Optimising Crew Scheduling to Enhance Safety Outcomes International Airline Study Results

Research project between RMIT and AGIFORS

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Overview

- Research background
- Methodology
  - Survey approach
  - Survey demographics
- Results
- Conclusions and future research

Research background

- Well-established relation between **safety risk and fatigue management** in multiple domains, resulting in relevant regulations, e.g., Civil Aviation Order (CAO) 48.1, specifying **limits** and requirements percolating to **planning / rostering / scheduling**
- Several researchers have investigated the relation of crew scheduling and fatigue (risk) management, including:
  - Caldwell (2012): Management of fatigue-related risks in aviation operational contexts: demanding flight schedules → sleep disruptions & desynchronized circadian rhythms → potential decreased alertness and performance
  - Lee & Kim (2018): Factors contributing to fatigue risk: crew scheduling one of 7 independent variables identified
  - Rudin-Brown et al. (2019): fatigue management in freight rail operations, including role of shift scheduling
- However, primary focus in crew scheduling research is on optimization techniques and scheduling performance (e.g., Kasirzadeh et al. (2017)) **but not on ways to improve scheduling outcomes relative to fatigue (risk) management**

Research background

RMIT was approached by several members of the AGIFORS (Airline Group of the International Federation of Operational Research Societies) group to examine challenges in crew scheduling / the crew supply chain. We were interested in 2 main points:

1. Does a knowledge/formal training gap exist for this operational group?
2. Is there a need for a formalised/standardised training program?

It is worth noting that there is currently no internationally standardised/required training for airlines in crew scheduling.

- We established the answers to these questions by creating and implementing a Crew Scheduling survey that asked key airline personnel (flight deck crew, cabin crew, SMEs, vendors/IT, crew schedulers, management) what were the challenges in training.
- The project obtained ethical clearance and a signed MOU.

Methodology

Survey approach:

a. Understanding the "what"
b. Establishing the general perception/views of a larger sample
c. Determining the overall trend/mood
d. Revealing "gap" for further investigation from focus groups or interviews
e. Valid method for data collection

Methodology

Focus group discussions:

a. Understanding the "why"
b. Investigating the considerations
c. Determining future research direction
d. Deliberating preliminary findings revealed in online survey

Summary of initial findings

So far, there are results suggesting:

- Operational personnel are not trained the same way or for the same length of time and they would like further formal and standardised training for their airline
- There is an effect of Flight Deck Crew believing that crewing personnel does not get sufficient Fatigue, FRM, sleep quantity/quality and circadian rhythm training compared to the other groups
- The crewing department's decisions may be influencing crew fatigue and flight safety
- A trend for certain challenging parts of the job (i.e., last minute changes)

We are also looking at:

- Which groups significantly agree that standardised training would be useful?
- Which groups want an approved training organisation?
- Which groups want an approved training organisation for FRM?
- What is the average training period for each group? Do most groups use 'on the job'?
- What is the amount of agreement on the need for recurrent training?

Survey setup

- General questions
- Crewing personnel
- Crewing management
- Flight deck crew
- Cabin crew
- Ops other than crewing
- Vendors and IT

Questions about:

- Time pressure
- Software and IT systems
- Regulatory framework
- Training frequency/length
- Conflicts
- Schedules
- Work life balance
- Financial performance
- Customers
- Environmental impact
- Sleep management and safety management

Example items for flight deck crew

Crew schedulers / controllers / trackers are well trained on relevant regulatory framework
Crew schedulers / controllers / trackers are well trained on relevant software and systems
Properly trained operators within the crew supply chain would utilize the IT systems (a large investment) much better
Crew schedulers / controllers / trackers are well trained in/aware of their influence of sleep quality/quantity on flight crew and risks
Crew schedulers / controllers / trackers are well trained regarding fatigue and fatigue risk management

Two types of scales

No	I do not take this into account when making decisions	I take this into account when making decisions, but at low priority	Yes, and I consider that in my decisions	Yes, and proper training would help our organisation in that regard	I prefer to not answer that question
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	

