



Examining factors contributing to fatigue among KLM cabin crew

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Dissertation written under the supervision of professor Daniel
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Dissertation submitted in partial fulfilment of requirements for the
MSc in Business, at the Universidade Católica Portuguesa, 1st of June
2023.

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Keywords: Aviation, Fatigue, Cabin crew, Factor analysis, Regression analysis, ANOVA analysis, Time difference, Flight duration, Mixed research, Airbus, Boeing, Aircraft, WIFI, Aviation industry.

Abstract

This research study examines the factors influencing fatigue levels among cabin crew members. The study utilizes interviews and a survey questionnaire to collect data on various variables. While factor analysis was initially intended, it was found unsuitable due to low variable correlation and a high unsuitable number of identified components. Consequently, regression and ANOVA analysis was performed. The dependent variables, reveals average fatigue levels among respondents compared to other healthy adult populations. The independent variable, time difference of 6-7 hours and quality of the hotel facilities have a positive significant influence and a flight duration of 8-12 hours has a negative significant influence on current fatigue levels in the regression model. Alarming fatigue signals from cabin crew are observed from West-American destinations and the Airbus A330 aircraft. The influence of WIFI on fatigue levels is also studied with a situational recall experiment. A paired sample t-test shows a significant difference of increased fatigue levels on planes with WIFI than those without. Although the appropriateness of using current fatigue levels as the dependent variable is questioned, the findings offer valuable insights into identifying fatigue among cabin crew members. These results emphasize the importance of considering multiple factors to mitigate fatigue-related issues in the aviation industry.

Análise dos factores que contribuem para a fadiga da tripulação de cabina da KLM

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Palavras-chave: Aviação, Fadiga, Tripulação de cabina, Análise factorial, Análise de regressão, Análise ANOVA, Diferença horária, Duração do voo, Investigação mista, Airbus, Boeing, Aeronaves, WIFI, Indústria da aviação.

Abstracto Portuguese:

Este estudo de investigação examina os factores que influenciam os níveis de fadiga dos membros da tripulação de cabina. O estudo utiliza entrevistas e um questionário de inquérito para recolher dados sobre diversas variáveis. Embora inicialmente se pretendesse realizar uma análise factorial, esta foi considerada inadequada devido à baixa correlação entre as variáveis e a um número elevado e inadequado de componentes identificados. Consequentemente, foi efectuada uma análise de regressão e ANOVA. A variável dependente revela os níveis médios de fadiga dos inquiridos em comparação com outras populações adultas saudáveis. A variável independente, a diferença horária de 6-7 horas e a qualidade das instalações do hotel têm uma influência significativa positiva e a duração do voo de 8-12 horas tem uma influência significativa negativa nos actuais níveis de fadiga no modelo de regressão. Os sinais alarmantes de fadiga da tripulação de cabina centram-se nos destinos da América Ocidental e no avião Airbus A330. A influência do WIFI nos níveis de fadiga é também estudada através de uma experiência de recordação situacional. Um teste t de amostras emparelhadas mostra uma diferença significativa de aumento dos níveis de fadiga nos aviões com WIFI em relação aos aviões sem WIFI. Embora se questione a adequação da utilização dos níveis de fadiga actuais como variável dependente, os resultados oferecem informações valiosas para a identificação da fadiga entre os membros da tripulação de cabina. Estes resultados sublinham a importância de considerar múltiplos factores para atenuar os problemas relacionados com a fadiga na indústria da aviação.

Jargon and abbreviations

Concept	meaning
OCR	Overhead crew rest. Resting facility with horizontal beds.
ULR	Ultra-long-haul flight
Cabin crew	Flight attendants, cabin attendants
FRMS	Fatigue risk management system
Flight crew	Pilots
Stop-over	Long-haul flight with connecting national flight
Shuttle	Long-haul flight which after a day rest at destination has a return flight to a nearby destination
CFL	Current fatigue levels
MFI	Multidimensional fatigue inventory
Circulation	Days you have to work and how many days you are free in your schedule.

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1. Introduction

Fatigue is something we all deal with on a daily basis, but hard to battle and impossible to eliminate. When you take the plane, you expect the crew to function 100% to ensure your safety. However, cabin crew have often very demanding work schedules with rotating shift work, different time zones, delays, dealing with cultural differences and demanding passengers. There has been a lot of research done about fatigue in pilots. And yes, they carry the greatest responsibility of flying the aircraft, but cabin crew must not be forgotten. The target group of this research, the cabin crew, has thus far less been researched than pilots and are often considered less important by the general public. However, when disturbances occur they are the first ones to take action. Surveys of pilots and other cabin crew members show that fatigue is a significant issue in today's never ending flying operations (Caldwell, J. A. 2005). From a commercial aspect, the cabin crew is the frontline of the company. They ensure customer satisfaction and make sure customers will return. It is in the airlines interest to keep their cabin crew well rested, healthy and happy. Commercial factors that are influenced by fatigue are sick leave, customer satisfaction, upsell and overall performance of the staff. However, addressing fatigue is often considered as costly and non-profitable. Since the function of cabin crew is more than other jobs, influenced by fatigue, possibly on the long run this could be a profitable improvement for airline companies.

When cabin crew experiences fatigue, coping mechanisms could be offering less customer service like offering fewer rounds of drinks, telling passengers that things are sold out instead of refilling their carts, skip cleaning toilets or being hesitant in accepting passenger requests. KLM, the airline in which this research is being conducted, is a premium airline who justifies its higher ticket prices with outstanding customer service. Besides the obvious safety aspect, customer service is an important aspect of the tasks of cabin crew. This research is conducted to explore which factors influence fatigue and gives a basis to conduct further research and implement improvements.

Many research articles and regulations have been focused more on pilot fatigue than on fatigue of the rest of the cabin crew. In the article of Van Den Berg et al. (2020) it is mentioned that "Current ultra-long-haul (ULR) scheduling and fatigue risk management systems (FRMS) processes for cabin crew are predominantly based on flight crew (pilots) data, as information on cabin crew fatigue associated with ultra-long-haul flights is very

limited.” For instance, offering crew members sleep facilities and in-flight breaks on ULR flights is the primary method of reducing fatigue. They do, however, have less time for in-flight rest than pilots because all cabin crew must be awake and assist in food services. Also, the regulation standards for on-board rest facilities differ between pilots and cabin crew in various nations. (Van Den Berg et al., 2020). That is why it is important to have a cabin-crew focussed research on fatigue.

The variables that are studied in this research are:

Dependent variables	
CFL	Current fatigue levels
Independent variables	
F	Flight direction
	Flight destination
TD	Time difference
D	Flight duration
S	Flight scheduling
C	Crew planning
W	Work conditions
WI	WIFI

2. Theoretical Discussion

Fatigue is a significant issue among cabin crew members, and it can result from various factors, including work schedules, workload, and sleep quality. For instance, field research that tracked the sleep patterns of 202 cabin crew members over the course of three to four weeks revealed that they slept an average of 4.9 hours on international flights, 6.3 hours on free days, and 5.7 hours on workdays. (Roma et al., 2010). Which is below the recommended amount of hours of sleep for adults. Therefore, it is utmost important to have adequate research towards this topic since they carry the responsibility of hundreds of lives.

The study of Gander et al, 2011 mentions that the battle of fatigue is a responsibility of both the employer and the employee because fatigue is a matter of ‘all waking activities. The study focusses mostly on the company and industry organisational factors and fatigue risk management systems (FRMS). A paper by Di Milia et al, 2011 did more in-depth research

towards individual factors of fatigue, but not specified to aviation and recommends to investigate “greater interdisciplinary collaborations, incorporation of multiple demographic variables as independent factors, and use of within-participant analyses.” This current research paper is aimed to fill this gap of the existing literature and makes use of within-participant analyses by using a mixed research method.

2.1 Definition of fatigue

Fatigue is a complex and multifaceted phenomenon that can be difficult to define precisely. From a physiological point of view, fatigue is defined as an organ failure. This type of fatigue has been associated with sleep deprivation, infection, fever, anaemia and pregnancy. (Berger, McCutcheon, Soust, Walker, & Wilkinson, 1991). Psychological fatigue is described as a state of exhaustion associated with diminished motivation (Lee, Hicks, & Nino-Murcia, 1991). In a conceptualization by Stone and colleagues (1997), fatigue was one of 13 mood states. Depression and anxiety may be one of the more intense emotional experiences that are accompanied by psychological fatigue. Similar to physiological fatigue, psychological fatigue is a reaction to internal or external stresses that surpass one's capacity. (Aaronson, et al. 1999). Another definition of fatigue by Ream and Richardson (1997) is: “A subjective, unpleasant symptom which incorporates total body feelings ranging from tiredness to exhaustion creating an unrelenting overall condition which interferes with individuals’ ability to function to their normal capacity” (p. 45).

From these different definitions of fatigue it can be concluded that the experience of fatigue can vary widely from person to person and can be influenced by a variety of factors, including physical, psychological, and social factors. When looking at previously developed fatigue measuring models, they highlight that some of the challenges in defining fatigue include:

- **Subjectivity:** Fatigue is a subjective experience, which means that individuals may have different perceptions of their own fatigue levels. What one person may describe as fatigue, another may describe as simply feeling tired or sluggish. In the Lee and colleagues (1991) Visual Analog Scale for Fatigue (VAS- F) they use an 18-item scale to measure fatigue in current measurement time and measures the fatigue in the way that it is being experienced by the subject.
- **Multiple causes:** Fatigue can be caused by a wide range of factors, including physical exertion, illness, stress, medication side effects, and sleep disturbances. Because there

are so many potential causes of fatigue, it can be difficult to pinpoint a single definition that accurately captures the experience.

- **Overlap with other symptoms:** Fatigue can be a symptom of many different medical conditions, and it often co-occurs with other symptoms such as pain, weakness, or difficulty concentrating. This overlap can make it difficult to distinguish fatigue from other symptoms.

Despite these challenges, many researchers and medical professionals have attempted to define fatigue in a variety of ways, taking into account the many different factors that can contribute to this complex phenomenon. “No single measure of fatigue adequately captures the complexity of the phenomenon. Rather, investigators interested in including a measurement of fatigue in their studies must consider what it is about fatigue that is relevant to each study when selecting a specific measure.” (Aaronson et al., 1999). Ultimately, the definition of fatigue in this study is dependent on the specific context, cabin crew, in which it is being used, as well as the individual experiences and perceptions of those who are experiencing it.

The body that sets the minimum international standards of aviation, the International Civil Aviation Organization (ICAO), defined fatigue as: “A physiological state of reduced mental or physical performance capability resulting from sleep loss, extended wakefulness, circadian phase, and/or workload (mental and/or physical activity) that can impair a person’s alertness and ability to perform safety related operational duties” (ICAO, 2016, p. Xiii). Which is most suited to the type of fatigue that is studied in this research.

2.2 General factors that influence fatigue

Late arrivals, long duty days, early departures, and irregular work schedules, such as night duty, are challenges that pilots and other aircrew personnel must continually deal with. Many airline crew frequently cross meridian lines, which can disturb the circadian rhythm and make it hard to go to sleep. Hence, it has been argued that scheduling and workload are related to aircrew fatigue, which is supported by the findings of the pilot survey from Samel, A., Wegmann, H. M., & Vejvoda, M. (1995). In many respects, the fatigue issues that airline crew deal with are comparable to those that industrial shift workers deal with, with even an increased number of problems. (Caldwell, J. A. 2005). Some studies have been done towards

fatigue in cabin crew. Some fatigue factors that will also be studied in this research have previously been identified such as: high workload, insufficient rest and the work environment. The primary factors that they identified were circadian disruption and sleep loss. (Van Den Berg et al., 2020b).

2.2.1 Circadian rhythms and sleep

One way that circadian factors influence fatigue is through the timing of sleep. The circadian rhythm assists in regulating when the body is most awake and alert and when it is ready to sleep. If someone tries to sleep during a time when their circadian rhythm is promoting wakefulness, such as during the daytime, they may struggle to fall asleep or stay asleep. Lack of sleep and increased fatigue may be the results of this. (Cajochen, et al 2003)

Fatigue can also result from circadian rhythm disturbances like those brought on by shift work or jet lag. When the body is compelled to adapt to a new sleep-wake cycle, it may find it difficult to get used to the new schedule, which can lead to disturbed sleep and increased fatigue. (Wright Jr, et al 2013)

But also flight direction has a profound influence on the circadian rhythm. The rate to which crew is able to adapt to the new time zone depend on both the direction of the time as on the number of time-zones that are crossed. When a flight crosses more than five time-zones it is found that the adaptation rate is 50 percent higher when flying westwards than after flying eastwards. (Aschoff 1975; Klein and Wegmann 1980). Additionally, when the advance shift is between 8 and 12 hours, the re-adaptation after flying eastward is often done through prolonging the circadian period (Aschoff 1975; Gundel and Wegmann 1989).

