What makes for an effective Safety Recommendation?

Philip Sleight BSc(Hons), CEng MRAeS, CMgr MCMI

Deputy Chief Inspector of Air Accidents,

UK Air Accidents Investigation Branch

Introduction

A Safety Recommendation is intended to improve safety by providing to those who have the ability to act, a proposal to address identified safety issues. But how is this done in practice and how does an Accident Investigation Authority assess whether the Safety Recommendation was effective at meeting the aim to prevent a future accident or incident? This paper explores efficacy, effectiveness and efficiency and the interaction between each of these concepts. Also, how the approach of the AIA and the industry differs. It also looks at where the AIA can assist with inputs related to the Safety Recommendations and feeding these into State Safety Plans.

This paper explores the following:

1. What makes an effective Safety Recommendation?
2. How does the AIA, State or Safety Programmes at all levels measure this? if at all.
3. How industry reacts to Safety Recommendations and why in some cases on action is taken.
4. To highlight how AIA can assist in making their proposals more likely to be effective in improving overall aviation safety.
5. What role the State level safety system has in improving aviation safety using information from Safety Recommendations.
6. Where efficacy, effectiveness and efficiency come together to propose a model to assess what is likely to be implemented and what is likely to improve safety.

What is a Safety Recommendation?

A Safety Recommendation is a proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and may result from diverse sources, including safety Studies.

By its nature there is no compulsion on the addressee receiving a Recommendation to act on it. The reason an AIA raises a Safety Recommendation is to clearly identify, to someone who can act on it, the safety issue that needs to be addressed and to highlight how such an action will prevent recurrence of a future accident or incident.

The attitude of the recipient towards how to action a Safety Recommendation depends very much on the information provided by the accident investigation authority in the report and the justification. This information provides the rationale as to why the AIA felt the need to issue the recommendation, and to assist in identifying the safety issues that require addressing. It may also propose potential solutions that are known to exist that may improve safety and the risk of future accidents or incidents if the safety issue remains unresolved.

When is a Safety Recommendation "good"?

There is already a lot of guidance material on what is deemed to be a "good" Safety Recommendation. The Manual of Air Accident Investigation Part 4 Reporting provides detailed guidance on the drafting of Safety Recommendations (Appendix I). At the UK AAIB a check is used when drafting and assessing whether a Safety Recommendation should be issued (Appendix II).

The issue however is that this guidance is all well and good in drafting a Safety Recommendation to encourage action by the addressee, but are they effective? The guidance can appear to be quite prescriptive. Whilst it is good to have these to work through, it could perhaps put off some AIA from issuing a recommendation as they don't seem to fit the schema.

Similarly, for what appears on the face of it to be a good recommendation only to be rejected outright by the recipient from the start. Maria Gregson explored this particular issue in her Kapustin scholarship paper to ISASI in 2017 – "What makes a good safety recommendation in the aviation industry?"[1] and makes several observations about what can affect the drafting of a "good" recommendation as opposed to one that is perceived to be poorly formulated or not supported by facts.

A way to look at the drafting of a Safety Recommendation is to use the SMART model used principally for the setting of objectives. The first use of the SMART acronym was attributed to George T. Doran who published a paper titled "There's a S.M.A.R.T. Way to Write Management's Goals and Objectives".[2]

He stated that each objective should be:

Specific: target a specific area for improvement.

> So for a Safety Recommendation this would be to specify clearly the safety issue that needs to be addressed. However, it is not to prescribe the specific "solution" – that is for the recipient who is best able to "act" on the recommendation and address the safety issue.

Measurable: quantify, or at least suggest, an indicator of progress.

> For a Safety Recommendation the question is to measure whether it has attained the objective to prevent future occurrence. However, how to measure

[1] Gregson M, What makes a good safety recommendation in the aviation industry?, 2017, ISASI Kapustin Scholarship Entry - Maria Gregson.pdf

[2] Doran, G. T. (1981). There's a S.M.A.R.T. Way to Write Managements' Goals and Objectives. Management Review, 70, 35-36.

this practically and objectively is a challenge and one this paper will continue to explore.

Assignable: specify who will do it.

Clear and specific addressee who is best able to take action to address the safety issue.

Realistic: state what results can realistically be achieved given available resources.

The realism is around whether the safety issue is actually one that can realistically be addressed. For example to stop future air accidents or incidents then all aviation could be mandated to cease it will achieve the objective but is not realistic.

In some cases the efficacy of solutions can be provided in the recommendation or justification that lead into the recommendation text. More on efficacy later in the paper.

Time-related: specify when the result can be achieved.

All Safety Recommendations by their nature should be acted on immediately, even if the time to complete the solution may be years ahead. The initial response to a SR is 90 days. When there is perhaps a need for urgency as the risk of recurrence is very high then that can be specified.

The use of SMART is a good starting position but as there are many factors that can affect whether a recommendation is perceived to be “good”.

Indeed, a well drafted recommendation based on solid facts and very clear, may not be accepted by the addressee due to these others factors or due to aspects which were not considered or indeed known at the time the recommendation was drafted.

Effectiveness

So are “good” recommendations that follow the guidance effective at achieving the goal of prevention of an accident or incident that may result from the identified safety issue.

