The Effect of Commuting on Pilot Self-assessment of Stress and Performance

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Abstract

Airline-pilot commuting is one of the most unknown factors in a well-established aviation safety and fatigue risk management system (FRMS). In a National Transportation and Safety Board (NTSB) investigation report, pilot commuting was identified as a factor in the occurrence of a fatal accident, and the NTSB issued a recommendation that operators 'address fatigue risks associated with commuting' (NTSB 2010, p. 157). Given that pilot commutes, both before and after flight duty, can be time consuming and stressful, there is a potential for pilot commutes to have a significant negative effect on safety. However, pilot commuting remains one of the least understood aspects of aviation.

This research conducted a study on the commuting practices of airline pilots and the related stress experienced by pilots. The research collected data on self-assessed pilot performance on commuting days. The study investigated the mode, time and distance of commutes, the form of housing and intermediate housing used in the commutes, and the self-assessment of stress and performance. The study found significant results in relation to the stress experienced by commuter pilots and their self-assessment of work performance compared to non-commuter pilots. Non-commuters tend to rate their subjective stress experience lower and their work performance higher than commuter pilots on commuting days.

Introduction

Little is known about airline-pilot commuting in the highly regulated aviation industry. However, 'researchers recognise the commuting experience as a potential source of stress' (Koslowsky 1997, p. 153) and believe that the commuting might have an effect on the overall professional performance of a pilot (Young 2008, p. 12).

The aviation industry governing body, the International Civil Aviation Organization (ICAO), mandates operators to manage and control actively the adjacent issue of pilot fatigue and has created a fatigue risk management system (FRMS) implementation guide for operators (ICAO 2011, p. 2). In the guide, the ICAO addresses 'extended commute prior to scheduled flight duty period' (ICAO 2011, p. 6). The fatigue hazard associated with commuting is mentioned in only one line of the 150-page document. A personal mitigation strategy on a micro-level is presented to the responsible crewmember in the recommendation to 'arrive at duty with sufficient time to allow adequate sleep, ensuring fitness for duty' (ICAO 2011, p. 6). Delegating responsibility to mitigate the hazard of an industry-wide practice that has been occurring for many years to individual crewmembers appears to be an inadequate approach by industry.

For the first time, in the 2009 investigation report of the Colgan Air accident, the National Transportation and Safety Board (NTSB) recommended 'operators to address fatigue risks associated with commuting, including identifying pilots who commute, establishing policy and guidance to mitigate fatigue risks for commuting pilots, using scheduling practices to minimize opportunities for fatigue in commuting pilots, and developing or identifying rest facilities for commuting pilots' (NTSB 2010, p.157). However, it remains unclear what has changed since 2010 in relation to industry protocols for managing the fatigue related to pilot commuting. The

magnitude of the problem also remains unclear, as does the number of pilots who commute to work and how long their commutes are.

The present study investigated the commuting practices of European airline pilots in a broad study designed to gather empirical data on this issue. The data gathered focused on the following aspects of commuting: different modes used; time spent; cost associated with commute; intermediate housing away from place of residence; subjective stress experienced during commute; reason for commuting; frequency of commute. Data were also gathered on the pilots' self-perceived performance on commuting days.

Methodology

A investigation was conducted with selected European airline pilots of various European operators on the effect of commuting on pilot self-assessment of stress and performance.

As part of the study, 3906 pilots from European airlines were invited through emails sent to their work email addresses to participate in a survey. Additionally, 37 national associations of airline pilots were invited to distribute the survey to their national members. Five hundred and twenty-eight usable questionnaires were returned and used in the analysis. It was necessary to create a definition of 'commuter pilot' to ensure that commuter pilots could be distinguished from non-commuter pilots in the study. To answer this question, the study authors consulted general commuting studies.

In Europe, the general public's average daily commuting time is 37.5 minutes from place of residence to the workplace and back (Stutzer & Frey 2007), and most of this commute is along well-established routes of public and private transport infrastructure to central business districts.