Let's look at a real-life sample to see the difference between east and westbound flights. KLM's often flown westbound flight is Amsterdam – Vancouver. This flight is typically scheduled as a day flight, commencing between at 15:30. This flight is around 9,5 hours. When flying at 15:30 from Amsterdam, you would arrive around 16:00 local time. There is a 9-hour time difference so 16:00 Vancouver will correspond to 00:30 local time which is already a time that the circadian rhythm sets in and makes you more sleepy. If you would adapt to the local time immediately, sleep must be delayed about 7 hours. Adding up to the fact that during the flight your body already tells you it's time for bed. When flying back, eastward flights are typically scheduled as night flights. KLM departs from Vancouver at 18:00, so the crew already has to start their shift after a full day of wakefulness, the flight

takes about 9h and 15 min and will arrive in Amsterdam around 12:15 (3:15 Vancouver time). Immediately adapting to local night time would mean another delay of sleep of 11 hours, adding up to the already missed night, and being sleep deprived (>24h awake). Sleep quality after such shifts in the circadian rhythm is often poor and alertness decreases. “Accumulated sleep loss and acute sleep deprivation lead to increasing sleep pressure and consequently to sleepiness and fatigue during flight duty (Neville et al. 1994; Samel et al. 1994b) The disruption of the circadian rhythm and crossing of multiple time zones is an intuitive factor of fatigue and part of the job in which the company itself cannot make any improvements. Cabin crew often develop their own strategy on dealing with a disrupted circadian rhythm by sticking to that of their country of origin for short shifts and adapting to the country of destination for their longer shifts. For these reasons this research will not include this as an independent variable.

2.2.1 Pilot fatigue studies

The importance of fatigue research within cabin crew is highlighted by the results of numerous studies in pilot fatigue, having concerning results. The study of Jackson, C. A., & Earl, L. (2006)a examines fatigue of pilots on short haul flights and including comparison between low-cost and scheduled airline companies. Seventy-five percent of the respondents say they are experiencing sever fatigue symptoms and even more reported that their fatigue is worse than a few years ago. New knowledge and technical advancements should ensure lowering fatigue levels over the years, but this study shows otherwise. Things that did increase over the years are airport, governmental and environment taxes driving up the ticket prices of airlines. Budget-airlines are up and coming taking over more and more of the market. The study of Jackson, C. A., & Earl, L. (2006) also shows that sever fatigue was significantly ($p<0.05$) more reported for low-cost airlines. KLM is a scheduled premium airline company, and hopefully have lower fatigue levels among their crew. But besides short-haul flights, the company has a wide array of mid- to long-haul flights. Within a Portuguese airline company, research has been done to compare fatigue levels between short-, mid- and long-haul flights. (Reis et al., 2013). In this study, fatigue levels for short- to mid-haul flights were higher than for long-haul flights. The study of Yen, J., et al. (2009) also measured the difference in fatigue levels among 3 groups: oceanic, regional and short-haul, in a Taiwanese airline company. They however did not find a statistically significant difference between the

fatigue levels of the three groups. The fatigue level of the oceanic group did increase the most comparing to the other groups.

Again, in all of these studies, pilots have been the sole research group. Regulations and management systems like FRMS are mostly based upon those studies. But it is important to highlight the difference in mental and physical load between crews. Some studies also even show large differences between individuals. There were considerable individual disparities in the quantity of sleep received by cabin crew, both in flight, at home and at destinations. Furthermore, as compared to flight crew heading the same route, cabin crew slept less before- and in-flight, and a higher proportion of them dozed off when on duty. (van den Berg MJ 2016). This shows that a broader range of work-related, personal and/or environmental factors, may have impacted their sleep, indicating the need for more research in order to create more effective recommendations for optimising fatigue management for cabin crew. (Van den Berg MJ, et al, 2015)

2.3 Fatigue risk management systems of KLM (FRMS)

The adverse effects of fatigue are well established, yet their influence is sometimes underappreciated. In the 1920s, Lindberg recognised the negative impact of lengthy duty hours (and prolonged wakefulness) on flight performance. In the early 1930s, scientists started to recognise the harmful effects of quick time zone changes. Such information was undoubtedly essential for creating rules like the Civil Aeronautics Act of 1938, which was intended to regulate flight times and aircrew duty hours. (Caldwell, 2004). Aircrew scheduling guidelines and flight-time restrictions have not changed much since they were initially implemented. Although scientific knowledge of shift work, fatigue, circadian physiology and sleep has considerably increased over the past few decades, present laws and business practises have mostly failed to appropriately take this new information into account. (Dinges et al., 1996).

A Fatigue Risk Management System (FRMS) is defined by the ICAO as following “A data-driven means of continuously monitoring and managing 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, 2010).

An FRMS strives to make sure that crew members are alert enough to perform tasks at an appropriate level. The standard regulation strategy is currently still setting general minimum and maximum restrictions both for day to day operations as for monthly or annual flight scheduling. This strategy builds on a lengthy tradition of working-hour restrictions that dates back to the industrial revolution. This single defence tactic of prescribing flight and duty time restrictions provide a relatively oversimplified perspective of safety in that staying within the limits is safe and anything outside the limit is potentially dangerous. (ICAO, 2012).

Regardless of the cause of fatigue, a FRMS applies multi-layered defensive techniques to control risk factors connected to fatigue. It consists of data-driven, ongoing dynamic processes that may anticipate fatigue risks before developing. And then assessing and applying mitigation measures. These cover both individual as well as organizational mitigation tactics. The deployment of a FRMS within diverse aviation situations demands practical expertise and understanding. It must be developed, comprehended, and managed by individuals with in-depth knowledge of the challenging operating environment of airlines. by interpreting various data analyses properly, practical operational strategies can be created. (ICAO, 2012).

According to the (EASA-FTL) European Aviation Safety Agency Flight Time Limitations (EASA-FTL) airlines have to implement a FRMS. On the publish date of this research KLM has not implemented a FRMS. Although over the years they have mentioned that they are or will be working on it, it has not been approved and taken in to use yet. The FRMS system should mitigate or eliminate the risks of decreased work performance because of fatigue. KLM does however has a system to track factors that influence fatigue which is based on the input of crew. They can file reports, called a voluntary safety report (VSR) about experienced factors that contributed to their fatigue. When staff experiences high levels of fatigue and feel unfit to fly they are able to file a VSR and unfit to fly, to be taken out of the roster. According to KLM itself however, there currently is a misunderstanding that you are not able to report unfit to fly. They also state that if you feel unfit to fly but you fail to report so, you are personally responsible for the mistakes you are making, because of fatigue, in safety and security tasks. Indicating another reason why research towards fatigue in cabin crew is important.

3. Methodology and Data Collection

The methodology used in this research is both qualitative as quantitative. Fatigue is a very complex phenomenon to study. It cannot be recorded completely with solely qualitative or quantitative. This research is able to take the positive sides of qualitative research such as having in dept information about the thoughts and feelings of the target group, being able to capture insights that the researcher itself did not think of and having information from the target groups perspective before commencing quantitative research. With the quantitative research, it will make this research more reliable and reproducible, are able to conduct surveys on a much larger population, use statistical and mathematical computations to test hypothesis and draw correlations and/or causations. The questions of the qualitative interview are open questions and opt to give the participant the opportunity to speak freely and add information they view as important or related. (See appendix). The disadvantage of using both is that there are generally more participants needed for this study. With the use of KLM social groups on Facebook for example, this disadvantage was dealt with, and were able to reach a large population.

3.1 Cabin crew fatigue model

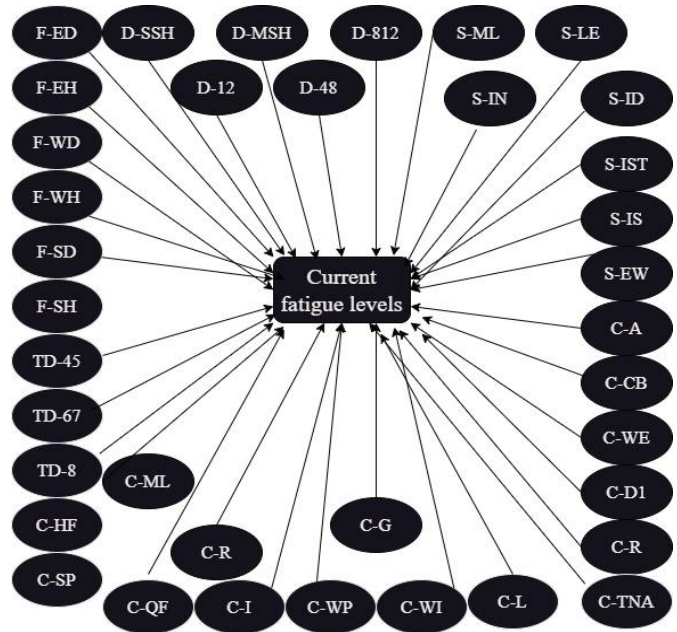
3.1.1 Cabin crew interviews

A 30-question qualitative interview has been conducted with 3 participants with questions based on the literature review. All the participants of the interviews were currently employed with KLM, flown for several years and had experience with short and long-haul flights. With the results of these interviews, questions for the larger scale survey were formed.

Figure 1: Research model

3.1.2 Research model (survey)

From the interviews sub-questions were drafted. These can be found in the appendix, Figure 4: Fatigue model. These questions were shared through Qualtrics in the cabin crew Facebook group of KLM. A total of 124 respondents have been recorded (incomplete responses were deleted). The research model is depicted in Figure 1. The survey used the following methods to gather data:



- Multiple choice questions: Q7.2 to identify differences and uncomfortable resting areas. This can be used for further recommendations towards reducing fatigue.
- Open questions: Q4.1 to identify possible destinations that are overall experienced as more fatigue influencing than other destinations. Q5.2 and Q5.3 to ask the opinion on the length of lay-overs at destinations. These are aimed to provide the possibility of researching further in which destinations generate greater fatigue.
- Matrix questions using the scale of Lee, S., & Kim, J. K. 2018: The scales used in that paper range from 1-slight influence to 5-deep influence with the possibility of skipping a statement when it has no influence on fatigue. However since this survey is online and not paper based like the previous meant survey, some adjustments had to be made, and no influence had to be part of the scale. To prevent complicity for the participants, and not exceed 5 answer options, the scales have been simplified to the following range; 1-no influence 2-light influence 3-moderate influence 4-significant influence. Questions that used these scales: Q3.1, Q4.2, Q4.3, Q5.1, Q7.1, Q6.1
- Situational recall questions using a standard Likert scale from the MFI: Q8.1 (yes/no filter question), 8.2 (control with WIFI), 8.3 (yes/no filter question) and 8.4 (control without WIFI) are aimed at researching in depth the influence of WIFI on fatigue and whether the crew experiences more or less fatigue because of WIFI. Only cabin crew that flies planes without WIFI is able to answer the question in the situation of having no

WIFI. The participant is asked to remember their last flight with/without WIFI and answer some fatigue related statements with a standard Likert scale. This is based upon but adjusted from the Multidimensional Fatigue Index (Shahid et al., 2011).

- Multidimensional fatigue index.

The MFI (Shahid et al., 2011) is used to measure the current fatigue levels of cabin crew at KLM. Positive phrased statements have an inverted scoring from the negative phrased statements. The scale ranges from totally agree-agree-neutral-disagree-completely disagree.

To ensure measuring validity, survey questions from other studies that have been statistically validated have been used in this survey as well.

- The study of Sun, J. Y., & Sun, R. S. 2023 questions have been used for question 3.1 and 7.1. However since the research paper did not give the scales used in this survey, the scales from Lee, S., & Kim, J. K. 2018 have been followed to maintain structure and overview for the participants.
- The study of Lee, S., & Kim, J. K. 2018 questions have been used for questions 4.2, 4.3, 5.1, 7.1 and 6.1. With accompanying scales as mentioned above.
- The complete use of the Multidimensional fatigue index (Shahid et al., 2011) including questions and scales.

For the analysis of the results, multiple statistical test were used such as factor analysis, multiple regression and ANOVA. The statistical program that was used is SPSS (SPSS Software, n.d.).

4. Analyses and Results

First the reliability of the survey questions is tested with Cronbach's alpha. This measure ranges from 0 to 1 with higher values indicating greater internal consistency or reliability of the scale items. The alpha values indicate a high level of internal consistency with a Cronbach alpha of 0,886. This Cronbach alpha cannot be increased if items were deleted. So we keep the initial data set.

Answer options	Frequency	Response percentage of total respondents
Age		
20-29 years old	12	9.68%

30-39 years old	19	15.32%
40-49 years old	30	24.19%
50-59 years old	59	47.58%
60 or older	4	3.23%
Gender		
Male	11	8.87%
Female	112	90.32%
Prefer not to say	1	0.81%
Work experience		
Less than 1 year	1	0.81%
Between 1 and 3 years	5	4.03%
Between 3 and 5 years	3	2.42%
Between 5 and 10 years	19	15.32%
Between 10 and 15 years	7	5.65%
Between 15 and 20 years	10	8.06%
Between 20 and 30 years	49	39.52%
More than 30 years	30	24.19%
Position		
1-stripe cabin attendant	57	45.97%
2-stripe cabin attendant	43	34.68%
3-stripe assistant purser	0	0.00%
4-stripe purser	15	12.10%
Senior purser	9	7.26%
Fleet		
Airbus A330	63	51.61%
Boeing 737	77	62.10%
Boeing 777	123	99.19%
Boeing 787	122	98.39%

4.1 Factor analysis

To determine the number of underlying factors the variables and evaluate the acceptability of the data for factor analysis, 3 measures of factor analysis were used.

Bartlett's test of sphericity is used to examine whether the correlation matrix of the variables is significantly different from an identity matrix. If the correlation matrix is not significantly different from an identity matrix, then there is no evidence to support the presence of underlying factors. (Zach, 2021). And the Keiser-Meyer-Olkin (KMO) measure of sampling adequacy is used to look at how much variance the variables share and whether they can be used in factor analysis. The KMO has a value between 0 and 1, with values nearer 1 indicating a better fit for factor analysis. KMO values greater than 0.7 are often regarded as acceptable for factor analysis and values greater than 0.8 are considered good. (Sekaran, 2003). The outcomes of these tests are: Bartlett's test showed Sig (P) < 0.001 ($\chi^2=1857.109$, degree of freedom=666). Which means that the variables do have a correlation with another.

