Pilot Fatigue and Safety Events: Results from Analysis of Investigation Reports

A/Prof Nektarios Karanikas

Health, Safety & Environment Discipline, School of Public Health & Social Work, Faculty of Health

PACDEFF Conference, 3-5 September 2019, Gold Coast, QLD, Australia

Presentation based on Karanikas, N. & Nederend, J. (2018). Pilot Fatigue and Safety Events: Results from Analysis of Investigation Reports, In H. Becherstorfer, J. Lasry & M. Schwarz (Eds.), Proceedings of the 33rd Conference of the European Association for Aviation Psychology: Connecting People, Organisations & Technology in Aviation (pp.390-401). Groningen, Netherlands: European Association for Aviation Psychology. ISBN: 9789081525367



Current situation

- Pilot fatigue remains a determinative parameter in aviation safety.
- (Pilot) fatigue levels have been associated with:
 - age and other individual physiological characteristics
 - length of wakefulness
 - work pressure
 - length of duty time periods
 - flight phases
 - complexity of tasks
 - level of automation
 - teamwork and resource management
 - daypart of activities





Study motivation

- Most of the fatigue-related studies in aviation are based on:
 - experiments
 - self-evaluations
- How are fatigue factors reflected in safety investigation reports?
- Are there associations of pilot characteristics and event parameters with fatigue-attributed incidents and accidents, as expected according to literature?





Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

Name	Task	Date			
Mental Demand	How mentally dema	anding was the task?			
Very Low		Very High			
Physical Demand How physically demanding was the task?					
Very Low		Very High			
Temporal Demand	How hurried or rushed was	the pace of the task?			
Very Low		Very High			
Performance	How successful were you in you were asked to do?	accomplishing what			
Perfect		Failure			
Effort How hard did you have to work to accomplish your level of performance?					
Very Low		Very High			
Frustration	How insecure, discouraged, and annoyed wereyou?	, irritated, stressed,			
Very Low		Very High			





Sample & variables



- 296 randomly selected safety investigation reports published in English by five safety authorities (318 cases).
- Dependent variable: had the event been attributed to fatigue as causal or contributing factor?
- Independent variables for the Captains and First Officers:
 - 1. Age (years)
 - 2. Flying experience (hours) in the aircraft type involved in the event and total
 - 3. Hours on duty until the event
 - 4. Duration of latest sleep before reporting for duty (hours)
 - 5. Duration of rest before reporting for duty (hours)
 - 6. Arithmetic mean (additive power), geometric mean (multiplicative relationships) and harmonic mean (varying time periods) for the variables No 1-5 above



More variables - Tests

- Independent variables for event:
 - Aircraft registration region (5 regions; identity not disclosed)
 - Daypart of occurrence (morning, afternoon, evening, night)
 - Aircraft age
 - Aircraft type (jet, propeller, rotary)
 - Type of operation (passenger, non-passenger & commercial, non-commercial)
 - Flight phase (en-route, ground, other)
- Mann-Whitney tests for numerical variables
- Chi-square/Fisher's Exact tests for nominal variables





Results – Nonsignificant associations

- Pilots' age
- Flying experience
- Duration of rest
- Duration of latest sleep
- Country of registration
- Aircraft age
- Aircraft type
- Operational type





Significant associations: Duty duration

- Longer duty times were associated more often with fatigue-attributed occurrences
- The picture was the same when considering the arithmetic, geometric and harmonic means

Variable	Fatigue case	Test results	Highest Mean Rank (Fatigue YES/NO)
Duty Duration	Captain	p = 0.000	YES
Duty Duration	First Officer	p = 0.017	YES
Duty Duration Arithmetic Mean	Event	p = 0.001	YES
Duty Duration Geometric Mean	Event	p = 0.001	YES
Duty Duration Harmonic Mean	Event	p = 0.003	YES



Significant associations: Daypart

- Safety events occurred in the night were the ones where fatigue was stated as contributing/causal factor more frequently
- Events attributed to fatigue were more frequent in the:
 - morning compared to afternoon
 - evening compared to morning and afternoon

Time of day	Event	Captain	First Officer	Event	Captain	First Officer
	Not attributed to fatigue (%)		Fatigue as contributory/causal factor (%)			
Morning (06:00-12:00)	92.6	92.6	93.5	7.4	7.4	6.5
Afternoon (12:00-18:00)	95.1	95.1	98.3	4.9	4.9	1.7
Evening (18:0-24:00)	87.3	87.3	94.0	12.7	12.7	6.0
Night (24:00-06:00)	62.5	62.5	71.4	37.5	37.5	28.6

Event (DF=3, χ^2 = 19.313, p=0.000), Captain (DF=3, χ^2 = 19.313, p=0.000), First Officer (DF=3, χ^2 = 17.988 p=0.003)

a university the real worl

Significant associations: Flight phase

'Other flight phases' category (i.e. take-off, climb, descend and landing) was associated with occurrences attributed to fatigue more frequently, followed by ground-related phases.

Flight phase	Event	Captain	First Officer	Event	Captain	First Officer
	Not attributed to fatigue (%)			Fatigue as contributory/causal factor (%)		
En-route	96.9	96.9	100.0	3.1	3.1	0.0
Ground	95.6	95.6	96.6	4.4	4.4	3.4
Other flight phases	84.0	84.0	89.7	16.0	16.0	10.3

Event (DF=3, χ² = 14.578, p=0.000), Captain (DF=3, χ² = 14.578, p=0.000), First Officer (Fisher's Exact, p=0.001)



Implications – Fatigue factors in reports

- Factors associated:
 - Time of day
 - Duty period length
- Factors not associated:
 - Sleep duration
 - Rest duration
 - Age
 - Type of operation
- Other remarks:
 - No differences across regions: similar implementation of fatigue risk management strategies (?)
 - Expected associations not found: flying experience, aircraft age and type



Limitations – Further research



 The samples of events attributed or not to fatigue were unequal (8.3% fatigue-related), yet representative of the overall frequency of fatigue-related events.

-> future research with stratified sampling

• Insufficient sample to employ statistics with layer variables (e.g., duty duration vs fatigue when controlling for flight phase or daypart)

-> future studies with larger samples to allow tests with layer variables

- The recording of fatigue as a contributory factor was entirely dependent on the investigations' quality and comprehensiveness
 - -> support investigators in the examination of fatigue as possible factor???
- Studies use, almost exclusively, arithmetic means
 - -> consider the exploitation of geometric and harmonic means



Pilot Fatigue and Safety Events: Results from Analysis of Investigation Reports

A/Prof Nektarios Karanikas

Contact details Email addresses: <u>nektarios.karanikas@qut.edu.au</u>, <u>nektkar@gmail.com</u> Work phone number: +61731385813



