航空體系安全績效評估

盧衍良 譯

現為博士候選人兼北大西洋公約組織（NATO）空運管理計畫安全經理的Ilias Panagopoulos，協同Chris Atkin教授以及倫敦城市大學機械工程及航空學系資深學者Ivan Sikora博士，共同致力於有關航空安全績效的博士研究。

Ilias分別於2016年9月5-7日，在土耳其伊斯坦堡舉辦的第19屆歐洲運輸研討會(EWGT2016)，以及2016年11月3-4日，在荷蘭由阿姆斯特丹大學應用科學分部航空學院舉辦的第一屆國際跨領域安全研討會(ICSC 2016)中，提出對於如何評估航空體系績效的方法和相關研究成果。

ICAO第19號附約中指出：「安全，就是將隨航空作業風險降低，並且控制在可接受程度下。」

全新一致性作法

安全是一種系統品質，藉由法規和監理的機制展現，具體規範了嚴格的高性能目標以及航空業者必須執行的相關工作。ICAO第19號附約指出，航空服務提供者（即航空公司、機場單位、航空器維修機構、航空訓練機構和飛航管制單位）應至少：

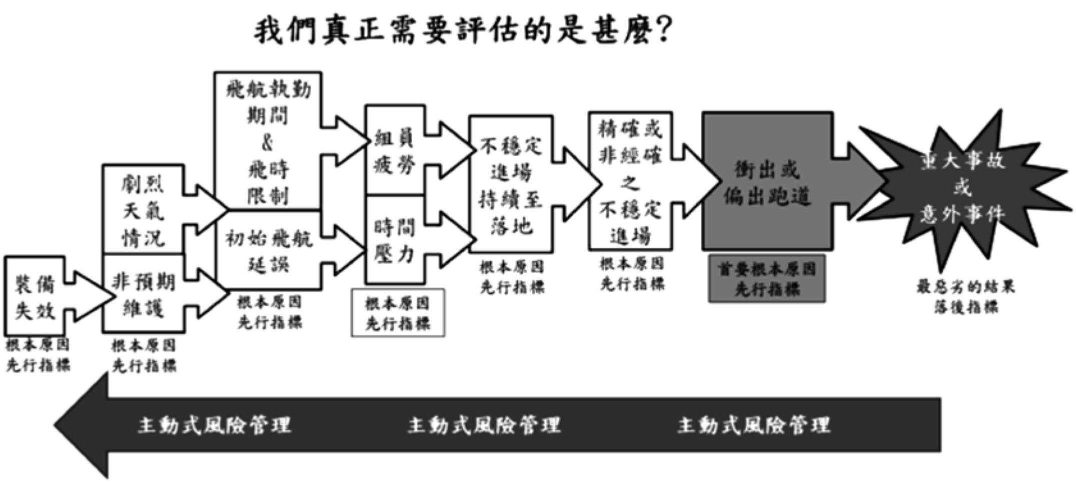
- 建置一套安全管理系統
- 對安全績效採取持續監理和定期評估
- 確保補救做為能維持應有績效
- 持續提高性能

以歐洲而言，相較於民航法規的相關規定，歐洲航空安全局（EASA）闡述一套全新一致性作法，藉由引入清楚明瞭的指標與目標來建立以績效為基準的飛航環境，並以此來評估民航主管機關的監理成效。

現今的航空業中，儘管以現有方法來評估已達到優良安全記錄（例如零失事或零重大意外事件）且作業程序受控管的航空業者尚屬合宜，但仍然存在相當程度的不確定性，有必要更加強化。

而且，透過預先定義的指標，以評估航空系統安全績效的程序，至今仍未被標準化或引進採用。

此外，安全績效指標（SPIs）本身或相關制度的發展和評估方法不夠明確，且評估SMS有效性的實際作業經驗非常有限，因此，就如何評估安全績效的作法上，仍然存在許多的疑問有待解答。



持續精進方法

因此，如何控制維持安全績效在可接受的程度範圍，以及如何發展出主動調查和評估目前系統績效與原訂目標之差異性的客觀方法，仍然為當前的主要挑戰。

本研究進一步探討兩個關鍵問題：

- 有無可主動評估系統安全績效，以及評估安全績效改善情況的方法？
- 概念性架構是否有助於持續地改善安全績效評估的程序?