KMO shows a value of 0.756, which is considered acceptable. The data satisfies the assumptions for factor analysis.

The correlation coefficient among question items is used to examine the strength and direction of the linear relationship between pairs of variables. High correlation between items is a sign that the factor or construct being measured may be the same. As a result, elements with a high correlation with another make for excellent candidates for factorization. When analysing the correlation matrix it is noticed that most variables in the desired construct, for example flight direction, do not have an equally good correlations with another. Correlation ranges from 0.223 to 0.619. This can be explained by that the question often ask opposite things such as flying west vs flying east. When running Confirmatory factory analysis on this data set to identify components, it shows that there are actually 11 components within this data set instead of 5. Within these components, almost all variables are included either with a correlation of <0.6 or a negative correlation again. All variables measure fatigue thus correlation between each other is understandable, however the factorisation of 11 constructs is in the case of this study unwanted and should be further researched. (UCLA, n.d.)

The data is thus not suited for factorisation, and regression analysis is used instead to analyse the relationship of the variables as independent items.

4.2 Regression analysis

Multiple linear regression is used to examine the relationship between a dependent variable and multiple independent variables at the same time. It has the advantage of identifying the individual contributions of each independent variable while controlling for the effects of other variables. By including several predictors in the analysis, it can be investigated how each variable affects the outcome while holding other variables constant. This helps in comprehending the distinct impact of each independent variable and provides a more complete grasp of the underlying relationships. Moreover, multiple regression allows it to analyse each predictor's relative strength and importance. It is possible to discover which variables have a greater influence on the dependent variable using statistical approaches such as hypothesis testing and coefficient computation. (Bevans, R. 2022, November 15)

The data meets the assumptions for multiple linear regression showing no signs of multicollinearity. The results of the predicted probability plot demonstrate minor and allowable deviations from the normality line and the residuals are not homoscedastic.

The following regression model is used: (Bevans, R. 2022, November 15)

$$y = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n + \epsilon$$

y = predicted value of the dependent variable

β_0 = the y-intercept

$\beta_1 X_1$ = the regression coefficient of the first independent variable

$\beta_n X_n$ = the regression coefficient of the last independent variable

ϵ = model error

The model summary of the regression analysis gives us an adjusted R square of 0.171 meaning that 17.1% of the variance of the dependent variable, current fatigue levels, is explained by the independent variables. In Table 1 you can see the regression coefficients of the model with the standard error and significance. Explanation of the acronyms used for the variables are in Figure 4: Fatigue model. A variable is deemed significant if the p-value is < 0.05, and is highlighted in blue.

Table 1: Regression coefficients

Variable	Unstandardized Coefficients		Sig.	Variable	Unstandardized Coefficients		Sig.
	B	Std. Error			B	Std. Error	
(Constant)	22,738	13,025	0,084	S-IST	-0,63	2,787	0,822
F-ED	-0,008	1,512	0,996	S-IS	-0,004	1,667	0,998
F-EH	-0,725	1,979	0,715	S-EW	-1,715	1,517	0,261
F-WD	1,678	1,61	0,3	C-A	1,73	1,363	0,208
F-WH	0,45	1,633	0,784	C-CB	-3,828	2,709	0,161
F-SD	-3,431	2,274	0,135	C-WE	0,08	1,683	0,962
F-SH	0,768	1,804	0,672	C-D1	1,088	2,502	0,665
TD-45	-2,811	2,038	0,171	W-R	1,341	2,2	0,544
TD-67	5,962	2,571	0,023	W-TNA	-2,999	1,584	0,062
TD-8	-1,304	3,357	0,699	W-L	-0,66	1,484	0,657
D-SSH	1,195	1,215	0,328	W-WI	0,874	1,61	0,589
D-MSH	2,147	1,697	0,209	W-G	-2,992	1,906	0,12
D-48	2,365	1,803	0,193	W-WP	-0,77	1,774	0,665
D-812	-5,348	2,662	0,048	W-I	2,622	2,039	0,202
D-12	3,629	2,549	0,158	W-R	0,171	1,392	0,902
S-ML	2,226	1,393	0,114	W-QF	1,674	1,678	0,321

S-LE	0,616	1,605	0,702	W-ML	-1,782	1,752	0,312
S-IN	1,977	2,039	0,335	W-HF	3,124	1,411	0,029
S-ID	1,888	1,875	0,317	W-SP	0,677	1,568	0,667

Three variables show a significance effect on current fatigue levels. A time difference of 6-7 hours has a positive significant effect of 5.962 ($p = 0.023$). A flight duration of 8-12 hours has a negative influence on fatigue levels of -5.348 ($p = 0.048$) and lastly the quality of the hotel facilities has a positive significant influence of 3.124 ($p = 0.029$).

Expanding our examination besides only significant results it can be seen that some variable have a rather large positive regression coefficient, but not a high significance level such as; flight duration of +12 hours (coef. 3.629, $p = 0.158$), social pressure (coef. = 3.124, $p = 0.667$), rest facilities (coef. = 2.662, $p = 0.544$). And some have a rather large negative regression coefficient; crew's cultural background (coef. = -3.828, $p = 0.161$), flying south to destination (coef. -3.431, $p = 0.135$), lighting of aircraft (coef. = -2.999, $p = 0.657$), work pressure (coef. - 2.992, $p = 0.665$). Although the effect of these variables is not significant it is worth taking a closer look.

4.3 Individual analysis of the sub-questions

For the individual analysis, statistical test with ANOVA (analysis of variance) was used to compare means. ANOVA is useful to compare means of more than 3 groups. The groups being in this case the level of influence the respondents think the variable has on fatigue, ranging from 1- no influence to 4- significant influence. (Bevans, R. 2022, November 17).

4.3.1 What are the current fatigue levels?

To identify the dependent variable, the current fatigue levels, the Multidimensional fatigue inventory score is calculated for each respondent. The mean score of all respondents is 49.79. When comparing to other populations scores, this score is average. In an assessment of the MFI to the German population the overall total score was 41.69 (Westenberger, A., et al 2022). In another study with a smaller, Greek population the total MFI score was 50.51 for healthy adults (Bakalidou, D., et al, 2022) Comparing to other self-assess scoring models on a scale of 100 points, a score of <50 is considered normal (Lin et al., 2009), since the MFI does not give an indication saying which scores are normal, only the higher the score the more fatigued. The score also consist of 5 subscales of which general fatigue is higher (11.53 out of

20) than the other subscales, but also has a higher standard deviation (3.46) than the others (between 9.33 and 10.03). It also has the highest maximum score of 19 indicating that some of the respondents have severe general fatigue, with 20 being the maximum score for a subscale. See Table 5.

The conversation from the interviews about the current fatigue levels are very mixed. Some of the interviewees say they found a mode to work with their irregular schedule. Fatigue during the work hours are generally managed but consensus is found in the following: “you fly at night, did not sleep well the night before, did not sleep on board and then you still have to get in the car to get home. Which is pretty dangerous.”(interview 1) This highlights the ‘whole of life issue’ of fatigue. The issues of fatigue do not stop the moment you sign off. “It remains a job that you chose, it should fit you, and it depends on how you deal with it”. (interview 2). This is supported by other studies where it is said that fatigue among airline crew is inherent to the nature of the work: “The nature of this job in itself will have a lot of fatigue [...] it is an international airline so it will travel at the wrong time, so that is the nature of the job” (Group 2, J, Van Den Berg, et al, 2020).

4.3.2 Which flight direction experiences more fatigue?

The results show that flying westwards towards home is said to influence fatigue the most with a mean of 3.01 (on a scale of 1 to 4). What also can be noticed is that the mean of question items that have a flight direction towards home (minimum mean of 2.26) are all higher than their equal flying towards the destination. This suggests that higher fatigue is overall more perceived on flights with a direction towards home. See Table 6.

When running multiple ANOVA tests on each of the variables on flight direction, the independent variable West towards destination is the only one showing levels that significantly differ from each other as a whole (F-value 3.371, p-value 0,021). When looking at the difference between the groups in this variable, it shows that with the Bonferroni method the moderate and significant influence on fatigue groups significantly differ from another with a mean difference of 9.56 (p-value 0.015). Also when using a two-way ANOVA test it shows that flying west towards the destination (F-value 2.956, p-value 0.036) has more influence on the current fatigue levels than flying towards home ($f = 0.698$, $p = 0.555$). There is no significant interaction between flying west towards destination and towards home ($p = .130$). With a ANOVA 3-way

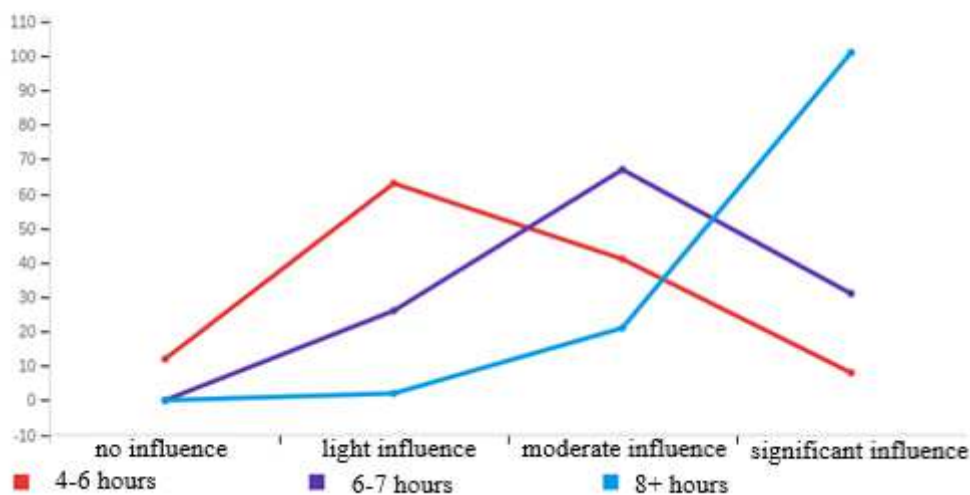
test, the data shows also no significant interaction between all homewards flights on fatigue levels.

4.3.3 Does time difference influence fatigue?

When analysing the responses, the line chart below gives a good insight to the distribution of responses. Even though all forms of time difference have influence on fatigue levels, the influence of a time difference of 8 or more hours is seen as significant for most respondents (101 responses). Whereas a time difference of 6-7 hours is mostly classified as moderate influence and a time difference of 4 to 5 hours as no influence to light influence. These results are interesting given that a time difference of 6-7 hours has a positive significant influence on the current fatigue level instead of 8+ hours. See Table 7 for the descriptive statistics.

When running a 3-way ANOVA, it is shown that there is no significant difference in interaction between the 3 groups. However within a time difference of 6-7 hours there is a significant interaction between light-moderate ($p = 0.009$) and light-significant ($p = 0.004$) with their effect on current fatigue levels.

Figure 2 Line chart time difference



4.3.4 Does flight duration influence fatigue?

When looking at the descriptive statistics for flight duration it can be noticed that the longer the flight the higher the mean is (2.27 for single short haul to 3.53 for 12h+ flights), a higher self-perception of fatigue is, but also the standard deviation gets lower (1.062 for single short haul to 0.630 for 12h+ flights). Indicating that mean is more accurate for the population.

Interesting is that the minimum of flights longer than 12 hours is 2. Indicating that a flight

longer than 12 hours always has an impact on fatigue according to the respondents, since there have been no respondents answering 1-no influence. See Table 8. This result stands opposite from the influence flight duration has on current fatigue levels, with a flight duration of 8-12 hours having a rather large significant negative influence on fatigue levels whilst having a high mean score of 3,16.

4.3.5 Does flight scheduling influence fatigue?

4.3.5.1 Route schedule

As could be expected, intercontinental flights with a stop-over, flights where they execute a long-haul flight to a country, and immediately fly to the next city, for example Amsterdam – Bogota – Cartagena, has the highest mean of 3.68, lowest standard deviation of 0.519 and a minimum of 2, indicating that it always has some influence on fatigue according to the respondents. This outcome makes sense given the long working hours. Other high scoring items are ICA night flights (mean 3.40) sign-off late followed up by early sign-in (mean 3.37), flying east to west in opposite direction (mean 3.34). See Table 9.

4.3.5.2 Lay-over schedule

Upon asking the cabin crew about which routes have too short layovers the result from the word count are very unanimous. See Table 10. 40.32% of the respondents (word count of 50) mention in their answer that a 24 hour lay-over, also known as a 3 day ICA trip is considered more fatiguing. These flight schedules are often described as ‘killing’, ‘too short to properly rest’, ‘fatiguing’, ‘throwing you off’ in the answer field. The destinations that are often mentioned, are those that are scheduled as 3-day flights with 24 hour lay-overs explaining the equal high rate of responses.

The other high scoring comments such as 5+ hour time difference (13), night flights (12), Airbus planes without OCR (6) and unfavoured calling times (5) are often the working conditions accompanying these same 3-day trips. Indicating a relation between these conditions. All of these items also have fairly high mean scores in the other sub-questions.

