BUSINESS BENEFITS ASSOCIATED WITH IMPROVING FATIGUE INDICATORS OF CARGO PILOTS

by

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This Capstone Project was prepared and approved under the direction of the
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It was submitted to Embry-Riddle Aeronautical
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Abstract

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Title: Business Benefits Associated with Improving Fatigue Indicators of Cargo Pilots

Institution: Embry-Riddle Aeronautical University

Year: 2022

The central idea of this research is to assess business-related issues in the Pilots´ Fatigue Regulations and evaluate if a more flexible regulation would improve productivity of airline cargo pilots in Brazil.

The results of the study have indicated that Brazilian Civil Aviation Authority (ANAC) can create a regulatory environment that may lead to around 35% of improved productivity of pilots´ availability in cargo operations, which may contribute for gains of around USD $3.6 million for an airline with cargo 70 pilots.

Aviation fatigue regulations are an extremely important subject in the aviation industry as they are a part of an evolution of operational processes within the Safety Management System (SMS). However, some restrictions in regulation may produce some business-related inefficiencies in terms of additional costs or revenue loss to airline companies.

The research conducted revised the bibliography available with regards this subject of pilots´ fatigue regulation in the USA and Brazil.

The Group also compared important business-related indicators related to cargo pilots´ operations in Brazil and calculated potential gains of a hypothetical scenario of an adjusted pilot´s schedule.

At last, the research included evaluation of safety levels of cargo operations in the USA and Brazil to compare if safety is impacted by fatigue in an environment of an optimized schedule of cargo pilot.

A crucial finding of this research is that the proposed changes shall not impact current safety levels caused by fatigue of pilots.

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Chapter I

Introduction

In November 2011 the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA) and the International Federation of Air Line Pilots´ Associations (IFALPA) published the Fatigue Risk Management System (FRMS) as part of the ICAO Annexes 6 and 8 to provide regulators with a specific framework for implementing airline crew fatigue monitoring and tracking. The main goal of the FRMS is to seek a crew fatigue monitoring schedule, based on the Safety Management System (SMS) principles (International Civil Aviation Organization, 2011).

As in Safety Management Systems (SMS), FRMS strives to find the realistic balance between safety, productivity, and costs in an organization, through collection of data and a formal assessment of risk. Such a schedule includes balancing risks to the operation, operational performance, and costs. All these factors must be based on science and supported by basic questions of human physiology.

Some regulators, such as the Federal Aviation Administration (FAA), understood that this model was not applicable to the operation of cargo aircraft. Some operators, as IATA members, have a fatigue monitoring program in place, but not as effective for cargo operations as they are for passengers' operations.

In the United States, both passenger and cargo companies operate under the Code of Federal Regulations (CFR) PART 121/91. These airline operators are also subject to the same CFR Part 117, which deals with the subject of fatigue. However, this regulation excludes the cargo operations from the scope of it. In Brazil, this topic is included in the National Civil Aviation Agency´s (ANAC) Brazilian Regulation of Civil Aviation

Number 117 (RBAC 117) and it does not differentiate the application of the regulations between passenger and cargo pilots.

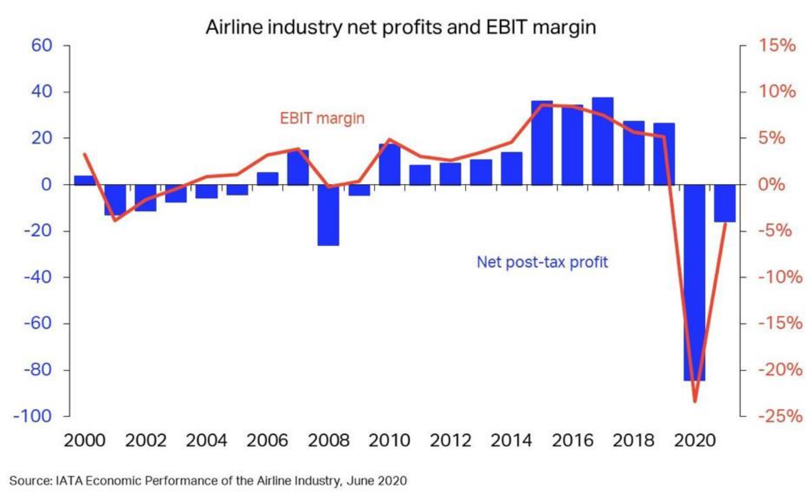
Project Definition

The industry perception suggests that the rules are somehow much more restrictive than what it really needs to be. These restrictions may produce some productivity inefficiencies by not optimizing the usage of this valuable resource, which is the pilot. Our research evaluated potential gains to air cargo operators and if better results could be achieved by changing some parts of the actual fatigue regulations. Allowing more flexibility, obviously without posing any additional risk to aviation safety**.**

Problem Statement

The airline industry is known for historically having very high costs, low margins, and the constant need for intense capital cash-flow to maintain operations amidst a recurrent challenging scenario as demonstrated at Figure 1 below (IATA, 2020):