On 21 November 1997 a BAC 1-11 Registration G-AWYR[3] was taking off from Runway 15 at Birmingham Airport. During rotation there was a loud bang. Arriving aircraft on the Runway then reported rubber debris on the side of the Runway. Following an uneventful landing, the right main outboard tyre was extensively damaged and there was damage to hydraulic lines and damage to the flaps. The tyre had failed due to fatigue owing to the tyre running under inflated. No records had been kept of the tyre pressures or reports of underinflation. The report at the

[3] BAC One Eleven 501EX, G-AWYR, 21 November 1997 at 1037 hrs - GOV.UK (www.gov.uk)

time in 1999 showed that there had been 34 other cases of tyre failure on 1-11 aircraft since 1976 with flap damage in 27 cases.

As a result of the investigation the AAIB issued two recommendations with a view to prevent occurrences of tyre failure on aircraft by the identification of underinflated tyres.

> **Safety Recommendation 99-11** The CAA consider a requirement for the installation, on the wheels of UK registered aircraft where a potentially hazardous level of tyre underinflation can be undetectable by external visual inspection, of a device to provide ready indication of such a condition during routine pre-flight external inspection.
>
> **Safety Recommendation 99-12** The CAA consider requiring the fitment on future aircraft types on the UK Register of a system to provide continuous flight deck indication of tyre pressures and/or warning of abnormal pressures.

The recommendations were to provide a means of identification to the crew of low tyre pressures.

The CAA response, made in December 1999, stated that they accepted both recommendations and would *"consider the need for such a requirement by conducting a review, which is intended to be completed by 31 December 1999."*

The CAA completed their review of service history in May 2000 and concluded

> *"This review has indicated that the tyre low pressure condition alone is not responsible for a significant proportion of the tyre failure incidents, therefore a tyre low pressure indication device, capable of interpretation during routine pre-flight inspection, would be of limited benefit and would not lead to a significant reduction in the number of tyre failures. The Authority therefore considers that this review has confirmed that current design requirements are adequate in minimising the hazards associated with a tyre failure or tread release."*

Although the recommendation provided quite detailed information on the safety issue, the consequences and risks – no action was taken by the addressee.

The recommendation was "good" by the guidance provided but was not effective in preventing recurrence and did not meet its intended objective.

On 3 October 2000 a Boeing 737-300, 4X-BAU[4], suffered tyre bursts on landing at Gatwick Airport. Tyres 7 and 8 on the right main landing gear were destroyed. Tyre debris had caused damage to the flaps and aircraft skin, damage to hydraulic hoses and wiring. The aircraft did not have a tyre pressure indication system fitted.

[4] Boeing 757-300, 4X-BAU, 3 October 2000 - GOV.UK (www.gov.uk)

Given the rejection of the recommendation in 1999, the AAIB issued a subsequent recommendation:

> **Safety Recommendation 2002-14** It is recommended that Airworthiness Authorities such as the JAA and FAA consider implementing the measures outlined in AAIB Safety Recommendations 99-11 and 99-12 concerning requirements for tyre pressure monitoring and warning systems.

This recommendation was quite broad to all airworthiness authorities, so it was not clear which organisation was required to action the Safety Recommendation. Given this was wide spread and ambiguous as to the addressee, it was not taken on by any authority until some time later. So this was a poorly written recommendation and was not effective in addressing the safety issue – mainly as there was no action taken at the time by any authority.

In the years that followed there were several events of tyre failure due to underinflated tyres.

In 2003 an Embraer 145 suffered a tyre failure due to it running under inflated. Recommendations to the aircraft manufacturer to amend maintenance practices on tyre pressures were rejected.

In 2004 the ATSB investigated tyre failures on Boeing 737 aircraft which had suffered failures following retreads; running underinflated was a factor in increasing fatigue loads. The manufacturer issued guidance on tyre maintenance but no wider actions were taken.

In 2008 a Learjet 60, registration N999LJ[5], on 19 September 2008 suffered a runway excursion due to

> *"the operator's inadequate maintenance of the airplane's tires, which resulted in multiple tire failures during takeoff roll due to severe underinflation, and the captain's execution of a rejected takeoff (RTO) after V1, which was inconsistent with her training and standard operating procedures."*

The NTSB issued several Safety Recommendations to the FAA including:

> *'Require that all 14 Code of Federal Regulations Part 121, 135, and 91 subpart K operators perform tire pressure checks at a frequency that will ensure that the tires remain inflated to within aircraft maintenance manual-specified inflation pressures.' (A-10-47)*
>
> *'Require that aircraft maintenance manuals specify, in a readily identifiable and standardized location, required maintenance*

[5] AAR 10/02 (ntsb.gov)

> *intervals for tire pressure checks (as applicable to each aircraft).' (A-10-48)*
>
> *'Require tire pressure monitoring systems for all transport-category airplanes.' (A-10-50)*

The FAA responded[6] in 2011 to A10-50 with a rejection that

> "*The FAA believes that, while a tire pressure monitoring system (TPMS) may provide an indication of underinflated tires, the logic associated with the range of tire pressure changes that result from the drastic changes in tire temperature experienced in operations may require wide pressure thresholds. Therefore, TPMS may not be a practical solution to detect impending tire failures due to low pressure in all instances.*"

In 2010 the EASA took on the responsibility to review Safety Recommendation 2002-014, some 8 years after its initial issue. Which shows how much effect the ambiguity had on the lack of action.