To look at both sides of the lay-over schedule the respondents were asked to list any destinations with a too long lay-over. 68 respondents answer no, which is understandable because it is free/rest time. However 56 of the respondents did indicate some trips which they

think are too long and/or could be better distributed to a different destination with a shorter layover. See Table 2

Table 2

Destination	Aircraft	Flight time	Time difference	Report times	Debrief times	Possible lay-over	Circulation
Singapore (+stopover in Bali)	Boeing 777	12h30	6	17:55 16:10	8:55 7:55	96h (67%) 120h (29%) 144h (5%)	7/7 8/6 9/6
Kuala Lumpur	Boeing 777	12h20	7	17:35 14:35	8:10 5:50	126h (50%)	8/5
Kuala Lumpur + stopover Jakarta						113h (25%) 137h (25%)	8/7 9/6
Kuwait + stopover Bahrain/Muscat	Airbus 330	6h	2	8:55 23:30	17:30 8:30	48h (58%) 70 (17%) 72h (17%)	4/3 5/2 5/3

*based upon winter schedule okt-march 2022/2023 (KLM 2022)

Analysing the destinations it is noticed that Kuala Lumpur and Singapore are very similar in a long flight time, moderate time difference, both night flights, and a lengthy circulation of 7 to 9 days away from home. Kuwait is a bit of an outlier where possible other factors are playing a role of why this destination's lay-over is considered too long.

4.3.6 Does crew planning influence fatigue?

Looking at the means of crew planning variables they are all on the low side, between 1.25 and 3.04. The decrease of 1 crew member being the highest (3.04), and 3 meaning a moderate influence on fatigue. See

Table 11. This outcome is also represented in the interviews. Most participants did not recognise the influence of colleagues/crew on fatigue and mentioned “we are very used to dealing with different age, cultures and backgrounds. I like having different colleagues”. Regarding the reduction of crew members on board, it was said to have influence on safety rather than fatigue. “In case of an emergency we can only handle 1 problem, not 2. You

would have to pull people away of the tasks they already have. You just don't have enough people on board, it the minimal of what is needed.”

4.3.7 Do the working conditions influence fatigue?

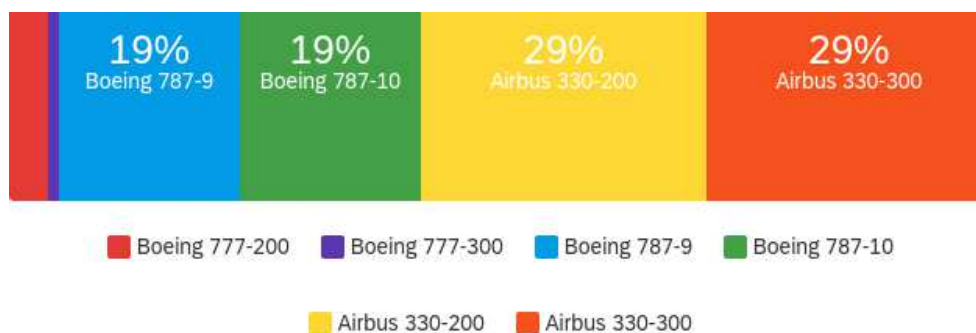
The respondents indicate that the resting facilities have the highest influence on their fatigue with a mean of 3,63 indicating either moderate to significant influence on fatigue. Also temperature, noise, air quality of the aircraft (mean 3.42 and a minimum of 2) and the quality/facilities of the hotel (mean 3.27) have a moderate to high influence on fatigue. See Table 12.

In the interviews it is mentioned by multiple participants on hotel quality that the curtains play a big role. If the sunlight from the windows is not fully blocked by the curtains, this has an impact on the ability to fall asleep and the quality of it. Connecting it with the influence it has on the current fatigue levels it could be an indication that sleep quality is possibly an important aspect of the fatigue levels. It was also mentioned in the interviews that the working spaces of the 787 are physically demanding. “You can never pull the trolley straight out, because it will hit the wall. You have to remove it oblique”.

4.3.7.1 Does the aircraft influence fatigue?

As anticipated from the interviews and as resulted from the working conditions matrix answers, the resting facilities play a big part in fatigue. It is important to identify which aircraft is the main cause and why this increases fatigue levels. The results show that the majority of the respondents feel that their quality of rest on the Airbus worse than on other planes. Together taking up 58% of the responses. See Figure 3.

Figure 3



The difference between the aircrafts resting facilities:

Boeing 787 has a small OCR

Boeing 777 has a somewhat larger OCR

Airbus 330 ‘high comfort’ crew seat. This seat is inclinable and includes a small leg pillow, with a curtain that can be pulled around it. This seat is near the door in the galley. Depending on your function group this can be at door 12 or 13 (has a toilet in the galley).

In the interviews it is mentioned that the OCR of the Boeing 787 is experienced as very small and cramped. One of the participants standard writes a trip report saying it gives her back problems. Furthermore the ‘high comfort’ seats of the Airbus are not described as comfortable by anyone. “There is mentally a difference between resting on a seat or in a bed”. The lack of OCR seems to be a recurring problem statement in both the survey and the interviews. ‘On long flights on the Airbus without OCR I have trouble staying on the rest seat for a longer period of time’. Comfort level is also dependant on your function. Amidst cabin crew, pursers get the better seat near door 12 which does not have a toilet next to it unlike door 13, giving them somewhat less interruptions by passengers. But the biggest difference lies between cabin crew and pilots. For pilots, 2 business-class seats on the Airbus are blocked for use as resting facilities. Giving them the option of laying down horizontally, which the cabin crew can’t on the comfort seats. Also in the OCR’s of the Boeing aircrafts, the mattresses are better/thicker of the pilots than those of the cabin crew.

4.3.8 To which destination is more fatigue experienced?

If the data aligns the result of the previous sub questions, the result for this question should be a destination west from homebase Amsterdam. The results of which destination is more fatigue experienced were calculated with a word count of the cities, sometimes countries when the respondent did not explicitly mentioned a city. The respondents were able to give a top 3. The most mentioned city, with a word count of 45 is Los Angeles, followed up by San Francisco with a word count of 29, and third Vancouver with a word count of 24. These results are very noticeable since the mean of a certain city being mentioned is 5.36 times. See Table 3 below (see Table 4 for a more extended version).

When zooming in on the flight conditions of these destinations, all 3 cities share a big time difference of 9 hours. Los Angeles and San Francisco both also have similar flight time and

report/debrief times and the majority of flight towards these destinations have a 24 hour lay-over.

What is curious however is that Vancouver also made top 3 without having the 24 hour layover characteristic. The time difference is the same but the flight time is shorter than the other two cities. So you would assume it is less fatiguing than other cities that do have a 24 hour layover. To get a better understanding of why Vancouver is part of the top 3, a closer look is given to the respondents answers. They mention that the hard part of the Vancouver flight is the time difference, flight time and aircraft, the Airbus 330. The latter being a distinguishable difference from the other two cities, flying with a Boeing 787. This indicated for a need to investigate further on the influence of the aircraft on fatigue, see 4.3.7.1.

Looking to the report and debrief times of all 3 cities it is noticed that the flight back home is always a night flight, which is reported as well as more fatiguing in the other sub-questions.

Table 3

Destination	Aircraft	Flight time	Time difference	Report times	Debrief times	Possible lay-over	Circulation
Los Angeles	Boeing 787	11 hours	9 hours	6:30/7:00	20:20	24h (70%)	3/5
				20:25	8:35	48h (20%)	4/5
				10:00/10:30 23:50	23:50 12:00	72h (10%)	5/5
San Francisco	Boeing 787 Boeing 777	11 hours	9 hours	6:50/7:20	20:45/20:40	24h (37.5%)	3/5
				21:05	8:55	48h (37.5%)	4/4
						72h (25%)	5/3
Vancouver	Airbus 330	9.30 hours	9 hours	9:50/10:20 22:30	22:25 9:40	48h (67%) 72h (33%)	4/4 5/4

*based upon winter schedule okt-march 2022/2023 (KLM, 2022)

4.3.9 Does having WIFI influence fatigue?

The following hypotheses is: WIFI has a positive influence of fatigue levels.

107 (82.29%) of the respondents says they use WIFI on flights, with only 17 (13.71%) not. Of these 107 respondents, 55 (51.40%) use WIFI during their work activities and 95 (88.78%) of them use WIFI during their rest time. 94 (75.81%) of the respondents works on planes that do not have WIFI on board. There are 80 participants that both use WIFI and fly on planes without WIFI. These will be part of the experiment if having WIFI onboard contributes to fatigue levels.

The hypothesis is tested using a paired samples t-test. This statistical test is used to compare means from 2 related sets of data, comparing the situation with and without WIFI and see if the difference is statistically significant. As seen in Table 4, the mean fatigue score when WIFI is present is higher than that of the situation without WIFI, indicating that WIFI has indeed a significant positive effect on fatigue levels. This outcome of the paired samples t-test shows a p-value of <0.001 (a p value of <0.05 is deemed significant) and we reject the null-hypothesis. WIFI has a positive (increasing) effect on fatigue levels.

Table 4

		Mean	N	Std. Deviation	t	df	One-sided p (significance)
Paired Samples Statistics							
Pair 1	Mean_WIFI	2,7688	80	0,66890			
	Mean_NOWIFI	2,4438	80	0,81809			
Paired samples test							
Pair 1	Mean_WIFI – Mean_NOWIFI	0.3250		0.66251	4.388	79	<0.001

These results are interesting because if when the crew was asked if they think that having WIFI contributes to their fatigue levels 87% of the respondents disagreed.

5. Conclusion and general discussion

Fatigue is a very actual subject at the moment. However at KLM, after several years they still have not implemented a FRMS. Over the last few years, they even have been decreasing layovers and home rest. Fatigue is measured by voluntary reports and action is taken only after

complaints. Factors that have the highest reported self-perceiving effect on fatigue in this study are (from highest to lowest): ICA with stopover (3.68), resting facilities (3.63), 12h+ flight duration (3.53), temperature/noise/air-quality of aircraft (3.42), ICA nightlight (3.40), end late/start early (3.37), hotel quality (3.27), 8-12 hour flight (3.16), decrease of 1 crew member (3.04) and flying west towards home (3.01). All these factors have a moderate influence, a mean between 3 and 4, on their self-perceived fatigue.

When we look at the results from the regression model only one of the high reported fatigue factors can be justified by the regression model, the hotel quality. With a 8-12 hour flight showing significant negative results that directly goes against the individual analysis findings. Furthermore a time difference of 6-7 hours showing significant positive results but having a lower mean (3.04) than 8+ hours of time difference (3.80). When thinking deeper about the meaning of fatigue, the results start to connect more. When comparing the influence of the independent variables on the current fatigue levels to the response counts and means in the individual analysis it became clear why the highest scoring self-perceiving factors scored lower or opposite in the regression analysis. Healthy crew employees with low current fatigue level scores will perceive moderately long and intense flights as less fatiguing than colleagues with more severe fatigue issues. Cabin crew with high current fatigue levels will perceive these moderate flights as more fatigue influencing in their self-perception. It can be speculated that respondents with high CFL scores will sooner choose the moderate/significant influence answer and those with low CFL scores. Tough flights such as 12+ hour flights and more than 8 hours of time difference will be seen as fatiguing by almost anyone, no matter your CFL, thus it having less influence on the CFL levels cause also respondents with low CFL scores will classify those as fatiguing.

Combining the quantitative and qualitative results of this study insights are given to flights containing multiple fatigue inducing factors and should be given a closer look by KLM. North Atlantic flights such as Los Angeles, San Francisco and Vancouver all share highly fatiguing working conditions such as long flight duration, crossing multiple trans meridian lines, both trips (destination and homewards) being night flights and a high percentage of flights only allowing a lay-over of 24 hours. Giving you 4 to 5 days to recover. Of course it is not possible for the airline company to solve all of these issues, such as flight duration. But most factors that come up in this study are at least alleviable.

There are also flights within KLM where cabin crew indicates they experience an abundance of at destination rest time. Eastward flights like Singapore or Kuala Lumpur, flights with almost the same factors as North Atlantic flight have much longer rotations, with lay-overs totalling 97 and 137 hours at destination. From the data, it cannot be recognised why the lay-over and rotation of Kuala Lumpur without stop-over is so much longer than the North Atlantic city flights. Most of these destinations however do have a shuttle. Explaining some of the increased time at the destination and increased circulation. It can be noted that perhaps KLM could improve their flight scheduling and distribute resting hours more evenly across destinations, not making cabin crew too fatigued, but also avoid them spending too much time away from home.

It is a good thing that crew has a large influence on their work schedule. They are able to cancel flights in their schedule draft up to 3 times, avoiding for example long haul flights in opposite directions from the home base, getting completely lost in their circadian rhythm, or creating schedules that are more suited to their sleeping pattern and preferences. As was shown in the interviews that it differs from person to person if they prefer west or eastward flights.

The respondents also make clear how much impact the Airbus 330 has on crew because of the lack of OCR. To be able to rest horizontally. Besides the comfortless of the resting chair it is also mentally hard on cabin crew, knowing beforehand they are not able to rest and lay flat for a while, shut off for a moment in a secluded area. Instead, their sitting next to the door, often in a cold temperature, visible and approachable for passengers. Also the inequality of pilots having the two blocked business-class seats, and cabin-crew not indicating that it is a purely financial and prioritizing decisions to not grant them the same comfort. The reason for KLM's Airbus aircrafts not having an OCR is cost reduction. It is hoped that with this and further research on fatigue in cabin crew KLM will be incentivised to look further than a simple cost reduction. That they will understand that an investment in having an OCR is worthwhile both for the health and happiness of the employees and could count as a step towards increasing the customer service and satisfaction of their clients which is presumably influenced by cabin crew's fatigue levels, showing in the interviews. According to a recently promoted to purser flight attendant, customer reviews are standard worse on flights homewards, indicating this relationship. The self-assessment of fatigue for all homewards flights is higher than that of

those towards the destination, with a combination of minimal rest at the destination it is understandable that crew performs less on the way back.