Figure 1 – Airline industry net profits and EBIT Margin

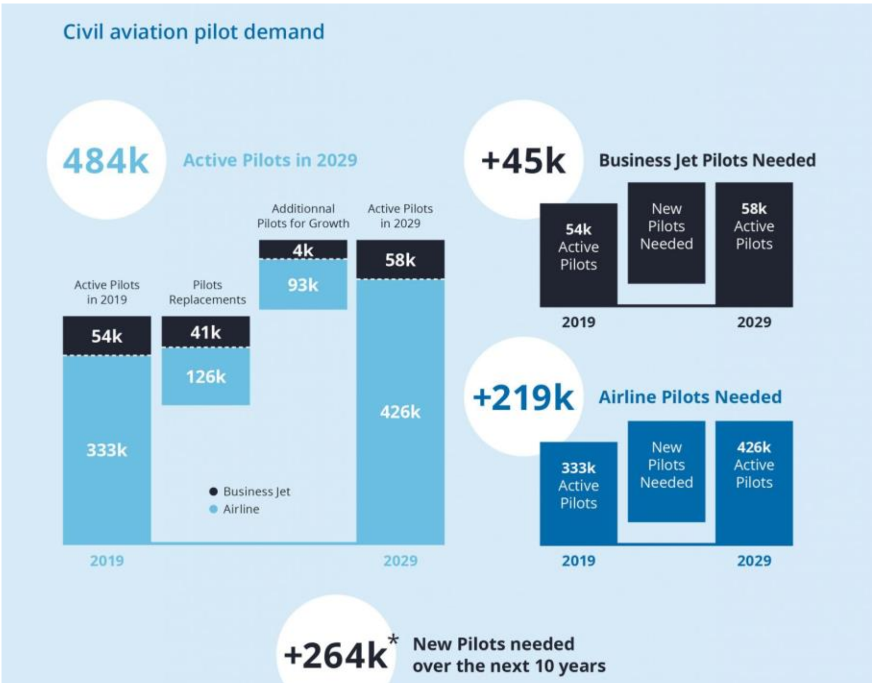


Thus, airlines are continuing to seek potential opportunities for cost reductions. Even minor cost reduction concepts could lead to cost savings of millions to the industry.

A key factor in airline costs are the pilots. The industry is facing a drastic shortage of trained pilots due to the rigorous and expensive application process and the pandemic of COVID-19 which accelerated some early retirement packages (Salas, 2022). Salas still comments that in the next twenty years, airlines in North America will need around a hundred thirty thousand (130.000) new pilots and projections show that the global pilot shortage could reach fifty thousand (50.000) pilots by 2025 (Salas, 2022).

The demand for civil aviation pilots can be demonstrated on Figure 2 below (CAE, 2020):

Figure 2 – Civil aviation pilot demand



Source: CAE, 2020.

So, is critical that potential pilots be identified, trained, and certified. In this way, the current pilots' schedules could be better optimized to allow them improve productivity by operating more cargo flight hours. Our research focused on ways to address some of these pilot issues as well as identified ways to save money for the airlines, as it relates to cargo pilots.

Some of the potential benefits our research explored included:

- Improved allocation of cargo pilots resulting in pilots flying more hours and doing more flights
- Reduction of the number of flight cancellations and delays due to crew working hours expired
- Revisions to airline schedules that could be improved by having more availability of pilots to operate them, while maintaining the safety of the operations which is the most important premise to be protected

Project Goals and Scope

The goal of this study was to appraise potential outcomes and conclusions around a hypothetical more flexible cargo pilot´s fatigue regulations in terms of schedules by assessing the following business-related indicators and factors:

- comparison on fatigue levels between cargo and passengers´ operations

- main points of current regulations that might create some business inefficiencies for cargo operations in Brazil

- simulation of proposed changes based on improved business factors

- analysis of cost-situations of before and after scenarios, if certain changes in current restrictions were applied for cargo pilots
- potential business-related gains and synergies to cargo operators

The principal research question is to understand if a change in current regulations would be feasible, and if it would reduce costs and/or generate more revenues to cargo operators. The hypothesis is that there are certain parts of the regulation that could be more flexible without impacting aviation safety. These changes could bring positive results in terms of reduced cost of delayed/cancelled operations due to unavailability of pilots in certain flights. Also, there is the possibility of cargo operators adding more flights, thus generating more revenues despite some additional costs for paying extra working hours to pilots.

Contributions Expected

As the aviation industry is known for historically having very high costs, low margins, and needs for intense capital cash-flow to maintain operations, cargo aviation are continuing to seek potential opportunities for cost reductions.

Based on the description of the aviation issue we have described; this research came at an opportune time. There is a need for the better optimization of the usage of such cargo crew resource bringing more productivity and by consequence more rewards to the companies.

Definitions of Terms

ANAC	ANAC is a regulatory agency which was established to regulate and inspect civil aviation activities as well as aeronautical and airport infrastructure in Brazil. The agency was created in 2005, replacing the Department of Civil Aviation (DAC) as the new National Civil Aviation Authority (National Civil Aviation Agency, 2018).
Circadian Rhythm	Study of innate rhythms driven by the daily cycle of the circadian biological clock (a pacemaker in the brain) (ICAO, 2011).
FRMS	A Fatigue Risk Management System (FRMS) has been defined by ICAO as "*a data-driven means of continuously monitoring and maintaining fatigue related safety risks, based upon scientific principles and knowledge as well as operational experience that aims to ensure relevant personnel are performing at adequate levels of alertness"* (ICAO, 2011).
IATA	The International Air Transport Association (IATA) is the trade association for the world's airlines, representing some 290 airlines or 83% of total air traffic. We support

	many areas of aviation activity and help formulate industry policy on critical aviation issues (IATA, 2022).
Sleep Science	Particularly the effects of not getting enough sleep (one night or across multiple nights), and how to receover from them (ICAO, 2011)

List of Acronyms

ANAC	National Civil Aviation Agency
CAA	Civil Aviation Authorities
CFR	Code of Federal Rules
FAA	Federal Aviation Administration
FRMS	Fatigue Risk Management System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFALPA	International Federation of Air Line Pilots´ Associations
RBAC	Brazilian Regulations of Civil Aviation
SMS	Safety Management System

Plan of Study

Chapter two: Literature Review: On Fatigue Regulations and Labor Legislation in different areas of the world.

Chapter three: Research Methodology: Included analysis over ANAC statistics to compare important operational and business-related factors and indicators related to cargo operations in Brazil. Additionally, the research accesses the system that monitors fatigue reports. The group also compared the pilot crew schedules from different global cargo operators.

