

Line Operations Safety Audit (LOSA) for the management of safety in single pilot operations (LOSA:SP) in Australia and New Zealand

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Abstract

This paper investigates the feasibility, effectiveness and benefits of implementing a single pilot operations variant of the multi-crew Line Operations Safety Audit (LOSA) methodology, in the management of safety in single pilot operations. LOSA is designed to provide a proactive snapshot of system safety and flight crew performance as a way of preventing incidents and accidents (Klinec, 2006). The data indicators underlying this effort are based on a conceptual framework known as Threat and Error Management (TEM) (Helmreich, R.L., Wilhelm, J.A., Klinec, J.R., & Merritt, A.C. 2001).

A number of incidents and accidents involving single pilot operations both in Australia and New Zealand have given emphasis to the vulnerability of this group to safety issues and confirms statistics that show this category of aviation has a higher incidence of accidents and incidents than in other sectors of the industry (CASA, 2009, NZCAA, 2009). By adapting LOSA to single pilot operations (LOSA:SP) the framework/methodology could provide a proactive method of diagnosing operational safety performance strengths and weaknesses under normal operations leading to the identification of additional training requirements and improved procedures without relying on adverse safety events for such information.

A case study was undertaken at a mid-sized company operating exclusively single-pilot, twin turbo-prop fixed wing aircraft to ascertain whether the methodology was viable in the single-pilot environment. Observers rated pilot performance on a 4 point scale using four standard threat and error counter-measure categories under 12 sub-headings.

Whilst the study achieved its objective of determining whether a single-pilot line operations safety audit could be successfully developed, the data were indicative and insufficient for statistical analysis. Larger samples are required from future studies for more definitive conclusions and recommendations about threat and error management.

Introduction

Most of aviation's understanding of safety performance is based on data concerning adverse safety events, such as those collected from incident reporting and accident investigations (Maurino, 2001). These can be seen as reactive measures of safety as they are dependant on negative flight outcomes (Reason, 1997). Although these approaches will continue to be essential in guiding future aviation policy and regulation, as well as informing aircraft and systems design (Applegate and Graeber, 2005), because of their unreliability in preventing future incidents (Helmreich, 2006) they are increasingly being supplemented by more proactive approaches.

The Line Operations Safety Audit is a proactive measure that serves to fill this gap with its collection of TEM data in normal flight operations. It can be seen as a proactive safety measure that complements existing data sources such as line evaluations, quick access recorders, voluntary incident reports and accident investigations.

The LOSA methodology, which is endorsed by the International Civil Aviation Organisation (ICAO) (ICAO, 2002) is a formal process that requires expert and highly trained observers to occupy the jumpseat during regularly scheduled flights in order to collect safety related data on environmental conditions, operational complexity and flight crew performance. *'It provides a diagnostic snapshot of strengths and weaknesses that an airline can use to bolster its safety margins and prevent their degradation.'* (Helmreich, 2006). LOSA uses a targeted observation instrument based on the TEM framework.

LOSA has been developed and refined since 1996 with major international airlines becoming involved forming a collaborative partnership with The University of Texas Human Factors Research Project (UTHFRP) (Klinect, 2006). Captain Don Gunther, Manager of Human Factors Training at Continental Airlines hailed LOSA as a success, saying that Continental Airlines provided the 'proof of concept' for LOSA that transformed it from a research tool to an industry-ready safety tool (Gunther, D. 2002).

In 2001, LOSA became a central focus of the Flight Safety and Human Factors Programme (Klinect et al, 2003). ICAO has also introduced a standard making TEM training mandatory for airline flight crews engaged in international operations (Merritt and Klinect, 2006), which must be delivered during initial as well as recurrent training. TEM based LOSA is now considered to be best practice for normal operations monitoring and aviation safety by ICAO, the Federal Aviation Authority (FAA) and the Civil Aviation Authority (CAA).

More recently, regional airlines operating turboprop aircraft have seen the potential benefits of a Line Operations Safety Audit with a plan by the LOSA collaborative to bring regional airlines into the LOSA sphere (Rosenkrans, 2007). Air New Zealand regional carrier Mt Cook Airlines and Australia's Regional Express were amongst the world's first regional operators to implement LOSA

The Guild of Air Pilots and Air Navigators (GAPAN) conducted a series of TEM courses in Australia in 2008/9 for pilots involved in low capacity public transport and single - pilot operations. The ATSB's safety report AR-2006-156(2) looked at the threats and errors that participants of these courses considered were the five most common in their industry (ATSB, 2009).

This paper considers those smaller (single - pilot) operations and the actual threats and errors that occur in flights.

Research Overview

The LOSA methodology provides the tools to record threats to safety that the pilot might encounter and errors that are made by pilots and the response to those errors. An example of a threat would be adverse weather conditions or an aircraft system malfunction. LOSA identifies the occurrence of these threats and facilitates the analysis of the actions taken by pilots to manage them Thomas (2003). Errors are seen as 'an unavoidable and ubiquitous aspect of normal operation' (Thomas, 2003) but it is an important aspect of pilot performance in how those errors are recognised, trapped and mitigated.

