LUND UNIVERSITY
School of Aviation

An overview of EFB usage in Scandinavia

discrepancies between EASA's recommendations
and operators' implementation

Authors: Jimisola Laursen and Anders Ludvigsson
Supervisor: Dr. Nicklas Dahlström
Class: SEDE 15
Date: February 15, 2018 (revision 3)
Lund University School of Aviation
Ljungbyhed, Sweden

"Anything that can go wrong, will go wrong."

Murphy's Law

"Murphy was an optimist."

O'Toole's Comment

Foreword

This thesis was part of a course in aeronautical sciences leading to a BSc at Lund University School of Aviation (LUSA). It constitutes 15 credits (or the equivalent of 10 weeks full-time studies) but was written between fall 2015 and fall 2017 as both of the authors work full-time as airline pilots.

The author Jimisola Laursen is a First Officer with 8 years experience as an airline pilot and holds an MSc in Computer Science.

Anders Ludvigsson is a Captain with 12 years experience as an airline pilot, with the last 8 years in aviation management positions and holds a BSc in Informatics.

We would like to take this opportunity to thank the participating airlines and all the individual pilots who were kind enough to complete our survey.

A special thanks to our supervisor, Dr Nicklas Dahlström, whose patience and thoughtful guidance have been invaluable.

Also, a final thanks to Donald Knuth, TEX and LATEX for the typesetting of this thesis.

Fly safe.

Abstract

The use of Electronic Flight Bags (EFBs) have become widespread and common among a majority of commercial airlines in Scandinavia and the United States in recent years. This development was enabled by modernized rules and regulations and the availability of suitable and affordable commercial-off-the-shelf (COTS) devices.

This bachelor thesis studied EFB usage and user experience among pilots in commercial airlines in Scandinavia and identified if there were any discrepancies between usage and associated recommended best practices issued by the European Aviation Safety Agency (EASA). Focus areas were EFB training, performance calculations and documentation.

Over 500 pilots from 11 airlines in Scandinavia responded to an online survey consisting of 42 questions. The survey showed that a large majority of the pilots used their EFB for mission critical purposes such as performance calculations.

The results revealed discrepancies between recommendations by EASA and operators' implementation regarding EFB training and procedures for performance calculations. Furthermore, the new technology must be implemented in a structured way. Information shall be made available based on the needs and abilities of the pilots within their various roles and not based solely on available software features.

Contents

List of Figures

List of Tables

Outline

This thesis is structured as follows:

- Section 1 Introduction: introduction and background of Electronic Flight Bags (EFBs) and some EASA regulations
- Section 2 Method: describes the method used for the thesis
- Section 3 Results: presentation of results
- Section 4 Discussion: discussion based on results
- Section 5 Future work: recommendations on future work
- Appendix A LUBsearch: summary of the academic literature searches made
- Appendix B Survey: original survey sent out to pilots
- Appendix C Acronyms: common acronyms used in report

1 Introduction

Computers in various forms have been in use on flight decks around the world for many years. Performance calculations were made on PalmPilots and other similar handheld devices since the beginning of the millennium or before. Initially some baby steps were taken towards expanding the use of computers on flight deck into replacing navigation charts and flight plans but it was not until the introduction of the iPad, and other similar tablets, that the development really took off (Pschierer et al. 2012). The technical development paired with changes in the regulations such as the move from *Commission Regulation (EC) No 859/2008 of 20 August 2008* into *Commission Regulation (EU) No 965/2012 of 5 October 2012* and the associated *ED Decision 2014/001/R 09/02/2014 Annex II AMC 20-25* simplified the implementation for airlines and lead to a fast development in the beginning of the last decade. Since then the use of tablets and other computing devices have replaced, partially or completely, all papers used during flight operations and it has done so to a greater or lessor extent for almost all commercial operators. Airlines have become dependent on EFBs to an extent where malfunctions can cause delays and canceled flights. An example of this is an event reported in the news in April 2015 where American airlines had to delay several flights due to a computer glitch in the charting software[1]. Information provided by Federal Aviation Administration (FAA)[2] in 2015 shows that there are 67 operators that hold an Air Carrier Certificate operating under Part 121 in the United States. Of those 67 operators, 44 hold an authorization by the FAA to use an EFB. That is 66% with EFB approval.

If looking at commercial airlines operating fixed wing aircraft in Scandinavia the situation is similar. Information provided by the civil aviation authorities in the three countries Denmark, Norway and Sweden in 2016[3] shows that 7 out of 10 Danish operators, 3 out of 4 Norwegian operators and 8 out of 9 Swedish operators have approval to use EFB. Or in total, 78% of the Scandinavian operators of fixed wing aircraft in commercial aviation are approved to use EFB.

The report *Take-off performance calculation and entry errors: A global perspective* by the Australian Transport Safety Bureau (ATSB) from 2011, revealed that there where around 20 events world wide in the period 1989 to 2009 where the calculation or entry of erroneous take-off performance parameters were cited as contributing to commercial jet aircraft accidents and incidents. Other similar reports such as *Flight Crew Computer Errors (FMS, EFB) - Case Studies (1st ed)* by IATA (2011) also give reason to be cautious when it comes to EFBs, especially regarding performance calculations.

Despite how widespread the use of EFBs has become and the potential impact errors resulting from its use can have on flight safety, relevant research material on the topic is surprisingly scarce. Searching for relevant material in LUBsearch, a collective search entry point at Lund University, gave only a few relevant returns (see section A LUBsearch for details). The search was conducted in a generous way and results were rather included than excluded. Yet there were only 20 relevant and unique returns for all combinations of search strings where at least 11 were non-academic, e.g. news material. There is some older research material regarding the use of paper on flight deck which mention the, at that time, coming development of EFBs, for example that made by Nomura et al. (2006). However, it does not cover the present times after EFBs became mainstream. There is also research made regarding design of flight crew procedures, for example that by Degani et al. (1991), which is still relevant today but was made long before EFBs became common. Such older research do not reflect any of the specific challenges there may be with the new technology. A report by Löfgren Bengtson (2013) gives an overview of different types of EFBs and a summary of the applicable regulations, but it was made in the transition period between the older rules and the new and therefore had to be based on proposed changes rather than the final version of *AMC 20-25*. The report is further limited in scope to one airline with a specific fleet and

[1] `http://www.bbc.com/news/technology-32513066` (Retrieved 6 Aug, 2017)
[2] Information provided by FAA via email 2016.
[3] Information provided by inspectors from the respective Civil Aviation Authority (CAA) via email in 2016.

financial data mentioned therein can not easily be generalized but most importantly it does not provide any data about use of EFBs.

The aviation industry is a heavily regulated industry and generally seen as a complex high risk industry (Perrow 2011). Therefore the lack of available research material is somewhat surprising and leaves room for further studies of the impact the widespread introduction of EFBs have had. This thesis strives to provide a contribution by mapping actual EFB usage among commercial pilots in Scandinavia and show to what extent the recommended best practices are actually being applied by the operators using EFBs.

The thesis target groups are primarily pilots, airline management staff and personnel within Civil Aviation Authorities (CAAs) but also researchers within the field of aviation and companies involved in software development for EFBs.

1.1 Overview of Regulations and Best Practices

In order to understand the present situation with EFBs it is necessary to know the past and how the conditions under which EFBs may be used have developed. A short overview of the regulatory changes that took place during the past 10 years follows. In Europe it is European Aviation Safety Agency (EASA), which develops regulations for commercial aviation. EASA has worked with modernizing the rules governing EFBs for commercial aviation as well as harmonizing them with other worldwide standards and best practices (EASA 2014b).

An example of this, which is relevant in the context of EFBs, is the change of the rules which allow digital reports and documents in flight deck instead of paper copies. In the former rules there was a requirement for each national aviation authority to give a specific approval for each operator who would like to publish their so called operations manual in a format other than on printed paper, Subpart P, Ops 1.1040 (m) in *EC No 859/2008*. In the current rules, which entered into force 28 October 2014, the rules changed into stating that the operations manual may be published in any form, including electronic, as long as accessibility, readability and reliability is assured, AMC1 ORO.MLR.100 (b) in *EU No 965/2012*. This may seem like a small change but reflects a change away from specific approvals by each national aviation authority into a general approval in the rules common for all European operators irrespective of which country they are registered in.

Another example of modernized rules are those laying down guidelines for how to implement an EFB in an organization, *AMC 20-25*. Those are guidelines for how to handle the hardware and software which is intended to be used in lieu of paper copies and whether the applicable hardware or software will require a specific approval from the national aviation authority or not. In the older guidelines published by the Joint Aviation Authorities (JAA) in 2004, *Leaflet No. 36: Approval of Electronic Flight Bags (EFBs)*, most applications of an EFB required prior approval by the national aviation authority of both software and hardware. The guidelines had also become more or less obsolete due to the fast development of information technology and the introduction of commercial-off-the-shelf (COTS), products such as the iPad and other tablets. COTS devices were mentioned in *TGL 36* but with the introduction of *AMC 20-25* they became more or less free to use by each operator as long as the operator took certain measures. For example to ensure it was reliable, did not have security deficiencies, did not interfere with other systems on-board e.g. through electromagnetic interference and that it could handle sudden decompression in the cabin.

In Europe *AMC 20-25* is the applicable rule set to use but many stakeholders in the industry are still referring to older terminology when it comes to describing EFBs. Internationally there are also some terms still in use which differs from those in *AMC 20-25*. Therefore it is relevant to be aware of them and have at least a general understanding of what they mean in order to view any article or information published about EFBs.

In the past, different types of EFB hardware were broadly divided into three subcategories: Class 1, 2 and 3. Depending on the class, different levels of authority approvals were needed.

For example Class 3 types of EFBs were installed as part of the aircraft and required airworthiness approval. Class 2 types of EFBs were not installed but could be mounted in the flight deck. Most Class 2 EFBs could receive data from the aircraft but could not send any data to the aircraft. Therefore they did not require airworthiness approval. It is worth noting that the mounting device which was used to hold the Class 2 EFB could require an airworthiness approval but not the EFB itself. The EFBs which fell under the category Class 1 were usually standalone laptops, PalmPilots, etc., used to support the operation during pre-flight preparations but were not necessarily used during flight.

When *AMC 20-25* replaced *TGL 36* some of the changes were to modernize the terminology and abandon the three classes. Instead the two terms, *installed* and *portable*, were introduced as they better describe the different types of hardware used for EFBs. The EFB definitions used in *AMC 20-25* are:

portable a portable EFB host platform, used on the flight deck, which is not part of the certified aircraft configuration.

installed an EFB host platform installed in the aircraft and considered as an aircraft part, covered, thus, by the aircraft airworthiness approval.

Software for EFBs is divided into two categories: type A and type B. According to *AMC 20-25* they are defined as follows:

Type A applications are EFB applications whose malfunction or misuse have no safety effect.

Type B applications are applications:

- whose malfunction or misuse are limited to a minor failure condition; and
- which do neither substitute nor duplicate any system or functionality required by airworthiness regulations, airspace requirements, or operational rules[4].

The risk assessment and evaluation of the EFB platform is left to each operator to perform. Most applications of an EFB do not require approval by the CAA. Yet EASA has identified several key issues which are considered essential to safe use of an EFB. These entail recommendations about training and checking, power supply, human machine interaction and special focus on e.g. performance calculations. One important example is the recommendation to perform independent performance calculations with subsequent formalized cross checks of the results. These recommendations stem from research in the human factors field. Humans tend to have rather high accuracy when inputting data (>99,5%) but significantly lower error detection rate (40-70%) when reviewing own or others' data (Panko 2008).

Battery depletion does not necessarily lead to as significant safety issues as incorrect performance calculations but considering how widespread the portable type of EFBs have become it is also worth mentioning the recommendations regarding power supply. If the EFB does not get power from the aircraft an operator shall consider battery depletion and review the need for a spare battery (EASA 2014a). Poor battery capacity could lead to a change in pilots behavior where they do not review e.g. charts as often as they would otherwise have done if they did not have any concern about battery depletion.

AMC 20-25 specifically recommends that flight crew are given specific training on the use of an EFB *before* it is operationally used and gives a list of topics to be covered as a minimum. A list of recommended training is mentioned in question 22 (see 3.22) later in this thesis. For a full list refer to *AMC 20-25*. Additionally it is recommended to integrate training and checking of EFBs in the simulator environment in order to make it as representative of actual use as possible. If an operator's Standard Operating Procedures (SOP) is dependent

[4]This does not preclude Type B software applications from being used to present the documents, manuals, and information required by CAT.GEN.MPA.180 in *EU No 965/2012*

on the use of an EFB, proficiency in its use shall be assessed during Proficiency Check / Operator Proficiency Check (PC/OPC) and line checks.

1.2 Purpose

To survey EFB usage and user experience among pilots in commercial airlines in Scandinavia and to identify if there are any discrepancies between usage and associated recommended best practices issued by the European Aviation Safety Agency (EASA).