Airports are seldom near a central business district. There is no typical airport location and there is limited data on airline-pilot commutes, as well as uncertainty among official institutions about typical pilot commutes and duration of a typical airline pilot commute (National Research Council 2011, p. 18). In addition, the National Research Council sees these values on the typical pilot commute duration and 'these dividing lines [as] arbitrary' (National Research Council 2011, p. 19). To account for this lack of information, this study uses the data on the daily commuting time of the general public in Europe, doubles this value, and adjusts it to account for airport-location inconsistencies, rounding the commute time for airline pilots to 45 minutes of one-way travel time. The commute time of 45 minutes of one-way travel was set as the dividing line between non-commuter and commuter pilots. Based on

this dividing line, the following question was posed to the participants: ‘Are you commuting to your pilot base from outside a travel radius of 45 minutes?’

After answering yes or no to this question, the survey directed participants to the appropriate set of questions for a commuter or non-commuter pilot. Both groups were posed a set of questions related to subjective stress and pilot performance. It is important to note that the survey was self-assessed, which means that all the measures are subjective and highly dependent on the participants’ retrospective judgement and recall. Therefore, the data yielded from the surveys reflects this subjectivity, and the veracity of the answers depends entirely on the degree to which the participants provided accurate answers.

In the survey, the measure of pilot self-assessed stress was conducted for the commuting and non-commuter pilots through a set of stress-measuring questions. The following was the entry question for the set: ‘How do you feel about your commute?’ The rating was provided on a five-point Linkert scale, ranging from ‘totally agree’ (1) to ‘totally disagree’ (5).

The following lists the factors posed on stress:

- Commuting imposes stress on my life
- Commuting imposes stress on my partner
- Commuting leads to discussions in my relationship
- Commuting limits the socialisation time with my friends
- Friends turned away from me because of my commuting/time issues
- Commuting makes me think about the safety issues connected to my commuting
- I think that commuting influences the quality of my colleagues’ work
- Commuting influences my overall life happiness.

To measure the factor of self-assessment pilot performance, the standardised test by Sloan and Cooper (1986) was used. Sloan and Cooper (1986, p. 469) note that ‘it seems reasonable to conclude that there is such a thing as self-reported pilot performance and that the test appears to measure at least part of it’. They further explain that the test is ‘to be used as a screening device for application on relatively larger sample sizes with an aim of making broad discriminations between groups of pilots’ (Sloan & Cooper 1986, p. 469). The 15-item test for pilot self-report performance used a five-point range. This part of the survey was presented to the commuter and non-commuter pilots at the end of the survey.

The original introduction text to the commuter pilots on the test was modified from Sloan and Cooper’s (1986) wording, ‘Think about your last few flights recently’ to ‘Think about your

last few flights recently on days where you commuted to work' to ensure that the pilots' answers responded more directly to the cause and effect of pilot commuting.

In addition, in the direction 'Please rate yourself on the scales by circling the number of your answer. Remember, we are relying on you to make this as accurate a measure as possible' (Sloan & Cooper 1986), the word 'scientific' was added before the word 'measure' for both commuters and non-commuters, so that the direction then read, 'Please rate yourself on the scales by circling the number of your answer. Remember, we are relying on you to make this as accurate a scientific measure as possible'. In addition, for both groups, the following assurance was provided: 'The answers are 100% anonymous and confidential'. This line was intended to support the honesty of the required answers provided and to ensure a non-punitive level.

Results

Demographic Information of Participants

The 528 participants were residents of 29 different European nations, and had their crew based in 31 different European countries. Of all the participants, 49.4 per cent (n = 261) reported their role as captain, the remaining 50.6 per cent (n = 267) stated their position as a form of co-pilot. Of the 528 participants, 504 were male (95.5 per cent) and 24 were female (4.5 per cent).

The majority of the respondents declared themselves as commuter pilots (56.8 per cent; n 300); the remaining 228 participants (43.2 per cent) reported they were non-commuter pilots.

The role of captain indicated having an influence on the commuting practices of the pilots: 52.2 per cent of captains reported being non-commuters, compared to 43.2 per cent of the total participants. This supports the hypothesis that captains are more willing to take residence within a 45-minute range of the home base.

Age was not indicated as having an influence on whether the pilots were commuter (mean age for commuter pilots: 41.2 years) or non-commuter (mean age of non-commuter pilots 41.2 years). Table 1 presents the demographic characteristics of the participants.