Survey demographics

	Gender			
	Male	*Female*	*Prefer not to say*	*Not entered*
Total sample	208	60	2	8
Crewing personnel	11	5	0	0
Crewing management	46	17	0	0
Cabin Crew	4	4	0	0
Flight Deck Crew	66	7	1	0
Operations other than Crewing	39	17	0	0
Subject Matter Expert	23	4	0	0
Vendors and IT	19	6	1	0

Survey general statistics

# respondents	353		
Completions	278		
Completion rate	**79%**		
Completion rate by group			
	# respondents	# Completions	
Crewing personnel	21	16	76%
Crewing managemer	90	63	70%
Cabin Crew	14	8	57%
Flight Deck Crew	88	74	84%
Operations other tha	65	56	86%
Subject Matter Exper	27	27	100%
Vendors and IT	40	26	65%
Blank	8	8	

Survey demographics

	Age range					
	18-25	*26-35*	*36-45*	*46-55*	*56+*	*Not entered*
Total sample	6	54	92	79	37	10
Crewing personnel	1	8	2	5	0	0
Crewing management	1	19	22	19	2	0
Cabin Crew	1	1	2	4	0	0
Flight Deck Crew	0	11	27	26	10	0
Operations other than Crewing	2	11	21	12	10	0
Subject Matter Expert	1	2	7	8	9	0
Vendors and IT	0	2	11	5	6	2

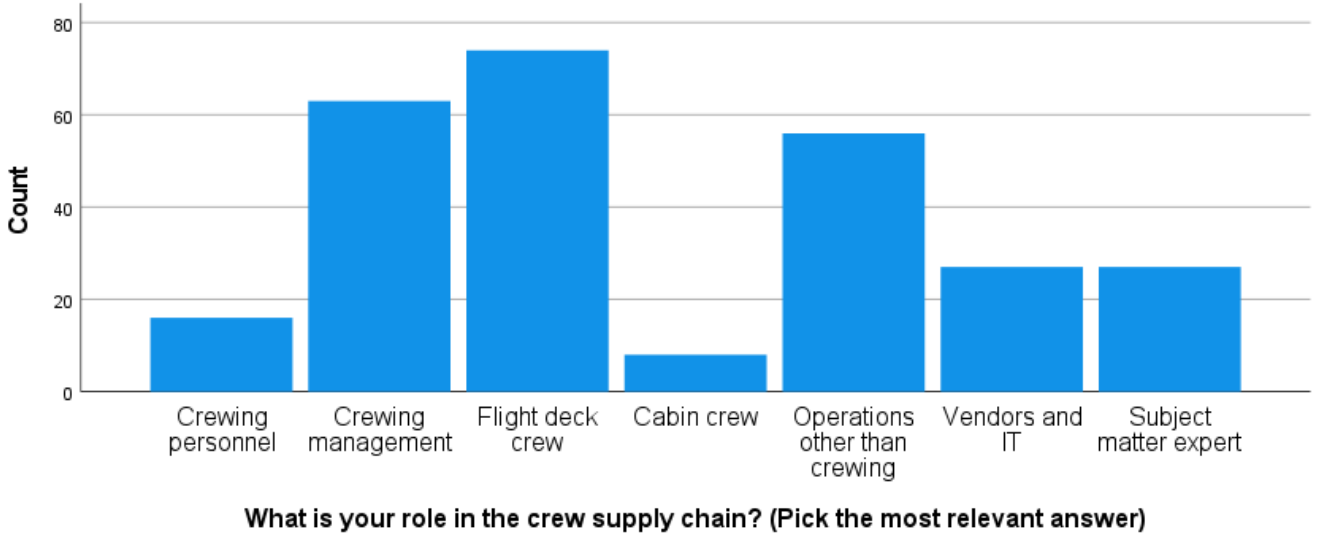
Survey demographics

	Operating mode								
	Schedule airline	*Charter airline*	*Business aviation*	*Low Cost Airline*	*Cargo Carriers*	*Military Aviation*	*Other*	*Combination*	*Not entered*
Total sample	120	5	2	17	29	0	11	94	11