1.3 Limitations

The scope of this thesis is EFBs used by commercial airlines operating fixed wing aircraft with air operator certificates issued by the Civil Aviation Authorities (CAAs) in one of the Scandinavian countries Denmark, Norway or Sweden.

The focus of the thesis is usage of EFB in general such as general user experience including battery life, weight or size limitations. Additionally two specific areas are surveyed namely performance calculations and documentation. Other types of usage such as usage of operational flight plans, reporting tools, etc., are excluded. Differences between various software/hardware manufacturers or versions are also excluded.

2 Method

In order to get an overview of the topic, more specifically an overview of research within the field of EFBs, work started by performing database searches about EFB using several search keywords (see section A LUBsearch).

Two decisions regarding the thesis were the target group and method to be used. The options regarding target groups were targeting pilots and/or EFB administrators. Regarding the method a decision had to be made whether it should be a quantitative method, a qualitative method or a combination of both.

To gather data a quantitative method was chosen. Data was collected through a digital online survey (see section B Survey) and analyzed using IBM SPSS Statistics (SPSS). A standardized email consisting of a short introduction and a link to the survey was prepared. This email was sent out (forwarded) by each of the 11 participating airlines to all their pilots.

A quantitative method was chosen in order to identify differences between documented procedures and how the EFBs are used in line operations. A qualitative method could have been chosen but to get the most out of a qualitative method, one-on-one interviews with pilots which could enable follow up questions would have been desired. The authors are not trained in interview techniques and might not have been able to get the most out of such interviews. Due to time constraints it would not be possible to reach as large population as with a quantitative method. Using a qualitative method with a population which is too small could give an inaccurate representation of the actual group. An additional aspect in favor of the quantitative method is anonymity. A quantitative method also makes it possible to explain what is observed by classifying features, counting them and use statistical methods and models. A quantitative survey can be replicated easier in the future to see if there has been any change in user perception/experience.

Anonymity for each participating airline including each individual responding pilot has been ensured.

Some questions in the survey, such as *Type of EFB (Q1)*, *How is the EFB issued? (Q8)*, *Is the EFB approved for all phases of flight? (Q9)*, *Type of power supply (Q12)* and *EFB is used for Documentation/Information in my company (Q36)*, could have been answered by the EFB admins for the pilots and probably more accurately so as well. There would likely not have been the inconsistent answers regarding e.g. *How is the EFB issued? (Q8)* and *Is the EFB approved for all phases of flight? (Q9)*. However, since most of the questions were about how things were perceived or experienced by the user, i.e. pilot, the decision was made to ask all questions directly to pilots. In addition, one hypothesis was that actual usage might differ from the documented procedures and therefore it would be relevant to reach out to the actual users. This was particularly important as there was some material about EFB available from regulators and some grey material but very little or non-existing documentation about the users' experience of the new work tools despite how common they had become.

3 Results

The results of this thesis are the 517 individual responses to the EFB survey. The survey was an online questionnaire using Google Forms (see B). It composed of 42 questions excluding the question "I fly for" (which was used to determine each pilot's airline[5]). Twelve (12) airlines, identified to be within the scope of the thesis, were contacted for participation resulting in eleven (11) participating airlines.

3.1 Type of EFB (Q1)

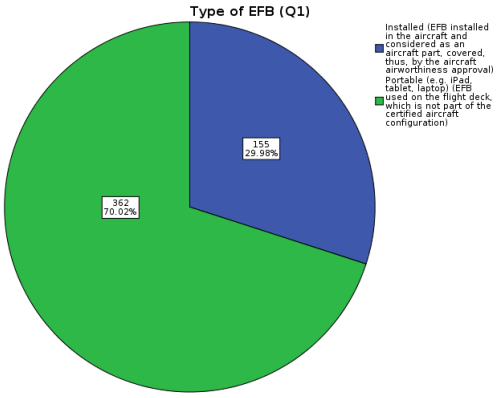

FIGURE 1. Type of EFB (Q1)

Type of EFB (Q1)				
		Frequency	Percent	Valid Percent
Valid	Installed EFB	155	30.0	30.0
	Portable EFB	362	70.0	70.0
	Total	517	100.0	100.0

TABLE 1. Type of EFB (Q1)

70% (362) of the pilots use a portable EFB, which typically is a consumer electronic device such as an iPad or tablet. 30% (155) use an EFB that is installed in the aircraft and that is part of the aircraft airworthiness approval.

It has been noticed that despite explanatory text some pilots have answered this question incorrectly, e.g. their airline only has portable EFBs but one or more pilots answered that they use an installed.

[5]Participating airlines are not named in the survey for integrity reasons. However, airlines may be compared to each other for statistical purposes.

3.2 Your current position/rank (Q2)

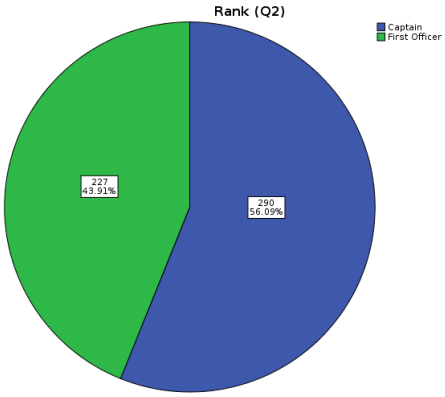

FIGURE 2. Your current position/rank (Q2)

Rank (Q2)				
		Frequency	Percent	Valid Percent
Valid	Captain	290	56.1	56.1
	First Officer	227	43.9	43.9
	Total	517	100.0	100.0

TABLE 2. Your current position/rank (Q2)

56.1% (290) of the pilots were Captains and the remaining 43.9% (227) First Officers.

3.3 Your age in years (Q3)

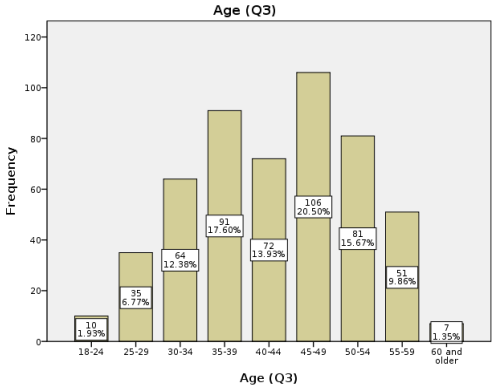

FIGURE 3. Your age in years (Q3)

Age (Q3)				
		Frequency	Percent	Valid Percent
Valid	18-24	10	1.9	1.9
	25-29	35	6.8	6.8
	30-34	64	12.4	12.4
	35-39	91	17.6	17.6
	40-44	72	13.9	13.9
	45-49	106	20.5	20.5
	50-54	81	15.7	15.7
	55-59	51	9.9	9.9
	60 and older	7	1.4	1.4
	Total	517	100.0	100.0

TABLE 3. Your age in years (Q3)

The age groups with the largest population were between 30 to 54 years. More specifically, 45-49 years 20.5% (106), 35-39 years 17.6% (91) and 50-54 years 15.7% (81).

3.4 Your total flight hours (Q4)

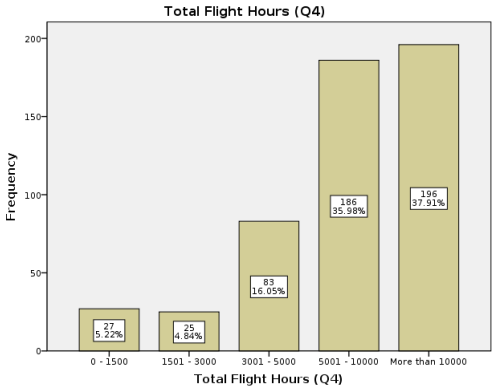

FIGURE 4. Your total flight hours (Q4)

Total Flight Hours (Q4)				
		Frequency	Percent	Valid Percent
Valid	0-1500	27	5.2	5.2
	1501 - 3000	25	4.8	4.8
	3001 - 5000	83	16.1	16.1
	5001 - 10000	186	36.0	36.0
	More than 10000	196	37.9	37.9
	Total	517	100.0	100.0

TABLE 4. Your total flight hours (Q4)

Based on total flight hours the largest group, those with more than 10000 hours, constituted 37.9% (196). Closely followed by the group of 5001-10000 hours 36.0% (186) and then 3001-5000 hours with 16.1% (83).

3.5 I have experience of flight decks without the use of EFBs (Q5)

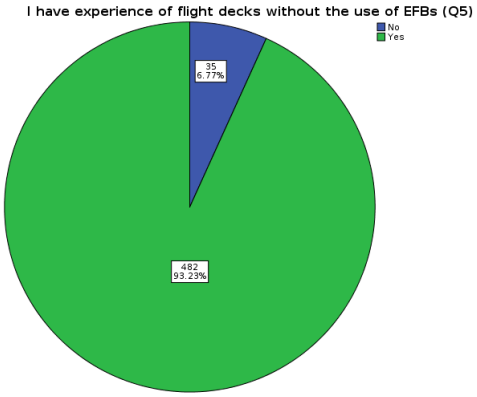

FIGURE 5. I have experience of flight decks without the use of EFBs (Q5)

I have experience of flight decks without the use of EFBs (Q5)				
		Frequency	Percent	Valid Percent
Valid	No	35	6.8	6.8
	Yes	482	93.2	93.2
	Total	517	100.0	100.0

TABLE 5. I have experience of flight decks without the use of EFBs (Q5)

93.2% (482), as opposed to 6.8% (35), had experience of flight decks without the use of EFBs.

3.6 I have previous experience of using EFBs in OTHER companies (Q6)

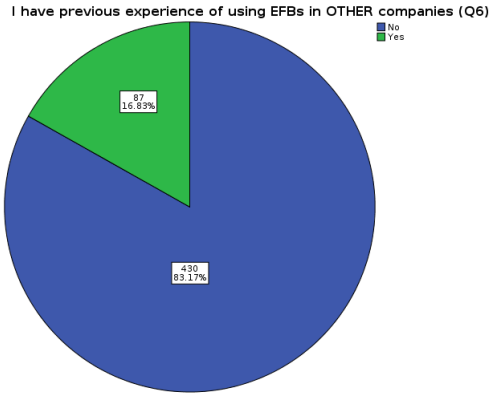

FIGURE 6. I have previous experience of using EFBs in OTHER companies (Q6)

I have previous experience of using EFBs in OTHER companies (Q6)				
		Frequency	Percent	Valid Percent
Valid	No	430	83.2	83.2
	Yes	87	16.8	16.8
	Total	517	100.0	100.0

TABLE 6. I have previous experience of using EFBs in OTHER companies (Q6)

83.2% (430), as opposed to 16.8% (87), had no previous experience of using EFBs in other companies.

3.7 I had previous experience of other EFBs in MY CURRENT company prior to starting to use the current EFB (Q7)

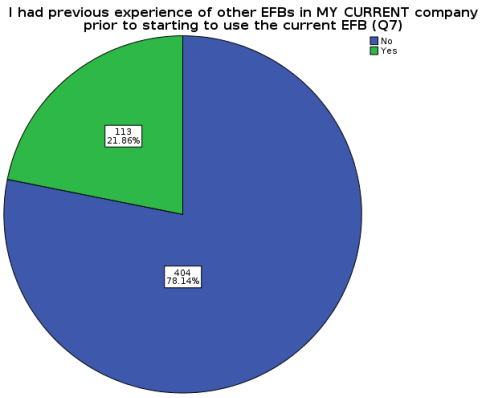

FIGURE 7. I had previous experience of other EFBs in MY CURRENT company prior to starting to use the current EFB (Q7)

I had previous experience of other EFBs in MY CURRENT company prior to starting to use the current EFB (Q7)				
		Frequency	Percent	Valid Percent
Valid	No	404	78.1	78.1
	Yes	113	21.9	21.9
	Total	517	100.0	100.0

TABLE 7. I had previous experience of other EFBs in MY CURRENT company prior to starting to use the current EFB (Q7)

78.1% (404) had previous experience of using other EFBs in their current company prior to the EFB they currently use. For 21.9% (113) this was the first EFB that they used in their current company.

3.8 How is the EFB issued? (Q8)

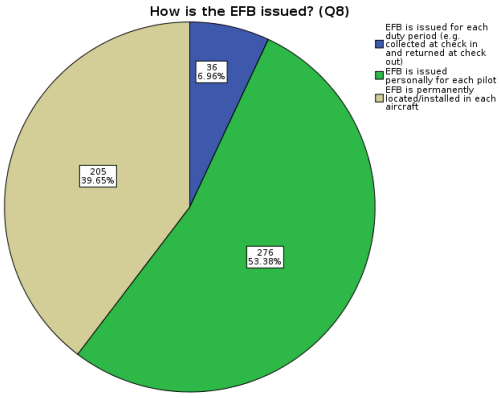

FIGURE 8. How is the EFB issued? (Q8)

How is the EFB issued? (Q8)				
		Frequency	Percent	Valid Percent
Valid	EFB is issued for each duty period (e.g. collected at check in and returned at check out)	36	7.0	7.0
	EFB is issued personally for each pilot	276	53.4	53.4
	EFB is permanently located/installed in each aircraft	205	39.7	39.7
	Total	517	100.0	100.0

TABLE 8. How is the EFB issued? (Q8)

A majority of the pilots, 53.4% (276), were issued a personal EFB. 39.7% (205) pilots answered that EFBs were located/installed in each aircraft. The remaining 7% (36) were issued an EFB for each duty period.