It is seen that these cost effective measures of the company are the things that affect the fatigue of the crew the most. Saving money on airplane configuration of the Airbus 330, making galleys as small as possible to fit more seats in the cabin is resulting in more physical constraint on crew, having short layovers (24h stops) to save hotel and pay check costs. Adding shuttles in trips to add more cities to the airlines portfolio. This study indicates that it would be a best practise to promote strong collaboration between departments such as finance department and HR to ensure that new measures or ideas can be implemented with the health of their employees in mind. Improvements of resting facilities are possible, as can be seen by the differences that are offered to pilots than to cabin crew.

The different views on fatigue and how it is part of the job as cabin crew has influence on the measurability of fatigue. Some crew feel that fatigue is part of the job and you should just deal with it. Others recognise some fatigue issues that should be addressed and improved. Especially in studies like this where fatigue is measured from self-assessment, biases can occur. It is therefore also important to measure fatigue objectively through clinical monitoring of bodily functions such as heart rate, eye movement and observation. The suitability of the MFI can be questioned in this study. During data analysis it was noted that perhaps the questions could be more specified to fatigue in the workplace. The MFI measures the overall fatigue levels, which has possibly less extreme outcomes than a fatigue questionnaire focused only on the work floor. The average score of the participants on the MFI could have correlation with the fact that cabin crew recovers enough at home to not have much high scores. However this study could be used for a comparison between overall fatigue and fatigue in the work place. It could be researched whether cabin crew recovers enough at home to reset their fatigue levels for the next flight. What also can be discussed is the prevalence of 11 components within the independent variables. More research should be done in what those components represent and how those variables correlate.

6. Future research and limitations

While this study provides valuable insights into the factors influencing fatigue levels among cabin crew members and offers suggestions for improving flight scheduling and resting

facilities, there are several areas that warrant further investigation. Future research can focus on the following aspects:

Implementing Fatigue Risk Management System (FRMS): The current study highlights the absence of an FRMS at KLM and the need for its implementation. Further research can delve into the development and evaluation of an FRMS tailored to the specific needs of cabin crew members. This would involve studying the effectiveness of fatigue mitigation strategies, such as optimized duty and rest periods, crew rotation patterns, and proactive monitoring of fatigue levels.

Impact of work schedule flexibility: The study mentions that cabin crew members have some influence over their work schedules, including the ability to cancel flights in their draft schedule. Future research can explore the extent to which flexible work schedules contribute to reducing fatigue and improving overall well-being. Additionally, investigating the effects of other work schedule adjustment options, such as shift swapping or preferences for specific flight routes, can provide valuable insights into optimizing crew schedules. The interviews and surveys show that people that consider themselves as a night owl have a preference for eastwards flights for example.

Evaluation of Resting Facilities: The study identifies the lack of adequate resting facilities, particularly in Airbus 330 aircraft, as a significant factor contributing to fatigue among cabin crew members. Future research can focus on assessing the impact of improved resting facilities, including positive impact of the provision of OCR's on fatigue and overall job satisfaction.

While this study provides valuable insights, it is important to acknowledge its limitations, which should be considered in future research and practical applications:

- **Sample size and generalizability:** The study's findings are based on a specific sample of cabin crew members from KLM. To enhance the generalizability of the results, future studies can involve larger and more diverse samples from multiple airlines to ensure a broader representation of the cabin crew population.
- **Self-report measures:** The study relies on self-report measures, including interviews and survey questionnaires, to collect data on fatigue levels and related factors. Although self-report measures are commonly used in research, they are subject to

biases and individual perceptions. Future studies can consider incorporating objective measures, such as physiological data or performance assessments, to complement self-report measures and provide a more comprehensive understanding of fatigue.

- External factors: The study primarily focuses on internal factors related to flight operations and crew conditions. However, external factors, such as individual lifestyle choices, personal circumstances, and non-work-related stressors, can also contribute to fatigue levels. Future research can incorporate a more comprehensive examination of both internal and external factors to provide a more holistic understanding of cabin crew fatigue.

By addressing these future research directions and considering the limitations of the current study, further advancements can be made in understanding and managing fatigue among cabin crew members, ultimately leading to improved well-being, safety, and efficiency in the aviation industry.

Appendix

Figure 4: Fatigue model

Dependent variable:

What are the current fatigue levels?

CFL current fatigue levels

Independent variables:

Sub question 2: Does flight direction influence fatigue?

F-ED flying east, to destination

F-EH flying east, homewards

F-WD flying west, to destination

F-WH flying west, homewards

F-SD flying south, to destination

F-SH flying south, homewards

Sub question 3: Does time difference influence fatigue?

TD-45 a time difference of 4-5 hours

TD-67 a time difference of 6-7 hours

TD-8 a time difference of more than 8 hours

Sub question 4: Does flight duration influence fatigue?

D-SSH Single-leg short-haul flight

D-MSH multi-leg short haul flight

D-48 flights between 4-8 hours

D-812 flights between 8 and 12 hours

D-12 flights longer than 12 hours

Sub question 5: Does flight scheduling influence fatigue?

S-ML multi-leg stretches on one day

S-LE end late, start early next day

S-IN ICA night flight

S-ID ICA day flight

S-IST ICA stop-over

S-IS ICA with shuttle

S-EW flying east to west and reverse

Which routes have a too short layovers for proper rest?

Sub question 6: Does crew planning influence fatigue?

C-A age

C-CB cultural background

C-WE work ethics

C-D1 recent decrease of 1 crew member

Sub question 7: Do the working conditions influence fatigue?

W-R rest facilities

W-TNA temperature, noise, air quality

W-L lighting of the aircraft

W-WI WIFI

W-G galley configuration

W-WP work pressure
W-I interruptions of work
W-R repeating nature of work
W-QF quality of available food
W-ML mental load
W-HF hotel facilities
W-SP social pressure
Which plane has worse resting facilities than others?

Sub question 8: To which destination is more fatigue experienced?

Sub question 9: Does having WIFI influence fatigue?

WI-Y situation with WIFI
WI-N situation without WIFI

Table 5 Descriptive statistics: 1 Fatigue Levels

	Mean	Std. deviation	Minimum	Maximum
Overall score	49.79	12.22	22	83
General fatigue	11.53	3.46	4	19
Physical fatigue	9.56	2.95	4	17
Reduced activity	9.34	2.95	4	17
Reduced motivation	9.33	2.59	5	18
Mental fatigue	10.03	3.01	4	17

Table 6 Descriptive statistics: 2 Flight direction

Direction	Mean	St. Deviation	No influence	Light influence	Moderate influence	Significant influence
Eastwards, to destination	2.82	0.963	12 (9.7%)	34 (27.4%)	42 (33.9%)	36 (29%)
Eastwards, home	2.88	0.861	6 (4.8%)	36 (29%)	49 (39.5%)	33 (26.6%)
Westwards, to destination	2.52	1.040	23 (18.5%)	42 (33.9%)	31 (25%)	28 (22.6%)
Westwards, home	3.01	0.879	7 (5.6%)	26 (21%)	50 (40.3%)	41 (33.1%)
Southwards, to destination	1.96	0.790	39 (31.5%)	53 (47.2%)	30 (24.2%)	2 (1.6%)
Southwards, home	2.26	0.864	24 (19.4%)	54 (43.5%)	36 (29%)	10 (8.1%)

Table 7 Descriptive statistics: 3 Time difference

	Missing	Mean	Median	Std. Deviation	Variance	Minimum	Maximum
Time difference - 4-5 hours	0	2,36	2,00	0,747	0,558	1	4
Time difference - 6-7 hours	0	3,04	3,00	0,680	0,462	2	4
Time difference - 8 or more	0	3,80	4,00	0,441	0,195	2	4

Table 8 Descriptive statistics: 4 Flight duration

	Mean	Median	Std. Deviation	Variance	Minimum	Maximum
Single-leg short-haul flights	2,27	2	1,062	1,127	1	4
Multi-leg short-haul flights	2,73	3	0,859	0,737	1	4
Flights between 4 and 8 hours	2,34	2	0,774	0,6	1	4
Flights between 8 and 12 hours	3,16	3	0,691	0,478	1	4
Flights longer than 12 hours	3,53	4	0,63	0,397	2	4

Table 9 Descriptive statistics: 5 Flight scheduling

	Mean	Median	Std. Deviation	Variance	Minimum	Maximum
Multi-leg Europe	2,41	2	1,059	1,122	1	4
End late, start early	3,37	4	0,86	0,739	1	4
ICA Night flight	3,40	4	0,697	0,486	1	4
ICA day flight	2,42	2	0,787	0,619	1	4
ICA with stop-over	3,68	4	0,519	0,269	2	4
ICA with shuttle	2,72	3	0,832	0,692	1	4

Table 10 Word count: 5 Flight scheduling

Comment	Word count	City	Word count
24h layover / 3 day trip	50	Los Angeles	33
+5h time difference	13	San Francisco	17
Night flights	12	Vancouver	11
BIP Europe	8	Beijing	6
Airbus without beds	6	New York	5
Calling	5	Bangkok	4
Short ICA, no bedrest	4	Bogota/Cartagena	4
Arrival in the night	3	Paramaribo	4
Home rest too short	3	America	3
I like short layovers	2	Japan	3
Busy flight	2	Kuwait	3
2x sign off late	1	Nador	3
Shuttle on route (24h)	1	*below 3 is cut off	
Long drive to hotel	1		

Table 11 Descriptive statistics: 6 Crew planning

	Mean	Median	Std. Deviation	Variance	Minimum	Maximum
Age	1,85	2	0,937	0,879	1	4
Cultural background	1,25	1	0,504	0,254	1	3
Work ethics	2,44	2	0,858	0,737	1	4
Decrease of 1 crewmember	3,04	3	0,966	0,933	1	4

Table 12 Descriptive statistics: 7 Working conditions

	Mean	Std. Deviation	Variance	Minimum	Maximum
Rest facilities	3,63	,618	,382	1	4
Tem/noice/air	3,42	,676	,457	2	4
Lighting	2,61	,917	,841	1	4
Having WIFI	1,38	,812	,660	1	4
Galley config.	2,52	1,008	1,016	1	4
Work pressure	2,66	,910	,827	1	4
Interruptions	2,30	,919	,845	1	4
Repeating nature	1,62	,761	,579	1	4
Quality of food	2,52	1,008	1,016	1	4
Mental load	2,28	,851	,725	1	4
Hotel quality	3,27	,847	,717	1	4
Social pressure	1,95	,900	,811	1	4

Table 13 word count: 8 Destinations

Destination	Word count	Destination	Word count
Los Angeles	45	Edmonton	5
San Francisco	29	Kuala lumpur	5
Vancouver	24	Europe	5
Buenos Aires	14	Entebbe	4
Cartagena	12	Houston	4
Tokyo	12	Las Vegas	4
Bangkok	10	Mexico City	4
Calgary	10	Port of Spain	4
Seoul	10	Middle-east	4
New York	9	Delhi	3
Singapore	9	Hongkong	3
Quito	7	Lima	3
Japan	7	Osaka	3
Asia	7	Shanghai	3
Narita	6	Taipei	3
Beijing	6	China	3
USA	6	Far east	3

South-America	6	*below 3 is cut off	
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Interview transcriptions

Interview 1

1. Does the direction you fly in affect your work performance or fatigue?

You mean from east or to west? Yes I think so anyway. I think in terms of fatigue, I suffer more when flying west. Because then you're actually over your limits in terms of pulling through anyway. You go into Dutch time at night. Dutch time you're walking around at 4 a.m. whereas in America it's only 4 p.m.. You do wake up on Dutch time. So you wake up at 4am in America. So you also actually sleep more restlessly and shorter. In Asia, you often sleep through the night but you go to bed at Dutch time, reasonably on time, and you do have to get out of bed in the afternoon, but that's Dutch time as well. So I do have better sleeping hours.

2. Does the time zone affect your work performance or fatigue?

I never really paid direct attention to it. But yes actually I do. I usually have a harder time coming from America than from Asia. There is also a big difference whether I have 5 or 9 hours time difference. Vancouver, San Francisco, LA, has 9 hours time difference and then sometimes you only have a 24-hour stop. That's almost killing. And so is new York. Although here again the difference is that you can rest a bit longer on board, especially on longer flights, because yes the more time difference the longer the flight is. And the shorter the flight is like new York, you don't really have time to rest on board either. So you fly at night, you've already had a bit of a broken night for this, and then you don't sleep on board either and then you have to get into a car afterwards which is quite dangerous. So I live in Naaldwijk so then I have that I'm driving from Schiphol to den haag and I thought, where is leiden anyway?

3. Does your work schedule affect your work performance or fatigue?

Sure, recently I started doing Europe. I just became a purser. That's why I have a bit of a cold now, because the tension has come out from the courses. Definitely though, when I flew Ika alone especially, when I was 2-bander, I really had to be a bit careful not to fly back and forth all the time. So not then one week west and the other week east. Because if you do that you get a bit woozy, also with the service. You end up in a kind of cloud in your head.