The group explored potential optimization opportunities that they can potentially envision. Adding to that, the research will include discussions with personnel from the Safety, Human Factors and Aerospace Medicine Departments of some air companies to also understand their perspective over these factors.

To bring the mathematical validation of potential optimization, the research will run statistical modeling comparing the schedules of pilots in hypothetical scenarios and the potential results of optimized reduced costs or additional revenue generation of a more flexible regulation and schedules.

Chapter four: Conclusions: We intended to present the results of data analysis including simulation of potential gains to airlines and costs involved in certain adjusted regulation scenarios to prove if the hypothesis of gains was valid or null.

Chapter five: Recommendations: This chapter will contain the study’s recommendations, theoretical and practical implications, limitations of the study, and suggestions for further research on other aspects non-business related of fatigue regulation.

Chapter II

Review of the Relevant Literature

The International Civil Aviation Organization has a dedicated Task Force to study and promote the principles of Fatigue Risk Management Systems (ICAO, 2016). The literature shows that ICAO, IATA and IFALPA have been working on the production of comprehensive documents and manuals regarding FRMS to jointly lead and serve industry in the ongoing development of fatigue management, using the most current science. Some of the most important documents are the ICAO Doc. 9966 - Manual for the Oversight of Fatigue Management Approaches (ICAO, 2016) and the Fatigue Management Guide for Airline Operators (IATA et al., 2011).

These documents serve as a reference for the Civil Aviation Authorities in most countries to create their local regulations regarding the subject of fatigue at certain operational professions. Some of the most prominent examples of consistent regulations around this issue are the FAA Code of Federal Aviation (CFR 117), the European Aviation Safety Agency (EASA) Regulation 117, and the Brazilian Civil Aviation Regulation (RBAC) 117.

Fatigue effects on pilot´s profession

The phenomenon of fatigue influence on a pilot´s profession is well-known in the industry. As mentioned above, there are strong and deep studies and materials which demonstrate the influences of fatigue into the pilot´s awareness during flight and how it may affect the safety of operations such as absence of alertness, physical and mental performance, mood, risk of falling asleep, among others (ICAO, 2016 p.1-1).

The FRMS Implementation Guide for Operators advocates that companies move from prescriptive to performance based regulatory oversight. In addition, it strives to find the realistic balance between safety, productivity, and costs in an organization (IATA et al., 2011). The majority of this document and the other manuals refer to the physiological understanding of fatigue factors and the safety risk management initiatives (ICAO, 2016 p. 2-1).

Those manuals and studies give special focus on essential sleep science, required rest periods, and Circadian Rhythms of the pilots and propose predictive, proactive, and reactive hazard identification, potential risks´ assessment and mitigation, safety assurance, training and promotion, culture of reporting occurrences and operational monitoring.

Therefore, labor legislation for pilots and Civil Aviation Authorities searches for prescribing restrictions in the labor rules regarding pilot´s working schedules and rostering (CFR, 2012), (EASA, 2006), and (ANAC, 2019).

Productivity on pilot´s profession

The group also researched other Capstone Projects at Embry-Riddle but none of them discussed this subject before. However, one of them discussed about pilot´s seniority versus performance indicators and promotion criteria and called our attention. This correlates in parts with some of the objectives of our study which is the assessment of potential pilot´s performance optimization generating business benefits to air cargo companies by an adjusted and more flexible fatigue regulation.

In this study the group worked with other performance indicators like technical competencies evaluations, disciplinary procedures, customer evaluation, absenteeism, and on-time performance (Andrade et al., 2017). They demonstrate there is an industry desire for improving business-related indicators to produce more productivity form the flight crew resource. (Andrade et al., 2017).

Opportunities for flexible regulations

Olaganathan et al. (2021) bring an interesting question on the fatigue subject with special attention to pilots when they indicate future research directions for investigation like finding any potential relationship between ethnic, demographic, and cultural differences in the way they respond to fatigue. This kind of study could demonstrate the possibility of having different approaches to fatigue regulation in certain parts of the world according to ethnic, demographic, and cultural differences.

The (Olaganathan et al. 2021) study brought an inquiry at organizational level, about the efficacy of in-flight napping among long-haul pilots to be explored. A fatigue scoring system can be developed. An anonymous peer-to-peer investigation can be performed to assess fatigue management. In addition, a bio-mathematical modeling can be developed to measure the performance of pilots. The group also cites that studies can also focus on the robustness of sleep/wakeup times for crew members as these times are not necessarily rigid in real practice as assumed by regulations.

So, although it is not the scope of our research to go into the physiological aspects of fatigue, these questions may guide us for some discussions towards adjustments on the regulations with regards the crew schedules and rest hours. Thus, this research assessed opportunities to increase cargo pilot´s availability and reach our hypothesis of potential business-related gains to air cargo operations.

An interesting study about the perception of pilots on the impact of Part 117 was addressed to see pilot´s ability to operate the aircraft safely (Lukas et al., 2016). In this study the results showed that it was not a unanimous consensus that these changes were positive. Most of the responses indicated that pilots found no positive impacts or found it slightly positive. The same research indicated most of the survey participants strongly agree that cargo pilots should be included in Part 117. This research brought a qualitative open question which results led to a general impression that the crew rest changes are more often viewed negatively than positively among the pilots' providing comments. (Lukas et al., 2016)

This study called our attention that actual regulation does not necessarily favors the good perception of pilots about the positive impacts over the operations. This might support our research case to explore more flexibilization in the current regulations to allow cargo pilots to fly more.