3.9 Is the EFB approved for all phases of flight? (Q9)

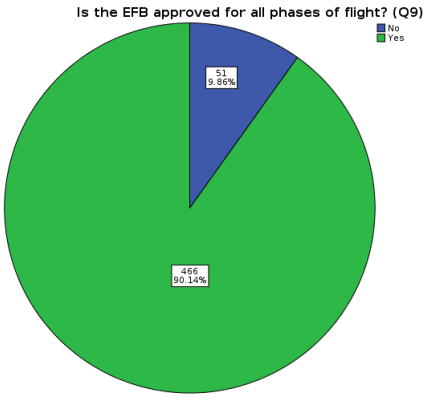

FIGURE 9. Is the EFB approved for all phases of flight? (Q9)

Is the EFB approved for all phases of flight? (Q9)				
		Frequency	Percent	Valid Percent
Valid	No	51	9.9	9.9
	Yes	466	90.1	90.1
	Total	517	100.0	100.0

TABLE 9. Is the EFB approved for all phases of flight? (Q9)

A clear majority 90.1% (466) used an EFB approved for all phases of flight. 9.9% (51) used an EFB that were not approved for all phases of flight.

3.10 I'm allowed to use my personally issued EFB for private/non-company use (e.g. installing other apps)? (Q10)

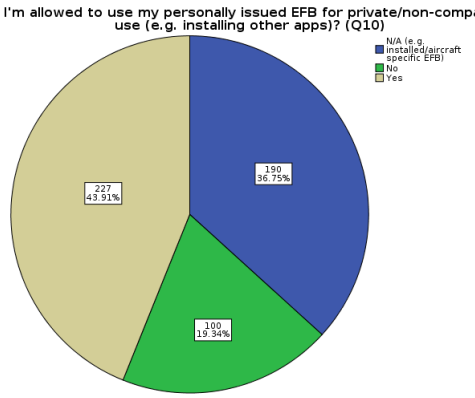

FIGURE 10. I'm allowed to use my personally issued EFB for private/non-company use (e.g. installing other apps)? (Q10)

I'm allowed to use my personally issued EFB for private/non-company use (e.g. installing other apps)? (Q10)				
		Frequency	Percent	Valid Percent
Valid	N/A (e.g. installed/aircraft specific EFB)	190	36.8	36.8
	No	100	19.3	19.3
	Yes	227	43.9	43.9
	Total	517	100.0	100.0

TABLE 10. I'm allowed to use my personally issued EFB for private/non-company use (e.g. installing other apps)? (Q10)

43.9% (227) of the pilots were allowed to use their personally issued EFB for private use while 19.3% (100) were not. 36.8% (190) answered that they used an installed EFB and, hence, it was not applicable.

3.11 Do you find the weight, size or installment/stowage of the EFB to limit the way you use it in cockpit? (Q11)

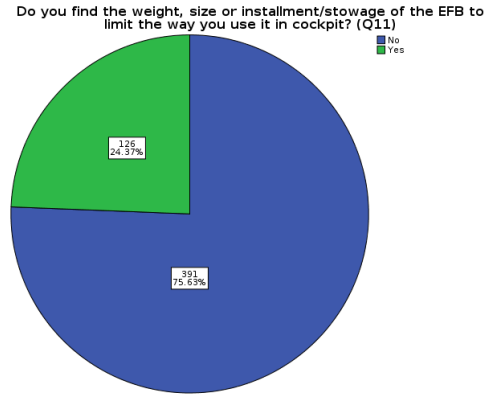

FIGURE 11. Do you find the weight, size or installment/stowage of the EFB to limit the way you use it in cockpit? (Q11)

Do you find the weight, size or installment/stowage of the EFB to limit the way you use it in cockpit? (Q11)				
		Frequency	Percent	Valid Percent
Valid	No	391	75.6	75.6
	Yes	126	24.4	24.4
	Total	517	100.0	100.0

TABLE 11. Do you find the weight, size or installment/stowage of the EFB to limit the way you use it in cockpit? (Q11)

75.6% (391) of the pilots did not find that the weight, size or installment/storage of the EFB limited how they used it in the cockpit. 24.4% (126) answered that it affected them.

3.12 Type of power supply (Q12)

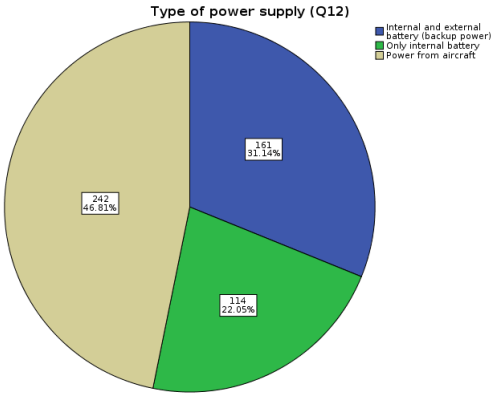

FIGURE 12. Type of power supply (Q12)

Type of power supply (Q12)				
		Frequency	Percent	Valid Percent
Valid	Internal and external battery (backup power)	161	31.1	31.1
	Only internal battery	114	22.1	22.1
	Power from aircraft	242	46.8	46.8
	Total	517	100.0	100.0

TABLE 12. Type of power supply (Q12)

Almost half of the pilots, 46.8% (242), used an EFB that were powered from the aircraft. 31.1% (161) used internal and external battery (backup power). While the power supply of remaining 22.1% (114) was internal battery only.

3.13 I find battery depletion to be a problem during line operation? (Q13)

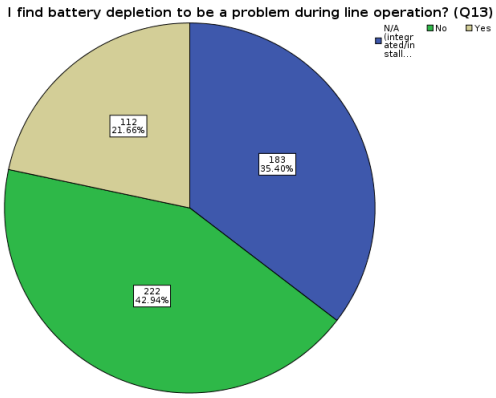

FIGURE 13. I find battery depletion to be a problem during line operation? (Q13)

I find battery depletion to be a problem during line operation? (Q13)				
		Frequency	Percent	Valid Percent
Valid	N/A (integrated/installed/power from aircraft)	183	35.4	35.4
	No	222	42.9	42.9
	Yes	112	21.7	21.7
	Total	517	100.0	100.0

TABLE 13. I find battery depletion to be a problem during line operation? (Q13)

42.9% (222) of the pilots did not find battery depletion to be a problem during line operation. For 21.7% (112) it was and the remaining 35.4% (183) answered not applicable (N/A) because was integrated/installed/powered from aircraft.

3.14 I'm satisfied with the general performance of the EFB in use (Q14)

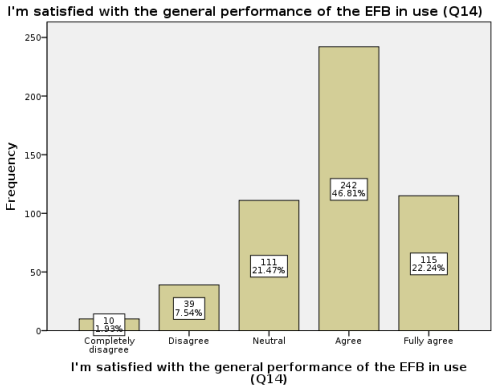

FIGURE 14. I'm satisfied with the general performance of the EFB in use (Q14)

I'm satisfied with the general performance of the EFB in use (Q14)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	10	1.9	1.9
	Disagree	39	7.5	7.5
	Neutral	111	21.5	21.5
	Agree	242	46.8	46.8
	Fully agree	115	22.2	22.2
	Total	517	100.0	100.0

TABLE 14. I'm satisfied with the general performance of the EFB in use (Q14)

69% (357) of the pilots were satisfied with the general performance of the EFB in use, 9.4% (49) were not satisfied and 21.5% (111) were neutral.

3.15 Procedures and requirements regarding sync of EFB content are clear and well-documented? (Q15)

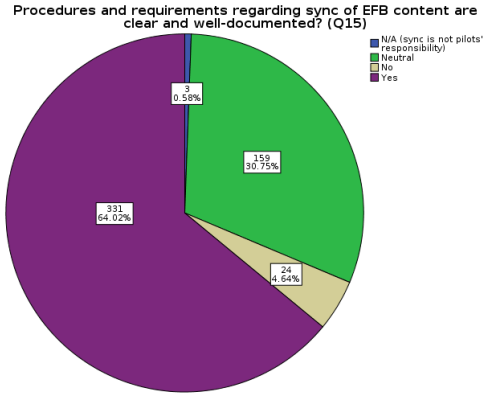

FIGURE 15. Procedures and requirements regarding sync of EFB content are clear and well-documented? (Q15)

Procedures and requirements regarding sync of EFB content are clear and well-documented? (Q15)				
		Frequency	Percent	Valid Percent
Valid	N/A (sync is not pilots' responsibility)	3	0.6	0.6
	Neutral	159	30.8	30.8
	No	24	4.6	4.6
	Yes	331	64.0	64.0
	Total	517	100.0	100.0

TABLE 15. Procedures and requirements regarding sync of EFB content are clear and well-documented? (Q15)

A majority of the pilots, 64% (331), answered that procedures and requirements regarding sync of EFB content were clear and well-documented. 4.6% (24) answered that they were not clear and well-documented. Remaining 30.8% (159) were neutral. 0.6% (3) answered not applicable (N/A) because was not the pilots' responsibility.

3.16 I find it easy to check if the EFB is up-to-date (Q16)

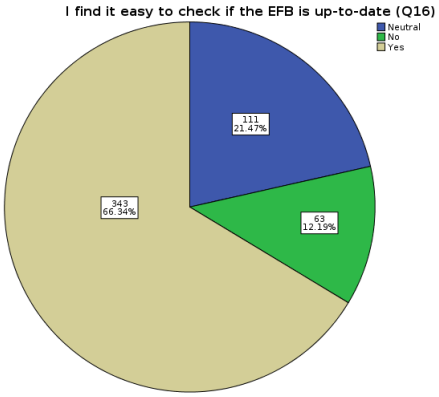

FIGURE 16. I find it easy to check if the EFB is up-to-date (Q16)

I find it easy to check if the EFB is up-to-date (Q16)				
		Frequency	Percent	Valid Percent
Valid	Neutral	111	21.5	21.5
	No	63	12.2	12.2
	Yes	343	66.3	66.3
	Total	517	100.0	100.0

TABLE 16. I find it easy to check if the EFB is up-to-date (Q16)

66.3% (343) found it easy to check if the EFB was up-to-date. 12.2% (63) answered that they did not find it easy. 21.5% (111) were neutral. 0% (0) answered not applicable (N/A) because it was not the pilots' responsibility.

3.17 I find it easy to sync EFB content (Q17)

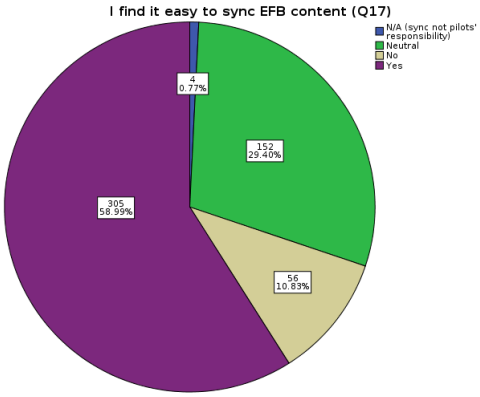

FIGURE 17. I find it easy to sync EFB content (Q17)

I find it easy to sync EFB content (Q17)				
		Frequency	Percent	Valid Percent
Valid	N/A (sync not pilots' responsibility)	4	0.8	0.8
	Neutral	152	29.4	29.4
	No	56	10.8	10.8
	Yes	305	59.0	59.0
	Total	517	100.0	100.0

TABLE 17. I find it easy to sync EFB content (Q17)

59% (305) of the pilots found it easy to sync EFB content. 10.8% (56) answered that they did not find it easy. 29.4% (152) were neutral. 0.8% (4) answered not applicable (N/A) because it was not the pilots' responsibility.

