Institution: London School of Economics and Political Science		
Unit of Assessment: 17 – Business and Management Studies		
Title of case study: Measuring and improving safety culture in the aviation industry		
Period when the underpinning research was undertaken: 2006-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Tom Reader	Associate Professor in Organisational Psychology	2010 to present
Period when the claimed impact occurred: 2013-2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact (indicative maximum 100 words)

Poor safety culture is a causal factor in serious aviation accidents. LSE research has informed the development of a methodology for systematically measuring safety culture in the European Air Traffic Management (ATM) industry. The methodology has been used by EUROCONTROL (the European ATM network manager) to monitor and improve safety management across the European ATM industry, being applied to measure and develop safety culture in more than 30 European Air Navigation Service Providers (ANSPs). Combined, these ANSPs operate in most European countries, employ over 50,000 staff, and coordinate up to 30,000 flights daily. The methodology has subsequently been used to measure safety culture and generate institutional change at UK airports (e.g. Luton) and major airlines (e.g. EasyJet).

2. Underpinning research (indicative maximum 500 words)

Safety culture refers to the norms and practices for how risk is managed within an organisation. In a strong safety culture, employees and managers agree on the importance of safety and this is instantiated into everyday practices such as incident reporting, teamwork, training, and resourcing. Where such practices are absent, the ability of management and employees to identify, discuss, and ameliorate threats to safety is degraded. Impacts described here are associated with the development of a methodology for measuring and improving safety culture in European Air Traffic Management (ATM). ATM relates to the safe navigation of aircraft through airspaces. In Europe there are approximately 40 Air Navigation Service Providers (ANSPs) employing over 50,000 staff and coordinating up to 30,000 flights a day (15,000 post-COVID). Although effective safety management is key to ATM, mid-air collisions in 2001 (Milan Linate) and 2002 (Überlingen) revealed serious problems in the safety culture of European ANSPs. In 2003, EUROCONTROL responded to this by launching a major programme for measuring, establishing, and improving safety culture in European ATM.

Safety culture research had traditionally focused on measuring culture qualitatively or through generic surveys, and within single companies, industries, or countries. Conversely - and uniquely - the EUROCONTROL project specified a highly international and practice-focused approach, capturing the complexity and highly technical nature of work in ATM. It was initially established in 2006 as a collaboration between EUROCONTROL and the University of Aberdeen, where Reader was employed and worked on the project. When he moved to LSE in 2010, the project and collaboration with EUROCONTROL came with him. EUROCONTROL were co-creators and full partners in developing the methodology during work at Aberdeen and LSE. The project aimed to develop the first safety culture model and measurement tool for:

i) identifying the core components of a “safe culture” within the unique domain of ATM;

ii) facilitating in-depth and meaningful analysis of the strengths and critical areas for development within an ANSP safety management system (SMS); and

iii) reliably measuring safety culture across different national contexts. This is essential to ensuring the validity and comparability of safety culture data between ANSPs and creating a common set of values and practices for managing safety in European ATM. This consistency is important for the safe navigation of aircraft across Europe.

The resulting safety culture methodology was developed through a systematic literature review, and interviews and focus groups with safety managers and front-line ATM staff in different

countries. It was initially designed and piloted at the University of Aberdeen in work led by Dr Kathryn Mearns and supported by Reader. Then, and led by Reader, research subsequently conducted at LSE has included further development of the methodology (e.g. the addition of new survey questions, refined theoretical underpinnings, reporting, and benchmarking analyses) and testing of aspects such as its questionnaire structure and psychometric properties. Reader also established the methodology in different cultural settings to facilitate the critical element of comparison and monitoring of culture data between ANSPs. As the ATM network manager, EUROCONTROL led the application of the methodology in ANSPs across Europe.

The project's first output was published in 2013 using data collected from 2006-2008 and reported on the initial development of the safety culture methodology **[1]**. This involved the design and application of a bespoke (rather than generic) questionnaire capturing practices essential for safety management in air traffic control across ANSPs in four countries. It further developed a six-dimension conceptual model of safety culture, used for parsing and exploring these practices in focus groups, interviews, and discussions with executives to interpret the culture and generate recommendations for improvement. The conceptual model was underpinned by both top-down analysis (using safety culture theory to design and interpret survey items), and bottom-up assessment of survey responses (involving exploratory and then confirmatory statistical factor analysis). It is outlined below.