Study-Cases of Optimization

In 2006, DHL was already seeking for increasing productivity after the EasyJet success case (Learmount, 2006). At that time DHL was working with UK regulators to increase the night flights by looking at the encouraging results of a study from the Low-Cost Carrier EasyJet. This aviation airline got from the CAA the permanent alleviation to operate a more precise and tailored flight crew rostering by extending the Flight-Time Limitations (FTL).

Another interesting paper studied a multi-objective optimization of airline crew roster recovery problems under disruption conditions (Chen, 2017). As per the complex nature of aviation industry, the planned crew schedules may be interrupted by many unexpected disruption scenarios and factors, such as mechanical problems in the aircraft, weather conditions, and crew unavailability.

The common method to solve this issue is to make a recovery plan. However, it might not be simple because it depends on several criteria related to practical resource or management issues, such as pilots' availability to assume this recovery plan. So, this study evaluated recovery approaches by formulating a Crew Roster Recover (CRR) problem as a multi-objective combinational optimization problem (Chen, 2017).

The CRR problem presents some constraints such as legal working days and reallocated activities. These factors must also be considered in the recovery process to optimize multiple objectives. Furthermore, for cases where the recovery schedule cannot be obtained because of tight resources after the disruptions, a Constraint-Loosening Mechanism (CLM) is proposed to enable the evolutionary cancellation of flexible nonflight tasks (Chen, 2017). Through implementation of the CLM method, the proposed approach can recover the rostering schedule from severe disruptions.

In summary, the experiments showed that the proposed evolutionary approach had a favorable solution quality. It could successfully obtain recovery solutions after disruptions. Having this in mind, our research shows excellent chances to demonstrate cost savings to air cargo operators on these disruption scenarios if we can make some regulations constraints more flexible in the sense of turning more pilots available to process this schedule recovery plan.

Another study focused on an article which investigated an Airline Crew Rostering Problem (ACRP) originated with a Chinese airline. The intent of that study was to utilize the manpower resources in the most effective way in the process of assigning pairings to individual crewmembers in a sequence of consecutive flight segments (or legs) separated by rests and layovers as per practical rules or constraints. These elements are imposed by government administrations, airlines, or crew itself (Zhang, 2020).

This is an operational research transportation problem on how to optimize the airline crew resources in the Chinese market. These are critical resources for their daily operations. A research question was working in high utilization of crew as more important than crew labor cost savings. Labor cost in the cost structure of Chinese civil aviation is much smaller than the rest of the world. It also reinforces the challenge of having pilot crew availability which is crucial for the growth of aviation industry worldwide.

With modernization, airlines use crew scheduling, rostering, and software to assist in performing mathematical analysis. Airlines have already been employing whatever is possible to optimize the usage of this valuable resource of cabin crew. This is supported by the study performed by Air New Zealand in 2001, which resulted in a savings of NZ$ 15.656.000,00 per year (Butchers, 2001). However, in order to move one step ahead in optimizations, there would be a need to change the current regulations´ restrictions in place for cargo operators’ pilots. Our research analyzed this issue with more details ahead.

Summary

In conclusion, this literature explains the current regulatory environment about ICAO, IATA and CAA regulations and recommended practices. It shows studies around the physiological aspects of fatigue. However, some research indicates that industry is pursuing better performance and productivity levels of the flight crew resources. This in the end shall produce business benefits to the aviation industry.

Literature also inquires whether fatigue may have the same influences on different group of individuals, places, etc. Thus, the research shall evaluate opportunities for a more flexible cargo pilots scheduling with regards to current Brazilian regulations to create benefits to local air cargo operators in Brazil.

Moreover, recent studies move towards more optimization of air crew resource. However, these advances are still limited by current regulations. Making some of these regulations more flexible could generate considerable gains to air cargo operators in terms of cost savings or revenue production by more flights operated.

Chapter III

Methodology

Considering the purpose of our research, the group started revising the bibliography available from ICAO and IATA related to fatigue regulations to understand the influence of their dispositions on current labor regulations imposed by CAAs in some countries like USA, Brazil and in the European Union. Such research assessed the following documentation:

- ICAO Fatigue Risk Management System (FRMS) Document 9966
- Brazilian Civil Aviation Regulation (RBAC) 117
- FAA Code of Federal Aviation (CFR 117)
- European Aviation Safety Agency (EASA) Regulation 117

Research conducted at Embry-Riddle´s Hunt Library looked at available articles regarding pilot´s productivity indicators. Also, the research consulted different flight databases to assess flight crew data regarding scheduling and rostering and flight cancellations caused by lack of crew availability.

Additionally, the group accessed the system that concentrates the monitoring of fatigue indicators (BAM). We compared pilots' schedules from different air cargo operators in the world.

The group conducted some inquiry to the Safety, Human Factors and Aerospace Medicine Departments of some airlines. This was done to better understand their perspective over possible optimization in some business-related factors by a flexibilization on current rules for cargo pilots.

At last, to bring a mathematical validation of potential gains and benefits to the operators, the group ran some statistical quantitative models. These models compared the schedules of pilots in hypothetical scenarios of a more flexible regulation. In addition, the study assessed potential results with reduced costs or more revenue generation if a more flexible regulation was implemented in Brazilian cargo operations.

Experimental Design

The experimental design of this research considered in a first stage the review of certain rules in the current fatigue regulations. These regulations could be potentially adjusted to a more flexible permission of pilots flying without increasing level of fatigue. Such measures could improve safety.

In the second stage the study searched for data concerning the number of flights that could not happen because of crew unavailability, as well as flights which were delayed because the crew had expired their limit of hours and had to be replaced. With this information the group estimated some average losses by delayed or cancelled cargo flights.

In a third stage of the research, the group ran a simulation analysis in some fatigue and crew scheduling systems. This analysis was to determine the number of flights that could have been maintained or departed on-time if those flexibilization in the crew schedule rules (listed in the first part of the research) were applied.