3.18 Have you received training for your current EFB? (Q18)

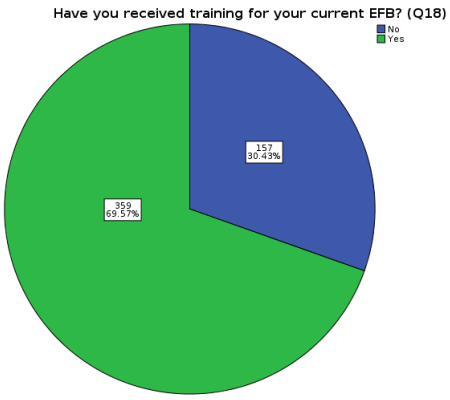

FIGURE 18. Have you received training for your current EFB? (Q18)

Have you received training for your current EFB? (Q18)				
		Frequency	Percent	Valid Percent
Valid	No	157	30.4	30.4
	Yes	359	69.4	69.6
	Total	516	99.8	100.0
Missing		1	0.2	
Total		517	100.0	

TABLE 18. Have you received training for your current EFB? (Q18)

69.6% (359) had received training for their current EFB while 30.4% (157) had not.

3.19 What type of EFB training have you received? (Q19)

What type of EFB training have you received? (Q19)		
	Frequency	Percent
Self-studies (e.g. CBT)	246	68.3
Hands-on class room training	200	55.6
Integrated with simulator training	134	37.2
Other	30	8.3

TABLE 19. What type of EFB training have you received? (Q19)

In terms of received EFB training, 68.3% (246) of the pilots answered they had performed self-studies (e.g. CBT), 55.6% (200) had hands-on class room training, 37.2% (134) had EFB training integrated with simulator training and 8.3% (30) had some other form of training.

3.20 Do you have Initial and/or Recurrent EFB training? (Q20)

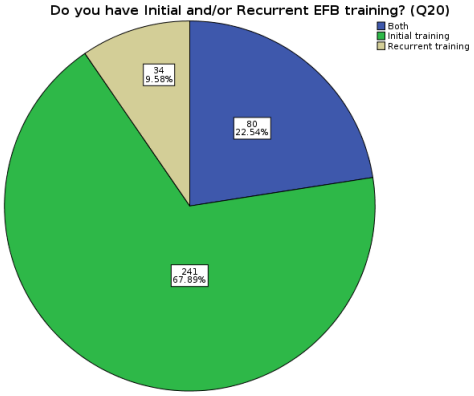

FIGURE 19. Do you have Initial and/or Recurrent EFB training? (Q20)

Do you have Initial and/or Recurrent EFB training? (Q20)				
		Frequency	Percent	Valid Percent
Valid	Both	80	15.5	22.5
	Initial training	241	46.6	67.9
	Recurrent training	34	6.6	9.6
	Total	355	68.7	100.0
Missing		162	31.3	
Total		517	100.0	

TABLE 20. Do you have Initial and/or Recurrent EFB training? (Q20)

67.9% (241) of the pilots had received Initial training, 9.6% (34) had received Recurrent training and 22.5% (80) had received both.

3.21 Is EFB use during simulator training representative for daily operational use? (Q21)

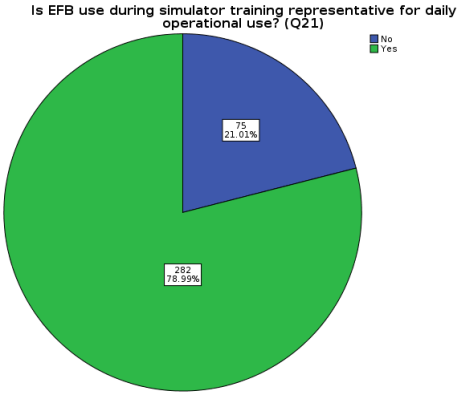

FIGURE 20. Is EFB use during simulator training representative for daily operational use? (Q21)

Is EFB use during simulator training representative for daily operational use? (Q21)				
		Frequency	Percent	Valid Percent
Valid	No	75	14.5	21.0
	Yes	282	54.5	79.0
	Total	357	69.1	100.0
Missing		160	30.9	
Total		517	100.0	

TABLE 21. Is EFB use during simulator training representative for daily operational use? (Q21)

79% (282) answered that the EFB used during simulator training was representative for daily operational use. 21% (75) answered that it was not representative for daily operational use.

3.22 I have received the following training (Q22)

I have received the following training (Q22)		
	Frequency	Percent
An overview of the system architecture	258	75.0
Pre-flight checks of the system	222	64.5
Limitations of the system	154	44.8
Specific training on the use of each application and the conditions under which the EFB may and may not be used	20	5.8
Restrictions on the use of the system, including where some or the entire system is not available	147	42.7
Procedures for normal operations, including cross-checking of data entry and computed information	288	83.7
Procedures to handle abnormal situations, such as a late runway change or diversion to an alternate aerodrome	170	49.4
Procedures to handle emergency situations	153	44.5
Phases of the flight when the EFB system may and may not be used	150	43.6
CRM and human factor considerations on the use of the EFB	121	35.2
Additional training for new applications or changes to the hardware configuration	84	24.4

TABLE 22. I have received the following training (Q22)

Three (3) types of training had been received by almost 1/3 (64.5%) or more:

1. "procedures for normal operations, including cross-checking of data entry and computed information" 83.7% (288)
2. "an overview of the system architecture" 75% (258)
3. "pre-flight checks of the system" 64.5% (222)

The training with the lowest received percentage, 5.8% (20), was "specific training on the use of each application and the conditions under which the EFB may and may not be used".

3.23 Would company EFB training (initial and/or recurrent) be useful? (Q23)

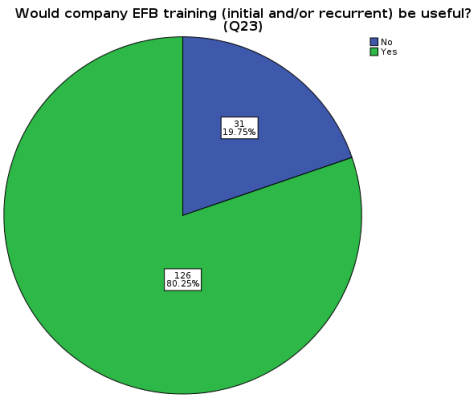

FIGURE 21. Would company EFB training (initial and/or recurrent) be useful? (Q23)

Would company EFB training (initial and/or recurrent) be useful? (Q23)				
		Frequency	Percent	Valid Percent
Valid	No	31	6.0	19.7
	Yes	126	24.4	80.3
	Total	157	30.4	100.0
Missing		360	69.6	
Total		517	100.0	

TABLE 23. Would company EFB training (initial and/or recurrent) be useful? (Q23)

Of the 157 pilots that had not received training for the current EFB (see 3.18), 80.3% (126) answered that company EFB training (initial and/or recurrent) would be useful. The remaining 19.6% (31) answered that it would not be useful.

3.24 Select one or more of the alternatives below which you believe should have been included in initial and/or recurrent EFB training (Q24)

Select one or more of the alternatives below which you believe should have been included in initial and/or recurrent EFB training (Q24)		
	Frequency	Percent
An overview of the system architecture	80	65.0
Pre-flight checks of the system	46	37.4
Limitations of the system	59	48.0
Specific training on the use of each application and the conditions under which the EFB may and may not be used	1	0.8
Restrictions on the use of the system, including where some or the entire system is not available	46	37.4
Procedures for normal operations, including cross-checking of data entry and computed information	65	52.8
Procedures to handle abnormal situations, such as a late runway change or diversion to an alternate aerodrome	64	52.0
Procedures to handle emergency situations	56	45.5
Phases of the flight when the EFB system may and may not be used	35	28.5
CRM and human factor considerations on the use of the EFB	67	54.5
Additional training for new applications or changes to the hardware configuration	72	58.5
Other	3	2.4

TABLE 24. Select one or more of the alternatives below which you believe should have been included in initial and/or recurrent EFB training (Q24)

Five (5) types of training had been selected by a majority (50% or more) to be included in initial and/or recurrent EFB training:

1. "an overview of the system architecture" 65% (80)
2. "additional training for new applications or changes to the hardware configuration" 58.5% (72)
3. "CRM and human factor considerations on the use of the EFB" 54.5% (67)
4. "procedures for normal operations, including crosschecking of data entry and computed information" 52.8% (65)
5. "procedures to handle abnormal situations, such as a late runway change or diversion to an alternate aerodrome" 52% (64)

"Specific training on the use of each application and the conditions under which the EFB may and may not be used" had the lowest percentage 0.8% being selected by only one (1) pilot.

3.25 Is correct use of the EFB assessed during PC/OPC? (Q25)

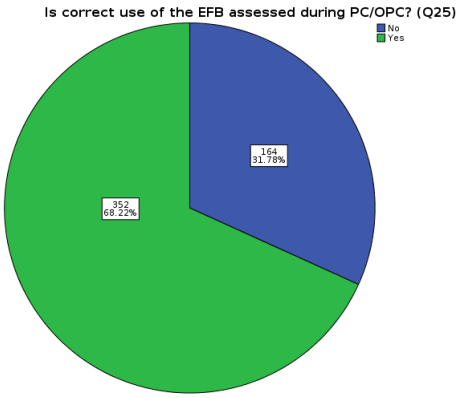

FIGURE 22. Is correct use of the EFB assessed during PC/OPC? (Q25)

Is correct use of the EFB assessed during PC/OPC? (Q25)				
		Frequency	Percent	Valid Percent
Valid	No	164	31.7	31.8
	Yes	352	68.1	68.2
	Total	516	99.8	100.0
Missing		1	0.2	
Total		517	100.0	

TABLE 25. Is correct use of the EFB assessed during PC/OPC? (Q25)

68.2% (352) of the pilots answered that the correct use of the EFB was assessed during PC/OPC. 31.8% (164) answered that correct use was not assessed during PC/OPC.

3.26 Is correct use of the EFB assessed during LINE CHECKS? (Q26)

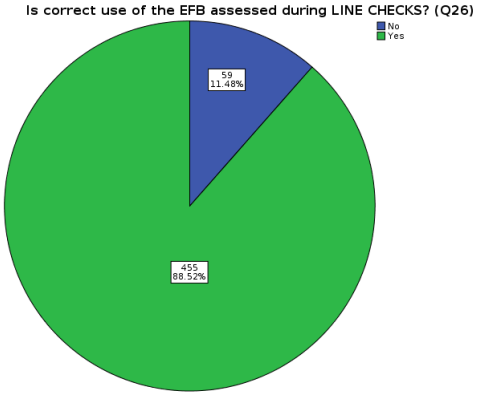

FIGURE 23. Is correct use of the EFB assessed during LINE CHECKS? (Q26)

Is correct use of the EFB assessed during LINE CHECKS? (Q26)				
		Frequency	Percent	Valid Percent
Valid	No	59	11.4	11.5
	Yes	455	88.0	88.5
	Total	514	99.4	100.0
Missing		3	0.6	
Total		517	100.0	

TABLE 26. Is correct use of the EFB assessed during LINE CHECKS? (Q26)

88.5% (455) of the pilots answered that the correct use of the EFB was assessed during line checks. 11.5% (59) answered that correct use was not assessed during line checks.

3.27 The company has clear and well-documented procedures for use of EFB? (Q27)

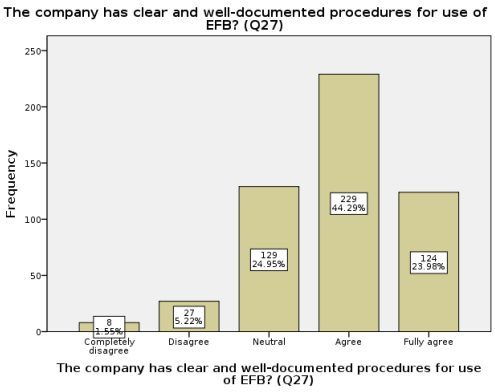

FIGURE 24. The company has clear and well-documented procedures for use of EFB? (Q27)

The company has clear and well-documented procedures for use of EFB? (Q27)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	8	1.5	1.5
	Disagree	27	5.2	5.2
	Neutral	129	25.0	25.0
	Agree	229	44.3	44.3
	Fully agree	124	24.0	24.0
	Total	517	100.0	100.0

TABLE 27. The company has clear and well-documented procedures for use of EFB? (Q27)

68.3% (353) of the pilots agreed that their company had clear and well-documented procedures for use of EFB, 6.7% (35) disagreed and 25% (129) were neutral.

3.28 I have to come up with own procedures due to lack of company procedures (Q28)

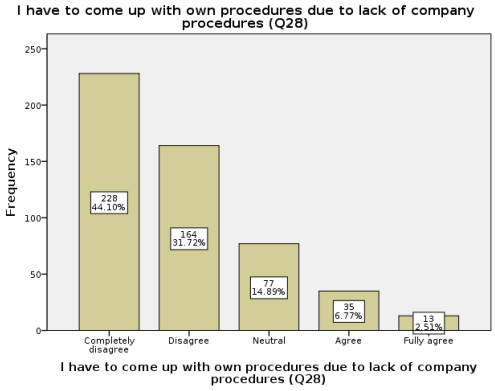

FIGURE 25. I have to come up with own procedures due to lack of company procedures (Q28)

I have to come up with own procedures due to lack of company procedures (Q28)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	228	44.1	44.1
	Disagree	164	31.7	31.7
	Neutral	77	14.9	14.9
	Agree	35	6.8	6.8
	Fully agree	13	2.5	2.5
	Total	517	100.0	100.0

TABLE 28. I have to come up with own procedures due to lack of company procedures (Q28)

75.8% (392) of the pilots disagreed that they had to come up with own procedures due to lack of company procedures, 9.3% (48) disagreed and 14.9% (77) were neutral.

