Standardized Measures of Safety: Finding Global Common Ground for Safety Metrics

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Abstract

In an interconnected global industry like aviation, commonality of an organization's safety language and its performance measurements are critical. Entire air transportation systems are forming in countries that will soon compete in a rapidly changing and competitive multinational aviation marketplace. This growth also poses a risk to the tremendous safety record currently enjoyed in aviation around the world. As global outsourcing and supply chains in aviation become the norm, it has become evident that safety goals and standards, even when mandated and accepted by regulatory agencies around the world, can vary widely company to company and internationally, culture to culture. Standardized measures of what is safe performance and who should perform certain risk management activities are still being grappled with throughout the industry. One avenue for standardizing measures of organizational safety performance is being investigated in Purdue University's Department of Aviation Technology. Targeting aviation operators of flight and technical maintenance services, researchers are pursuing the difficult task of identifying and evaluating outcomes-based assessments of an organization's safety and risk readiness. This paper discusses initial steps and preliminary research on this difficult road to development, and the pursuit of performance based safety metrics in aviation.

Introduction

Research and hard experience have shown that common language, measures, and rapid communication of key safety data play a pivotal role in safety. An organization depends upon both human and capital resources being interconnected and utilized as a defensive network to combat hazards and their risks. A holistic systems approach to managing safety is required for dynamic, high risk environments like aviation. This view of safety has given rise to the concept of safety management systems (SMS). The International Civil Aviation Organization (ICAO), a global aviation standards setting body, describes SMS as "an organized approach to managing safety including organizational structures…policies and procedures" [1] and is an approach that can be compared to most other common business practices.

The concept of safety is rapidly becoming a key organizational element in aviation business processes. Safety can no longer be considered a secondary component relegated to the role of a safety coordinator or isolated safety department, as it once was. New air transportation systems and market economies have emerged as competitive world players in aviation, impacting all facets of the industry from global supply chains to air carriers to third-party

maintenance. Few aviation organizations operate exclusive of partnerships and other aviation entities interconnecting them with the larger air transportation system. Therefore, what affects one organization in safety can cause a chain reaction affecting all. The aviation community must find new ways to identify and manage the challenge of maintaining safety in the midst of growth, interconnectivity, and change.

A Global Effort

Based on a systematic, businesslike approach to managing safety, the concept of an organized, proactive safety approach has been adopted by global regulatory and standards setting bodies into requirements for air operators in not only flight and maintenance operations but across the whole of the organization [2, 3, 4]. Countries who wish to participate and compete internationally in aviation must incorporate SMS principles into the operation to meet emerging safety requirements now recognized on an international scale.

Despite economic and political differences, safety is a common factor affecting all participants in air transportation. While safety is almost universally understood as the logical and morally right thing to do, the current growth of aviation demands a new approach in the way hazards and associated risk levels are identified, analyzed, and mitigated. To meet the demands of growing air transportation systems that will overlap and must accommodate each other within the next 10 to 20 years, more harmonized standards and measures used in the management of safety are being called for [5], as well as sharing of key safety performance data that can benefit all parties involved.

As more experience is gained implementing SMS, the aviation community is already seeing the need to find new ways to harmonize key concepts of safety, risk, and communication of critical information, if it is to meet the challenges and requirements of safe, seamless operation around the globe in the 21st century. This is reflected in the U.S. structure of the Next Generation Air Transportation System (NGATS), where premier objectives for safety management include maintaining aviation's record as the safest mode of transportation, improving the level of safety of the U.S. air transportation system, and increasing the safety of worldwide air transportation [5]. Additionally, in its safety roadmap, ICAO lays out 12 areas for global member states to address to maintain safety of the entire aviation system, from local operators to the government level [6]. This is a difficult task. As noted by the FAA, the "low hanging fruit" for safety improvements worldwide is essentially gone [7], and the new challenge of making SMS a proactive, global tool is upon us.

Performance Based Safety Metrics

To be effective, SMS must incorporate shared learning, common measurements, and critical data to identify and compare risks across a growing global, technology-based aviation landscape. The basic components of an SMS are already established. An example of SMS common elements used by Transport Canada [4] and encompassing those of the FAA and ICAO, as well, are listed below. They represent a generally accepted framework for an SMS:

- Safety plan with management commitment
- Documentation management

- Risk monitoring
- Education and training
- Safety assurance (quality management on safety)
- Emergency response plan

There is a risk that organizations will simply develop the system and related audits to ensure the components are in place. However, mere compliance does not necessarily mean that an organization is safe or that its SMS is functioning effectively. A successful SMS must include evidence of active use (performance) of the system's assessment and risk tools.