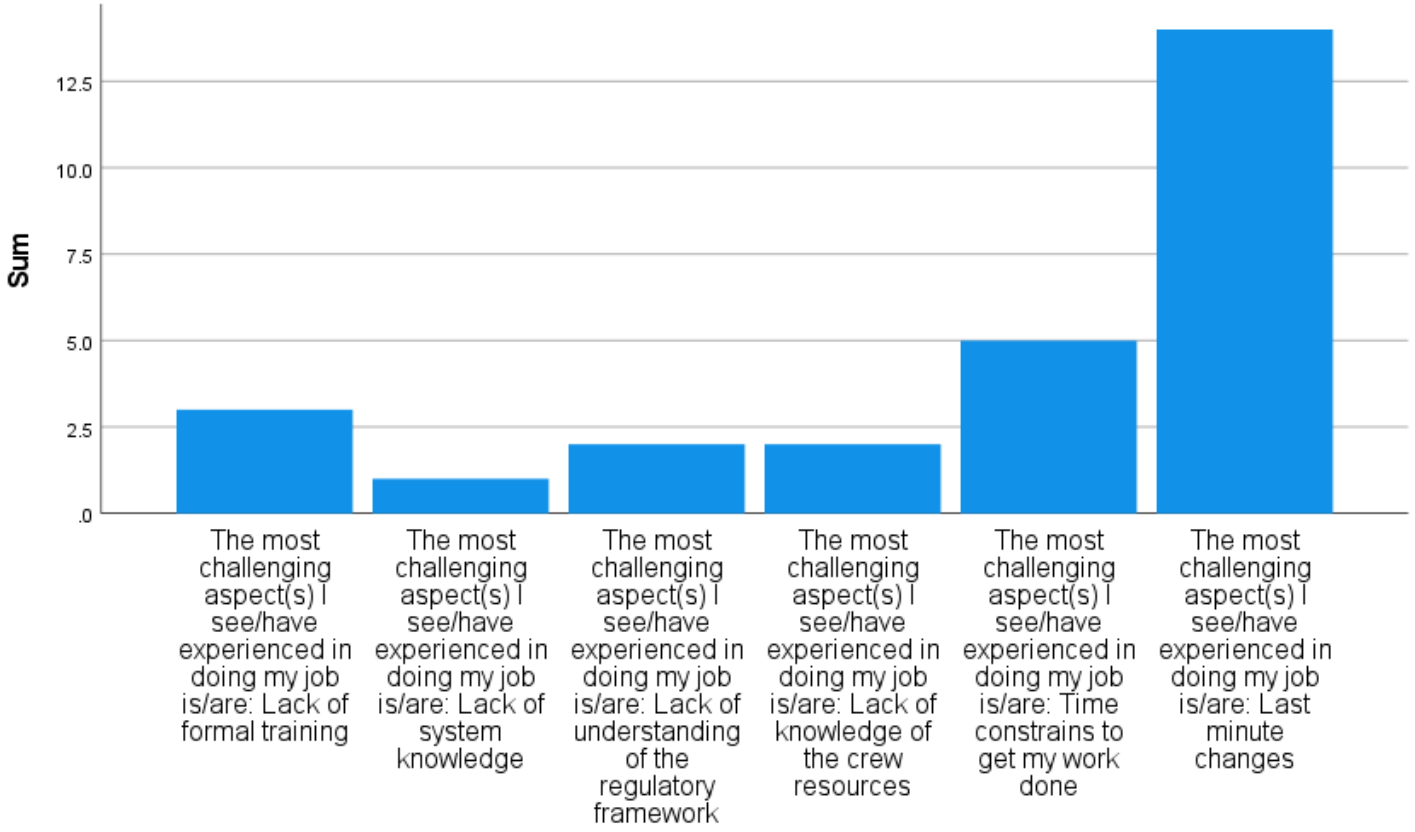
	# Crew bases						
	1	*2*	*3-5*	*6-10*	*More than 10*	*Not sure*	*Not entered*
Total sample	86	55	48	34	32	10	13
	Flight deck crew size population						
	0-100	*101-1000*	*1001-5000*	*>5000*	*Not sure*	*Not entered*	
Total sample	24	115	75	44	8	12	
	Cabin crew						
	0-100	*101-1000*	*1001-5000*	*>5000*		*Not entered*	
Total sample	47	39	77	84	15	16	