➤ And KLM doesn't take that into account? That you fly back and forth

So yeah that's the downside, of course you get to make your own rosters a bit. And no KLM doesn't take that into account that you can just do that. Of course it would be wiser if east Africa west, especially if you fly 100%, no they don't take that into account, that choice is up to you whether you pay attention to that.

4. Does the type of flight (europe/intercontinental) affect your work performance or fatigue?

N.A.

5. Do your fellow colleagues affect your work performance or fatigue? (age, culture, background, etc.)

The older you get, the harder it is to recover from fatigue. I was 25 when I started. And am now 22 years on. When I was 25 and had just started, if I came home or boarded. Everything could be done everything was fine, hop on and on again. And now I really do notice that I need my rest more than anything else. And there are also fewer of us than when I started. So it's even harder to recover completely before the next flight.

➤ And the culture/background of your fellow colleagues?

Whether I notice any difference? Actually just not. I just find that, that does make it easier sort of thing. Not really culture maybe age. Of course, we are also very used to dealing with it, something that maybe has become normal for us. I wouldn't really know if it's more of a culture thing or a mindset and age thing. Yes, I certainly can't stand it, I think it's typically Westland, when people cut corners. I was always brought up with hard work. Keep going and don't bullshit but clean up. And yes, someone from Amsterdam, for example, is a notorious complainer to me. If you generalise for a moment. But they don't do shit. That's definitely something I can get annoyed about. But no that's not very specifically culture. Neither is age, more of gosh if I were that fresh and fruity. Although I have to say again, when I think further, but then again that might be culture. That you find the younger generation tired easily. Hey where does that come from. But that is more because of everything that happens around them with the stimuli they receive and with which they have to keep up. They do focus differently from other generations. And that doesn't directly affect service.

6. Do aircraft conditions affect your work performance or fatigue? (light, temperature, OCR etc.)

Oh yes definitely. Yes we have different aircraft like the airbus. I really have them all now. Definitely, you have different ocr's and one is so small and that makes you stuffy. I get really broken back from that too. By default, I also write a trip-report that my back hurts on the 787. And that's really the case, it's very low, your body doesn't come out any better. And then on the airbus you sit folded in a chair. That's supposed to be high comfort. I still lost that comfort part. But that's really not comfortable at all. You don't really come out of that fresher than you went in either. But well. It's a seat that sits by the door on the airbus. Those can be pushed out below. They are quite old. Those can be pushed out a little bit underneath. There will then be a footstool underneath that is not like that (horizontal) but then so slanted. So that slide. That's not comfortable. They call it high comfort but that comfort is really lost. High irritating. It certainly affects your service, you just can't take as much. Especially from passengers, you just do something quickly. So you could say it affects your work.

7. Does KLM's current management or policies affect your work performance or fatigue?

Yes think so. Anyway changes from there being fewer people on board. You really are on non-stop. Imagine you are off, then you can sleep so you can go out, but if you are on, then sometimes you just have fewer people on board. And if something happens then yes I do see real danger in that. Really only one thing can happen and a second thing, that means you have to pull people or away because you just don't have enough puppets on board. You don't have extra personnel, really a minimum what you need you have on board. And that makes me think, ooh, should we have taken off that many people? Because on a lot of flights, they sometimes took out two. And wouldn't that have been better to have 1. And free time has also really changed in recent years. It's really minimal free time actually. Maximum what's allowed, minimum what you get. And in terms of recovery, that's really not enough sometimes. They should also take a better look at the type of flights. For instance, I find a New York heavier than a Singapore. Singapore is 2x longer flights, but gives 3x more time off. While you also sleep 3 hours on board. So have rest. Time difference I find is the same there, but I find it less intense than new York where I have 6 hours time difference. Have to fly 6 hours, have 24 hours of rest. Really come home like that and only have 3 days off to recover. I do find that spicy. An akra is also a 3 to 2 so then no time difference that is quite spicy. Then I think, oh, after 2 days you're still holding your breath, and you can't blow it out because you have to go again. Then I think, gosh, couldn't they divide that better? Look at what is really physically more taxing that should be included in your leave. Or your rest on the route.

8. Do you often suffer from physical fatigue? (during or after the flight)

Oh yes, definitely. We sometimes write trip reports about this, which is then called a vsr. A voluntary safety report. And then you can make a report about fatigue. I even had one time, that was so bad, on board, I was so tired, I was writing this report, and then I fell asleep while writing it. I was actually up. I had to function at that time, but I was devastated. Also due to delays. Late on schedule. That's what they call an STD, a captain's decision, who then has to determine that you're going over your legal hours. On certain flights, you can go over your legal 2 or 3 hours to catch a flight, but that often means that you have to work for 1. Bang on time and 2. You have a shorter rest period where you arrive, because you miss those few hours that you are already delayed. But you do go back the same time. That would be something, you do have to look at it carefully and weigh up what effect it could have on fatigue, on the body.

➤ And the captain alone makes a decision on that?

He has to officially check with everyone if they are OK with that and you may indicate there I already know I am not fit to go and do that. But you do that before you hang around for another 6 or 10 hours on the plane. So usually you don't actually know at that point if then, often 5 hours before that you're already awake and then you still have to fly. And that you are then busy and then think ooh I shouldn't have gone after all. That's quite a difficult decision to make. But it's okay to make that one and step away from I can't do it.

9. As a result, do you ever make mistakes or forget anything (due to fatigue)?

Sure. Yes very often I do forget things. Very simple things like bringing a cushion to a passenger. I'll do that in a minute. Then my head is not so focused, then I walk away, I get distracted and then it's done. Yes you just forget little things. Often a service element that I forget to come back to, though. In terms of danger; forgetting to arm a slide once. That halfway through the flight you then look like this, oh wait I think it should have been in the fitting and not on the door because if we had to make an emergency landing then the slide wouldn't go out. Eventually fixed of course. A colleague checks that but so he had also forgotten. So 2 men are actually standing there making a mistake due to probably fatigue.

➤ Are there enough signals to remind you if you forget something from flight safety

Yes actually you do you always have a check up from a colleague. On Europe, if you have the slide armed, then you don't have the trigger from in front also in the cockpit, they get a notification of that. That's all manual, there's no electronics attached to that. On Ika, you do have that. If it does or doesn't do that they see before it, a green light or orange light. That door is done, that door is not done. Then you have an extra check, which you don't have on Europa.

10. Do you ever get sleepy during flights?

N.A.

11. Do you sometimes have difficulty performing flight procedures due to fatigue?

Yes definitely. Could also be because I'm a bit chaotic myself. But I still have to do that. This week I also had the feeling that I am very tired and I am not completely fit. I forget to pass on a command. Then you get another call saying, 'am I missing something? Shouldn't I get something? You always get triggered by something external. But internally I really didn't have it in my head at all. Being tired does make me focus harder on what I normally have to do.

12. Do you ever suffer from mental fatigue at work (during or after the flight)?

N.A.

13. Are there ever situations when you cannot or do not want to do something because of this fatigue?

I think you can do anything. But whether it then goes all the way as it should is then the question. And not wanting to do, there are so many things I don't want to do.

➤ For example, that you think of yes then they just wait a bit longer on that cushion. Or then I start serving drinks 10 min later

Yes I can have that sometimes.

14. Do you ever have trouble thinking clearly, due to fatigue?

N.A.

15. Do you feel you have enough rest time on flights? Is there any difference in feeling enough rest time between long-haul and short-haul flights?

Just already explained a bit of Singapore I really like those 48 hours on the itinerary but back home, I love having a week off but I don't find it commensurate with the short haul flights like New York, Akra etc. Montreal where after 3 days I'm really beat and still have to go back to work. No I don't like the ratio.

➤ And during flights?

During flights, I definitely notice that even on the return flight from New York then it's really survival towards the end.

➤ Because on New York, you don't get any rest during the flight?

What is left you get to rest, but sometimes that is only 15 minutes and then you are really lucky. Sometimes you just don't have time for it because you've been a bit busier. The first service already takes almost 3 hours and the last 1.5 hours. Do the math on a 6-hour flight you keep 1.5 hours. And divide that by 2 and there should be 15 min in between and after as well. Then you are left with half an hour per person to sit for a while. That's not much. And working 6 hours is not much in principle, but of course you have to remember that it's in the night, somewhere around 2 a.m. Dutch time, and then not coming home until 8 a.m.

16. During your break, can you unwind properly?

I can do that reasonably well. I actually sleep anywhere. That is my advantage. Except on the Airbus because there you sit in the gally, you hear all the noises, when the passengers come to chat, yes that's not really convenient then. There is a thin curtain in between, which is not really soundproofing. And especially if you sit near door 13, then you also sit near the toilet and near the family row where sometimes babies sit, that's really great. I'm glad I became a purser though because I never sit there now. As a purser you can always sit near door 12. Typical KLM, all those fixed seats.

17. How do you experience having wifi on board? Does it affect your fatigue or rest?

Good, very good. Yes I think. That's a really mean one. Yes that affects your rest. You go on the phone for a while anyway because that's what's allowed. After all, you are not officially allowed on board during other times, only during your rest. What a good one. Yes that definitely has an impact. You go on your phone anyway, especially if something is going on at home that is not so nice. Then it just really does get into your head. Even fun things you're going to answer anyway, still take a look. You're going to be busy with that. Yes you probably have more information there about how much influence the phone has anyway before bedtime. Is obviously just not good, gives too many stimuli. Before your brain goes into rest mode I think you are 15 minutes to an hour away and then your rest is almost over.

18. Do passengers affect your mental or physical fatigue?

Yes definitely. Do sometimes have a flight to curaçao, sorry to say that's all Dutch, but that's just difficult people, let me put it this way. That sucks so much energy. They want everything, they have to do everything, they know everything and that is just very intense. And in Asia they are such quiet people, never show the back of their tongue. That doesn't really bother you. You do notice that difference. America and New York are really high-maintenance people, not always annoying but high-maintenance. You definitely notice that. You just have to work harder. That's not bad, but mentally constantly doing things again. Just more focus. Which I also like but not always.

19. Do you have a 2nd or additional source of income?

No

20. How is your sleep quality? Do you sleep better or worse at home than in hotels?

Same. The quality could be better. I actually sleep 5/6 hours then I'm often awake. Still extremely tired and then I hope, if I still have time after an hour, to turn over. I often manage to do that. But to say I always wake up fresh and fruity, no. I wouldn't even know what that feels like.

21. Does the hotel/country you stay in affect the rest you get?

Yes definitely the hotel. For example curaçao has those curtains. For me, it really has to be dark. Because sometimes you also need to sleep during the day. I want to sleep for 2/3 hours before a flight if I have a long flight. Then I often go to my room during the day. And if the room can't be dark then. That definitely affects, then I can't actually sleep. And a curaçao if then really under the curtains the sun shines. Then I barricade that with suitcase chairs. That definitely has an influence. Also whether your hotel is soundproof. That you don't hear doors rattling in the corridor, children running. Yes definitely has an influence. And the mattress, pillow, is it comfortable, too high, too hard. That's really important to facilitate well. Do they do a reasonable job. That's sometimes tricky.

➤ And the country you are in, does that also have an impact?

Yes sure. The more stimuli, the harder it becomes to say no to something. So I also notice this in cities in America, when everyone always has to shop. So yes some shop till the end and just barely make it to their calling. That they are the foot across the threshold in their room. Those are triggers that can compromise your peace and quiet, though. But that is something you have to look for in yourself. And taking responsibility yourself. Is that then the company's fault, no, but it should perhaps be better indicated. It's not for nothing that you're there to do some nice shopping. In Bangkok, you have to go till 5/6 every day while 3 o'clock is also a nice time. Yes those are really things you have to learn too, they have become stricter on that. When we started flying, there was really less enforcement on excessive behaviour. Now they do look at that more. Alcohol consumption has been tightened up a lot, and people started challenging each other about whether it is useful to drink a 7° beer when you are only allowed 4. People do challenge each other more, but not always. The downside is that people start doing it secretly. Which makes it harder to control. They are still human beings, so it is difficult to give it a cause.

22. Do you find your job physically or mentally demanding? If so, how do you experience it?

That you are always tired, always living in a cloud. I noticed that especially in corona time when I spent a few months at home myself. When I started flying again, it was only one flight a month. And then I did notice that a kind of fog cleared up in my head and my body was also much better. After that, everything went back to normal, and now I do notice what it does to your body. The fatigue, an ailment this, eczema there. Physical complaints like that. All those little things that are negligible though. I almost didn't have that in the corona year. And then you notice how much flying does to your body. Also the working environment itself. Some galleys are set up in such a way that it is also physically taxing on your body. And that in turn contributes to being more tired, everything is physically taxing, also costs energy. Sometimes there are also things that I think, ow, the more often you have that load, the less energy you have.

➤ Which plane has a galley that you find more taxing?

787, which is really the most taxing galley

➤ What's different about that?

The rooms are too small. Really very small. And the positioning of certain trolleys in that corridor, so you can never pull the trolley out straight because otherwise it will already hit the wall of the corridor. So you have to pull the trolley out at an angle. Just the movement at an angle when you stand, you already feel your back doing something. Then you have to pull it with weight, and they never go out completely smoothly, so you have to pull extra. That kind of load and above your power are the passenger trolleys. You have to pull out a drawer above your head and there are heavy cups in there, for example. That's just not good, not well built. You can't do every movement very consciously. Sometimes you don't even have time for that. You actually have to do that, you have to protect yourself in that. Sometimes the space is also just not there to do the actions correctly.