Table 1: Demographic Characteristics of Pilot Participant

Participant Characteristics	Number	Percentage
Sex	528	100
Female	24	4.5
Male	504	95.5
Age	527	100
19–30	67	12.7
31–40	202	38.3
41–50	170	32.3
51–60	80	15.2
61–65	8	1.5
Role	528	100
Captain	261	49.4
First Officer	173	32.8
Senior First Officer	89	16.9
Second Officer	5	0.9
Type of Operation	528	100
Long haul	125	23.7
Mid-haul and short-haul	371	70.3
Domestic only	32	6.0

The study found that the European non-commuter pilots live an average of 111.79 km distance away from their home base compared to commuter pilots, who indicate that they commute to work on average 753.06 km. The difference in the commuting distance is evident when considering the intermediate housing facilities at the designated home base. The commuter pilots who reported using a form of intermediate housing facilities at their home base lived statistically significantly further away from the home base than the commuter pilots not using intermediate housing facilities.

Similar to distances the difference in commuter qualities is also visible in the travel times from the place of residence to home base. The non-commuters average a travel time of 25 minutes (mean 00:25, SD 00:11) (values in hours:minutes), whereas the commuters average a travel time of 03.02 hours (mean 03:02, SD 02:55) (values in hours:minutes).

The commuter pilots were asked the following question: ‘How often per month in an average duty schedule do you commute to your place of residence?’ The frequency was a little under five times per month (mean 4.99, SD 2.85). The maximum number of commutes in this question was presented as >9 times; interestingly, 15.9 per cent of commuter pilots indicated this intense amount of commuting behaviour. It is important to note also that 43.1 per cent of the commuter pilots reported travelling five times or more per monthly duty schedule between the place of

residence and home base. This average of this travel time was 03.02 hours (hours.minutes) of one-way travel time per trip, indicating a very intense engagement of time and resources. Table 2 presents the Commuting Time and Commuting Distances of pilot commuters of the study participants.

Table 2: Commuting Time and Commuting Distances of pilot commuters

Participant Response	**Number (432)**	**Percentage (100)**
One-way commuting time pilot residence to home base (in minutes per trip)		
<45	191	44.2
46–60	43	10.0
61–90	38	8.8
91–179	71	16.4
>180	8	20.6
Participant Response	**Number (431)**	**Percentage (100)**
One-way commuting distance from pilot residence to home base (in kilometres per trip)		
<45	165	38.3
45–150	88	20.4
151–500	104	24.1
501–900	31	7.2
901–1500	18	4.2
1501–2500	9	2.1
2501–3000	4	0.9
>3000	12	2.8

The responses of the commuter pilots found (n = 300) that 43.9 per cent plan this journey ‘almost always’ or ‘always’ on a long-term basis. It was also found that 67.1 per cent ‘sometimes’ experience problems in their commute. This result was indicated by the following question: ‘How often do you experience problems in your commute?’ Considering the connection between this factor and self-reported pilot performance finds interesting results related to pilot commuting. Results indicate a negative correlation between problems experienced during commutes and subjective performance in the cockpit (r_s=-0.28, $p<0.001$,

one-tailed). This result indicated that when fewer problems occur in a commute, the self-reported performance of the pilot during flight duty is better (Sloan & Cooper test).

Analysis

Stress

The total stress level was calculated for both groups from a set of eight different questions related to stress. The answer range was from 'totally agree' (indicating stress from commuting) to 'totally disagree' (indicating no stress from commuting). The analysis found a significant difference between the two groups, supporting the hypothesis that the non-commuter pilots feel less stress from their journey to work (mean 2.9) than do the commuter pilots (mean 2.6). ($t_{(394)}$=3.168 p<0.001, one-tailed). Table 3 presents the Stress Levels of Commuter (C) and Non-commuter (NC) Pilots of the study participants.

Table 3: Stress Levels of Commuter (C) and Non-commuter (NC) Pilots

Item	Group	1–2	3	4–5	Mean	SD	n	*p*
Total stress level	C	51.6	30.6	17.8	2.55	0.93	219	<0.001
from commuting	NC	41.2	27.1	31.6	2.88	1.15	177	

Note: 1–2 '(totally) agree' (high stress); 3 'neither agree nor disagree' (medium stress); 4–5 '(totally) disagree' (low to no stress). The values are provided as a percentage of valid answers.