The EASA in 2017 started a Rule Making Task RMT 0586 to propose regulatory change including the consideration for mandating the carriage of tyre pressure monitoring equipment. A Notice of Proposed Amendment was issued in 2020. Amendment 26 of Certification Specification 25 was issued so that either there are clear instructions on the management of tyre pressures or to install a tyre pressure monitoring system – this was also expanded to cover already certificated aircraft.

It is still to be seen if this action will prevent future occurrences of tyre failure due to underinflation. However, as it now stands the recommendations appear to have now been effective in putting place an intervention albeit several years after it was first put in place.

This case study show that it can take a long time to realise the safety benefit from actions taken to a safety recommendation. Similarly, that the initial reaction is potentially to reject the recommendation as it will take a long time to implement and that there is a perception that short term actions may obviate the need for the more difficult intervention.

Even in this case it is still unknown if the intervention is fully effective and only time will tell.

Efficacy

Efficacy is a term used in the medical industry as a means to identify if the intervention, be it a drug or medical procedure, addresses the issue in ideal conditions. That is without any other factors or unintended attributes. It doesn't

[6] https://www.ntsb.gov/investigations/AccidentReports/_layouts/ntsb.recsearch/Recommendation.aspx?Rec=A-10-050

however provide a measure of how effective the intervention in real life will be when the other factors now influence the outcome. Efficacy does not imply effectiveness.

On 22 August 1985 a Boeing 737, G-BGJL[7], was on its take off run from Runway 24 at Manchester when the left engine suffered an uncontained failure, puncturing the wing fuel tank and starting a fire. Following a rejected take off the aircraft was positioned off the runway but the wind carried the fire over the fuselage which penetrated into the hull. 55 persons sadly lost their lives that day.

A very extensive investigation was carried out by the AAIB which explored the reason for the high number of fatalities. The conclusions were that some of the fatalities were due to rapid incapacitation from inhalation of dense toxic/irritant smoke in the cabin along with evacuation delays.

Two aspects were looked at to reduce the possibility of fatalities in this situation – passenger smoke hoods and water spray systems.

The investigation already established through trials that passenger smoke hoods could provide a cost effective solution to protect passengers respiratory systems and eyes, thereby maintain vision, consciousness and mobility. This showed that in ideal conditions a passenger smoke hood will reduce the possibility of fatality following a cabin fire. The AAIB made the following recommendation:

> *"The Civil Aviation Authority should urgently give consideration to the formulation of a requirement for the provision of smokehoods/masks to afford passengers an effective level of protection during fires which produce a toxic environment within the aircraft cabin. (Made December 1985)"*

The CAA accepted the recommendation initially and they did consider requirements, so a positive response. However, in 1991 the CAA eventually provided their final response. They assessed the risk of passengers being able to put on a smoke hood, including those for small children which could introduce delays in evacuation. Indeed, there were several other developments in cabin safety including furnishings, evacuation alarms and door/galley widths that the focus from regulators was to enable those on board to evacuate as quickly as possible rather than on providing respiratory protection.

During the accident to an Airbus A340, F-GLZQ[8], in Toronto on 2 August 2005 where the aircraft overran the end of the runway into a ravine. All passengers were able to evacuate before the fire reached the escape routes. One cabin crew member, whose station was just aft of row 31, donned a smoke hood for personal protection due to significant amount of black smoke in the area of the L3 cabin crew station. However, the crew member removed it because the passengers could not

[7] 8-1988_G-BGJL.pdf (publishing.service.gov.uk)

[8] Transport Safety Board Canada, Aviation Investigation report A05H0002, Runway overrun and fire, Air France, Airbus A340-313, F-GLZQ, Toronto/Lester B Pearson International Airport, Ontrario, 2 Aug 2005.

hear/understand what she was saying to them. So the smoke hood could have hindered the evacuation.

Another aspect that was explored was water spray systems, the logic being that the water spray/mist would rapidly improve the environment by reducing temperature and removing particulate and soluble gases from the atmosphere. The investigation had already established it could potentially assist in reducing fatalities due to smoke inhalation so the recommendation was made to the CAA:

> *"Onboard water spray/mist fire extinguishing systems having the capability of operating both from on-board water and from tender-fed water should be developed as a matter of urgency and introduced at the earliest opportunity on all commercial passenger carrying aircraft."*

Subsequent tests and trials have proven that water spray/mist systems have efficacy in the suppression of fires and been demonstrated in many studies.[9][10]

However, cost and weight penalties were high for installation, also the cost of recovery of an aircraft should the water system inadvertently be activated – especially in flight where it could cause contamination of electrical systems – was high. It is also unknown how a passenger would react to water spray during an evacuation or its effect on the ability to evacuate promptly.

So, these demonstrate that the recommendations themselves propose solutions that have efficacy in attempting to deal with the safety issue of fatalities as a result of smoke inhalation or delayed evacuation when faced with a cabin fire. Although the solutions have efficacy when assessed on their own and in ideal conditions, they were not effective when considered in the wider picture of the unintended consequences of such systems. Indeed, such systems had the potential of causing injury or damage in future situations.

What the investigation into G-BGJL did is provide detailed learning on cabin fire safety and has led to many improvements in safety and those other recommendations were effective as demonstrated by recent evacuations from aircraft fires with only minor injuries.