By using the threat and error management (TEM) conceptual framework, LOSA focuses simultaneously on the operating environment and the humans working in that environment. As the TEM taxonomy can also quantify specifics and effectiveness of performance, the results are also highly diagnostic (Merritt and Klinect, 2006).

Traditionally the smaller operators have experienced a higher accident rate than larger carriers, both in Australia, New Zealand and worldwide (ATSB, 2007). Occurrence figures show that smaller companies with single pilot operation are experiencing an increase in accident statistics (CASA, 2009, CAA 2009). Despite efforts in this area to increase safety with traditional methods (training, seminars, education, regulation, inspection etc), there appears to have been less research in this segment of the industry when compared with that conducted for and by major carriers and more recently regional carriers.

All LOSAs to date have been conducted in multi crew operations where the LOSA observer occupies a jumpseat on the flight deck. However, it is proposed that, by applying the LOSA concept to single pilot operations, with a carefully designed research methodology pertaining to this type of operation

(LOSA:SP), such methodology could provide an opportunity to understand the operational context, pilot processes and outcomes during single pilot routine flights. If successful, in a similar manner to LOSA, LOSA : SP will give an insight into normal operations, through diagnosing strengths and weaknesses of pilots without relying on accidents or incidents to gain that information. Helmreich compares CRM in both multi-crew operations and single-pilot operations, identifying several points where CRM can be adapted for single pilots (Flight Safety Australia, 2006). Introducing the LOSA methodology to improve threat and error management in single pilot operation could therefore be achievable and successful in reducing incidents and accidents. Thus safety could be enhanced in a field where other methods have failed.

Objectives

McDonald and colleagues state that the results of a “LOSA – Like” trial in passenger train operations, where in – cab observations were made on single driver operations, could ultimately highlight future directions for training and awareness and make potential improvements to organisational systems and processes (McDonald, A., Garrigan, B., Kanse, L. 2006).

By applying LOSA to single pilot operations (LOSA:SP) and using an appropriate data analysis system, threats and errors could be decreased, awareness enhanced and training and education improved, based on the results of the assessments.

Methodology

At the heart of LOSA are non-jeopardy observations, without which flight crew may be unwilling to accept the presence of an observer in their domain. As LOSA has progressed, pilots and managers are seeing the safety benefits of the system and as Airlines conduct future LOSA assessments the willingness to contribute has increased.

Various methods were considered to collect data in single pilot operations, both where an observer was possible but also in situations where an observer was not possible or not appropriate. Adaptations were made to the LOSA methodology in order to facilitate the comprehensive and unique differences applicable to the single pilot situation. This included, for example, revisions to some of the error categories. However, LOSA data indicators based on the established TEM framework were retained due to their proven nature. ICAO specifies ten characteristics that define LOSA (ICAO, 2002). These were replicated for single pilot operations.

As in LOSA, LOSA:SP collected data on pilot demographics, threat occurrence and management, error occurrence and management and CRM effectiveness through TEM - based behavioural markers.

Following initial meetings with management and crews at a mid-sized aviation company, a draft proposal was sent outlining the research. Following agreement by the company and representatives from the pilot group to participate in the research, an introductory newsletter was circulated, observer expressions of interest were called for, and a presentation of LOSA to pilots and managers was conducted.

Subsequently a 4 day observer training course was conducted by a member of the LOSA Collaborative and the two observers chosen for this study flew on 14 observation sectors covering a sample of the company’s route network and crew.

It was emphasised that one of the prime defining characteristics of LOSA is the de-identification and confidentiality of all data which in this experiment would be collated and analysed by the research team at Griffith University.

The aim of the research was to provide information on whether LOSA methodology could be usefully deployed in single-pilot operations (LOSA:SP). The trial was developed to provide a useful short-term safety focus for the company but on the understanding that the number of observations would not be sufficient for statistical analysis.

The observations were supplemented by separate post-flight interviews with crew on safety concerns, suggestions for safety improvements, automation and operational efficiency.

Concerns

Concerns on observer reliability, establishing trust with those being observed, and an accurate coding scheme are similar within most field observation methodologies. Possibly the most important data quality issue is one of observation reactivity, which occurs when individuals may alter their normal behaviours because of an observer's presence in the cockpit.

Also, it is important to observe pilots who are both willing to participate in the study and who are representative of the group. Amongst the considerations stated by pilots included balancing a desire to participate in a study that may result in a safer operation versus potential monetary loss (loss of paid flight hours). Also, for single pilot commercial passenger flight operations, the addition of an 'observer' may reduce the 'paying capacity' of the spare seats.

Ethical clearance was obtained prior to commencement of the flights observations. This was considered to be an integral part of establishing the feasibility of the study. The LOSA defining principles emphasising complete de-identification of individuals together with strict confidentiality and "no jeopardy" provisions (ICAO, 2002) assisted greatly.