The question is how does one measure this? One way is to measure an SMS's ability to help return a process back to a state of control within safety limits when hazards are identified or an excursion in the process has been detected. Termed "performance based" measures of safety by the FAA [4], the goal is to identify SMS capabilities and effectiveness through demonstrated organizational and individual behaviors.

In May 2008, preliminary research was conducted to evaluate the progress and characteristics of an established SMS at two international air carriers in the growing Asian air transportation market. The goal was to gather data of the structure and general performance of air carriers who had begun implementation of SMS within the previous 18–24 months, where regular use of an SMS would most likely be underway. Researchers wanted to evaluate the feasibility of determining safety outcomes behavior outside of the U.S. air transportation system, where English was more than likely a second language among a majority of the workforce. It was hypothesized that behaviors and system tools related to SMS performance could be identified regardless of language or cultural differences. To protect the identity of the two organizations, who compete internationally on the open market, they will be referred to as "Airline A" and "Airline B" in this report.

Both air carriers operated scheduled passenger service within the Asian market, as well as internationally to Australia and the United States, which equated to operations in the United States falling under Part 121 Federal Aviation Regulations. Both air carriers were considered large, each with more than 7,000 employees and flying international routes. Both had begun SMS implementation within the preceding two to three years.

Method

A list of three general questions was prepared to generate open discussion with each air carrier regarding the construction and use of their current SMS, followed by direct observations of the operation. The questions were, as follows:

- What existing safety processes or programs do you currently use?

- Have you developed new programs since implementation of SMS?

- What process do employees and managers follow to report hazards?

Both air carriers began by giving overview presentations concerning the structure and depth of their safety management systems. High ranking members of the airline administration, safety department supervisors, and front line employees were present, ensuring the thoroughness and accuracy of the shared information.

Two different approaches taken by each air carrier's respective safety management systems were discovered, as well as the access and use of risk mitigating tools by front line employees. While results could not be compared evenly due to time and resource access restrictions (a maintenance operation SMS was observed at one airline and flight operations SMS at the other), the initial data gathered is considered valuable, providing insight into the cultural aspect of SMS structure at two organizations with functioning safety management systems containing similar core components. The following is a description of the initial observed condition and characteristics of the SMS and employee risk tools. It should be noted that these observations represent initial impressions and observations, and require more in-depth evaluation.

Airline A – SMS Architecture

This airline had multiple levels of accountability and responsibility for their safety management system. The accountability and safety reporting structure is shown in Figure 1.

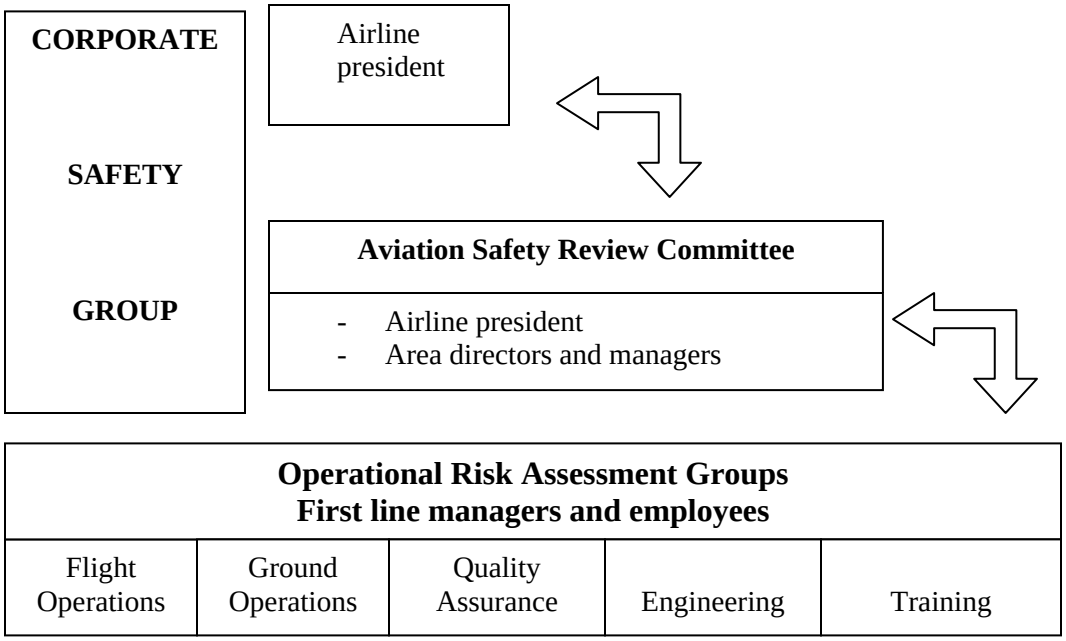

Figure 1: Airline A - Safety Accountability and Reporting Structure

It was interesting to note that during development of their SMS, this airline benchmarked several other air carrier safety systems and adapted an existing safety structure from another major air carrier in the Pacific region to their own operation.