As a result, the research identified some potential costs saved. Part of the gains could have been reduced by the additional payment of salaries to those pilots that would be doing more flights but still the gains were higher and compensated the additional flight hours.

Finally, the hypothesis stated that there is some room for optimization in Brazilian fatigue regulation.

Data Source(s), Collection, and Analysis

To collect data, the group first accessed IATA, ICAO, FAA (CFR) and ANAC (RBAC) websites to get the regulations and manuals about fatigue to understand current rules in place.

Moreover, the group went through collecting statistical data from databases such as: CIRIUM, CAPA, FAA, ANAC, among others, to access the number of flight delays and cancellations caused by crew unavailability in cargo operations.

The calculations of costs associated with disruption and potential savings were based on average costs for reaccommodating cargo shipments on other carriers, the loss of perishable cargo and contractual penalties due to the non-delivery on time.

Kinds of sensitive cargo include food, chilled or frozen cargo, living animals, flowers, organ transport, vaccines, medicines, machinery, equipment, and various industry products.

The additional costs for paying more flight hours were based on average pilot´s salaries in the market as per U.S. Bureau of Labor Statistics (2021) and research available on specialized labor websites in Brazil (Salario, 2022).

Chapter IV

Conclusions

During the Research Project, our Group found opportunities to compare the Brazilian Fatigue Risk Program (RBAC 117) and the North America regulation of fatigue, CFR Part 117, and the exceptions on CFR Part 121 Subpart Q/R/S for Cargo Operations. At the present moment, there is an ongoing discussion between ANAC (Brazilian Aviation Agency), ABEAR (Brazilian Aviation Companies Association), and the safety department of some Brazilian companies for adjustments to the current ANAC Fatigue Risk Program around this subject. The main objective of this discussion is to bring additional flexibility to the pilot's scheduling amplifying the gaps in productivity and safety margin based on fatigue risk management.

In this research, the group focused exclusively on the Cargo Operators and on how the Brazilian fatigue program financially impacted the companies. Other factors studied included applying for work and rest limits that are far from the ones foreseen in the original ICAO (International Civil Aviation Organization) document, the FRMS (Fatigue Risk Management System) and the limits foreseen by the American legislation already mentioned in this text.

Based on the research conducted which included literature review, simulation methods, and calculation of revenue opportunities and cost savings, the group reached three main conclusions described below:

- **Conclusion 1: Revenue-Generation and Cost-Saving Potentials of US$ 3,6M**
  - **Data Collection Methodology**

For the research, the group compared the way to set the limits of the Brazilian, North American, European, Australian, and England fatigue regulations. Comparing those regulations, we discovered that the Brazilian regulation are the most restrictive and that the methodology of the time windows that specify the maximum duty and flight time hours are much more restrictive than the orders fatigue regulations.

The research accessed the system that stores the pilots´ past schedules and roster of Brazilian cargo pilots. The group also simulated a hypothetical scenario as if the regulation was adjusted on the particular points:

1. Maximum Duty Time
2. Maximum Flight Time
3. Minimum Time of Rest
4. Maximum Fly Hours over the 28 days consecutive / Calendar Year

The group also evaluated the most common costs associated with the delay or cancellations of cargo operations, such as: allocating new crew when the crew designated for that flight needs to be changed for another one when their maximum working hours have expired. Included in this research were contractual penalties for not attending agreed schedules with cargo clients because of delay or cancellation because of crew times; or, lost perishable cargo; among others.

- **Results**

Fatigue Regulations and if we applied the CFR Part 117 at this group on the construction of their schedule, the company would save around 35% of additional capability on pilot’s productivity with no penalty on safety and fatigue.

The same aspects and considerations of the first paragraph, if considered no fatigue limitation the gain could be much bigger than the gain obtained considering fatigue limitations. However, if the company needs to be part of IATA (International Aviation Transport Association) it must have a fatigue program implemented for their crewmembers.

- **Conclusion**

The conclusion shows that, in the group of 70 pilots the gain, with the adjustment on the limits, following the set of CFR PART 117, will be around 35%. This number represents that the company could run all the flights with 24 pilots less without compromise the safety.

Additionality, the mean salary in Brazil Cargo Operation is around U$150M per year. The company's total cost with pilots per year is U$10.5MM and the capability of savings of 35% represent a total saving of U$3.6M.

See Recommendation 1 in Chapter V.

- **Conclusion 2: Opportunities for Review in the Brazilian Regulation for Cargo Pilots´ Scheduling**

- **Data Collection Methodology**

Current ANAC Regulation RBAC 117 and FAA CFR 117 were analyzed and compared in the points where it specifies pilots rest hours, total of hours flown in a single day and week to find opportunities for extension on working hours.

- **Results**

Comparisons demonstrated the main differences on both regulations specially when referring to:

1. Maximum Duty Time
2. Maximum Flight Time
3. Minimum Time of Rest
4. Maximum Fly Hours over the 28 days consecutive / Calendar Year

These main differences were the basis for our simulations of a different rule on the Brazilian regulation.

- **Conclusion**

After reviewing and comparing both, USA and Brazil regulations, the group identified that there are good opportunities to provide a new set of limits to Brazilian regulations to be more in line with the North American Fatigue Risk Program and the main document of fatigue (FRMS – ICAO Doc 9966).

More specifically on how to set the limits to ensure the duty limits to the flight crew, the accumulative hours of flight during the month or consecutive days and years, and finally the rest limits.

See Recommendation 2 in Chapter V.

- **Conclusion 3: Proposed Changes to Regulations will not impact safety to cargo operations due to fatigue of pilots**

- **Data Collection Methodology**

The research accessed the USA National Transport Safety Board (NTSB) Accidents´ Database & Synopses and NTSB Annual Summary of US Civil Aviation

Accidents to check for the list of accidents in the last few years. This data was compared to the Brazilian National Center for Investigation and Prevention of Accidents (CENIPA) databases and Statistics and other world accidents reports.