就此，本研究提出一個能夠改善安全績效評估程序以及整體航空系統安全績效的概念性架構。

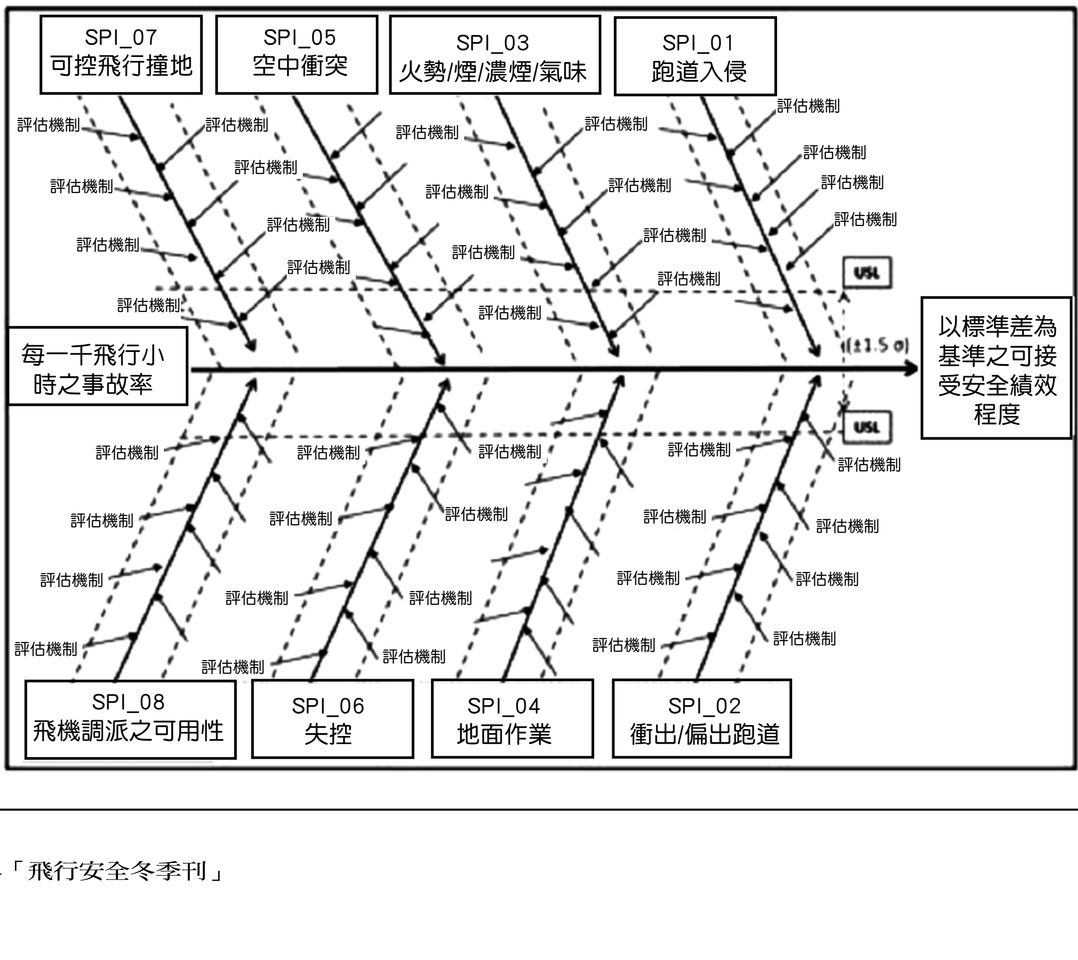
在此架構中，將「安全績效指標標準差模式（Safety-PILS）」導入了「定義-評估-分析-改善及控制（DMAIC）」這樣一個持續改善的程序。此一整合產生了一個可評估系統安全績效的持續改善方法，更降低了與原訂目標的差異性。此外，本研究提供一套實施指南予航空業各界，透過此一架構以設計發展主動式和以績效為基準的方法：以標準差為基準，以評估所謂「可接受安全績效程度（ALoSP）」。

在第一階段的安全評估程序中，「安全績效指標標準差模式（Safety-PILS）」提供指引予各航空機構有關如何設計、實行以及使用此主動式和以績效為基準的量測工具，用以評估可接受的安全績效程度（ALoSP）。「安全績效指標標準差模式（Safety-PILS）」也協助航空業者根據可接受的安全績效指標（SPIs）、目標以及規格限度去理解和設計其自身的安全系統。