23. Are there any other things you would like to say about fatigue due to or during your job?

No

24. Do you ever have sleep deprivation due to work demands?

Yes always. Skipping nights no one does for fun.

25. How often do you experience and disrupted sleep pattern due to working in shifts?

Weekly. With Europe, it's less so. You have pretty normal sleep times. You do sometimes have 2x late reports and then once the alarm clock at 3:00. But you can have some more normal nights.

26. Have you ever suffered from sleep disorders due to work-related stress or anxiety?

N.A.

27. Have you ever used sleeping pills to deal with fatigue?

3 nights of bad sleep then I sometimes want to take a sleeping pill. But if that happens once a month, that's a lot.

28. Have you ever shared fatigue-related concerns with a medical professional?

Yes, I have talked to the GP about it. Surely that is then often quickly written off to your profession.

29. What changes would you suggest to improve fatigue management in the workplace?

That you look more with personal aspects and the physical aspects what a flight does to you, how much leave that should generate. Comparing those short flights, IKA, with long-haul. Of yes is that ratio in terms of load right? And where should or shouldn't an extra person be added. Especially on the short flights, you have to work so fast and through. You have so little rest on board because there are fewer of

you, so you are working longer. And on long-haul flights you do have that time to work long hours because we have enough time in between to have a good rest. So we should also look at the fact that on certain flights that are shorter than so many hours, you have to add a person.

➤ And how do you think these things affect customer service

I think especially on return flights where fatigue kicks in harder than on the outward flight that customer service, then people are more likely to cut corners, so you do just a little less. This is actually proven in the reviews. They do these tests of how a flight is rated on both outward and return flights. And almost all return flights are rated worse. I think that's a very big factor why a flight is rated worse. The fatigue.

30. How would you rate current fatigue management practices in your workplace?

Lean 7. They are working on it and they really do care about fatigue, but it costs money. It's still a commercial business. But on the other hand, I think, and briefly, if you stretch it out over all the different facets, I think you can generate more money if you invest in that. Because you get happier people again, more customers because of that, people get less sick. We have a lot of fatigue complaints in the sector. As a result, people are sitting at home sick, even for long periods of time. Not just a week at home, your schedule flips right out. Then people go on being sick for longer. That's another thing, that your schedule changes less. That if you're sick once, if you're tired anyway, it all costs money. I think commercially they need to look at that better. That it really can be a profit. That's my opinion.

Interview 2:

1. Does the direction you fly in affect your work performance?
Being an evening person, I prefer to fly west but the destination does not affect my work performance or fatigue.
2. Does the time zone involved on your work performance?
With a big time difference, I adjust quite easily, especially to the west. To the east, I sometimes find it difficult to go to sleep after arriving because you arrive in the morning, the moment the alarm clock rings after that is sometimes inconvenient.
3. Does your work schedule affect your work performance or fatigue?
I have been flying full-time for 30 years and have rarely felt huge pressure from the work schedule. Getting up 5 mornings at 4am during a Europa Bip builds up fatigue but then sometimes I also went to sleep at 6pm.
4. Does the type of flight (Europe/intercontinental) affect your work performance or fatigue?
It's a matter of setting yourself up for the flight to come and adapting to it, the lesser workload on intercontinental allows you to distribute your energy better.
5. Do your fellow colleagues affect your work performance or fatigue? (age, culture, background, etc.)
I have never experienced colleagues influencing my work performance or fatigue except colleagues who demand a lot of attention which takes a lot of energy. To protect myself, I set limits on the influence these colleagues have on me.
6. Do aircraft conditions affect your work performance or fatigue? (light, temperature, OCR etc.)
Since I still have the Airbus without ocr in my package, I do experience these flights as heavier, it is a mental issue that there is a difference between resting in a bed or on a high comfort seat.
7. Does KLM's current management or policies affect your work performance or fatigue?
I am convinced that if you follow the current policy, with today's work and rest times and use them sensibly and responsibly, my work is perfectly fine.
8. Do you often suffer from physical fatigue? (during or after the flight)
No, rarely suffer from physical fatigue, the other day I did spend 22 hours on my heels to Cartagena via Bogota, then I do have tired hoofs but that recovers quickly.
9. As a result, do you ever make mistakes or forget anything (due to fatigue)?
In my head, I go down my checklist even after a long and tired flight so rarely do I make a mistake. That checklist is relevant to avoid mistakes though I think.
10. Do you ever feel sleepy during flights?
On night flights alone in the galley, yawning can sometimes strike, but you can learn to deal with that too by doing something distracting then. Through years of experience, I have found a mode in this.
11. Do you sometimes have difficulty performing flight procedures due to fatigue?
With me, very quiet flights are more tiring than flights with a bit of commotion, distraction is best and I go well on adrenaline.
12. Do you ever suffer from mental fatigue at work (during or after the flight)?
I don't easily experience meta fatigue either, perhaps also because of my position (senior purser) I feel a certain responsibility towards my colleagues and passengers to stay alert which comes easily to me.
13. Are there ever situations when you cannot or do not want to do something because of this fatigue?
As just mentioned, this does not bother me easily; I also find it a challenge to motivate colleagues to do something when I notice that they are not that committed due to fatigue, for instance. By doing something together, the will soon returns.
14. Do you ever have trouble thinking clearly, due to fatigue?
As I mentioned earlier, I go nice on adrenaline, it seems like it makes me think more clearly about the problem to be solved and actively pursue it.
15. Do you feel you have enough rest time on flights? Is there any difference in feeling enough rest time between long-haul and short-haul flights?
I think the current work and rest time policy is fine, monitoring it is essential though so colleagues can perform their work performance properly. On long flights on the Airbus without ocr, I do find it difficult to lie/sit on the rest seat for long periods.
16. During your break, can you unwind properly?

I almost always sleep during my rest, in the ocr and on a chair, if I am not tired enough to sleep, I also rest by reading a bit behind the curtain.

17. How do you experience having wifi on board? Does it affect your fatigue or rest?
I never use WiFi on board, though I see colleagues using it.
18. Do passengers affect your mental or physical fatigue?
Some passengers demand a lot of attention to the detriment of those who do not. I try to guard my limits well and distribute my attention as fairly as possible.
19. Do you have a 2nd or additional source of income?
No, I have been flying full-time for 30 years
20. How is your sleep quality? Do you sleep better or worse at home than in hotels?
I am a good sleeper, if I have to get up early at home I sleep more restlessly than on the route, there I am a relaxed sleeper because they won't leave without me anyway, the pressure of responsibility is less.
21. Does the hotel/country you stay in affect the rest you get? No, I always sleep well in hotels, it has to be dark well, I wake up from rooms that are too bright or curtains that don't close properly.
22. Do you find your job physically or mentally demanding? If so, how do you experience it?
I love my work incredibly and do not experience it as hard, neither physically nor mentally.
23. Are there any other things you would like to say about fatigue due to or during your job?
Everyone has to find their own mode in this particular job to deal with fatigue. Skipping nights and staying in time zones is still special, it works differently for everyone.
24. Do you ever have sleep deprivation due to work demands?
No, never experienced.
25. How often do you experience and disrupted sleep pattern due to working in shifts?
I am an easy sleeper so it doesn't bother me much. Not even when I get to sleep the first shift.
26. Have you ever suffered from sleep disturbances due to work-related stress or anxiety?
I have exam anxiety so during my PhD tracks I was nervous and slept restlessly but not during my work.
27. Have you ever used sleeping pills to cope with fatigue?
Never swallowed before.
28. Have you ever shared fatigue-related concerns with a medical professional?
Never experienced either, so not shared.
29. What changes would you suggest to improve fatigue management in the work environment?
Equipping the new intercontinental aircraft all with an ocr, mentally it does something to you when you know beforehand that horizontal rest can be offered.
30. How would you rate current fatigue management practices in your workplace?
Again, I think the current policy works fine for me, it also remains work you choose to do and it has to suit you, it's just how you deal with it.....

Interview 3

1

Yes, absolutely. Not on my work performance, but on my fatigue. I am much better on flights to the west than on flights to the east. During the flight it makes no difference, at the destination itself it does. If I really listened to my body in the Far East, I would want to go to bed straight after arriving there (usually in the afternoon), but then you end up with the local night wrong there because you are awake at night. So I force myself to stay awake into the evening. That works, but I always sleep much shorter there than at home. Although this doesn't bother me much during the day, apart from an occasional moment of slump in the afternoon.

2.

Yes. Not on my work performance, but on my fatigue. Up to -6 (e.g. Toronto, Washington) I'm not bothered, but -9 (Vancouver, Los Angeles) I do feel. Same to the east: +2 in Bahrain no problem, +8 in Seoul I do feel.

3

Can. But you have a lot of influence on that yourself, especially with KLM. For example, I make sure I don't fly everything mixed up all the time. So not to Vancouver (-9 hours) and then to Singapore (+6 hours) and then again to Houston (-7 hours), for example. Occasionally that's fine, but I make sure it doesn't happen often.

Work schedule on Europe does affect my fatigue. KLM often has Europe schedules where you start the week late, but suddenly have to get out of bed very early halfway through. I personally don't pull that off well. Flying intercontinental through the night suits me much better than being called out of bed at 3.30am on Europe for an early flight.

4

I find flying Europe more tiring. You often do several flights in a day and I find the boarding process with all that hand luggage in a cramped aircraft (the B737) very tiring. Also, they are often short flights, lots of noise in the back alley, little work space, so work is not relaxing. And often an aircraft comes in late from the previous flight, so we can start our preparations too late and then you are rushed to make up time, so we then have to start boarding again quickly (which actually never makes sense, because other departments like baggage handling etc also need their time). Then we as cabin crew have made sure that everyone has boarded quickly and

then you find yourself waiting for half an hour because we have to wait for a new departure time from air traffic control. That a few days in a row and then I'm cooked.

No, much prefer me to fly intercontinental, much more relaxed.

5

Generally not. Very rarely do I fly with a colleague who I find fatally exhausting (irritating), but it is rare that that affects my fatigue or performance.

6

Yes, absolutely. As mentioned earlier, I find the cramped space on the B737 exhausting. You only have one aisle, so if you're on a full flight with service and people want to go to the loo all the time, it's very irritating because then you have to go back to the galley with your trolley because the aisle is too narrow to let people pass.

Also, a full day flight on the B777 can be more tiring than other flights if you have busy/moving crowds (South America), as there are SO many seats rammed into that aircraft and the aisles are very narrow.

7

No. KLM did take days off from flights over the years and many KLM people are a bit resentful about that ('we've already sacrificed so much' you'll hear them say), but I think we are compensated very well in free time. When I hear how many days off some flights gave in the past, that was pretty absurd.

8

No, I don't find the work physically tiring. I exercise, watch my diet, sleep well at home, so in terms of fitness, I can easily handle this work.

9

I don't make mistakes, but sometimes I catch myself thinking about something during the flight and then realise a little later that it made no sense or didn't make sense. Or that you ask something to a colleague out of interest and when you hear the answer you realise you have asked that before, because you recognise the answer.

10

Yes, especially on early Europe flights. If you then sit in the galley after service, I do get a cave-in. If, for example, you fly Athens-Amsterdam at 06.00 local time (05.00 NL time) and finish the service pretty quickly and then have 1.45h to fly and all the passengers are asleep, you have nothing to do, then I do have a tough moment.

Sometimes also on a very long intercontinental night flight, where you are allowed to rest for 3 hours or more. You then have to agree with your colleague who is going to rest first and who is going to rest second (after all, half the crew must be 'up'). Then, when all the passengers are asleep and there is nothing to do and you get tired, it can be tough sometimes.

11

No.

12

Yes. On a very full flight with busy passengers (e.g. to South America on the B777-300) where there are constantly people standing in the aisle, coming to your galley to get drinks, you have to keep an eye on people to make sure they don't drink too much alcohol, sometimes you have to put the brakes on them, there are annoying children on board, people in your aura all the time, then I sometimes get mentally tired. I then also just want to go to my hotel room after arrival and not see anyone for a while.

13

Not really. But sometimes when I enter the galley from the OCR (the rest room for crew) and there are passengers who immediately want something from you, I can have a moment when I think to myself 'ok, and now let's all get out of here, I need to get started'.

14

Yes (see answer to question 9)

15

Yes, absolutely. With KLM, on intercontinental flights, you are always allowed a short 'off' time. How long that is depends on the flight duration and how much time is left between service rounds to distribute, so sometimes you have an hour (e.g. on a flight of around 6 hours) sometimes more than three hours (on flights longer than 10 hours). I never actually sleep during my rest (rarely), but purely the fact that you don't have to be available to others for a while, can close your eyes, sit in your own space for a while helps me get through the flight.

At the beginning of my flying career with Martinair, this was not the case and there you actually always had to stay awake all night. There, I also experienced forms of fatigue that I haven't experienced anywhere else in my life. Also, for example, reporting to Schiphol at 03.15 and then going up and down to the Canary Islands, that could be really killing.

On Europe at KLM, it's a different story. There, the flights are too short to rest. You often have time after service to sit in the galley, drink coffee or eat something, but you don't really have a moment to yourself then (you can't sit on your crew seat for half an hour with your eyes closed)

16

As mentioned, I never actually sleep. That is because it is always noisy on board, even with earplugs in. Especially on the A330 where you have to rest on a crew seat by a door behind a curtain. You hear sounds of colleagues in the galley, of a toilet being flushed, the hum of the airchillers (the cooling system) in the galleys, it is cold at a door and the 'high comfort seat' is far from comfortable. So sleeping does not work then, your thoughts go on, you are aware of your surroundings. Still, it makes a huge difference that you don't have to do anything for a while, don't have to have a conversation and can close your eyes.