The analysis of the stress factor and the factor of time of commute to arrive at home base found a significant difference in the stress levels of the non-commuters (<45 minutes of one-way travel time) and commuters that needed more than 180 minutes to arrive at home base ($F_{(4/390)}$=-4.379, p< 0.001, ANOVA). This further set of results in relation to self-reported stress levels is similar to the findings comparing stress levels with travel irregularities in the commute. These two factors correlated (r_s=0.350, p< 0.001, one-tailed) between non-commuters and commuters. One explanation for this result is that fewer travel irregularities result in less subjective stress experience.

This result is similar to the result between the factors of travel cancelations and stress level. To gain answers to the factor of travel cancelations, the following question was posed to the commuters participants: 'How often do you have to cancel/change your commute due to external factors?' The answers to this question were compared to the factor of stress level

(r_s =0.260, p<0.001, one-tailed). Fewer cancelations or changes in travel plans generate significantly less stress in commuter pilots. This means that the stability and plannability of the commute has an indirect proportional significant influence on the stress level experience of commuter pilots.

Another interesting finding is that the cost of commuting was found to have no influence on the self-perceived performance of commuter pilots and only a very minor influence on their self-reported stress level (r_s =0.209, p<0,001, one-tailed).

An in-depth review was conducted on the individual stress items posed in the survey. This review found significance results in the relationship between quality of work and stress–safety. It was found that commuter pilots are more conscious of commuting stress and have higher stress values than non-commuter pilots.

The following lists selected individual stress items in the survey:

- Commuting makes me think about the safety issues connected to my commuting ($t_{(368.3)}$=-2.555, p<0.05, one-tailed)
- I think that commuting influences the quality of my colleagues' work ($t_{(365,4)}$=3.022, p<0.05, one-tailed)
- Commuting influences my overall life happiness ($t_{(397)}$=-3.155, p<0.001, one-tailed).

Table 4 presents the Individual Stress Levels of Commuter (C) and Non-commuter Pilots (NC) of the study participants.

Table 4: Individual Stress Levels of Commuter (C) and Non-commuter Pilots (NC)

Item	Group	1–2	3	4–5	Mean	SD	n	Cohen's *d*	*p*
Commuting makes me think about the safety issues connected to my commuting	C	53.9	21.0	25.1	2.58	1.27	219	0.295	<0.05
	NC	44.1	17.9	38.0	2.97	1.38	179		
I think that commuting influences the quality of my colleagues' work	C	42.5	28.3	29.2	2.84	1.22	219	-0.314	<0.05
	NC	61.1	16.7	22.2	2.44	1.34	180		
Commuting influences my overall life happiness	C	62.6	18.7	18.7	2.34	1.20	219	0.323	<0.001
	NC	50.5	16.7	32.8	2.76	1.42	180		

Note: 1–2 '(totally) agree' (high stress); 3 'neither agree nor disagree' (medium stress); 4–5 '(totally) disagree' (low to no stress). The values are provided as a percentage of valid answers.

Performance

To analyse the self-perceived performance data, we employed the strategy expressed by Sloan and Cooper (1986, p. 468) which weights the scores differentially according to importance.

The testing of self-perceived performance indicated a significant result. Non-commuter pilots reported better performance during duty (mean 0.107) than the commuter pilots (mean 0.138) ($t_{(374)}$=-3.575, p<0.001, one-tailed)

Examining the data on average commuting time in comparison with self-reported performance levels reveals a significant difference in self-reported performance between the non-commuter pilots and the commuter pilots that report travelling more than 180 minutes from residence to homebase. The non-commuter pilots subjectively indicated a higher performance during their cockpit tasks ($F_{(4/,370)}$=6.825, p<0.001, analysis of variance –*ANOVA*-test)

A significant difference was also noted between commuter pilots who have 91–179 minutes of one-way travel time to home base and commuter pilots that have more than 180 minutes of one-way travel time to home base The results found that the commuter pilots with the shorter commuting times self-reported a significantly higher level of work performance (($F_{(4/,370)}$=6.825, p<0.001, analysis of variance –*ANOVA*-test, Bonferroni: p<0.05, mean difference = -0.04949). post-hoc tests, Bonferroni). These results support the hypothesis that shorter commuting times support a higher level of self-reported work performance in the cockpit.