From the top down, the SMS architecture and function at this airline was as follows. The president of the company chaired a quarterly meeting with the highest level of the safety structure to hear information concerning current events, check data for trends, identify systemic problems, and ensure accountability of the lower levels of the organizational structure. Below the top most level of the safety organization there were multiple working groups for aviation safety, cabin safety, maintenance, cargo, and ramp safety. Each of these groups was designed to address identified problems within their respective areas, and each of these working groups had their own written safety plan that was inclusive of the airline's top safety documents.

This structure allowed for the individuality and flexibility of a safety system tailored to each department and the flexibility to place an emphasis on the areas of the highest concern, while remaining underneath the umbrella of the higher levels. Each division utilized their own risk analysis and management tools that fit the needs of their particular area. However, to stay connected with each other, they met on a monthly basis to discuss issues they were currently addressing. A technical review board consisting of individuals from each division of the safety department and individuals from the front lines of the operational staff met, as necessary, to diagnose any situation involving human error.

From the start of the meeting, it was apparent that there was a significant level of organization consisting of committees, working groups, and dedicated staff. But the question that needed to be addressed was, "Did this transfer to observable safe practices on the shop floor and flight line?"

Key efforts to facilitate the access and utilization of risk identification tools were observed. Reporting forms were readily accessible, notification boards were on the job site, and appropriate usage of personal protective equipment was apparent throughout the operation. When asked, employees displayed awareness of the appropriate procedures in the event that a hazard was identified. Of particular interest was the active use of job task hazard notification boards in use on the work floor. This system used flashing lights, which could be activated whenever an employee felt a specific job task presented a hazard. In cases where an immediate hazard to life or the aircraft existed, another separate light could be activated that would shut down the maintenance operation until the hazard was managed. In either instance, a front line supervisor would immediately follow up using a standardized event root cause investigation form. Even in instances where departments interconnected, there appeared to be general knowledge of initial mitigation steps to be taken to ensure the highest level of safety alerting.

Airline B—SMS Architecture

The organizational structure of Airline B was similar to Airline A, in that the CEO chaired a safety promotion committee at the highest level and there were safety divisions set up for aviation security, ground safety, maintenance, cabin safety, flight safety, and quality assurance. The airline made a concerted effort ensuring employees had knowledge on SMS. They used a CD training format to educate individuals on the basic components and the management needs of an SMS. The difference between the two airlines became apparent

when the process for risk assessment was demonstrated specific to flight operations. Unstable approaches, flight operational quality assurance (FOQA), Go-Around on approaches, training failures, irregular events, and line oriented safety audits were the main emphasis areas within Airline B's flight safety department. However, it appeared that the control and execution of risk assessment stopped at higher levels of the organizational structure, and the top safety administrators emphasized the necessity to establish goals for acceptable errors.

There was significant emphasis for accountability of the front line workers (pilots) within the flight safety department. However, there appeared to be little inclusion of line personnel when performing actual risk evaluation processes; much of the evaluation and go/no-go decision making for front line personnel was made by the operations planning center. This mindset made it difficult for lower level employees to engage or make input when assessing risk. A question this raised for the researchers was, "Could this create a higher potential for front line employees to reject, rather than embrace, the goals of the safety management system when the system did not appear to readily allow for input and observations from them?"

Despite the comparatively low direct employee involvement and the potential for employee disconnects observed, it was apparent that the company invested significant resources towards their safety management system. They had created, tested, and implemented in-depth tools for risk management, which was demonstrated in one flight risk assessment program used by the flight operations department.

Discussion

Airline A, as described here, appeared overall to have an SMS in place that allowed for a greater vertical range of employee use and inputs, along with more notable front line employee involvement. Explicit use of risk tools (such as the employee hazard alerting board in use at each maintenance bay) seemed to indicate more direct employee engagement in the safety process. Hazard and risk assessment follow up were more readily apparent and were farther reaching when described. By comparison, Airline B, while possessing tools for hazard and risk assessment, had fewer opportunities for front line employee direct input and access into these assessments.

It was interesting to note that the corporate culture at Airline A allowed for more consultative input from middle managers, lower managers, and employees, while also displaying the most explicit use of front line hazard and risk tools. By comparison, Airline B had a much more rigid and traditional command and control management structure and style of management. Risk inputs for flight crews were made within the flight operations center with little or no input of risk conditions from flight crews themselves. Although the risk assessment tool used was functional and capable of taking logical inputs, it was questioned if important inputs for assessing flight operation risks may be missed due to tighter control of the front line workforce activities. Despite these differences, Airline B has been recognized for its outstanding safety record.