Descriptive Statistics of Interest

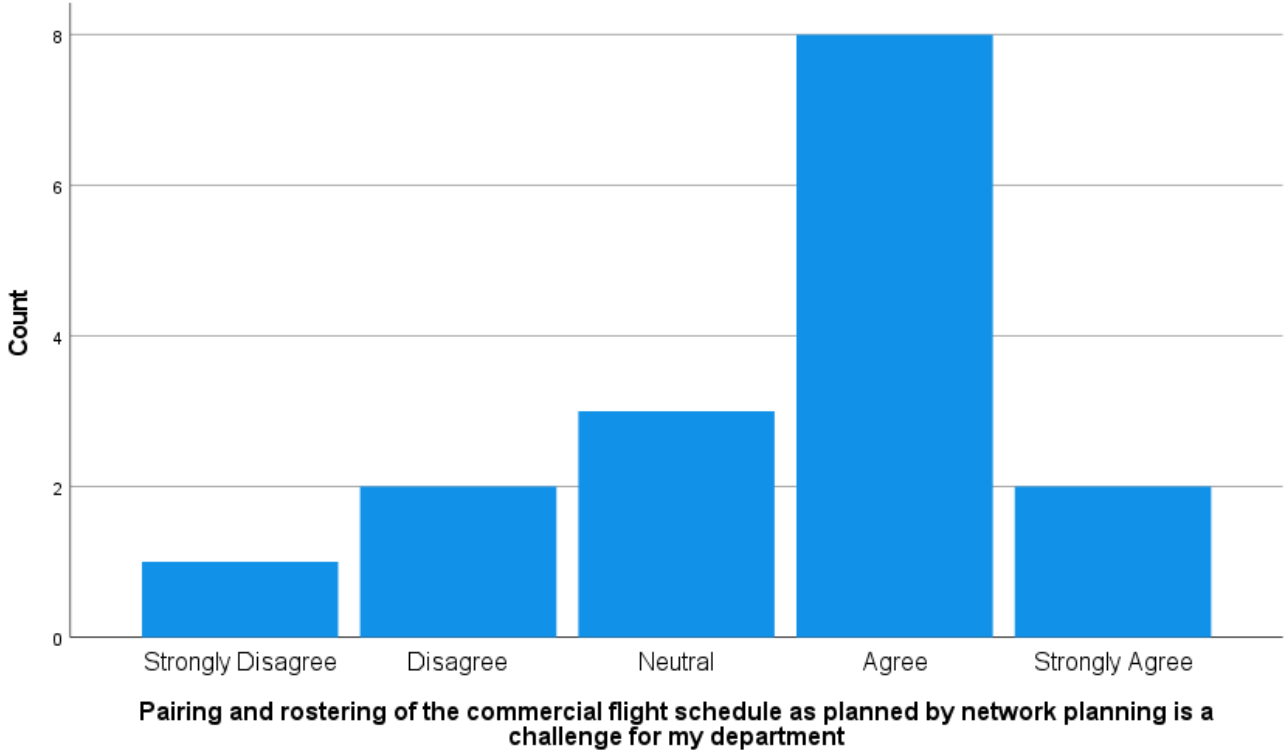
General questions



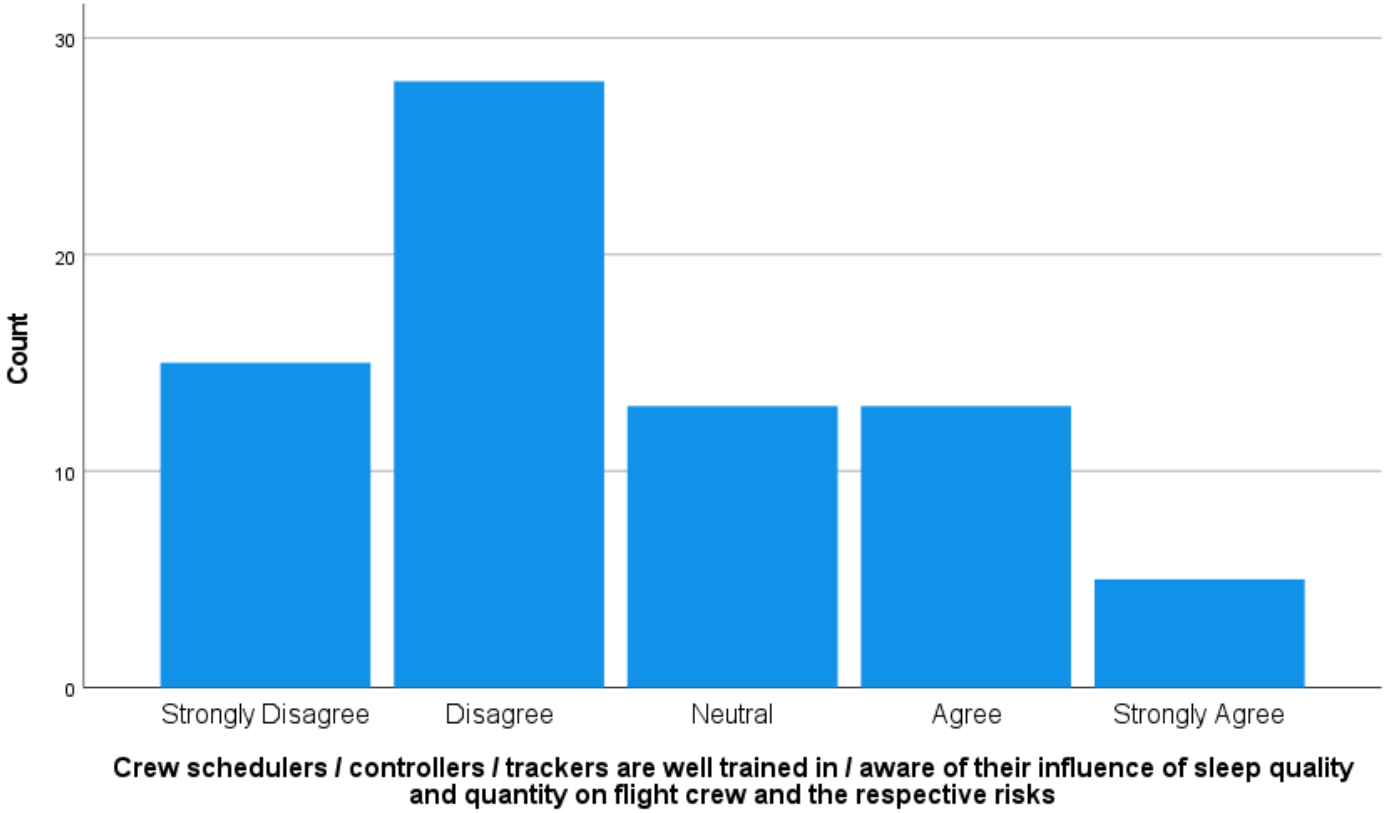
Crewing personnel