3.29 EFB is used for performance calculations in my company (Q29)

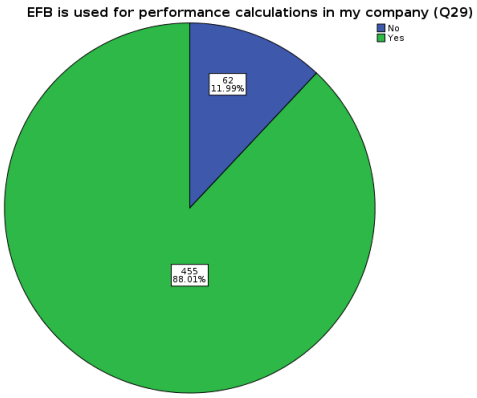

FIGURE 26. EFB is used for performance calculations in my company (Q29)

EFB is used for performance calculations in my company (Q29)				
		Frequency	Percent	Valid Percent
Valid	No	62	12.0	12.0
	Yes	455	88.0	88.0
	Total	517	100.0	100.0

TABLE 29. EFB is used for performance calculations in my company (Q29)

88% (455) of the pilots used EFB for performance calculations in their company. Remaining 12% (62) did not use EFB for performance calculations in their company.

3.30 I find that my company has well described company procedures for performance calculations? (Q30)

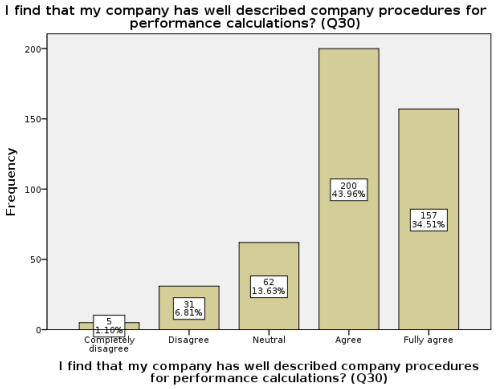

FIGURE 27. I find that my company has well described company procedures for performance calculations? (Q30)

I find that my company has well described company procedures for performance calculations? (Q30)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	5	1.0	1.1
	Disagree	31	6.0	6.8
	Neutral	62	12.0	13.6
	Agree	200	38.7	44.0
	Fully agree	157	30.4	34.5
	Total	455	88.0	100.0
Missing	System	62	12.0	
Total		517	100.0	

TABLE 30. I find that my company has well described company procedures for performance calculations? (Q30)

78.5% (357) of the pilots agreed that their company had well described company procedures for performance calculations, 7.9% (36) disagreed and 13.6% (62) were neutral.

3.31 I find that my company procedures for performance calculations are good (Q31)

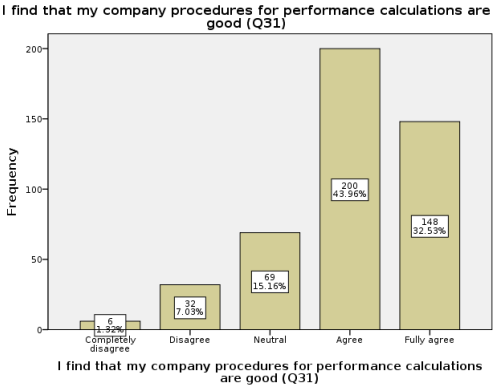

FIGURE 28. I find that my company procedures for performance calculations are good (Q31)

I find that my company procedures for performance calculations are good (Q31)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	6	1.2	1.3
	Disagree	32	6.2	7.0
	Neutral	69	13.3	15.2
	Agree	200	38.7	44.0
	Fully agree	148	28.6	32.5
	Total	455	88.0	100.0
	System	62	12.0	
Total		517	100.0	

TABLE 31. I find that my company procedures for performance calculations are good (Q31)

76.5% (348) of the pilots agreed that their company procedures for performance calculations were good, 8.3% (38) disagreed and 15.2% (69) were neutral.

3.32 Performance calculation(s) and cross-checking (Q32)

Performance calculation(s) and cross-checking (Q32)				
		Frequency	Percent	Valid Percent
Valid	Independent performance calculations and cross-check of result	294	56.9	64.6
	FO performs calculation, Captain cross-checks result	69	13.3	15.2
	PF performs calculation, PNF/PM cross-checks result	59	11.4	13.0
	PNF/PM performs calculation, PF cross-checks result	22	4.3	4.8
	Other option	7	1.4	1.5
	Captain performs calculation, FO cross-checks result	4	0.8	0.9
	Total	455	88.0	100.0
Missing		62	12.0	
Total		517	100.0	

TABLE 32. Performance calculation(s) and cross-checking (Q32)

64.6% (294) of the pilots performed independent performance calculations and cross-check of results.

For roles Captain and First Officer, 15.2% (69) answered that FO performed calculation and captain cross-checked results. 0.9% (4) answered that it was the opposite, i.e. captain performed calculation and FO cross-checked results.

For roles PF and PNF/PM, 13% (59) answered that PF performed calculation and PNF/PM cross-checked results. 4.8% (22) answered that it was the opposite, i.e. PNF/PM performed calculation and PM cross-checked results.

1.5% (7) answered that performance calculation and cross-checking was made in some other way.

3.33 Our SOP includes a Gross-error check of performance calculations (Q33)

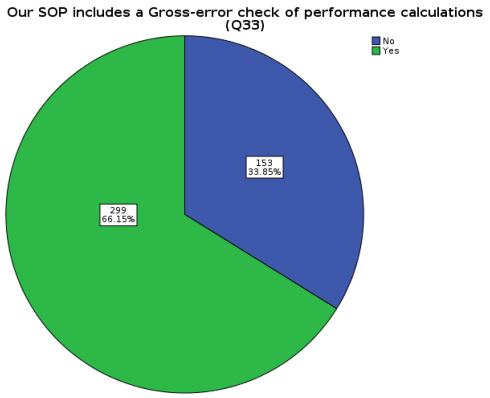

FIGURE 29. Our SOP includes a Gross-error check of performance calculations (Q33)

Our SOP includes a Gross-error check of performance calculations (Q33)				
		Frequency	Percent	Valid Percent
Valid	No	153	29.6	33.8
	Yes	299	57.8	66.2
	Total	452	87.4	100.0
Missing		65	12.6	
Total		517	100.0	

TABLE 33. Our SOP includes a Gross-error check of performance calculations (Q33)

66.2% (299) of the pilots answered that their SOP included a gross-error check of performance calculations. 33.8% (153) answered that their SOP did not include it.

3.34 Results of performance calculations are available even when swapping between apps (Q34)

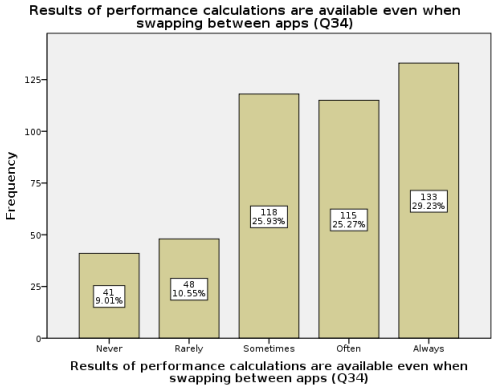

FIGURE 30. Results of performance calculations are available even when swapping between apps (Q34)

Results of performance calculations are available even when swapping between apps (Q34)				
		Frequency	Percent	Valid Percent
Valid	Never	41	7.9	9.0
	Rarely	48	9.3	10.5
	Sometimes	118	22.8	25.9
	Often	115	22.2	25.3
	Always	133	25.7	29.2
	Total	455	88.0	100.0
Missing	System	62	12.0	
Total		517	100.0	

TABLE 34. Results of performance calculations are available even when swapping between apps (Q34)

29.2% (133) of the pilots answered that results of performance calculations always were available even when swapping between apps. While 19.6% (99) answered that the performance calculations never or rarely were available.

3.35 Results from performance calculations are transferred to paper or other app (Q35)

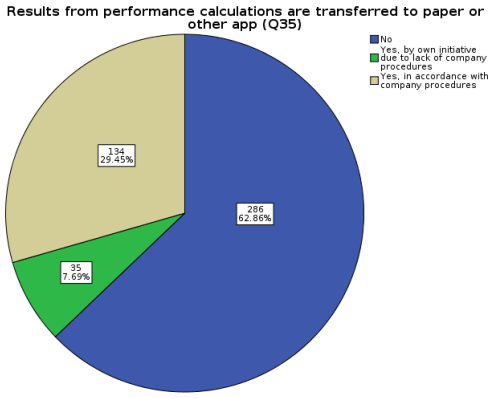

FIGURE 31. Results from performance calculations are transferred to paper or other app (Q35)

Results from performance calculations are transferred to paper or other app (Q35)				
		Frequency	Percent	Valid Percent
Valid	No	286	55.3	62.9
	Yes, by own initiative due to lack of company procedures	35	6.8	7.7
	Yes, in accordance with company procedures	134	25.9	29.5
	Total	455	88.0	100.0
Missing		62	12.0	
Total		517	100.0	

TABLE 35. Results from performance calculations are transferred to paper or other app (Q35)

62.9% (286) did not transfer results from performance calculations to paper or other app. 29.5% (134) did transfer in accordance with company procedures and 7.7% (35) transfered by own initiative due to lack of company procedures.

3.36 EFB is used for Documentation/Information in my company (Q36)

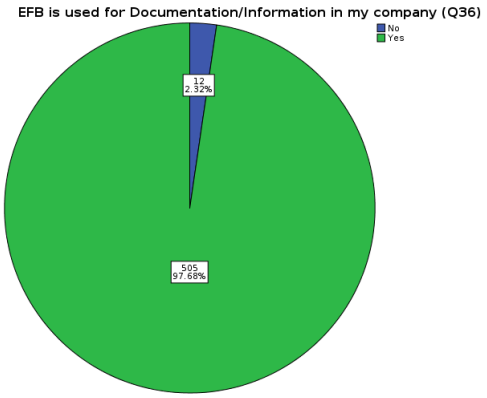

FIGURE 32. EFB is used for Documentation/Information in my company (Q36)

EFB is used for Documentation/Information in my company (Q36)				
		Frequency	Percent	Valid Percent
Valid	No	12	2.3	2.3
	Yes	505	97.7	97.7
	Total	517	100.0	100.0

TABLE 36. EFB is used for Documentation/Information in my company (Q36)

97.7% (505) of the pilots used the EFB for documentation/information in their company. The remaining 2.3% (12) did not use the EFB for this.

3.37 I find it easy to make and use bookmarks (Q37)

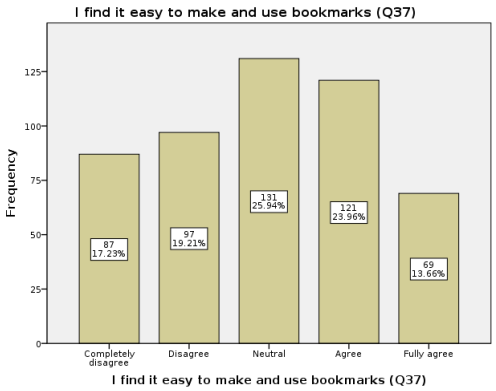

FIGURE 33. I find it easy to make and use bookmarks (Q37)

I find it easy to make and use bookmarks (Q37)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	87	16.8	17.2
	Disagree	97	18.8	19.2
	Neutral	131	25.3	25.9
	Agree	121	23.4	24.0
	Fully agree	69	13.3	13.7
	Total	505	97.7	100.0
Missing	System	12	2.3	
Total		517	100.0	

TABLE 37. I find it easy to make and use bookmarks (Q37)

37.7% (190) of the pilots agreed that they found it easy to make and use bookmarks, 36.4% (184) disagreed and 25.9% (131) were neutral.