Both airlines had senior management commitment, documentation management, risk assessment tools, training and education efforts, quality assurance programs for safety, and emergency response plans. The basic components of an SMS were present, but the key question was, "Did both airlines have a successful safety management system?" At this point, it was difficult to make this determination. Without a consistent standard for assessing safety management systems, it often falls to the experience of auditors overseeing the airlines to determine whether or not the minimum levels of compliance equating to safe operations have been established. Regulators themselves continue to struggle with the metrics needed to ensure compliance.

With the variety of ways to establish a safety management system, it is imperative that the system structure be easily understood, easily measured, and consistently applied across organizations. However, given the performance based approach described here, Airline A seemed to have the most explicit employee involvement, along with a management culture that had characteristics of being more open to front line worker inputs for tool construction, as well as participation. This was evidenced by the active use of risk tools by front line employees and supervisors observed, along with the direct comments from the senior airline officials stating each operating area's freedom to develop methodologies that fit their particular operating area.

An example of performance based safety metrics being evaluated is taken from the SMS component area of risk monitoring listed earlier. In this case, the audit question to ask would not just be "Does the organization have a risk assessment strategy in place," but, "What is the evidence of this activity being performed?" Performance audit criteria might include the following:

- Front line personnel such as supervisors, leads, and technical personnel being trained and demonstrating fluency in basic risk assessment techniques.
- Risk review and assessments explicitly incorporated into routine daily meetings or debriefings by front line personnel.
- Risks routinely identified and evaluated in a standardized manner, using a common process (i.e., process hazard assessment. The Bow-Tie method is one example).

Another possibility would be to revamp the audit investigation tools commonly used when assessing the safety programs in an organization. To remain consistent with the previous example, common questions that could be asked to assess the risk management program within an organization during a traditional safety audit could be:

- Is there an established system to receive occurrence reports?
- How many reports have been filed?
- What is the extent of follow-up for reported events?
- What is the procedure for reporting an observed incident or occurrence? (Asked of front line personnel.)

While these questions assess the establishment of a hazard and risk assessment process, they still fall short of determining whether or not the tools being used connect with the larger system. Each of the components of a safety management system must interact with each other. More importantly, to be effective, they must have a positive effect on the culture of safety and the mindset of each employee from the shop floor, cabin area, passenger boarding gate, airplane cockpit, baggage loading dock to the boardroom and corporate headquarter offices. Rewording the previous safety audit questions to those below, it may be possible to determine the depth of acceptance of the safety management system and the willingness of the employees to embrace its concepts. To more accurately assess the safety climate, better questions might be those listed below.

- What is the elapsed time (in days) from employee indoctrination for hazard identification to their first reported observation?

- What is the vertical spread of reporting across the entire structure of the organization?
    - Mostly senior employees?
    - Mostly "floor level" employees?
    - Is it consistent with the percentage of each employee group?

- What is the breadth of types of reports?
    - Do they cover a variety of topics or consistently cover the same issues?

These questions would enable those responsible for oversight to determine not only if a sufficient structure for hazard identification exists but if a willing and participative culture exists to support the structure as well.

Both airlines evaluated in this report had the noble stated desire to establish procedures and programs ensuring the safety of their employees and the flying public. Most aviation organizations have this same goal. But the trend of open skies, growing international route structures, and global outsourcing has serious implications for the future safety structure of aviation. Industry must move beyond good intentions and even beyond establishing a functional SMS at the local organizational level. Safety metrics must be identified, and the knowledge gained locally must be shared in some form on a global scale. While excellent progress is being made in development and deployment of SMS, as evidenced by the two airlines cited here, it is clear that one cannot simply prescribe how to achieve key components of an SMS. What might work for one company in one culture may not work for another company a continent away or just across the road. Airlines A and B described here are good examples of differing approaches toward the same goal of safe, sustainable operations.

Summary

Hallmarks of safety performance begin first at the very top of an organization but are evident by actions at the front line. Both must be engaged in the system inputs and actions. The summary of the findings is that a management-driven safety culture inviting more direct front

line employee engagement in the hazard/risk management process makes behavioral observations of safety performance easier to identify. It is believed that having such a safety culture might also allow such an organization to react quicker to safety issues and realize further reaching reforms in safety. Given this, it was the researchers' discovery and a new assertion that one early key performance based measure to be developed should focus on the upper management safety management characteristics and how those characteristics facilitate employee input and involvement on the front line at the individual operator. While front line performance can be easier to see, it must be remembered that performance is driven by the tone and structure set at upper management levels.

Additionally, as the industry seeks more standardized measures of safety, it may do well to consider more standardized management approaches, which might lead to more explicit and predictable front line safety behavior and participation. This is extremely important as the aviation industry pursues more stringent levels of safety and a global safety language necessary for sustainability of aviation in the 21st century.

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Biography

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