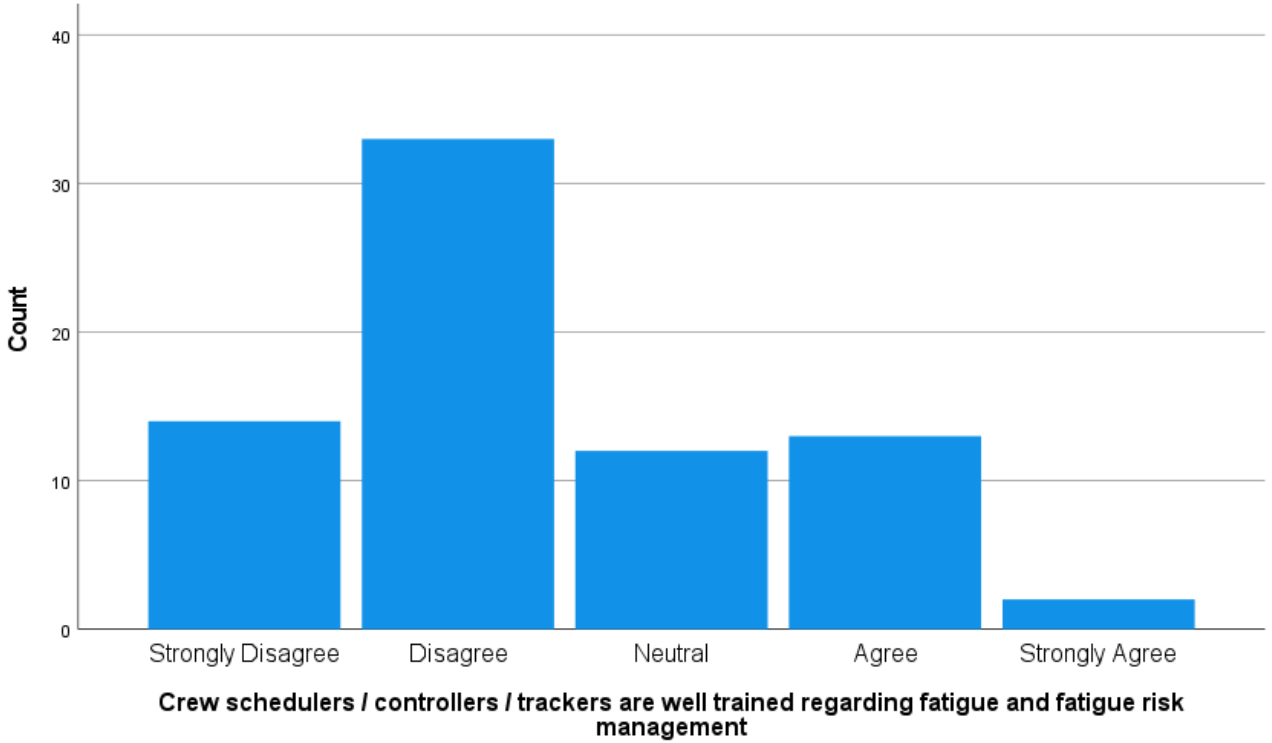
Crewing personnel



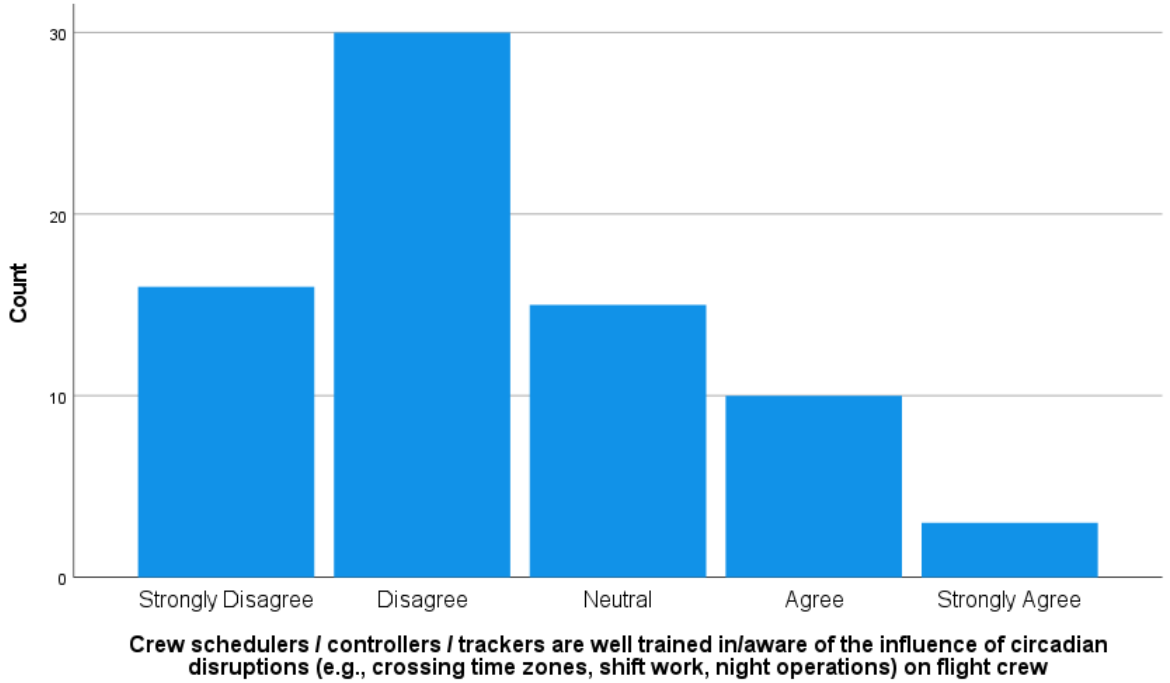
Flight deck crew



Flight deck crew



Flight deck crew



Inferential Test Results

ANOVA analysis

"Crew schedulers / controllers / trackers are well trained in / aware of their influence of sleep quality and quantity on flight crew and the respective risks"