Dimension	Definition	Relevance for safety management
Management commitment to safety	Extent to which management prioritise safety	Influences employee beliefs on the prioritisation of safety within an ANSP
Collaborating for safety	Group attitudes and activities for safety management	Extent to which there is a norm for coordinating amongst ANSP staff on safety
Incident reporting	Extent to which ANSP staff believe it is safe to report safety incidents	Essential for identifying system weaknesses and learning
Communication	Extent to which staff are informed about safety-related issues in the ATM system	Important for ensuring staff are aware of system or institutional changes that impact operations
Safety support	Availability of resources and information for safety management	Indicates active support within the institution for maintaining safety
Colleague commitment to safety	Beliefs about the reliability of colleagues' safety-related behaviour	Highlights reliability of ANSP staff for engaging in safety critical activities

The second output, published in 2015 **[2]**, reports on the widespread application and testing of this six-dimension model in ANSPs in different cultural contexts. It used data collected from 2011-2013 from air traffic controllers (n = 5,176) and managers (n = 1,230) in 17 countries. This was essential for ensuring that the model outlined above could be used reliably to interpret survey responses in different countries. Work published in **[2]** supported its use as a single conceptual model to explain, interpret, and benchmark safety culture in ANSPs across Europe in ways that allow the identification of both best practices and emerging problems. Additional research with 13,000 employees in 21 ATM centres found that safety culture is determined, in part, by national norms for uncertainty avoidance (the extent to which people in a society are comfortable with uncertainty) **[3]** and power distance (tendencies for challenging authority) **[4]**. These findings are significant because they show that safety culture can be shaped by factors outside of managerial control; as such, work to improve safety needs to be tailored to different national environments.

Together, this research has delivered a novel system for benchmarking and ensuring organisational learning on safety culture, which controls for the structural influence of national culture on safety culture perceptions and practices. By developing and applying theoretical and methodological principles on safety culture and psychometric measurement, a methodology has been developed that is customised for ensuring safety within the critical global ATM industry. That methodology has both supported new relationships between academia and industry (notably with EUROCONTROL) and been used to pioneer new areas of academic research (particularly on the role of safety culture in international and highly technical industries). It now represents the

standard for measuring safety culture in ATM and has subsequently been adapted to the wider airline industry **[5] [6]**.

3. References to the research (indicative maximum of six references)

[1] Mearns, K., Kirwan, B., Reader, T. W., Jackson, J., Kennedy, R., and Gordon, R. (2013). Development of a methodology for understanding and enhancing safety culture in Air Traffic Management. *Safety Science*, 53, pp. 123-133. DOI: 10.1016/j.ssci.2012.09.001. Leading safety journal; Impact Factor: 4.105.

[2] Reader, T. W., Noort, M. C., Shorrock, S., and Kirwan, B. (2015). Safety san frontières: an international safety culture model. *Risk Analysis*, 35(5), pp. 770-789. DOI: 10.1111/risa.12327. CABS Grade 4; Impact Factor 3.137; 5/51 (Social Sciences, Mathematical Methods).

[3] Noort, M., Reader, T. W., Shorrock, S., and Kirwan, B. (2016). The relationship between national culture and safety culture: implications for international safety culture assessments. *Journal of Occupational and Organizational Psychology*, 89(3), pp. 515-538. DOI: 10.1111/joop.12139. CABS Grade 4; Impact Factor 2.636; 24/84 (Psychology, Applied).

[4] Tear, M., Reader, T. W., Kirwan, B., and Shorrock, S. (2020). Safety culture and power: Interactions between perceptions of safety culture organisational hierarchy, and national culture. *Safety Science*, 121, pp. 550-561. DOI: 10.1016/j.ssci.2018.10.014.

[5] Reader, T. W., Parand, A., and Kirwan, B. (2016). *European pilots' perceptions of safety culture in European Aviation*. European Commission Report. Available at: https://safeorg.eu/beta/wp-content/uploads/2018/07/5_Safety-Culture.pdf

[6] Reader, T. W., Parand, A., and Kirwan, B. (2017). *Mapping safety culture onto processes and practices: the Safety Culture Stack approach*. European Commission Report. Available at: https://www.futuresky-safety.eu/wp-content/uploads/2018/03/FSS_P5_LSE_D5.13_v2.0.pdf

4. Details of the impact (indicative maximum 750 words)

The safety culture methodology described above is standardised, fully tested, and free for ANSPs to use. Its application has supported one of the largest ever international and industry-wide programmes of safety culture assessment and development, as recognised in the project's receipt of the 2014 Chartered Institute of Ergonomics & Human Factors Presidents' Award **[A]**. The methodology has been used in over 30 European ANSPs, with more than 30,000 survey respondents and 1,000+ focus group participants **[3]**. Since it was first established in the literature, the methodology **[1]** has been applied in over 20 ANSPs. LSE has helped ANSPs to run the survey and analyse data, while EUROCONTROL has used the findings of this in work with ANSPs to develop their safety culture. Through these processes, the methodology has had impacts on individual ANSPs, the ATM industry as a whole, and the wider aviation sector. It is also beginning to deliver impacts in other industries (e.g. financial services).