航空業的各個系統能夠從「安全績效指標精實標準差模式（Safety-PILS）」得知如何訂立先行指標，並且從更全面的角度監管整個組織的運作，以便找出影響安全績效的根本原因，以及如何找出可能的落後指標，並且反饋回整個組織以改善組織整體安全的表現（例如：飛航事故次數）。

「安全績效指標標準差模式（Safety-PILS）」的核心優勢係為利用中央極限理論（Central Limit Theorem），由於此一原理重複地使用大量數據、方法，資料庫，最終將會呈現出常態的分布情況。航空業者的下一步即依照第二階段的「定義-評估-分析-改善及控制程序（DMAIC）」，來持續增進整個組織系統的安全績效評估機制。

透過「定義-評估-分析-改善及控制程序（DMAIC）」，



第二階段 六個標準差法 － DMAIC程序之運用
3. 假設檢定之資料蒐集計畫 - 假設檢定 － 資料正規化
4. 控制圖表選擇 － 路線圖 - 針對逐個安全績效指標與評估機制作圖表選擇之控制 - 找出特殊的肇因：若無則表示該流程在受控管範圍內
5. 評估系統分析 - 資料出現差異情況的緣由為何？ - 流程是否精確？
6. 流程之性能 - 流程是否有用（例如：具有效率）？ - 標準差多大？
7. 分析資料 - 找出根本原因以及有待改進的部分 - 找出最佳且最具可行性之解決辦法
8. 飛行員之解決之道 - 將解決方案實際運用並提供回饋給整體機制
9. 擬定首次測試之控制計畫 - 監控該計畫以保持可變性
10. 評估整體系統之安全績效 - 內部流程的檢討

航空業者可運用精實六個標準差法（Lean Six Sigma）評估逐項已設定的指標或系統安全績效和核心安全目標的差異情況。

本研究採用之整體性概念架構，滿足了航空管理當局欲建立以績效為基準的評估方法，進而有效地確保飛航安全的需求。

本研究發現，填補了存在於過往文獻中的缺口，並提出實際可用來評估航空系統安全績效的實施指南與方法。

此研究顯示透過精實六個標準差法（Lean Six Sigma）可改善安全評估制度。

最後，對於如何在一可接受的規格限度內設計以安全目標為結果導向之實施方案，本研究亦提出了嶄新的思維。

譯自PHYS.ORG 網站Dec 5, 2016

Measuring an aviation system's safety performance

PhD candidate and Safety Manager at NATO's Airlift Management Programme, Ilias Panagopoulos, has collaborated with Professor Chris Atkin and Dr Ivan Sikora, senior academics in the Department of Mechanical Engineering & Aeronautics at City, University of London, for his doctoral research in aviation safety performance.

Ilias presented his methodology for measuring performance and research results at the 19th EURO Working Group on Transportation Meeting (EWGT2016) on 5th to 7th September 2016, Istanbul, Turkey, and at the 1st International Cross-industry Safety Conference (ICSC 2016), organised by the Amsterdam University of Applied Sciences (Aviation Academy) in the Netherlands from 3rd to 4th November 2016.

Annex 19 of the International Civil Aviation Organization (ICAO) says: 'safety is the state in which risks associated with aviation activities are reduced and controlled to an acceptable level'.

New harmonised approach

Safety is a system quality stemming from a legal and regulatory framework which stipulates strict and high- performance targets as well as a number of activities which must be performed by air operators. Annex 19 goes on to say that aviation service provider (i.e. airlines, airports, aircraft maintenance organisations, air training organisations and air traffic services) shall, as a minimum:

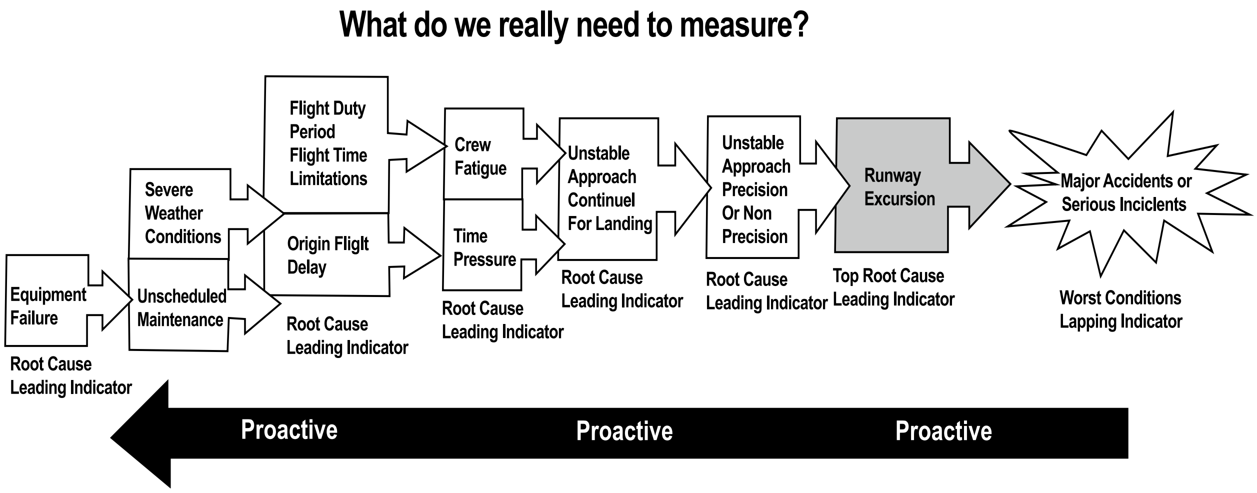
●Establish a Safety Management System (SMS)

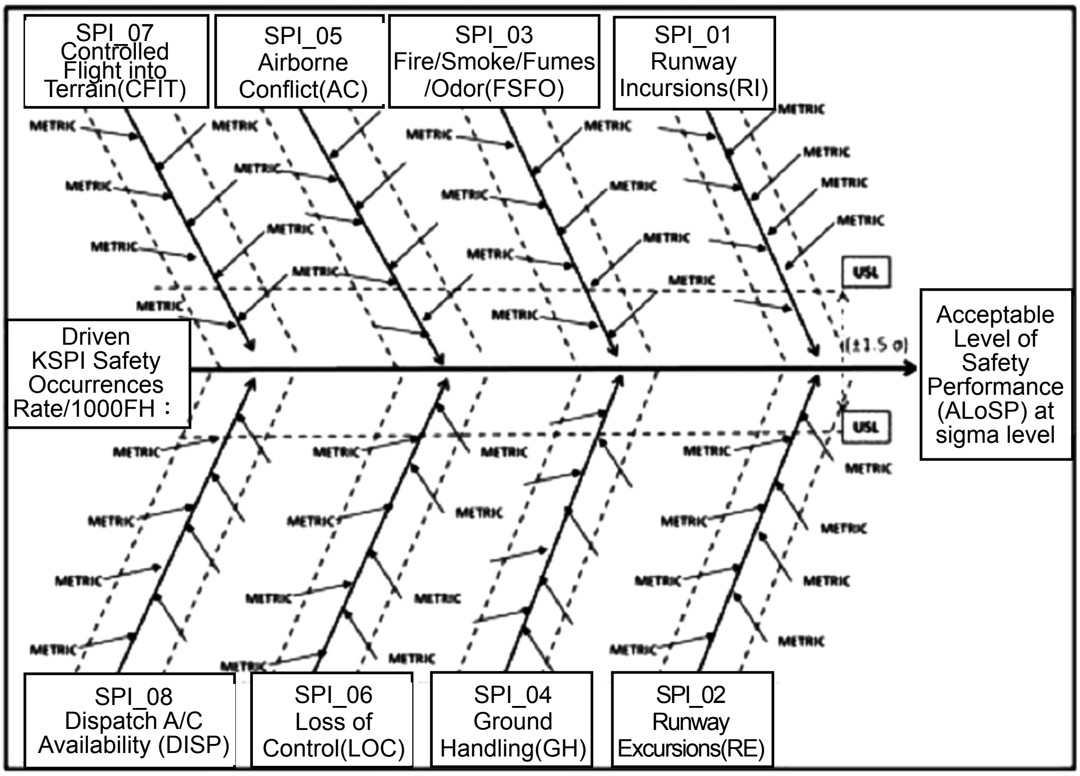
●Provide continuing monitoring and regular assessment of safety performance

●Ensure remedial action to maintain agreed performance

●Aim at a continuous performance improvement

At the European level, the European Aviation Safety Agency (EASA), in parallel with management system requirements, outlined its new harmonised approach for establishing a Performance-Based Environment by introducing a clear set of indicators and targets against which the oversight performance of civil aviation authorities is assessed.