Results

Results were illustrative rather than definitive and larger samples are required from future studies to draw meaningful conclusions and recommendations regarding threat and error management. Furthermore, there are no other similar audit results on single-pilot operations available as a basis for comparison.

However, some similarities with other LOSA audits were noted including comparable raw numbers of threats and errors per flight, the type of threats (weather, Air Traffic Control (ATC), operational pressures, airport conditions etc) and the distribution of error types. It was apparent that there were some operation specific threats and induced errors.

Not all threats have equal impact. While all may have the potential to affect safety adversely, some categories of threats are better managed than others by pilots. A LOSA establishes the rates of threats or errors and highlights those that are 'mismanaged', i.e. those that are either not detected at all or those that are detected but not managed adequately. The most worrying to safety are those threats or errors with a high rate of occurrence and high rates of mismanagement; that is those that have increased risk potential.

As an example checklist errors alone may not be seen as important, yet checklists are designed to trap procedural errors. So, when checklists are missed on several occasions, in the event of an earlier procedural error, the risk factor can increase dramatically and may be the final hole in Reason's Swiss cheese model of accident causation (Reason, 1997)

The five flight phases in which a threat or error could occur were: pre-departure/taxi, take off/climb, cruise, descent/approach/landing, and taxi-in. Generally, LOSA's show that the descent, approach and landing phase has a proportionately larger number of errors due to the high workload at this time (Flight Safety Foundation, 1998). Because of the nature of the operation, this case study indicated that threats and errors occurred in approximately equal numbers in the pre-departure phase and the descent/approach and landing phase. However, this observation may have been biased by the small number of observations.

In multi-pilot operations, there is invariably a requirement for pilots to verbalise their actions or intentions. In single-pilot operations generally there is no such requirement, although anecdotally views are split as to the value of this process. In the company involved in this experiment verbalisation of procedures is optional and the pilot force is split between those who routinely verbalise and those who don't. This case study compared the error rates between the two groups. Although there was relatively little difference between the groups, the results suggested that pilots who verbalised their intentions were more assiduous in cross-checking and had fewer mismanaged procedural errors. This was not a big enough sample to draw firm conclusions, but this aspect merits further investigation.

Discussion

Whilst mechanisms such as incident reports and confidential reporting systems, together with line checks are commonplace in organisations attempting to improve their safety performance, these may not provide

sufficient information for an organisation to unmask hidden latent errors in the system (Thomas 2003). LOSA acts as a pro-active evaluation tool and is potentially more powerful with respect to safety measures.

Ashleigh Merritt, one of the original data analysts from early LOSA's comments that TEM based LOSAs continue to provide valuable diagnostic information about an airline's strengths and vulnerabilities and sees LOSA as best practice for normal operations monitoring and safety. (Merritt and Klinect, 2006) Furthermore LOSA is now recognised and recommended to airlines as a best practice for normal operations monitoring:

"LOSA is proposed as a critical organisational strategy aimed at developing countermeasures to operational errors. It is an organisational tool used to identify threats to aviation safety, minimise the risks such threats may generate and implement measures to manage human error in organisational contexts." (ICAO, 2002)

As LOSA developed as a powerful pro-active safety tool, the methodology was adapted to other areas with equally positive results. Air Traffic Control (Normal Operations Safety Survey – NOSS (Henry, 2007), the military, (Mission Operations Safety Audits – MOSA (Burdekin, 2003)), and Queensland Rail (Confidential Observations of Rail Safety – CORS (McDonald et al, 2006)) all completed successful "LOSA – Like" audit activities.

Now that LOSA has been established as a successful and innovative tool, the adaptation to single pilot commercial operations was a logical step. Within this case study, the analytical data achieved and the subjective data obtained in interview indicated that the company had established a strong framework of safety to support its flight operations.

The sample size in this study was selected to determine whether the LOSA methodology could be adapted to single-pilot operations and obtain useful data. However, a sample size of around 60 flights has been calculated as necessary to capture data in sufficient quantity to undertake valid quantitative data analysis for definitive conclusions.

The objective of this study was achieved in that the LOSA methodology proved completely transferrable so that all categories of the TEM model were observable with minimal adaptation of the methodology for single-pilot operations

In this case study most of the adaptation (other than obvious multi-crew to single-crew adaptation communication) was operator specific. This case study strongly indicated that while the methodology could be used in single-pilot operations, further refinement may be necessary for differing operations. E.g. rotary wing aircraft.

It is proposed that LOSA:SP model will provide a feedback mechanism to single pilot aircraft operators which in turn will assist pilots to manage threats and errors more successfully in the future and thereby increase their safety margins. Ultimately it is proposed that the data would form part of a LOSA:SP archive which could be compared with the existing LOSA archive. Eventually it could be used to inform training and regulatory interventions within the aviation industry, leading to safer outcomes in single pilot operations..

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