For example this Safety Recommendation to the CAA:

---

[9] *National Academies of Sciences, Engineering, and Medicine. 1997. Fire Suppression Substitutes and Alternatives to Halon for U.S. Navy Applications. Washington, DC: The National Academies Press. https://doi.org/10.17226/5744.*

[10] (PDF) Water mist fire suppression workshop, March 1-2, 1993 | Kathy Notarianni - Academia.edu
Water mist fire suppression workshop, March 1-2, 1993, proceedings

> *"The applicable regulatory requirements for aircraft cabin materials certification should be amended at the earliest opportunity to include strict limitations of smoke and toxic/irritant gas emissions."*

Since then many developments have been put in place and regulations regarding the aircraft cabin materials to minimise fires and toxic gases.

Efficiency

When an addressee receives a Safety Recommendation their usual response is to try and deal with it in the most efficient manner possible. That is to take into account the cost of implementation of an intervention/action against the benefits of doing such an implementation.

When assessing the benefits of an intervention, the risk of not doing an action on perhaps reputation or future litigation should there be recurrence comes into their considerations which would not have been in the minds of the investigator.

An expensive intervention or one that takes a long time to implement, although known to be effective, could be too detrimental to the business and compromise the organisation's future prosperity. So, there is a propensity to favour the less expensive actions or those that are easier to implement in a shorter time frame.

An example where the AIAs are proposing systems that will take time to implement and has expenditure associated with it, but where less effective cheaper and more timely interventions have been put in place is around the attempts to reduce the risk of runway excursions due to incorrect take off performance calculations.

Take off performance calculation errors that lead to incorrect power setting on take off remains a problem. Several AIA have raised recommendations to improve the situation by installation of warnings systems that inform the crew in enough time that they can abort a take off if the acceleration is not adequate. Such systems exist but no standards have been set and are expensive to install. The reaction of industry and regulators has been to avoid technical solutions but to prefer operational procedural solutions instead.

In 2017 a Boeing 737, C-FWGH[11], took off from Belfast International Airport with insufficient power set to meet regulatory performance requirements. The aircraft struck a light at the end of the runway. The wrong outside air temperature had been set into the flight management computer and the low acceleration was not recognised by the crew. It was established that technical solutions were being developed but required standards to be fitted so the AAIB recommended the following with a view to preventing aircraft attempting to take off with abnormally low acceleration.

> ***Safety Recommendation 2018-014*** *It is recommended that the European Aviation Safety Agency, in conjunction with the Federal*

[11] Air Accidents Investigation Branch, AAIB Bulletin 2/2018, Ref EW/C2017/07/02 (2017), Report on the serious incident to Boeing 737-86J, C-FWGH Belfast International Airport on 21 July 2017

Aviation Administration, sponsor the development of technical specifications and, subsequently, develop certification standards for a Takeoff Acceleration Monitoring System which will alert the crew of an aircraft to abnormally low acceleration during takeoff.

The response from EASA was to focus on entry of data rather than a technical solution. They had issued a safety information bulletin 2016-02[12] "Use of Erroneous Parameters at Take-off' to alert operators and flight crew to the safety issue and to recommend the implementation of operational mitigation measures. Indeed, even ICAO's Flight Operations Panel Working Group consensus was to focus on making procedural improvements, rather than to explore technological aids.

On the face of it, if the procedural improvements work it would be effective in stopping incidents of poor take off performance due to erroneous parameters. Yet it is still a problem and there are recurrences so the recommendations have not been effective in preventing future occurrences but is seen as the most efficient solution by the regulators.

The AAIB carried out a subsequent investigation to a Boeing 737-800, G-JZHL[13], on 1 December 2021 at Kuusamo Airport, Finland. During takeoff from Kuusamo Airport in Finland the flight crew inadvertently left the thrust set at the 70% engine run-up setting rather than the 89% required for takeoff. The aircraft became airborne with 400 m of runway remaining and climbed away slowly.

This has led the AAIB to issue the following recommendation:

Safety Recommendation 2022-018 *It is recommended that the UK Civil Aviation Authority, in conjunction with other regulatory authorities, develop a set of technical specifications and, subsequently, develop certification standards for an on-board system that will alert the crew of an aircraft to abnormally low acceleration during takeoff.*

It remains to be seen if this will be effective given the apparent efficient approach of industry and lack of movement to consider technological solutions. Indeed, there might be some unintended consequences to consider, including the crews reactions to such alerts and the attendant risk from rejected take offs.

[12] EASA Safety Publications Tool (europa.eu) 2016-02R1 : Use of Erroneous Parameters at Take-off

[13] Air Accidents Investigation Branch, AAIB Bulletin 11/2022, Ref AAIB-27895 (2022), Report on the serious incident to Boeing 737-800, G-JZHL Kuusamo Airport, Finland on 1 Dec 2021

How does efficacy/effectiveness/efficiency come together?