Exploring single items from the 15-item Sloan and Cooper (1986) test found significant differences between commuter and non-commuter pilots in the following items:

- Being ahead of the game ($t_{(388.6)}$=-3.848, p<0.001, one-tailed (Cohen's d=-0.348)
- Excess mental capacity ($t_{(390)}$=-2.797, p<0.01, one-tailed) (Cohen's d= 0.284)
- Coping with things that go wrong ($t_{(390)}$=-4.473, p<0.001, one-tailed) (Cohen's d=-0.444)
- Quality of interpersonal relations with aircrew ($t_{(381)}$=-2.789, p<0.01, one-tailed) (Cohen's d=-0.281)
- Degree of mental and physical coordination ($t_{(376.3)}$=-3.109, p<0.001, one-tailed) (Cohen's d=0.326)
- Number of errors made ($t_{(379)}$=-1.984, p<0.05, one-tailed) (Cohen's d=0.201)
- Extent of errors made ($t_{(379)}$=-1.714, p<0.05, one-tailed) (Cohen's d=0,176)
- Many pilots when asked to assess the quality of their performance reply that it is 'just a feeling'—can you assess yourself on a scale in this way? ($t_{(373.1)}$=-2.784, p<0.01, one-tailed) (Cohen's d=-0,282).

Correlation between the weighted Sloan–Cooper total value of self-perceived performance and the total calculated stress level supported a significant level (r_s=-0.482, p<0.001, one-tailed) of performance difference. This indicates less self-perceived stress levels experienced supports higher levels of self-perceived work performance.

Table 5 presents the Subjective Levels of Performance in Commuter (C) and Non-commuter (NC) Pilots.

Table 5: Subjective Levels of Performance in Commuter (C) and Non-commuter (NC) Pilots

Item	Group	1-2	3	4-5	Mean	SD	n	Cohen's *d*	*p*
Being ahead of the game	C	13.1	17.3	69,6	0.8131	0.9556	214	-0.348	<0.0001
	NC	4.5	9.6	85.9	1.1582	0.8173	177		
Excess mental capacity	C	26.2	22.4	51.4	0.3224	1.1168	214	0.284	<0.01
	NC	19.1	16.9	64.0	0.6517	1.1508	178		
Coping with things that go wrong	C	13.1	21.5	65.4	0.7383	0.9723	214	-0.444	<0.001
	NC	3.4	12.9	83.7	1.1404	0.8078	178		
Quality of interpersonal relations with aircrew	C	10.5	18.7	70.8	0.9378	0.9859	209	-0.281	<0.01
	NC	4.6	17.2	78.2	1.2126	0.9285	174		
Degree of mental and physical coordination	C	14.9	24.0	61.1	0.6442	0.9623	208	0.326	<0.001
	NC	6.4	22.0	71.7	0.9364	0.8704	173		
Number of errors made	C	15.4	24.0	60.6	0.7019	1.0391	208	0.201	<0.05
	NC	6.9	19.1	74.0	0.8960	0.8698	173		
Extent of errors made	C	4.8	21.6	73.6	1.0337	0.8702	208	0.207	<0.05
	NC	3.5	15.6	80.9	1.1850	0.8425	173		
Many pilots when asked to assess the quality of their performance reply that it is "just a feeling"— can you assess yourself on a scale in this way?	C	9.2	31.1	59.7	0.6699	0.8932	206	-0.282	<0.01
	NC	4.7	22.2	73.1	0.9123	0.7959	171		

Note: 1–2 'Low/very low performance '; 3 'average performance'; 4–5 'good/very good performance'. The values are provided as a percentage of valid answers.

Discussion

Commuting between place of residence and the workplace is rarely considered an enjoyable time. Generally, commuting time involves exposure to some form of physical and psychological stress (e.g., heat, cold, smells, people, etc.), and the level of stress experienced in commuting can be affected by the mode of transport or the form of transport (i.e., active or passive).