3.38 I find it easy to find documentation/information that I'm looking for (Q38)

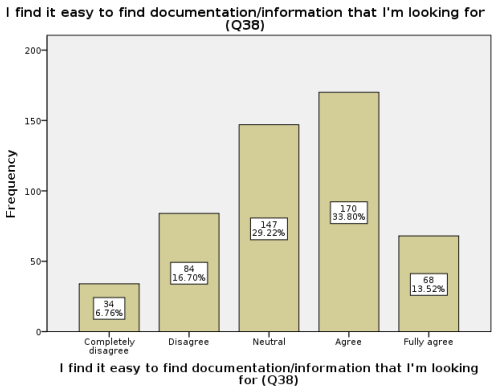

FIGURE 34. I find it easy to find documentation/information that I'm looking for (Q38)

I find it easy to find documentation/information that I'm looking for (Q38)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	34	6.6	6.8
	Disagree	84	16.2	16.7
	Neutral	147	28.4	29.2
	Agree	170	32.9	33.8
	Fully agree	68	13.2	13.5
	Total	503	97.3	100.0
Missing	System	14	2.7	
Total		517	100.0	

TABLE 38. I find it easy to find documentation/information that I'm looking for (Q38)

47.3% (238) of the pilots agreed that they found it easy to find documentation/information that they were looking for, 29.2% (147) were neutral and 23.5% (118) disagreed.

3.39 I find it easy to make and access notes (Q39)

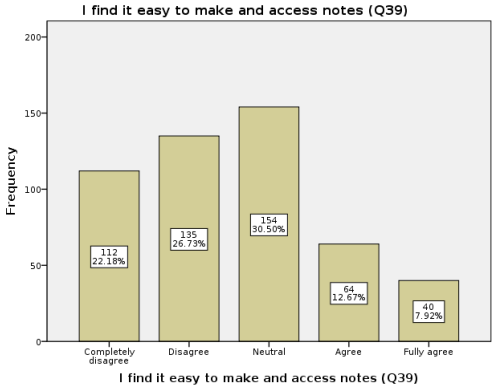

FIGURE 35. I find it easy to make and access notes (Q39)

I find it easy to make and access notes (Q39)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	112	21.7	22.2
	Disagree	135	26.1	26.7
	Neutral	154	29.8	30.5
	Agree	64	12.4	12.7
	Fully agree	40	7.7	7.9
	Total	505	97.7	100.0
Missing	System	12	2.3	
Total		517	100.0	

TABLE 39. I find it easy to make and access notes (Q39)

48.9% (237) of the pilots disagreed that they found it easy to make and access notes, 30.5% (154) were neutral and 20.6% (104) agreed.

3.40 I generally find it easy to use new technology (Q40)

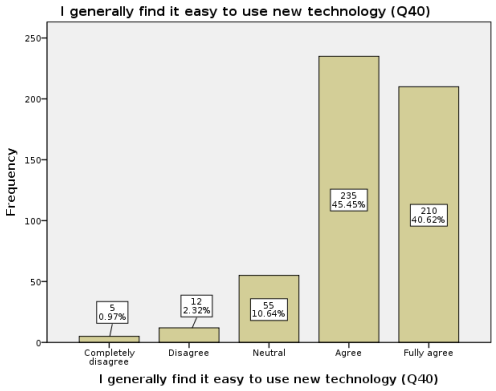

FIGURE 36. I generally find it easy to use new technology (Q40)

I generally find it easy to use new technology (Q40)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	5	1.0	1.0
	Disagree	12	2.3	2.3
	Neutral	55	10.6	10.6
	Agree	235	45.5	45.5
	Fully agree	210	40.6	40.6
	Total	517	100.0	100.0

TABLE 40. I generally find it easy to use new technology (Q40)

86.1% (445) of the pilots agreed that they found it easy to use new technology, 10.6% (55) were neutral and 3.3% (17) disagreed.

3.41 I had a good experience of the EFB during introduction/when I first started using it (Q41)

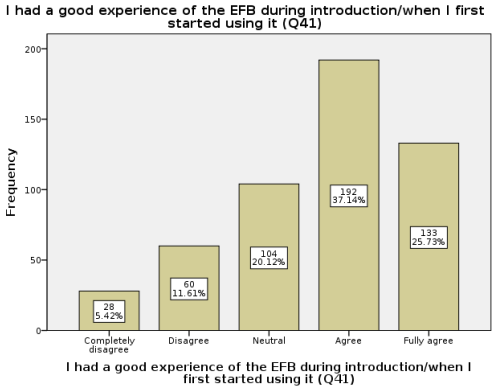

FIGURE 37. I had a good experience of the EFB during introduction/when I first started using it (Q41)

I had a good experience of the EFB during introduction/when I first started using it (Q41)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	28	5.4	5.4
	Disagree	60	11.6	11.6
	Neutral	104	20.1	20.1
	Agree	192	37.1	37.1
	Fully agree	133	25.7	25.7
	Total	517	100.0	100.0

TABLE 41. I had a good experience of the EFB during introduction/when I first started using it (Q41)

62.8% (325) of the pilots agreed that they had a good experience of the EFB during introduction/when they first started using it, 20.1% (104) were neutral and 17% (88) disagreed.

3.42 I have a good experience of the EFB now/when I have gotten used to it (Q42)

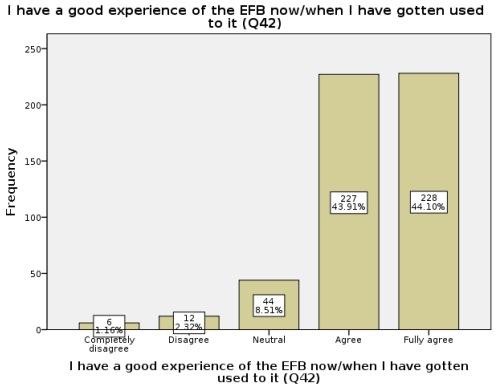

FIGURE 38. I have a good experience of the EFB now/when I have gotten used to it (Q42)

I have a good experience of the EFB now/when I have gotten used to it (Q42)				
		Frequency	Percent	Valid Percent
Valid	Completely disagree	6	1.2	1.2
	Disagree	12	2.3	2.3
	Neutral	44	8.5	8.5
	Agree	227	43.9	43.9
	Fully agree	228	44.1	44.1
	Total	517	100.0	100.0

TABLE 42. I have a good experience of the EFB now/when I have gotten used to it (Q42)

88.0% (455) of the pilots agreed that they had a good experience of the EFB during introduction/when they first started using it, 8.5% (44) were neutral and 3.5% (18) disagreed.

4 Discussion

Discussion about survey

The creation of the survey was an iterative process using feedback from test subjects yet several things of improvement came up after the survey had been published.

The majority of the questions were created based on *AMC 20-25* in order to give an indication of to what extent the recommended best practices were applied among the participating airlines. For many questions a symmetric five item Likert scale was used in order to capture the pilots perception of a certain item as accurately as possible. All questions were meant to require an answer. However, during the creation of the survey several questions (18-26 and 38) were created without this requirement. Hence, the count of answers do not always add up while going through the results. Therefore, if question 18 *Have you received training for your current EFB? (Q18)* (see 3.18) was not answered the online survey continued as if *EFB Training* had been received with *What type of EFB training have you received? (Q19)* (see 3.19). It should not have any significant impact since this only happened for one (1) pilot of the 517 responding pilots.

Question 3 *Your age in years (Q3)* (see 3.3) should have been entered explicitly by the respondent instead of creating groups based on different age intervals. The reason for this is that by creating groups granularity was lost. It made it more difficult to analyze the data in SPSS and if there was a need for grouping that could have been done in SPSS. The hindsight on explicit input instead of groups applies to question 4 regarding *total flight hours* as well (see 3.4).

Question 6 *I have previous experience of using EFBs in OTHER companies (Q6)* (see 3.6) should have been asked only to those pilots that have been in other companies with an additional option that their previous company did not have EFBs.

Question 8 *How is the EFB issued? (Q8)* (see 3.8) should have been a multiple choice. There could be companies where both are used depending on e.g. fleet and time in the company. It was assumed that the respondent's answer is the option most used.

Question 21 *Is EFB use during simulator training representative for daily operational use? (Q21)* (see 3.21) should have been asked to all pilots and not only pilots who received training.

The list of answers in questions 22 and 24 are from *AMC 20-25* (EASA 2014a).

Question 39 *I find it easy to make and access notes (Q39)* (see 3.39) is two questions in one. It is not possible to determine if the pilots answered that they found it easy or hard to *make notes* or if they found it easy or hard to *access notes* they had already created. It was only possible to determine that there was some discontent with creating *and/or* accessing notes.

If more advanced statistical methods, such as correlation, was to be used the questions might have had to be adjusted.

With the chosen method and the relatively few missing replies the survey fulfilled requirements for validity and reliability.

Discussion about results

Even though the rules governing use of EFBs are the same for all European operators it is up to each operator to interpret and show compliance with them in a way which is acceptable to the national aviation authorities in each country. That is likely why the results of the survey revealed differences in the use of EFBs among the participating operators.

Regarding the population, a clear majority of the pilots were above 40 years. That together with total flight hours gave an indication that the pilots surveyed had a lot of flying experience. 7% of all the pilots had no experience of flight decks without EFBs. With time this number

is likely to increase as a result of new pilots joining the industry. Almost 64% of the pilots answered positive to them having a good experience of the EFB during introduction and/or when they first started using it. This number increased even further to 88% being positive at the time of the survey and/or when they had gotten used to it.

The type of EFB used was 70% portable and 30% installed. The airlines seemed to favor portable EFBs for various reasons. It has become a working tool for their pilots both inside and outside of the flight deck having access to email, charts, manuals, etc. One question is whether the number of installed EFBs will increase with newer airplane models being added to the fleet. There are, of course, pros and cons with portable and installed EFBs. Installed EFBs most likely provide better integration with the airplane but not necessarily better ergonomics. Whereas portable EFBs can be used everywhere and can be replaced easier. Portable EFBs can also have less strict rules regarding app usage as they do not necessarily require airworthiness approvals *AMC 20-25*. Implications are not only in the actual working environment, but also during training and checking, e.g. if the EFBs are not available in the simulator.

With regards to the general performance of the EFB in use, 69% of the pilots answered that they were positive. At the same time, almost 22% (112) of the pilots found that battery depletion ws a problem during line operation despite recommendations regarding power source and acceptable margins (EASA 2014a). If this experience stems from factual or perceived circumstances remains undetermined. One can argue whether it is too high or not to be satisfactory. However, there is no immediate threat with regards to running out of battery compared to e.g. making an incorrect performance calculation. A brief search on the internet has not revealed any cases where battery depletion has been reported as a contributing factor to accidents or incidents. You will become aware of the battery depletion whereas the incorrect performance calculation might go unnoticed and actually affect flight safety. A potential problem for pilots experiencing battery depletion is that it could alter how the pilot uses the EFB in order to reduce power consumption. That is, the pilot will e.g. lower brightness and turn off the screen more often. Turning off the screen, e.g. during arrival phase, will likely result in a lower situational awareness than if the screen had been on and the charts available at all times. With every fifth pilot reporting concerns over battery depletion, further investigation by the operators is called for in order to improve the user experience.

Most pilots used an EFB in their airline that was approved for all phases of flight. Even with the incorrect answers (see 3.9) the tendency was clear. Almost 25% of the pilots found the weight, size or installment/stowage of the EFB to limit the way they used it in the cockpit. A high percentage considering it is one of the tools pilots use the most while at work and that ergonomics and job satisfaction are related (Andersson et al. 2007).

Training

It is generally accepted that training is needed to ensure adequate performance and to ensure improved performance. In addition the applicable regulations governing EFBs stipulate that training shall be conducted in relevant aspects of EFBs before they are introduced into line operation (EASA 2014a). Therefore it is surprising to see that almost a third of the pilots reported that they had not received any training (see 3.18) and 80.3% (126) of these pilots answered that it would be useful (see 3.23). There could be reasons to have no or very limited training for EFBs with very basic functionality but the results from the survey indicate that most operators use the EFBs for mission critical purposes. For example, 88% (455) of the pilots answered that they used the EFB for performance calculations (see 3.29).

For the same reason it is relevant to note that only about one third of those who received training, received recurrent training (see 3.20). Meaning that 77% (398 out of 516) pilots either received no training at all or only initial training. No recurrent training would be understandable if the EFB remain static. That is, there are no relevant software application

updates, software applications is neither added nor removed, etc., after the initial training, if any, was completed. However, it is reasonable to assume that hardware and software changes in the realm of EFBs happen just as fast as in the rest of the digitalized world.

When it comes to the content of the training received the answers indicates good correlation between what is recommended topics (EASA 2014a) and what the pilots have received (see3.22). There are two items which stand out as exceptions. One is additional training for new applications or hardware changes which less than one quarter of the pilots who had received training answered they had received. This data relates to the finding above that a majority of the pilots did not receive recurrent training. The other item which stands out from the rest is "Specific training on the use of each application and the conditions under which the EFB may or may not be used" with as few as 5.8% selected. Further investigation will need to be done by the respective stakeholders if they are to find out the underlying reasons.

Only 37.2% of EFB training was integrated with simulator training (see 3.19). This may very well be due to the high cost of simulator time and that it is considered more cost efficient and effective due to less disturbance from other stimuli to do EFB training outside of the actual simulator. Most important is that EFB is used and checked in simulator training and not that EFB training is integrated in simulator environment.