On the B777 and B787, we do have crew beds, but I rarely sleep there either. The mattresses are uncomfortable, it is often either too cold or too hot in that room and the most irritating thing is when you feel you have to pee at some point. It is quite a hassle to get out of that cramped space, you don't want to disturb your colleagues and you have to enter the cabin to go to the toilet. When you see that you only have 35 minutes or so left before your rest is over then you just keep lying down, but actually you think about the fact that you have to pee all the time.

Then again, it's really nice to have a moment to yourself, which makes me arrive much fitter than if I didn't.

17

I make very little use of the fact that we have WiFi on board. Besides, only whatsapp is free, for real internet surfing you have to pay. Sometimes whatsapp can be handy if you forgot to send something to someone before departure, but I don't really use it during a flight. I'm not into social media anyway (I do have Facebook, but haven't used it much for years) and I don't feel the need to always be reachable. So this doesn't affect my fatigue or rest on board, when I'm flying I'm just not reachable.

18

See answer question 12.

19

I have been renting out my flat since I started living together. But I don't have a second job besides flying.

20

I definitely sleep better at home than in hotels. At home, the quality of my sleep is actually always good, unless there is something going on in my life at the time that I can mull over/something stressful. Fortunately, this does not happen often and is actually always something that lasts for a short time.

The quality of my sleep in hotels is often less than at home. This is usually due to the time difference. I also always sleep shorter on the route than at home.

21

Absolutely. So the time difference plays a role, but certainly also the comfort of the room itself. I sleep badly(er) if it's too hot in the room, have an air-conditioner that makes noise, dry air, pillows that are too flat or too high, no duvet but sheets and blankets, curtains where a lot of light passes by on the sides.

22

No. Of course you cannot escape being tired sometimes due to time difference or a busy flight, but generally I am rested and carefree. I still really enjoy flying life after 23 years of flying. Especially with KLM where you have a very luxurious request system where you have a lot of influence on your schedule and can choose yourself where you fly to and therefore how long you are off (and we have a lot of time off compared to a 'normal job'!)

23

No.

24

If by work demands you mean that the work asks too much of me then the answer is no. That's also what I find relaxing about flying: when the flight is done then the work is also done. You don't have to answer e-mails, have no deadlines or targets, etc. When I am free I am really free.

I do sometimes suffer from sleep deprivation during a Europe week when I then have to get out of bed around 3.30am three nights in a row, for example. So if that's what you mean by work demands then the answer is yes.

25

Rarely. Sometimes if I've been away from home for a long time that I can't get to sleep properly the second night at home (the first night always manages fine), but otherwise I don't suffer.

26

No.

27

No. I did once (about 10 years ago) have a period of 6 weeks in which I suddenly slept very badly. I fell asleep normally, but when I woke up, it was finished and I couldn't fall asleep again. And whether I had slept for 3 hours or 5 hours, it didn't matter, awake was awake. I fell very many hours of sleep short there. I did feel normal during the day (not tired) but worried, because I just knew how much sleep I was lacking. There was nothing going on in my life at the time that I was stressed about or anything like that, so I couldn't explain why I was suddenly sleeping so badly.

At the end, I then got some sleeping pills from my mother (which she had from the GP for her own sleep problems). I then used them about three times, but noticed little difference (according to my mother, I could sleep a whole night on those, but I still didn't sleep for more than 6 hours continuously).

As suddenly as that period started, it was over again. Never had that after that, thankfully.

28

No.

29

Don't have any ideas about it.

30

There is a reporting system where you can indicate if you find a certain flight/combination of flights too heavy. When new schedules have to be made for the change from summer to winter shifts, findings from the shop floor are taken into account where possible and some flights are adjusted (e.g. you get more days off than you should get based on the calculation formula).

I don't have personal experience with it, but I know from colleagues who have (had) sleep problems that you can do temporary medical reduced flying with your manager in the office to get over your sleep problems.

So attention is definitely paid to it from the company, I rate the practices as good. But jet lag cannot be completely avoided and you have a responsibility yourself (e.g. not having a busy second job alongside flying or too busy a social life)

31

No.

Bibliography

Aaronson, L. S., Teel, C. S., Cassmeyer, V. L., Neuberger, G. B., Pallikkathayil, L., Pierce, J. D., Press, A. N., Williams, P. D., & Wingate, A. (1999). Defining and Measuring Fatigue. *Image--the Journal of Nursing Scholarship*, 31(1), 45–50. <https://doi.org/10.1111/j.1547-5069.1999.tb00420.x>

Aschoff, J. Problems of re-restraintment of circadian rhythms: Asymmetry effect, dissociation and partition. In: Assenmacher and D. S. Farner (Eds) *Environmental Enocinology*, Springer Verlag, New York, 1975: 185-195

Bakalidou, D., Krommydas, G., Abdimioti, T., Theodorou, P., Doskas, T., & Fillopoulos, E. (2022). The Dimensionality of the Multidimensional Fatigue Inventory (MFI-20) Derived From Healthy Adults and Patient Subpopulations: A Challenge for Clinicians. *Cureus*, 14(6). <https://doi.org/10.7759/cureus.26344>

Berger, P.J., McCutcheon, L., Soust, M., Walker, A.M., & Wilkinson, M.H. (1991). Electromyographic changes in the isolated rat diaphragm during the development of fatigue. *European Journal of Applied Physiology*, 62,310- 316.

Bevans, R. (2022, November 15). Multiple Linear Regression | A Quick Guide (Examples). Scribbr. Retrieved May 22, 2023, from <https://www.scribbr.com/statistics/multiple-linear-regression/>

Bevans, R. (2022, November 17). One-way ANOVA | When and How to Use It (With Examples). Scribbr. Retrieved May 31, 2023, from <https://www.scribbr.com/statistics/one-way-anova/>

Cajochen, C., Kräuchi, K., & Wirz-Justice, A. (2003). Role of Melatonin in the Regulation of Human Circadian Rhythms and Sleep. *Journal of Neuroendocrinology*, 15(4), 432–437. <https://doi.org/10.1046/j.1365-2826.2003.00989.x>

Caldwell, J. A. (2005). Fatigue in aviation. *Travel Medicine and Infectious Disease*, 3(2), 85-96. <https://doi.org/10.1016/j.tmaid.2004.07.008>

D.F. Dinges, R.C. Graeber, M.R. Rosekind, A. Samel (1996) Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation, NASA Ames Research Center, Moffett Field, CA United States.

Gundel, A. and Wegmann, H. M. Transition between advance and delay responses to eastbound transmeridian flights, *Chronobiology Intern.*, 1989, 6: 147-156

ICAO. (2016). Doc 9966: Manual for the Oversight of Fatigue Management Approaches (2nd ed.). ICAO, Montreal.

International Civil Aviation Organization (ICAO), Annex 6 Operation of Aircraft (2010)

International Civil Aviation Organization (ICAO), Fatigue Risk Management Systems Manual for Regulators, (first ed.), C.F.R (2012)

Jackson, C. A., & Earl, L. (2006). Prevalence of fatigue among commercial pilots. *Occupational Medicine*, 56(4), 263-268. <https://doi.org/10.1093/occmed/kql021>

Klein, K.E Wegmann, H. M. Significance of circadian rhythms in aerospace operations. AGARDograph N. 247. Neuilly-Sur-Seine: NATO-AGARD, 1980

KLM. (2022). Trips overview. In myklm.klm.com.

Lee, K.A., Hicks, G., & Nino-Murcia, G. (1991). Validity and reliability of a scale to assess fatigue. *Psychiatry Research*, 36,291 -298

Lee, S., & Kim, J. K. (2018). Factors contributing to the risk of airline pilot fatigue. *Journal of Air Transport Management*, 67, 197-207. <https://doi.org/10.1016/j.jairtraman.2017.12.009>

Lin, J., Brimmer, D. J., Maloney, E. M., Nyarko, E., BeLue, R., & Reeves, W. C. (2009). Further validation of the Multidimensional Fatigue Inventory in a US adult population sample. *Population Health Metrics*, 7(1). <https://doi.org/10.1186/1478-7954-7-18>

Neville, K. J., Bisson, R. U., French, J., Boll, P. A. and Storm, W. F. Subjective fatigue of C-141 aircrew during Operation Desert Storm *Hum. Factors*, 1994, 36: 339-349.

Ream, E., & Richardson, A. (1997). Fatigue in patients with cancer and chronic obstructive airways disease: A phenomenological enquiry. *International Journal of Nursing Studies*, 34,44-53.

Reis, C., Mestre, C., & Canhão, H. (2013). Prevalence of Fatigue in a Group of Airline Pilots. *Aviation, Space, and Environmental Medicine*, 84(8), 828–833. <https://doi.org/10.3357/ase.3548.2013>

Samel, A., Wegmann, H. M., & Vejvoda, M. (1995). Jet lag and sleepiness In aircrew. *Journal of Sleep Research*, 4, 30–36. <https://doi.org/10.1111/j.1365-2869.1995.tb00223.x>

Samel, A., Wegmann, H. M., Vejvoda, M., Gundel, A., Diedrich, A., Drescher, J., Wittiber, K. and Wenzel, J. 2-crew operations-stress and fatigue during long-haul night flights. *Report for the Commission of the European Union, directorate-General for Transport, 1993 and DLR-Internal Report*, 1994b, IB 316-94-02.

Shahid, A., Wilkinson, K., Marcu, S., & Shapiro, C. M. (2011). Multidimensional Fatigue Inventory (MFI). In Springer eBooks (pp. 241–243). Springer Nature. https://doi.org/10.1007/978-1-4419-9893-4_57

SPSS Software. (n.d.). IBM. <https://www.ibm.com/spss>

Stone, A.A., Broderick, J.E., Porter, L.S., & Kaelin, A.T. (1997). The experience of rheumatoid arthritis pain and fatigue: Examining momentary reports and correlates over one week. *Arthritis Care and Research*, 10, 185-193

Sun, J. Y., & Sun, R. S. (2023). Pilot fatigue survey: A study of the mutual influence among fatigue factors in the “work” dimension. *Frontiers in Public Health*, 11. <https://doi.org/10.3389/fpubh.2023.1014503>

Two-way ANOVA Output and Interpretation in SPSS Statistics - Including Simple Main Effects | Laerd Statistics. (n.d.). <https://statistics.laerd.com/spss-tutorials/two-way-anova-using-spss-statistics-2.php>

UCLA, (n.d.). A Practical Introduction to Factor Analysis: Exploratory Factor Analysis. <https://stats.oarc.ucla.edu/spss/seminars/introduction-to-factor-analysis/a-practical-introduction-to-factor-analysis/>

Uma Sekaran, Roger Bougie (2003). *Research Methods For Business*. https://books.google.pt/books?hl=en&lr=&id=Ko6bCgAAQBAJ&oi=fnd&pg=PA19&ots=2C5OY1LXqR&sig=q2VKuGsaK57S3-7m87S1f0Vbuik&redir_esc=y#v=onepage&q&f=false

van den Berg MJ (2016) Fatigue management developments for cabin crew, FMAS 2016. International Civil Aviation Organisation, Montréal, Canada, Powerpoint presentation, 1–21, https://www.icao.int/Meetings/fmas/Documents/Presentations/Margo%20VandenBerg_FM%20Developments%20for%20Cabin%20Crew.pdf.

van den Berg MJ, Signal TL, Mulrine HM, Smith AAT, Gander PH, Serfontein W (2015) Monitoring and managing cabin crew sleep and fatigue during an ultra-long range trip. *Aerosp Med Hum Perform* 86, 705–13.

Van Den Berg, M. J., Signal, T. L., & Gander, P. H. (2020b). Fatigue risk management for cabin crew: the importance of company support and sufficient rest for work-life balance—a qualitative study. *Industrial Health*, 58(1), 2–14. <https://doi.org/10.2486/indhealth.2018-0233>

Westenberger, A., Nöhre, M., Brähler, E., Morfeld, M., & de Zwaan, M. (2022). Psychometric properties, factor structure, and German population norms of the multidimensional fatigue inventory (MFI-20). *Frontiers in Psychiatry*, 13. <https://doi.org/10.3389/fpsy.2022.1062426>

Wright Jr, K. P., Bogan, R. K., & Wyatt, J. K. (2013). Shift work and the assessment and management of shift work disorder (SWD). *Sleep Medicine Reviews*, 17(1), 41-54.

Yen, J., Hsu, C., Yang, H., & Ho, H. (2009). An investigation of fatigue issues on different flight operations. *Journal of Air Transport Management*, 15(5), 236-240.

<https://doi.org/10.1016/j.jairtraman.2009.01.001>

Zach. (2021). A Guide to Bartlett's Test of Sphericity. Statology.

[https://www.statology.org/bartletts-test-of-](https://www.statology.org/bartletts-test-of-sphericity/#:~:text=Bartlett's%20Test%20of%20Sphericity%20compares,are%20orthogonal%2C%20i.e.%20not%20correlated)

[sphericity/#:~:text=Bartlett's%20Test%20of%20Sphericity%20compares,are%20orthogonal%2C%20i.e.%20not%20correlated](https://www.statology.org/bartletts-test-of-sphericity/#:~:text=Bartlett's%20Test%20of%20Sphericity%20compares,are%20orthogonal%2C%20i.e.%20not%20correlated)