(1 – Strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

Descriptives

Sleep_quality

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Flight deck crew	74	2.5270	1.19615	.13905	2.2499	2.8042	1.00	5.00
Cabin crew	8	2.8750	1.12599	.39810	1.9336	3.8164	1.00	4.00
Operations other than crewing	56	3.4464	.89279	.11930	3.2073	3.6855	2.00	5.00
Vendors and IT	22	3.1364	1.08213	.23071	2.6566	3.6162	1.00	5.00
Subject matter expert	26	2.9615	1.11286	.21825	2.5120	3.4110	1.00	5.00
Total	186	2.9516	1.14033	.08361	2.7867	3.1166	1.00	5.00

ANOVA

Sleep_quality

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27.852	4	6.963	5.925	<.001
Within Groups	212.713	181	1.175		
Total	240.565	185			

ANOVA analysis

"Crew schedulers / controllers / trackers are well trained regarding fatigue and fatigue risk management"

(1 – Strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

Descriptives

Fatigue_and_FRM

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Flight deck crew	74	2.4054	1.07166	.12458	2.1571	2.6537	1.00	5.00
Cabin crew	8	2.3750	1.18773	.41993	1.3820	3.3680	1.00	4.00
Operations other than crewing	56	3.3750	1.07132	.14316	3.0881	3.6619	1.00	5.00
Vendors and IT	23	3.0435	.82453	.17193	2.6869	3.4000	2.00	5.00
Subject matter expert	25	2.7600	.87939	.17588	2.3970	3.1230	1.00	4.00
Total	186	2.8226	1.09827	.08053	2.6637	2.9815	1.00	5.00

ANOVA

Fatigue_and_FRM

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.791	4	8.198	7.795	<.001
Within Groups	190.354	181	1.052		
Total	223.145	185			

ANOVA analysis

"Crew schedulers / controllers / trackers are well trained in/aware of the influence of circadian disruptions (e.g., crossing time zones, shift work, night operations) on flight crew"

(1 – Strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; 5 – strongly agree)

Descriptives

Circadian_disruptions

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Flight deck crew	74	2.3784	1.09423	.12720	2.1249	2.6319	1.00	5.00
Cabin crew	8	2.6250	1.06066	.37500	1.7383	3.5117	1.00	4.00
Operations other than crewing	56	3.3750	.96413	.12884	3.1168	3.6332	2.00	5.00
Vendors and IT	23	3.1739	.88688	.18493	2.7904	3.5574	2.00	5.00
Subject matter expert	26	2.9231	1.12865	.22135	2.4672	3.3789	1.00	5.00
Total	187	2.8610	1.11294	.08139	2.7004	3.0215	1.00	5.00

ANOVA

Circadian_disruptions

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34.829	4	8.707	8.104	<.001
Within Groups	195.556	182	1.074		
Total	230.385	186			

Independent samples t-test

"My initial training on relevant regulatory framework was provided in:"

(1 – 0-1 days; 2 – 2-5 days; 3 – 6-10 days; 4 – 10+ days)

Group Statistics

	What is your role in the crew supply chain? (Pick the most relevant answer)	N	Mean	Std. Deviation	Std. Error Mean
Initial_regulatory_training	Crewing personnel	16	2.6875	1.01448	.25362
	Crewing management	63	2.6984	1.05700	.13317

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Initial_regulatory_training	Equal variances assumed	.132	.717	-.037	77	.485	.970	-.01091	.29363	-.59560	.57378
	Equal variances not assumed			-.038	23.971	.485	.970	-.01091	.28646	-.60217	.58034

Independent samples t-test

"My initial training on the relevant crewing software was provided in:"

(1 – 0-1 days; 2 – 2-5 days; 3 – 6-10 days; 4 – 10+ days)

Group Statistics

	What is your role in the crew supply chain? (Pick the most relevant answer)	N	Mean	Std. Deviation	Std. Error Mean
Initial_crewing_software_training	Crewing personnel	16	2.5625	1.03078	.25769
	Crewing management	62	2.6774	.91927	.11675

