type of barriers against fatigue hazards, e.g. prevention barriers. Recovery barriers prevent an event from resulting in unwanted consequences and protection or mitigation barriers limit the impact of the unwanted consequences (Sklet, 2006). Contrary to road transport industry, where several technologies have been considered to prevent, recover and mitigate fatigue risks (Dawson et al., 2014), there are few initiatives that addressed sociotechnical barriers against pilots' fatigue (Cabon et al., 2003). More research is needed to develop solutions to prevent fatigue consequences, such as memory lapses, errors, omissions, violations, both crewmembers falling asleep at control, etc. from resulting in serious incident or accident. Potential research questions to be considered are as follow: what would be the design principles for aircraft cockpits that are tolerant of crew fatigue? In the case of severe crew fatigue, what type of advanced flying assistance could be activated? How to provide an effective ground support or a better air traffic control interaction during approach and landing for fatigued crews, etc.?

In conclusion, we would like to emphasize that looking for ways to flexibly manage pilots' fatigue while trying to strike a good balance between productivity, safety and cost is understandably legitimate. Safety, through fatigue related-accident avoidance, is only one aspect of managing the risks that can kill a company; some risks (economic, strategic…) can sometimes kill a business faster than others (Amalberti, 2013). However, the increase of the complexity of situational factors combined with the depletion of crew cognitive resources due to fatigue increase the probability of taking human performance into the "coffin corner" of cognition (ICAO, 2002, p. 13). An independent and sensible regulator's oversight of the FRMS is a vital necessity for the benefits of airlines, their employees and the safety of passengers. A better labour management is crucial as the number of air travellers could double to 8.2 billion in 2037 (IATA, 2018) and with the perspective of pilot supply shortage, companies with poor talent management programs are at risk in the race to attract and retain qualified pilots. Finally, the international research community should broaden the scope of their studies to imagine, develop, test and implement sociotechnical recovery and protection barriers against fatigue hazards.

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[2] The aim of CHIRP is to contribute to safety in aviation and maritime by a) providing a totally independent and confidential reporting system for individuals to raise safety-related issues of concern, such as errors, fatigue, poor ergonomics, management pressures, deficiencies in communication or team performance, without being identified to their peer group, management, or the Regulatory Authority and b) when appropriate, acting or advising on information gained through confidential reports.

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