68% of the pilots answered that correct use of the EFB was assessed during PC/OPC. Hence, almost 32% answered that they were not. It is important to note that the answers reflect the pilots *perception* of what is assessed during PC/OPC and line checks. It is not possible to completely rule out that the use of EFB is assessed but not in a way that it is noticed by the pilots, e.g. if the EFB is not explicitly mentioned during debriefing of the pilots. There could be several reasons why more pilots report that correct use of EFBs is not assessed during PC/OPC than during line checks. For commercial air transport, PC/OPC are done in a simulator. If the EFBs are of the installed type they may not be installed in the simulator in use and consequently correct use of them cannot be assessed. Similar problems could arise if EFBs are aircraft specific and not issued to each individual pilot. If representative samples of the EFB are not placed in the simulator in use they cannot be assessed. In the same way there could be EFBs present but the assessment of them does not get done explicitly as a vast amount of other test and checks are performed which might obscure those of the EFB. No matter what the underlying reasons are for not assessing proper use of EFBs during PC/OPC it is troubling that as many as one third reported that they perceived that it was not assessed.

Performance

Performance calculations is one of the key topics referred to in *AMC 20-25* and errors associated with such calculations are often mentioned as contributing factors in accidents and incidents (ATSB 2011). The result from the survey shows that it is one of the most common things EFBs are used for. A vast majority, almost 90%, of the pilots answered that they used the EFB in their company for calculating performance thus making it a relevant and important topic to study.

It is positive to find that more than 75% answered that they had well described and good procedures for performance calculations. Almost 65% had procedures for calculation and crosschecking which were in line with relevant research and EASA's recommended best practices, namely independent calculations with subsequent cross checks of the results. It is not clear why the remaining 35% were not following the recommendations. There could be reasons such as only one EFB on-board which for practical purposes would make it difficult to perform independent calculations. It is worth noting that from the options which do not follow the recommendations it would be considered favorable to let the first officer perform the data entries and the captain checking the results rather than vice versa. The reason for this is that captains tend to be better at detecting errors made by the first officers than the

other way around (Thomas et al. 2004).

In order to detect data entry and calculation errors etc., *AMC 20-25* recommends gross error checks of the results by using a rule of thumb or cross checks against other sources of data from e.g. the aircraft. Yet above 33% of the pilots answered that their respective SOP did not contain a requirement for such gross error checks. Due to the complexity of the topic it is not possible to define a common standard but International Air Transport Association (IATA) recommends each operator to continue to develop principles and share experiences across airlines and fleets in order to further improve safety (IATA 2015).

As described by Nomura et al. (2006) different paper documents had different locations in a traditional paper based flight deck. With the introduction of an EFB, this may no longer be the case as many different types of documents and charts are co-located in the same device; operational flight plan, navigation charts, data from performance calculations etc. This has the risk of increasing the mental workload of the pilots and can induce errors if for example data no longer can be read from one paper and entered into another. Instead data has to be kept in memory by the pilots while they swap between the applicable applications in the EFB. If applications in the EFB do not retain data in memory when a user is swapping between applications it can cause even more strain and increase workload if calculations have to be re-made etc. Not even 30% of the pilots answered that their performance calculations always were available even when swapping between apps. Hence, 70% of the pilots might not have their performance calculations available after swapping between apps. This might be by application design and one can argue whether it is safer to enter all data (QNH, wind, takeoff weight etc.) or to just change e.g. takeoff weight or runway intersection. However, being able to go back and verify a performance calculation when in doubt instead of having to re-calculate in a possibly time-critical phase of flight has obvious advantages.

Documentation

Almost all pilots answered that they use the EFB for documentation. A check of the pilots who answered that they did not use the EFB for documentation revealed that they came from airlines where the authors know for a fact that the EFBs were used for documentation and all other pilots from the respective airline had replied that they did in fact use it for documentation. It is therefore likely that the few who answered no did so by mistake and that EFBs were used for documentation in all of the surveyed airlines.

One third answered that they were not pleased with the possibility to add bookmarks. As many as half of all pilots answered that they did not find it easy to create and access notes. One could argue that adding notes is a feature which might not be necessary for some operators and that could be the reason why it has not been given as much attention. Further investigation by each operator or software manufacturer is necessary to determine how bookmarks and notes can be improved.

Almost 25% answered that they did not find it easy to find the information they were looking for. Although a comparison with the old paper type of manuals has not been made in this survey, it is still worth considering that such a large group have difficulties finding the information they are looking for. Different types of search functions can, depending on how they are constructed, make it easier or more difficult to find the right information. Being able to search for information in a digital manual is a fast way of browsing through many pages and many different manuals. It can be difficult to ensure that the search returns are from the right section in the right manual if the search function is not designed in a user-friendly way. It can be overwhelming and time consuming to find the right search return if the result consists of a long list of search returns. Being able to narrow down the search to e.g. a certain aircraft registrations, a certain manual or even a specific chapter in a certain manual, are features which can minimize the risk of *confirmation bias* and help the pilots ensure they get the right returns when searching. This is particularly important in periods of high workload as information retrieval time has been shown to increase significantly with moderate to high

levels of workload when an EFB is used in lieu of paper (Hamblin 2004). To make manuals associated with abnormal and emergency procedures user-friendly is very important but considering how many pilots who use the manuals and how many who answered they found it difficult to find the information they were looking for, operators and software manufacturers should strive to improve user-friendliness of all parts of the digital libraries.

There is room for improvement regarding how the EFBs are used for content management. Information in terms of company and aircraft manufacturers' manuals and other published documents and forms can easily end up being in the numbers of hundreds with a total of 6000 pages or more. The exact number is not relevant. It is the tendency with more manuals and more pages, hence more information, which is important to be aware of and consider. Complexity is increased since the information can be communicated through several different channels, such as content management (documentation) app on EFBs, email and company NOTAMs.

Information overload, which was mentioned already back in year 1964, is even more current today due to information technology and as applicable for pilots as for any other category of professionals. Information technology gives the possibility to easily create and disseminate vast amounts of information to a wide audience and may be a primary reason for information overload (Evaristo et al. 1995; Hiltz et al. 1985). In an airline there exists a plethora of different roles among the pilots. There are various categories of instructors, checkers, administrators of various levels, pilots on different fleets or aircraft types etc. In order to prevent information overload an effort must be made to structure information based on the needs and abilities of the user groups or individuals rather than the available software features (Hiltz et al. 1985). This is important since an individual who is close to being overloaded could build up resistance to adoption (Evaristo et al. 1995). Such overload can be due to high mental workload being induced by technology which otherwise has many advantages. Needless to say adoption of new procedures and adherence to rules is very important in aviation.

5 Conclusions

There is very little public academic research on EFB, its use, effect on its users and their working environment as well as potential consequences on flight safety. With EFBs likely to become an aviation industry standard world-wide and an essential working tool in potentially every flight deck, more public research is essential to ensure an equivalent or improved level of safety.

The study showed that a large majority of the pilots used their EFB for mission critical purposes, such as performance calculations. Yet 77% of the pilots received no training or only initial training from the operators despite explicit recommendations by EASA. Operators are used to various mandatory recurrent training for their pilots, both theoretical and practical. It should be just as standardized to perform EFB training to ensure safe and efficient use.

The recommendation by EASA to perform independent performance calculations with cross check of result is well supported by research. Still a considerable number of the pilots in the surveyed airlines did not follow these recommendations. The operators are directly responsible for development of procedures used by their pilots and therefore need to assure that industry best practices are implemented in order to improve flight safety.

Introduction of EFBs has enabled operators to disseminate information in an unsurpassed way. Implementation of EFBs must be viewed not only from the perspective of the operator but also from the perspective of its users. For successful implementation and adaptation of the new technology and safety related procedures, information shall be structured and made available for its users based on the needs and abilities of the user groups or individuals and not based solely on available software features. In addition, pilots' abilities can be improved by relevant training. The operators also have the opportunity to reduce complexity by limiting the number of communication channels. This in order to limit the risk of information overload, minimize adoption resistance and, thereby, maximize return on investment and positive impact of the EFB.

The introduction of EFBs by operators happened over a relatively short period of time. Today, with more experience, it is time for reflection and improvement to make sure this new tool reaches its full potential and is used to improve efficiency and safety.

6 Future work

During the work with this thesis several topics suitable for further work and studies were identified. Below is a list of such topics in a non-specific order:

- Study and compare different software and hardware from a usability point of view
- Study and compare actual training received with what pilots want
- Study and compare ergonomics with respect to EFB in flight deck. Pros and cons with installable vs portable etc.
- Study the effect of personal iPads and tablets and the effect of "always being reachable"
- Study "information overload", i.e. with tablets the amount of information can be somewhat overwhelming. How does a pilot keep up? How does the pilot know that he/she hasn't missed any vital information during e.g. revision changes? What information channels are there (email, crew bulletins, NOTAMs, manuals)?
- Study and compare retaining of performance calculations results when swapping between apps with regards to verification and re-calculation due to e.g. new runway intersection, change of runway or change of runway surface friction coefficient.
- Study and compare differences between various groups of the pilots as well as possible correlations in the result.

Appendices

A LUBsearch

LUBsearch[6] is a collective entry point at Lund University to all the libraries' joint resources. Through a single search field, you can find primarily academic material such as articles, journals, doctoral theses and books.

LUBsearch was used to search for research material relevant for this thesis. The searching was generous, i.e. with an inclusion-bias rather than exclusion-bias.

A search was conducted for peer-reviewed academic material to exclude e.g. news articles and commercial non-peer-reviewed research.

There are an unknown number of non-public surveys, studies and other material potentially done within major companies (such as airline companies, software development companies etc).

search string	All	Peer-reviewed	relevant and unique
efb	4337	2679	insignificant[7]
efb AND aviation	238	8	5
efb AND electronic	470	38	7
efb AND electronic AND aviation	221	6	5
electronic flight bag	718	23	18[8]
ipad AND aviation	325	8	4[9]
ipad AND flight	661	10	2
fatigue	1032177	498776	
fatigue AND aviation	6464	2622	
fatigue AND aviation AND crew	604	265	majority
pilots AND decision AND airline	343		

Table 43. LUBSearch Results

[6] http://www.lub.lu.se/en/search-systems-and-tools/lubsearch
[7] almost all are non-aviation related, e.g. regarding biotechnology and chemical engineering
[8] at least 7 are non-academic, e.g. news material
[9] at least 1 are non-academic, e.g. news material

B Survey

EFB Survey

Dear colleagues,

We are two active pilots currently undertaking a bachelor degree at Lund University School of Aviation. As part of these studies we are writing a thesis about the use of EFBs. Considering how common EFBs have become the last few years there is surprisingly little research material available. We want to make at least a small contribution by mapping EFB usage in Scandinavia and to be able to do so we need your help.

We would be very thankful if you can help us by answering a few questions in a survey. It takes not much more than 5 minutes. Answers are of course anonymous and results will not be presented in a way which can identify a respondent or which airline the various responses refer to.

This is your chance to contribute and maybe be able to influence how EFBs will be used in the future.

* Required

General

Unless explicitly stated otherwise, all questions refer to the EFB currently in use.

1. **Type of EFB** *
   Mark only one oval.

   ◯ Portable (e.g. iPad, tablet, laptop) (EFB used on the flight deck, which is not part of the certified aircraft configuration)
   ◯ Installed (EFB installed in the aircraft and considered as an aircraft part, covered, thus, by the aircraft airworthiness approval)

2. **Your current position/rank** *
   Mark only one oval.

   ◯ Captain
   ◯ First Officer

3. **Your age in years** *
   Mark only one oval.

   ◯ 18-24
   ◯ 25-29
   ◯ 30-34
   ◯ 35-39
   ◯ 40-44
   ◯ 45-49
   ◯ 50-54
   ◯ 55-59
   ◯ 60 and older

4. **Your total flight hours** *
   Mark only one oval.
   - ◯ 0 - 1500
   - ◯ 1501 - 3000
   - ◯ 3001 - 5000
   - ◯ 5001 - 10000
   - ◯ More than 10000

5. **I have experience of flight decks without the use of EFBs** *
   This question strives to find out how many have started their career after EFBs were introduced, thus never operated without EFBs.
   Mark only one oval.
   - ◯ Yes
   - ◯ No

6. **I have previous experience of using EFBs in OTHER companies** *
   Mark only one oval.
   - ◯ Yes
   - ◯ No

7. **I had previous experience of other EFBs in MY CURRENT company prior to starting to use the current EFB** *
   Mark only one oval.
   - ◯ Yes
   - ◯ No

Hardware

Unless explicitly stated otherwise, all questions refer to the EFB currently in use.

8. **How is the EFB issued?** *
   Mark only one oval.
   - ◯ EFB is issued personally for each pilot
   - ◯ EFB is issued for each duty period (e.g. collected at check in and returned at check out)
   - ◯ EFB is permanently located/installed in each aircraft

9. **Is the EFB approved for all phases of flight?** *
   Mark only one oval.
   - ◯ Yes
   - ◯ No

10. **I'm allowed to use my personally issued EFB for private/non-company use (e.g. installing other apps)?** *
    Mark only one oval.
    - ◯ Yes
    - ◯ No
    - ◯ N/A (e.g. installed/aircraft specific EFB)

11. **Do you find the weight, size or installment/stowage of the EFB to limit the way you use it in cockpit?** *
Mark only one oval.