The National Research Council (2011, p. 3) notes 'that commuting is one of many activities that usually occur during a pilot's off-duty time [and that a] pilot commuting differs from the commuting of other workers in terms of frequency and variability, distance, transport modes, and time of day'. It is also true that that most other industries lack strong regulating legislation, and commercial aviation operators require regulation relating to fatigue-risk management to ensure efficient and safe management of fatigue risk associated with commuting.

Currently, the reference to commuting in the ICAO guidelines is vague and assigns responsibility for fatigue management to the individual crew member. Such guidelines are insufficient in an industry that is highly regulated, and in some cases even encourages or obliges pilots to commute through industry-based policies and subsidised crew tickets.

In the aftermath of the Colgan Air accident investigation, the NTSB highlighted a risk in connection with pilot commuting and fatigue, and found that very limited data existed in relation to pilots commuting and that operators are not required to 'know' whether their pilot employee is a commuter because the commuting is conducted in the off-duty hours (National Research Council 2011, p. 3). However, aviation operators know, or at least have the opportunity to monitor, the travel behaviour of their pilots through examining information revealed through subsidised ticketing sales. Considering the 'commuting trip [as] the time during which one is free from the duties from work and family' (Rouwendal & Nijkamp 2004, p. 299) is an inappropriate approach reflecting on how pilots cope with occupational stress (Cooper & Sloan, 1985).

The results of this study demonstrate that pilot commuting is a prevalent industry factor, with 56.8 per cent of the study sample of European airline pilots reporting themselves to be commuters. A factor adding to the prevalence of pilot commuting is the shift from legacy airlines to low-cost carrier (LCC) operation, and their scheduling policies in relation to save on overnight costs and per diems for pilots. Returning daily to their designated home base to having pilots provide themselves with overnight accommodation at home base rather than scheduling

them on overnight duty flight schedules. In this study, 70.3 per cent of participants indicated working for a mid- and short-haul operator, which means they face this challenge.

A possible result of this scheduling policy could be an aggregated commuting behaviour to save money on overnight costs and to return to the residence to friends and family during duty to avoid cost for accommodation for the result of reduced sleeping periods. The study results indicate that 15.9 per cent of pilots commute more than nine times in a duty period and 43.1 per cent commute more often than the average of 4.99 times. This 43.1 per cent commute of an average one-time commute time of three hours and two minutes highlights that pilots experience significant levels of fatigue when off duty.

The findings of this study demonstrate that the variables of commuting cause pilots stress. As Green (1985) notes, people who are stressed are more prone to committing errors due to their cognitive engagement with stress factors, rather than with their work duty. The study also found in the self-reported work performance of pilots that the number of errors made by commuter pilots was significantly higher on commuting days compared with non-commuter pilots.

The factor of mental engagement noted by Green (1985) is also indicated in the item of 'Being ahead of the game' (Sloan & Cooper 1986), for which a significantly better result was reported by the non-commuter pilots in the study. The non-commuter pilots also indicated having higher levels of 'Excess mental capacity' available in the cockpit during duty, and self-reported that they found 'Coping with things that go wrong' significantly easier than did the commuter pilots, which might be due to a lack of preconditioned mental engagement.

The 'Quality of interpersonal relations with aircrew' and the 'Degree of mental and physical coordination', which have been demonstrated as vital to crew resource management, were found by the study to be significantly impaired in the commuter pilots on commuting days compared to the non-commuter pilots.

Stress was found to effect self-reported performance in this study, and commuting times were found to cause stress. Sexton, Thomas and Helmreich (2000, p.1) note that 'pilots were least likely to deny the effect of fatigue on performance'. The authors of this study also hypothesise that pilots are least likely to deny the effect of commuting on stress and performance, and self-report knowing the risks associated with commuting. In this study, the pilots were posed the following question: 'Many pilots when asked to assess the quality of their performance reply that it is 'just a feeling'—can you assess yourself on a scale in this way?' Although the answer

to this is general, the commuter pilots in this study self-reported impairment in performance significantly more than did the non-commuter pilots in this study.

The responses to the item: 'Commuting makes me think about the safety issues connected to my commuting', indicate that pilots are aware that commuting causes stress, and that commuter pilots are significantly more aware of the safety issues associated with commuting.