ANSP-level impacts: the safety culture methodology helps organisations to identify both strengths and areas for development in safety management. Since 2013, its application has had wide-ranging impacts on participating ANSPs, supporting improvements against the six thematic dimensions set out in the conceptual model published in **[1]**. Illustrative examples of such impacts are outlined here. These impacts, occurring from 2013 to 2020, have been collected from a sample of seven of the 30 ANSPs using the methodology. Those seven ANSPs run between 150,000 and two million flights annually in countries across Europe ([redacted]). All impacts summarised here are described further in a draft EUROCONTROL White Paper **[B**, pp. 12-18**]**. Changes were realised across all of the ANSPs in the six thematic areas of the conceptual model; e.g. improving incident reporting and management commitment to safety. However, the methodology allows specific changes in pursuit of these broader thematic improvements to vary according to the needs of different ANSPs. Examples of the sorts of specific changes used to achieve thematic improvements are outlined below. Some of these were widely applied (e.g. improved communication on safety, improving incident reporting), whilst others (e.g. relating to executive activities, investments in safety) were limited to specific ANSPs **[B**, pp. 12-18**]**.

Management commitment to safety. Changes to support the instantiation and emphasis of management priorities on safety include: increasing the focus on safety in organisational decision-making; executive board meetings with explicit focus on safety; employing more safety specialists;

and strategies for emphasising management commitment to safety (e.g. safety-focused CEO videos, walkarounds, town hall meetings, etc.).

Collaborating for safety. To improve team-working on safety, ANSPs reported changes including: ensuring technical staff are represented in safety decision-making groups; increasing staff participation in safety activities; safety training for non-operational staff; and regular workshops for safety managers and controllers to share perspectives.

Incident reporting. ANSPs report: developing new voluntary and proactive reporting tools for capturing safety information; introducing annual training for incident investigators; changing organisational departments leading incident investigations; and developing policies for ensuring incidents are investigated fairly (e.g. using independent investigators). One large ANSP with 500,000+ flights annually reported increases of up to 80% in incident reporting, alongside significant improvements in the quality of information gathered on errors and safety problems.

Communication. Changes include: publishing a clear overview of safety roles and responsibilities in their organisation; constant and clear communication on changes in the safety management system; and promotion of work and changes by the safety team.

Safety support. ANSPs report: increasing resources and staffing for managing safety; a focus on reducing fatigue amongst controllers (e.g. through improving rota systems); and ensuring safety is explicitly considered in change management, procurement, and project management.

Colleague commitment to safety was not identified as a concern in the sample.

ATM industry-level impact: the application of the methodology throughout European ATM has helped prioritise and support the development of a coordinated approach to safety culture across Europe. The majority of European ANSPs have used the methodology. Many also participate in an annual safety culture workshop hosted by EUROCONTROL and attended by LSE researchers, at which they share approaches both to developing organisational safety culture and to addressing industry-wide challenges such as fatigue management **[C]**. For EUROCONTROL, the methodology provides a mechanism to engage ANSPs on the topic of safety culture, to benchmark and monitor that culture, and to make recommendations for improving safety at both ANSP and industry levels **[B]**.

CEOs of ANSPs using the methodology (including four of the seven contributors to **[B]**) state that the assessment process has helped them to recognise safety culture as "*the bedrock*" of operations within ANSPs, as a "*business imperative*", and "*the compass which shows your current position so that you can reach your desired destination*" **[D]**. They argue that safety culture enables them to drive change from the top of the organisation and report that information sharing on safety has improved drastically. Many ANSPs now conduct their own safety culture surveys and workshops, with some (such as [redacted] and [redacted]) using the methodology described here. Others, such as [redacted], draw upon the methodology to develop their own approaches **[B**, pp. 26**]**. The scientific, coordinated, and collaborative approach of using the methodology in European ATM has contributed to safety culture featuring prominently on ANSP websites and communications, including reporting on the safety culture surveys in high-level corporate strategy documents or annual reports **[E]**.

Aviation-industry impact: the methodology developed for ATM has been adapted and extended to the wider aviation system. In cooperation with the European Cockpit Association (ECA; the Union for European Pilots), the safety culture survey has been customised to measure safety culture across the airline industry. In 2016, a sample of 7,000 pilots from more than 30 airlines completed the survey, run by LSE and ECA. This was the largest ever engagement of pilots on safety culture. The results, reported in **[5]**, provided crucial new insight on issues such as zero-hour contracts and ineffective fatigue management. Those insights catalysed and informed MEPs' questions on Europe's "Ultra-safe aviation industry" **[F]**; further investigation by the European Commission into the working conditions of airline crews **[G]**; and European Aviation Safety Agency recommendations on fatigue management **[H]**.