Additionally, the group investigate the results of the fatigue reports that make part of fatigue program of LATAM Cargo and the group discovered that the system of reports clearly demonstrate that the pilots are not suffering any kind of fatigue during the flights.

- **Results**

Comparisons showed that the rate of accidents in the USA per number of cargo flights compared to the rest of the world´s index is below. Even though, most of the cases were not attributed to fatigue reasons. In Brazil levels of safety on cargo operations are very high in similar levels to the USA and world average. Similarly, to the USA, the few accidents which occurred with cargo flights were not caused by fatigue levels of pilots.

- **Conclusion**

These comparisons between the safety indicators and past incidents/accidents involving cargo operations in the USA and Brazil demonstrated that even on the most flexible scenario of the USA regulation with a less restrictive rule on pilots' schedules and roster, it does not necessarily impact the safety of the operations.

Moreover, the few occurrences of incidents and accidents involving cargo flights in both Brazil and the United States were not caused by issues with pilot´s fatigue, as demonstrated in the historic files showed below in more details.

See Recommendation 3 in Chapter V.

Conclusion Details

- **Conclusion 1: Revenue-Generation and Cost-Saving potentials**

According with the compilation of those regulations, we discovered that the Brazilian way to set the maximum duty and flight times are much more restrictive than the orders. In this first table, we present the Brazilian and the North American regulatory limits:

Table 1 - Brazilian and North America regulatory limits

	ANAC	**FAA**	**TOTAL HC SAVING**
Max Duty Time	70	61	9
Max Flight Hours	70	63	7
Minimum Rest	70	65	4
Max Month and Year hopurs	70	67	4
TOTAL SAVING	n/a	n/a	24 / 35%

(Data retrieved from Rostering and Scheduling System)

- **Conclusion 2: Opportunities for review in Brazilian Regulations**

According with the compilation of those regulations, we discovered that the Brazilian way to set the maximum duty and flight times are much more restrictive than the orders. In this first table, we present the Brazilian and the North American regulatory limits:

Table 2 – CFR Part 117 - Flight Duty Period: Unaugmented Operations

Scheduled time of start (acclimated time)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7 +
0000-0359	9	9	9	9	9	9	9
0400-0459	10	10	10	10	9	9	9
0500-0559	12	12	12	12	11.5	11	10.5
0600-0659	13	13	12	12	11.5	11	10.5
0700-1159	14	14	13	13	12.5	12	11.5
1200-1259	13	13	13	13	12.5	12	11.5
1300-1659	12	12	12	12	11.5	11	10.5
1700-2159	12	12	11	11	10	9	9
2200-2259	11	11	10	10	9	9	9
2300-2359	10	10	10	9	9	9	9

Table 3 – CFR Part 117 - Flight Duty Period: Augmented Operations

Scheduled time of start (acclimated time)	Maximum flight duty period (hours) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 pilots	4 pilots	3 pilots	4 pilots	3 pilots	4 pilots
0000-0559	15	17	14	15.5	13	13.5
0600-0659	16	18.5	15	16.5	14	14.5
0700-1259	17	19	16.5	18	15	15.5
1300-1659	16	18.5	15	16.5	14	14.5
1700-2359	15	17	14	15.5	13	13.5

Table 4 – ANAC RBAC 117 - Flight Duty Period: Unaugmented Operations

Hora aclimatada referente ao início da jornada	Duração máxima da jornada e tempo máximo de voo (entre parênteses) de acordo com o número de etapas a serem voadas (em horas)				
	1-2	3-4	5	6	7+
06:00-06:59	11 (9)	11 (9)	10 (8)	9 (8)	9 (8)
07:00-07:59	13 (9,5)	12 (9)	11 (9)	10 (8)	9 (8)
08:00-11:59	13 (10)	13 (9,5)	12 (9)	11 (9)	10 (8)
12:00-13:59	12 (9,5)	12 (9)	11 (9)	10 (8)	9 (8)
14:00-15:59	11 (9)	11 (9)	10 (8)	9 (8)	9 (8)
16:00-17:59	10 (8)	10 (8)	9 (8)	9 (8)	9 (8)
18:00-05:59	9 (8)	9 (8)	9 (7)	9 (7)	9 (7)

Table 5 – ANAC RBAC 117 - Flight Duty Period: Augmented Operations

Hora aclimatada referente ao início da jornada	Duração máxima da jornada e tempo máximo de voo (entre parênteses), de acordo com a classe de acomodação a bordo da aeronave e o tipo de tripulação (em horas) – Tripulantes de voo					
Classe de acomodação	Classe 1		Classe 2		Classe 3	
Tipo de tripulação	Composta	Revezamento	Composta	Revezamento	Composta	Revezamento
06:00-06:59	15 (13,5)	17 (15,5)	14 (12,5)	16 (14,5)	13 (11,5)	14 (12,5)
07:00-13:59	16 (14,5)	18 (16,5)	15 (13,5)	17 (15,5)	14 (12,5)	15 (13,5)
14:00-17:59	15 (13,5)	17 (15,5)	14 (12,5)	16 (14,5)	13 (11,5)	14 (12,5)
18:00-05:59	14 (12,5)	16 (14,5)	13 (11,5)	14 (12,5)	12 (10,5)	13 (11,5)

Table 6 – Unaugmented Operations Compilations by Five Different Regulations Suggestion