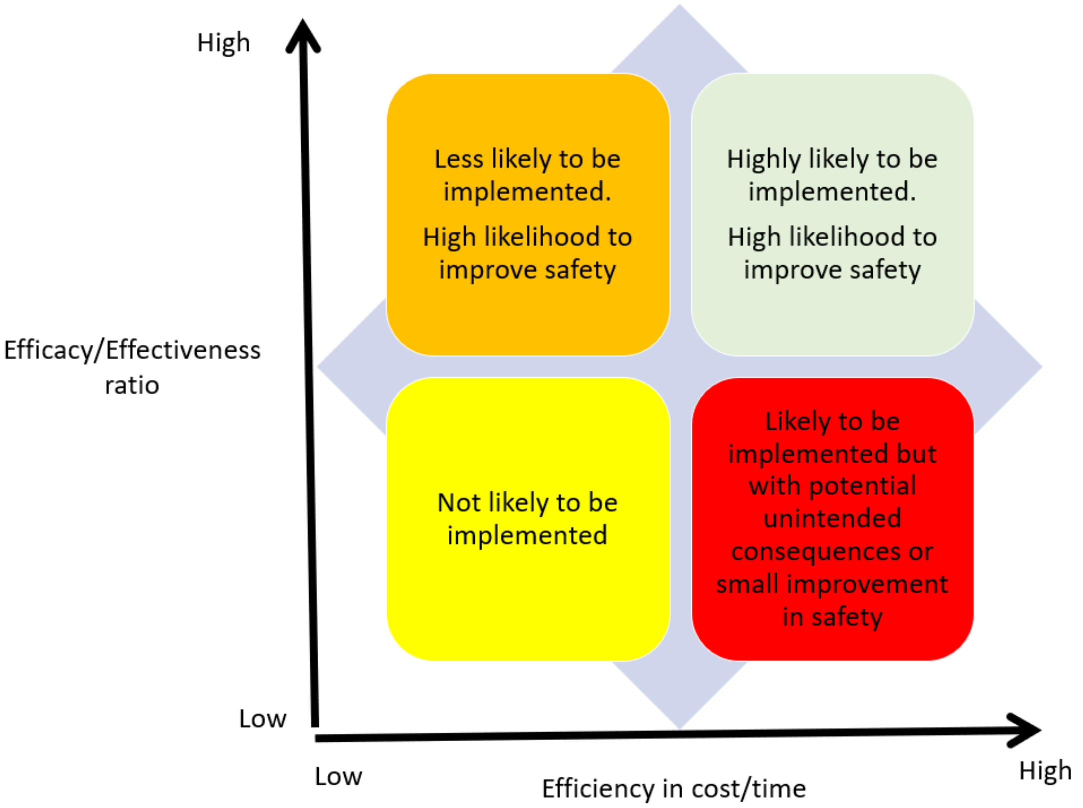

Figure 1

As described a Safety Recommendation could lead to an intervention that has strong efficacy but in the real world, the intervention is not really effective and indeed has potential unintended consequences.

Whereas an intervention that has strong efficacy and effectiveness will improve safety and prevent recurrence. Its implementation though is dependent on the efficiency to implement, one that is easy to implement from a cost and time perspective will highly likely be implemented and will have an immediate impact. Whereas one that is costly or takes a long time to implement due to factors such as development on new specifications or regulations or technological challenges may potentially be rejected in favour of what is perceived to be a cheaper and less time consuming solution that is less effective.

The area of most concern is where an intervention has low efficacy and effectiveness but is easy to do, this has the potential to have unintended consequences or only a short term effect. Such as information bulletins, warnings in manuals, updates to procedures which are not looked at regularly or research with no real objective.

So whether a Safety Recommendation will make a difference is perhaps not necessarily related to whether the recommendation itself is “good” but whether the intervention required by the actionee to address the safety issue has efficacy, effectiveness and efficiency.

This should not lead to AIA only issuing Safety Recommendations that are efficient only because they feel these are the only ones to be implemented. Indeed, most Safety Recommendations should be in the top half and those in the top left are where the AIA is putting down a marker.

It could be argued that an AIA should not need to raise recommendations for the bottom right of figure 1, as most of these are easy wins which could be proactively implemented before a recommendation is needed. Examples being safety notices and manuals. In the AAIB experience this is the area where most "safety action" takes place.

Tools to measure effectiveness

The ICAO Manual of Air Accident Investigation Part 4 reporting has as small section on measuring the success of the recommendations. It does emphasise the full potential to prevention of future accidents or incidents can only be after the appropriate action has been put in place.

But what is appropriate?

It suggests setting performance expectations of the Safety Recommendation, then evaluating the actions and assessing responses from the addressee as to whether they are satisfactory.

A paper search on the subject revealed quite a lack of definitive evidence on how to measure the effectiveness of a recommendation or indeed interventions that have been put in place following such recommendations. A paper "*What works in safety. The use and perceived effectiveness of 48 safety interventions"* published in February 2023 in Safety Science[14] by various authors in the Netherlands reviewed the perception of effectiveness to interventions in reducing work related accidents and fatalaties. Their main focus was that several interventions were perceived to be effective by the industry but there was no clear measure of whether they were actually effective in improving safety. The study found that

> "*Intervention types with a comparatively high perceived effectiveness seem to be more active, future oriented and include more agency for and involvement by the safety professional themselves….By contrast, interventions with a low perceived effectiveness seem to be more passive from the safety practitioner's perspective….In addition, some intervention types may not be perceived as effective whilst they actually are, perhaps because they have existed for a long time."*

The authors acknowledged that

[14] What works in safety. The use and perceived effectiveness of 48 safety interventions, Jakko van Kampen, Marre Lammers, Wouter Steijn, Frank Guldenmund, Jop Groeneweg, Safety Science 162 (2023) pg 2 - 7

"A more objective understanding of the effectiveness of interventions could benefit safety practitioners, although finding new ways of disseminating this information will be a challenge."