- ◯ Yes
- ◯ No

12. **Type of power supply** *
Mark only one oval.

- ◯ Only internal battery
- ◯ Internal and external battery (backup power)
- ◯ Power from aircraft

13. **I find battery depletion to be a problem during line operation?** *
E.g. Do you turn off the screen during critical phases (taxi, takeoff, approach and landing) to conserve battery?
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ N/A (integrated/installed/power from aircraft)

14. **I'm satisfied with the general performance of the EFB in use** *
E.g. is it calculating or displaying charts fast enough or does it take too long time?
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

15. **Procedures and requirements regarding sync of EFB content are clear and well-documented?** *
E.g. procedures describing when and how to sync, who is responsible etc. are well documented.
Mark only one oval.

- ◯ Yes
- ◯ Neutral
- ◯ No
- ◯ N/A (sync is not pilots' responsibility)

16. **I find it easy to check if the EFB is up-to-date** *
Is it easy to actually check if the EFB is fully synced with all required content up to date.
Mark only one oval.

- ◯ Yes
- ◯ Neutral
- ◯ No
- ◯ N/A (sync is not pilots' responsibility)

17. **I find it easy to sync EFB content** *
    Is the process to sync the EFB easy/fast?
    Mark only one oval.

    - ◯ Yes
    - ◯ Neutral
    - ◯ No
    - ◯ N/A (sync not pilots' responsibility)

EFB Training

18. **Have you received training for your current EFB?**
    Mark only one oval.

    - ◯ Yes *Skip to question 19.*
    - ◯ No *Skip to question 23.*

EFB Training - Received

All questions refer to the EFB currently in use.

19. **What type of EFB training have you received?**
    Tick all applicable alternatives.
    Check all that apply.

    - ☐ Self-studies (e.g. CBT)
    - ☐ Hands-on class room training
    - ☐ Integrated with simulator training
    - ☐ Other

20. **Do you have Initial and/or Recurrent EFB training?**
    Mark only one oval.

    - ◯ Initial training
    - ◯ Recurrent training
    - ◯ Both

21. **Is EFB use during simulator training representative for daily operational use?**
    (e.g. performance calculations made in simulator not in briefing room)
    Mark only one oval.

    - ◯ Yes
    - ◯ No

22. **I have received the following training**
Tick all applicable alternatives.
Check all that apply.

- [ ] An overview of the system architecture
- [ ] Pre-flight checks of the system
- [ ] Limitations of the system
- [ ] Specific training on the use of each application and the conditions under which the EFB may and may not be used
- [ ] Restrictions on the use of the system, including where some or the entire system is not available
- [ ] Procedures for normal operations, including cross-checking of data entry and computed information
- [ ] Procedures to handle abnormal situations, such as a late runway change or diversion to an alternate aerodrome
- [ ] Procedures to handle emergency situations
- [ ] Phases of the flight when the EFB system may and may not be used
- [ ] CRM and human factor considerations on the use of the EFB
- [ ] Additional training for new applications or changes to the hardware configuration

Skip to question 25.

EFB Training - Useful?

23. **Would company EFB training (initial and/or recurrent) be useful?**
Mark only one oval.

- ◯ Yes *Skip to question 24.*
- ◯ No *Skip to question 25.*

EFB Training - Useful

24. **Select one or more of the alternatives below which you believe should have been included in initial and/or recurrent EFB training**
Check all that apply.

- [ ] An overview of the system architecture
- [ ] Pre-flight checks of the system
- [ ] Limitations of the system
- [ ] Specific training on the use of each application and the conditions under which the EFB may and may not be used
- [ ] Restrictions on the use of the system, including where some or the entire system is not available
- [ ] Procedures for normal operations, including cross-checking of data entry and computed information
- [ ] Procedures to handle abnormal situations, such as a late runway change or diversion to an alternate aerodrome
- [ ] Procedures to handle emergency situations
- [ ] Phases of the flight when the EFB system may and may not be used
- [ ] CRM and human factor considerations on the use of the EFB
- [ ] Additional training for new applications or changes to the hardware configuration
- [ ] Other

EFB Checking

All questions refer to the EFB currently in use in your company.

25. **Is correct use of the EFB assessed during PC/OPC?**
Mark only one oval.

- ◯ Yes
- ◯ No

26. **Is correct use of the EFB assessed during LINE CHECKS?**
Mark only one oval.

- ◯ Yes
- ◯ No

Procedures

All questions refer to the EFB currently in use.

27. **The company has clear and well-documented procedures for use of EFB?** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

28. **I have to come up with own procedures due to lack of company procedures** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

Performance Calculations

29. **EFB is used for performance calculations in my company** *
Mark only one oval.

- ◯ Yes *Skip to question 30.*
- ◯ No *Skip to question 36.*

Performance Calculations

30. **I find that my company has well described company procedures for performance calculations?** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

31. **I find that my company procedures for performance calculations are good** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

32. **Performance calculation(s) and cross-checking** *
Mark only one oval.

- ◯ FO performs calculation, Captain cross-checks result
- ◯ Captain performs calculation, FO cross-checks result
- ◯ PF performs calculation, PNF/PM cross-checks result
- ◯ PNF/PM performs calculation, PF cross-checks result
- ◯ Independent performance calculations and cross-check of result
- ◯ Other option

33. **Our SOP includes a Gross-error check of performance calculations**
Gross-error check is a reasonability check of EFB output by means of either a ‘rule of thumb’ or comparison of the same data from other sources in the aircraft
Mark only one oval.

- ◯ Yes
- ◯ No

34. **Results of performance calculations are available even when swapping between apps** *
Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

35. **Results from performance calculations are transferred to paper or other app** *
Mark only one oval.

- ◯ Yes, in accordance with company procedures
- ◯ Yes, by own initiative due to lack of company procedures
- ◯ No

Documentation/Information

36. **EFB is used for Documentation/Information in my company** *
Documentation as in Manuals, Bulletins, Normal Checklist, FCOM, QRH, FCTM, etc.
Mark only one oval.

- ◯ Yes *Skip to question 37.*
- ◯ No *Skip to question 40.*

Documentation/Information (yes)

37. **I find it easy to make and use bookmarks** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

38. **I find it easy to find documentation/information that I'm looking for**
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

39. **I find it easy to make and access notes** *
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

User experience - Past and Present

40. **I generally find it easy to use new technology** *
This refers to your general experiences with new technology and not EFBs.
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

41. **I had a good experience of the EFB during introduction/when I first started using it** *
This refers to the EFB currently in use.
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

42. **I have a good experience of the EFB now/when I have gotten used to it** *
This refers to the EFB currently in use.
Mark only one oval.

	1	2	3	4	5	
Completely disagree	◯	◯	◯	◯	◯	Fully agree

C Acronyms

ATSB Australian Transport Safety Bureau

CAA Civil Aviation Authority

CBT Computerbased Training

COTS commercial-off-the-shelf

EASA European Aviation Safety Agency

EFB Electronic Flight Bag

FAA Federal Aviation Administration

IATA International Air Transport Association

JAA Joint Aviation Authorities

NOTAM Notice to Airmen

PC/OPC Proficiency Check / Operator Proficiency Check

SOP Standard Operating Procedures

SPSS IBM SPSS Statistics

References

Andersson, Annica and Malin Karlsson (2007). "Arbetstillfredsställelse inom tandhygienistprofessionen." URL: http://www.diva-portal.org/smash/get/diva2:4847/FULLTEXT01.pdf (visited on 08/07/2017).

ATSB (2011). *Take-off performance calculation and entry errors: A global perspective.* URL: https://www.atsb.gov.au/publications/2009/ar2009052.aspx (visited on 08/07/2017).

EC No 859/2008 (2008). *Commission Regulation (EC) No 859/2008 of 20 August 2008.* amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane. URL: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008R0859 (visited on 08/07/2017).

EU No 965/2012 (2012). *Commission Regulation (EU) No 965/2012 of 5 October 2012.* laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council. URL: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:296:0001:0148:EN:PDF (visited on 08/07/2017).

Degani, Asaf and Earl L Wiener (1991). "Philosophy, Policies, and Procedures: The Three P's of Flight-Deck Operations." In: URL: https://ti.arc.nasa.gov/m/profile/adegani/3Ps.pdf (visited on 08/07/2017).

EASA (2014a). *ED Decision 2014/001/R 09/02/2014 Annex II AMC 20-25.* Airworthiness and operational consideration for Electronic Flight Bags (EFBs). URL: https://www.easa.europa.eu/system/files/dfu/2014-001-R-Annex%20II%20-%20AMC%2020-25.pdf (visited on 08/07/2017).

— (2014b). *Explanatory Note to Decision 2014/001/R.* Explanatory note to AMC 20-25 regarding EFBs. URL: https://www.easa.europa.eu/system/files/dfu/2014-001-R-ED%20Decision%202014-001-R%20Explanatory%20Note.pdf (visited on 08/07/2017).

Evaristo, Roberto, Carl Adams, and Shawn Curley (1995). "Information Load Revisited: A Theoretical Model." In: *ICIS 1995 proceedings*, p. 18. URL: https://pdfs.semanticscholar.org/1843/aa30618f238dd4405716152cd67564ced1ab.pdf (visited on 08/07/2017).

Hamblin, Christopher J (2004). "Usability of Mobile Devices in the Cockpit." In: URL: http://usabilitynews.org/usability-of-mobile-devices-in-the-cockpit/.

Hiltz, Starr R and Murray Turoff (1985). "Structuring computer-mediated communication systems to avoid information overload." In: *Communications of the ACM* 28.7, pp. 680–689. URL: https://pdfs.semanticscholar.org/f93e/64689c54a1316cd4e4443e07f7c49da8095f.pdf (visited on 08/07/2017).

IATA (2011). *Flight Crew Computer Errors (FMS, EFB) - Case Studies (1st ed).* URL: http://www.ukfsc.co.uk/files/Safety%20Briefings%20_%20Presentations/Acc%20-%20Incident%20-%20IATA%20Flight%20Crew%20Computer%20Errors%20Case%20Studies%20Oct%202011.pdf (visited on 08/07/2017).

— (2015). *FMS Data Entry Error Prevention - Best Practices (1st ed).* URL: https://www.iata.org/whatwedo/safety/runway-safety/Documents/FMS-Data-Entry-Error-Prevention-ed-1-2015.pdf (visited on 08/07/2017).

JAA (2004). *Leaflet No. 36: Approval of Electronic Flight Bags (EFBs).* JAA Administrative & Guidance Material Section Four: Operations, Part Three: Temporary Guidance Leaflets

(JAR-OPS). URL: https://selvbetjening.trafikstyrelsen.dk/civilluftfart/Dokumenter/English/Rules%20and%20Regulations/Joint%20Aviation%20Requirements%20(JAR)/TGL%2036%20Electronic%20Flight%20bag.pdf (visited on 08/07/2017).

Löfgren Bengtson, Erik (2013). "Förstudie till implementering av Electronic Flight Bag." URL: http://www.diva-portal.org/smash/get/diva2:652659/FULLTEXT01.pdf (visited on 08/07/2017).

The Uses of Paper in Commercial Airline Flight Operations (2006). ACM, pp. 249–258. URL: http://pages.ucsd.edu/~ehutchins/documents/fp146-nomura.pdf (visited on 08/07/2017).

Panko, Raymond R. (2008). "Thinking is Bad: Implications of Human Error Research for Spreadsheet Research and Practice." In: *CoRR* abs/0801.3114. URL: https://arxiv.org/pdf/0801.3114 (visited on 08/07/2017).

Perrow, Charles (2011). *Normal Accidents: Living with High-Risk Technologies*. Princeton University Press. URL: https://stuff.mit.edu/afs/athena.mit.edu/course/other/esd.83/OldFiles/www/notebook/Normal%20Accidents%20.doc (visited on 08/07/2017).

From captain Jeppesen's little black book to the iPad and beyond (2012), 1A2. URL: http://ieeexplore.ieee.org/abstract/document/6382277/ (visited on 08/07/2017).

An Exploratory Study of Error Detection Processes During Normal Line Operations (2004). URL: http://www.unisanet.unisa.edu.au/staff/MatthewThomas/Paper/Thomas_ErrorDetection.pdf (visited on 08/07/2017).

Bibliography

Backman, Jarl (2008). *Rapporter och uppsatser*. Studentlitteratur. URL: https://www.studentlitteratur.se/#9789144097329/Rapporter+och+uppsatser.

University of Melbourne (2012). *Using tenses in scientific writing*. URL: http://services.unimelb.edu.au/__data/assets/pdf_file/0009/471294/Using_tenses_in_scientific_writing_Update_051112.pdf (visited on 08/11/2017).