In the aviation industry there is nevertheless a level of uncertainty about the extent existing methodologies for measuring performance are suitable for those operators who have achieved excellent safety records (i.e. zero accidents or serious incidents) and in-control processes, and as such the need to look for further improvements.

In addition, within the aviation industry, the measurement process regarding a set of pre-defined indicators for measuring an aviation system's safety performance has not yet been introduced or standardised.

Besides, the development and measurement of proper Safety Performance Indicators (SPIs) or metrics is not straightforward and the operational experience for measuring the effectiveness of SMS is very limited, since there are many questions yet to be answered on measuring safety performance.

Continuous improvement methodology

Consequently, the main challenge remaining is how to control and maintain performance within agreed safety specification limits and how to develop an objective methodology that will proactively investigate and measure system performance variability from target.

As a consequence, this study further investigated the following key research As a consequence, this study further investigated the following key research questions:

●What methodology could proactively measure system safety performance and improve the safety performance measurement process?

●Could a conceptual framework assist the continuous improvement of the safety performance measuring process?

So as to address the key research questions, the research presents a conceptual framework that will improve the safety performance measurement process and the aviation system safety performance.

In this framework, the Safety-Performance Indicator Lean Sigma (Safety- PILS) model has been embedded within Define-Measure-Analyse-Improve and Control (DMAIC) continuous improvement process. This integration results in a continuous improvement methodology that measures system safety performance

Phase-II, Apply Six Sigma-DMAIC methodology
3.Data Collection Planning (DCP) for Hypotheses tests - Hypothesis Testing –Data normalization
4. Control Chart selection – road map -Control Chart selection for each VOB SPI and Metric -Identify special causes: If none the process is In-Control
5. Measurement System Analysis (MSA) - Where does the variation of data comes from? - Is the process Accurate and Precise?
6. Process Capability - Is the process capable {i.e efficient}? - At what sigma level?
7. Analyse the data -Identify root cause and attractive areas for improvement - Identify best and feasible solutions
8. Pilot solutions -Demonstrate that piloted solution provides a Return of Investment [ROI]
9. Define Control Plan and Roll-out improvement - Monitor the Control Plan to sustain the change
10. Measure total system safety performance - Voice of the safety Process [VOP]=VOB

and reduces the safety process variability. In addition, the study provides an implementation guide on how organisations could use this framework to design and develop a proactive, performance-based methodology for measuring Acceptable Levels of Safety Performance (ALoSP) at sigma (σ) level, a statistical measurement unit.

In Phase I of the safety measurement process, the Safety-PILS model provides guidance on how organisations could design, implement and use a proactive, performance-based measurement tool for assessing and measuring ALoSP. Also, Safety-PILS model assists operators to comprehend and design their safety system in accordance with the agreed Safety Performance Indicators (SPIs), targets and specification limits.

Nevertheless, the Safety-PILS model provides a holistic view on how organisations could set leading performance indicators and monitor metrics on the top of identified root-causes that affect safety performance or how to set lagging indicators and feedback metrics on the top of safety outcomes (e.g. number of occurrences).

Moreover, the core advantage of the Safety-PILS model is that applies the Central Limit Theorem and since it repeatable uses a large size of data and means, the distribution of the sample means will finally approach a normal distribution. Accordingly, the next step for the operator is to follow at Phase II the DMAIC process for continuously improving the overall system's safety performance measurement process.

Through DMAIC process shown in the Figure below, the operator could apply Lean Six Sigma methodology for measuring both the performance of each established indicator and system safety performance variability at sigma level from core safety objectives. The research study introduces an integrated, empirical-tested conceptual framework that may satisfy the requirements of aviation authorities for establishing a performance-based approach in aviation safety.

Furthermore, the study identified and filled the gap existing in the literature and proposed a practical implementation guide and tools for measuring aviation system safety performance. Finally, the study revealed that the application of Lean Six Sigma methodology can enhance the safety measuring process. To this end, the proposed guide is a new way of thinking for designing a safety case aims to achieve desired outcomes within agreed specifications limits.

From PHYS.ORG Dec 5, 2016