When attempts have been made to measure effectiveness of actual interventions such as *"measuring the effectiveness of mental health courts*"[15] and *"Impact evaluation of the Control of Major Accident Hazards (COMAH) Regulations 1999"*[16] it was found that it is not a simple case of looking at certain indicators and that many other factors can affect the outcome of the indicators selected that makes comparison difficult. Lastly to pin any improvements specifically on the intervention is not simple. Indeed, sample sizes and time is seen to be relatively small and that any small adjustments of these macro and local influences and some relational dynamics. In both cases the studies were not able to establish reliably if the intervention had lead to reduction in the risks they were trying to address.

One of the factors on whether a Safety Recommendation is effective is that the background that led to the recommendation is based on the event and the findings by the investigation team. A paper *"What you find is not always what you fix—How other aspects than causes of accidents decide recommendations for remedial actions*"[17] concluded that

"the limited scope of investigation of causes to those that are preventable can be a source of bias in examining a "bigger picture" of causes of accidents at large—which becomes limited to those causes that are currently seen as fixable by investigators….Accident investigation is not a rational process. Neither is the choice and implementation of remedial actions….This means that some of the 'fixes' are reasonable from a practical point of view, while others are unreasonable."

For a Safety Recommendation to be effective the author suggest that any actions are 'reasonable' in the sense of practicality but the limitation of the safety investigation may make this difficult as all the other factors that may affect the system are broadly unknown. This may lead to a Safety Recommendation when acted on becoming a contributory factor in another accident.

The paper *"issues in safety science*"[18] explores the paradox of major accident inquiries in that the

"logic of accident causal analysis does not lead directly to recommendations for prevention. Strictly speaking recommendations

[15] Nancy Wolff & Wendy Pogorzelski, Measuring the Effectiveness of Mental Health Courts: Challenges and Recommendations, 11 Psychol. PUB. POL'y & L. 539 (2005).
[16] Impact evaluation of the Control of Major Accident Hazards (COMAH) Regulations 1999, Fenning N, Boath M, Health and Safety Executive research report 343,2006, https://www.hse.gov.uk/research/rrpdf/rr343.pdf
[17] What you find is not always what you fix—How other aspects than causes of accidents decide recommendations for remedial actions, Jonas Lundberga, Carl Rollenhagenb, Erik Hollnagel, Accident Analysis and Prevention 42 (2010), pg 2132 - 2139
[18] Hopkins, A. Issues in safety science. Safety Science (2013), http://dx.doi.org/10.1016/j.ssci.2013.01.007

for prevention depend on additional argument or evidence going beyond the confines of the particular accident."

One problem highlighted was that a safety investigation is looking back in time at what had happened, whereas a Safety Recommendation is to prevent recurrence in the future but can only really be effective in avoiding the same event when exactly the same causal and contributory factors occur. However, in reality no set of circumstances will ever be the same and there will be other factors, for example the environmental factors will certainly be different. The more these factors differ then the less likely the intention of the Safety Recommendation when acted would be effective and therefore cannot be certain that it would reduce the likelihood of a future accident.

When more information comes to light, possibly from several similar events then the strength of knowledge is such that the possibility of an effective Safety Recommendation increases. As can be seen with the examples in this paper, the initial recommendations may not be effective, but became effective as more data was made available and the addressee felt more inclined to act.

The main conclusion from these papers is that to truly understand if action taken to a Safety Recommendation is to be assessed properly on its effectiveness requires a capture of data on the direction and strength of the effects. This of course would require extensive data collection and gathering of information beyond what is readily available.

How do AIA measure recommendations at present?

When a recommendation is made, at present the only real method of data collection by the AIA is through the receipt of a recommendation response and the limited database information from serious incidents or accidents.

So coming back to assessing a Safety Recommendation who sets the performance expectations and the evaluation?

What happens in practice is that those AIA that assess responses use internal criteria to assess whether the response will meet the "intent" of the recommendation.

In Europe for example the term "adequacy" is used rather than is it satisfactory. Where the assessment is not or partially adequate there is an expectation for a further response and action taken to achieve an adequate response.

The NTSB use the terms "acceptable" or "unacceptable". Acceptable being the response meets the intent and will address the safety issue. Using the term acceptable is subjective. Regulators will tend to use the term "accept" to mean they have received the recommendation and are acting on it. Whereas to "reject" means they are not acting on it. For an AIA then is "acceptable" an assessment that the response is acceptable or that the addressee deemed their response was acceptable.

Other terms from AIAs are “addressed” and some do use “satisfactory”.

There is a wide differential across the AIA on their assessment of the response to a Safety Recommendation from an addressee. The AIA will also have to take it on trust that the information provided it honest and that any proposed action will actually take place.

The means the possibility that an addressee has promised to do something in their response and it is deemed satisfactory by the AIA, but it hasn’t yet been implemented so the intervention hasn’t occurred yet – therefore is it really satisfactory until the promised action is complete.

Indeed, anecdotally an addressee informed me that that when they see an AIA assessment of “adequate” or “satisfactory” they take that as meaning the AIA is content and therefore the addressee can now slow down or not complete the proposed actions as they have met the needs of the AIA.

This is why there is a need to monitor the proposed actions toward full implementation and why Annex 13[19] 6.12 was updated to implement monitoring of actions to Safety Recommendation by States.

The UK AAIB regularly ask for updates on progress to Safety Recommendations following the initial response and will not close a recommendation until all proposed actions have been completed. This has proven to be powerful in holding addressees to account when they promise actions. On occasion the addressee will change their mind and not do an action at which point a new assessment is made of the response.