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Initial_crewing_software_training	Equal variances assumed	.384	.538	-.435	76	.332	.665	-.11492	.26424	-.64119	.41135
	Equal variances not assumed			-.406	21.566	.344	.689	-.11492	.28291	-.70232	.47248

Independent samples t-test

"My initial training on fatigue, FRM and the impact of rostering on crew was provided in:"

(1 – 0-1 days; 2 – 2-5 days; 3 – 6-10 days; 4 – 10+ days)

Group Statistics

	What is your role in the crew supply chain? (Pick the most relevant answer)	N	Mean	Std. Deviation	Std. Error Mean
Initial_FRM_training	Crewing personnel	16	1.5000	1.09545	.27386
	Crewing management	63	1.9365	1.40130	.17655

Independent Samples Test

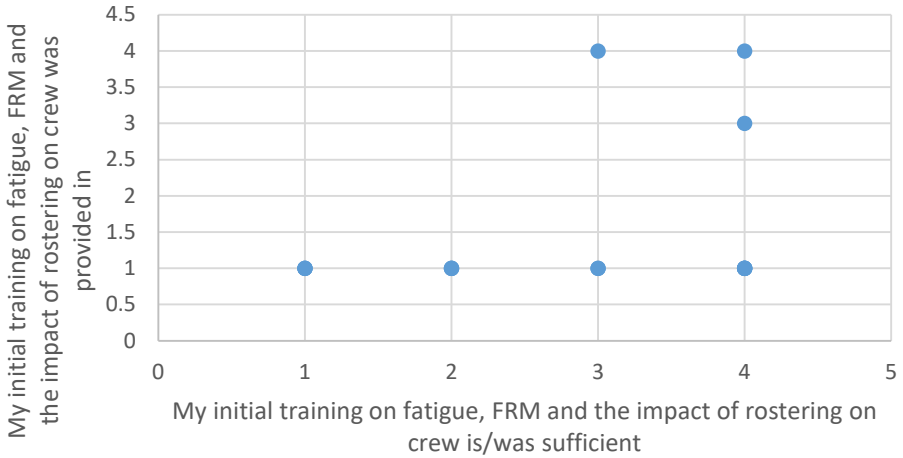
		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Initial_FRM_training	Equal variances assumed	2.027	.159	-1.157	77	.125	.251	-.43651	.37714	-1.18750	.31448
	Equal variances not assumed			-1.340	28.853	.095	.191	-.43651	.32584	-1.10306	.23005

Correlation (Spearman's rho)

"My initial training on fatigue, FRM and the impact of rostering on crew was provided in:" versus "My initial training on fatigue, FRM and the impact of rostering on crew is/was sufficient"

Correlations

			My initial training on fatigue, FRM and the impact of rostering on crew is/was sufficient	My initial training on fatigue, FRM and the impact of rostering on crew was provided in
Spearman's rho	My initial training on fatigue, FRM and the impact of rostering on crew is/was sufficient	Correlation Coefficient	1.000	.298
		Sig. (2-tailed)	.	.262
		N	16	16
	My initial training on fatigue, FRM and the impact of rostering on crew was provided in	Correlation Coefficient	.298	1.000
		Sig. (2-tailed)	.262	.
		N	16	16



Note: ordinal scales, paired observations, *but* no clear monotonic relationship

Analysis conclusions

The following can be concluded at this preliminary stage of analysis:

1) Operational personnel are not trained the same way or for the same length of time and they would like further formal and standardised training for their airline → statistically significant, fairly uniform across groups

2) There is an effect of Flight Deck Crew believing crewing personnel do not get sufficient Fatigue, FRM, sleep quantity/quality and circadian rhythm training compared to the other groups → statistically significant, major difference

3) The crewing department's decisions may be influencing crew fatigue and flight safety → needs further substantiation

4) A trend for certain challenging parts of the job (i.e., last minute changes) exists → results are indicative but require further substantiation

Future research

1. Conduct additional (inferential) analysis

2. Process focus groups responses to explore findings in additional detail.

3. Demonstrate need for international training program/inform ICAO standards.