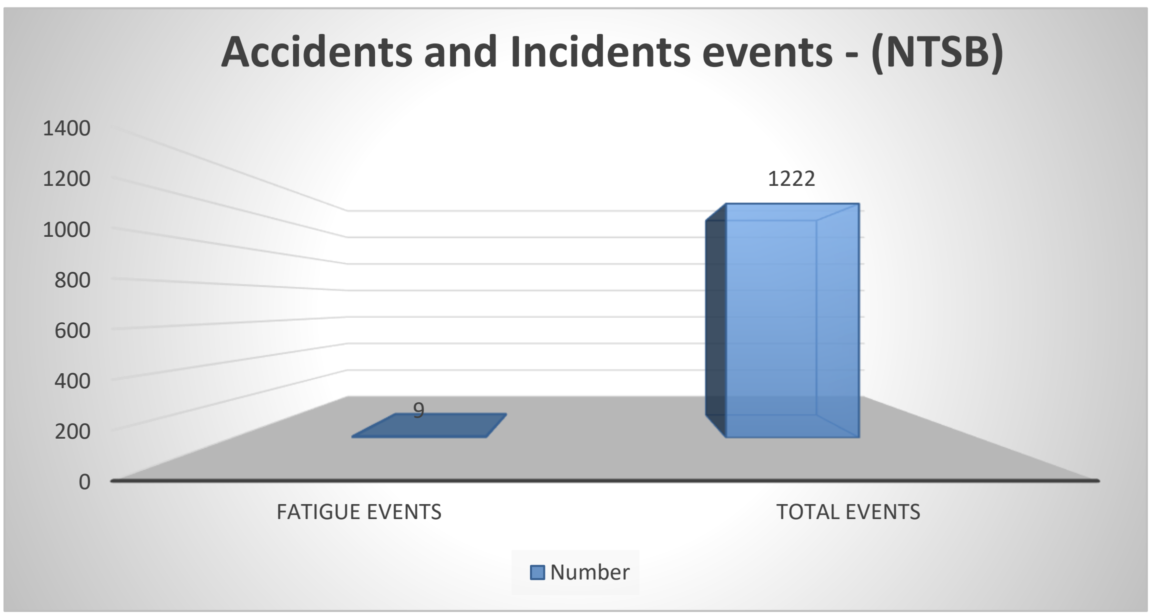
Legs	Propuesta RBAC					
Inicio PSV Aclimat	1-2	3	4	5	6	7+
00:00	9	9	9	9	9	9
00:30	9	9	9	9	9	9
01:00	9	9	9	9	9	9
01:30	9	9	9	9	9	9
02:00	9	9	9	9	9	9
02:30	9	9	9	9	9	9
03:00	9	9	9	9	9	9
03:30	9	9	9	9	9	9
04:00	10	9	9	9	9	9
04:30	10	9	9	9	9	9
05:00	11	10	10	9	9	9
05:30	11	10	10	9	9	9
06:00	12	11	11	10	10	9
06:30	12	11	11	10	10	9
07:00	13	12	12	11	11	10
07:30	13	12	12	11	11	10
08:00	13	13	13	12	11	10,5
08:30	13	13	13	12	11	10,5
09:00	13	13	13	12	11	10,5
09:30	13	13	13	12	11	10,5
10:00	13	13	13	12	11	10,5
10:30	13	13	13	12	11	10,5
11:00	13	13	13	12	11	10
11:30	13	13	13	12	11	10
12:00	13	12	12	11	11	10
12:30	13	12	12	11	11	10
13:00	12	12	12	11	11	10
13:30	12	12	12	11	10,75	10
14:00	12	11	11	10	10	9
14:30	12	11	11	10	10	9
15:00	11	11	11	10	9	9
15:30	11	11	11	10	9	9
16:00	10	10	10	9	9	9
16:30	10	10	10	9	9	9
17:00	10	10	10	9	9	9
17:30	10	10	10	9	9	9
18:00	10	9	9	9	9	9
18:30	10	9	9	9	9	9
19:00	10	9	9	9	9	9
19:30	10	9	9	9	9	9
20:00	10	9	9	9	9	9
20:30	10	9	9	9	9	9
21:00	10	9	9	9	9	9
21:30	10	9	9	9	9	9
22:00	10	9	9	9	9	9
22:30	10	9	9	9	9	9
23:00	10	9	9	9	9	9
23:30	10	9	9	9	9	9

- **Conclusion 3: No impacts to safety**

An analysis of accident and incident events was performed using the National Transportation Safety Board (NTSB) database from 2000 until JULY 2022, with a total reading of 1222 events. Of these events, a filter was performed considering only the events that had crew fatigue as a probable cause.

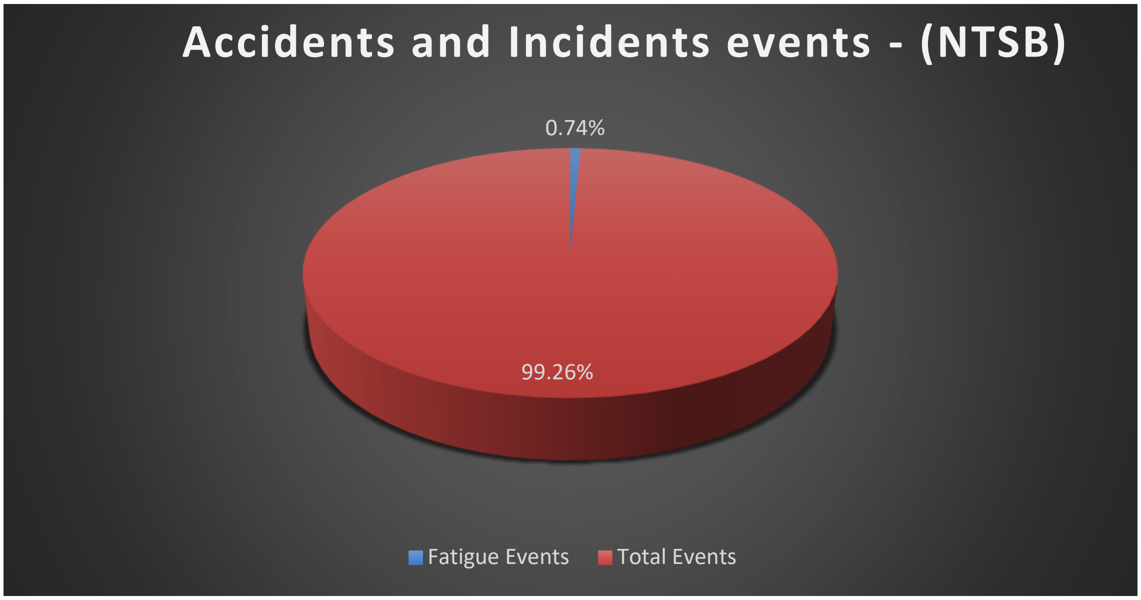
The total number of events (accidents or incidents) associated with the cause crew fatigue was 09 of the total, being 0.74% of the total number of events in the USA. Of this total of 9 events, the total applied only to cargo flights are 3 events from airline flights such as FEDEX and UPS.