Major airlines have also used the insights generated through their use of the safety culture survey to improve their own safety management. EasyJet, for example, made changes in its schedules and rosters, delivered new training, and created a pilot-peer support programme following its first use of the safety culture survey **[I]**.

The survey is also being used to measure safety culture across the entire aviation system at specific sites such as Luton Airport **[6]** and Bristol Airport; in 2021, discussions are ongoing to extend this to other airports (e.g. [redacted]). Luton Airport, for example, was surveyed by EUROCONTROL and LSE in 2016 **[6]**. Here, the methodology has helped to develop a more harmonised approach to managing safety by bringing together 15 different organisations within the aviation system. The "Luton Safety Stack" pulls together airport, ATM, airline, and ground handling staff to help manage safety across interfaces. Improvement has been supported by regular workshops between these various organisations on topics such as improving communication and learning from incidents, and through the use of self-managed surveys (based on that developed at LSE) to improve coordination between them **[J]**. This approach led to a revision of procedures for improving the safety of ground handling at Luton airport. Improvements associated with this were recognised by a 2018 award from the International Air Transport Association **[K]**.

Impacts in other industries: impacts of the safety culture methodology are now also being felt in industries outside ATM. It has been used by the Financial Conduct Authority to shape thinking (for both the regulator and firms) on how to effectively conceptualise, measure, and manage culture in the financial industry **[L]**. The OECD has also used the methodology as a framework for investigating the extent to which workers in regulated entities think behavioural insights principles would be effective in promoting safety behaviours. It has been applied in this context to develop a toolkit for improving safety culture at: the National Energy Board in Canada; Agency for Safety, Energy and Environment in Mexico; Commission for Regulation of Utilities, Ireland; and Authority of Electricity Regulation, Oman **[M] [N]**.

5. Sources to corroborate the impact (indicative maximum of ten references)

[A] Chartered Institution of Ergonomics & Human Factors President's Award Roll of Honour. 2014 award presented to project partners in EUROCONTROL's Safety Culture Team.

[B] **"**The Future of Safety Culture in European Air Traffic Management, A White Paper", EUROCONTROL/LSE. Description of ANSP-level impacts pp. 12-18; references **[1]**-**[6]**.

[C] Agendas/participant lists from annual regional safety culture workshops (2012-2018), involving safety managers from ANSPs across Europe, and LSE.

[D] "CEOs on Safety Culture. Views from the top". A EUROCONTROL-FAA Action Plan 15 White Paper, October 2015. See pp. 5-6 and 19.

[E] References to the safety culture programme, including organisational surveying: Irish Aviation Authority Corporate Strategy Report 2016-2020 (pp. 2, 5 and 8-9); Avinor annual report (Norway) (p. 32); and Malta Air Traffic Services (MATS) Annual Report 2018 (p. 33).

[F] "Just how safe is Europe's 'ultra-safe' aviation industry?", *International Airport Review*, 27 March 2017. Summary of MEP breakfast debate responding to **[5]**.

[G] **"**Study on employment and working conditions of aircrews in the EU internal aviation market", European Commission, January 2019. References **[5]**, p. 11.

[H] "Practical Guide: Management of hazards related to new business models of commercial air transport operators", European Aviation Safety Agency, August 2017. References **[5]**, p. 7.

[I] **"**EasyJet's experience of our first safety culture survey", EasyJet Future Sky Safety Public Workshop, 2017.

[J] "Towards the harmonisation of Just Culture across organisations: the London Luton Airport case", CEO of Luton Airport. References use of safety culture methodology (p. 2).

[K] "LTN Stack receives IATA award as the first airport to harmonise ground handling procedures", Safeorg, 20 December 2018.

[L] "Transforming Culture in Financial Services", Financial Conduct Authority, March 2018. Reader authored Essay 1.2, (pp. 23-27), drawing on research including **[2]**, **[3]**, and **[5]**.

[M] "Delivering better policies through behavioural insights", OECD (2019). References LSE input (including use of survey questions in **[2]**) to develop and run survey of representatives of the OECD Network of Economic Regulators (pp. 125-127).

[N] "Behavioural Insights and Organisations: Fostering Safety Culture", OECD (2020). Chapter 4 references use of LSE survey questions **[2]** in a behavioural change safety culture experiment.