However, not all States do this and there is inconsistency which causes some confusion with addressees when they receive Safety Recommendations from overseas. At the AAIB any that are received by a UK entity are monitored as to the actions proposed and regular reports back to the issuing AIA is carried out. When reporting back to overseas AIA, it is usual not to receive any further correspondence.

What is clear is that when monitoring actions, it can take years and in some cases decades for actions to be completed. Even then many years before the full potential is realised and this makes it very difficult for AIAs to assess if their Safety Recommendation was effective.

What can be indicated is that if a Safety Recommendation is acted upon it is the expectation of the AIA that it will be effective in addressing the safety issue and therefore prevent future accidents or incidents directly related to the safety issue that has been identified.

---

[19] ICAO Annex 13 [Explore (icao.int)]

However, even monitoring actions stops at the point the intervention is in place – there is no further monitoring or activity on whether the intervention was actually effective at improving safety it is inferred.

Where does a Safety Recommendation fit into Safety Plans?

ICAO Annex 19[20] Safety Management lays down the Standard and Recommended practices for States to manage aviation safety risks. The foundation being the appropriate implementation of a State Safety Plan. A tenet of this is safety data collection and of course the input from AIA from their safety investigations and importantly from Safety Recommendations.

In the UK the State Safety Board is accountable for the National Aviation Safety Programme (NASP) and the CAA is responsible for maintenance of the NASP and actions to address the safety risks identified.

The State Safety objectives indicators is no fatal accidents in commercial air transport aeroplanes or rotorcraft where the UK has oversight responsibility and no fatal accidents involving people on the ground as a result of an aircraft accident.

As Safety Investigation is carried out to prevent future accidents and incidents and that a Safety Recommendation is a proposal intended to prevent accidents or incidents this information is an important facet of the State Safety Programme.

This includes assessing whether responses to Safety Recommendations adequately address the safety risk and if not to potentially put in place mechanisms to do so to meet the objectives. Similarly, the SSB can chose to accept the risk if no action is taken. The AAIB provide a key input by providing regular updates on Safety Recommendation progress and the possible on-going risks. The actual risk assessment though is carried out by the CAA using their multiple safety intelligence inputs including occurrences.

The Regional Aviation Safety Plan (RASP) for Europe contains similar Safety Performance Indicators to maintain a decreasing trend in regional accident rate which feeds into the Global Aviation Safety Plan (GASP) by ICAO to achieve a continuous reduction of operational safety risks.

So with the AIA being a fundamental part of Global Aviation Safety Plans – it is important to provide timely reports which clearly identifies the causal and contributory factors, safety issues and makes clear Safety Recommendations with the intention that if acted on appropriately would be effective.

Conclusions

The paper asks the question of what makes an effective safety recommendation. However, the answer is not simple and indeed attempts in other industries similarly show that it is not something that is easily achieved. Some Safety Recommendations are perceived to be effective, but it is difficult to say whether it

---

[20] ICAO Annex 19 Explore (icao.int)

was the intervention from the Safety Recommendation that did this or whether it was simply the factors that caused the accident have not happened again in the same exact sequence.

The likelihood of implementation of an action to a Safety Recommendation is influenced by the efficiency of such an intervention on cost and time. A more efficient proposal, in the eyes of the industry, is more likely to be implemented - however it may not be effective or only have short term effectiveness. The likelihood of implementation of easy, cheap short term perceived solutions would be unaffected by how "good" a recommendation is.

The AIA will usually propose that the areas that need to be addressed and the expected intervention to have high efficacy, but without taking account of the real world. So, in these cases it is less likely an intervention will be put in place or worse an intervention that although has high efficacy actually has unintended consequences and is therefore ineffective.

This does not mean that an AIA should not raise a Safety Recommendation just because they know it will take time and be costly to implement and therefore likely to be rejected by the industry. Especially if the intervention is known to have high efficacy and high effectiveness. These markers by the AIA help to promote the actions needed to address the safety issue rather than using short term ineffective solutions. Also, subsequent incidents will add data to that will eventually strengthen the argument for an effective intervention.

To assess if actions are effective in addressing the intended safety issues it is difficult to directly measure this but monitoring of actions to Safety Recommendations as required by Annex 13 6.12 goes someway to providing some means of showing progress towards addressing the safety issue and achieving the goal of prevention.

There is no consistency in the assessing of responses or monitoring by States around the world and each apply different assessment criteria to responses and actions to Safety Recommendations which does cause confusion.

Safety Recommendations and the actions taken (or lack of action) by addressees can be important data to feed into State Safety Plans this includes all those up to the GASP. Hence the importance of monitoring the actions being taken to Safety Recommendations and the use of safety data.