Figure 3 – Accidents and Incidents events



Source: NTSB

Figure 4 – Accidents and Incidents events



Source: NTSB

Based on this study we understand that the regulatory model based on crew fatigue applied in the USA has not reflected as a main factor in events related to flight safety.

Of course, as a complement to this study, the fatigue reports made by the crew of each airline could be evaluated, but we were not able to access this data for a better reading of the impacts that may be occurring.

Chapter V

Recommendations, Limitations of Study, Future Research, and Lessons Learned

This research project appraised potential outcomes and conclusions around a hypothetical scenario of a more flexible pilot´s fatigue regulations in terms of scheduling and rostering by assessing business-related indicators with the main purpose to indicate opportunities to improve pilots´ productivity to airlines.

Based on the studies conducted, the Group reached some conclusions, which addressed to some recommendations to be evaluated by airlines for submission to Brazil Civil Aviation Authority.

If approved and implemented by the airline industry the research project demonstrated that there will be positive gains to airlines which operate cargo transportation.

- **Recommendation 1 - Airlines might reach a potential gain of around USD $3.6 million with the implementation of an adjusted schedule and rostering of cargo pilots**
- **Recommendation 2 – ANAC can generate up to 35% in productivity of pilots´ flight hours to airline industry by approving recommended changes into the current regulations.**
- **Recommendation 3 – Besides the history of good safety levels it is important that airlines and Civil Aviation Authorities monitor the fatigue indicators after implementation of the proposed changes in the regulations.**

Recommendations Supporting Material

Conclusion 1

The first recommendation is for the airlines to implement the proposed adjustments in the scheduling and rostering of cargo pilots once the regulations are changed considering the gains of USD $3.6 million as demonstrated in the simulations of this research.

Conclusion 2

As stated in the Group's Conclusion 2, the Group recommends that the Brazilian Civil Aviation Authority ANAC consider approving and adjusting the proposed changes highlighted by this study. Our Group offered the next steps that would be a movement in this investigation to the current RBAC 117, either by applying the adjustments to the current regulation or by creating a specific annex for cargo pilots. To be considered are the limits dealing with pilot productivity and flexibility are under the umbrella and protection of the safety regulations.

Conclusion 3

Conclusion 3 indicated the proposed changes in the fatigue regulations would not impact safety levels. The Group recommends that the implementation of such changes do not exceed the limits of the USA Regulation CFR 117, which was the benchmark used by the research. This regulation is a positive case of good safety levels. Moreover, once implemented proposed changes, the Group recommends that the airlines and authorities monitor the fatigue levels of pilots and safety performance of such cargo operation more closely to make sure that no negative effects arise.

Limitations of Study

As expected, due to the format and duration of the course modules, the main limitation for deeper studies was the time. For this reason, the Group decided to have a very restricted focus on few aspects of the fatigue regulations and focus into specific business-related indicators of air cargo operations.

Moreover, the Group found some difficulties on finding proper bibliography related to business-related factors when talking about fatigue subject in pilots´ regulations. Most studies and articles are mainly related to the physiological aspects of fatigue of airline pilots´ operations and fatigue risk management. This factor made our theoretical support depend on more experimental research of data.

Future Research

As this research focused some business-related indicators of fatigue regulations in cargo operations there are important opportunities for further studies on the potential for optimization in the regulations for pilots of passengers´ operations.

Additionally, when talking about the passengers´ operations there is also opportunities for evaluations concerning adjustments in the fatigue regulations of commercial crew team (flight attendants).

Another factor that the research did not evaluate, was regarding possible physiological impacts of this flexile rule on fatigue levels in the long-term, if those proposed changes were implemented. This would have to be addressed by physiological studies and monitored and/or adjusted (if needed) if the fatigue levels got increased during operation of this new schedules.

Finally, the Group did not have the chance to access the acceptance of these proposed changes by the labor unions of pilots and understand the pilots´ perception about these changes considering that they would be flying more but, in contrast, in a certain way, improving their financial gains.

Lessons Learned

The participation in the introductory Module 6 with Dr. Peter O´Reilly helped the Group to get prepared for the introductions to the Capstone course on Module 7, drive the mindset of the Group to everything related to this subject and start conducting the research.

Moreover, the process conducted by the course on requesting weekly assignments also proved to be very positive. This allowed our Group to conduct the small deliverables along the weeks, thus avoiding accumulating work to be done at the end of the modules.

However, one important lesson learned by the Group was that since the beginning of the first courses the teams could start discussions about the Capstone project. This would allow us to conduct more research along the months of the whole AVM program. This preliminary preparation could have helped the Group on reaching the Capstone Modules with more articles, more data analyzed, and, thus, be more advanced on the theoretical data crossing at this final stage.

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