It must be asked how it is possible to manage the safety risks associated with pilot commuting through industry regulation (or through macro-level regulation) rather than through assigning micro-level (or personal) responsibility to pilots. A possible approach is to understand that pilot commuting is an industry standard that requires actively addressing and managing individual pilots' commutes on an operator level in a manner that reduces the experience of stress as part of an expanded FRMS that implements safety regulations.

Some operators in the United States (e.g., FedEx, which reported to the committee that it allows pilots to reserve the jump seat in advance) provide sleeping facilities at both the sorting hubs and the outlying stations, and include time spent in commuting from the pilot's home airport to the domicile in their calculation of duty time 'with respect to the limits established by the labour contract' (National Research Council 2011, p. 40). Delta Airlines reported 'that they provided reserved seats for the trip to the pilot's duty location and provided minimum rest periods of 4–9 hours, depending on the carrier, between the arrival of the commuting flight and commencement of pre-flight activities for a pilot's operational flight' (National Research Council 2011, p. 40)

Operators ensuring that the commuting trip is plannable and that pilots receive support for the journey will decrease pilots' stress levels, which according to the results of this study, will increase pilots' work performance. Ensuring such strategies are implemented is an appropriate risk-mitigation strategy in relation to pilot commuting. Achieving sound cooperation in the development of an industry–pilot commuting model based on research to improve aviation safety is a further research aim of the authors of this study.

Conclusion

Commuting, self-reported stress experienced in a commute and self-reported pilot work performance are closely connected variables. Analysis of empirical data can clarify the factors that reduce the stress associated with pilot commuting and allow the pilot to better perform in a cockpit environment. Managing pilot commuting through a sound industry-level fatigue risk-

management programme, rather than assigning responsibility to individual pilots, will enhance flight safety through lower levels of pilot fatigue.

References

Cooper, CL & Sloan, S (1985), 'The sources of stress on the wives of commercial airline pilots', *Aviation Space and Environmental Medicine*, vol. 56, no. 4, pp. 317–321.

Cooper, C. L. and Sloan, S. (1985), "Occupational and psychosocial stress among commercial aviation pilots", *Journal of Occupational Medicine.: Official Publication Of The Industrial Medical Association,* vol. 27, no. 8, pp. 570-576

Green, RG (1985), 'Stress and accidents', *Aviation Space and Environmental Medicine*, vol. 56, no. 7, pp. 638–641.

International Civil Aviation Organization (ICAO) (2011), *Fatigue Risk Management System (FRMS) Implementation Guide For Operators*, 1st ed, ICAO, Montreal.

Koslowsky, M (1997), 'Commuting stress: problems of definition and variable identification', *Applied Psychology: an International Review*, vol. 46, no. 2, pp. 153–173.

National Research Council (2011), *Committee on the Effects of Commuting on Pilot Fatigue, Board on Human-Systems Integration. Division of Behavioral and Social Sciences and Education,* The National Academies Press, Washington, DC.

National Research Council (2011), *Issues in Commuting and Pilot Fatigue: Interim Report*, The National Academic Press, Washington, DC.

NTSB - National Transportation Safety Board (2010), Loss of Control on Approach, Colgan Air, Inc., Operating as Continental Connection Flight 3407 Bombardier DHC-8-400, N200WQ, Clarence Center, New York , *NTSB/AAR-10/01, PB2010-910401*, Washington, D.C.

Rouwendal, J & Nijkamp, P (2004), 'Living in two worlds: a review of home-to-work decisions', *Growth and Change*, vol. 35, no. 3, pp. 287–303.

Sexton, JB, Thomas, EJ & Helmreich, RL (2000), 'Error, stress, and teamwork in medicine and aviation: cross sectional surveys', *British Medical Journal*, vol. 320, no. 7237, pp.745–749.

Sloan, SJ & Cooper, CL (1986), 'The measurement of self-reported pilot performance', *Aviation Space and Environmental Medicine*, vol. 57, no. 5, pp. 466–471.

Stutzer, A & Frey, BS (2007), 'Commuting and life satisfaction in Germany', *Informationen zur Raumentwicklung*, vol. 2, no. 3, pp. 1–11.

Young, J. A. (2008), "The Effects of Life-Stress on Pilot Performance", *NASA STI Program Office*, [Online], no. Ames Research Center, pp. 1-22.