Bibliography

1. Air Accidents Investigation Branch, AAIB Bulletin 4/99, Ref EW/C98/11/8 (1999), Accident to BAC One Eleven 501EX, G-AWYR, 21 November 1997 at 1037 hrs - GOV.UK (www.gov.uk)
2. Air Accidents Investigation Branch, AAIB Bulletin 7/2002, Ref EW/C2000/10/3 (2002), Accident to Boeing 757-300, 4X-BAU, 3 October 2000 - GOV.UK (www.gov.uk)

3. Air Accidents Investigation Branch, AAR 8/1988, Ref EW/c929, (1988), Accident to Boeing 737-236 Series 1, G-BGJL at Manchester International Airport on 22 August 1985
4. Air Accidents Investigation Branch, AAR 2/2018, Ref EW/C2017/07/02 (2017), Report on the serious incident to Boeing 737-86J, C-FWGH Belfast International Airport on 21 July 2017
5. Air Accidents Investigation Branch, AAIB Bulletin 11/2022, Ref AAIB-27895 (2022), Report on the serious incident to Boeing 737-800, G-JZHL Kuusamo Airport, Finland on 1 Dec 2021
6. Doran, G. T. (1981). There's a S.M.A.R.T. Way to Write Managements' Goals and Objectives. Management Review, 70, 35-36.
7. European Union Aviation Safety Agency, EASA Safety Publications Tool (europa.eu) 2016-02R1 : Use of Erroneous Parameters at Take-off
8. Fenning N, Boath M, Impact evaluation of the Control of Major Accident Hazards (COMAH) Regulations 1999, Health and Safety Executive research report 343 (2006) https://www.hse.gov.uk/research/rrpdf/rr343.pdf
9. Gregson M, What makes a good safety recommendation in the aviation industry? (2017), ISASI Kapustin Scholarship Entry - Maria Gregson.pdf
10. Hopkins, A. Issues in safety science. Safety Science (2013), http://dx.doi.org/10.1016/j.ssci.2013.01.007
11. International Civil Aviation Organization [ICAO]. (2016). Annex 19 to the Convention of International Civil Aviation – Aircraft accident and incident investigation (2nd ed.).
12. International Civil Aviation Organization [ICAO]. (2020). Annex 13 to the Convention of International Civil Aviation – Aircraft accident and incident investigation (12th ed.).
13. International Civil Aviation Organization [ICAO]. (2020). Manual of aircraft accident and incident investigation – Part IV, Reporting (Doc 9756, 3rd ed.)
14. Jakko van Kampen, Marre Lammers, Wouter Steijn, Frank Guldenmund, Jop Groeneweg, What works in safety. The use and perceived effectiveness of 48 safety interventions, Safety Science 162 (2023) pg 2 - 7
15. Nancy Wolff & Wendy ogorzelski, Measuring the Effectiveness of Mental Health Courts: Challenges and Recommendations, 11 Psychol. PUB. POL'y & L. 539 (2005).
16. *National Academies of Sciences, Engineering, and Medicine. 1997. Fire Suppression Substitutes and Alternatives to Halon for U.S. Navy Applications. Washington, DC: The National Academies Press. https://doi.org/10.17226/5744.*
17. National Institute of Standards and Technology, US Department of Commerce Technology Administration (1993), Water mist fire suppression workshop, March 1-2, 1993, proceedings
18. National Transportation Safety Board, NTSB/AAR-10/02 (2010), Runway Overrun During Rejected Takeoff Global Exec Aviation Bombardier Learjet 60, N999LJ Columbia, South Carolina September 19, 2008

19. Transport Safety Board Canada, Aviation Investigation report A05H0002, Runway overrun and fire, Air France, Airbus A340-313, F-GLZQ, Toronto/Lester B Pearson International Airport, Ontrario, 2 Aug 2005.
20. What you find is not always what you fix—How other aspects than causes of accidents decide recommendations for remedial actions, Jonas Lundberga, Carl Rollenhagenb, Erik Hollnagel, Accident Analysis and Prevention 42 (2010), pg 2132 - 2139

Appendix I

The ICAO Manual of Air Accident Investigation Part 4 Reporting provides detailed guidance on the drafting of Safety Recommendations and provides that :

"A good recommendation is one that is written in a way that clearly states:

— The deficiency (underlying factor and residual risk);

— The action required to mitigate the risk (or to make the risk tolerable); and

— The expected result of action being taken"

With a corollary that a weak recommendation is one that has these characteristics:

"a)The action addressee is not identified:

b) Too many action addressees:

c) The action addressee does not have the mandate to mitigate the identified deficiency:

d) The addressee is not the one that can correct the deficiency on a systemic level:

e) The factual information is incorrect or inappropriately skewed:

f) The logic linking facts, analysis and conclusions is flawed:

g) The risk or consequences are exaggerated:

h) The recommendation is not based on a finding or a cause/contributing factor:

i) The recommendation is too specific:

j) The recommendation is too broad:

k) The recommended action is not achievable:

l) The performance expectations of the recommendation are unclear:

m) Too many recommendations in a report:

n) Recommendations made on low-risk issues:

o) A recommendation based on a single, local event:

p) The recommendation is not clearly identified as such"

Appendix II

The UK AAIB provides a checklist for assessing whether the Safety Recommendation that has been proposed by the IIC is suitable and asks the following questions:

- *Does the SR identify the authority/organisation best able to take action to mitigate the deficiency upon which the recommendation is based?*
- *Does the report contain validated information and analysis concerning the immediate circumstances that led to the event and the adverse consequences?*
- *Does the report identify the safety deficiencies underlying the adverse consequences?*
- *Does the report contain information regarding the probability of a recurrence and adverse consequences of a recurrence?*
- *Does the report include information on the magnitude of the existing risk, including inadequacies of existing defences?*
- *Does the report contain information on the extent to which people/equipment will continue to be exposed to the risk of no action is taken?*
- *Is there a clear proposal to the responsible authority/organisation as to what action to take?*